United States
Department of
Agriculture

Forest Service

United States
Department of
the Interior

**Bureau of Land
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United States
Department of
Health and
Human Services

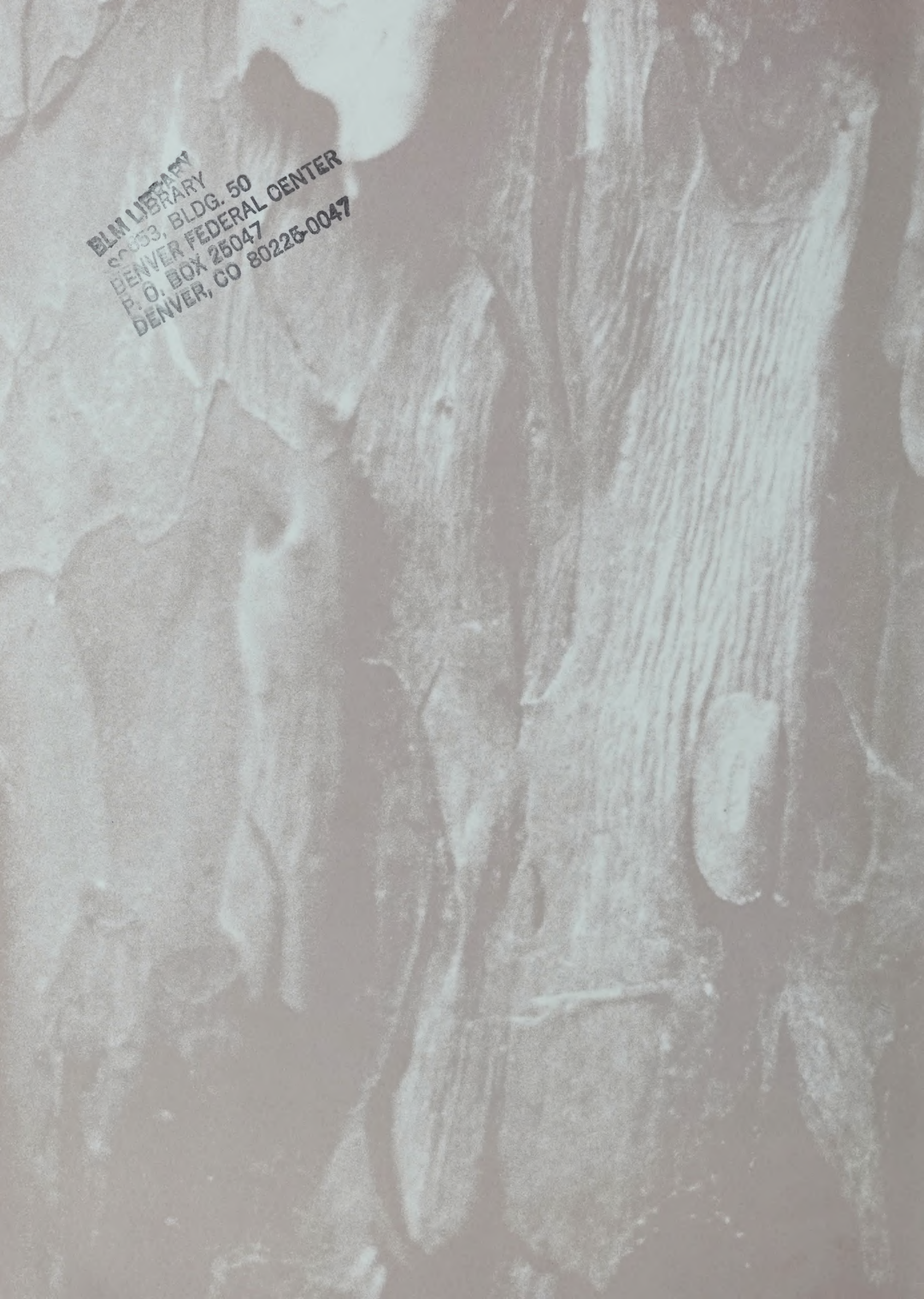
**Food and Drug
Administration**

FDA

Pacific Yew

Final Environmental Impact Statement

September, 1993



Pacific Yew

Final Environmental Impact Statement

USDA Forest Service
in Cooperation with USDI Bureau of Land Management
and USDHHS Food and Drug Administration

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Abstract

The Forest Service and the Bureau of Land Management (BLM), in compliance with the National Environmental Policy Act of 1969, is presenting seven alternative ways of managing the five-year (1993 to 1997) harvest of the Pacific yew tree (*Taxus brevifolia*) on federal lands. This harvest program is prompted by the need for taxol, a compound found in the yew tree which is an effective treatment for cancer.

Highlights of the alternatives are as follows:

A - Alternative A gives no emphasis to Pacific yew bark harvest; it emphasizes all resources according to forest plans and BLM resource management plans.

B - Alternative B emphasizes utilization of Pacific yew where it would otherwise be wasted; production of yew bark is dependent on timber harvest programs.

C - Alternative C emphasizes the highest degree of protection of Pacific yew and the ecosystem in yew harvest areas; it would produce a small amount of bark.

D - Alternative D emphasizes a high degree of protection of Pacific yew and the ecosystem in yew harvest areas while producing a moderate amount of bark.

E - Alternative E was dropped (see Chapter II).

F - Alternative F emphasizes high yew bark production with moderate protection of Pacific yew and the ecosystem in yew harvest areas.

G1 - Alternative G1 emphasizes moderate to high bark production and efficiency of bark collection with moderate protection of yew and the ecosystem in yew harvest areas.

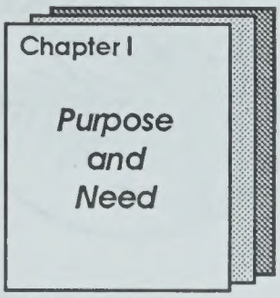
G2 - Alternative G2 emphasizes entry into owl conservation areas (as well as other areas) to provide the highest level of bark production with moderate protection of Pacific yew and the ecosystem in yew harvest areas.

Alternative A is the No Action Alternative.
Alternative B is the Forest Service and BLM preferred alternative.

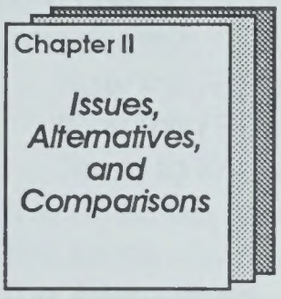
Note to Reviewers

A precedent established in court obliges reviewers participating in the National Environmental Policy Act (NEPA) process to alert the agency to their positions in a meaningful way. Also important to those concerned with the issues presented in this EIS is another legal precedent which established that environmental objections that could have been raised at the draft stage may be waived if they are not raised until after completion of the final environmental impact statement (FEIS).

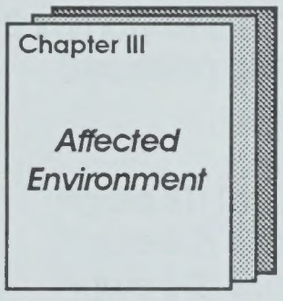
How This EIS is Organized



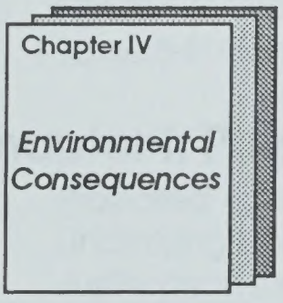
Introduces Pacific yew and the underlying need for taxol; discusses the major public issues associated with the Pacific yew, taxol, and the EIS; and discusses the relationship of the Pacific yew EIS to other documents.



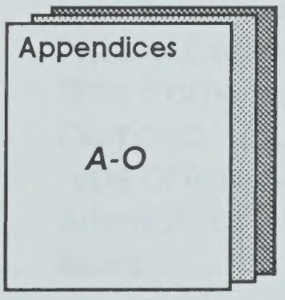
Discusses the public issues used to help evaluate the alternatives; gives an overview of the alternatives; presents the Pacific yew harvest Mitigation Measures; and summarizes how the alternatives respond to the issues.



Addresses the affected environment. This chapter is divided into three parts: Part One--The Pacific yew, Part Two--The Forest, and Part Three--The Yew and People.



Provides the analysis used for comparison of the alternatives; and discusses the environmental consequences of the alternatives. This Chapter is divided in the same manner as Chapter III.



Additional supporting and background information is presented in Appendices A-O.

Pacific Yew FEIS

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Summary

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Summary

Pacific Yew Final Environmental Impact Statement

In the Final Environmental Impact Statement (FEIS) we, the interdisciplinary team, analyze the choices for a proposed five-year (1993-1997) program to harvest Pacific yew *(Taxus brevifolia),* a source of taxol. Yew harvest is proposed on National Forest System lands and Bureau of Land Management lands in Oregon, Washington, Idaho, Montana, and California. For the native range of the Pacific yew see Figure S-1.

In this summary, we highlight the major points of the FEIS. We discuss the purpose and need for an analysis, the areas that would be affected by yew harvest, the issues surrounding the choices, and the alternatives. We also summarize the analysis of the effects of implementing the alternatives. We look at the effects on Pacific yew biology and range; the forest ecosystems yew is a part of; and the socioeconomic implications of harvesting yew for taxol production.

How this FEIS is organized

Environmental Impact Statements are organized in several sections, and it is sometimes confusing and difficult to follow the issues or to find out about the particular topics that are of most interest to you. In order to help you find your way, this is how the document is organized:

- Chapter I discusses the purpose and need of the proposed action.
- Chapter II describes the proposed alternatives or choices. We compare the choices and the consequences of implementing them (based on the analysis in Chapter IV).
- Chapter III describes the ecological, social, and economic aspects of the affected area. This chapter is divided into three sections: The Pacific Yew; The Forest; and The Yew and People.
- Chapter IV describes the consequences of implementing the alternatives proposed in Chapter II. We analyze the possible ways the environment could be affected. This is a prediction based on available information and our analysis; we consider what might happen in the near future and long-term.

The following Appendices are also a part of the document:

- Appendix A Public Involvement
- Appendix B Monitoring
- Appendix C Analysis Process for Port-Orford-Cedar
- Appendix D Land Ownerships
- Appendix E Bristol-Myers Squibb and Federal Government Agreements
- Appendix F Pacific Yew Inventories
- Appendix G Insects and Diseases of Pacific Yew
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- Appendix I Soils
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- Appendix L Cultural History of Pacific Yew
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- Appendix N Pacific Yew Act
- Appendix O Annotated Bibliography

Why This FEIS? — Purpose and Need

The Forest Service, the Bureau of Land Management, and the Food and Drug Administration (the three agencies cooperating to prepare this EIS) propose to harvest, over the next five years, Pacific yew on lands administered by the BLM and on National Forest System lands.

The underlying need is for an immediate supply of Pacific yew, from which taxol can be extracted for cancer research and treatment. Taxol, a compound found in all parts of Pacific yew, is among the most effective drugs currently available for treating ovarian and other types of cancer. Extraction of taxol from the bark of the Pacific yew is currently the only FDA-approved process for taxol production.

In the FEIS, we weigh the effects of various yew harvest alternatives on Pacific yew, the ecosystem, and the communities located within the native range of the Pacific yew. The Forest Service Regional Forester for the Pacific Northwest Region and the Oregon State Director of the Bureau of Land Management (BLM) used the analysis of effects in this FEIS to select a yew harvest alternative. Their decisions and rationale are documented in a joint Record of Decision which is published and distributed along with this FEIS.

The following are definitions of a few terms used throughout this summary:

Terms to Know

Timber Sale Unit— *an area within a timber sale that has a silvicultural prescription for a (1) clearcut, (2) shelterwood, or (3) seed tree harvest. It also can be an area where Pacific yew would otherwise be destroyed by road building or other construction, prescribed fire, or similar activities.*

Partial-cut Sale Unit— *an area within a timber sale that has a silvicultural prescription to cut only part of a stand. Techniques that involve "partial cutting" include thinning, salvage operations, and prescriptions designed to produce an uneven-aged stand of trees.*

Non-sale Area— *an area in a national forest or BLM district where no timber sales, as described above, are scheduled in the next five years, but where yew harvest is allowed according to land use plans.*

Old Growth— *A forest composed of many large trees, snags, and numerous down logs with a multilayered canopy composed of several tree species, usually the final or a transitional stage of forest stand development.*

"Owl Conservation Areas"— *those areas formally designated for protection of the northern spotted owl. They provide a contiguous block of habitat to be managed and conserved for spotted owls. The blocks are placed so as to be well distributed throughout the range of the owl and spaced closely enough to facilitate dispersal of owls among them. We are using "owl conservation areas" (OCAs) to include Forest Service Habitat Areas (HCAs), and BLM Old-Growth Emphasis Areas (OGEAs), Designated Conservation Areas (DCAs), Reserved Pair Areas, Managed Pair Areas, Residual Habitat Areas, Protected Habitat Areas (PHAs), and Protected Habitat Area Buffers (PHABs) as described in the BLM's draft resource management plans.*

Set-aside Areas— *for this EIS, these are defined as lands where timber harvest is precluded by other resource management objectives.*

The Affected Area

In the FEIS we cover a large portion of the native range of the Pacific yew (see Figure S-1).

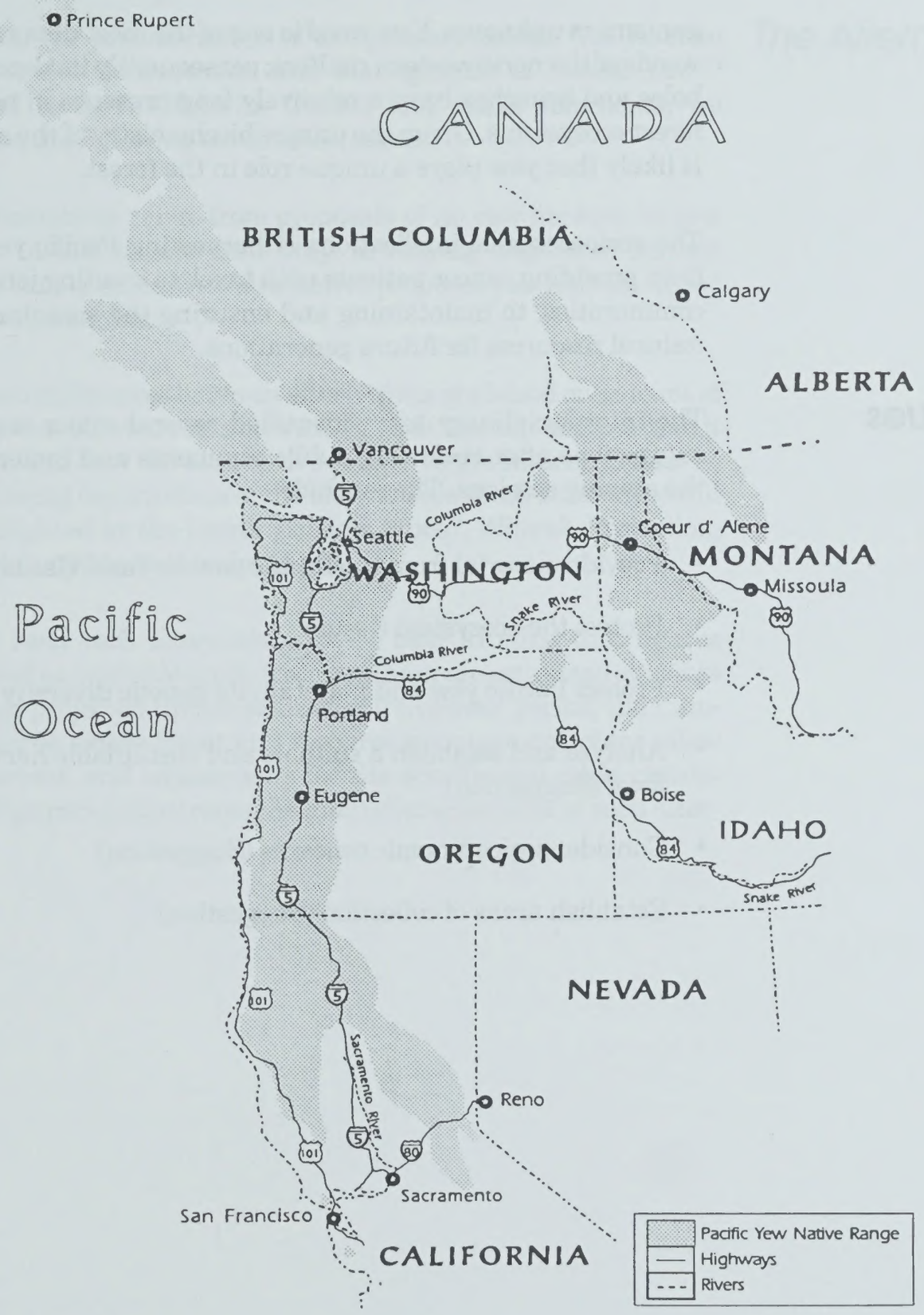
The Pacific yew tree and shrub is unique to northwestern forests. Although important to Native Americans and a small contingency of woodworkers, it has been overlooked by modern society. Recently, taxol, a chemical substance extracted from yew, dramatically enhanced its visibility and value. Taxol is considered the most promising cancer fighting compound discovered in recent years.

Pacific yew grows in forests from the southern tip of southeast Alaska to central California, and as far inland as western Montana and the Kamloops and Kootenai Districts of British Columbia. Yew is relatively uncommon in the coast ranges of Washington, Oregon, and Northern California, with only scattered distribution. Yew is primarily found in riparian areas or lower slope positions in the northern portion of the Sierra Nevada, the Blue Mountains of Northeastern Oregon, and the Klamath Mountains of Northern California. It is fairly common in low to moderate elevations within the Cascade range and in the Siskiyou Mountains. Pacific yew is unusually abundant in a few localized areas in the Northern Rocky Mountains. It forms dense, continuous shrub thickets in portions of the Flathead National Forest in Northwestern Montana. In some localized areas within the south fork of the Clearwater River basin in Idaho, yew is the predominate tree species beneath a scattered overstory.

When Pacific yew became important as a source of taxol, the Forest Service and the BLM developed procedures to inventory the species. Inventory crews worked in the field in 1991 and 1992 gathering information for a sample estimate (a complete census of yew trees would take years and be too costly). The inventory numbers are presented under each alternative as number of yew trees available, number of acres available for yew harvest, and pounds of dry bark.

Pacific yew as an ecosystem component is not well-understood. The importance of yew in cycling nutrients, modification of microclimate, maintenance of specialized mycorrhizae, and other or-

Figure S-1: The Native Range of Pacific Yew



ganisms is unknown. Yew wood is one of the most decay resistant woods of the northwestern conifers; consequently its decomposing boles and branches have a relatively long presence in northwest forest ecosystems. Given the unique biochemistry of the species, it is likely that yew plays a unique role in the forest.

The socioeconomic implications of harvesting Pacific yew range from providing cancer patients with taxol, to creating jobs in local communities, to maintaining and ensuring the sustainability of natural resources for future generations.

The Issues

The interdisciplinary team identified several major issues and suggestions after reviewing public comments and material from the scoping sessions. They include:

- Provide material from the Pacific yew for taxol (Issue)
- Protect the ecosystem (Issue)
- Protect Pacific yew and maintain its genetic diversity (Issue)
- Analyze and establish a suitable and sustainable harvest level (Suggestion)
- Consider socioeconomic concerns (Suggestion)
- Establish areas of collection (Suggestion)

The Alternatives

Based on our considerations of the primary issues, "An Interim Guide to the Conservation and Management of Pacific Yew" [1] (referred to as the Interim Guide), and public comments, we proposed the following seven alternatives.

The alternatives range from proposals of no yew harvest, to yew harvest in timber sale units only, to varying degrees of harvest outside timber sales. One alternative proposes yew harvest in owl conservation areas.

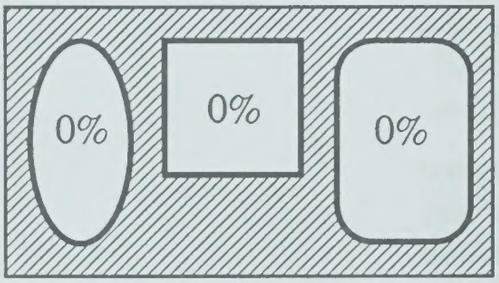
The main differences between alternatives are based on amount of yew harvested, where it is harvested, what amount of protection it is given, and how the alternative relates to the Interim Guide. In the following descriptions of the alternatives these differences will be highlighted by the headings: How Much?, Where?, Protection, and Relationship to Interim Guide.

As you read each alternative, please bear in mind that figures presented as available acres, trees, and bark are estimated amounts based on projected timber sales over a five-year period, the number of acres where forest and resource management plans allow yew harvest, and adjustments for site-specific and other restrictions. Figure S-2 illustrates the main characteristics of each alternative.

1 U.S. Department of Agriculture, Forest Service. 1992. An Interim Guide to the Conservation and Management of Pacific Yew. Pacific Northwest Region, 78 p.

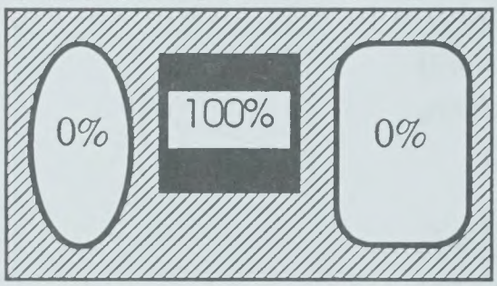
Figure S-2
Graphic Overview of the Alternatives: Alternatives A, B, and C

Alternative A



--No yew harvest for taxol production
--No protection of yew
--No yew regeneration
--No genetic reserves

Alternative B



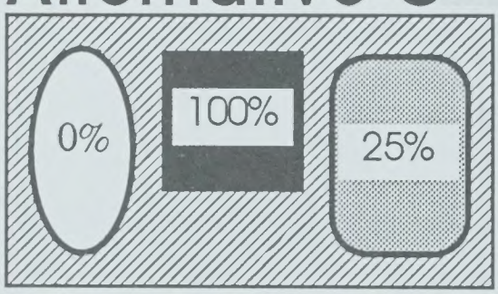
--Harvest 100% utilizable yew
--Yew regeneration and protection

--No yew harvest

--No yew harvest

--No genetic reserves
--No yew harvest near streams

Alternative C



--Harvest 100% utilizable yew

--Harvest maximum of 25% per diameter class
--Retain 75% or 5 TPA per diameter class

--No yew harvest

--No yew harvest near streams
--Yew regeneration and protection
--Genetic reserves

Key

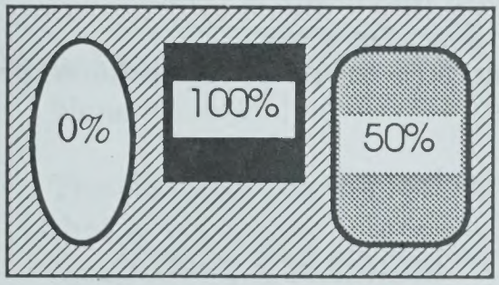
Owl Conservation Area

Timber Sale (TS) units—clearcut, shelterwood, or seedtree harvest

Partial-cut sale units such as thinning or uneven-aged cuts and non-sale areas where yew harvest is allowed in the Forest Plans and BLM Resource Management Plans

Figure S-2 (continued)
Graphic Overview of the Alternatives: Alternatives D and F

Alternative D



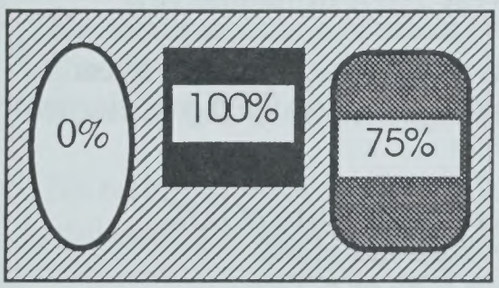
--Harvest 100% utilizable yew

--Harvest maximum of 50% per diameter class
--Retain 50% or 5 TPA per diameter class

--No yew harvest

--No yew harvest near streams
--Yew regeneration and protection
--Genetic reserves

Alternative F



--Harvest 100% utilizable yew

--Harvest maximum of 75% per diameter class
--Retain 25% or 2 TPA per diameter class

--No yew harvest

--No yew harvest near streams
--Yew regeneration and protection
--Genetic reserves

Key

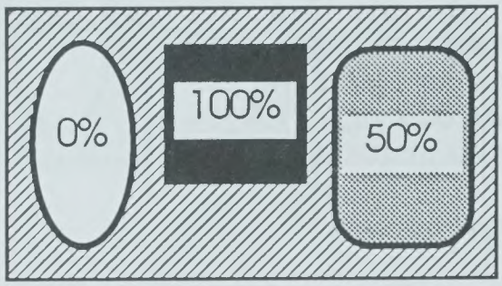
Owl Conservation Area

Timber Sale (TS) units—clearcut, shelterwood, or seedtree harvest

Partial-cut sale units such as thinning or uneven-aged cuts and non-sale areas where yew harvest is allowed in the Forest Plans and BLM Resource Management Plans

Figure S-2 (continued)
Graphic Overview of the Alternatives: Alternatives G1 and G2

Alternative G1



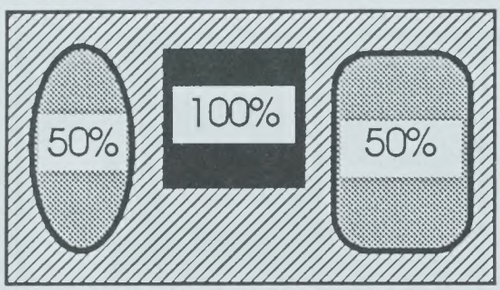
--Harvest 100% utilizable yew

--Harvest maximum of 50% per diameter class
--Retain 50% or one TPA per diameter class

--No yew harvest

--No yew harvest near streams
--Yew regeneration and protection
--Genetic reserves

Alternative G2



--Harvest 100% utilizable yew

--Harvest 50% per diameter class
--Retain 50% or one TPA per diameter class

--Harvest maximum of 50% per diameter class
--Retain 50% or 5 TPA per diameter class

--No yew harvest near streams
--Yew regeneration and protection
--Genetic reserves

Key

Owl Conservation Area

Timber Sale (TS) units—clearcut, shelterwood, or seedtree harvest

Partial-cut sale units such as thinning or uneven-aged cuts and non-sale areas where yew harvest is allowed in the Forest Plans and BLM Resource Management Plans

Alternatives

Alternative A - No Action

Alternative A gives no particular emphasis to Pacific yew harvest for taxol; it emphasizes all resources according to forest plans and BLM resource management plans.

How Much?

- None
- The National Environmental Policy Act (NEPA) requires that a "No Action" alternative be included in every Environmental Impact Statement
- Yew would be managed as it was before bark was in demand

Where?

- Not on federal lands, including owl conservation areas and designated wildernesses

Protection

- No special protection
- No requirement to retain a certain number of yew trees or shrubs per acre in any area (other than that specified in forest or resource management plans)
- No requirement to regenerate yew after any project, or to maintain the genetic diversity of Pacific yew

Relationship to Interim Guide

- No aspects of the Interim Guide would be incorporated

Alternative B Alternative B emphasizes utilization of Pacific yew where it would otherwise be wasted; production of yew from federal lands would be dependent on timber harvest programs; it provides the highest degree of protection to yew trees and the ecosystem.

How Much?

- 0.078 to 0.118 million acres over the next five years
- 0.26 to 0.39 million yew would be available for harvest
- 1.29 to 1.93 million pounds of dry bark could be produced
- 3.43 to 5.15 million pounds of dry needles could be produced

Where?

- Timber sale units only— 100 percent of utilizable-sized yew (excluding residual green tree reserves)

Protection

- No yew harvest within 75 feet on either side of perennial streams
- Some protection for yew remaining after yew harvest in timber sale units
- Regeneration of yew to preharvest or prescribed levels
- No provisions for establishing specific genetic reserves of Pacific yew
- Harvest methods would follow the Mitigation Measures for Alternative B, found at the end of Chapter II and in Appendix C in the FEIS

Relationship to Interim Guide

- Incorporates the yew harvesting guidelines for timber sale areas from the Interim Guide

Alternative C

Alternative C emphasizes a high degree of protection of Pacific yew and the ecosystem in yew harvest areas; it would produce a relatively small amount of bark.

How Much?

- 1.47 to 2.20 million acres over the next five years
- 1.51 to 2.27 million yew would be available for harvest
- 5.58 to 8.37 million pounds of dry yew bark could be produced
- 9.16 to 22.35 million pounds of dry yew needles could be produced

Where?

- In timber sale units— 100 percent of utilizable-sized yew (excluding residual green tree reserves)
- In partial-cut and non-sale areas— 25 percent

Protection

- No yew harvest within 75 feet on either side of perennial streams
- Genetic reserve areas would be established in yew harvest areas
- In partial-cut and non-sale areas, at least 75 percent of the yew or five yew trees per acre (whichever is greater) in each of three diameter classes (<11, 11-20, >20 inches) would be retained
- Yew would be regenerated to preharvest or prescribed levels in timber sale units
- Additional regeneration would not be required in partial-cut sale units and non-sale areas
- Harvest methods would follow the Mitigation Measures for Alternatives C through G2, found at the end of Chapter II and in Appendix C in the FEIS

Relationship to Interim Guide

- Most parts of the Interim Guide would be incorporated into this alternative
- Harvest levels in partial-cut and non-sale areas are lower than prescribed in the Interim Guide (50 percent in Guide, 25 percent for Alternative C)

Alternative D

Alternative D emphasizes a high degree of protection of Pacific yew and the ecosystem in yew harvest areas while producing a moderate amount of bark.

How Much?

- 1.47 to 2.20 million acres over the next five years
- 2.63 to 3.94 million yew would be available for harvest
- 9.41 to 14.12 million pounds of dry yew bark could be produced
- 14.28 to 37.69 million pounds of dry yew needles could be produced

Where?

- Timber sale units — 100 percent of utilizable-sized yew (excluding the residual green tree reserves)
- Partial-cut sale units and non-sale areas — 50 percent (Interim Guide level)

Protection

- No yew harvest within 75 feet on either side of perennial streams
- Genetic reserve areas would be established in yew harvest areas
- In partial-cut and non-sale areas, at least 50 percent of the yew or five yew trees per acre (whichever is greater) in each of three diameter classes (<11, 11-20, >20 inches) would be retained

- Yew would be regenerated to preharvest or prescribed levels in timber sale units
- Additional regeneration would not be required in partial-cut sale units and non-sale areas
- Harvest methods would follow the Mitigation Measures for Alternatives C through G2, found at the end of Chapter II and in Appendix C in the FEIS

Relationship to Interim Guide

- Alternative D would incorporate most parts of the Interim Guide.

Alternative E

Alternative E was dropped from further consideration (See Alternatives Considered but Not Carried Forward in the FEIS).

Alternative F

Alternative F emphasizes high yew bark production with moderate protection of Pacific yew and the ecosystem in yew harvest areas.

How Much?

- 1.47 to 2.20 million acres over the next five years
- 4.23 to 6.35 million yew would be available
- 15.87 to 23.81 million pounds of dry bark could be produced
- 22.90 to 63.56 million pounds of dry needles could be produced

Where?

- Timber sale units — 100 percent of utilizable-sized yew
- Partial-cut sale units and non-sale areas — 75 percent of utilizable-sized yew

Protection

- No yew harvest within 75 feet on either side of perennial streams
- Genetic reserve areas would be established in yew harvest areas
- In partial-cut and non-sale areas, at least 25 percent of the yew or two yew trees per acre (whichever is greater) in each of three diameter classes (<11, 11-20, >20 inches) would be retained
- Yew would be regenerated to preharvest or prescribed levels in timber sale units
- Additional regeneration would not be required in partial-cut sale units and non-sale areas
- Harvest methods would follow the Mitigation Measures for Alternatives C through G2, found at the end of Chapter II and in Appendix C in the FEIS

Relationship to Interim Guide

- Most parts of the Interim Guide would be incorporated
- The main difference is the level of harvest (50 percent in Guide, 75 percent in Alternative F) and
- The number of trees per acre (TPA) retained in each diameter class (five TPA in Guide, two TPA in Alternative F) in partial-cut and non-sale areas

Alternative G1 Alternative G1 emphasizes efficiency of yew sale preparation and moderate to high bark production, with moderate protection of yew and the ecosystem in yew harvest areas.

How Much?

- 1.47 to 2.20 million acres over the next five years
- 3.14 to 4.71 million yew would be available for harvest

- 15.35 to 23.02 million pounds of dry bark could be produced
- 22.20 to 61.46 million pounds of dry needles could be produced

Where?

- Timber sale units — 100 percent of utilizable-sized yew (excluding the residual green tree reserves)
- Partial-cut sale units and non-sale areas — 50 percent of the yew, with only one tree per acre per diameter class retained.

Protection

- No yew harvest within 75 feet on either side of perennial streams
- Genetic reserve areas would be established in yew harvest areas
- In partial-cut and non-sale areas, at least 50 percent of the yew or one yew tree per acre (whichever is greater) in each of three diameter classes (<11, 11-20, >20 inches) would be retained
- Yew would be regenerated to preharvest or prescribed levels in timber sale units
- Additional regeneration would not be required in partial-cut sale units and non-sale areas
- Harvest methods would follow the Mitigation Measures for Alternatives C through G2, found at the end of Chapter II and in Appendix C in the FEIS

Relationship to Interim Guide

- Much of the Interim Guide would be incorporated
- The main difference would be the number of trees per acre (TPA) retained in each diameter class in partial-cut and non-sale areas (five TPA in Guide, one TPA in Alternative G1)

Alternative G2 Alternative G2 emphasizes efficiency of yew sale preparation, as well as entry into owl conservation areas, to provide the highest level of bark production with moderate protection of Pacific yew and the ecosystem in yew harvest areas.

How Much?

- 2.31 to 3.47 million acres over the next five years
- 4.22 to 6.33 million yew would be available for harvest
- 18.89 to 28.33 million pounds of dry bark could be produced
- 26.93 to 25.63 million pounds of dry needles could be produced

Where?

- Owl conservation areas — 50 percent of the yew, with five leave trees per acre per diameter class
- Timber sale units — 100 percent of utilizable-sized yew (excluding the residual green tree reserves)
- Partial-cut sale units, non-sale areas — 50 percent of the yew, with one leave tree per acre per diameter class

Protection

- No yew harvest within 75 feet on either side of perennial streams
- Genetic reserve areas would be established in yew harvest areas
- In partial-cut and non-sale areas, at least 50 percent of the yew or one tree per acre (whichever is greater) in each of three diameter classes (<11, 11-20, >20 inches) would be retained
- In owl conservation areas, at least 50 percent of the yew or five TPA in each diameter class (whichever is greater) would be retained

- Yew would be regenerated to preharvest or prescribed levels in timber sale units
- Additional regeneration would not be required in partial-cut sale units and non-sale areas
- Harvest methods would follow the Mitigation Measures for Alternatives C through G2 and the Mitigation Measures for owl conservation areas, found at the end of Chapter II and in Appendix C in the FEIS

Relationship to Interim Guide

- Much of the Interim Guide would be incorporated into Alternative G2
- The main differences would be the number of trees left per acre in each diameter class in partial-cut and non-sale areas (five TPA in Guide, one TPA in Alternative G2) and entry into owl conservation areas for yew harvest

Summary of the Comparison of the Effects of the Alternatives

Table S-1 compares the seven alternatives based on the issues and suggestions presented to the interdisciplinary team, summarized earlier.

The table is organized with the issues and suggestions as major headings, and the resource areas listed below each relevant issue as a subheading.

A discussion of the comparison of effects between the alternatives is provided following Table S-1.

Table S-1: Comparison of the Effects Between Alternatives

MAIN ISSUES: Provide Taxol, Protect the Ecosystem and the Yew	ALTERNATIVES						
	A (No Action)	B (Preferred) Timber Sales Only	C 25%, 5 TPA	D 50%, 5 TPA	F 75%, 2 TPA	G1 50% 1 TPA	G2 50%, 1 TPA, OCAs
a. Landscape Patterns							
--probability of reducing yew population connectivity	low risk	low risk	low risk	low risk	moderate risk	moderate risk	moderate risk
--probability of reducing the range of yew	low risk	low risk	low risk	low risk	low risk	low risk	low risk
b. Biology of Yew							
--seed production	moderate reduction	minor reduction	minor reduction	minor reduction	minor to moderate reduction	minor to moderate reduction	minor to moderate reduction
--vegetative reproduction	moderate reduction	minor reduction	minor reduction	minor reduction	minor reduction	minor reduction	minor reduction
--needle regeneration	not applicable	not applicable	no effect	no effect	minor impact	minor impact	minor impact
--planting	no planting	planting if needed	planting if needed	planting if needed	planting if needed	planting if needed	planting if needed
c. Genetics of Yew							
--change in overall genetic variation (based on before and after harvest; probability of losing rare alleles)	minor reduction	none	none	minor reduction	moderate reduction	minor reduction	minor reduction
--effects on heterozygosity of next generation (future breeding, education and aesthetic values)	minor	none	minor	minor	high	moderate	moderate
--effects on genetic erosion at edges	continued erosion	none	reduced (positive change)	reduced (positive change)	reduced (positive change)	reduced (positive change)	reduced (positive change)
d. Insects and Diseases							
--change in incidence of pests on Pacific yew	no change	minor increase	minor increase	minor increase	minor increase	minor increase	minor increase
--Port-Orford-cedar root disease impact on yew	no impact	minor impact	minor impact	minor impact	minor impact	minor impact	minor impact
e. Fire							
--risk of increased fire occurrence	minor	minor	*minor	*minor	*minor to moderate	*minor to moderate	*minor to moderate
			<-----*(depends on yew density and harvest percentage)------>				
--impact of yew harvest on yew survival and regeneration following fire	moderate to high decrease	minor decrease	*minor decrease	*minor decrease	*minor to moderate decrease	*minor to moderate decrease	*minor to moderate decrease
			<-----*(depends on yew density and harvest percentage)------>				

Table S-1: Comparison of the Effects Between Alternatives (continued)

MAIN ISSUES: *Provide Taxol, Protect the Ecosystem Protect Yew (continued)*	ALTERNATIVES						
	A (No Action)	B (Preferred) Timber Sales Only	C 25%, 5 TPA	D 50%, 5 TPA	F 75%, 2 TPA	G1 50%, 1 TPA	G2 50%, 1 TPA, OCAs
f. Ecosystem --potential for negative impact on ecosystem structure and function	low risk	low risk	low risk	low to moderate risk	high risk	moderate risk	moderate risk
g. Biodiversity --loss of diversity	some loss of diversity	little or no loss	little or no loss	little or no loss	little or no loss	little or no loss	little or no loss
h. Soils --potential for impact on soils (1 = least; 6 = most)	no impact	1	2	3	4	5	6
i. Water and Aquatic Habitat --impact on resource	no impact	no impact	negligible to minor	negligible to minor	negligible to minor	negligible to minor	negligible to minor
j. Wildlife --composite risk to wildlife in late successional forests	minor	minor	minor	minor	high	moderate	moderate
--composite risk to wildlife in early successional forests	minor	minor	minor	minor	minor	minor	minor
--composite risk to wildlife in riparian areas	none	none	none to minor	none to minor	none to minor	none to minor	none to minor
k. Threatened and Endangered Species --potential for impacts to T&Es	minor	minor	minor	moderate	moderate to high	moderate	moderate
l. Northern Spotted Owl --potential for impacts on prey species	minor	minor	minor	minor	moderate	minor	moderate to high
--potential for impacts on roosting habitat	none	none	moderate	moderate	high	moderate	moderate to high
m. Forest Health --impact to forest health	minor	*minor	*minor	*minor	*minor	*minor	*minor
	*(increased impact on forest health with amount of yew harvested)						

Table S-1: Comparison of the Effects Between Alternatives (continued)

SUGGESTION: Establish Sustainable Collection Level	ALTERNATIVES						
	A (No Action)	B (Preferred) Timber Sales Only	C 25%, 5 TPA	D 50%, 5 TPA	F 75%, 2 TPA	G1 50% 1 TPA	G2 50% 1 TPA, OCAs
a. Number of Available Trees	0	0.26-0.39 MM	1.51-2.27 MM	2.63-3.94 MM	4.23-6.35 MM	3.14-4.71 MM	4.22-6.33 MM
b. Sustained Yield	<----------All alternatives meet sustained yield.---------->						
c. Available Bark from Federal Lands Over Five Years (in lbs.)	0	1.29-1.93 MM	5.58-8.37 MM	9.41-14.12 MM	15.87-23.81 MM	15.35-23.02 MM	18.89-28.33 MM
SUGGESTION: Consider Socioeconomic Concerns							
a. Public Health and Safety							
--bark availability in pounds from federal lands per year	0	.3-.4 MM	1.1-1.7 MM	1.9-2.8 MM	3.2-4.8 MM	3.2-4.6 MM	3.8-5.7 MM
--taxol available for clinical trials, per year, in kilograms, based on bark from federal lands (15,000 lbs. bark= 1 kilogram)	0	17.3-26.0 kilos	73.3-113.3 kilos	126.6-186.7 kilos	213.3-320.0 kilos	213.3-306.7 kilos	253.3-380.0 kilos
--potential patients treated per year, based on bark from federal lands (assuming 1 kilogram treats 480 patients)	0	8,300-12,400	35,184-54,384	60,768-89,616	102,384-153,600	102,384-147,216	121,584-182,400
--injuries to forest workers	none	0-5	0-10	0-15	0-25	0-25	0-30
b. Social Setting-- Groups Affected	*Jobs-Related*						
--bark harvester jobs (seasonal)	no job creation	75-113	347-521	566-849	937-1,406	909-1,363	1,113-1,669
--traditional woodworkers and yew log purchasers	no effect	<----------minor effect---------->					
	Recreationists						
--hikers, campers, hunters	no effect	<----------minor effect---------->					
	Native Americans						
--ceremonial, cultural, traditional use of wood	Effects on uses would be minor. Spiritual and medicinal value effects must be assessed after local consultation.						
c. Women and Other Minorities	slight negative	<----------positive if demand met---------->					

MM=millions
M=thousands

Table S-1: Comparison of the Effects Between Alternatives (continued)

SUGGESTION: Consider Socioeconomic Concerns (continued)	ALTERNATIVES						
	A (No Action)	B (Preferred) Timber Sales Only	C 25%, 5 TPA	D 50%, 5 TPA	F 75%, 2 TPA	G1 50%, 1 TPA	G2 50%, 1 TPA, OCAs
d. Social Setting -- Geographic Areas Affected							
--areas where yew is processed	no effect	*small benefit	*small benefit	*small benefit	*small benefit	*small benefit	*small benefit
	<----------*(some jobs created spread throughout a five-state area; positive community feelings associated with beneficial activity)---------->						
--areas where yew is not processed	no effect	no effect	no effect	no effect	no effect	no effect	no effect
e. Economics (average annual)							
--government expenditures associated with bark harvest	$0	$0.3 MM	$5.9 MM	$5.9 MM	$5.9 MM	$2.9 MM	$4.6 MM
--stumpage values of other commercial species	no effect	possible decrease	possible decrease	possible decrease	possible decrease	possible decrease	possible decrease
--potential receipts to government	none	$0.1-0.2 MM	$0.3-0.7 MM	$0.6-1.1 MM	$1.0-1.9 MM	$0.9-1.8 MM	$1.1-2.3 MM
--potential returns to counties	none	<$0.1 MM	$0.1-0.2 MM	$0.1-0.3 MM	$0.2-0.5 MM	$0.2-0.4 MM	$0.3-0.4 MM
SUGGESTION: Establish Areas of Collection							
a. Types of Areas							
--owl conservation areas	no	no	no	no	no	no	yes
--wilderness	no	no	no	no	no	no	no
--research natural areas	no	no	no	no	no	no	no
--riparian areas	no	no	no	no	no	no	no
--other special mgmt. areas (i.e. old growth, national recreation areas)	<---------- According to Forest and District Plans ---------->						
--timber sale units	no	yes	yes	yes	yes	yes	yes
--partial cut sale units	no	no	yes	yes	yes	yes	yes
--non-sale area	no	no	yes	yes	yes	yes	yes
--unique rock and special areas	<---------- According to Forest and District Plans ---------->						
b. Travel and Access							
--impact by yew harvest	no change	some impact (roads may be required)	same as B	same as B	same as B	same as B	same as B

MM=Millions
M=Thousands

Discussion of the Comparison of the Effects of the Alternatives

This section presents a discussion of the comparison of effects between proposed alternatives. The discussion is organized by issue and suggestion and pertains to the table above. For a full discussion of the potential environmental effects of each alternative, refer to Chapter IV of the FEIS.

Main Issues: Provide Taxol, Protect the Ecosystem, and Protect Pacific Yew

Landscape Patterns

Alternative A poses a low risk of impact on yew population connectivity and range. Some Pacific yew would be destroyed in timber sale units, but yew would continue to exist in the harvested areas, managed according to the forest and resource plans and the principles of ecosystem management.

Alternative B poses a low risk of impact on yew population connectivity and range. Yew would be regenerated and the long-term distribution of the species would be maintained. The low risk is due to the relatively small size of the harvested areas and the small amount of acres harvested over the five-year period.

Alternatives C and D pose a low risk of impact on yew range and population connectivity. No yew harvest would be allowed in areas where genetic reserves cannot be established or where there are not at least five trees per acre in each harvestable diameter class. This would preclude yew harvest at the peripheries of the yew range. A significant proportion of Pacific yew would be retained throughout the landscape.

Alternatives F through G2 pose a low risk of impact on the Pacific yew geographic range and a moderate risk to landscape connectivity. Yew harvest would not be allowed in areas where genetic reserves cannot be established; the peripheries of the yew range would be protected. Harvest would be allowed in areas of sparse yew distribution (if reserves could be found), where there are less then five trees per acre in each harvestable diameter class. The 75 percent reduction in the yew population across the landscape under Alternative F increases the risk of impact to population connectivity.

Biology of Yew: Reproduction and Regeneration

Alternative A poses a minor to moderate risk to yew regeneration. Some yew would be destroyed or damaged during timber harvest activities, thus reducing potential seed sources, particularly in areas of sparse populations. Vegetative reproduction (sprouting, layering) would also be impacted to some extent, particularly where environmental conditions are harsher. No special provisions for yew protection and regeneration are included in this alternative.

Alternative B poses a minor impact on vegetative reproduction. Harvest of yew in sale areas would remove most of the seed producing yew, thus delaying seed production until residual yew or planted yew grow to reproductive size. In many cases, adequate seed would be produced in the interim by yew adjacent to the units, or yew retained as seed trees. Some of the remaining yew stumps and seedlings would be protected.

Alternatives C through G2: Yew would be replanted in sale units and some stumps and seedlings would be protected. An average of 70 percent of the stumps left after harvest may resprout.

Alternatives C and D pose minor risks to regeneration of Pacific yew. Harvest of yew at 25 and 50 percent levels in partial cut and non-sale areas would not adversely affect the reproduction and regeneration potential. The removal of no more than half of the foliage on 25 or 50 percent of the yew would not adversely affect needle regeneration.

Alternatives F, G1 and G2 pose minor to moderate risks to Pacific yew regeneration. They may reduce regeneration as a result of yew harvest at 75 or 50 percent levels with one tree per acre retained. There would be a moderate decrease in seed production. Effects may be greater in areas of sparse yew population where there may not be adequate numbers of sexually mature trees left following harvest. The removal of no more than half the foliage on 75 percent of the trees in Alternative F may impact needle regeneration slightly.

Genetics

Alternative A may result in a small decrease in levels of genetic variation as small populations on the periphery as well as in the center of the range may not maintain themselves. No efforts would be made to maintain genetic diversity under this alternative. Some populations with unique genetic combinations could be lost; this would affect the ability of subsequent generations to adapt to changing environments, as well as reduce the yew's potential for use in breeding programs.

Alternative B would have less impact on genetic diversity and potential contribution to breeding programs than Alternative A, because provisions are made for the protection of individual yew in harvest units, and units are regenerated to preharvest or prescribed levels. This ensures the survival of more genotypes in populations. Current erosion of small, peripheral populations would be halted under this alternative.

Alternatives C through G2: Alternative C (25 percent harvest) would result in no reduction in overall genetic variation. The reduction potential would increase slightly for Alternative D, and for each alternative as larger proportions of trees are harvested. Genetic reserves would be established in harvest areas in order to protect genetic diversity. Slight reductions in genetic variation could occur, however, as larger proportions of trees are harvested.

The current erosion of genetic variation in peripheral yew populations would be halted or reversed.

Gene conservation for use in future breeding programs would remain unchanged in Alternatives C and D, but would be reduced by Alternatives F, G1, and G2 because of reduced overall genetic variation in future generations.

Insects and Diseases

Alternative A would result in no change in levels of impact by insects and diseases.

Alternatives B through G2 would have a minor impact on insect and disease populations. Harvest in areas that contain Port-Orford-cedar (POC) must follow the mitigation measures specified in the POC analysis, intended to reduce or prevent the spread of POC root disease.

Fire

Alternative A: Risk of wildfire would remain unchanged. However, survival and regeneration of yew could be quite poor on some sites where fire is used for site preparation, as there would be no attempt made to change burning prescriptions to protect yew on the site.

Alternative B poses no increased risk of contributing to wildfire. There would be a higher probability for survival and regeneration of yew following fire for site preparation or other purposes, because there would be an attempt to protect and replant wherever residual survival was poor. Some yew may be damaged or killed by site preparation fires, but the probability of affecting the current distribution of yew is minor.

Alternatives C through G2 pose minor to moderate risk of contributing to wildfire, varying with the level of harvest and density of yew (generally higher for those alternatives that harvest higher levels of yew). The probability of survival and regeneration of yew following fire for site preparation treatment, would be high to moderate, decreasing as the amount of slash and the number of people involved in the harvesting increases.

Ecosystem

Alternatives A and B would result in minimal effects on ecosystem structure and function. The impacts of 100 percent yew removal (Alternative B) or loss of some of the yew in harvest units (Alternative A) would be minimal; the effects result from timber harvest, not yew harvest. Pacific yew would be a part of the

regenerating stand. There would be less risk of impact in timber sale units which retained yew in green tree reserves.

Alternatives C through G2: The impacts of yew harvest on ecosystem structure and function would vary from stand to stand depending on the presence of substitute species and structures. Risk of impact increases with the amount of yew that is harvested:

Alternative C (25 percent yew removal) — low risk of impact;

Alternative D (50 percent yew removal) — low to moderate risk of impact;

Alternative F (75 percent yew removal) — high risk of impact;

Alternatives G1 and G2 (50 percent yew removal) — moderate risk of impact due to the harvest of more of the larger yew trees and to harvest in areas of sparse yew distribution;

Alternative G2, with harvest in spotted owl conservation areas, would have the most impact on old growth ecosystems.

Biodiversity

Alternative A would result in some loss in genetic and species diversity in areas where yew is sparse, due to potential loss of unique populations in these areas.

Alternatives B through G2 would result in little or no impact on biodiversity. As stands regenerate and abundance of yew increases, the contributions to genetic, species, and community diversity would increase.

Soils, Water and Aquatic Habitat

Alternative A poses no additional risk to forest soils, water, and aquatic habitat managed according to the current standards and guidelines of forest plans and BLM resource management plans.

Alternatives B through G2 pose minimal risks on the soil and negligible to small impacts on water and aquatic habitat. The risk of impact would increase proportionately with the level of yew harvest: Alternative B — least impact; Alternative C — next largest impact; followed by Alternatives D, F, G1 and G2.

Wildlife

Alternative A poses insignificant risks on plant and animal populations. Animal species diversity might be reduced over time because of the incremental loss of yew from the understory of many timber sale units and changes in the mid-story vegetative structure.

Alternatives B through G2 pose minor to high risks, increasing as the level of harvest increases. Yew harvest in late-successional forests would change the character of the habitat, which could affect some species. In general, removal of 50 percent or less of the yew (Alternatives B through D) has a low probability of reducing or removing species from the area; removal of 75 percent of the yew (Alternative F) could have a moderate effect on some species abundance.

Very little information is available about the role of yew in providing for wildlife habitat. As a result, there could be a substantial risk to some species of wildlife if large areas of yew were harvested in a short time frame that would not allow developing problems to be identified.

Threatened and Endangered Species

Alternative A would have no added impact to threatened and endangered species. The impacts result from timber harvest, not yew harvest.

Alternatives B through G2 have a potential for impacts to threatened and endangered populations, increasing proportionately with the level of yew harvest.

The potential exists for positive and negative impacts (minor to moderate in intensity) to deer, elk, and moose and associated predator populations. In certain cases the positive and negative impacts could cancel each other out (i.e. the decrease in thermal cover from yew and timber harvest could be partially or completely mitigated by the increase in forage from yew sprouting and from opening the canopy), depending on local conditions.

There is potential for minor negative impacts to fish species that increases proportionately with the level of yew harvest.

The potential exists for positive and negative impacts (minor to moderate in intensity) to avian populations and associated predator populations. Impacts increase with the level of yew harvest, but are site-specific in some cases.

Northern Spotted Owl

Alternatives A and B pose little or no risks to spotted owls and their habitat, because there would be no habitat disturbance in addition to that normally occurring from implementing forest plans or BLM resource management plans.

Alternatives C through G2 would result in negative impacts both on prey species and on roosting habitat for spotted owls, increasing with the level of harvest. The intensity of the impact would depend on the proportion of yew in the stand and how much is harvested. Alternatives C, D, F and G1 permit harvest within suitable habitat, including removal of a portion of the midstory before scheduled timber harvest. Alternative G2 poses the greatest negative impacts because the largest area is available for harvest and includes harvest within owl conservation areas.

Forest Health

Alternative A would have little or no change in forest health under the present guidelines for ecosystem management. Although the numbers of yew trees in harvested stands would decline, it is unlikely that populations would disappear.

Alternatives B through G2 pose a minor risk to forest health. Mitigation measures for the protection of Pacific yew populations would maintain yew at acceptable threshold levels, no matter what percentage of yew is harvested.

Biological sustainability of the yew species is discussed under the genetics and the biology sections. This section responds to sustained yield as it is defined in the FEIS glossary. All harvest alternatives meet the definition of sustained yield.

Suggestion: Establish Sustainable Collection Leve

Public Health and Safety

Suggestion: Socioeconomic Concerns

Alternative A: Because there would be no yew harvested from federal lands, there would be no yew bark or taxol available from federal sources and no potential for treating patients with taxol derived from federal yew. There would be no increase in injuries to forest workers associated with yew bark collection on federal lands.

Alternatives B through G2 would have varying impacts on public health by offering a range of amounts of yew available for taxol for potential treatment of cancer patients.

These alternatives pose a small potential for injuries to forest workers associated with each of the action alternatives.

Social Setting: Groups Affected

Alternative A: No additional job opportunities would be created for forest workers and log purchasers. There would be no effect to recreational or Native American uses of the Pacific yew or the forest.

Women and other minorities would experience a slightly negative effect if the demand for taxol could not be met through other sources.

Alternative B through G2: These alternatives would generate some seasonal employment. The yew program is not expected to affect access to yew logs or supply of yew logs for woodworkers and log purchasers.

There may be a minor decrease in long-term timber yield because of less effective site preparation.

Recreationists may experience minor effects due to visual degradation.

Effects on Native American uses could be minor under these alternatives. Spiritual and medicinal effects must be assessed after local consultation.

Women and other minorities would experience positive effects given that the yew bark supplied would contribute to current demand.

Social Setting: Geographic Area

Alternative A would have no effect on the social/geographical setting.

Alternatives B through G2 would result in a small benefit to the social setting, due to some jobs created, but unevenly distributed in the five-state region, and positive feelings associated with yew harvest programs.

Economics

Alternative A: There would be no government expenditures or returns, and no jobs created as a result of yew bark harvest from federal lands. Bark harvesting jobs would increase on other ownerships in response to yew bark demand. This alternative is not responsive to yew bark demand from federal lands.

Alternatives B through G2 would have various economic impacts. Government expenditures would vary with the amount of harvest, the number of acres accessed, and the number of trees retained on each acre. Alternatives C through F require specified numbers of yew trees to be maintained by diameter class which increases survey and layout costs above Alternatives G1 and G2. Potential revenues returned to the government vary between $100,000 and $2,300,000. Yew bark would be sold at market value.

The increase in jobs associated with yew bark harvest would vary between 75 and 1,700 bark harvesters per year and is directly related to the amount of available bark.

Increased protection of yew in timber sale areas increases commercial harvesting costs resulting in slight decreases in stumpage values received by the federal government. There is also a potential for slight reductions in long-term commercial forest production if yew protection results in substandard site preparation.

Alternative B would meet the demand experienced in 1993, but would not meet the demand seen in previous years. Alternatives C through G2 would allow for bark harvest at levels that would meet the demand seen in previous years.

Areas and Access

Suggestion: Establish Areas of Collection

Alternative A allows for no areas of yew harvest for taxol and would result in no change in access to the forest under this alternative.

Alternatives B through G2 may result in some increase in access to timber sale units, partial-cut sale units, and non-sale areas; road or trail construction and upgrading may be required.

For mitigating measures and more details about the alternatives and the analysis see the FEIS.

Chapter I

Purpose and Need

Changes Made Since the Draft EIS

Chapter I-Purpose and Need

Revised the Purpose and Need, and Demand sections to reflect the Food and Drug Administration's approval of taxol and the announcement by Bristol-Myers Squibb that they would no longer be needing raw yew material from public lands.

Revised Spotted owl information under the following sections:

- Recovery Plan for the Northern Spotted Owl USDI Fish and Wildlife Service
- The FEIS on Management for the Northern Spotted Owl in the National Forests

Added the following sections:

- Forest Service Interagency Scientific Committee Conservation Strategy
- Other Legislation

Chapter I

Purpose and Need

Chapter One

Contents

Chapter I
Purpose and Need

The Pacific Yew EIS

Proposed Action

The proposed action in this environmental impact statement (EIS) is for harvest of Pacific yew *(Taxus brevifolia)* for taxol[1], over the next five years (1993-1997), from public lands administered by the US Forest Service and the Bureau of Land Management (BLM).

Underlying Need for Proposed Action

The underlying need to which the lead agencies—the Forest Service, the BLM, and the Food and Drug Administration (FDA)—are responding is the need for a supply of Pacific yew from public lands administered by the Forest Service and the BLM for cancer research and treatment. The purpose of the proposed action is to make a reasonable amount of yew available for taxol from federal lands while sustaining yew and minimizing the adverse effects to the ecosystem.

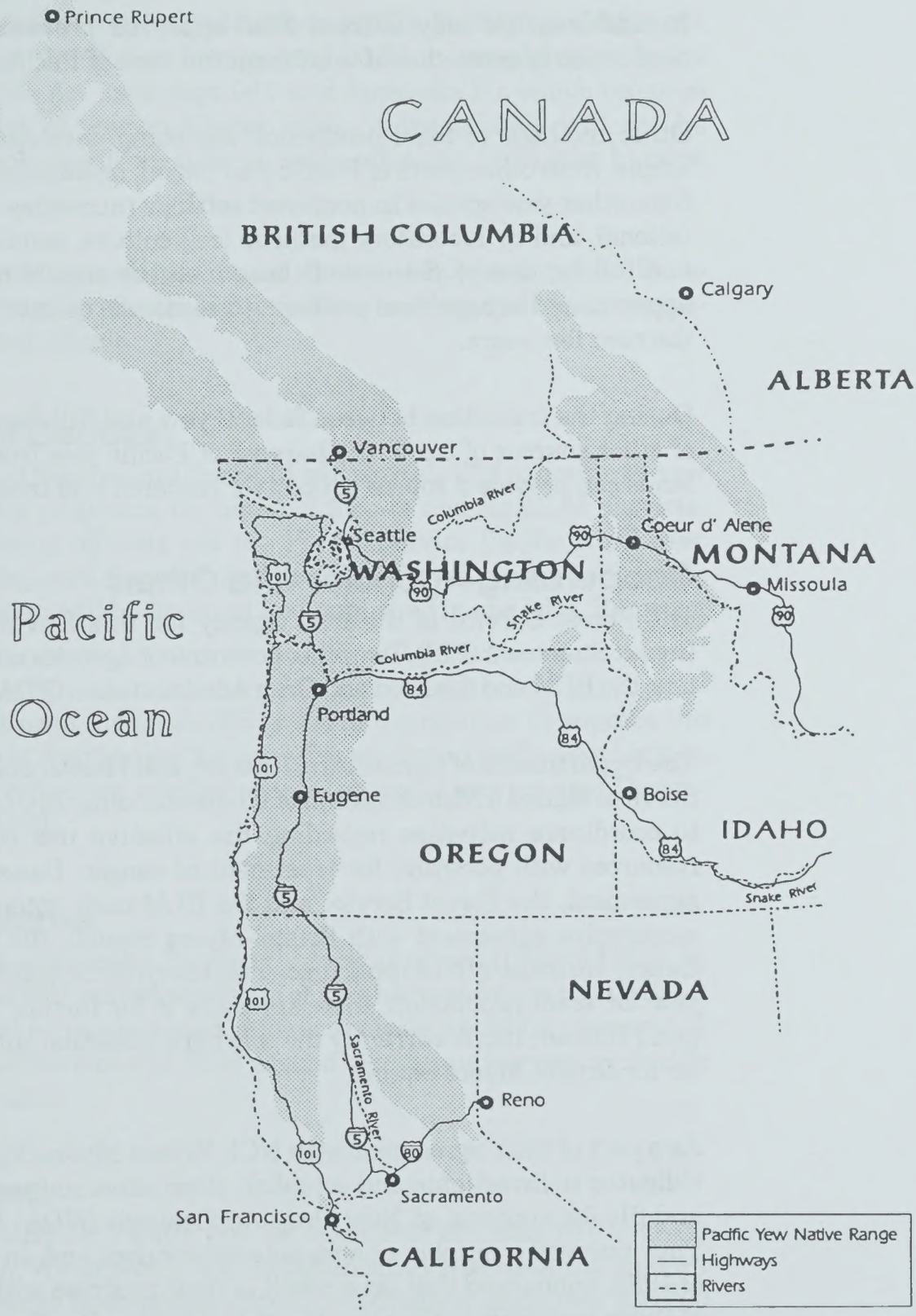
Justification for Need

The bark, needles and heartwood of Pacific yew contain the compound taxol and related chemicals. Results from clinical trials indicate that taxol is an effective drug for treatment of ovarian and other types of cancer. According to the National Cancer Institute (NCI), taxol is one of the most important anti-cancer drugs discovered in the past 15 years (Medford Tribune, 1992). (See Chapter III, and Appendix K for further details on taxol history and alternate sources.)

Currently, only taxol from Pacific yew bark has FDA approval for commercial use in treating cancer. Bristol-Myers Squibb, a pharmaceutical firm, obtained approval to market taxol for refractory ovarian cancer on December 29, 1992.

1. Taxol is now a registered trademark name (Taxol®). However, the word "taxol" will be used throughout this EIS to refer to the generic chemical compound paclitaxel (taxol)and related taxanes that are present in Pacific yew.

Figure I-1: Map of the Native Range of Pacific Yew



In addition, the only current FDA-approved process for taxol production is extraction of taxol from the bark of Pacific yew.

Other methods of taxol production are being developed; for example, from other parts of Pacific yew (wood, needles, and twigs), from other yew species in nonforest settings (nurseries and plantations), and by laboratory methods (cell culture, semisynthesis, and full synthesis). Several of these methods should have FDA approval and be capable of producing commercial quantities within the next few years.

During the transition between federal yew and full development of other sources of taxol, the harvest of Pacific yew from federal lands can provide a source of taxol for research and treatment.

Cooperating Agencies and Others

The Forest Service is the lead agency for this Environmental Impact Statement (EIS). Two other government agencies are cooperators: the BLM and the Food and Drug Administration (FDA).

The Departments of Agriculture, Interior, and Health and Human Services signed a Memorandum of Understanding (MOU) in 1991 to coordinate activities regarding the effective use of natural resources with potential for treatment of cancer. Based on this agreement, the Forest Service and the BLM each entered into a cooperative agreement with Bristol-Myers Squibb, the National Cancer Institute's (NCI) pharmaceutical partner, to supply Pacific yew for taxol production. (See Appendix E for further information.) Hauser, Inc. is currently the sole bark collection subcontractor for Bristol-Myers Squibb.

As a part of their agreement with NCI, Bristol-Myers Squibb was obligated to investigate and establish alternative sources of taxol and file for approval of New Drug Applications (NDA) for taxol. They pursued a number of alternate approaches and, in January of 1993, announced that, as a result of their progress with several of these approaches, they would not be needing Pacific yew bark from federal lands in 1993. Although Bristol-Myers Squibb will

purchase bark from federal lands in 1993 to fulfill past obligations and assist the Forest Service and BLM in complying with the Pacific Yew Act (see page I-11 and Appendix N), which requires preharvest of yew in timber sales, it most likely will not be purchasing yew from federal lands after the 1993 yew harvest season.

Pacific yew on national forest system lands and public lands administered by the BLM is available to other qualifying companies or individuals.

Type of Decision

The Forest Service and the BLM will use this EIS to decide on yew harvesting programs for national forests and for BLM districts. The deciding officials are the Forest Service Pacific Northwest Region Regional Forester, and the BLM State Director for Oregon. The decision will be finalized and published in one joint Record of Decision.

The FDA used the Draft EIS to aid in the decision to approve the New Drug Application for use of taxol from Pacific yew bark in treating refractory ovarian cancer (approval was granted December 29, 1992).

Time Frame

This EIS addresses a five-year harvest program (1993 to 1997). At the end of this period, the issue of yew harvest for taxol on federal lands will be re-examined. A new analysis would be necessary if the Forest Service and BLM wished to continue harvesting Pacific yew for taxol.

Demand

The demand for Pacific yew for taxol over the next five years is unknown. We expect it will be significantly less than the amount transferred to Bristol-Myers Squibb from federal lands (over 800,000 pounds of dry bark per year) during peak collection years (1991 and 1992) and that it will be variable from year to year.

Type of Raw Material

This EIS will discuss the impacts of harvesting Pacific yew bark and needles. Currently, the only FDA-approved process for taxol production is extraction of taxol from the bark of Pacific yew. Approval for extraction from needles may occur within the time period covered by this EIS.

Taxol is also present in the wood of Pacific yew, but amounts are too small to currently develop a commercial extraction process. Because it is unlikely that taxol extracted from wood will be developed in the next five years, we are not analyzing the impacts of removing yew wood from the forests.

Alternatives

The alternatives in this EIS (except for Alternative A, the "no action" alternative) all respond to the underlying need for Pacific yew for taxol.

This EIS documents the analyses used by members of the interdisciplinary team in considering these alternative ways of meeting the short-term need for Pacific yew from lands administered by the Forest Service and the BLM during the proposed five-year period.

See Chapter II for the description of the alternatives, the comparison of their effects, and discussion of the degree to which the alternatives satisfy both the needs of the proposal and the concerns raised in the issues.

Issues

The regulations for implementing the National Environmental Policy Act of 1969 (NEPA) require that important environmental issues be identified early. Information about issues related to this proposal were distilled from the comments of the general public, members of interested groups, and employees of government agencies who participated in early public involvement (scoping) efforts.

After reviewing the material from the scoping sessions and reading the comments, the interdisciplinary team identified the major issues associated with the proposal. These major issues and suggestions, listed below, played a substantial role in forming the alternatives and in raising questions for analysis. They include:

Issues:

Provide material from the Pacific yew for taxol.

Protect the ecosystem.

Protect the Pacific yew and maintain its genetic diversity.

Suggestions:

Analyze and establish a suitable and sustainable level of. harvest and taxol production.

Consider cultural, social, spiritual, and tribal values of yew.

Plant and manage for regeneration of yew.

Consider the economic effects of yew collection on resources, economies, and future options.

Establish and define areas of collection and reserve areas.

Establish collection methods.

Utilize all parts of harvested yew.

Develop other sources of taxol as soon as possible.

Stop theft and illegal harvest of yew.

A description of all issues, including those outside the scope of this proposal, is presented at the beginning of Chapter II as an aid to understanding and evaluating the alternatives. In addition, more detail about the issues can be found in Appendix A, Public Involvement.

Relationship of the Pacific Yew EIS to Other Plans and Laws

The Pacific yew EIS and Record of Decision (ROD) will give direction for harvesting Pacific yew on federal lands administered by the Forest Service and the BLM in five states. How it relates to other NEPA documents and other yew strategy documents is outlined below.

Regional and Multi-regional Vegetation Management EIS's

There are several programmatic EIS's in the west for vegetation management programs on public lands administered by the Forest Service and the BLM. These are listed below. We do not expect inconsistencies between the vegetation management EIS's and the Pacific Yew EIS.

FEIS for Managing Competing and Unwanted Vegetation

This EIS provides direction for vegetation management on national forests in the Pacific Northwest Region; it was completed in November 1988.

FEIS Pacific Southwest Region Vegetation Management for Reforestation

This EIS, published in December 1988, provides direction for vegetation management on national forests in the Pacific Southwest Region.

FEIS Western Oregon Program Management of Competing Vegetation

This EIS provides direction for vegetation management on public lands administered by the BLM in western Oregon; it was published in August, 1992.

FEIS Vegetation Treatment on BLM Lands in Thirteen Western States

This EIS, completed in May 1991, gives direction for vegetation management on public lands administered by the BLM in Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, eastern Oregon, South Dakota, Utah, Washington, and Wyoming.

Forest Service Interagency Scientific Committee (ISC) Conservation Strategy

A "Conservation Strategy for the Northern Spotted Owl" was completed in May 1990 (Thomas et al., 1990). The following September, the Secretary of Agriculture issued a decision to manage the national forests in a manner not inconsistent with the ISC Conservation Strategy. All the alternatives presented in this FEIS, with the exception of Alternative G2, are consistent with the Conservation Strategy. The Forest Service's Northern Spotted Owl Oversight Team determined that Alternative G2, which allows for harvest of Pacific yew within designated areas managed primarily for spotted owl habitat, would not be consistent with the standards and guidelines of the ISC Conservation Strategy.

Recovery Plan for the Northern Spotted Owl USDI Fish and Wildlife Service

The Recovery Plan, prepared by USDI Fish and Wildlife Service, is in a draft stage. The decision by the Forest Service and BLM to adopt the plan in lieu of other plans has not yet been made. The Forest Service has considered the recovery plan as a possible additional alternative in the supplement to the FEIS on Management for the Northern Spotted Owl in National Forests.

The FEIS on Management for the Northern Spotted Owl in the National Forests

This is a Forest Service programmatic EIS for northern spotted owl management in the Pacific Northwest and the Pacific Southwest Regions. A supplement to this Spotted Owl FEIS is being

prepared in response to a court order issued in July, 1992. The supplement will include strategies developed by the Northwest Forest Policy Working groups, the groups formed following President Clinton's Forest Conference on April 2, 1993. Alternative G2 in the Pacific Yew EIS, the only alternative proposing entry into spotted owl habitat conservation areas, may not be consistent with this supplement. If Alternative G2 is selected, consistency will be evaluated by an internal Forest Service process and then referred to the Interagency Scientific Oversight Group (a group of directors from state and federal organizations in the Pacific Northwest) for final resolution.

Forest Plans

Activities on national forests are guided by forest plans. Project level decisions developed for yew harvest will be consistent with forest plans and the decision that results from this EIS.

Resource Management Plans

Activities on BLM Districts will be guided by resource management plans (RMPs); RMPs will replace management framework plans. Direction in RMPs should be consistent with that in the Pacific Yew EIS; draft RMPs for western Oregon were published in August 1992, with the finals expected in 1993.

Forest Service and BLM Yew Policies and Direction

Direction given to national forests and BLM districts regarding yew harvest and management will be revised to reflect the guidance in the Pacific Yew EIS, if there are differences or conflicts.

District and Forest Decision Documents

Direction given in environmental assessments (EAs) or other decision documents may need to be amended to reflect guidance in the Pacific Yew EIS if inconsistencies are present.

Project Level Analysis Documents

Specific yew harvesting activities and projects on districts and forests will be planned, analyzed, and implemented to carry out the direction in the Pacific Yew EIS. Because this EIS is a programmatic document, future project level (site-specific) environmental analyses will be required. Project level environmental analyses will be tiered to the Pacific Yew Final EIS.

An Interim Guide to the Conservation and Management of Pacific Yew

This guide, developed by a team of scientists called the Pacific Yew Technical Committee, outlines a low-risk strategy for managing and conserving yew. This strategy, completed in March 1992 and updated in April 1993, was used by the Forest Service and BLM until this Final EIS and Record of Decision were published and the decision implemented. Many aspects of the strategy are incorporated in the EIS by the Pacific Yew EIS interdisciplinary team.

Pacific Yew Comprehensive Management Strategy

This document was prepared by the BLM in response to direction from Congress in November of 1991 "to develop a comprehensive strategy document for ensuring a sustainable supply of Pacific yew for the medical community with the least impact to the environment and to the Pacific yew resource." Published in December, 1992, it describes the current and planned Pacific yew programs undertaken by the BLM.

Pacific Yew Act of 1992

The Pacific Yew Act was passed by Congress in August of 1992 (see a copy of the Act in Appendix N). Its purpose was to ensure that the Forest Service and BLM carry out efficient collection and utilization of Pacific yew for taxol. The Act will expire once it is determined that sufficient supplies of taxol are available from sources other than the Pacific yew. All the action alternatives (Alternatives B through G2) are consistent with the Act.

Other Legislation

Pacific yew harvest under this FEIS will be consistent with all applicable federal, state, and local laws and regulations. Major legislation relating to this EIS includes the following:

- Pacific Yew Act of 1992 ;
- National Environmental Policy Act of 1969 (as amended) (NEPA);
- Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA);
- National Forest Management Act of 1974 (NFMA);
- Federal Land Policy and Management Act of 1976 (FLPMA)
- Water Quality Act of 1987;
- Endangered Species Act of 1973 (as amended).

Chapter II

Issues, Alternatives, and Comparisons

Changes Made Since the Draft EIS

Chapter II-Issues, Alternatives, and Comparisons

Added a needles only harvest alternative under the "Alternatives Considered but Eliminated" section.

Clarified the definition for "Timber Sale Unit;" and added a definition for "Interim Guide," in the Terms to Know box.

Changed the "Description of the Alternatives" section as follows:

- Replaced "No minimum trees per acre" with "one tree per acre per diameter class." This is the actual minimum number of trees that can be left under the 50% harvest alternatives with no minimum level specified.
- Changed the "no yew harvest zone" next to perennial streams from 50 to 75 feet to simply 75 feet.
- Added needle amounts under the "Available Trees, Bark, and Needles" sections.
- Revised "Sustainability of Harvest" sections.

Changed Table II-1 "Comparison of the Effects Between the Alternatives" as follows:

- Omitted "Amount of Bark Available...enough to meet current demand" section under "Main Issue: Provide Taxol, Protect the Ecosystem and the Yew," because demand is currently unknown.
- Changed effect from "minor to moderate" to "minor" under, "Fire, Impact of yew harvest on yew survival and regeneration following fire," under the Alternative B column.
- Changed the effect to "minor," (from "moderate to high") under, "Northern Spotted Owl, Potential for impacts on prey species," for Alternative G1; and changed the effect to "moderate" (from "moderate to high") under "Potential for impacts on roosting habitat," same alternative.
- Changed all the numbers under "Suggestion: Establish Sustainable Collection Level," and under "Suggestion: Consider Socioeconomic Concerns," due to a revision of inventory figures from the Forest Service Northern Region.
- Changed the effect from "no effect" to "minor," under "Suggestion: Consider Socioeconomic Concerns, Social Setting—Groups Affected, traditional woodworkers and log purchasers," for Alternatives B through G2.

Updated "The Mitigation Measures" section as follows:

- Changed the "no yew harvest zone" next to perennial streams from 50 to 75 feet to simply 75 feet.
- Added a requirement to plant 50 yew plants per acre in site-specific prescriptions where preharvest yew densities are greater than 50 plants per acre.
- Consolidated methods for maintaining or replacing yew in timber sale units for shrub and tree-form yew.

Redefined owl conservation areas for BLM lands.

- Changed yew harvest restriction around known Spotted Owl nest sites from a 100 acre radius for BLM to a 500 acre radius for both agencies.
- Moved description of optimum conditions for moose winter range to Chapter III.

Chapter II

Issues, Alternatives, and Comparisons

Chapter Two

Contents

Chapter II
Issues, Alternatives, and Comparisons

Introduction

This chapter describes and summarizes a range of alternatives for harvesting yew. Issues identified during scoping are presented. Alternatives considered but eliminated from further study are documented, and the reasons for their elimination are given. Following this is a detailed discussion of the seven alternatives, including the "No Action" alternative and a preferred alternative, Alternative B. The alternatives are developed to address the major issues identified in Chapter I and in this Chapter. Next, the effects of each alternative are compared and contrasted in a table and accompanying summary discussion. Mitigation measures for each of the action alternatives are presented at the end of the chapter.

Issues Used to Help Evaluate the Alternatives

The following section describes the public issues and suggestions that were used to help evaluate the alternatives. In some cases, suggestions were made that are outside the scope of this proposal for various reasons. For example, in the case of developing other sources of taxol, the concern was outside the jurisdiction of the agencies involved. See Appendix A for a more detailed discussion of the issues and suggestions.

Special Note
If an issue is outside the scope of the proposal, the reasons are documented here.

Issue Provide Pacific Yew for Taxol

Most people who responded want the Pacific yew to be available for the production of taxol and its use in clinical trials and treatment of ovarian and possibly other cancers. Some say that saving human lives should be the top priority; yew harvest should be maximized regardless of environmental impacts; and wilderness and roadless areas should be opened for yew collection.

Others say, although taxol should be made available, the yew tree and the ecosystem are important in themselves and for future generations and deserve protection; the harvest of yew for taxol should proceed with care, caution, and safeguards.

In this EIS... The need for the cancer-fighting drug taxol is the purpose that drives the proposed action to harvest Pacific yew trees or shrubs. Our big question is: **How can we provide material from the Pacific yew for taxol and protect the species and the ecosystem?** We will show how much yew is available under different alternatives, look at various areas where yew might be harvested, and analyze the effects of harvest on the species, and the ecosystem (including humans).

Protect the Ecosystem

Issue

People who commented want protection for the yew's ecosystem in order to ensure forest diversity. They want studies of the role yew plays in its community and the impact of yew harvest; some feel the forest has already been ruined by timber harvest. A major concern within ecosystem protection is the old growth or ancient forests; people want to protect and sustain ancient forests for future generations and for the unknown resources they may contain.

Other concerns regarding the health of the ecosystem are for protection and understanding of wildlife, including deer, elk, moose (Idaho and Montana), birds, insects, the northern spotted owl and other threatened or endangered species; riparian zones, watersheds, and fish habitat; plants, including fungi; soils and soil organisms; and aesthetics.

In this EIS... Protecting the Pacific yew ecosystem is part of every alternative and is covered by the mitigation measures for six of the seven alternatives. The measures provide for yew reserve areas; protection of riparian areas; and consultation with wildlife biologists about deer, elk, moose, northern spotted owl habitat, and many other wildlife species.

Issue Protect Pacific Yew and Maintain its Genetic Diversity

Here, the concern is for careful management to protect Pacific yew and its gene pool, while balancing short versus long-term needs for taxol. People want studies of yew in order to understand how to maintain the population and provide a viable gene pool for the future. With recent reports of infection of a few yew trees with the root disease *Phytophthora lateralis,* found in Port-Orford-cedar, people want to know what steps can be taken to protect yew from this disease.

In this EIS... Protecting Pacific yew and maintaining its genetic diversity is part of six of the seven alternatives presented. Most of the alternatives call for reserves to be established in every harvest area; all the alternatives, except Alternative A, ensure regeneration of Pacific yew. We also discuss the effects of *Phytophthora lateralis.* (See the section on insects and diseases in Chapters III and IV.)

Suggestion Analyze and Establish a Suitable and Sustainable Level of Harvest and Taxol Production

This issue refers to the need for an accurate inventory of Pacific yew and its range in order to avoid over-harvesting, and to carefully manage for present needs and future generations.

In this EIS... We incorporate the Pacific yew inventory, discuss sustained yield (see "Terms to Know," page II-20), and analyze a short-term (five-year) output. Until other sources can provide sufficient quantities of taxol, the harvest of Pacific yew from federal lands can provide a short-term source of taxol for research, development, and the treatment of various cancers. (See section on sustainability and inventory in Chapters III and IV.)

Suggestion Consider Cultural, Social, Spiritual, and Tribal Values of Yew

Most people who responded were in favor of utilizing a balanced system of harvest while preserving the yew at historic levels, and giving consideration to multiple use and whole-ecosystem health. Many people felt that more attention should be given to the

spiritual, cultural, and historical value of the yew. Some said that, because Native Americans have a long tradition of using the yew for its healing powers, they should be guaranteed continued access to the trees. Several people felt that the yew is sacred, and no harvesting of wild stands should take place.

In this EIS... We discuss cultural social, spiritual, and tribal values of yew in the "Yew and People" sections of Chapters III and IV.

Plant and Manage for Regeneration of Pacific Yew

Suggestion

In this case, people who commented are concerned about protecting the Pacific yew as a future resource. Most who commented agreed with harvesting yew trees for taxol, as long as sound reforestation practices that allow for natural regeneration or call for replanting are in place and that nursery propagation efforts continue.

In this EIS... We include requirements for regeneration to preharvest or prescribed levels in six of the seven alternatives. Forest Service and private nurseries continue to propagate Pacific yew for reforestation.

Consider the Economic Effects of Yew Collection on Resources, Economies, and Future Options

Suggestion

Here, many people commented that maintaining a sustained forest ecology is essential for ensuring the future of taxol and other important drugs yet to be discovered.

A significant number of people said they think the agreement with Bristol-Myers Squibb company is "monopolistic," and that many companies, not just one, should benefit from taxol production.

The economic impacts of yew harvest and bark collection on the timber industry was another area of concern. Several people suggested that yew harvest take place only in active timber sale areas. Some expressed concern over whether yew harvest and bark collection projects would be used to provide jobs for local residents, especially in areas where there are significant numbers of displaced timber workers.

In this EIS... We look at the economic impacts of yew harvest. (See section on Economics in Chapters III and IV.) Modification of agreements with Bristol-Myers Squibb is outside the scope of this EIS. (See Appendix E for more information about the agreements.)

Suggestion Establish and Define Areas of Collection or Reserve Areas

In this issue the number one public concern is the Forest Service treatment of set-aside areas. Sentiment is divided between those favoring:

a. Absolutely no harvest in any set-aside areas. This includes Research Natural Areas (RNAs), designated wilderness, and owl conservation areas (OCAs) (see "Terms to Know," page II-20).

b. Limited harvest in set-aside areas.

c. Comprehensive harvest of yew wherever it is found, in whatever quantity needed.

Many people think that old growth forests should be left alone, although minimum intrusion may be allowed for research and inventory purposes.

In this EIS... We consider one alternative (G2) that looks at yew collection in one type of set-aside area, owl conservation areas. Owl conservation areas cover a large number of acres, and could make a sizable difference in the amount of yew material available for harvest.

In this EIS we do not consider entering wilderness areas, or Research Natural Areas for yew harvest.

Suggestion Establish Collection Methods

In this case, many people want to know what kinds of yew harvest methods will be allowed, and how harvests will be incorporated into existing forest management prescriptions. Some said efficient collection methods should be established to ensure full utilization of the tree. Others said harvest methods that result in the death of the tree should be discontinued. Several people asked whether the yew trees can survive if they are partially stripped of their bark. A

small number of respondents said only the needles and twigs should be collected. At least two people asked for a definition of "harvest" in regards to the yew.

In this EIS... We look at harvest of bark from cut trees and harvest of needles from standing live trees. Specific collection methods are beyond the scope of this EIS, and will be addressed in site-specific analyses. Current yew harvest direction calls for harvesting yew before timber is cut on sale units. Partial-stripping of yew bark is not currently practiced because of the unknown effect on the viability of the tree and the fact that more trees would be affected. Current utilization standards call for stripping all bark from boles and branches down to two inches in diameter.

Utilize All Parts of Harvested Yew

Suggestion

Most people who commented want the whole yew tree to be used if the bark is going to be collected. They suggest it be used (perhaps commercially, for a fee) for fenceposts, firewood, bows, musical instruments, ornamental wood working, tool handles, and lumber.

Many people are concerned about waste of the tree during the harvesting process and want all bark from large and small limbs to be collected; they don't want to see the remaining tree burned or left to rot. Many want the small branches and needles to be used as well as the bark; some suggest collecting needles instead of bark in order to save the trees. Others would like to see the entire tree used for the extraction of taxol.

In this EIS... We analyze the effects of harvesting needles and bark. Currently, the only FDA-approved process for taxol production is extraction of taxol from the bark of Pacific yew. We are analyzing needle harvest because processes and approval for extraction from needles may be developed within the time period covered by this EIS. Although taxol is present in wood, current taxol extraction methods from wood are not practical. Yew wood for purposes other than taxol is available to those who can make use of it, including bowyers, musical instrument makers, and other woodworkers. Current utilization standards require that bark be stripped from branches and boles down to two inches in diameter.

Suggestion Develop Other Sources of Taxol as Soon as Possible

Many people called for the development of other sources of taxol as soon as possible, to avoid the burden on the yew species and the potential impacts of a long-term harvest program.

Many wanted to see a progress report on the development of other sources of taxol through synthesis, semisynthesis, cell culture, nursery propagation, heartwood extraction, and needle extraction. Some people feel the Forest Service and BLM should fund research into alternate methods of producing taxol. Several say that taxol will soon be synthesized and the need for yew harvest will diminish. A few people asked what will become of the yew when it is no longer desired for its taxol.

In this EIS... A number of efforts to develop other sources are underway. While this issue is outside the scope of the proposal, information on alternate sources can be found in Chapter III and Appendix K.

Our "no action" alternative assumes other sources of taxol will be developed. All alternatives could accommodate possible breakthroughs in taxol production from another source.

Suggestion Stop Theft and Illegal Harvest of Yew

Many people expressed concern about the theft and illegal harvest of wild yew trees. Most wanted to know how illegal harvest would be stopped, and what kinds of punishment poachers would face if caught. Many felt there should be serious consequences for stealing yew trees. Some people questioned how to protect wild yew trees on their private lands. At least one respondent suggested using public awareness to monitor poaching and discourage theft.

In this EIS... Theft may have an impact on how much yew is available for harvest. Law enforcement responsibilities are assigned to each national forest and BLM resource area or district. Because yew theft law enforcement is included with all other types of law enforcement, this issue is outside the scope of this EIS.

Alternatives Considered but Eliminated From Further Study

In addition to the seven alternatives discussed in this chapter, several other alternatives were considered but eliminated from further study. Many different components were suggested, but not all of them were included. The first part of this section will describe those components and explain why they were not incorporated. The second part will describe the broader, more fully developed alternatives and provide an explanation of why they were excluded.

Components Considered but Eliminated

Harvest Yew in Wilderness Areas

Yew harvest in wilderness areas and in (BLM) Areas of Critical Environmental Concern would require revision of current legislation at the congressional level. Projected harvest goals are attainable without entering these areas.

Harvest Yew in Research Natural Areas (RNAs)

RNAs are areas set aside for the study of ecological systems in a setting that has been undisturbed by humans. Removal of yew from these areas would defeat their purpose. Because these areas tend to be fairly small in terms of overall acreage, yew on these acres would not contribute substantially to taxol production.

Harvest Yew in Special Management Areas

Acreage and management in these areas varies so widely across different forests, that a programmatic EIS could not adequately address yew harvest in them.

Harvest Complete Tree in Timber Sale Areas, Strip Bark in Other Areas

Agency scientists recommend either cutting the trees or removing the foliage. They do not recommend partial bark stripping from standing live trees because of lethal risk. Therefore the mitigation measures and alternatives in this FEIS do not include partial bark stripping.

Alternatives Considered But Eliminated

Protect Yew

An alternative was considered that would modify existing management plans to protect yew. Yew would not be harvested on Forest Service and Bureau of Land Management lands; all yew material would be obtained from other sources such as privately owned lands, biomass production in nurseries, cell culture, and total synthesis.

The "no harvest" part of this alternative is covered in Alternative A (see Description of Alternatives in this chapter). The majority of the alternatives and mitigation measures in this EIS, call for protection of the genetic diversity and viability of the yew species. Comprehensive management of yew is beyond the scope of this analysis; we focus solely on the potential impacts of a five-year yew harvest program.

Harvest Yew Only if Other Activities Would Harm Yew

An alternative was considered that would allow harvest of yew only where it would be destroyed by other activities, such as clearcutting and road building. Yew that would not be impacted within the activity area would not be harvested.

Additional components of this alternative are:

- Do not harvest yew in non-sale/non-activity areas. Take only the yew that would be killed during the activity; all other yew within the activity area boundary would be untouched;
- Harvest bark, needles, and branches;
- Harvest whole tree (cutting instead of barkstripping);
- Base the supply of yew products for taxol on the level of timber sales or other activity;
- Do not make specific provisions for regeneration;
- Do not modify harvest regimes to enhance yew production or to protect yew;

- Do not provide for specific gene pool reserve areas; and
- Do not harvest in restricted areas.

This alternative is identical to Alternative B (see Description of Alternatives in this chapter) except that in B we harvest all yew meeting size standards within the unit (not just the ones that would be damaged) and we regenerate to preharvest or prescribed levels. It was not carried forward because Alternatives A and B more fully encompass the intent of this alternative.

Prioritize Harvest Areas

In another considered alternative, yew would be harvested according to the Interim Guide (see "Terms to Know," page II-21). The following priorities would be used to identify yew harvest areas:

- Near communities that would most benefit from the increased employment created by yew harvest activities;
- In general forest areas designated for timber management in forest or resource management plans;
- No harvest in designated wilderness areas, (BLM) Areas of Critical Concern, or Research Natural Areas; and
- In other areas, only if designated amounts of bark and/or needles cannot be provided by the above areas, in this order:
    a. roadless areas
    b. owl critical habitat areas
    c. significant old growth areas
    d. owl conservation areas (OCAs)

This alternative addresses the concerns about the increasing numbers of displaced timber workers, and harvest in old growth forests and spotted owl designated areas. It was not carried forward because all the action alternatives provide for increased employment opportunities for displaced timber workers. Harvest areas are prioritized in the Mitigation Measures section of this chapter.

Harvest 100% of Yew

An alternative was considered that would allow yew harvest according to the Interim Guide, but with 100% harvest in partial-cut sale units and non-sale areas and some harvest in OCAs (see "Terms to Know," page II-20). Because of its similarity to Alternative G2 it was eliminated from further analysis.

Maximize Yew Harvest for Taxol Production

Another alternative was considered that would harvest yew at a 100% level from all areas. Additional components of this alternative would be:

- Harvest at a level that maximizes production of taxol over the short-term;
- Emphasize maximum drug production without provisions for long-term viability of the species;
- Enter set-aside areas (wilderness, OCAs, botanical areas);
- Plan timber sales specifically for yew harvest (areas of high concentration);
- Harvest regardless of unusual parent rock, geology, or vegetation; and
- Harvest in riparian areas.

This alternative would maximize production of taxol through an intense short-term harvest strategy. It was eliminated from further analysis due to its total lack of protection for the yew or sensitive areas, coupled with intense harvest in all areas.

Alternative E

This alternative proposed harvesting yew in owl conservation areas as well as partial-cut sale units, non-sale areas, and timber sale units (see "Terms to Know," page II-20). Harvest levels would follow the Interim Guide (leave 50% of the yew or five trees per acre (TPA) per diameter class, whichever is greater; harvest the

remainder). Mitigation measures developed for Alternatives C, D, F, G1, and G2 would be followed.

Alternative E was eliminated from further consideration in order to avoid redundancy with Alternative D and G2.

Long-Term Even-Flow Harvest

This alternative covered harvesting yew in sale units, partial-cut sale units, and non-sale areas at a level that could be harvested each year for 100 years. No more than a specified amount of yew could be harvested over the five-year period (five percent of the total trees available) of the yew harvest program. A minimum of five TPA would be retained in each of three diameter classes. Mitigation measures would be the same as those for Alternatives C, D, F, G1, and G2.

This alternative was dropped from further consideration because it is unlikely that we will need a long-term, low-yield yew harvest program. The best information currently available indicates that there will be adequate amounts of taxol from alternative sources available on a commercial scale within three to five years. When this happens, harvest of yew for taxol on federal lands will cease.

Harvest Needles Only

Reviewers of the draft environmental impact statement suggested an alternative that would allow for the harvest of only the needles from the Pacific yew tree, rather than the bark. The rationale for a needles only harvest includes the desire not to kill the tree in order to obtain taxol and to provide for a long-term forest product collection industry in the northwest.

The analysis of a needles only alternative was not carried to completion in the final environmental impact statement for the following reasons:

- Currently, the Food and Drug Administration has not issued approval for the production of taxol from Pacific yew needles.

- There is currently no market for needles from Pacific yew growing in forests.
- Methods for the collection of needles from wild Pacific yew have not been established.
- All action alternatives (B through G2) allow for needle harvest as well as bark harvest.

The Alternatives

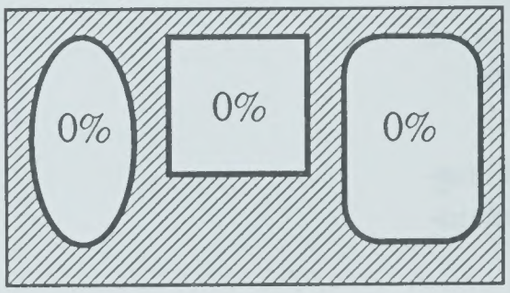
This section describes the seven alternatives for managing harvest of Pacific yew on federal lands. These seven alternatives include a "no action" alternative which defines the continuation of yew harvest as it was prior to any large scale harvest for taxol.

The first part of this section is a graphic overview of the alternatives (see Figure II-1), followed by full descriptions of each alternative.

After the description of the alternatives we compare the effects of each alternative on each resource in a table and discussion section. The chapter closes with the mitigation measures.

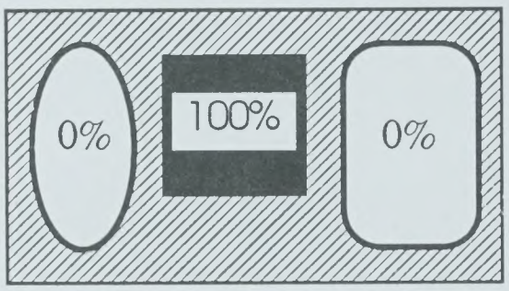
Figure II-1
Graphic Overview of the Alternatives: Alternatives A, B, and C

Alternative A



--No yew harvest for taxol production
--No protection of yew
--No yew regeneration
--No genetic reserves

Alternative B



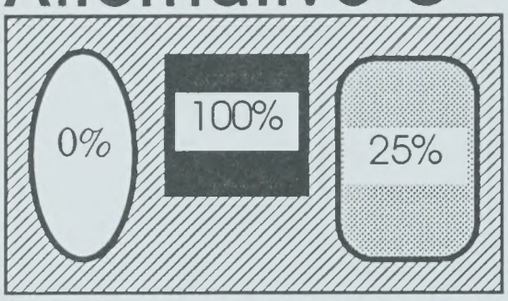
--Harvest 100% utilizable yew
--Yew regeneration and protection

--No yew harvest

--No yew harvest

--No genetic reserves
--No yew harvest near streams

Alternative C



--Harvest 100% utilizable yew

--Harvest maximum of 25% per diameter class
--Retain 75% or 5 TPA per diameter class

--No yew harvest

--No yew harvest near streams
--Yew regeneration and protection
--Genetic reserves

Key

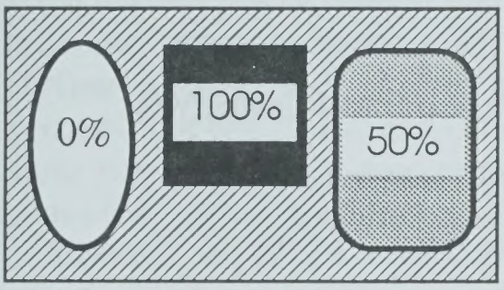
Owl Conservation Area

Timber Sale (TS) units—clearcut, shelterwood, or seedtree harvest

Partial-cut sale units such as thinning or uneven-aged cuts and non-sale areas where yew harvest is allowed in the Forest Plans and BLM Resource Management Plans

Figure II-1 (Continued)
Graphic Overview of the Alternatives: Alternatives D and F

Alternative D



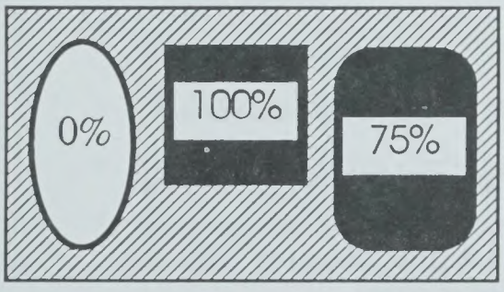
--Harvest 100% utilizable yew

--Harvest maximum of 50% per diameter class
--Retain 50% or 5 TPA per diameter class

--No yew harvest

--No yew harvest near streams
--Yew regeneration and protection
--Genetic reserves

Alternative F



--Harvest 100% utilizable yew

--Harvest maximum of 75% per diameter class
--Retain 25% or 2 TPA per diameter class

--No yew harvest

--No yew harvest near streams
--Yew regeneration and protection
--Genetic reserves

Key

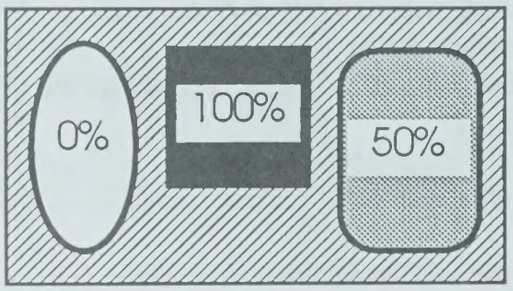
Owl Conservation Area

Timber Sale (TS) units—clearcut, shelterwood, or seedtree harvest

Partial-cut sale units such as thinning or uneven-aged cuts and non-sale areas where yew harvest is allowed in the Forest Plans and BLM Resource Management Plans

Figure II-1 (Continued)
Graphic Overview of the Alternatives: Alternatives G1 and G2

Alternative G1



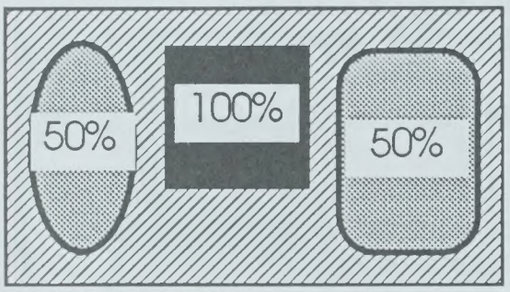
--Harvest 100% utilizable yew

--Harvest maximum of 50% per diameter class
--Retain 50% or 1 TPA per diameter class

--No yew harvest

--No yew harvest near streams
--Yew regeneration and protection
--Genetic reserves

Alternative G2



--Harvest 100% utilizable yew

--Harvest maximum of 50% per diameter class
--Retain 50% or 1 TPA per diameter class

--Harvest maximum of 50% per diameter class
--Retain 50% or 5 TPA per diameter class

--No yew harvest near streams
--Yew regeneration and protection
--Genetic reserves

Key

Owl Conservation Area

Timber Sale (TS) units—clearcut, shelterwood, or seedtree harvest

Partial-cut sale units such as thinning or uneven-aged cuts and non-sale areas where yew harvest is allowed in the Forest Plans and BLM Resource Management Plans

Description of Alternatives

This section describes the seven alternatives for harvest of yew trees and shrubs on federal lands. The alternatives are identified with the letters A through G2. Alternative E was dropped from further consideration during a late stage in the development process. The two G alternatives were designated G1 and G2 due to their similarity in all aspects except entry into owl conservation areas (permitted in G2).

Each alternative description includes the following components:

- Landscape Perspective;
- Harvest Location; Harvest Levels;
- Set-Aside Areas;
- Protection of Yew;
- Protection of Other Resources;
- Regeneration;
- Genetic Diversity;
- Relationship to Interim Guide;
- Available Trees and Bark; and
- Sustained Yield Harvest.

A succinct statement distilling the highlights of each alternative precedes its description. Further details about the numbers of available acres for harvest, trees, and bark mentioned in each alternative description can be found in Chapter IV, Pacific Yew Population and Inventory. Terms mentioned throughout the description of the alternatives are defined on the next page.

Terms to Know

"Residual green tree reserve"— *green trees left on a site to provide a local seed source or for other purposes. Where silvicultural prescriptions call for retaining green trees, the inclusion of yew trees and shrubs in the green tree reserve provides a local seed source for natural regeneration.*

"Timber sale unit"— *an area within a timber sale which has a silvicultural prescription for a (1) clearcut, (2) shelterwood, or (3) seed tree harvest method. It also can be an area where yew would otherwise be destroyed by road building, prescribed fire, or similar activities.*

"Partial-cut sale unit"— *an area within a timber sale which has a silvicultural prescription to cut only part of a stand. Techniques which involve "partial cutting" include thinning, salvage operations, and prescriptions designed to produce an uneven-aged stand of trees.*

"Non-sale area"— *an area in a national forest or district where no timber sales, as described in above definitions, are scheduled in the next five years, but where yew harvest is allowed according to land use plans.*

"Owl conservation areas"— *those areas formally designated for protection of the northern spotted owl. They provide a contiguous block of habitat to be managed and conserved for spotted owls. The blocks are placed so as to be well distributed throughout the range of the owl and spaced closely enough to facilitate dispersal of owls among them. We are using "owl conservation areas" (OCAs) to include Forest Service Habitat Areas (HCAs), and BLM Old-Growth Emphasis Areas (OGEAs), Designated Conservation Areas (DCAs), Reserved Pair Areas, Managed Pair Areas, Residual Habitat Areas, Protected Habitat Areas (PHAs), and Protected Habitat Area Buffers (PHABs) as described in the BLM's draft resource management plans.*

More Terms to Know

"Uncommon Parent Rock"— *refers to the ultramafic rocks peridotite and serpentine as found in the Siskiyou Mountains.*

"Interim Guide"— *refers to the publication "An Interim Guide to the Conservation and Management of Pacific Yew" (USDA FS, 1992a) and as revised (USDA FS 1993a).*

"Sustained-Yield (of Products and Services)"— *the achievement and maintenance in perpetuity of a high-level annual or regular periodic output of the various renewable resources of the National Forest System without impairment of the productivity of the land.*

Alternative A

Alternative A gives no particular emphasis to Pacific yew harvest for taxol; it emphasizes all resources according to forest plans and BLM resource management plans.

Alternative A is the "no action" alternative. A "no action" alternative is required by the National Environmental Policy Act (NEPA). Under Alternative A, no harvest of Pacific yew for taxol production would take place; thus, no yew material for taxol production would be available from federal lands. This alternative also describes the manner in which Pacific yew was managed on federal lands prior to 1989, before the demand for yew bark for taxol emerged. Alternative A conflicts with the Pacific Yew Act (see Chapter I).

Landscape Perspective

There would be no planned harvest of yew for taxol under this alternative. Pacific yew trees could potentially be killed or injured without utilizing the bark or needles on 0.078 to 0.118 million acres over the next five years in timber sale units that contain Pacific yew.

Harvest Locations; Harvest Levels

Pacific yew for bark or needle production would not be collected in or removed from any area.

Locations	Yew Harvest?	Maximum Amount Harvested	Minimum Yew Left of Utilizable Size
Timber Sale Unit	No	None	NA
Partial-Cut Sale Units	No	None	NA
Non-sale Areas	No	None	NA
Owl Conservation Areas	No	None	NA

Set-Aside Areas

Yew would not be harvested in owl conservation areas, designated wilderness, or other areas in national forests or BLM districts set aside for specific purposes.

Protection of Yew

Yew in danger of being killed or damaged by various other activities (including timber harvest) would not be given special protection. There would be no requirement to retain a certain number of yew trees or shrubs per acre in any area (other than that specified in forest or resource management plans).

Protection of Other Resources

Streams, wildlife, and other vegetation would be protected by the guidelines provided in site-specific NEPA analyses, forest plans, and BLM resource management plans.

Regeneration

There would be no special requirement to regenerate Pacific yew after any project, other than that specified in site-specific silviculture prescriptions.

Genetic Diversity

There would be no special provisions for maintaining the genetic diversity of Pacific yew.

Relationship to Interim Guide

No aspects of the Interim Guide would be incorporated into Alternative A.

Available Trees, Bark, and Needles

There would be no yew needles or bark available for taxol production under this alternative.

Sustained Yield Harvest

There would be no yew harvest for taxol production in this alternative, and therefore, no output of yew for that purpose over the five-year period covered by this EIS.

Alternative B—The Preferred Alternative

Alternative B emphasizes utilization of Pacific yew where it would otherwise be wasted; production of yew from federal lands would be dependent on timber harvest programs; it provides the highest degree of protection to yew and the ecosystem.

Alternative B would allow harvest in timber sale units only. Approximately 1.29 to 1.93 million pounds of dry yew bark and 3.43 to 5.15 million pounds of dry needles would be available over five years with this alternative.

Landscape Perspective

Yew would be harvested from an estimated 0.078 to 0.118 million acres over the next five years in timber sale units that contain Pacific yew (see tables in Chapter IV Pacific Yew Population and Inventory section).

Harvest Locations; Harvest Levels

Alternative B would allow harvest of 100 percent of the yew of utilizable size in timber sale units (excluding residual green tree reserves).

Locations	Yew Harvest?	Maximum Amount Harvested	Minimum Yew Left of Utilizable Size
Timber Sale Unit	Yes	100%	no mininum
Partial-Cut Sale Units	No	None	All
Non-sale Areas	No	None	All
Owl Conservation Areas	No	None	All

Set-Aside Areas

Yew would not be harvested in spotted owl conservation areas, designated wilderness, or other areas in national forests or BLM districts set aside for specific purposes.

Protection of Yew

No yew would be harvested within 75 feet (slope distance) of the average high-water level on either side of perennial streams. Some of the yew remaining after yew harvest (stumps, seedlings, etc.) would be protected in timber sale units. Yew harvesting activities would follow mitigation measures for Alternative B, found at the end of this chapter.

Protection of Other Resources

Streams, wildlife, and other vegetation would be protected by the guidelines provided in site-specific NEPA analyses, forest plans, and BLM resource management plans. Harvest of yew in moose winter range and in the vicinity of Port-Orford-cedar would follow the mitigation measures for moose (found at the end of this chapter) and the Port-Orford-cedar analysis process (found in Appendix C).

Regeneration

Yew would be regenerated to preharvest or prescribed levels by planting seedlings or rooted cuttings and/or by ensuring survival of residual yew on the site.

Genetic Diversity
No specific genetic reserves would be required, although Pacific yew outside timber sale units would maintain genetic diversity.

Relationship to Interim Guide
Alternative B would incorporate the yew harvesting guidelines for timber sale units from the Interim Guide.

Available Trees, Bark, and Needles
From 0.26 to 0.39 million yew trees would be available for harvesting, based on current projections of timber sale acres over a five-year period and adjustments for other harvest restrictions. Approximately 1.29 to 1.93 million pounds of dry bark and 3.43 to 5.15 million pounds of dry needles could be removed from these trees over five years.

Sustained Yield Harvest
This alternative will meet the requirements of sustained yield. (See the Sustained Yield section in Chapter IV-Part One and Appendix F.)

Alternative C

Alternative C emphasizes a high degree of protection of Pacific yew and the ecosystem in yew harvest areas; it would produce a relatively small amount of bark and needles.

Alternative C would allow yew harvest in both sale and non-sale units. Harvest levels would be lower than those specified in the Interim Guide. Approximately 5.58 to 8.37 million pounds of dry yew bark and 9.16 to 22.35 million pounds of dry needles would be available over five years under this alternative. (These numbers have been adjusted to reflect additional harvest restrictions, e.g. from site-specific analysis.)

Landscape Perspective
Yew could potentially be harvested from an estimated 1.47 to 2.20 million acres over the next five years. No yew harvest would be allowed in areas where genetic reserves could not be established,

either within or outside of timber sale units (see exceptions in Mitigation Measures section). There would be no yew harvest in riparian areas, in the set-aside areas described below, or in the genetic reserves. Yew could be harvested from all other areas where there are more than five yew trees per acre (TPA) in each harvested diameter class (<11, 11-20, and >20 inches stump diameter).

Harvest Locations; Harvest Levels

Alternative C would allow the harvest of 100 percent of utilizable size yew in timber sale units (excluding the residual green tree reserves) and 25 percent of utilizable size yew in each of three diameter classes in partial-cut sale units and non-sale areas.

Locations	Yew Harvest?	Maximum Amount Harvested	Minimum Yew Left of Utilizable Size
Timber Sale Unit	Yes	100%	no minimum
Partial-Cut Sale Units	Yes	25%	5 Trees/Acre
Non-sale Areas	Yes	25%	5 Trees/Acre
Owl Conservation Areas	No	None	All

Set-Aside Areas

Yew would not be harvested in owl conservation areas, designated wilderness, or other areas in national forests or BLM districts set aside for specific purposes, nor in areas with unusual features such as uncommon parent rock or vegetation.

Protection of Yew

No yew would be harvested within 75 feet (slope distance) of the average high-water level on either side of perennial streams. At least five yew TPA in each of the three diameter classes or 75% of the yew (whichever is greater) must be left in the partial-cut and non-sale areas. Yew harvesting activities would follow the Mitigation Measures for Alternatives C through G2, included at the end of this chapter.

Protection of Other Resources

Streams, wildlife, and other vegetation would be protected by the guidelines provided in site-specific NEPA analyses, forest plans,

and BLM resource management plans. Harvest of yew in moose winter range and in the vicinity of Port-Orford-cedar would follow mitigation measures for moose (found at the end of this chapter) and the Port-Orford-cedar analysis process (found in Appendix C).

Regeneration

In clearcut, shelterwood, and seed-tree sale units, yew would be regenerated to preharvest or prescribed levels by planting seedlings or rooted cuttings and/or ensuring survival of residual yew on the site. No additional regeneration of yew would be required in partial-cut units and non-sale areas.

Genetic Diversity

Under this alternative, genetic reserve areas would be established. Yew harvest, or any other activity that alters the structure or composition of the stands, would not be permitted in these reserves.

Relationship to Interim Guide

Alternative C would incorporate most parts of the Interim Guide. The main difference would be that the level of harvest prescribed in this alternative for partial-cut and non-sale areas (25 percent) would be lower than the level permitted by the Interim Guide (50 percent).

Available Trees, Bark, and Needles

Approximately 1.51 to 2.27 million yew trees would be available for harvest, based on projected timber sale acres over a five-year period, the number of acres where management plans allow for yew harvest, and adjustments for other harvest restrictions. Approximately 5.58 to 8.37 million pounds of dry bark and 9.16 to 22.35 million pounds of dry needles could be removed from these trees over five years.

Sustained Yield Harvest

This alternative will meet the requirements of sustained yield. (See the Sustained Yield sections in Chapter IV-Part One and Appendix F.)

Alternative D

Alternative D emphasizes a high degree of protection of Pacific yew and the ecosystem in yew harvest areas while producing a moderate amount of bark and needles.

Alternative D would allow harvest in partial-cut sale units and non-sale areas as well as timber sale units. Harvest levels would follow those in the Interim Guide. Approximately 9.41 to 14.12 million pounds of dry yew bark and 14.28 to 37.69 million pounds of dry needles would be available under this alternative over five years. (These numbers have been adjusted to reflect additional harvest restrictions, e.g., from site-specific analysis.)

Landscape Perspective

This alternative would impact the same amount of acreage as Alternative C. Yew could potentially be harvested from an estimated 1.47 to 2.20 million acres over the next five years. No yew harvest would be allowed in areas where genetic reserves could not be established (see exceptions in the Mitigation Measures section), either within or outside of timber sale units. There would be no yew harvest in riparian areas, in the set-aside areas described below, or in the genetic reserves. Yew could be harvested from all other areas where there are more than five yew TPA in each harvested diameter class (<11, 11-20, and >20 inches stump diameter).

Harvest Locations; Level of Harvest

Alternative D would allow the harvest of 100 percent of utilizable yew in timber sale units (excluding the residual green tree reserves) and 50 percent utilizable size yew in partial-cut sale units and non-sale areas.

Locations	Yew Harvest?	Maximum Amount Harvested	Minimum Yew Left of Utilizable Size
Timber Sale Unit	Yes	100%	no minimum
Partial-Cut Sale Units	Yes	50%	5 Trees/Acre
Non-sale Areas	Yes	50%	5 Trees/Acre
Owl Conservation Areas	No	None	All

Set-Aside Areas

Yew would not be harvested in owl conservation areas, designated wilderness, or other areas in national forests or BLM districts set aside for specific purposes, nor in areas with unusual features such as uncommon parent rock or vegetation.

Protection of Yew

No yew would be harvested within 75 feet (slope distance) of the average high-water level on either side of perennial streams. At least five yew TPA in each of the three diameter classes, or 50% of the yew (whichever is greater), must be left in the partial-cut sale units and non-sale areas. Yew harvesting activities would follow the mitigation measures for Alternatives C through G2, included at the end of this chapter.

Protection of Other Resources

Streams, wildlife, and other vegetation would be protected by guidelines provided in site-specific NEPA analyses, forest plans, and BLM resource management plans. Harvest of yew in moose winter range and in the vicinity of Port-Orford-cedar would follow mitigation measures for moose (found at the end of this chapter) and the Port-Orford-cedar analysis process (found in Appendix C).

Regeneration

In clearcut, shelterwood, and seed tree sale units, yew would be regenerated to preharvest or prescribed levels by planting seedlings or rooted cuttings and/or ensuring survival of residual yew on the site. No additional regeneration of yew would be required in either partial-cut or non-sale areas following yew harvest.

Genetic Diversity

Under this alternative, genetic reserve areas would be established. Yew harvest, or any activity that alters the structure or composition of the reserve stands, would not be permitted.

Relationship to Interim Guide

Alternative D would incorporate the majority of the Interim Guide.

Available Trees, Bark, and Needles

From 2.63 to 3.94 million yew trees would be available for harvest, based on projected timber sale acres over a five-year period, the number of acres where management plans allow for yew harvest, and adjustments for other harvest restrictions. Approximately 9.41 to 14.12 million pounds of dry bark and 14.28 to 37.69 million pounds of dry needles could be removed from these trees over five years.

Sustained Yield Harvest

This alternative will meet the requirements of sustained yield. (See the Sustained Yield sections in Chapter IV-Part One and Appendix F.)

Alternative E

Dropped. (Refer to "Alternatives Considered but Not Carried Forward.")

Alternative F

Alternative F emphasizes high yew bark and needle production with moderate protection of Pacific yew and the ecosystem in yew harvest areas.

Alternative F would allow harvest in partial-cut sale units and non-sale areas as well as timber sale units. Harvest levels would exceed those in the Interim Guide. Approximately 15.87 to 23.81 million pounds of dry yew bark and 22.90 to 63.56 million pounds of dry needles would be available with this alternative over five years. (These numbers have been adjusted to reflect additional harvest restrictions, e.g., from site-specific analysis.)

Landscape Perspective

Yew could potentially be harvested from an estimated 1.47 to 2.20 million acres over the next five years. No yew harvest would be allowed in areas where genetic reserves could not be established, either within or outside of timber sale units (see exceptions in

Mitigation Measures section). There would be no yew harvest in riparian areas, in the set-aside areas described below, or in the genetic reserves. Yew could be harvested from all other areas where there are more than two yew TPA in each harvested diameter class (<11, 11 to 20, and >20 inches). This alternative would impact more acreage than Alternatives C and D, because of the two TPA minimum; harvest would be allowed in areas of more sparse yew distribution, which would not be harvested under the previous alternatives.

Level of Harvest; Location of Harvest

Alternative F would allow the harvest of 100 percent of utilizable yew in timber sale units (excluding the residual green tree reserves) and 75 percent utilizable size yew in partial-cut sale units and non-sale areas.

Locations	Yew Harvest?	Maximum Amount Harvested	Minimum Yew Left of Utilizable Size
Timber Sale Unit	Yes	100%	no minimum
Partial-Cut Sale Units	Yes	75%	2 Trees/Acre
Non-sale Areas	Yes	75%	2 Trees/Acre
Owl Conservation Areas	No	None	All

Set-Aside Areas

Yew would not be harvested in owl conservation areas, designated wilderness, or other areas in national forests or BLM districts set aside for specific purposes, nor in areas with unusual features such as uncommon parent rock or vegetation.

Protection of Yew

No yew would be harvested within 75 feet (slope distance) of the average high-water level on either side of perennial streams. At least two yew TPA in each of the three diameter classes, or 25 percent of the yew (whichever is greater), must be left in the partial-cut and non-sale areas. Yew harvesting activities would follow the mitigation measures for Alternatives C through G2, included at the end of this chapter.

Protection of Other Resources

Streams, wildlife, and other vegetation would be protected by the guidelines provided in site-specific NEPA analyses, forest plans, and BLM resource management plans. Harvest of yew in moose winter range and in the vicinity of Port-Orford-cedar would follow mitigation measures for moose (found at the end of this chapter) and the Port-Orford-cedar analysis process for Port-Orford-cedar (found in Appendix C).

Regeneration

In clearcut, shelterwood, and seed tree sale units, yew would be regenerated to preharvest or prescribed levels by planting seedlings or rooted cuttings and/or ensuring survival of residual yew on the site. There would be no additional regeneration required in partial-cut units and non-sale areas following yew harvest.

Genetic Diversity

Under this alternative, genetic reserve areas would be established. Yew harvest, or any activity that alters the structure or composition of the reserve stands, would not be permitted within reserves.

Relationship to Interim Guide

Alternative F would incorporate most parts of the Interim Guide. The main difference would be the level of harvest in partial-cut and non-sale areas prescribed (50 percent) versus the level prescribed in this alternative (75 percent) and the number of trees per acre (TPA) retained in each diameter class (five TPA in the Interim Guide and two TPA in this alternative).

Available Trees, Bark, and Needles

From 4.23 to 6.35 million yew trees would be available for harvest, based on projected timber sale acres over a five-year period, the number of acres where management plans allow yew harvest, and adjustments for other harvest restrictions. Approximately 15.87 to 23.81 million pounds of dry bark and 22.90 to 63.56 million pounds of dry needles could be removed from these trees over five years.

Sustained Yield Harvest

This alternative will meet the requirements of sustained yield. (See the Sustained Yield sections in Chapter IV-Part One and Appendix F.)

Alternative G1

Alternative G1 emphasizes efficiency of yew sale preparation and moderate to high bark and needle production, with moderate protection of yew and the ecosystem in yew harvest areas.

Alternative G1 would allow harvest in partial-cut sale units, non-sale units, and timber sale units. Harvest levels exceed those in the Interim Guide. Approximately 15.35 to 23.02 million pounds of dry yew bark and 22.20 to 61.46 million pounds of dry needles would be available under this alternative over five years. (These numbers have been adjusted to reflect additional harvest restrictions, e.g., from site-specific analysis.)

Landscape Perspective

Yew could potentially be harvested from an estimated 1.47 to 2.20 million acres over the next five years. No yew harvest would be allowed in areas where genetic reserves could not be established, either within or outside of timber sale units (see exceptions in the Mitigation Measures section). There would be no yew harvest in riparian areas, in the set-aside areas described below, or in genetic reserves. There would be only one yew tree or shrub per acre per diameter class left after harvest, allowing harvest in areas of sparse yew distribution.

Harvest Locations; Harvest Levels

Alternative G1 would allow the harvest of 100 percent of utilizable yew in timber sale units (excluding the residual green tree reserves) and 50 percent, retaining at least one tree per acre per diameter class in partial-cut sale units and non-sale areas.

Locations	Yew Harvest?	Maximum Amount Harvested	Minimum Yew Left of Utilizable Size
Timber Sale Unit	Yes	100%	No minimum
Partial-Cut Sale Units	Yes	50%	1 Tree/Acre
Non-sale Areas	Yes	50%	1 Tree/Acre
Owl Conservation Areas	No	None	All

Set-Aside Areas

Yew would not be harvested in designated wilderness, or other areas in national forests or BLM districts set aside for specific purposes, nor in areas with unusual features such as uncommon parent rock or vegetation.

Protection of Yew

No yew would be harvested within 75 feet (slope distance) of the average high-water level on either side of perennial streams. Half of each existing diameter class (<11, 11-20, >20 inches stump diameter) or one yew per acre per diameter class (whichever is greater) would be left on each acre in harvested areas. Yew harvesting activities would follow the mitigation measures for Alternatives C through G2, included at the end of this chapter.

Protection of Other Resources

Streams, wildlife, and other vegetation would be protected by the guidelines provided in site-specific NEPA analyses, forest plans, and BLM resource management plans. Harvest of yew in moose winter range and in the vicinity of Port-Orford-cedar would follow mitigation measures for moose (found at the end of this chapter) and the Port-Orford-cedar analysis process (found in Appendix C).

Regeneration

In timber sale units, yew would be regenerated to preharvest or prescribed levels by planting seedlings or rooted cuttings and/or ensuring survival of residual yew on the site. No additional regeneration would be required after bark harvesting in partial-cut units and non-sale areas.

Genetic Diversity

Under this alternative, genetic reserve areas would be established. Yew harvesting, or any activity that alters the structure or composition of the reserve stands, would not be permitted within reserves.

Relationship to Interim Guide

Alternative G1 would incorporate most parts of the Interim Guide. The main differences would be the number of trees per acre or TPA retained in each diameter class (five TPA in the Interim Guide, and one TPA required under this alternative).

Available Trees, Bark, and Needles

From 3.14 to 4.71 million yew trees would be available for harvest, based on projected timber sale acres over a five-year period, the number of acres where management plans allow yew harvest, and adjustments for other harvest restrictions. Approximately 15.35 to 23.02 million pounds of dry bark and 22.20 to 61.46 million pounds of dry needles could be harvested from these trees over five years.

Sustained Yield Harvest

This alternative will meet the requirements of sustained yield. (See the Sustained Yield sections in Chapter IV-Part One and Appendix F.)

Alternative G2

Alternative G2 emphasizes efficiency of yew sale preparation as well as entry into owl conservation areas (and other areas) to provide the highest level of bark and needle production, with moderate protection of Pacific yew and the ecosystem in yew harvest areas.

Alternative G2 would allow harvest in owl conservation areas as well as partial-cut sale units, non-sale units, and timber sale units. If selected, consistency with the current spotted owl decision would have to be evaluated and referred to the Interagency Scientific Oversight Group for final resolution. Harvest levels exceed those in the Interim Guide. Approximately 18.89 to 28.33

million pounds of dry yew bark and 26.93 to 75.63 million pounds of dry needles would be available under this alternative over five years. (These numbers have been adjusted to reflect additional harvest restrictions, e.g., from site-specific analysis.)

Landscape Perspective

This alternative would impact the largest area. Yew could potentially be harvested from an estimated 2.31 to 3.47 million acres over the next five years, including owl conservation areas. No yew harvest would be allowed in areas where genetic reserves could not be established, either within or outside of timber sale units (see exceptions in the Mitigation Measures section). There would be no yew harvest in riparian areas, in the set-aside areas described below, or in genetic reserves. Except in owl conservation areas, there would be only one yew tree or shrub in each diameter class left on each acre after harvest, allowing harvest in areas of more sparse yew distribution.

Harvest Locations; Harvest Levels

Alternative G2 would allow the harvest of 100 percent of utilizable yew in timber sale units (excluding the residual green tree reserves); up to 50 percent, retaining one tree per acre per diameter class, in partial-cut sale units and non-sale areas; and up to 50 percent, retaining five trees per acre per diameter class in some areas within owl conservation areas.

Locations	Yew Harvest?	Maximum Amount Harvested	Minimum Yew Left of Utilizable Size
Timber Sale Unit	Yes	100%	No minimum
Partial-Cut Sale Units	Yes	50%	1 Tree/Acre
Non-sale Areas	Yes	50%	1 Tree/Acre
Owl Conservation Areas	Yes	50%	5 Trees/Acre

Set-Aside Areas

Yew would not be harvested in designated wilderness, or other areas in national forests or BLM districts set aside for specific purposes, nor in areas with unusual features such as uncommon parent rock or vegetation.

Protection of Yew

No yew would be harvested within 75 feet (slope distance) of the average high-water level on either side of perennial streams. Half of each existing diameter class (<11, 11-20, >20 inches stump diameter) or one yew per diameter class, whichever is greater, would be left on each acre in partial-cut sale units and non-sale areas. At least five yew TPA in each of the three diameter classes must be left in owl conservation areas. Yew harvesting activities would follow the mitigation measures for Alternatives C through G2, included at the end of this chapter.

Protection of Other Resources

Streams, wildlife, and other vegetation would be protected by the guidelines provided in site-specific NEPA analyses, forest plans, and BLM resource management plans. Harvest of yew in owl conservation areas and in moose winter range would follow mitigation measures found at the end of this chapter. Yew harvest in the vicinity of Port-Orford-cedar would follow the Port-Orford-cedar analysis process found in Appendix C.

Regeneration

In timber sale units, yew would be regenerated to preharvest or prescribed levels by planting seedlings or rooted cuttings and/or ensuring survival of residual yew on the site. No additional regeneration would be required after bark harvesting in partial-cut units, non-sale areas, and owl conservation areas.

Genetic Diversity

Under this alternative, genetic reserve areas would be established. Yew harvesting, or any activity that alters the structure or composition of the reserve stands, would not be permitted within reserves.

Relationship to Interim Guide

Alternative G2 would incorporate most parts of the Interim Guide. The main differences would be entry into owl conservation areas, and the minimum TPA retained in partial-cut and non-sale areas

(one TPA per diameter in this alternative, compared to a minimum of five TPA prescribed in the Interim Guide).

Available Trees, Bark, and Needles

From 4.22 to 6.33 million yew trees would be available for harvest, based on projected timber sale acres over a five-year period, the number of acres where management plans allow yew harvest, the number of available acres within owl conservation areas, and adjustments for other harvest restrictions. Approximately 18.89 to 28.33 million pounds of dry bark and 26.93 to 75.63 million pounds of dry needles could be harvested from these trees over five years.

Sustained Yield Harvest

This alternative will meet the requirements of sustained yield. (See the Sustained Yield sections in Chapter IV-Part One and Appendix F.)

Summary of the Comparison of the Effects of the Alternatives

Table II-1 compares the seven alternatives based on the issues and suggestions presented to the interdisciplinary team. These are:

- Provide taxol (Issue);
- Protect Pacific yew (Issue);
- Protect the ecosystem (Issue);
- Establish a sustainable collection level (Suggestion);
- Socioeconomic concerns (Suggestion); and
- Establish areas of collection (Suggestion).

The table is organized with the above issues and suggestions as major headings, and the resource areas listed below each relevant issue as a subheading.

A discussion comparing the effects of the seven alternatives is provided following Table II-1.

Table II-1: Comparison of the Effects Between Alternatives

MAIN ISSUES: Provide Taxol, Protect the Ecosystem and the Yew	ALTERNATIVES						
	A (No Action)	B (Preferred) Timber Sales Only	C 25%, 5 TPA	D 50%, 5 TPA	F 75%, 2 TPA	G1 50% 1 TPA	G2 50%, 1 TPA, OCAs
a. Landscape Patterns							
--probability of reducing yew population connectivity	low risk	low risk	low risk	low risk	moderate risk	moderate risk	moderate risk
--probability of reducing the range of yew	low risk	low risk	low risk	low risk	low risk	low risk	low risk
b. Biology of Yew							
--seed production	moderate reduction	minor reduction	minor reduction	minor reduction	minor to moderate reduction	minor to moderate reduction	minor to moderate reduction
--vegetative reproduction	moderate reduction	minor reduction	minor reduction	minor reduction	minor reduction	minor reduction	minor reduction
--needle regeneration	not applicable	not applicable	no effect	no effect	minor impact	minor impact	minor impact
--planting	no planting	planting if needed	planting if needed	planting if needed	planting if needed	planting if needed	planting if needed
c. Genetics of Yew							
--change in overall genetic variation (based on before and after harvest; probability of losing rare alleles)	minor reduction	none	none	minor reduction	moderate reduction	minor reduction	minor reduction
--effects on heterozygosity of next generation (future breeding, education and aesthetic values)	minor	none	minor	minor	high	moderate	moderate
--effects on genetic erosion at edges	continued erosion	none	reduced (positive change)	reduced (positive change)	reduced (positive change)	reduced (positive change)	reduced (positive change)
d. Insects and Diseases							
--change in incidence of pests on Pacific yew	no change	minor increase	minor increase	minor increase	minor increase	minor increase	minor increase
--Port-Orford-cedar root disease impact on yew	no impact	minor impact	minor impact	minor impact	minor impact	minor impact	minor impact
e. Fire							
--risk of increased fire occurrence	minor	minor	*minor	*minor	*minor to moderate	*minor to moderate	*minor to moderate
			<-----*(depends on yew density and harvest percentage)------>				
--impact of yew harvest on yew survival and regeneration following fire	moderate to high decrease	minor decrease	*minor decrease	*minor decrease	*minor to moderate decrease	*minor to moderate decrease	*minor to moderate decrease
			<-----*(depends on yew density and harvest percentage)------>				

Table II-1: Comparison of the Effects Between Alternatives

MAIN ISSUES: *Provide Taxol, Protect the Ecosystem Protect Yew (continued)*	ALTERNATIVES						
	A (No Action)	B (Preferred) Timber Sales Only	C 25%, 5 TPA	D 50%, 5 TPA	F 75%, 2 TPA	G1 50%, 1 TPA	G2 50%, 1 TPA, OCAs
f. Ecosystem --potential for negative impact on ecosystem structure and function	low risk	low risk	low risk	low to moderate risk	high risk	moderate risk	moderate risk
g. Biodiversity --loss of diversity	some loss of diversity	little or no loss	little or no loss	little or no loss	little or no loss	little or no loss	little or no loss
h. Soils --potential for impact on soils (1 = least; 6 = most)	no impact	1	2	3	4	5	6
i. Water and Aquatic Habitat --impact on resource	no impact	no impact	negligible to minor	negligible to minor	negligible to minor	negligible to minor	negligible to minor
j. Wildlife --composite risk to wildlife in late successional forests	minor	minor	minor	minor	high	moderate	moderate
--composite risk to wildlife in early successional forests	minor	minor	minor	minor	minor	minor	minor
--composite risk to wildlife in riparian areas	none	none	none to minor	none to minor	none to minor	none to minor	none to minor
k. Threatened and Endangered Species --potential for impacts to T&Es	minor	minor	minor	moderate	moderate to high	moderate	moderate
l. Northern Spotted Owl --potential for impacts on prey species	minor	minor	minor	minor	moderate	minor	moderate to high
--potential for impacts on roosting habitat	none	none	moderate	moderate	high	moderate	moderate to high
m. Forest Health --impact to forest health	minor	*minor	*minor	*minor	*minor	*minor	*minor
	*(increased impact on forest health with amount of yew harvested)						

Table II-1: Comparison of the Effects Between Alternatives

SUGGESTION: Establish Sustainable Collection Level	ALTERNATIVES						
	A (No Action)	B (Preferred) Timber Sales Only	C 25%, 5 TPA	D 50%, 5 TPA	F 75%, 2 TPA	G1 50% 1 TPA	G2 50% 1 TPA, OCAs
a. Number of Available Trees	0	0.26-0.39 MM	1.51-2.27 MM	2.63-3.94 MM	4.23-6.35 MM	3.14-4.71 MM	4.22-6.33 MM
b. Sustained Yield	<----------All alternatives meet sustained yield.---------->						
c. Available Bark from Federal Lands Over Five Years (in lbs.)	0	1.29-1.93 MM	5.58-8.37 MM	9.41-14.12 MM	15.87-23.81 MM	15.35-23.02 MM	18.89-28.33 MM
SUGGESTION: Consider Socioeconomic Concerns							
a. Public Health and Safety							
--bark availability in pounds from federal lands per year	0	3-.4 MM	1.1-1.7 MM	1.9-2.8 MM	3.2-4.8 MM	3.2-4.6 MM	3.8-5.7 MM
--taxol available for clinical trials, per year, in kilograms, based on bark from federal lands (15,000 lbs. bark= 1 kilogram)	0	17.3-26.0 kilos	73.3-113.3 kilos	126.6-186.7 kilos	213.3-320.0 kilos	213.3-306.7 kilos	253.3-380.0 kilos
--potential patients treated per year, based on bark from federal lands (assuming 1 kilogram treats 480 patients)	0	8,300-12,400	35,184-54,384	60,768-89,616	102,384-153,600	102,384-147,216	121,584-182,400
--injuries to forest workers	none	0-5	0-10	0-15	0-25	0-25	0-30
b. Social Setting-- Groups Affected	*Jobs-Related*						
--bark harvester jobs (seasonal)	no job creation	75-113	347-521	566-849	937-1,406	909-1,363	1,113-1,669
--traditional woodworkers and yew log purchasers	no effect	<----------minor effect---------->					
	Recreationists						
--hikers, campers, hunters	no effect	<----------minor effect---------->					
	Native Americans						
--ceremonial, cultural, traditional use of wood	Effects on uses would be minor. Spiritual and medicinal value effects must be assessed after local consultation.						
c. Women and Other Minorities	slight negative	<----------positive if demand met---------->					

MM=millions
M=thousands

Table II-1: Comparison of the Effects Between Alternatives

SUGGESTION: Consider Socioeconomic Concerns (continued)	ALTERNATIVES						
	A (No Action)	B (Preferred) Timber Sales Only	C 25%, 5 TPA	D 50%, 5 TPA	F 75%, 2 TPA	G1 50%, 1 TPA	G2 50%, 1 TPA, OCAs
d. Social Setting -- Geographic Areas Affected							
--areas where yew is processed	no effect	*small benefit	*small benefit	*small benefit	*small benefit	*small benefit	*small benefit
	<----------*(some jobs created spread throughout a five-state area; positive community feelings associated with beneficial activity)---------->						
--areas where yew is not processed	no effect	no effect	no effect	no effect	no effect	no effect	no effect
e. Economics (average annual)							
--government expenditures associated with bark harvest	$0	$0.3 MM	$5.9 MM	$5.9 MM	$5.9 MM	$2.9 MM	$4.6 MM
--stumpage values of other commercial species	no effect	possible decrease	possible decrease	possible decrease	possible decrease	possible decrease	possible decrease
--potential receipts to government	none	$0.1-0.2 MM	$0.3-0.7 MM	$0.6-1.1 MM	$1.0-1.9 MM	$0.9-1.8 MM	$1.1-2.3 MM
--potential returns to counties	none	<$0.1 MM	$0.1-0.2 MM	$0.1-0.3 MM	$0.2-0.5 MM	$0.2-0.4 MM	$0.3-0.4 MM
SUGGESTION: Establish Areas of Collection							
a. Types of Areas							
--owl conservation areas	no	no	no	no	no	no	yes
--wilderness	no	no	no	no	no	no	no
--research natural areas	no	no	no	no	no	no	no
--riparian areas	no	no	no	no	no	no	no
--other special mgmt. areas (i.e. old growth, national recreation areas)	<---------- According to Forest and District Plans ---------->						
--timber sale units	no	yes	yes	yes	yes	yes	yes
--partial cut sale units	no	no	yes	yes	yes	yes	yes
--non-sale area	no	no	yes	yes	yes	yes	yes
--unique rock and special areas	<---------- According to Forest and District Plans ---------->						
b. Travel and Access							
--impact by yew harvest	no change	some impact (roads may be required)	same as B	same as B	same as B	same as B	same as B

MM=Millions
M=Thousands

Discussion of the Comparison of the Effects of the Alternatives

This section presents a summary of the comparison of effects between proposed alternatives. The discussion is organized by issue and suggestion and pertains to the table above. For a full discussion of the potential environmental effects of each alternative, refer to Chapter IV.

Issues: Provide Taxol, Protect the Pacific yew, and Protect the Ecosystem

Landscape Patterns

Alternative A This alternative would have a low risk of impact on yew population connectivity and the range of Pacific yew. Some Pacific yew would be destroyed in timber sale units, but yew would continue to exist in the harvested areas under the forest and resource plans and the principles of ecosystem management.

Alternative B There would be a low risk of impact on yew population connectivity and the range of yew under this alternative. Yew would be regenerated and the long-term distribution of the species would be maintained. Due to the relatively small size of the harvested areas and the small amount of acreage impacted over the five-year harvest period, there should be only a low risk of reducing yew population connectivity.

Alternatives C and D No yew harvest would be allowed in areas where genetic reserves cannot be established or where there are not at least five trees per acre (TPA) in each harvestable diameter class. This would preclude yew harvest at the peripheries of the species' range, and there would be a low risk of impact on the range of yew. A significant proportion of Pacific yew would be retained throughout the landscape and there would be a low risk of impact to population connectivity.

Alternatives F through G2 Yew harvest would not be allowed in areas where genetic reserves cannot be established. The peripheries of the species' range would be protected and there would be a low risk of impacts on the Pacific yew geographic range. Harvest would be allowed in areas of sparse yew distribution (if reserves could be found), where there are less then five TPA in each harvestable diameter class, posing a

moderate risk to landscape connectivity. The 75 percent reduction in the yew population across the landscape under Alternative F increases the risk of impact to population connectivity.

Biology of Yew: Reproduction and Regeneration

Alternative A

Some yew would be destroyed or damaged, thus reducing potential seed sources, particularly in areas of sparse populations. Vegetative reproduction (sprouting, layering) would also be impacted to some extent, particularly where environmental conditions are harsher. No special provisions for yew protection and regeneration are included in this alternative.

Alternative B

Harvest of yew in timber sale units would remove most of the seed producing yew, thus delaying seed production until residual yew or planted yew grow to reproductive size. In many cases, adequate seed would be produced in the interim by yew adjacent to the units, or yew retained as seed trees. Some of the remaining yew stumps and seedlings would be protected; therefore the impact on vegetative reproduction would be minor.

Alternatives C through G2

Yew would be replanted in timber sale units and some stumps and seedlings would be protected. An average of 70% of the stumps left after harvest may resprout.

Alternatives C and D

Harvest of yew at the 25 percent and 50 percent levels in partial-cut and non-sale areas would not adversely affect the reproduction/regeneration potential. The removal of no more than half of the foliage on 25 percent or 50 percent of the yew would not adversely affect needle regeneration.

Alternatives F, G, and G2

Harvest of yew at the 75 percent level or 50 percent level with one or two TPA retained may affect regeneration. There would be a moderate decrease in seed production under these alternatives. This would have a greater effect in more sparse areas where there may not be adequate numbers of sexually mature trees left following harvest as potential seed producers. The removal of half the foliage on 75 percent of the trees in Alternative F may impact needle regeneration slightly.

Genetics

Alternative A No efforts would be made to maintain genetic diversity under this alternative. This may result in a small decrease in levels of genetic variation as small populations on the periphery as well as in the center of the range may not maintain themselves. Some populations containing unique genetic combinations could be lost, which would affect the ability of subsequent generations to adapt to changing environments, as well as reduce the yew's potential for use in breeding programs.

Alternative B Alternative B would have less impact on genetic diversity and potential contribution to breeding programs than Alternative A, because provisions are made for the protection of individual yew in harvest units, and units are regenerated to preharvest or prescribed levels. This ensures the survival of more genotypes in populations. Current erosion of small, peripheral populations would be halted under this alternative.

Alternatives C through G2 Under these alternatives, genetic reserves would be established in harvest areas in order to protect genetic diversity. Slight reductions in genetic variation could occur, however, as larger proportions of trees are harvested. Thus, in Alternative C (25% harvest) there would be no reduction in overall genetic variation. The reduction potential would increase slightly for Alternative D, and for each alternative as larger proportions of trees are harvested.

The current erosion of genetic variation peripheral yew populations would be halted or reversed under these action alternatives.

Gene conservation for use in future breeding programs would remain unchanged in Alternatives C and D, but would be reduced for Alternative F, G1, and G2 because of reduced overall genetic variation in future generations.

Insect and Diseases

There would be no change in what are considered insignificant levels of impact on insects and diseases. ***Alternative A***

All alternatives proposing harvest would have an estimated minor impact on insect and disease populations. Harvest in areas that contain Port-Orford-cedar (POC) must follow the mitigation measures specified under the POC analysis process, intended to reduce or prevent the spread of POC root disease. ***Alternatives B through G2***

Fire

Risk of wildfire would remain unchanged, due primarily to fuels treatment on sale units. However, survival and regeneration of yew could be quite poor on some sites where fire is used for site preparation, as there would be no attempt made to pull slash away from yew trees, stumps or seedlings or change burning prescriptions to protect yew in the site. ***Alternative A***

For the same reasons described under Alternative A, there would be no increased risk of wildfire under this alternative. There would, however, be a higher probability for survival and regeneration of yew following fire for site preparation or other purposes, because there would be an attempt to protect and replant wherever residual survival was poor. Some yew may be damaged or killed by site preparation fires due to site-specific conditions or lack of knowledge or experience in protecting yew from fire; but the probability of affecting the current distribution of yew is minor. ***Alternative B***

The increased risk of wildfire occurrence, due to yew harvest, would be minor to moderate under these alternatives, varying with the level of harvest and density of yew (generally higher for those alternatives that harvest higher levels of yew). The probability of survival and regeneration of yew following fire for fuels or site preparation treatment would be high to moderate, decreasing as the amount of slash and the number of people involved in the harvesting increases. ***Alternatives C through G2***

Ecosystem

Alternatives A and B The impacts of 100% yew removal (under Alternative B) or loss of some of the yew in harvest units (under Alternative A) on ecosystem structure and function would be minimal compared to the effects of the timber harvest itself. Pacific yew would be a part of the regenerating stand. There would be less risk of impact in timber sale units which retained yew in green tree reserves.

Alternatives C through G2 The impacts of yew harvest on ecosystem structure and function would vary from stand to stand depending on the presence of substitute species and structures. Risk of impact increases with the amount of yew that is harvested. Alternative C (with 25% yew removal) would have a low risk of impact, Alternative D (with 50% yew removal) would have a low to moderate risk of impact, and Alternative F (with 75% yew removal) would have a high risk of impact to ecosystem structure and function. Alternatives G1 and G2, while only harvesting 50% of the yew, would have a moderate risk of impacting the ecosystem due to the harvest of more of the larger yew trees and to harvest in areas of sparse yew distribution. Alternative G2, with harvest in spotted owl conservation areas, would have the most impact on old-growth ecosystems.

Biodiversity

Alternative A There could be some loss in genetic and species diversity in areas where yew is sparse, due to potential loss of unique populations in these areas (refer to Genetics section).

Alternatives B through G2 There would be little or no impact on biodiversity under each of the action alternatives. As stands regenerate and abundance of yew increases again, the contributions to genetic, species and community diversity would increase.

Soils, Water and Aquatic Habitat

Alternative A There would be no additional impact to forest soils under the current standards and guidelines of forest plans and BLM resource management plans. Similarly, there would be no added impact to water and aquatic habitat.

Alternatives B through G2

Impacts on the soil resources are expected to be minimal under current standards and guidelines of forest plans and BLM resource management plans. The risk of impact would increase proportionately with the level of yew harvest. Alternative B, therefore, would have the least amount of impact; Alternative C would have the next largest impact, followed by Alternative D, then F, then G1 and G2.

The effect of yew harvest on water and aquatic habitat is expected to be negligible to small, especially with mitigation measures in place.

Wildlife

Alternative A

The effects on plant and animal populations would probably not be significant in most cases. Animal species diversity might be reduced over time because of the incremental loss of yew from the understory of many timber sale units. This would also lead to changes in the mid-story vegetative structure and possible changes in animal species distribution and abundance compared with forest areas of comparable age.

Alternatives B through G2

Yew harvesting in late-successional forests would change the character of the habitat, which could affect some species. The risk of impacts would probably be minor to moderate, increasing as the level of harvest increases. In general, removal of 50% or less of the yew in the area (Alternatives B through D) has a low probability of reducing or removing species from the area, whereas removal of 75% of the yew population could have a moderate effect on some species abundance.

In most cases there would probably be no significant effect on early successional forest species or riparian species under any of the action alternatives except that caused by other activities.

Very little information is available about the role yew has in providing for wildlife habitat. This could result in a substantial risk to wildlife if large areas of yew were harvested in a short time frame that would not allow developing problems to be identified.

Threatened and Endangered species

Alternative A There would be no added impact to threatened and endangered species associated with Alternative A beyond that of timber sales.

Alternatives B through G2 A potential exists for impacts to threatened and endangered populations under all action alternatives, increasing proportionately with the level of yew harvest.

The potential exists for positive and negative impacts (minor to moderate in intensity) to ungulates and associated predator populations under all action alternatives. The level of impact increases proportionately with the level of yew harvest. In certain cases the positive and negative impacts could cancel each other out (i.e., the decrease in thermal cover from yew and timber harvest could be partially or completely mitigated by the increase in forage from yew sprouting and the increase in forage from opening the canopy), depending on local conditions.

There is potential for minor negative impacts to fish species under all action alternatives that increases proportionately with the level of yew harvest.

The potential exists for positive and negative impacts (minor to moderate in intensity) to avian populations and associated predator populations under all action alternatives. The level of impact increases with the level of yew harvest, but is site-specific in some cases.

Northern Spotted Owl

Alternatives A and B There would be little or no impacts on spotted owls and their habitat under these alternatives, because there would be no habitat disturbance in addition to that normally occurring from implementing forest plans or BLM resource management plans.

Alternatives C through G2 Negative impacts both on prey species and on roosting habitat for spotted owls would increase with the level of harvest. The intensity of the impact would depend on the proportion of yew in the stand and how much is harvested. Alternatives C, D, F and G1 permit harvest within suitable habitat, including removal of a

portion of the midstory before scheduled timber harvest. The greatest negative impacts would be possible under Alternative G2, because the largest area is available for harvest and includes harvest within owl conservation areas.

Forest health

Alternative A

There would be little or no change in forest health equilibrium under the present guidelines for ecosystem management. Although the numbers of yew trees in harvested stands would decline, it is unlikely that those populations would disappear.

Alternatives B through G2

There is an increased impact on ecosystem forest health with the amount of yew harvested. However, mitigation measures for the protection of Pacific yew populations would maintain yew at acceptable threshold levels, no matter what percentage of yew is harvested. Impact on ecosystem forest health is therefore considered minor.

Suggestion: Establish Sustainable Collection Level

Alternative A

No federal yew for taxol would be available under this alternative. Therefore, there would be minor impacts on the yew population on federal lands although impacts to the yew population on non-federal lands could be significant.

Alternative B

From 0.26 to 0.39 million yew could be harvested from federal lands with this alternative. This would have minor impacts on the yew population on Forest Service and BLM lands. This alternative will meet the requirements of a sustained yield level of harvest (see "Chapter III, Part One" and "Chapter IV, Part One," Sustained Yield sections).

Alternatives C through G2

The amount of yew harvested on federal lands under these alternatives would range from 1.51 to 6.33 million. The impact on the total yew population ranges from 3 percent to 12.7 percent of the total inventoried yew population on Forest Service and BLM lands. These alternatives would also meet the requirements of a sustained yield harvest level.

Suggestion: Consider Socioeconomic Concerns

Public Health and Safety

Alternative A Because there would be no yew harvested from federal lands under this alternative, there would be no yew bark or taxol available from federal sources and no potential for treating patients with taxol derived from federal yew. There would be no increase in injuries to forest workers associated with yew bark collection on federal lands.

Alternatives B through G2 Refer to the summary table for preliminary data on bark availability and potential patients treated by alternative.

There would be a small potential for injuries to forest workers associated with each of the action alternatives.

Social Setting: Groups Affected

Alternative A No additional job opportunities would be created for forest workers and log purchasers. There would be no effect to recreational or Native American uses of the Pacific yew or the forest.

Women and other minorities would experience a slightly negative effect if the demand for taxol could not be met through other sources.

Alternatives B through G2 Some seasonal employment would be generated under all action alternatives. The yew program is not expected to affect access to logs or supply of logs for timber workers and log purchasers.

Recreationists may experience minor effects in the form of visual degradation.

Effects on Native American uses could be minor under these alternatives. Spiritual and medicinal effects must be assessed after local consultation.

Women and other minorities would experience positive effects given that the yew bark supplied would contribute to current demand.

Social Setting: Geographic Area

There would be no effect on the social/geographical setting associated with this alternative. (See Table II-1.) ***Alternative A***

Some small benefit to the social setting could result under the action alternatives, due to some jobs created, but unevenly distributed in the five-state region, and positive feelings associated with yew harvest programs. ***Alternatives B through G2***

Economics

There would be no government expenditures or returns, and no jobs created as a result of yew bark harvest from federal lands. Bark harvesting jobs would increase on other ownerships in response to yew bark demand. This alternative is not responsive to yew bark demand from federal lands. ***Alternative A***

Under each of the action alternatives, government expenditures vary with the amount of harvest, the number of acres accessed, and the guidelines for establishing the number of trees retained on each acre. Alternatives C through F require specified numbers of yew trees to be maintained by diameter class which increases survey and layout costs above Alternatives G1 and G2. Yew bark would be sold at market value. Potential revenues returned to the government vary between $100,000 and $2,300,000. ***Alternatives B through G2***

The increase in jobs associated with yew bark harvest varies between 75 and 1700 bark harvesters per year and is directly related to the amount of available bark.

Increased protection of yew in timber sale areas increases commercial harvesting costs resulting in slight decreases in stumpage values received by the federal government. There is also a potential for slight reductions in long-term commercial forest production if yew protection results in substandard site preparation.

Alternative B would meet the demand experienced in 1993, but would not meet the demand seen in previous years. Alternatives C through G2 would allow for bark harvest at levels that would meet the demand seen in previous years.

Suggestion: Establish Areas of Collection

Areas and Access

Alternative A There would be no new areas established and no change in access to the forest under this alternative.

Alternatives B through G2 Some increase in access to timber sale units, partial-cut units, and non-sale areas could occur with each of the action alternatives, as road or trail construction and upgrading may be required.

Mitigation Measures for Yew Harvest

This section describes a number of mitigation measures which accompany the alternatives. The mitigation measures help define each alternative by describing more specifically how the yew is to be harvested, protected, and regenerated under each alternative.

The mitigation measures are based on the recommendations of the Pacific Yew Technical Committee, the group of scientists who wrote "An Interim Guide to the Conservation and Management of Pacific Yew," using the most current and accurate information available (USDA, Forest Service 1992a).

Terms to Know

"Tree form yew"— *Upright yew plants exhibiting apical dominance, usually with only one main stem. Tree form yew typically grows taller than shrub form yew, with larger diameter stem(s).*

"Shrub form yew"— *Those yew plants with a more brush-like form, having multiple, smaller diameter stems, none of which exhibit apical dominance. Shrub form yew are typically shorter than tree form yew.*

"Timber sale unit"— *an area within a timber sale which has a silvicultural prescription for a (1) clearcut, (2) shelterwood, or (3) seed tree harvest method. It also can be an area where yew would otherwise be destroyed by road building, prescribed fire, or similar activities.*

"Partial-cut sale unit"— *an area within a timber sale which has a silvicultural prescription to cut only part of a stand. Techniques which involve "partial cutting" include thinning, salvage operations, and prescriptions designed to produce an uneven-aged stand of trees.*

"Non-sale area"— *an area in a national forest or district where no timber sales, as described in above definitions, are scheduled in the next five years, but where yew harvest is allowed according to land use plans.*

"Local management area"— *is used for Forest Service lands and refers to an area not larger than about 20,000 acres, or to "one National Forest System Watershed (fourth or fifth-order stream basin)." (Refer to Forest Service Handbook 2509.24.)*

"Tree seed zones"— *are used for BLM lands and refer to the areas established by the Western Forest Tree Seed Council; they delineate areas of similar climatic and geographic conditions.*

For definitions of ***"Clearcut," "Shelterwood Cut," "Seed Tree Cut,"*** *refer to the Glossary section of this EIS.*

Mitigation Measures for Alternative B

Timber Sale Units

- If a timber sale is planned in a unique area where the only yew in the drainage is located in the sale area, then mitigation is required to assure the protection of this yew. The purpose for this would be to protect the genetic importance of this unique population from timber sale unit locations.

- Consider including vigorous, undamaged yew trees or shrubs in the green tree reserves whenever possible.

- Harvest yew only where practical (i.e. sufficient number of stems of utilizable size).

- Where yew harvest is planned, harvest yew in the sale unit prior to the harvest of other species, to the extent that timber harvesters' health and safety will not be jeopardized. Preharvesting may be accomplished by decking yew logs in specific locations within the sale unit during logging operations.

- Harvest yew that is not in the residual green tree reserve.

- Do not harvest yew for the primary purpose of yew products within 75 feet slope distance from the average high-water level of a perennial stream. Where forest plans, resource management plans, or other plans or prescriptions set wider streamside buffers, these greater buffers will be adhered to.

- Site-specific prescriptions will identify logging systems, site preparation and fuels reduction treatments, and conifer regeneration plans with regard to yew survival and regeneration.

- Use one or more of the following methods to maintain or replace yew on the site at preharvest levels. Where preharvest yew densities are estimated to be greater than 50 yew plants per acre, then a minimum of 50 yew plants per acre will be prescribed in a site-specific prescription.

    1. **Retain and protect**...as much of the residual yew (stumps, trees, shrubs, advanced regeneration remaining after harvest) as possible and practical from post-harvest activities such as slash piling and burning. Plan logging systems and slash disposal methods which favor the survival of residual yew plants and stumps, e.g., grapple

piling or combined machine and burning methods or special burn prescriptions. Include retention of yew and yew stumps as one of the prescribed fire objectives in burning plans. Leave litter and down wood in those patches for seedling establishments.

Site preparation treatments that favor yew regeneration generally fall in the following order of preference (local site analysis and ongoing research results will determine the final choice of treatment):

a. No post-harvest site preparation.

b. Low intensity mechanical site preparation which maintains patches of undisturbed ground including yew stumps and residual yew shrubs.

c. Slashing, where resulting fuel hazards are acceptable, in lieu of burning.

d. Cool burning prescriptions to maintain duff on site and limit mineral soil exposure (a cool burn would retain more duff and expose 10-20% mineral soil).

e. Yarding of whole trees or unmerchantable timber (YUM) prior to burning to facilitate slash disposal (by reducing fuel loading and the resulting burn intensities). Slash from yew harvest could be spot piled away from residual plants and stumps.

f. High intensity burning will be a last resort, when other methods will not meet management objectives.

Protect yew stumps by the following procedures:

a. To facilitate sprouting, leave yew tree stumps at the scientifically recommended height (currently 12"). Yew shrubs should be cut to leave a similar length from the root collar; generally this can be met by cutting shrubs where the stem emerges from the duff.

b. Leave bark intact on yew stumps.

c. Wherever possible and practical, shade yew stumps with slash or adjacent vegetation and position reserve green trees to provide shade for yew stumps and advanced yew regeneration. Shading is not nor-

mally required on shrub form yew; site-specific analysis may help determine how much shading is needed.

2. **Encourage seed germination**...(from seed already present on site) by using any site preparation methods known to favor yew seed germination and establishment. Site-specific prescriptions will provide seed sources and desired site conditions for natural regeneration of yew and protect concentrations of existing yew where feasible, while still meeting other management objectives. Where on-the-ground conditions preclude this, planting of yew will be prescribed.

3. **Plant seedlings**...according to site-specific prescription, if prescribed regeneration of yew has not been achieved and there is assurance that regeneration by other means is not occurring. Obtain rooted cuttings or seedlings from sources within the local management area. Cuttings could be collected before harvest. Animal protection measures need to be considered where browsing of young yew is predicted. Refer to "An Interim Guide to the Conservation and Management of Pacific Yew," page 27, for transfer of genetic material guidelines.

- *Monitoring:* Where possible, monitor yew regeneration in conjunction with normal regeneration and other area surveys.

- *Seasonal Restrictions for Listed Species:* Pacific yew harvest will follow the appropriate seasonal restrictions for the affected listed species indicated during the project level (site-specific) Section 7 formal consultation required by the Endangered Species Act.

- *Utilization of Yew Material:* Follow current Forest Service and BLM policies for utilization of yew wood, bark, and needles. These policies may differ between Forest Service regions or national forests or between BLM districts.

- *Transfer of Yew, Administration of Permits, and Theft Prevention:* Follow current Forest Service and BLM policies.

- *Tribal Treaties:* Comply with all Native American tribal treaties and consult with tribes where yew harvest may impact trust lands.

All Sites

- *Conditions for Harvesting:* In order to harvest yew in a local management area or tree seed zone, genetic reserve sites of 20 to 100 acres within that management area should be established first. Reserves should have at least an effective population size of 500 sexually mature trees (may require census numbers larger than 500) that show evidence of reproductive buds. The trees should be at least 25 feet apart. Genetic reserve areas are established for every 1,000-foot (BLM) or 2,000-foot (Forest Service) elevation band in each management area where yew is present in sufficient numbers. Reserve areas may be located within larger reserve systems such as northern spotted owl conservation areas, designated wilderness, selected old growth areas or Research Natural Areas. BLM elevation bands were established at 1,000-feet intervals to compensate for the intermingled private lands which often are barren of reproductive yew.

- If there are not sufficient yew in a local management area or tree seed zone to meet the above criteria, no yew would be harvested and existing populations would be protected as much as practical from other activities, except as provided below.

Sites Where There is Insufficient Yew for Yew Harvest

- Protect this yew by avoiding damage to it and maintaining or providing shade whenever practical or necessary.

- In some instances, yew may be harvested in local management areas or tree seed zones where there are not enough yew to establish a reserve area and, therefore, a yew harvest program. For example:

  Prior to a timber sale, road construction activity, prescribed fire, or other approved activities, remove yew that is in danger of being killed by the activities.

  Salvage yew that is inadvertently killed by management activities or by natural causes.

- If yew is killed during other activities, regenerate it to achieve the yew densities consistent with management objectives.

Sites Where There is Sufficient Yew for Yew Harvest

Both Sale and Non-sale Areas

- *Genetic Reserves:* Establish genetic reserve areas as described above under "Conditions for Harvesting."

- *Riparian Areas:* Do not harvest yew for the primary purpose of yew products within 75 feet slope distance from the average high-water level of a perennial stream. Where forest plans, resource management plans, or other plans or prescriptions set wider stream-side buffers, the greater buffers will be adhered to.

- *Seasonal Restrictions for Listed Species:* Pacific yew harvest will follow the appropriate seasonal restrictions for the affected listed species indicated during the project level (site-specific) Section 7 formal consultation required by the Endangered Species Act.

- *Utilization of Yew Material:* Follow current Forest Service and BLM policies for utilization of yew wood, bark, and needles. These policies may differ between Forest Service regions or national forests or between BLM districts.

- *Transfer of Yew, Administration of Permits, and Theft Prevention:* Follow current Forest Service and BLM policies.

- *Tribal Treaties:* Comply with all Native American tribal treaties and consult with tribes where yew harvest may impact trust lands.

Timber Sale Units

- Follow Mitigation Measures for Alternative B.

Partial-Cut Units/Non-sale Areas

Both Tree and Shrub Form Yew

- *Prioritization of Harvest Areas:* In areas where no clearcut, shelterwood, or seed tree timber sales are planned, stands containing yew will be prioritized for yew harvest. Stand priority order will vary from area to area. Low priority stands will be harvested for yew last; these stands will be stands that are valued for certain extraordinary characteristics (such as old-growth, wildlife habitat, unique yew scarcity/abundance). High priority stands are stands that are less extraordinary for the above values and will be harvested for yew first.

- *Percent of Harvest and Leave Trees or Shrubs:* The alternatives call for different maximum percentages of yew harvest in each stand, as well as different minimum numbers of unharvested yew trees per acre (TPA) for each of three diameter classes (For shrub form, there are no diameter classes):

Alternatives	Maximum Percent Harvest	Minimum TPA Not Harvested
A	0	NA
B	100	No minimum
C	25	5
D	50	5
F	75	2
G1	50	1
G2	50	5 in OCAs, 1 elsewhere

- *Fire Hazard Reduction:* Where fire risk due to yew harvest is high, decrease risk by one or more of the following measures: treat yew slash; identify potential fire-hazardous conditions and activities and develop guidelines to reduce or eliminate them in site-specific prescriptions; control human access to woods by regulating the number of people and time of entry; and when fire danger is high, prohibit use of machinery and use instead handtools, horses, etc.

Tree Form Yew

- Do not harvest yew trees adjacent to cut units due to their importance as a seed source, until cut units meet yew stocking prescriptions.

- Leave unharvested yew trees distributed through the stand to reflect the natural distribution in each of three diameter classes (< 11, 11-20, >20 inches stump diameter).

- In any one harvest area, either cut the whole yew tree for bark, wood, or needle production or remove up to half of the foliage for foliage-only production; partial stripping of bark is not allowed.

- For whole yew tree harvest, leave at least a 12" high stump, with the bark intact; shade the yew stump with slash or adjacent vegetation wherever possible or necessary; do not re-enter the stand to harvest whole yew trees for at least ten years.

- For foliage harvest, remove half of the foliage evenly throughout the crown from yew greater than 1" DBH (diameter at breast height); do not remove foliage from yew with less than 1" DBH; re-enter the stand only after foliage regrowth has occurred; re-harvest foliage from the same trees each time.

Shrub Form Yew

- In any one harvest area, cut either the whole shrub for bark or needle production or remove half the foliage for foliage-only production.

- Retain at least 75, 50, or 25 percent (depending on alternative) of the shrub cover by one of the following methods:

    1. Harvest shrubs from no more than 75, 50, or 25 percent of the unit. Site-specific prescriptions will decide whether

distribution of unharvested area is by strip, block or individual shrub harvesting method.

2. Harvest single shrubs or groups of shrubs.
3. Harvest all merchantable stems where there is at least 75, 50, or 25 percent cover provided by remaining unmerchantable stems.

- For whole shrub harvest, leave a stump length of 12" from the root collar, with bark intact; do not cut yew shrubs less than 1" diameter (the diameter is measured where the stem emerges from the duff); do not re-enter the stand to harvest whole shrubs for at least 10 years.

- For foliage harvest from shrubs, remove no more than half of the foliage, evenly distributed throughout the crown, from yew with diameters over 1" (the diameter is measured where the stem emerges from the duff); do not remove foliage from yew that is less than 1" diameter; do not reenter the stand to harvest foliage for at least five years.

Mitigation Measures for Yew Harvest in Owl Conservation Areas for Alternative G2

- *Conservation Areas:* Conservation areas are defined here as Habitat Conservation Areas (HCAs) for national forest land, as described in the Final EIS on Management for the Northern Spotted Owl in the National Forests (USDA FS, 1992b). For BLM forest lands, conservation areas are defined as Old-Growth Emphasis Areas (OGEAs) containing Designated Conservation Areas (DCAs), Reserved Pair Areas, Managed Pair Areas, and Residual Habitat Areas, as described in the revised preferred alternative of the BLM's draft resource management plans. For the BLM Klamath Resource Area, conservation areas are defined as Protected Habitat Areas (PHAs) and Protected Habitat Area Buffers (PHABs) as described in the Klamath Draft Resource Management Plan.

- There are four categories of HCAs for Forest Service lands:

  Category 1—blocks of habitat to support at least 20 pairs.

  Category 2—blocks of habitat to support 2 to 19 pairs.

  Category 3—blocks of habitat to support individual pairs.

Category 4—blocks of habitat that may be smaller than the median annual home-range size but provide connectivity or potential habitat for future nest sites.

- For BLM lands, Designated Conservation Areas set up in the Final Draft Recovery Plan for the Northern Spotted Owl are contained within OGEAs. There are two categories of DCAs:

  Category 1—blocks of habitat to support at least 20 pairs.

  Category 2—blocks of habitat to support 1 to 19 pairs.

- Harvest yew only in Category 1 HCAs or OGEAs with Category 1 DCAs that have more than 15 pairs or resident singles and Category 2 HCAs or OGEAs with Category 2 DCAs that have occupancy greater than 75% of the future adjusted occupancy target.

- Harvest yew only after the conservation area has been surveyed for northern spotted owls, following the agency's standard survey procedures.

- Do not harvest yew within 0.5 mile radius (500 acres) of known spotted owl nest sites or activity centers in owl conservation areas.

- Harvest yew in owl conservation areas according to the Partial-cut Units/Non-sale Areas guidelines, found within the Mitigation Measures for Alternatives C through G2. In each of the three diameter classes (<11, 11-20, and >20 inches stump diameter), harvest no more than 50% of the yew in each area while retaining at least 50% of the yew or five yew trees per acre (TPA), whichever is greater.

Mitigation Measures for Yew Harvest in Moose Winter Range for Alternatives B through G2

- *Designated Lands for Moose Winter Range on the Nez Perce National Forest:* Moose winter range is managed for its Pacific yew component on the Nez Perce National Forest in north-central Idaho. The Nez Perce Forest Plan identifies 63,000 acres as Management Area #21 (MA21). The stated goal for MA21 is to "Manage the grand fir-Pacific yew plant communities to provide for a continuing presence of Pacific yew 'suitable' for moose winter habitat."

- On areas of the Forest where site-specific NEPA analysis has been completed, stands have been validated as MA21. The Nez Perce National Forest is in the process of refining the standards for MA21 based upon Forest-wide inventory data collected during the 1992 field season. With the new inventory data, many more MA21 stands will be confirmed.

- Follow the Mitigation Measures for Alternatives C through G2. Exceptions are noted below.

All Sites

- Meet the mitigation measures for Management Area 21 of the Nez Perce National Forest Plan. Harvest Pacific yew only where the suitability as moose winter habitat is maintained.

Timber Sale Units

- Follow the Mitigation Measures for Alternative B, except leave 50% of the original preharvest yew in patches or other patterns that can be protected from logging damage or site preparation activities.

Partial-Cut Timber Sale Units

- Follow the Partial-cut Units/Non-sale Area portion of the Mitigation Measures for Alternatives C through G2, at the 50% harvest level.

- Leave either 50% of the yew trees or five yew TPA (whichever is greater) distributed across the stand to reflect ecological needs for each of three yew size classes (<11, 11-20, and >20 inches stump diameter).

Non-sale Areas

- Follow the Partial-cut Units/Non-sale Area portion of the Mitigation Measures for Alternatives C through G2, except for determining the harvest level.
- The interdisciplinary team conducting the site-specific analysis will include a wildlife biologist. Yew harvest will consider snow interception and browse availability, as well as providing yew products. Actual harvest levels will be recommended during site-specific analysis.
- Leave a minimum of either 50% of the yew trees or five yew TPA (whichever is greater) evenly distributed through the stand for each of three yew size classes (<11, 11-20, >20 inches stump diameter).
- Harvest a maximum of 50% of the yew in the stand; either cut the whole tree or remove one-half of the foliage.

Mitigation Measures for Yew Harvest in Port-Orford-cedar Areas for Alternatives B through G2

- Management of Pacific Yew in areas within the natural range of Port-Orford-cedar (POC) will follow the same analysis process developed for the management of Port-Orford-cedar root disease. The standards, guidelines, or mitigation measures to use are determined by using a process developed by pest management staff to analyze the risk inherent in various management activities. The complete process is described in Appendix C under Mitigation Measures for Yew Harvest in Port-Orford-cedar Areas.

Chapter III

Affected Environment

Changes Made Since the Draft EIS

Chapter III-Part One: The Pacific Yew

Revised the "Sustainability" section under "Pacific Yew Population and Inventory" for clarity and moved it to the front of this section.

Updated the estimated number of yew trees for the Forest Service Northern Region in Table III-2.

Chapter III-Part Two: The Forest

Rearranged the "Physiographic Provinces" section, for clarification. Moved the "Vegetation" subsections and Figure III-6, "Potential Natural Vegetation Types," to Appendix H, Plant Associations.

Changed the "Ecology" heading to "Ecosystem."

Added several references under "Wildlife," "Northern Spotted Owl," subsection; and added examples of animals that occur in riparian areas where Pacific yew is present under the "Yew; Influence" subsection.

Shifted several species between categories and added species according to the most current information, under the "Threatened and Endangered Species" section, Table III-9, "Summary of Threatened, Endangered, and Proposed Species."

Changed the "Yew As Forage" subsection heading to "Yew and Livestock."

Chapter III-Part Three: The Yew and People

Omitted the "Population" sections under "Social Setting;" and changed "3,909,341 acres" to "4,647,059 acres" under the "American Indian Trust Lands" subsection.

Updated bark harvest figures in Table III-14.

Added a new section, "Taxol From Fungus" under the "Market and Nonmarket Considerations" section.

Omitted an illustration of "Culturally Modified Trees" under the "Cultural Resources" section. Although it is known that yew trees were used for making bows, no yew trees with staves removed have yet been found.

Updated "Demand" subsection to reflect current information.

Updated "Supply" subsection to reflect current information.

Omitted last paragraph under "Agreements" subsection.

Rewrote "Current Market" subsection for clarification.

Rewrote "Theft of Pacific Yew Bark" section for clarification.

Added "Needle Collection and Processing" section.

Chapter III

Affected Environment

Part One: The Pacific Yew

Contents

Part One: The Pacific Yew

Chapter III
Affected Environment

Chapter III is arranged in three parts: Part One: The Pacific Yew, contains information specific to the species. Part Two: The Forest, provides information about the forest ecosystems of which the Pacific yew is a part. Part Three: The Yew and People, addresses its cultural, medicinal and economic values.

This part of Chapter III discusses the Pacific yew, from its geographic occurrence to afflicting diseases. It focuses on the distribution and biology of Pacific yew (*Taxus brevifolia*), and is arranged from broadest terms to more specific. Topics include population of Pacific yew, genetics, regeneration, and role of fire.

Geographical Range

Land Ownership Patterns

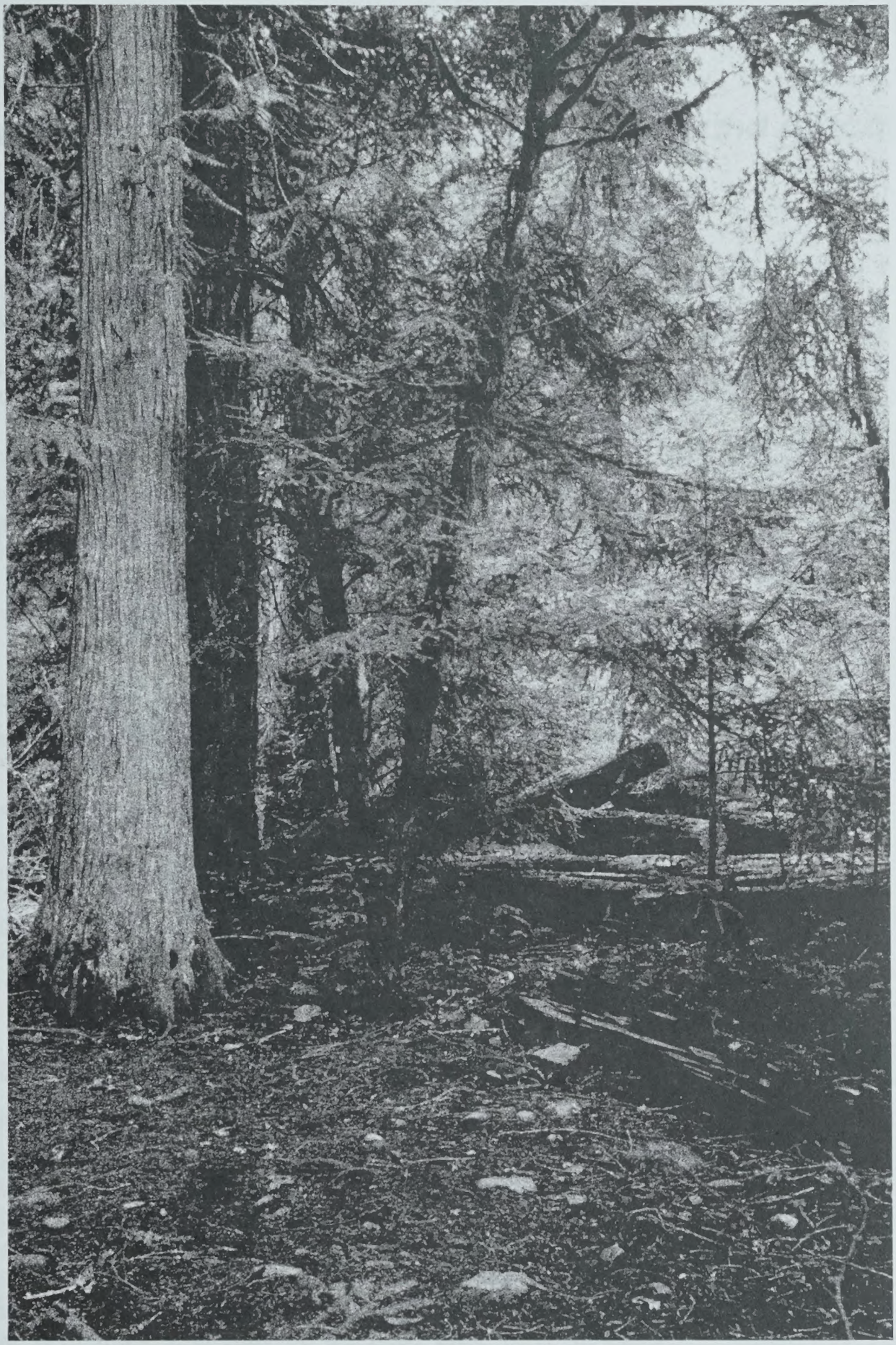
Mixed Ownerships

A variety of land ownerships and designations lie within the five state range of Pacific yew. These include state, county, city, industrial and nonindustrial private lands, as well as those administered by federal agencies.

These include lands administered by the U.S. Department of Agriculture Forest Service, and three U.S. Department of the Interior agencies—the Bureau of Land Management; the National Park Service; and the Bureau of Indian Affairs.

Affected Federal Lands

Of these lands, many of the Forest Service national forests and lands administered by the Bureau of Land Management in Oregon, Washington, Idaho, Montana, and northern California are covered by this EIS. See Table III-1.



Prime young yew in forest

Table III-1: Affected Federal Lands, by Administrative Unit

Forest Service

Pacific Northwest Region: All 19 National Forests and the Columbia Gorge National Scenic Area.

Northern Region: Clearwater, Kootenai, Idaho Panhandle, Flathead, Lolo, Bitterroot, and Nez Perce National Forests.

Pacific Southwest Region: Six Rivers, Klamath, Tahoe, Shasta-Trinity, Lassen, Eldorado, Mendocino, and Plumas National Forests.

Bureau of Land Management

Oregon: Medford, Salem, Eugene, Roseburg, Coos Bay, Vale, Prineville, and Lakeview Districts.

Washington: Spokane District.

Idaho: Coeur d'Alene District.

California: Ukiah, Susanville, and Bakersfield Districts.

For More Details

Tables in Appendix D provide detailed listings of administrative units within the five-state area affected by the proposal. These are displayed by state and, where useful, by geographical subarea.

Forest Service Management Plans

Land Allocations

Management Direction

Management direction varies by agency and is specific to the particular national forest or Bureau of Land Management (BLM) district involved. The management direction for an area is the basis for determining whether harvesting of Pacific yew is allowed. Also, it will be used to calculate activities, outputs, and environmental effects for the analysis in this EIS.

Source of Direction

For most national forests, management direction is provided by the recently completed land and resource management plans ("forest plans"). If the forest plans have not been implemented, forest lands are now being managed to be compatible with the plans when they are implemented.

Two Levels

Forest plans typically have two levels of management direction: (1) forest-wide direction, and (2) site-specific direction.

Forest-wide direction comes from formal goals and objectives and established standards and guidelines for each forest plan. Area-specific direction is spelled out in the management direction for management areas identified in each Forest. (See the discussion on the relationship of this EIS to other management direction in Chapter II.)

Forest Service Management Areas

Focus

Management areas tend to be larger areas of land that are managed towards a common focus. For example, most forests have management areas for such emphasis areas as developed recreation, designated wilderness, research natural areas, timber management, and visuals. Except for special administrative boundaries and those established by Congress, management area boundaries are not firm lines, and may be adjusted after more detailed

reconnaissance to better meet the focus of each of the bordering management areas. The exact type and number of management areas vary, forest by forest.

Direction; Roles

Typically, the direction for management areas include area-specific Standards and Guidelines, and identifies acceptable practices for managing the area. This would include whether yew harvesting is permissible.

Congressionally-Designated Management Areas

Many forests have management areas established by Congress as national monuments, national recreation areas, designated wilderness, or wild and scenic rivers. All are managed under direction that arises from the originally established legislation. No timber harvesting — including that of Pacific yew — is allowed in designated wilderness or in areas designated as "wild" in corridors of the National Scenic Rivers System.

Other Management Areas

Many forests have established management areas for old growth. Typically, harvesting is not permitted in these areas. The recent Environmental Impact Statement for the management of the northern spotted owl established formal owl Habitat Conservation Areas (HCAs) that will supersede the management direction originally established for those areas by the forest plans. In addition, the Secretary of Agriculture has designated "research natural areas." Typically, harvesting of yew is not allowed in research natural areas.

Locations

For a description of the management areas within a particular national forest, please refer to the forest plan for that forest. The map that accompanies each plan also provides the location of the management areas.

BLM Management Plans

Role and Status of Plans

The Bureau of Land Management (BLM) currently receives management direction from the Management Framework Plans and associated Timber Management Plans developed between 1979 and 1983. These plans include management areas similar to those in the forest plans described above. The BLM is presently preparing new Resource Management Plans, which are scheduled for release as final documents in 1993.

Sustainability of Pacific Yew

Sustainability of Pacific yew can be defined in two ways: 1. sustainability of the species and, 2. sustained yield of the product (yew bark or needles used to make taxol).

Sustainability of the Species

Sustainability of the Pacific yew as a species depends upon the amount of yew harvested, the range of acres harvested, the ability of the yew to regenerate and maintain its genetic diversity and adaptability, and protection efforts. These factors are discussed in various sections of this document (see Biology of Yew, Reproduction, Genetics, Ecosystem, etc. in Chapters III and IV, and Mitigation Measures in Chapter II).

Sustained Yield

The sustained yield of the product (bark or needles) "means the achievement and maintenance in perpetuity of a high-level annual or regular periodic output of the various renewable resources of the national forests without impairment of the productivity of the land." This should be distinguished from the flow of the product. How much is harvested each year determines the flow, and whether it is considered even or uneven. For example, a preset level of harvest that can be achieved consistently into the future would be even-flow, and a harvest level that varies on an annual basis would be uneven-flow.

In this EIS, we analyze the effects of several short-term, uneven-flow harvest levels under Alternatives B through G2. These alter-

natives would allow harvest of a given amount of yew within five years to meet the immediate needs for taxol for clinical trials and treatment. In contrast, a long-term, even-flow harvest would ensure a continuous supply of small amounts of material for taxol from wild yew, but may not meet the immediate demand.

Both types of flow allow for repeated harvests; however, the re-entry time would be longer for the uneven flow scenario. How soon the stand returns to preharvest levels will depend on how much is harvested, when it is harvested, growth rate of the residual stand and new seedlings, and mortality. Biological constraints or constraints from other resources may be as limiting to re-entry as the stand's ability to return to preharvest bark volume levels.

Pacific Yew Population and Inventory

Pacific yew was not inventoried in the past because it was not a valued commercial species. Because of limited time and money, inventory efforts had been concentrated on the more commercially valued timber species. This has changed in the last ten years as increased interest in the biological value of other flora and fauna prompted people to gather information on noncommercial species.

Inventories

Yew Inventories on State and Private Lands

The Forest Service Research Stations include yew as one of the species tallied in their ongoing inventories of state and private lands in five northwestern states. The Pacific Northwest Research Station in Portland estimates that there are approximately 10 million yew trees (greater than 1 inch) on state and private lands in California, Oregon and Washington. Most of those trees are in smaller size classes with only 35 percent larger than five inches and only seven percent larger than 11 inches (see Appendix F).

Yew Inventories on Federal Lands

Prior to 1991 the Forest Service and Bureau of Land Management had no inventory method specifically designed to measure Pacific yew trees. The Forest Service in Idaho had some information which had been collected in conjunction with the normal timber inventory, as did the Bureau of Land Management. However, for

national forests in Oregon, Washington, and California, no previous yew inventory existed.

When Pacific yew became important as a source of taxol, the Forest Service and BLM developed procedures that were specifically designed to inventory Pacific yew (see Appendix F).

Inventory crews began field work on six national forests in Oregon and Washington during the fall season of 1991. In 1992, another national forest was added, for a total of seven. The BLM incorporated many of the procedures from the Forest Service inventory. Yew was also inventoried on the Nez Perce National Forest in Idaho, using slightly different procedures due to differing site conditions. Each inventory was completed by the end of the 1992 field season.

Sampling

To get the best information in the shortest time available, efforts focused on those areas that are known to have concentrations of yew. The areas sampled include: the Rogue River, Umpqua, Siskiyou, Willamette, and Mt. Hood National Forests in Oregon; the Gifford Pinchot and Mt. Baker-Snoqualmie National Forests in Washington; the Nez Perce National Forest in Idaho; and BLM district lands in western Oregon.

Population Estimates

We recognize that by restricting the sampling we are missing portions of the yew population. As a result, our estimates of total population are conservative. We know populations of Pacific yew exist on state and private lands and in other national forests and BLM districts that were not sampled in the inventory.

The inventory does not provide mapped locations of yew populations; it simply gives us an estimate of the number of trees. Locating yew trees and shrubs on the ground will require further field work during site-specific planning. For more information about inventory methods and results see Appendix F.

Table III-2 shows the estimated numbers of Pacific yew trees and shrubs in one national forest in Idaho, seven national forests in Oregon and Washington, and BLM lands in western Oregon.

Table III-2: Estimated Number of Yew Trees In Several National Forests and BLM Districts

State	National Forest and BLM	Stems*
Idaho	Nez Perce National Forest	6,354,575
Oregon	Mt. Hood National Forest	1,961,300
	Roque River National Forest	8,732,600
	Siskiyou National Forest	352,800
	Umpqua National Forest	6,083,200
	Willamette National Forest	8,513,400
	Coos Bay District	41,196
	Eugene District	104,656
	Lakeview District	6,527
	Medford District	743,367
	Roseburg District	845,160
	Salem District	339,878
Washington	Gifford Pinchot National Forest	8,955,300
	Mt. Baker/Snoqualmie Nat'l Forest	6,797,400
Total		49,831,359

*The Nez Perce numbers are for trees greater than 3" diameter; twelve inches above ground level. All other Forest Service and BLM numbers are for trees greater than 1" DBH.

Size Distribution

The inventories show a wider variation in the average size and occurrence of Pacific yew than is typically found with more common tree species such as Douglas-fir. Yew often grows in clumps with widespread areas between without any yew at all. Yew

occurs over a broader area than we had originally suspected. One generalization that we can make is that there are many more small yew trees than large yew trees; preliminary theories attribute this pattern to wildfire history and browsing by wildlife.

Figure III-1: Pacific Yew Diameter Distributions

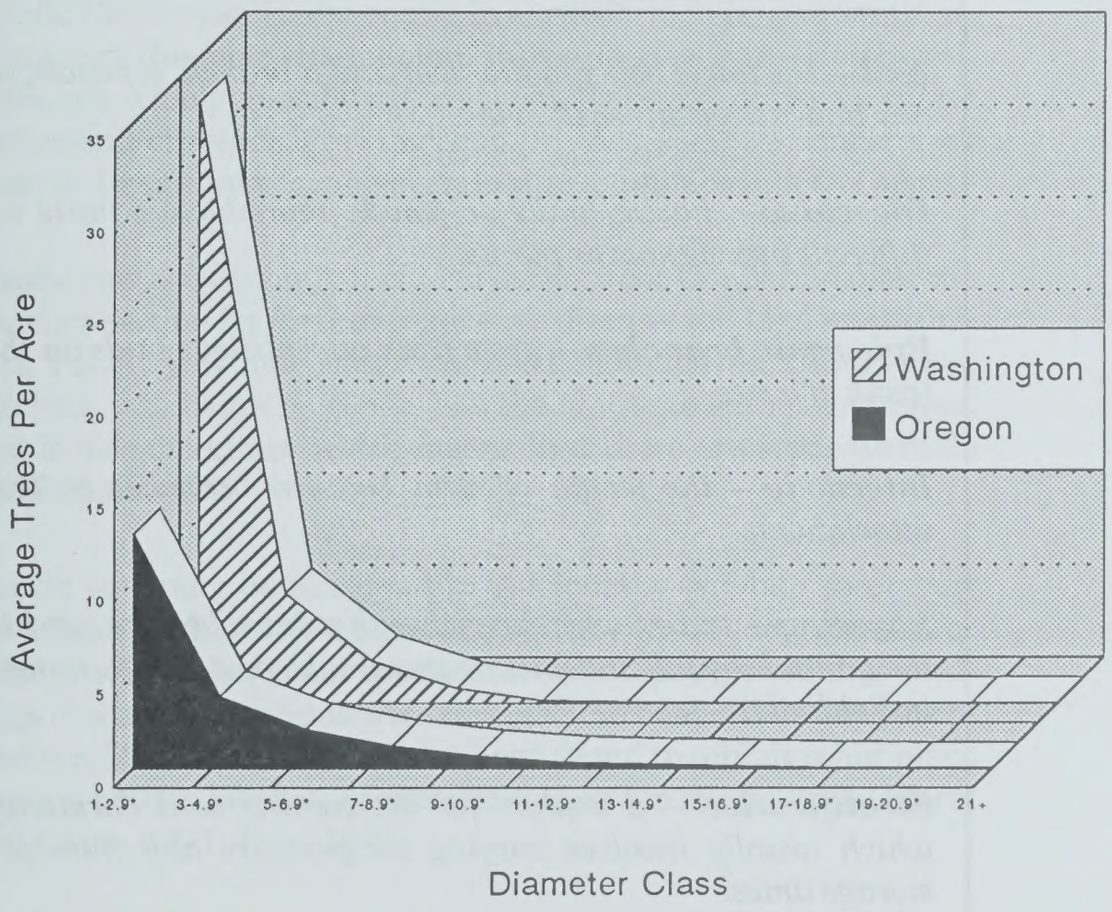


Figure III-1 illustrates the diameter distributions for the inventory plots measured on national forests in Oregon and Washington.

Biology

Terms to Know

Aril— *the fleshy, berry-like structure that encases the seeds on female yew trees.*

Allelopathy— *when secondary chemicals produced by a plant inhibit the germination, growth, or occurrence of other plant species.*

Axil— *the angle between the stem and a branch, a petiole, or any appendage attached to it.*

Dioecious— *having male or female reproductive parts on different individuals or plants.*

Epicormic branches— *grow from adventitious buds on the trunk of a tree.*

Internode— *the length of stem between branches or leaf attachments.*

Layering— *occurs when branches that have been pressed to the ground (by fallen debris or snow) take root and form new individuals.*

Stratification— *a method for overcoming seed dormancy which usually involves varying temperature and moisture storage times.*

Strobili— *cones; structures with spore-bearing or ovule-bearing appendages concentrated on a common axis.*

Overview

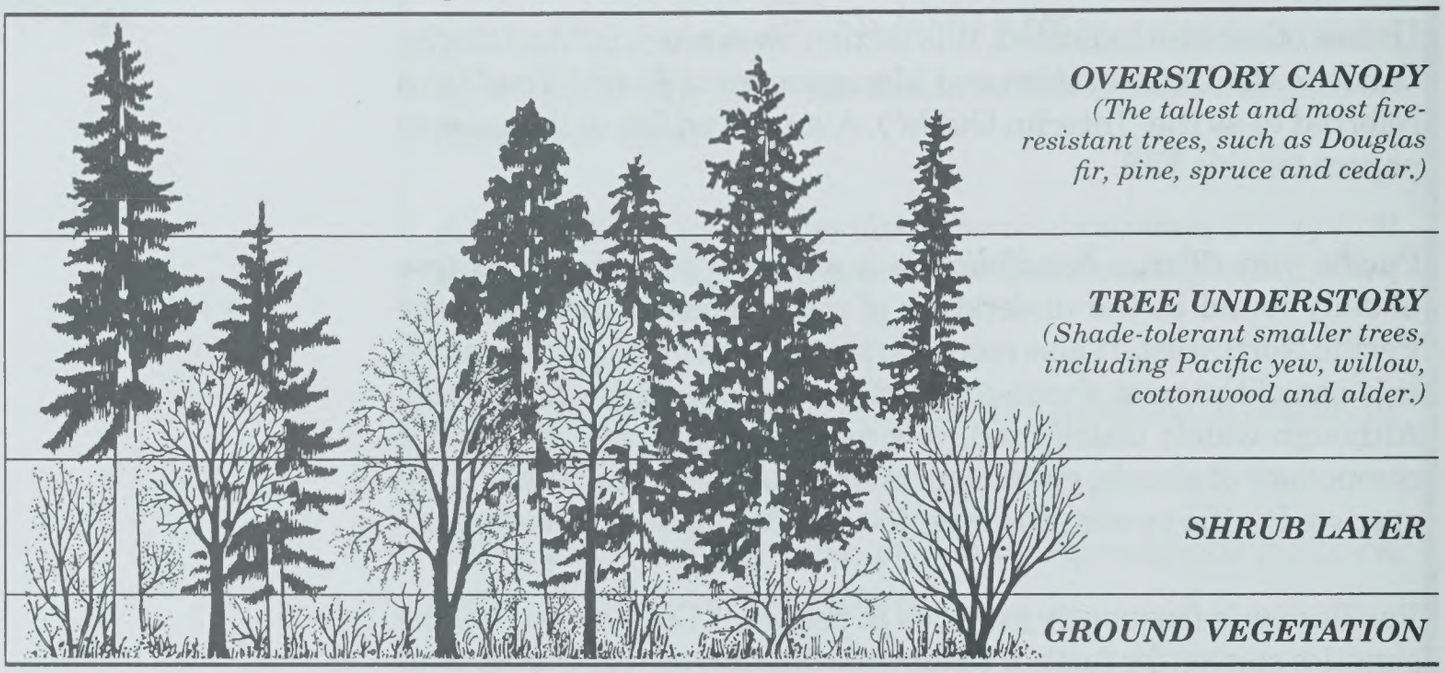
Unless otherwise indicated, this section owes much to "An Interim Guide to the Conservation and Management of Pacific Yew" (also referred to as the "Interim Guide"). A copy is on file in the process papers for this EIS.

Pacific yew *(Taxus brevifolia)* is a small to medium-sized tree usually found in the understory of the coniferous forests in the Pacific Northwest. It also occurs in shrub form in large quantities. It is one of the most shade-tolerant tree species in the Northwest. Although widely distributed, yew usually occurs only as a minor component of stands, growing primarily as a scattered understory species. Pacific yew is, however, locally abundant in a few areas.

Pacific yew is frequently included in the order Coniferales (see the genetics section for further taxonomic discussion). Like most conifers, Pacific yew has evergreen, needle-like leaves. Unlike most conifers, yew bears no cones, has the ability to sprout and layer, and is also dioecious, which means that there are separate male and female trees.

Pacific yew may be allelopathic. Allelopathy is when secondary chemicals produced by a plant inhibit the germination, growth, or occurrence of other plant species. McCune (1982) noted that seedlings of other tree species were rarely found beneath Pacific yew in western Montana. Yew has also been found to inhibit other plant species, both in laboratory experiments and in the field (Del Moral and Cates, 1971; Rice, 1974).

Figure III-2: Yew in the Understory



The Forest's Double Canopy, *formed by the overstory and understory, intercepts snow and rain, sheltering the animal habitat beneath, and protecting less hardy vegetation such as shrubs, herbs, grasses, mosses, lichens, and the fungi that live in the top layer of the soil.*

Growth Forms

Pacific yew occurs both as an upright tree and as a shrub. The tree form is found throughout most of the species range on the more productive forest sites. Tree form yew is fully branched even in dense shade. It has long limbs and the crown is often ragged and lopsided (Bolsinger and Jaramillo, 1990).

In some areas Pacific yew occurs only as a shrub. This happens near the extremes of its range, on harsh sites such as rocky ridges, adjacent to wetlands, and at high elevations. This shrub-form yew often forms dense thickets (Bolsinger and Jaramillo, 1990). There are areas where both the tree and shrub forms occur on the same site. The shrub form is believed to be a genetic trait in some places; in others it is more likely the result of browsing.

Tree form yew can be distinguished from the shrub form by the presence of a single main stem. The shrub form, conversely, is multi-forked and multi-stemmed. Shrubby yews in the Cascades can grow as tall as 12 to 15 feet, while the yew shrubs that form dense thickets in northern Montana rarely exceed five feet in height.

Yew Bark and Needles

Bark

The bark of Pacific yew is thin (approximately one-eighth of an inch thick), scaly, and dark reddish purple (Harlow *et al.*, 1979). The base of Pacific yew trees is frequently fluted and asymmetrical (Collingwood and Brush, 1978; Preston, 1976). The total amount of bark on individual yew trees varies due to these irregularities in the shape of the bole.

Table III-3 presents estimates of the average weight of freshly peeled bark for a range of tree diameters.

Table III-3: Average Amount of Bark (Pounds) by Diameter at Breast Height (dbh)

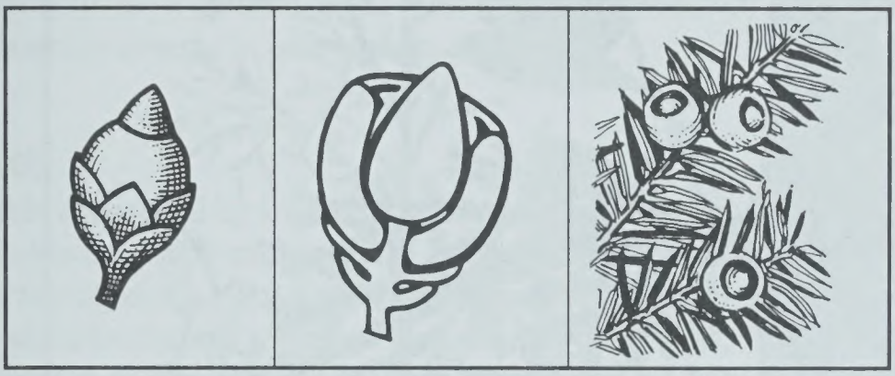
Diameter	Height*	Poundage
3"	1/2	2-5
4"	1/2 to 1	4-8
6"	1/2 to 1	8-14
8"	1 to 1-1/2	14-25
10"	1 to 1-1/2	30-40
12"	1 to 1-1/2	30-50
14"	1-1/2 to 2	40-60
16"	1-1/2 to 2	50-80
18"	2 to 2-1/2	70-100
20"	2-1/2 to 3	80-120
24"	2-1/2 to 3	100-140
28"	3 to 3-1/2	100-160
*Based on a 16' log length		

Needles

Pacific yew has evergreen, sharply-pointed needles. Studies regarding length of Pacific yew needle retention have not been made, but needles appear to remain on a tree for four to seven years.

Reproduction

Figure III-3: Seeds and Foliage of Pacific Yew



Development of the Seed, *left to right:*

- *Female Pacific yew ovule ready for pollination*
- *Seed with mature aril (cross section)*
- *Mature aril as it appears on foliage. The seed is poisonous to people and some animals, but the red berry is edible.*

Sexual Regeneration

Pacific yew is dioecious — there are separate male and female trees. Male strobili are stalked, globose, green when immature and pale yellow at pollination. These are borne on the underside of branches, at leaf axils, usually on the terminal and second internodes, and typically in clusters of four to several per internode.

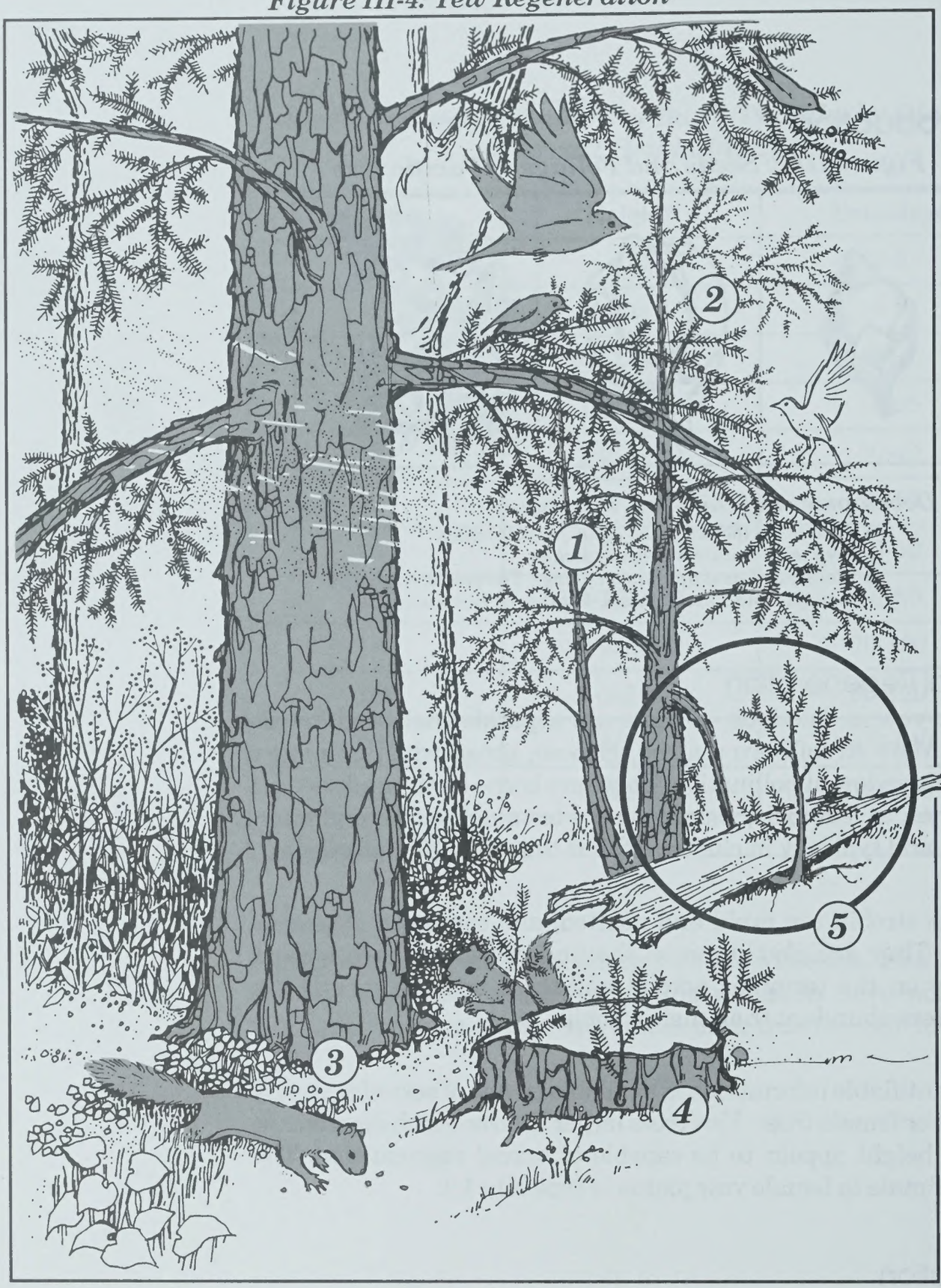
Female strobili are ovoid and pointed, and composed of several scales. They are also borne on the underside of branch sprays, usually on the terminal, second and third internodes, and are much less abundant than male strobili.

No quantifiable information is available on age of sexual maturity of male or female trees. Yew trees larger than one inch diameter at breast height appear to be capable of sexual reproduction. The ratio of male to female yew plants is typically 1:1.

Pollination

Yew trees are wind-pollinated. After pollination, female strobili develop into fleshy, berry-like fruiting bodies called arils. Each aril contains one seed. Most of the arils ripen between August and October. It is not unusual to find arils in various stages of maturity

Figure III-4: Yew Regeneration



Yew Regeneration

1 *Pollen from the male yew is carried by wind to the ovules of the female tree.*
2 and 3 *Seed is dispersed by berry and seed eating birds and mammals.*
4 *Stump sprouting is common both from cut trees and after forest fires.*
5 *Layering occurs most frequently when a branch is held to the ground by a fallen tree or other considerable weight.*

— from undeveloped and dark green to fully developed and yellow, pink, or scarlet — on the same tree. This suggests the possibility of a rather wide pollination "window," or multiple pollination events in one season.

Seeds

Seed is dispersed by birds, which are attracted to the fleshy arils, and also by small mammals. Like most tree species, Pacific yew does not produce a good seed crop every year. The frequency, size, and distribution of yew seed crops are unknown. (See also the discussion of genetics in this part of Chapter III.) Observations in Oregon and Washington (Vance, 1992; Wheeler *et al.*, 1992) indicate that more seeds are produced by Pacific yew trees in partial or full sun than those under complete canopy cover.

Germination

Germination of Pacific yew seeds usually occurs in heavy organic matter. A study in Idaho found that wild yew seedlings usually germinate in forest litter (61%), but can also be found on decaying wood (20%), in bird and rodent caches (16%), and occasionally in mineral soil (3%) (Crawford, 1983).

There is some indication that yew seeds can remain in the soil for many years before germinating (Hartzell, 1990; Hofmann, 1917). This could be a survival mechanism that allows yew to delay germination until after new forest growth has closed in, thus concealing yew seedlings from browsing animals.

Asexual Regeneration

Pacific yew can also regenerate vegetatively. It sprouts readily from stumps, rootstocks, and broken or cut limbs and branches. It is also capable of layering. Layering occurs when branches that have been pressed to the ground by fallen debris or snow, take root and form new individuals (Bolsinger and Jaramillo, 1990; Crawford, 1983).

Stump sprouting is most successful on stumps with intact bark and partial shading (Minore, 1991). Preliminary results of a sprouting study in western Oregon found that 69 percent of the

stumps sprouted in unburned timber sale areas (Minore, 1991). There is no information available about what percentage of sprouts can be expected to survive to maturity.

Artificial Regeneration

Inducing germination of Pacific yew is more difficult than for the seeds of conifer trees with which it is commonly associated. Apparently, Pacific yew possesses a compound dormancy, and stratification is necessary to break this dormancy.

The J. Herbert Stone Nursery, a Forest Service nursery in Oregon, reported 95 percent germination rates the second year after stratification (Steinfeld, 1992). Pacific yew can also be regenerated by cuttings. The J. Herbert Stone Nursery estimates rooting success between 40 and 50 percent (Steinfeld, 1992). Preliminary observations indicated that seedlings propagated from the seed of tree-form yew adopt a natural tree-form, while rooted cuttings retain a branching morphology.

Growth and Size

Growth Rate

Pacific yew is an extremely slow growing species, both in terms of diameter and height. As with any tree species, growth rates of Pacific yew vary considerably by age, stand characteristics, and site productivity. A typical 100-year old yew tree has an average diameter of 4 to 8 inches. There have been reports of some faster growing trees. A 29-inch diameter log at Hauser's processing facility in Cottage Grove, Oregon was found to be only 125 years old.

In Idaho, an analysis of increment cores and stem sections of yew trees and shrubs from mature stands showed the following growth rates (Crawford, 1983):

Table III-4: Growth Rates

Age (Years)	Diameter 6 Inches Above Ground (Inches)
25	1.0
50	2.0
75	4.5
100	6.0
125	9.0

Note: The diameter growth rate of the Idaho trees ranged from .02 to .1 inches each year. Average diameter growth rates of yew trees in western Oregon range from .02 to .08 inches per year (Betlejewski, 1991; Bolsinger, 1990). Yew trees remaining in partially harvested stands have been found to have increased diameter growth rates (Bolsinger, 1990).

Size

The maximum size of Pacific yew trees in most areas is 15 to 30 inches in diameter and 30 to 50 feet tall. Trees larger than 20 inches in diameter at breast height (4.5 feet from the base of the tree on the uphill side) and taller than 40 feet are rare throughout most of its range (Bolsinger and Jaramillo, 1990). The largest known Pacific yew tree (56 inches in diameter and 60 feet tall) was found in western Washington (Hunt, 1986).

Response to Disturbance

Overstory Removal

Pacific yew has the ability to grow in both full sunlight and in the deep understory shade of tall forests. Yew trees that have grown in the shade for long periods of time may be damaged if suddenly exposed to full sunlight. In many cases, however, Pacific yew is able to adapt to removal of the overstory canopy. The foliage frequently turns brown and the top dies back due to increased exposure to heat, frost, and wind, but the trees are often able to survive (Bolsinger *et al.*, 1988).

Inventories of nonfederal lands in California, Oregon, and Washington have found an estimated 700,000 Pacific yew trees 11 inches in diameter and larger (see Appendix F). Many of these trees are survivors of past removal of the old growth overstory (Bolsinger and Jaramillo, 1990).

Adaptation to overstory removal is made possible through changes in leaf morphology and twig distribution, and through the growth of epicormic branches from the bole and branches within the tree crown.

Fire

Pacific yew is sensitive to fire. (See the discussion of the role of fire at the end of this part of Chapter III.)

For More Information

Information about Pacific yew and its characteristics and requirements are found throughout this part of Chapter III. General information about forests and other lands within the native range of the species can be found in Part Two: The Forest.

Terms to Know

Allele— *one of a series of possible alternative forms of a given gene, differing in DNA sequence, and affecting the functioning of a single product (RNA and/or protein).*

Common-garden study— *an investigation in which different seed sources are grown in a uniform environment to examine genetic variation in traits or characteristics.*

Electrophoresis: *a laboratory technique used to characterize biological entities by inspecting the differential movement of charged molecules through a porous medium in an electric field.*

Heterozygosity— *the condition of having one or more pairs of dissimilar alleles at a locus.*

Locus (plural, loci)— *the location of a gene on a strand of DNA. Phylogenetic analysis— is used to determine relationships among taxonomic groups.*

Proembryology— *examines the development of reproductive buds.*

Relationships to Other *Taxus* Species

Taxus Species

Pacific yew is one of seven native species in the *Taxus* genus, family Taxaceae. There are three other native *Taxus* species in North America (Hitchcock *et al.*, 1971):

Taxus canadensis in the upper midwestern United States;
T. floridana in northwestern Florida; and
T. globosa in south-central Mexico.

The Taxaceae are very old plants, and their relationship to the class Conifereae (Coniferales) is the subject of some dispute. Based on similarities in proembryology, wood anatomy, and pollen and leaf morphology, the Taxaceae appear to be members of the Conifereae. Preliminary phylogenetic analysis also bears this out (Price, 1990).

Traits in Common

Genetically, *Taxus* species are closely related. They hybridize with each other; heartwood chemical characteristics are very similar among species; and the levels of total taxanes are similar among several species and hybrids (Bolsinger and Jaramillo, 1990). In addition, chromosome counts of 2N=24 have been observed for four species in *Taxus* (Price, 1990), which tends to indicate that *Taxus* species are fairly similar.

Genetic Variability

Growth Forms; Rooting

There has been limited investigation into genetic variability for specific traits in Pacific yew. Presumably there is genetic control over growth forms, as there are many specific cultivars of yew used in the landscaping industry, but the inheritance of form (tree or shrub) is unknown. Rooting studies in Corvallis, Oregon demonstrate that some individuals have greater rooting potential than others (Vance, 1992).

Taxol Content

Genetic variation in taxol content is being studied, and several early surveys indicate there is substantial phenotypic variation for this trait (Miller, 1991; Wheeler *et al.*, 1992). However, none of these surveys have been able to separate environmental variation from genetic variation.

Genetic Diversity

Role of Genetic Variation

The amount and distribution of genetic variation in Pacific yew is critical to its ability to persist in the ecosystem and adapt to changing environments. No single individual or small population contains all of the genetic information in the species. The sum of the genetic differences among scattered populations and individuals within these populations constitutes the gene pool.

Measuring Genetic Diversity—Methods; Objectives

Genetic diversity in forest trees is usually measured with common garden studies or electrophoresis studies. Each method has different objectives, and the results are used differently in practical application (see Terms to Know).

Common-garden studies reveal genetic differences in growth and growth rhythm traits. Variation in these traits shows adaptive responses to the environment and reflects previous natural selection pressures. Patterns in these adaptive traits are often correlated with the geographic distribution of the sample and show clinal trends.

Electrophoretic studies reveal genetic variation in selectively neutral traits. These studies are used to characterize genetic variability in a species over a broad geographic range. Patterns observed in electrophoretic studies show genetic relationships which may be due to ancestral migration routes. Mating patterns such as inbreeding and out-crossing can also be described.

Levels of Genetic Variation in Pacific Yew

Overall Levels

Overall levels of genetic variation for Pacific yew were determined from electrophoresis analysis of samples collected in 1990 from throughout the range of Pacific yew in the continental U.S. and Alaska.

Initial Estimates

Initial estimates of genetic variation (Table III-5) are somewhat higher than average for all plant species, though not as high as for conifers as a whole.

The following table displays the average observed heterozygosity for several plant groups and Pacific yew. Heterozygosity is the condition of having one or more pairs of dissimilar alleles (alternative forms of a given gene) at a locus (location) on a strand of DNA. The mean number of alleles per locus for Pacific yew is 2.21 (standard error, .19).

Table III-5: Overall Levels of Genetic Variation in Pacific Yew and Other Plants

Group Species	Number of Taxa	Average Observed Heterozygosity	Source
Pacific yew	1	.17	USDA Forest Service unpublished data, 1992
Tropical trees	6	.211	Hamrick (1990)
Coniferous trees	20	.207	Hamrick (1990)
Dicots	74	.113	Hamrick (1990)
All plant species	113	.141	Hamrick (1990)

Structure of Genetic Variation

Types

Overall genetic variation can be partitioned into "among-population" variation and "within-population" variation. Approximate expectations of genetic variation structure can be gained from surveys which correlate patterns found in electrophoretic studies with life history traits.

Among-Population Variation

Among-population genetic variation is important because different combinations of alleles and their frequencies occur in different populations. Populations located on the periphery of the species range are under different selection regimes than populations in the center of the range; this leads to genetic differentiation.

One common-garden study currently underway indicates there are genetic differences among populations from different geographic areas; there are also genetic differences among families within these populations for height, number of growing points, and bud-set (Wheeler, 1991).

Table III-6: Among-Population Variation in Pacific Yew

Species	Gst*	Source
Pacific yew	.107	USDA Forest Service unpublished data, 1992
Douglas fir:		
Coastal	.071	Li and Adams (1989)
North Interior	.043	Li and Adams (1989)
South Interior	.122	Li and Adams (1989)
Lodgepole Pine	.061	Wheeler and Guries (1982)
Ponderosa Pine	.015	Hamrick (1983)
*Proportion of genetic diversity due to among-population differences		

The amount of genetic diversity due to among-population differences was estimated from the electrophoretic analysis mentioned above (Table III-6). This amount is somewhat higher than for other wind-pollinated conifers in the Northwest, supporting the idea that Pacific yew populations are somewhat unique and no two are identical. Pacific yew propagates itself by asexual and sexual methods, and seed dispersed by animals. It has life history characteristics in common with plants that have high levels of among-population differences (Hamrick, 1990).

Within-Population Variation

All populations of a species do not have the same levels of genetic variation within them. Each population has a unique array of genotypes as a result of the mating patterns among individuals within the population over previous generations. (Note: Genotype refers to the genetic constitution of an organism, as distinguished from its physical appearance, or phenotype.) Adaptive responses of these genotypes to the local environment further shape within-population variation.

Table III-7 displays the average observed heterozygosity within populations for several conifers, including Pacific yew.

Table III-7: Comparison of Average Levels of Genetic Variation Within Populations of Pacific yew and Other Conifers.

Species	Average Observed Heterozygosity	Source
Pacific yew	.17	USDA Forest Service unpublished data, 1992
Douglas-fir	.21	Conkle (1990)
Ponderosa pine	.29	Hamrick (1983)
Monterey pine	.16	Conkle (1990)
Bishop pine	.15	Conkle (1990)

These estimates indicate that Pacific yew has an average level of within-population genetic variation that is less than conifers with wide environmental distributions, such as Douglas-fir and Ponderosa pine. This value corresponds more closely to conifers with a more restricted environmental distribution, such as Monterey pine or Bishop pine (Conkle, 1990).

Local populations of Pacific yew may have a strong family structure due to limited pollen dispersal and seed dispersal by birds and small mammals. This would result in levels of within-population variation lower than those of conifers with a wide environmental distribution.

Role of Fire

Terms to Know

Broadcast burn— *a prescribed fire that may be of uniform or varied intensity.*

Intense fire— *fires which burn hot enough to consume much of the forest floor organic matter, along with most of the vegetation and surface fuels in a stand.*

Light ground fires— *fires that consume less of the forest floor. They are often patchy, creating a mosaic of burned and unburned areas.*

Slash— *branches and other woody material left on a site after logging.*

Yew and Fire

Pacific yew has thin bark and is sensitive to fire. Tree form yew is frequently killed when exposed to flames or intense heat. Shrub form yew may be better adapted to survive light ground fires, but is still frequently killed by hotter burns. Stumps that are burned do not sprout (Minore, 1992). Severe fires can create post-fire environments that are unfavorable to yew seedling regeneration.

Pacific yew's sensitivity to fire does not mean that entire populations will be lost following a burn. Both surviving yew and yew regeneration can be found in areas that were burned by light ground fires. These fires are patchy, creating a mosaic of burned and unburned areas where yew can survive. It is possible to retain yew in prescribed fire areas, provided measures are taken to protect it from heat and flames.

Pacific Yew Response to Fire

There have been few studies documenting the response of Pacific yew to fire and research continues throughout the range of the species.

Survival of yew after a fire, either natural or prescribed, depends on the burn pattern and intensity. Even light ground fires can kill the thin-barked tree (Crawford, 1983; McCune, 1982), but it often persists in areas following a light burn. Surviving yews are usually on north aspects and near roads where heat from the fire is lowest, or in unburned patches. In areas where yew has survived fire, unburned slash and duff indicate that the fire was not intense, or was totally absent, immediately surrounding the yew tree. Yew can be totally lost from areas burned by intense fires (Spies, 1991).

There are many factors affecting the survival of yew on a site following a fire, these include: amount of fuel, fuel moisture content, ambient temperature, relative humidity, wind, ignition pattern, and slope position (Betlejewski, 1992).

Shrub Form Yew

There is speculation that shrub form yew may be better able to survive light fires than the tree form. Only the periphery of shrub clumps were found to have burned following a prescribed fire on the BLM's Medford District in southern Oregon (Betlejewski, 1992). It is possible that the interior of large shrub clumps have cooler, wetter microclimates, making them more fire resistant. There are also examples, however, where fire has completely eliminated shrub form yew from a site (Stickney, 1980). As with the tree form, survival of shrub form yew is probably dependent on a number of factors which determine the intensity and pattern of a fire.

Yew Regeneration

Yew regeneration (sprouts or seedlings) can be found in old clearcuts where the slash has been burned (Bolsinger, 1991) and in young forests that originated following fire (Spies, 1991). But it occurs in much smaller numbers in these situations than in mid-to-late seral stands that have little to no fire history (Spies, 1991).

Stumps burned by fire (showing evidence of charring) do not sprout (Minore, 1992; Green and Ward, 1991). Yew seedlings have been found growing in burned areas. Some have been found in the

shaded microsites surrounding dead yew stumps on sites in western Oregon (Minore, 1992). The seedlings were growing around only a few of the stumps, however, and this was in a moist environment. Yew seedlings have also been found in broadcast burn units on the BLM Medford District in southern Oregon, primarily in wetter areas where the fire would not have been intense (Betlejewski, 1992). On a broadcast burned clearcut in northwestern Montana, yew seedlings were found only on unburned microsites with disturbed mineral soil (Stickney, 1992).

Pacific Yew Effect on Fire Behavior

Pacific yew can also influence fire behavior in a stand. Tree form yew is a mid-story species which can provide fuel ladders for fire to the upper canopy. Yew's role as a fuel ladder is tempered, however, by its slow-to-burn foliage and the cool, damp microsite which it creates.

Management Implications

Past broadcast burning practices have reduced, and undoubtedly eliminated, yew from many sites. A 23-year study of post-logging forest succession in the Oregon Cascades found that cover of yew returned to prelogging levels most rapidly in plots where there was no evidence of burning for site preparation. Another study on the Nez Perce National Forest in northern Idaho found that only four out of 50 yew trees and shrubs survived a patchy broadcast burn.

Yew can be retained on a burned site, provided that it is part of the prescribed fire objective. There was a 90 percent yew survival rate following broadcast burning of six clearcut units in southern Oregon (Betlejewski, 1991). There was some effort made, by the ignition pattern, to keep hot fires away from the yew trees. Fire is a natural part of the ecosystem and is not inconsistent with yew management, as long as measures are taken to protect yew from flames and heat. Cooler burns, ignition patterns designed to protect yew, inclusion of yew in green tree reserves, piling and burning of slash, and pulling slash back from residual yew plants and stumps are just some of the options available to ensure yew survival after burning.

Insects and Diseases of Pacific Yew

Overview

Insects and diseases that affect yew are as much a natural part of the ecosystem as the tree itself. In balance, the activities of insects and diseases are neither positive nor negative from the tree's point of view; they are only considered pests when their activities cause effects such as mortality and growth reduction that are above some background or established threshold.

Little is known about the occurrence, distribution, or effects of insects and diseases on Pacific yew. Most reports of insect or disease damage are incidental and anecdotal because, until recently, yew has not been a major species in resource management in the Pacific Northwest. What we do know from the available literature and from personal contacts is that yew appears to be relatively free of any major insect or disease pest or combination of pests.

Insects and Diseases

In one of the few documented studies, Pacific yew was found to be resistant to damage by sulfur dioxide pollution when compared to other western conifers. The most visible indicator of potential damage to yew is a browning or bronzing of the foliage, especially when an overstory canopy is removed. However, this appears to be a physiological reaction by the tree to increased exposure to light, not of pest damage.

Twig bark beetles have been found in dead branches on Pacific yew, but the occurrence of primary stem bark beetles, defined as those that are the primary cause of mortality, is rare. Pacific yew has no important defoliators that we know of; in fact, damage that was thought to be related to a spruce budworm infestation turned out to be the effects of increased exposure to sunlight.

Of the major categories of forest diseases (dwarf mistletoes, root diseases, stem decays, rusts, and foliage diseases) only root diseases, stem decays, and foliage diseases have been reported on the tree. The effects of foliage diseases are rarely serious, usually only affecting needles on individual branches or small portions of the crown. Fungi that cause root diseases in other western conifers

have been seen on Pacific yew (except for Port-Orford-cedar root disease, see below) but have not been confirmed as pathogens; in many cases, only a few roots or portions of the root collar were affected.

Port-Orford-Cedar Root Disease

New Information

The newest, and potentially the most serious reported disease of Pacific yew is Port-Orford-cedar root disease. The root disease fungus, *Phytophthora lateralis,* normally associated with Port-Orford-cedar, has recently been found on some Pacific yew trees in southern Oregon and northern California. Laboratory tests have confirmed that the fungus can kill inoculated seedlings, although yew appears to be much less susceptible than Port-Orford-cedar. The potential effect of this disease on yew in the field is unknown.

The fungus most likely infects yew in the same manner that it infects Port-Orford-cedar: Penetration of root tips by motile spores of the fungus, followed by colonization and death of the cambium and phloem tissue of the roots and lower stem. Once the cambium and phloem are killed, the tree is unable to transport water upwards from the roots, and the tree becomes desiccated and dies.

Current Status

At present, 19 infected Pacific yew trees have been found in 13 locations. In all locations where infection of yew occurred, yew trees are mixed with infected Port-Orford-cedar. The total area with infected trees is less than 30 acres.

Management Significance

Practices that allow movement of infected water, soil, and plant material may contribute to the spread of the fungus and disease.

Chapter III

Affected Environment

Part Two: The Forest

Contents

Part Two: The Forest

This part of Chapter III describes the big picture in terms of landscape, diversity, and geography. It identifies major land ownership patterns within the range of Pacific yew, addresses land allocations and resources within the big "forest-level" picture, and identifies forest health-related concerns.

Landscape Patterns

Range of Pacific Yew

The range of Pacific yew extends from the coastal area of extreme southeastern Alaska to central California, and as far inland as western Montana and the Kamloops and Kootenai Districts of British Columbia.

This EIS covers five states, or portions of states, within the range of Pacific yew: Oregon, Washington, Idaho, northern California, and western Montana.

Physiographic Provinces

This area can be divided into 19 generalized physiographic provinces (see Figure III-5: Physiographic Provinces). The following is a brief description of the provinces in which yew can be found and its general occurrence within each area. For further information regarding the geology, climate, vegetation and soils of each province see Appendix I. For further information regarding vegetation within each province, and the plant associations in which Pacific yew occurs see Appendix H.

Map Legend Number	Area
1	Olympic
2	Coast Range
3	Siskiyous
7, 8, 9	Cascades
11	Sierra Nevadas
14	Okanogan Highlands
16	Blue Mountain
18	Wallowas
19	Rocky Mountains North Part
	Other Areas Where Yew Grows

Figure III-5: Physiographic Provinces Containing Significant Yew Populations

The following is a brief description of the dominant tree cover, climate, and occurrence of Pacific yew within each of the nine ecological regions.

Olympics

The major portion of the Olympic province exhibits extensive glaciation. The steep, rugged Olympic Mountains provide a central core surrounded by almost level lowlands. The climate of the region varies from very wet, humid and maritime along the far west coast, to relatively dry and almost continental in the rainshadow of the northeastern corner of the province.

The disturbance regime is primarily one of infrequent, high intensity events, such as wildfire and wind. Average fire frequencies in the area range from 138 to 900 years, depending on the vegetation type (Henderson *et al.*, 1989).

Pacific Yew

Pacific yew is widely distributed throughout the Olympic province, but it is never abundant. Tree-form yew is the dominant growth form in the province. Trees greater than six inches in diameter at breast height are rare. Pacific yew is most frequently found in the western hemlock and Douglas-fir vegetation zones. It is less common in the Pacific silver fir zone, and only very rarely found in the mountain hemlock zone (Henderson and Lesher, 1990).

Coast Ranges

The coast ranges of Washington, Oregon, and northern California are north-south running, generally low elevation mountains that parallel the Pacific Ocean. The coast ranges have a moist maritime climate with wet, mild winters and relatively dry summers. Temperature extremes are muted due to the moderating effects of the Pacific Ocean.

The natural disturbance regime is primarily one of infrequent, high intensity events, such as wildfire and wind.

Pacific Yew

Pacific yew in the coast ranges is found in the western hemlock, Sitka spruce and coast redwood vegetation zones (Hemstrom and

Logan, 1986). Yew is a relatively uncommon tree in the coast range province, with only scattered distribution.

Siskiyous

The Siskiyou province of northern California and southern Oregon is an area of unique geologic and ecological characteristics. The area contains regions of complex and strongly contrasting geology, including ultrabasic rock types such as serpentine (Franklin and Dyrness, 1973). There are also a large number of endemic species and unique plant communities. The area contains sharp temperature and moisture gradients (Whittaker, 1960). The coastal side of the region is relatively humid with more arid conditions in the east. The disturbance regime is one of frequent light ground fires.

Pacific Yew

Pacific yew in the Siskiyou province is found in the western hemlock, white fir, Douglas-fir, Pacific silver fir, and western redcedar vegetation zones (Atzet and Wheeler, 1984). Pacific yew is relatively widespread in the northern portion of the province, although it is still not abundant. Yew can be found in a wide variety of environments in the area from high elevation snow chutes to low elevation drainages. It is usually associated with areas of high humidity and in older, undisturbed stands. Yew is only occasionally found on midslopes or in open stand conditions (Atzet, 1991). In the southern portion of the province, yew is primarily found only in drainages and on the lower third of north-facing slopes (Scher and Jimerson, 1989).

Western, Northern, and Recent High Cascades

The Cascades are a chain of high mountains running north-south from British Columbia to northern California. The range is bisected by the Columbia River, which divides the states of Oregon and Washington. The average elevation of mountains in the Cascades is 8000-9000 feet, although there are a number of higher elevation volcanic peaks found throughout the range. Glaciation has been an important process at the higher elevations.

The Cascade range is the major barrier to the movement of maritime and continental air masses. Elevation and topography greatly affect the local climate and it is an area of climatic ex-

tremes. The Northwestern Cascades province has heavy annual precipitation, high humidities and relatively mild temperatures. The Western Cascades receive slightly less rainfall and also have relatively mild temperatures. The high elevation Recent High Cascades province receives more of its precipitation as snow and is characterized by warm summers and relatively cold winters. Summer thunderstorms are common. The eastern slope of the Cascades is much drier than the rest of the range.

The disturbance regime in the Cascades is one of large, intense, infrequent fires and windstorms. These high intensity events occur at intervals of several hundred years (Franklin, 1988). The eastern slope of the range has a much more frequent fire interval.

Pacific Yew

Pacific yew is primarily found in the Northern and Western Cascades Provinces. Occasional trees can be found in scattered localities in the Recent High Cascades, both along the crest and on the eastern slope of the range.

Pacific yew occurs as a scattered understory tree throughout the northern and western Cascades. It is found in occasional clumps and as stringers along riparian areas. Yew can be found in a wide variety of plant associations within the western hemlock, Pacific silver fir, western redcedar, Douglas-fir, white fir, and grand fir vegetation zones (Brockway *et al.*, 1983; Franklin *et al.*, 1988; Hemstrom *et al.*, 1982; Halverson *et al.*, 1986).

On the west side of the Cascades, yew can be found at a wide range of elevations, on all aspects and slope positions, on benches, ridgetops and bottomlands. Tree form yew is the dominant growth form, but the shrub form is also present. Shrub form yew is primarily found on harsh sites, adjacent to wetlands, and at higher elevations.

Pacific yew is also found on the east side of the Cascade range, although it is relatively uncommon. The shrub form predominates, and is usually found in riparian areas.

Sierra Nevada

The Sierra Nevada is the dominant mountain range in California, extending 360 miles along the eastern portion of the state, from Mt. Lassen to Bakersfield. The province is located within the Mediterranean climatic zone, and has wet winters and hot, dry summers. Climate varies throughout the Sierra Nevada Range due to its diverse topography and the wide span in latitude and altitude. The east side of the range, within a rain shadow, is much drier than the west side.

The natural disturbance regime is one of frequent, low-intensity ground fires (Barbour, 1988). Fire frequency varies with vegetation type, but an average interval is every 8 to 16 years.

Pacific Yew

Pacific yew is found in the northern portion of the Sierra Nevada range primarily within the mixed conifer vegetation zone, which occupies an elevational band between 3000 and 5000 feet. Yew is almost always associated with cool, moist riparian environments. It is usually found along drainages, or on the lower portion of north-facing slopes. Seedlings are occasionally found on mid-slopes, but full-grown trees are not (Fites, 1992).

Okanogan Highlands

The Okanogan Highlands province reflects repeated glaciation, resulting in a generally rolling terrain of moderate slopes and broad, rounded summits. Scattered peaks rise 3,000 to 4,000 feet above the general terrain, dividing the area into several upland areas separated by a series of broad north-south valleys. The province is in the continental climatic zone, with cold winters, warm summers and high summer rainfall intensities.

Pacific Yew

Pacific yew in the province occurs as a scattered, very low-growing shrub. It rarely reaches stem sizes that would be harvestable for bark. Pacific yew shrubs can be found in the western hemlock, western redcedar, and grand fir vegetation zones (Williams *et al.*, 1990).

Blue Mountains

The Blue Mountains Province is composed of several mountain ranges. The most prominent of these are the Blue and Ochoco Mountains. The topography of the region is highly variable, and moderately steep slopes are common. The province is within the warm continental climatic zone.

The Cascade range to the west provides a barrier to warm, moist fronts coming in from the Pacific Ocean. The Columbia River Gorge, however, allows cloudy, marine conditions to reach the northern portion of the Blue Mountains range. This provides an environment for some vegetation types similar to those found in the Cascade range (Johnson and Clausnitzer, 1992). The Blue Mountains region is characterized by light precipitation, low relative humidity, rapid evaporation, abundant sunshine, and wide fluctuations in temperature and precipitation.

The natural disturbance regime in the area is one of frequent, lightning-caused fires (Johnson and Clausnitzer, 1992).

Pacific Yew

Pacific yew is found only in the northeastern corner of the province, in the northern Blue Mountains. The yew is sporadically distributed both individually and in small, isolated clumps at moderate elevations within the grand fir vegetation zone (Johnson and Clausnitzer, 1992). The yew is found in cool, moist environments that have been sheltered from disturbances. It is often confined to canyon bottoms, lower slope positions, or favorable cove and basin settings at the head of drainages (Johnson, 1992). The growth-form of yew in the area is most commonly a mid-to-tall shrub-like tree (Johnson, 1992).

Wallowas

The Wallowas province consists of a mountainous "island" (the Wallowa Mountains) surrounded by lava plateaus. The Wallowas, unlike the Blue Mountains to the west, have been heavily glaciated, creating steep, rugged slopes. Climate is similar to that in the Blue Mountains province except that the Wallowas have higher precipitation and colder temperatures. The natural disturbance regime is one of frequent, lightning-caused fires.

Pacific Yew

The occurrence of yew in the Wallowas is similar to that described for the northern Blue Mountains. It is found primarily in undisturbed cool, moist environments in the grand fir vegetation zone (Johnson and Simon, 1987). The shrub-like tree is usually found in canyon bottoms, on lower slope positions, and at the head of drainages (Johnson, 1992). Although usually found on cool sites in the area, yew has been found growing in the bottom of Hell's Canyon along the Snake River, where summer temperatures can occasionally reach up to 115 degrees Fahrenheit.

Rocky Mountains North Part

This province encompasses the portion of the Rocky Mountain range that runs through northern Idaho, northwestern Montana, and northeastern Washington. It is an area of high rugged mountains and flat valleys. The Northern Rocky Mountains are in the continental climatic zone. The area has strong climatic seasons with cold, snowy winters and warm summers.

The disturbance regime in the Northern Rockies is variable. The low elevation ponderosa pine woodlands have a history of frequent, low intensity fires with an average fire interval of five to twelve years (Arno, 1980; Gruell, 1983). The higher elevation forests have a longer fire interval and more severe, stand-replacing crown fires.

Pacific Yew

Pacific yew occurs in very small amounts, in scattered localities over millions of acres in northern Idaho and western Montana. Yew can be found in the western hemlock, western redcedar, grand fir, and subalpine fir vegetation zones. It is also occasionally found in the mountain hemlock and spruce zones (Cooper *et al.*, 1991; Pfister *et al.*, 1977).

Pacific yew is locally abundant in a few areas within the province. One such area is the Nez Perce National Forest in northern Idaho in the drainage of the South Fork of the Clearwater River. Throughout most of the drainage, yew occurs as a clumped or scattered tree, but there are some localized areas of dense, tree-form yew. Yew is the predominant tree species in these stands, beneath a

scattered overstory of grand fir, larch, Douglas-fir, lodgepole pine, and Engelmann spruce. It has even been suggested that Pacific yew may be the climax species on these sites (Crawford, 1983).

Abundant yew can also be found in localized areas on the Flathead National Forest in northwestern Montana. The shrub-form yew in this area forms dense, continuous thickets.

Other Areas Where Yew Occurs

Pacific yew is also found in southeastern Alaska, western Canada, and on the Payette National Forest in Central Idaho. These areas are not covered by this EIS.

Landscape Ecology

Landscape ecology is an emerging discipline in the field of ecology that examines patterns in time and space across large land areas, and how these patterns develop. The landscape perspective shifts from a more traditional focus on individual stands to a view of the entire landscape. A landscape can be defined as a cluster of interacting ecosystems, and is usually measured on the scale of thousands of acres or multiple watersheds (Forman and Godron, 1986). Connectivity, or spatial continuity, across the landscape is an important aspect of viewing the forest through a landscape perspective.

A landscape approach is particularly appropriate to the management of Pacific yew because we are dealing with almost the complete range of the species. It is important to understand the distribution of Pacific yew both within and between the physiographic provinces described above. The reproductive dynamics, plant-animal relationships, growth forms, and habitats in which yew occurs are different between the provinces.

Viability of a species is dependent on interaction between localized populations, which facilitates gene flow and dispersal. Connections between populations also allow for the movement of organisms that may depend on that species, or on the kind of habitat which it creates. When examining connections between yew populations, it is important to remember that Pacific yew is a naturally "clumpy" species, with scattered distribution. The continued presence of Pacific yew throughout its natural range should be provided for by maintaining interaction and gene flow among yew populations.

Yew population connectivity across the landscape is an important consideration. Many areas such as wilderness, research natural areas, and unique and special interest areas, for example, are already reserved from any harvesting activity. These reserves provide for maintenance of the yew populations within these designated areas. Connections between these set-aside areas should be considered on a landscape scale - across ownership and management unit boundaries. A degree of replication in maintaining populations is desired in order to allow for reductions in concentration or abundance due to natural disturbances.

Ecosystem

Terms to Know

Ecology— *the study of the relationship between organisms and their environment.*

Population— *a group of individuals of any one kind of organism.*

Community— *all of the populations in a given area. The biotic community and the non-living environment function together as an ecosystem.*

Vertical structure— *the layering of vegetation, the vertical arrangement of herbs, shrubs, midcanopy and canopy trees, and snags.*

Horizontal structure— *the distribution and spatial arrangement of life forms and species.*

Overview of Ecology

Ecology is the study of the relationship between organisms and their environment. It examines the structure, function, and patterns of nature.

The biological world can be divided into six major levels of organization: genes, cells, organs, organisms, populations, and communities. A population is a group of individuals of a particular kind of organism. A community encompasses all of the populations within a given area. The community and the nonliving environment function together as an ecosystem (Odum, 1971).

It is important that we consider not only the most obvious components of the ecosystem, the large plants and animals, but also smaller and often overlooked organisms. Fungi, mosses, lichens, soil and canopy invertebrates, mycorrhizae, bacteria, and other microorganisms are all important parts of natural systems, although their roles in the forest ecosystem are not yet completely understood.

Note: Ecology, by definition, examines the interconnections in nature. There is therefore a great deal of overlap between this section and other sections of the EIS, particularly in Parts One and Two of this chapter and Chapter IV.

Roles of Pacific Yew in the Ecosystem

Note: This description of the ecology of Pacific yew owes much to the Interim Guide. A copy is on file with the process records for this EIS (see also Chapter II).

Pacific yew is an ecologically unique species. There are few other plant species in the world with broad habitat occurrence and wide distribution, that have such small local population sizes.

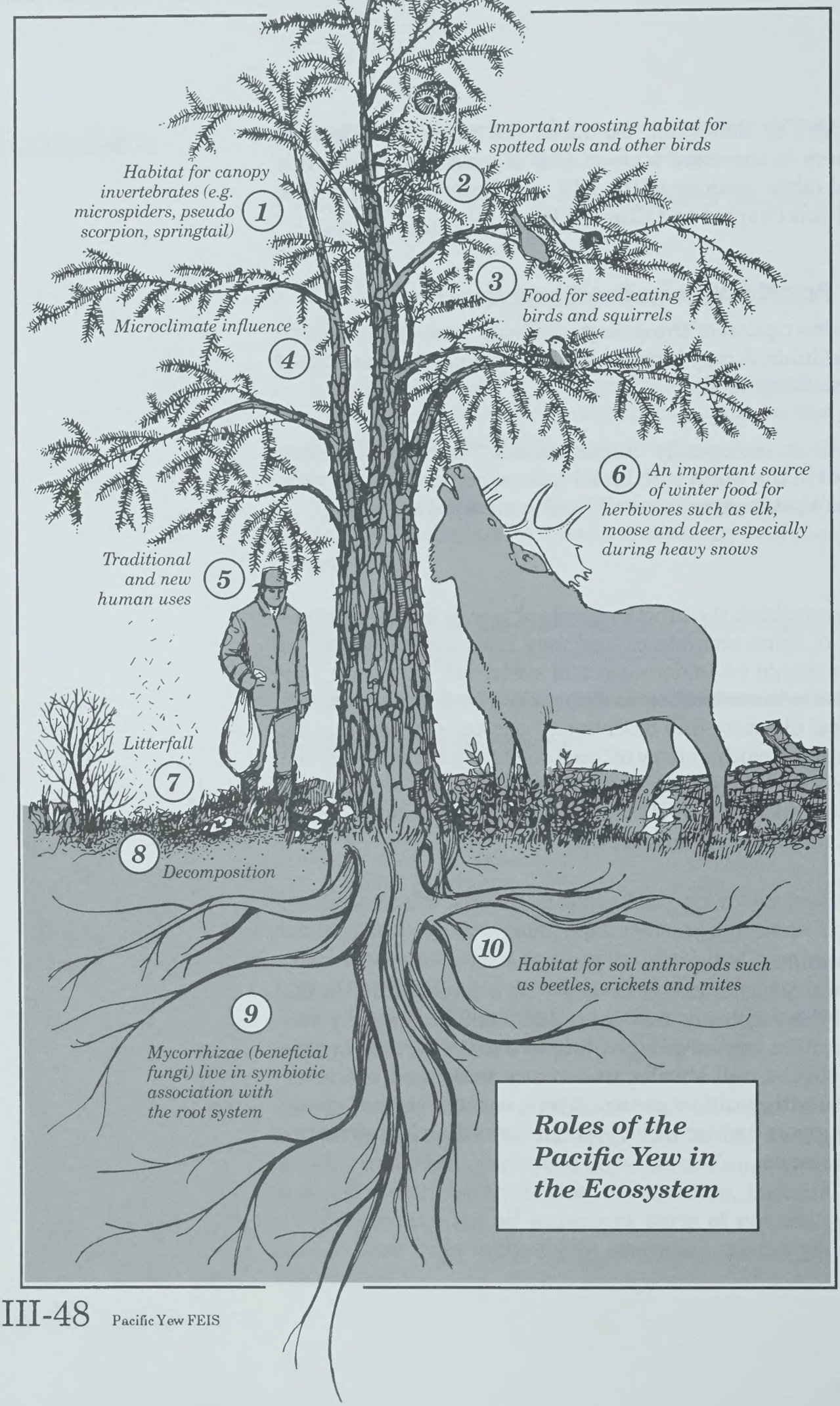
Function

Little is known about the functional role of yew. It is an important component of some ecosystems and may have a wide variety of roles which should be understood and sustained. Yew may play important roles in controlling the microclimate, nutrient cycling, and biological diversity (see biodiversity section) of forest stands. Given the unique biochemistry of the species, it is entirely possible that yew may play a special role in cycling nutrients, altering soil chemistry, and possibly maintaining a unique community of invertebrates and microorganisms.

Structure

Vertical Structure

An important determinant of diversity in a forest stand is the structure of the vegetation (see the wildlife and biodiversity sections). Vegetation can be grouped into five main vertical layers: herbs, low shrubs, tall shrubs, understory trees, and overstory trees. Stands with multiple canopy layers, or more vertical structure, often support a wider variety of organisms than less structurally diverse stands.


Important roosting habitat for spotted owls and other birds
2
Habitat for canopy invertebrates (e.g. microspiders, pseudo scorpion, springtail)
1
3
Food for seed-eating birds and squirrels
Microclimate influence
4
6
An important source of winter food for herbivores such as elk, moose and deer, especially during heavy snows
Traditional and new human uses
5
Litterfall
7
8
Decomposition
10
Habitat for soil anthropods such as beetles, crickets and mites
9
Mycorrhizae (beneficial fungi) live in symbiotic association with the root system
Roles of the Pacific Yew in the Ecosystem

Horizontal Structure

Horizontal structure, or the spatial arrangement of vegetation in a stand, also contributes to structural diversity. A patchy stand, with a variety of vegetation, is more diverse than a stand with uniform distribution. A horizontally diverse stand contains a variety of microsites, and can therefore support a more diverse biotic community.

Pacific Yew's Role in Stand Structure

Pacific yew contributes to both the vertical and horizontal structure of forest stands. It occupies the midcanopy layer in a wide variety of stand types, providing vertical structure. Pacific yew is a valuable long-term midstory species due to its small stature and shade tolerance. Its clumpy, scattered distribution also adds to horizontal diversity.

Snags and Woody Debris

Snags (standing dead trees) and down logs also contribute to structural and habitat diversity. Pacific yew's decay resistant wood could make it a valuable species for down woody debris, both on land and in streams. This may be offset, however, by yew's small size. The importance of snags and down logs to wildlife is discussed in the wildlife section. Yew's role in riparian areas and fish habitat is discussed in the water resources and aquatic section.

Community Ecology

More Terms to Know...

Plant association— *a grouping of plant species that recur across the landscape within particular environments (Daubenmire, 1968).*

Climax plant community— *a mature, highly stable, self-replacing plant community (Clements, 1916). It is the end result of the successional development of a plant community, in the absence of disturbance.*

Indicator species— *plant (or animal) species whose presence has been correlated with certain environmental conditions.*

Mycorrhizae— *an association, usually symbiotic, between a root tip of a plant and one of several species of fungi. The mycorrhizal relationship aids a plant in absorbing water and minerals.*

Succession— *the sequence of change in communities during development of vegetation in an area.*

Succession

Succession is the sequence of change in communities during development of vegetation in an area. Plant communities on a site replace each other over time, due to changes in physical and biological conditions. The end result of the successional process is the climax community, a mature, highly stable, self-replacing plant community (Clements, 1916). The climax condition is rarely reached, however, due to both natural and human-caused disturbances.

Plant Associations

Plant associations are units that are used to classify plant communities. They are groupings of plant species recurring across the landscape within particular environments (Daubenmire, 1968). Plant associations describe the potential, or climax, plant community, the vegetation that would eventually occupy a site in the absence of disturbance.

The group of species that eventually becomes dominant on a site is an indicator of environmental conditions. The classification of sites into plant association types allows us to make inferences about a wide range of ecosystem functions and responses, simply by examining the vegetation.

A stand does not have to be in a climax condition to classify the plant association type. The plant association concept relates to environmental conditions that determine where a species could be climax and where it could not. Plant associations are named after the climax tree species and the shrub or herbaceous species that typify the association.

Yew in Plant Associations

Pacific yew is found in an extremely large number of diverse plant associations, implying a wide environmental tolerance. It can be found in associations as varied as the sea level Sitka spruce/devil's club/ladyfern (Pisi/Opho/Atfi) association; the high elevation mountain hemlock-Alaska yellow-cedar/five-leaved bramble association (Tsme-Chno/Rupe); and the foothill type California black oak-bigleaf maple/Oregon ash (Quga-Acma/Frla2) association. Yew was found to occur in 108 different plant associations in Oregon and Washington, 29 in Idaho and Montana, and 16 in California.

For a listing of plant associations where yew is present in Oregon, Washington, Idaho, Montana, and California, see Appendix H.

Note: Terminology differs between Forest Service Regions: "Associations" in the Pacific Northwest Region are equivalent to "series/habitat type/phase" in the Northern Region.

Indicator species

Indicator species are plant species whose presence has been correlated with certain environmental conditions. Pacific yew is associated with a wide variety of indicator species, and therefore with a wide variety of environmental conditions.

Yew in Old growth Stands

Old growth forests are the later stages in forest development. They are often compositionally, and always structurally, distinct from earlier successional stages (Franklin and Spies, 1991). Definitions of old growth vary by geographic area and forest type, but old growth stands are typically characterized by a wide range of tree ages and sizes (including some very old trees), by a deep, multi-layered canopy, and by the presence of large snags and down woody debris.

Old, moss-laden yew

Pacific yew has been found to be more abundant in old growth Douglas-fir forests than in younger stands (Spies, 1991). It does, however, also grow in young stands (USDA Forest Service, 1991; USDI Bureau of Land Management, 1991). There is indication that yew trees and shrubs often originate after the main vegetation in a stand has already been established (Spies, 1992; McCune, 1982), making it more commonly a late seral species.

Past logging of old growth has undoubtedly reduced the quantity and distribution of larger yew trees. Yew has most likely been eliminated from many sites following burning after timber harvest. The reduction of Pacific yew as the result of past management practices may, however, be somewhat tempered by decades of fire suppression throughout the range of the fire-sensitive species. Historically, wildfire has also undoubtedly reduced or eliminated yew on many sites, although it has probably been able to eventually recolonize many areas over time.

Occurrence of Yew

Pacific yew occurrence is determined by more than simply the presence of late-successional forests. For example, the plant association in western Oregon (and parts of western Washington) in which Pacific yew was most commonly found was western hemlock/rhododendron/beargrass (Tshe/Rhma/Xete). Pacific yew is considered a late seral to climax species; it increases in number and relative dominance with time after disturbance. Because of this, one would expect late seral stages of the Tshe/Rhma/Xete association to have the highest probability of containing yew. Many such stands, however, are totally devoid of Pacific yew.

One of the puzzling aspects of Pacific yew is that, although it can grow in an extremely wide range of conditions, it is still an infrequent tree. Yew can even grow in some areas that could be classified as nonforest: in avalanche chutes (Deevy, 1991), on talus and scree slopes in which yew is the only tree present, on rocky cliffs, and in chaparral-like yew thickets in the mountains of northern Montana.

It is apparent that factors other than site are at play. Among these are fire history, browsing animals, and the possibility of other episodic events. Windstorms, drought, floods, past insect or disease epidemics, and long periods of poor seed crops could be involved. Another possibility is that Pacific yew could be less efficient than the other species with which it grows in utilizing site resources, and is therefore unable to successfully compete in many stands.

Other Components of the Ecosystem

There are other components of the ecosystem besides vegetation that must also be considered. These include above and below-ground invertebrates, canopy flora, fungi, and microorganisms. Much more remains to be discovered about Pacific yew's relationship with these organisms.

Mycorrhizae

The term mycorrhizae refers to an association between a root tip of a plant and one of several species of fungus. The mycorrhizal relationship aids a plant in absorbing water and minerals. Most woody plant species require mycorrhizae for their survival.

Pacific yew is strongly mycorrhizal (Trappe, 1992). The mycorrhizal fungi associated with yew is a variety that can also be found on other trees and shrubs. Pacific yew is associated with vesicular-arbuscular (VA) mycorrhizae (Trappe, 1992), a type found mainly on angiosperms, but also present on some genera of gymnosperms such as *Cupressus, Thuja, Taxodium, Juniperus,* and *Sequoia* (Gerdemann, 1975; Safir, 1980).

Invertebrates

Not much is known of Pacific yew's invertebrate community. Yew, like other tree families containing high levels of chemical compounds (such as the Cupressaceae), probably has an invertebrate community with lower species diversity than other coniferous families (Lattin, 1992). Yew's invertebrate community, however, may be quite distinct. Pacific yew, like other ecologically unique plant species, may support a community of invertebrate specialists of species that are not found on other plants (Lattin, 1992).

Overview of Biodiversity

Definition

Biological diversity, or biodiversity, refers to the variety of life, and its processes, in all its forms and at all levels of organization. It includes the variety of living organisms, the genetic differences among them, and the communities and ecosystems in which they occur. At large geographic scales (from watersheds to the entire biosphere), it includes variety in the kinds of ecosystems, their patterns, and linkages across regional landscapes (Keystone Policy dialogue, Keystone Center, 1991).

Importance

Maintaining biological diversity is important because it:

- is critical to maintaining the natural resiliency of forest ecosystems (Franklin, *et al.*, 1988);
- serves as a source of new foods and needed medicines (e.g. taxol);
- serves as a gene pool for the improvement of domesticated crops and animals; and
- has intrinsic aesthetic, educational, and recreational value.

Relevant Legislation

There are also legislative reasons for concern. The National Forest Management Act (1976), the National Environmental Policy Act (1969), and the Endangered Species Act (1973) mandate federal agencies to conserve biological diversity and consider it in the planning process.

Complexity

Levels and Components

Because of its complexity, ecologists often divide biological diversity into levels and components. Biodiversity can be divided into four levels: genetic, species, community, and landscape diversity.

The three main components of biological diversity are composition, structure, and function. Composition refers to the identity and variety of elements in a collection, and includes measures of species and genetic diversity. Structure is the pattern of organization and distribution of the different compositional elements. Function involves the ecological and evolutionary processes which occur at the various levels (Noss, 1990).

For a matrix view of how the levels and components fit together, see Table III-8 at the end of this section.

Levels

Genetic Diversity

The most basic level of life is genetic diversity. Genetic variation determines physical characteristics of species, and affects productivity, resilience to stress, and adaptability to change. (See the genetics discussion in Part One of this chapter.)

Species Diversity

Most people's concept of biological diversity focuses on species diversity. Species diversity includes both the number of species present (referred to as species richness), and the distribution of abundance among different species (known as evenness).

Pacific yew contributes to species diversity in several ways. Its presence adds a species to a community and region, and through its structural and functional role in the community, it provides habitat for other species. Due to Pacific yew's unique array of secondary chemicals, it may support some rather specialized and unique species which are not supported by the other components in the ecosystem. Pacific yew's allelopathic properties may also affect plant diversity by inhibiting the germination and growth of other plant species beneath its canopy.

Biological Communities

Associations of species, often called biological communities, are another level of biological diversity. These associations of species

share the same local environment, such as an old growth Douglas-fir forest stand, a riparian area, or an alpine meadow. Communities combined with the physical components of their environment (soil, moisture, light, etc.) are called ecosystems.

Vegetation structure, the kinds of structural units, and the vertical and horizontal dimensions of that structure are important community attributes. The structure of the vegetation is a key habitat feature for wildlife.

Pacific yew contributes both structurally and functionally to the communities in which it occurs. Its role as a midstory species adds to the vertical structure in stands. Yew's clumpy, scattered distribution may also add to horizontal diversity. This scattered distribution may break up continuous stands and could possibly reduce the risk of insect pest and disease epidemics (McCune, 1982).

Pacific yew has extremely decay-resistant wood, and any processes that depend on long-lasting woody structures are likely optimized with Pacific yew.

Landscape and Regional Scale

At the landscape and regional scale, biological diversity includes variety in types of ecosystems, and their patterns and linkages across large, regional landscapes. Landscape diversity involves spatial relationships. (See Landscape Patterns section in this chapter for further information on the landscape level perspective.)

At the landscape level, structure is important in terms of the patchiness of a given type of vegetation, sizes of the patches, and their pattern of distribution across a large area. Connectivity, or how continuous a certain community type is across a landscape, influences gene flow and distribution of species. Landscape structure can therefore affect the other levels of biodiversity.

A distribution of community types, with a variety of seral stages and age classes, is desirable for maximizing compositional diversity across a landscape. Some examples of landscape level func-

tional processes include nutrient cycling, energy flow, and hydrologic processes. These are all influenced by the disturbance regime, another landscape level process which greatly affects biodiversity.

Table III-8: Examples of Levels and Components of Biodiversity

	Components of Biodiversity		
Levels of Biodiversity	**Compositional**	**Structural**	**Functional**
Genetic	number of genes, alleles	genetic structure, levels of variation	recombination, evolution, mating systems
Species	number of species	species distribution and abundance	trophic levels, life histories
Community or Ecosystem	number of communities, ecosystems	habitat structure, community distribution and abundance	ecosystem processes
Landscape or Region	number of distinctive ecosystem patterns	pattern of successional stages and vegetation types over a large area	regional processes

Forest Health

Overview and Trends

A large segment of the public, as well as the resource management community, is concerned by the recent decline in the health of the nation's forests. This decline is particularly evident in the forests of eastern Oregon and Washington where increased levels of tree mortality, epidemic levels of forest insects and diseases, and a recent history of large catastrophic fires are seen as important indicators of this decline.

Measures of Forest Health

The term forest health can have many meanings. It can describe the forest's ability to meet the goals of the land manager and the landowner. In a broader sense, it also describes the relationship between biotic and abiotic influences, including the influence of human activities, on forests and their short and long-term impact on management objectives for a forest unit.

At the heart of this relationship is the concept of ecosystem sustainability on a broad scale or landscape level. The concept represents a balance of all the interrelated aspects of an ecosystem that allows the system to maintain and perpetuate itself throughout time.

Ecosystem function can be a hard concept to define. It is a combination of many influences, the most significant of which, for forest health, are the presence and activities of insects, diseases and fire.

A healthy forest, like a healthy body, is a self-regulating system composed of a myriad of interconnecting parts that must all be functioning correctly. It is the goal of good resource management

Terms to Know

Forest health— *A condition where biotic and abiotic influences (i.e. insects, diseases, atmospheric deposition, fire, silvicultural treatments, and harvesting practices) do not threaten ecosystem sustainability and attainment of management objectives for a given forest unit now or in the future.*

to ensure that all the parts of the system are present and balanced. One potential baseline for normality for forest health could be the condition of the forests before settlement; another could be the ability of forest ecosystems to meet desired future conditions in forest plans and BLM resource management plan.

Roles of Insects and Diseases

Insects and diseases have many roles in ecosystem functioning. They influence succession, they compete for resources, and they interact with fire to serve as important agents of necessary change. In the Pacific Northwest Region, insects, diseases, and fire are a natural part of any functioning ecosystem and have evolved as a part of that system.

Role of Change

Change is an important part of ecosystem development. Changes in vegetation quality, quantity, composition, density, and distribution are mediated to a large degree by the actions of the agents of forest health.

Forests become unhealthy when the balance between these agents is disturbed by human activities, such as the exclusion of fire, the introduction of exotic pests or vegetation, or by natural causes such as a change in local weather patterns, major geologic events, or global climatic changes.

Current Activities

Regional efforts to address forest health began with forest health assessments for the Blue Mountains National Forests (Wallowa-Whitman, Umatilla, and Malheur) and the Ochoco National Forest in 1991. The conclusion of these assessments was that forest health was declining due to a combination of past management practices, including the exclusion of fire from the ecosystem.

Forest health assessments will be drafted for the eastern Washington (Okanogan, Colville, and Wenatchee) national forests and other forests on the west side. A region-wide network of coordina-

tors to work with forest health-related activities now exists. In addition, the Blue Mountains Natural Resources Institute serves as a clearinghouse for research and demonstration projects on forest health.

The national forests most immediately affected by the decline in forest health include the limits of the natural range of Pacific yew. However, any long-term change in the overall health of the forest ecosystem could have a detrimental effect on the yew population.

At the same time, any significant decrease in the ability of the ecosystem to sustain a viable population of Pacific yew would be an important and serious indication of a decline in forest health. Efforts to maintain forest health should include the goal of maintaining viable, resilient populations of all species.

Soils

Soils in the Range of Yew

Great Variety

The range of the Pacific yew is so extensive that it is found in a great variety of soils and climatic conditions. The soils within the five-state area range from deep and productive forest soils at the lower and gentler slopes of the Cascade and coastal forests of California, Oregon and Washington, to shallower and stony soils of the steeper, mid and high elevations of the Cascades and recent (high) Cascades.

The tree seems to be able to grow on a wide range of soils including those in the orders Ultisols, Alfisols, and Inceptisols. Within these orders, it grows best on deep, moist and rich soils (such as alluvial deposits), and yet it can also be found on "avalanche chutes" in Montana.

East-side Soils

In the east-side forests of California, Oregon, Washington, Idaho, and Montana, Pacific yew can be found on soils derived from coarse pumice, finer volcanic ash, and even on soils that develop directly from the parent rocks. Within these east-side forests, glacial materials mixed with pumice and ash also influence soil development. Generally, areas with these soil types are moderately to highly productive tree-growing sites.

Soils from Ultramafic Materials

Pacific yew can also be found on soils developing from ultramafic* rocks such as serpentine, which are unique to the Six Rivers, Klamath, Siskiyou, Wenatchee, and Wallowa-Whitman National Forests. These soils are unusual in that they contain a nutritional imbalance limiting the kind of vegetation present to that which can adapt to this condition.

**Ultramafic*— Some igneous rocks and most varieties of meteorites containing less than 45 percent silica and virtually no quartz or feldspar, and composed essentially of ferro magnesium silicates, metallic oxides and sulfides, and native metals.

Soil Factors Influencing Yew

Best Soil Conditions for Yew

For the most part, moist, cool, and productive soils seem to promote the establishment of yew. In British Columbia, yew tends to be most productive in alluvial habitats where soils are nutrient-rich. A study conducted in the Bitterroot Mountains of Montana and Idaho indicated that sites dominated by Pacific yew have high levels of nitrogen (McCune, 1982).

Yew and Slope Position

Over much of its range within the humid parts of the northwest, Pacific yew can be found on all slopes, benches, ridgetops, and bottomlands.

In dry, subhumid areas with an average annual precipitation as low as 19 inches, yew is confined to canyon bottoms and the lower third of north-facing slopes. It is also found on dry, rocky sites and in avalanche chutes east of the Cascades (Deevy, 1991).

Near the southern limit of its range in California, yew is generally confined to canyon bottoms. In the coastal areas of British Columbia and southeastern Alaska (outside the area of consideration for the purposes of this proposal) it is seldom found far from tidewater (Yanchuk, 1992).

Fire and Soils

Although this tree is sensitive to fire, past wildfires and their effect on soils do not appear to provide any conclusive evidence regarding the presence or absence of Pacific yew.

Influence of Bedrock

Soils developing directly from bedrock do not appear to influence the growth of Pacific yew since it can be found on soils developing from sandstone, granite, diorite, gabbro, pre-Cambrian metasediments, schists, gneiss, basalts, and other materials mentioned earlier (Crawford and Johnson, 1985; Whittaker, 1960).

Site-Specific Analysis; Activities

There is great variation in soil and water resources and environmental conditions within the five-state region. Whether and how activities (including bark harvest) take place in specific areas is determined on a case-by-case basis using a prescription process compatible with each national forest or BLM district plan. These take into account such variables as the amount and condition of resources such as soil and water, as well as resource objectives.

Physiographic Provinces

Overview

For the purpose of describing the soil and water conditions associated with the variety of conditions, and for predicting the effects of yew harvest on soils, the affected area has been broken down into physiographic provinces, based on landforms. Generalized soil and water conditions usually associated with each particular province are included for the major vegetation zones, which are based on characteristic plant occurrences. Provinces are delineated in the following figure.

Note: Each province has been described, but the volume of material is too extensive to include here. Province descriptions are found in Appendix I.

Figure III-7: Provinces in the Range of Pacific Yew

Water Resources and Aquatic Habitat

Water Resources

Forested areas are important sources of water for aquatic habitats of streams, wetlands, lakes and ponds; groundwater recharge for aquifers; and for domestic, municipal, and industrial uses.

The interactions between climate, geology, human activity, and landforms directly affect watershed processes and water quality. The quality of the aquatic habitat reflects processes and activities occurring throughout the watershed.

Terms to Know

*A **snowmelt-dominated streamflow regime** typically has one peak flow period which commences with snowmelt and terminates with the onset of base flow, or the period when groundwater releases regulate flow levels.*

***High-intensity summer storms** can create devastating flash flood conditions such as those of summer, 1964, in the Northern Rocky Mountains of Montana along both sides of the Continental Divide.*

***Storms of lesser extent and intensity** and greater frequency occur throughout the regions east of the Cascades. Typically, these storms occur during periods in or approaching base flow and display a substantial, sharp increase of flow followed by an almost equally sharp decline in flow back to base flow.*

Stream Flow

Undisturbed forests typically regulate releases of water to the drainage network that has been shaped by land-forming processes and major climatic events. Less intense climatic events "fine tune" the network to accommodate the routine or yearly cyclic events that define the normal streamflow regime. Within the elevation ranges where Pacific yew is found, stream flows typically vary greatly during the course of the year.

In snowmelt-dominated streamflow regimes, the greatest annual streamflow occurs in the spring. The northern Rockies typify this regime. The period of annual high flows along the coast and Cascade ranges from California to Canada is mid-winter because of the prevalence of rain-on-snow events. This occurs especially in the 1500 to 4500 foot elevational range, called the transient snow zone, followed by smaller snowmelt-only flows during the spring. To a lesser extent, rain-on-snow affects the Okanogan highlands and the windward mountain front of northern Idaho.

In both regimes, the seasonal low flow period extends from early summer to mid-fall, or whenever the fall rains begin.

Extreme events resulting in major floods differ between the two regimes. In the transient snow zone, major floods occur during early winter. An example of this type of flood is that of December, 1964. The upper limit of this elevational range may extend to well above timberline during these periods. Where snowmelt dominates the flow regime, major floods occur during the summer. An example in this regime was that in the northern Rockies in July, 1965.

Peak Flows

The frequency and magnitude of peak flows may increase following land use activities. Intensive timber harvest may aggravate the effects of rain-on-snow events, situations where rainfall on snowpack can cause runoff amounts greater than the rainfall or snowmelt would alone. Rain-on-snow events may result in higher peak flows which may cause damage to stream channels and associated fish habitat. These effects are typically reduced in less-intensely disturbed watersheds.

Similar effects may occur in snowmelt-dominated streamflow regimes as well, principally the result of a redistribution of snow.

However, even in watersheds unaltered by land management activities, peak flows resulting from a major runoff-producing event will cause changes in channel alignment and encroach onto the floodplain and degrade some existing aquatic habitat while

creating new habitat elsewhere. Human intervention is not necessary to cause a change in this dynamic system, though it may accelerate change and create less desirable and complex habitats.

Water Quality

Water quality varies by season. During snowmelt or a rain-on-snow event, quality declines substantially, particularly that associated with sediment, as sediments are mobilized and transported downstream. During extreme events, even large boulders are mobilized.

In most stream systems, sediment supply is limiting, such that water quality begins to improve before flows reach their peak, and continues to improve at a faster rate than the flow peak declines. It is common for sediment concentrations to appear unusually high during the fall rains before the snowpack begins to build, as the summer's accumulation of fine sediment along stream bottoms and banks is mobilized and washed downstream with slowly increasing streamflows.

Dissolved minerals typically reach their peak concentration during annual low flows, and their lowest during snowmelt or rain-on-snow periods (a matter of dilution). The source of most minerals is the groundwater contribution to surface water flows, and it varies little throughout the year.

Dissolved gases, typically oxygen, are rarely a problem in forested streams due to the streams' turbulence.

Yew and Riparian Areas

Pacific yew in riparian areas contributes to stream bank stabilization, stream shading, and coarse wood input, adding structural complexity to the aquatic, terrestrial, and riparian habitats, important prey base habitat for riparian-dependent species. Its relatively small stature makes yew a more valuable source of woody debris in smaller, headwater channels than in large streams. Its durability has long been recognized. Ranchers, for instance, favor the species for fence posts. The larger branches of Pacific yew

remain in riparian or aquatic habitats substantially longer than the wood of other species such as alder, which decomposes rapidly. This makes it a valuable species for woody debris despite its small size. The tendency for large Pacific yew trees to have hollow boles (Bolsinger and Jaramillo, 1990; Crawford, 1983) could offset its relative longevity as in-stream large woody debris, since these portions would decompose faster than corewood. The boles, however, could play an important role by providing additional hiding cover for fish as well as small terrestrial mammals.

Aquatic and Fish Habitat

Mosaic of Conditions

National forests and BLM districts in the range of Pacific yew contain a mosaic of terrestrial, riparian, and aquatic habitat conditions. These range from pristine areas (i.e., wilderness, unroaded areas, reserves, etc.) with the normal seasonal variation in water quality and streamflow distribution and with complex, productive aquatic and fish habitats, to areas where man's land use practices have caused a decline in water quality and a substantial decrease in aquatic habitat complexity.

Large Trees, Debris, and Habitat

Large trees moderate water temperatures by shading streams. When these trees fall into the stream, the new large woody debris creates new habitat for fish and aquatic insects, provides nutrients, stabilizes and sorts bedload, and stabilizes the channel.

Many streams no longer have complex habitats due to activities such as removal of woody debris, channelization for flood control or river travel, and land use practices which now appear unsound. The functions of large wood in streams, the history of wood removal from streams, and the influence of forest and range land management throughout the Pacific Northwest are described by Maser *et al.*, (1988) and Mehan (1991).

Fish Populations

Fish populations are affected by many factors in addition to habitat, such as interactions with other species, commercial fishing, sport fishing, dams, high seas interception, and weather. Isolating any one factor's effect on populations is difficult. However, for many of the stocks at risk, the highest quality spawning and rearing habitat remaining is in national forests.

Salmonid Fishes

The salmonid fishes, notably the anadromous, or sea-going forms, are the most valuable to the region, both culturally and economically. Eight species of anadromous salmonids are found within the range of Pacific yew. These include:

- chum salmon *(Oncorhynchus keta);*
- pink salmon *(O. gorbuscha);*
- chinook salmon *(O. tshawytscha)*
- coho salmon *(O. kisutch);*
- sockeye salmon *(O. nerka)*
- cutthroat trout *(O. clarki);*
- steelhead trout *(O. mykiss)*
- Dolly Varden *(Salvelinus malma).*

Within the Pacific yew's range, most precipitation occurs from November through April. The increased volume of freshwater flowing into the ocean triggers spawning migrations for many stocks of anadromous fishes into rivers and streams.

Individual stocks of these species constitute unique gene pools for different river systems. A stock is defined as a group of interbreeding individuals which is largely reproductively isolated from other groups (Ricker, 1972). There may be several different stocks within a species in an individual river system.

Observing variations in life history characteristics, such as the timing of adult migrations, is one method to identify stocks. Examples include early and late run coho, spring, summer, fall, and winter chinook, and summer and winter steelhead.

Anadromous salmonids throughout the region support sport and commercial fisheries, Native American fisheries, and Native American cultural practices. The decline in populations of these fishes in many watersheds has led to serious concern among management agencies, user groups, the scientific community, and the general public. A committee of the American Fisheries Society, a professional society of fishery biologists and natural resource managers, recently identified 214 native, naturally-spawning stocks of anadromous fish at risk in California, Oregon, Idaho, and Washington (Nehlsen *et al.*, 1991). In addition, they listed 106 extinct populations of west coast salmon and steelhead.

Salmonid Spawning Habitat

National forests and BLM districts in the range of Pacific yew provide spawning habitat for returning adults and rearing habitat for juveniles before they migrate to the ocean. This is less true for chum and pink salmon, as they spawn in the lowermost reaches of streams near tidewater, and the juveniles spend little time rearing in freshwater.

Resident Salmonid and Nongame Species

Resident salmonid species and nongame fishes are also found within the range of the Pacific yew. Whether located within national forest or BLM district streams or downstream from them, they are also dependent on high-quality water and habitat resulting from activities and conditions upstream and upslope.

Endangered species

Two species of fish federally listed as endangered are found on national forests within lands considered in this document. They are the Klamath short-nosed sucker *(Chasmistes brevirostris)* and the Lost River sucker *(Deltistes luxatis).*

Indication of public and scientific concern about anadromous fishes in the region was the publishing in 1991 of proposed rules in the Federal Register by the National Marine Fisheries Service to list Snake River sockeye and chinook salmon under the Endangered Species Act. The National Marine Fisheries Service has since listed the Snake River sockeye as an endangered species.

These salmon use the Columbia River as they migrate to and from spawning grounds in the Snake River system.

Other Discussion in the EIS

For additional information, see the sections on bioregions, ecology, and wildlife in this part of Chapter III, and the discussion of fire in this chapter.

Yew provides forage and thermal cover for some species. Yew foliage in the midstory layer of the forest contributes to structural complexity and plant species diversity that may enhance animal diversity. Yew associated with headwater streams contributes to stream shading and water cooling.

Wildlife

Terms to Know

Late-successional forests *in this section refers to mature and old growth forests.*

The term ***"closely associated with late-successional forest"*** *refers to species that are significantly more abundant (based on statistical tests) in a specific late-successional forest compared to younger successional forests.*

Overview

While states retain specific responsibility for managing wildlife populations, the key responsibility of the Forest Service and the Bureau of Land Management is caring for wildlife habitat as well as meeting the intent of laws associated with wildlife management. Thus, this discussion of the wildlife resource is organized to reflect that apparent dichotomy in terms of habitat and species.

How This Section Is Arranged

After an introduction to Pacific yew as habitat, the subsections discuss wildlife by general habitat type (late-successional forests, early-successional forests, and riparian areas) with an additional discussion of threatened and endangered species.

Within each subsection is more information about habitat elements, especially as they relate to Pacific yew, and a discussion of species associated with that general habitat type. To improve readability, only common names of species are used. A list of scientific names of species mentioned in this section are included in Appendix J.

Pacific Yew As Habitat

Pacific yew provides habitat components for a variety of wildlife species. The most noted wildlife associations are found with late-successional forests and riparian areas.

Wildlife Associated with Late-Successional Forests

Pacific yew is closely associated with late-successional forests throughout its range (Bolsinger, 1990; Crawford and Johnson, 1985; Scher and Jimerson, 1989; Spies, 1991).

Species

Over 100 species of amphibians, reptiles, birds, and mammals occur in late-successional forests (Brown, 1985; Thomas *et al.*, 1979b). A summary of recent empirical studies for forests in the Douglas-fir/western hemlock zone of western Oregon and Washington and northwestern California (Ruggiero *et al.*, 1991) listed 17 species that were closely associated with late-successional forests. Other studies indicate strong associations between additional species and late-successional forests (USDA Forest Service, 1992b). Little is known about the relationship of yew to most of these species. Species for which information is available are discussed below.

Diversity; Functional Processes

The structural diversity and biological richness within late-successional forests provide unique habitat features that are required, preferred, or used by many wildlife species. The functional processes that occur within late-successional forests are not well understood. Some processes have been studied, such as those involving mycorrhizal fungi and arboreal rodents, but most ecological relationships among species in mature and old growth forests are virtually unknown. (See biodiversity and ecology sections for more information.)

Habitat Features

Habitat features commonly recognized as being important components of late-successional forests include snags, large logs, large trees, and multilayered canopies. The decay resistant nature of Pacific yew wood may make it a valuable species for woody debris, despite its relatively small size. There is a tendency for large Pacific yew trees to have hollow boles (Bolsinger and Jaramillo, 1990; Crawford, 1983). This may shorten the longevity of snags

and logs, but may also encourage use by some species of wildlife and invertebrates. The size and growth form of Pacific yew makes the species a noted contributor to the structure of multilayered canopies.

Moose and Other Ungulates

Many wild ungulates feed on Pacific yew including deer, elk, and moose (Bolsinger and Jaramillo, 1990; Crawford and Johnson, 1985; McCune, 1982; Pierce and Peek, 1984).

Moose

In parts of northern Idaho, yew is a preferred winter browse for moose (Crawford and Johnson, 1985). Old growth grand fir/Pacific yew forests are often considered critical winter habitat for moose (Pierce and Peek, 1984).

Crawford and Johnson (1985) estimated that these yew habitats occupy approximately 40,000 acres (16,000 hectares) in the Nez Perce National Forest, while Peek *et al.* (1987) estimate that they occupy as many as 74,000 acres (29,905 hectares). The Nez Perce National Forest Plan allocates about 62,900 acres (25,000 hectares) of complexes of Pacific yew and adjacent grand fir to management for moose winter range.

Limited research suggests that stands which have optimum conditions for the yew component of moose winter range have 50% cover from large overstory trees (at least 40 feet tall and usually over 90 years old) and at least 30 percent tree-form yew cover. (Suggested minimum size for land units to be managed for winter range is 1,000 acres.)

Key winter range characteristics related to Pacific yew include thermal cover and browse availability. Old growth double-canopy forests with Pacific yew in the understory (and grand fir in the overstory), provide winter habitat offering snow interception, thermal protection, and forage (Pierce and Peek, 1984; Peek *et al.*, 1987). Moose eat both bark and foliage (Crawford and Johnson, 1985).

Some other winter range characteristics include topographic site, elevation, and slope. Riparian areas, ridgetops, and benches are the most frequently used topographic areas. Patches of Pacific yew thought to be the most important as winter range appear above about 4,000 feet (1,220 meters) elevation in zones of snow accumulation, and below 6,000 feet (1,800 meters) elevation (USDA Forest Service, 1987).

Other Ungulates

Deer and elk also feed on Pacific yew throughout its range (Crawford and Johnson, 1985; Everett, 1957; McCune, 1982) and the dense subcanopy that develops in some areas provides hiding and thermal cover for large ungulates (Johnson and Simon, 1987).

Northern Spotted Owls

Northern spotted owls have been observed using Pacific yew as roost sites (USDA Forest Service, 1992b). Based on limited observations, owls were seen roosting in yew trees ranging in diameter from 4 to 16 inches, with 72 percent of the yew roost trees being greater than eight inches in diameter (USDA Forest Service, 1992b).

For a complete discussion of the habitat needs and life history of the northern spotted owl, see the "Report of the Advisory Panel on the Spotted Owl," (Dawson *et al.*, 1986); "Final Supplement to the Environmental Impact Statement for an Amendment to the Pacific Northwest Regional Guide," (USDA 1988b); the "Conservation Strategy for the Northern Spotted Owl," by the Interagency Scientific Committee (ISC) (Thomas *et al.*, 1990); and the U.S. Fish and Wildlife Service's three status reviews that listed the northern spotted owl as a threatened subspecies (Federal Register, 55:26114).

Wildlife Associated with Early-Successional Forests

A variety of wildlife species within the range of the Pacific yew use early-successional forests as primary habitat for breeding and feeding (Brown, 1985; Thomas, 1979a).

Some of these species include the western bluebird, orange-crowned warbler, song sparrow, white-crowned sparrow, American goldfinch, western meadowlark, mountain beaver, and Townsend's vole (Brown, 1985). Young forests, especially those in the open grass/forb/shrub stage, also provide foraging habitat for big game animals, such as the black-tailed deer, mule deer and elk. Browsing by ungulates may be a significant factor influencing the abundance, growth form, and distribution of yew in stands, especially during the early stages of plant succession (Bolsinger and Jaramillo, 1990; Bolsinger, 1990).

Wildlife Associated with Riparian Areas

Pacific yew is closely associated with riparian areas in parts of its range (Bolsinger and Jaramillo, 1990). This is possibly related to a history of infrequent fire (Bolsinger and Jaramillo, 1990; Scher and Jimerson, 1989). In some places, yew totally dominates the understory (Johnson and Simon, 1987).

Yew; Influence

On riparian sites, yew provides shade which maintains cool water temperatures. This benefits salmonids and other anadromous fish (Scher and Jimerson, 1989), and vertebrates associated with cool water, such as Olympic salamanders and tailed frogs (USDA Forest Service, 1992b). See the Water Resources and Aquatic Habitat section for additional information on fish habitat.

Riparian areas often support a greater abundance and variety of wildlife than adjacent uplands (Thomas *et al.*, 1979a; McGarigal and McComb, 1992), especially in drier environments. Yew may influence animal occurrence and abundance by contributing to plant species diversity and the structural complexity of vegetation. For example, snowshoe hare and predators such as the fisher may be more abundant in some riparian areas of Northern Idaho that have a thick understory of yew with some openings (Jones, 1993). See the Biodiversity section for more discussion of species diversity.

Other Wildlife Relationships

The fruit of Pacific yew is sweet, but reportedly poisonous to some species (Standley, 1921). It is readily eaten by many species of songbirds, including the Townsend's solitaire, varied thrush, and hermit thrush (Johnson and Simon, 1987). Raccoons also feed on the fruit of Pacific yew (Van Dersal, 1938). Woodpeckers and jays have also been observed feeding on the fruit (Mannan, 1977).

Chipmunks have been observed eating yew seeds (Crawford, 1992) and rabbits and other small herbivores may also browse Pacific yew (Everett, 1957). Yew trees provide nest opportunities for various neotropical birds (rufous hummingbird, hermit thrush, and American robin) and nest cavities for an occasional nuthatch and wren (Neitro, 1992). Little is known about the role that yew plays for other species of wildlife. For instance, the importance of yew for invertebrates of the tree canopy and of the soil is unknown.

Threatened and Endangered Species

Introduction; Role of This EIS

This EIS evaluates possible effects of harvesting Pacific yew from a "program" point of view, rather than looking at the specific effects of actions on a given site. Site-specific effects are evaluated during project planning through an environmental analysis, as required by NEPA. See Chapter IV for a discussion of these effects.

Terms To Know

Endangered— *The classification of endangered refers to those species in danger of becoming extinct throughout all or a significant portion of their range.*

Threatened— *Threatened species are those likely to become endangered in the foreseeable future (50 CFR 240).*

Proposed— *Those species named in formal documents published in the Federal Register under the direction of the Endangered Species Act and 50 CFS 402.2, but have not been listed as endangered or threatened at this time.*

Sensitive— *The classification "sensitive" refers to species designated by regional foresters or BLM state directors for which population viability is a concern. Sensitive species are not federally designated under the Endangered Species Act and are not discussed in detail in this document.*

Listed or Proposed Species in the Affected Area

The occurrence and status of federally listed threatened, endangered and proposed species on national forests and Bureau of Land Management districts within the geographic range of the Pacific yew are summarized in Table III-9. Species that do not occur within Pacific yew habitat will not be affected by yew harvest, and are not analyzed above. See Appendix J for a discussion of threatened, endangered, and proposed species that may be affected by yew harvest.

This listing does not completely cover BLM and USFS property in California.

Table III-9: Summary of Threatened, Endangered and Proposed Species

Federal **Threatened** Species that Occur in Range of Pacific Yew		
Species	**Occurrence**	**Habitat**
Foskett Speckled Dace*	--Documented on BLM Lakeview District	Aquatic: endemic to Foskett and Dace Springs, Lake Co., OR.
Lahontan Cut-throat Trout*	--Documented on BLM Vale and Burns District	Aquatic: restricted to southern Malheur and Harney Co., OR.
Paiute Cut-throat Trout*	--Documented on USFS Toiyabe National Forest	Aquatic: restricted to Silver King Creek, a tributary to Carson River.
Sacramento River Winter Chinook Salmon	--Documented on BLM Coeur d'Alene District. --Suspected on BLM Vale District. --Suspected on the USFS Umatilla and Wallowa-Whitman National Forests.	Aquatic; Sacramento River drainage in California.
Snake River Fall Chinook Salmon	--Documented on BLM Coeur d'Alene District. --Suspected on BLM Vale District	Aquatic; Grand Ronde River Drainage in OR.
Snake River Spring/Summer Chinook Salmon	--Documented on BLM Vale and Coeur d'Alene Districts	Aquatic; Grande Ronde River Drainage in OR.
Warner Sucker	--Documented on BLM Lakeview District	Aquatic: endemic to Warner Basin, Lake Co., OR.
Aleutian Canada Goose	--Documented on BLM Coos Bay District. --Suspected on BLM Spokane District. --Documented on USFS Siuslaw National Forest.	Stops in Pacific Northwest while migrating from Alaska to California. Winters at wetlands, grasslands, or cultivated fields, usually near large, undisturbed bodies or water.
Bald Eagle	--Documented on BLM Burns, Coos Bay, Eugene, Lakeview, Medford, Prineville, Roseburg, Salem, Spokane, and Vale Districts. --Documented on all USFS National Forests in Washington and Oregon.	Winter roosts in large trees in conifer and mixed conifer forests with structural or topographic protection. Nests in habitat similar to winter roost, within two miles of water.
Northern Spotted Owl	--Documented on BLM Coos Bay, Eugene, Lakeview, Medford, Roseburg, Salem, Spokane, and Vale Districts. --Documented on USFS Deschutes, Gifford Pinchot, Mt.Baker-Snoqualmie, Mt. Hood, Okanogan, Olympic, Rogue River, Siskiyou, Siuslaw, Umpqua, Wenatchee, Willamette, and Winema National Forests.	Resident of old growth conifer forests.
Western Snowy Plover*	--Documented on BLM Burns, Coos Bay, Lakeview, and Vale Districts. --Suspected on BLM Spokane District.	Coastal sand dunes and beaches.

**Threatened species that occur within this EIS's area of consideration, but do not occur within Pacific yew habitat*

Table III-9: Summary of Threatened, Endangered and Proposed Species (continued)

Federal **Threatened** Species that Occur in Range of Pacific Yew(cont.)		
Species	**Occurrence**	**Habitat**
Grizzly Bear	--Documented on BLM Spokane, and Coeur d'Alene Districts. --Documented on USFS Colville, Mt. Baker-Snoqualmie, and Okanogan National Forests. --Suspected on USFS Wenatchee National Forest.	An opportunistic feeder using a variety of habitats.
Oregon Silver-spot Butterfly*	--Documented on USFS Siuslaw National Forest	Restricted to salt-spray meadows.
Valley Elderberry Longhorn Beetle*	--Documented on USFS Six Rivers National Forest	Elderberry is required for the life cycle. Usually found in riparian areas due to elderberry growing there.
Nelson's Checkermallow	--Documented on BLM Salem District --Suspected on BLM Eugene District	Wet meadows in Willamette Valley and Coast Range, OR.

**Threatened species that occur within this EIS's area of consideration, but do not occur within Pacific yew habitat*

Federal **Endangered** Species that Occur in Range of Pacific Yew		
Species	**Occurrence**	**Habitat**
American Peregrine Falcon	--Documented on BLM Burns, Coos Bay, Lakeview, Medford, Prineville,Roseburg, Salem, Spokane, Vale, and Coeur d'Alene Districts. --Documented on USFS Clearwater, Flathead, Idaho Panhandle, Kootenai, Lolo, and Nez Perce National Forests in Region 1. --Documented in USFS Deschutes, Fremont, Mt. Baker-Snoqualmie, Mt. Hood, Rogue River, Siskiyou, Siuslaw, Umpqua, Wallow-Whitman, and Willamette National Forests. --Suspected on USFS Colville, Gifford Pinchot, Malheur, Olympic, Umatilla, Wenatchee, and Winema National Forests.	Typically nests on cliff or bluffs along river courses or other large bodies of water.
Peregrine Falcon (all species are listed due to similarity in appearance to American Peregrine Falcon)	--It is assumed that most observers could not differentiate between subspecies, so the known sightings could be for either falcon. The known locations would be identical for these falcons.	See habitat description for American Peregrine Falcon.

**Endangered species that occur within this EIS's area of consideration, but do not occur within Pacific yew habitat*

Table III-9: Summary of Threatened, Endangered and Proposed Species (continued)

Federal **Endangered** Species that Occur in Range of Pacific Yew (cont)		
Species	**Occurrence**	**Habitat**
Marbled Murrelet	--Documented on BLM Coos Bay and Salem Districts. --Documented also on Mount Baker-Snoqualmie, Olympic, Siuslaw, Siskiyou, Gifford Pinchot, and Six Rivers National Forests. --Suspected on USFS Klamath, Mendocino, Wenatchee, and Rogue River National Forests.	Nests on moss and lichen-covered large lateral branches of old growth trees, generally within 50 miles of the ocean.
Bald Eagle	--Documented on USFS Clearwater, Flathead, Idaho Panhandle, Kootenai, Lolo, and Nez Perce National Forests. --Documented on BLM Coeur d'Alene District.	See habitat description for Bald Eagle above.
California Brown Pelican*	--Documented on BLM Coos Bay, and Salem Districts. --Suspected on BLM Spokane District. --Documented on USFS Siuslaw National Forest.	Frequents beaches and offshore islands along the Pacific coast and occasionally large protected estuaries.
Borax Lake Chub*	--Documented on BLM Burns District.	Aquatic: endemic to Borax Lake, Harney Co., OR.
Lost River Sucker*	--Documented on BLM Lakeview District. --Documented on USFS Winema N.F.	Aquatic: Klamath Basin, Klamath Co., OR.
Shortnose Sucker*	--Documented on BLM Lakeview District. --Documented on USFS Winema N.F. --Suspected on USFS Fremont N.F.	Aquatic: Klamath and Lost River systems, Klamath Co., OR. Also in California.
Snake River Sockeye Salmon	--Documented on BLM Vale, and Coeur d'Alene Districts.	Aquatic: in the Snake River drainage.
Columbia Whitetailed Deer	--Documented on BLM Roseburg District. --Suspected on BLM Salem District.	Oak woodlands and savannahs; riparian areas of the lower Columbia River and Douglas Co., OR.
Woodland Caribou	--Documented on BLM Coeur d'Alene District. --Documented on USFS Colville National Forest.	Requires lichens associated with mature or old growth trees.

**Endangered species that occur within this EIS's area of consideration, but do not occur within Pacific yew habitat*

Table III-9: Summary of Threatened, Endangered and Proposed Species (continued)

Federal **Endangered** Species that Occur in Range of Pacific Yew (cont)		
Species	**Occurrence**	**Habitat**
Gray Wolf	--Documented on BLM Spokane, and Coeur d'Alene Districts. --Suspected on BLM Vale District. --Documented on USFS Clearwater, Flathead, Idaho Panhandle, Kootenai, Lolo, and Nez Perce National Forests. --Documented on USFS Colville, Fremont, Mt. Baker-Snoqualmie, and Wallowa-Whitman National Forests. --Suspected on USFS Okanogan N.F.	Utilizes many habitats; prey availability determines suitability of habitat.
Bradshaw's Desert-parsley*	--Documented on BLM Eugene District. --Suspected on BLM Salem District.	Wet prairies in Willamette Valley, OR.
Malheur Wirelettuce*	--Documented on BLM Burns District.	Endemic to a single zeolite hill with sagebrush in Harney Co., OR.
MacFarlane's Four O'Clock*	--Suspected on BLM Vale District. --Documented on USFS Wallowa-Whitman N.F.	Steep talus slopes with sunny exposure.
McDonald's Rock-cress*	--Suspected on BLM Medford District.	Serpentine soils.

**Endangered species that occur within this EIS's area of consideration, but do not occur within Pacific yew habitat*

Federal **Proposed** Species that Occur in Range of Pacific Yew		
Species	**Occurrence**	**Habitat**
Oregon Chub*	--Documented on BLM Roseburg District --Suspected on BLM Salem District --Documented on USFS Willamette NF --Suspected on USFS Umpqua NF	Ponds with little or no water movement.
Marsh Sandwort	--Suspected on BLM Salem and Spokane Districts.	Coastal salt marsh.
Applegate's Milk-vetch	--Suspected on BLM Lakeview District.	Endemic to moist meadows in the Applegate area in Klamath Co., OR.

**Proposed species that occur within this EIS's area of consideration, but do not occur within Pacific yew habitat*

Species, Responsibilities, and Existing Direction

On March 9, 1992 the Forest Service sent a letter to the U.S. Department of Commerce, National Marine Fisheries Service (NMFS) asking for a contact person and confirmation of a list of threatened and endangered anadromous fish species. Figure III-9 reflects NMFS confirmation of those species.

On March 9, 1992 the Forest Service sent a letter to the U.S. Department of the Interior, Fish and Wildlife Service (FWS) asking for a contact person and a list of the proposed and listed threatened and endangered species in the geographical range of Pacific yew. Table III-9 reflects the FWS list.

A list of endangered, threatened, proposed, and sensitive species, a discussion of Forest Service and BLM responsibilities under the Endangered Species Act, and biological evaluations can be found in most Forest Service offices in the USDA Forest Service Manual 2670, USDA Forest Service, 1990a and at Bureau of Land Management State Offices in the BLM Manual 6840, 1988.

A copy of the biological assessment prepared for this document can be found in Appendix J.

Yew as Forage for Livestock

Pacific yew provides habitat components for a variety of wildlife species, and may also occur on range lands where cattle forage. Green slash of yew may be harmful or fatal to domestic livestock when eaten in large quantities (Sampson and Malmsten, 1935; Muenscher, 1975).

Access to Yew Harvest Areas

Access to areas where yew could be harvested would most typically occur over the existing road system on each national forest or BLM district. Access to some areas may be allowed on roads and trails that are normally closed to vehicle travel, following site-specific analysis. It is also possible that yew harvest would occur in areas not currently accessible by roads. In these cases, access might be gained on foot trails, horse trails, or new road construction. Yew bark might also be removed by helicopter in areas not accessible by roads. The specific access method that would be used for each yew sale would be decided after a site-specific analysis for that sale.

Pacific Yew Harvest and Timber Harvest

Timber harvest programs in national forests and BLM districts are ongoing, and are undergoing change as the agencies develop and implement ecosystem management. They are currently guided by forest plans (Forest Service) and BLM resource management plans. Timber harvest programs for commercial species may be affected by the harvest of Pacific yew.

Roadless Areas

Roadless areas are those remaining undeveloped areas in the national forests outside designated wilderness areas. They were inventoried in the late 1970's during RARE II (Roadless Area Review and Evaluation), and subsequently re-analyzed in the forest planning process for each national forest. Each forest plan allocates the respective roadless areas to various management prescriptions.

Chapter III

Affected Environment

Part Three: The Yew and People

Contents

Part Three: The Yew and People

Talk to five different people, and you may get five different views of the value — or lack of value — of Pacific yew. Yew has been viewed as everything from good post wood and a source of material for expensive archery bows, to "just another noncommercial species," or even "a weed tree." This part of Chapter III synthesizes elements of the first two parts of the chapter — "The Yew" and "The Forest" in the context of people, values and uses.

Uses and Values

The wood of both the Pacific and the European yew played an important role in centuries past as an ideal material for making powerful bows vitally needed for hunting and warfare.

In Europe, longbows made of yew wood were first used by English archers at the battle of Crécy in 1346, where they proved to be such a superior weapon that they prevented the French from ever closing on the main English forces.

Before Europeans immigrated into the range of Pacific yew, indigenous people valued the wood and foliage for tools, bows, utensils, and even personal hygiene. Today Pacific yew is valued for its role as cover and browse for many wildlife species, and for spiritual implications for Native Americans as well (Tirmenstein, 1990). Most recently, Pacific yew has been in the news as a source of

taxol, a drug currently being used in clinical trials and for compassionate care of certain cancer patients.

What all these uses have in common is that they are a result of how people value the species.

Social and Economic Ties

Social Setting

Geography and Yew

Within the range of Pacific yew, the people and communities of Oregon, Washington, northern California, western Montana, and northern Idaho are most directly affected by yew harvesting activities in national forests and BLM districts.

Zones

The rugged Cascade range of mountains divides the Oregon and Washington portions of the Region into two distinct zones — west and east. Climate and vegetation — as well as population patterns and economic structures — differ between these areas. (For more information about the physical context within the range of Pacific yew, see Part Two: The Forest, in this chapter.)

Note: Information about northern California is sometimes presented separately, and sometimes combined with information about the western portion (sometimes called the "west-side") of the area affected by the proposal. Similarly, some discussions of the affected portions of Idaho and Montana are separate, but more often they are combined with discussions of the "east-side" of the five-state area.

Counties Inside the Affected Area

The range of Pacific yew does not conform neatly to boundaries set by human beings. While most counties in the states of Oregon, Washington, and the northern part of California are included in this analysis, a few are not. Table III-10 lists the counties within the range of Pacific yew. Because the "east-side" range of yew does extend into parts of Idaho and Montana, some counties (ten in Idaho; seven in Montana) in each of these states are included (see Table III-10).

Table III-10: Counties Inside the Range of Yew

Yew Range	Counties		
Oregon	Benton	Hood River	Multnomah
	Clackamas	Jackson	Polk
	Clatsop	Jefferson	Tillamook
	Columbia	Josephine	Umatilla
	Coos	Klamath	Union
	Crook	Lane	Wallowa
	Curry	Lincoln	Wasco
	Deschutes	Linn	Washington
	Douglas	Marion	Yamhill
Washington	Asotin	King	Skagit
	Clallam	Kitsap	Skamania
	Clark	Klickitat	Snohomish
	Columbia	Lewis	Spokane
	Cowlitz	Lincoln	Stevens
	Ferry	Mason	Thurston
	Garfield	Pacific	Wahkiakum
	Grays Harbor	Pend Oreille	Walla Walla
	Island	Pierce	Whatcom
	Jefferson	San Juan	
Northern California	Del Norte	Plumas	Placer
	Siskiyou	Mendocino	Colusa
	Humboldt	Glenn	Lake
	Trinity	Butte	El Dorado
	Shasta	Sierra	Marin
	Lassen	Yuba	Amador
	Tehama	Nevada	San Mateo
Northern Idaho ("Panhandle")	Benewah	Clearwater	Latah
	Bonner	Idaho	Lewis
	Boundary	Kootenai	Nez Perce
			Shoshone
Western Montana	Flathead	Lincoln	Missoula
	Lake	Mineral	Powell
			Sanders

Minorities

Percent of Population

Racial and cultural minorities are a small segment of the 9.6 million people living in the five states of the affected area (see Table III-11).

Table III-11: *Minorities by Group*
Total Numbers in the Affected Area and Percent of Population
(From 1990 Census)

Group	Total Number	Percent of Total Population
African (Black) Americans	249,983	2.6
Native Americans	152,535	1.6
Asians and Pacific Islanders	418,047	4.4
Other Racial Affiliations	173,874	1.8
Hispanic Origin*	464,052	4.8

*People of Hispanic origin (the largest minority group in the area under discussion) may be members of any racial group.

Urban/Rural Distribution

African Americans and Asians in the region are predominately urban dwellers, while Native Americans and Hispanics are more rural than the overall population. As a growing proportion of minorities are being employed in tree planting and related outdoor forest work, it is probable that Native American and Hispanic people could find more opportunities in the yew harvest on federal lands.

American Indian Trust Lands

Within the five-state area in the range of Pacific yew, there are 65 American Indian Trust Lands (reservations, rancherias, communities, etc.) that total some 4,647,059 acres (see Table III-12). Many of these trust lands vary in size from a few acres to over 1.4 million acres. Many are adjacent to national forests, and Native Americans have significant concerns about general forest and

wildlife/fish resources and management (USDI Bureau of Indian Affairs, 1990). The management of the Pacific yew may be of some concern to certain tribes.

***Table III-12:** American Indian Trust Lands in the Affected Area by State*

State	Acres	Trust Lands in the Affected Area	
Oregon	742,717	--Coos, Lower Umpqua, & Siuslaw --Cow Creek Band of Umpqua	--Grand Ronde --Klamath --Siletz --Umatilla --Warm Springs
Washington	3,142,050	--Chehalis --Colville --Hoh --Kalispel --Lower Elwha --Lummi; Makah --Muckleshoot --Nisqually --Nooksack --Ozette (Jamestown Klallam) --Port Gamble --Port Madison	--Puyallup --Quileute --Quinault --Sauk-Suiattle --Shoalwater Bay --Skokomish --Spokane --Squaxin Island --Stillaguamish --Suquamish --Swinomish --Tulalip --Upper Skagit --Yakima
Northern California	121,745	--Berry Creek --Big Bend --Big Lagoon --Big Valley --Blue Lake --Coyote Valley --Enterprise --Greenville --Hoopa Valley --Hopland --Karuk --Laytonville --Lookout --Montgomery Creek	--Pinoleville --Redwood Valley --Resighini --Roaring Creek --Robinson --Round Valley --Sherwood Valley --Smith River --Sulphur Bank --Susanville --Trinidad --Upper Lake --Yurok
Northern Idaho	58,640	--Kootenai --Nez Perce	--Coeur d'Alene
Western Montana	581,907	--Flathead	
Source: USDI Bureau of Indian Affairs, 1992.			

Age, Sex, and Labor Force Participation

Shifts

After 1970, the age composition of the region's population shifted, and by 1980 a larger proportion of the population was of working age than ever before. A significant increase — from 43% to 52% — in the number of women in the labor force occurred. As the age structure of the region continues to shift, the size and other characteristics of the labor force will be affected (U.S. Department of Energy, 1982).

Lifestyles, Attitudes, Beliefs, and Values

No One Lifestyle

Certainly, there is no one regional lifestyle or set of attitudes, beliefs, and values in the five-state area. Generalizations which typify an area's residents are as inaccurate today as they were in the past. However, if there is a thread of commonality in the region, it is the desirability of an active, outdoor lifestyle.

Continuing advancements in technologies are helping shift metropolitan economies from their historical resource bases to more diversified ones. Strong environmental concerns are being voiced in sectors of our society where previously little was ever said.

Perceptions

Because the economies of the rural communities are often associated with commodity production, residents of those areas are frequently perceived as being more likely to favor higher production levels and heightened development. Residents of metropolitan areas whose livelihoods are not directly or noticeably linked to the extraction of natural resources are more commonly viewed as favoring environmental concerns.

Environmentalists live in rural areas as well as in metropolitan areas, just as do those who favor development of the resource base. There is no simple line of demarcation between these camps. Environmentalists are concerned about their neighbors' jobs, and mill workers are frequently among the first to note their concern for the environment.

Relationship to Growth

Many people of all types find this region a very desirable place to live. To some extent, this quality has fostered the location of many new enterprises in the area. The 1980s, though, are likely to be remembered as a time when people in the region recognized that continued growth could not be ensured without effort; that it would have to attract suitable employers from a common, national pool, and that other areas of the country are indeed viable competition in our mutual marketplace.

Economic Diversity

Trend Toward Economic Diversity

The economy of the five-state region is moving toward greater diversity. The region's historic dependence on the removal of natural resources and the manufacture of "raw" products has lessened with the increase in other kinds of growth. With the social changes affected by these new directions has come a fresh recognition of the importance of the national forests. The opportunity to enjoy an unpolluted environment, to pursue one's favorite outdoor recreation, or to view a truly natural diversity, is still possible in the national forests.

West-Side, Northern California Are More Diverse

The economy in the western portion of the region is relatively diversified; more so in Washington than in Oregon. Northern California is moderately diversified, but becomes more highly diversified the closer one gets to the San Francisco-Sacramento corridor (Interstate 80).

Aircraft manufacturing, shipbuilding, forest products industries, major financial centers, government, commercial fishing, agriculture, the livestock industries, recreation facilities, and mining all contribute to the economic picture along the "I-5 Corridor."

East-Side Is Less Diverse

The economy of the eastern portion of the region depends more on agriculture, forest products industries, and the livestock industry

than does the western portion. The relative dependence on these sectors has not been balanced by growth in other major employment sectors, except for some localized growth in the recreation and service industries.

The eastern part of the five-state area has fewer opportunities for employment, and the cities and towns generally reflect a rural-based economy with little diversification. It is a region in transition, moving toward a more diversified economic base. The traditional employment sectors simply do not have the same labor requirements as they did in the past. Historically, many seem to feel that the natural wonders of the area would be sufficient to guarantee its growth.

Sources of Taxol

Market and Nonmarket Considerations

Development and Pharmacology

Thirty years ago scientists discovered that bark from the Pacific yew contained a chemical compound (one of the taxanes, now known as taxol) when Forest Service collectors sent a sample of randomly collected bark, needles, and twigs from Pacific yew in Washington State to the National Cancer Institute (NCI) laboratory in 1962. This was one of the revelations of a plant screening program sponsored by the Natural Products Branch of NCI.

The following is a chronology of the development of taxol as a cancer-fighting drug:

1963 NCI found that yew samples showed activity against 9KB cancer-cell tissue culture. NCI sent a subsample to Monroe Wall, Ph.D., a medicinal chemist working under contract to NCI at Research Triangle Institute in North Carolina.

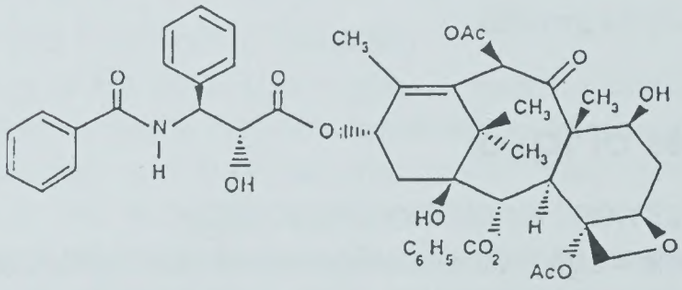
1964 Wall's group found that a crude extract of the yew bark was effective in both the cancer-cell tissue system and against a mouse leukemia. They worked to isolate the primary active principle of taxol.

1966 Wall asked NCI to give the yew material special priority for research. He isolated the active principle and named it taxol.

1969 NCI checked the activity of all parts of Pacific yew. They now knew three things: the structure of taxol, its success in cancer screens, and something about how it worked against cancer.

1971 Wall, with Mansukh Wani (at Research Triangle Institute) and Andrew McPhail (of Duke University), published the structure of the taxol molecule, a complex diterpene with an unusual oxetane ring and an ester side chain. This is illustrated in the following figure.

Figure III-8: *Taxol Molecule*



1974 Taxol began to show results against a recently developed B16 mouse melanoma system. During the 1970s, cytotoxicity tests continued with tumor lines in new animal screens, including human tumor xenografts (tissues grafted from one species to another).

1977 Preclinical work on taxol began. NCI contacted Susan Horowitz (professor of molecular pharmacology at Albert Einstein College of Medicine in the Bronx), who was working under an NCI Cancer Research Emphasis Grant, to ask her to investigate how taxol worked on cancer cells. With graduate student Peter Schiff, she found that taxol inhibited the replication of human tumor cells. (Specifically, the cancer cells stopped dividing. Taxol froze the division of microtubules, the structures needed at the critical point in cell division. The cell eventually died.)

1978 Taxol showed positive results in human cancer xenografts. Taxol showed activity in three systems, including a human breast cancer xenograft developed in the late 1970s.

1979 Horowitz and Schiff published their findings about taxol's action of freezing microtubules and causing the cell to die.

1980 Toxicology studies began. Scientists looked for a suitable surfactant formulation for administering the insoluble drug.

1982 NCI filed an Investigational New Drug Application (INDA) for taxol with the Food and Drug Administration.

1983 Phase I clinical trials began, testing patients who were not responding to other treatments, determining doses and toxicity, and generating data on dose limits of taxol.

1987 NCI contracted for collection of 60,000 (Daly, 1992) pounds of dry Pacific yew bark.

1988 Phase II clinical trials showed 30 percent improvement in patients with unresponsive cases of advanced ovarian cancer.

1989 Trials of taxol progressed for other forms of cancers: Breast, cervical, colon, gastric, non-small-cell lung, prostate, head and neck, small-cell lung, and renal. NCI contracted for an additional 60,000 pounds of dry bark.

1990 Phase II trials showed 48 percent tumor shrinkage with metastatic breast cancer patients who had at least one prior chemotherapy regime. (Metastatic refers to cancers which tend to spread from one body part to another.)

1992 Clinical trials were conducted at 20 centers on a number of different cancers, with some experimenting with combinations of chemotherapies. Currently, Horowitz continues to work on taxol's interactions with microtubules and tubulin.

The USDA Food and Drug Administration approved the New Drug Application for taxol from Pacific yew bark for commercial use.

Sacks of harvested bark

Demand and Supply for Yew Bark

Demand

Current demand for Pacific yew bark is due to the fact that it is the only FDA-approved source of taxol. In 1991, in response to a request from Bristol-Myers Squibb (BMS), over 800,000 pounds of dry yew bark was provided by the Forest Service and BLM. A similar amount was provided in 1992 (see table III-13).

The agreement (the CRADA) between the National Cancer Institute (NCI) and Bristol-Myers Squibb calls for BMS to develop a source for taxol that does not depend on the harvest of Pacific yew bark. In January of 1993, BMS announced they would not require any bark from federal lands in 1993. BMS will produce the taxol it needs from bark from private lands, as well as from other sources pending FDA approval. Right now, the demand for taxol is uncertain and subject to rapid change. Other purchasers besides BMS are interested in bark harvest; the level of interest is subject to change based on market forces and technology.

Taxol therapy continues to show good progress in treating ovarian cancer, as well as several other cancers. Because of this, the number of patients enrolled in clinical trials of taxol has increased and is expected to increase further.

The five-year harvest program covered by this analysis was predicated on the assumption that at the end of five years Pacific yew

bark from federal lands would no longer be needed as a source of taxol. Over the next five years, it is difficult to predict what bark demand from federal lands will be. We expect that there will be some demand in order to meet on-going research and patient treatment needs.

Supply

The supply of bark could come from several sources: federal lands, state and county lands, as well as private lands. The supply source being studied here is Forest Service and Bureau of Land Management (BLM) lands in Oregon, Washington, California, Idaho, and Montana. Table III-13 shows bark harvest information for the past several years.

Table III-13: Bark Harvest

Bark Requested by BMS	Forest Service	BLM	State	Totals
1990	69,000	4,000	0	73,000
1991	826,000	61,000	190,000	1,077,000
1992	684,000	120,000	60,000	864,000
1993*	250,000	34,000	300,000	584,000
* Projected harvest				

To date, the federal agencies have been able to supply all the bark that has been requested by Bristol-Myers Squibb. Processing capacity has also been sufficient. Existing bark processing capacity can convert two million pounds of dry yew bark into 130 kilograms of taxol each year. That capacity is expected to increase to 200 kilograms next year. The results of an inventory to assess the supply of bark is discussed in the inventory section of Part One

of this chapter, and in Appendix F which details the inventory procedures and results (see also Chapter IV).

Although actual bark supply from private lands is not available, it has been estimated that total production from these lands exceeded 500,000 pounds during 1991 and 1992. The analysis in this document assumes that the supply from private lands will continue at similar levels.

Market for Yew Bark

Agreements

To ensure a stable supply of Pacific yew bark, Bristol-Myers Squibb entered into an agreement with the USDA Forest Service and the Bureau of Land Management (BLM) to supply bark from lands they administer. (See Appendix E for more information on the agreements between the Forest Service, Bureau of Land Management, and Bristol-Myers Squibb.)

Current Market

The BLM and the Forest Service sell yew bark at fair market value. Hauser Northwest, Inc. has been the principal buyer of these sales. Most sales have been bought at a price of 30 cents a pound (green pound weight).

Theft of Pacific Yew Bark

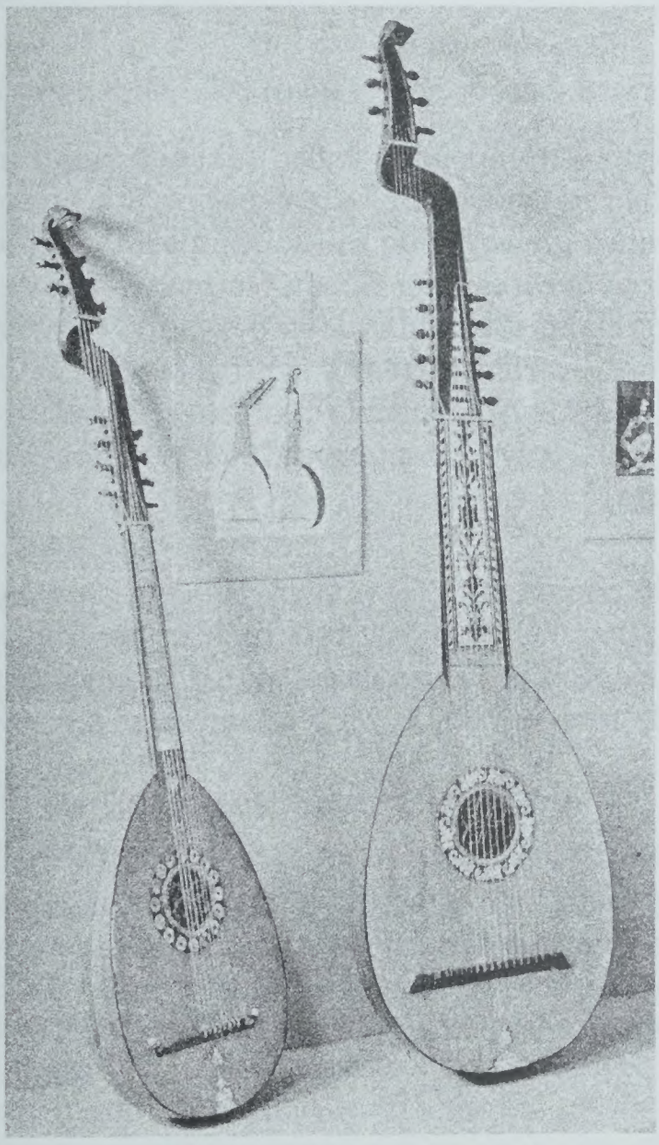
Information on the total amount of bark stolen during 1991 was only available from the Forest Service. For 1991, the Forest Service estimates approximately 150,000 pounds of bark (dry weight) were stolen. Much of the illegally harvested bark found its way back into the legitimate market. Approximately 825,000 pounds of bark were harvested legally. The Bureau of Land Management estimates that several times as much bark was stolen from its lands in 1991 as was harvested legally. With the implementation of a new yew bark harvest permit and tracking system, bark theft in 1992 was reduced to negligible levels on both Forest Service and Bureau of Land Management lands.

Market Value of Pacific Yew Tree

Commercial Value

The Pacific yew, although it has not been considered valuable on a large-scale commercial basis, does have some commercial value. This value is not for the bark, but for the wood. Pacific yew wood is resistant to decay, and can be bent and worked with good results. In the 1980s, Asian buyers were reported to have paid approximately $3,000 to $6,000 per thousand board feet for yew logs (Bolsinger et al., 1992).

The most common commercial use of the logs is for fenceposts. Woodworkers also value the wood, although they do not use it in great quantities.



Nonmarket Value of Yew

Cultural

The yew tree has been seen as a valuable species for human use for centuries. European cultures have made various uses of the yew. It has been tied to Druidic rituals, and was often planted in churchyards. The Victorians believed the roots of yew trees in churchyards grew into the throats of the dead.

Lute makers have prized the wood of both the European and the Pacific yew for many centuries.

Yew wood was, and still is, prized for use in the manufacture of useful and decorative products, as well as having a symbolic function. Native American cultures throughout the five-state area, historically, have also made extensive use of the yew, especially for tools, cups, and bowls (Hartzell, 1991). The Japanese use yew wood for ceremonial carvings. The resistance of yew to decay has also made it popular for fenceposts. Yew wood has also been used for furniture, musical instruments, and is particularly prized for bows (Richardson, 1991).

Alternate Sources of Taxol

> *"Nobody owns the compound. We didn't patent it when we isolated it."— Monroe E. Wall, chemist with Research Triangle Institute*

Taxanes

Taxol belongs to a group of compounds called taxanes found in *Taxus brevifolia* (Pacific yew) and other *Taxus* species; it is one of the most complex taxanes known. Due to the complexity of the taxol molecule (according to researcher Susan Horowitz, "It's the kind of molecule that no chemist would ever sit down and think of making. It definitely comes from a tree."), synthesis of taxol is difficult and has yet to be achieved in usable quantities. Presently, the bark of Pacific yew is the only FDA-approved source of taxol for research and clinical use.

The development of alternative sources of taxol is being pursued actively by both the National Cancer Institute and Bristol-Myers Squibb. The Cooperative Research and Development Agreement (CRADA) requires BMS to develop alternative sources as soon as possible.

Researchers at companies, universities, and agencies world-wide are working to develop taxol or a closely-related drug. They are working on clinical and laboratory creation of taxol (total chemical synthesis, semisynthesis, and cell culture) and on alternate methods of large-scale production (extraction from needles, and biomass).

Here is a partial list of some of the current research and development of taxol:

Total and Semisynthesis

Taxol can be partially synthesized from a precursor — 10-deacetyl baccatin-III — found in needles of *Taxus baccata*, European yew, and from baccatin-III, found in virtually all yew species.

After a decade of trying, chemists are finding total synthesis of the taxol molecule difficult. Some researchers are removing pieces of the molecule to find what parts are essential to the bioactivity of taxol. These studies have potential for finding similar molecules that might be simpler and easier to synthesize, and may lead to semisynthesis.

Meanwhile, Dr. Robert Holton and coworkers at Florida State University are working on partial and total synthesis of taxol. Thirty or more other research groups across the United States are also investigating synthesis of taxol.

In addition, Rhone-Poulenc Rorer, a French pharmaceutical firm, has developed Taxotere, a taxol analog made by partial synthesis from a taxol precursor extracted from the needles of European yew, *Taxus baccata*.

Cell Culture

Phyton Catalytic Inc. of Ithaca, New York, and ESCAgenetics of San Carlos, California, are producing taxol and taxol-like compounds from yew cells grown in culture.

Biomass From Nursery Cultivation

The Weyerhauser Company is propagating yew at five nurseries and greenhouses in Washington and Oregon. Under an agreement with the Bristol-Myers Squibb Company, it is engaged in research and cultivation of domestic yew to provide a reliable, long-term, and affordable supply of taxol from yew biomass (needles, twigs, and possibly roots). Weyerhauser is also working with cultivars and exotic yew species.

In a similar vein, the National Cancer Institute and the USDA Cooperative State Research Service are cooperating with Zelenka Nursery in Michigan; Zelenka Nursery is coordinating the project with the University of Mississippi, Ohio State University and several other nurseries.

Together, these groups are researching the best methods for harvesting and drying needles and twigs from ornamental yew (*Taxus hicksii* media *v. hicksii*). They will supply dried biomass to the National Cancer Institute (NCI), which will contract the extraction of taxol from the biomass, and then give the resulting material to Bristol-Myers Squibb for final purification of taxol.

Taxol From Yew Heartwood

Researchers at the USDA Forest Products Laboratory in Madison, Wisconsin have successfully extracted taxol from Pacific yew heartwood, but the amounts of taxol were so small that the process was not considered feasible.

Taxol From Needles

NaPro Biotherapeutics Inc., in Boulder, Colorado is extracting taxol from yew needles and bark.

Taxol from Fungus

At the University of Montana a plant pathologist and a chemist discovered a new species of endophytic fungus, *Taxomyces andreanae,* on the inner bark of a Pacific yew tree. They report that the fungus produces small amounts of taxol even after it is removed from its host. Possibly, the fungus could be cultured to produce taxol in larger quantities.

Collection Methods for Pacific Yew Bark, Needles, and Wood for Taxol Production

Bark, Needles, and Heartwood

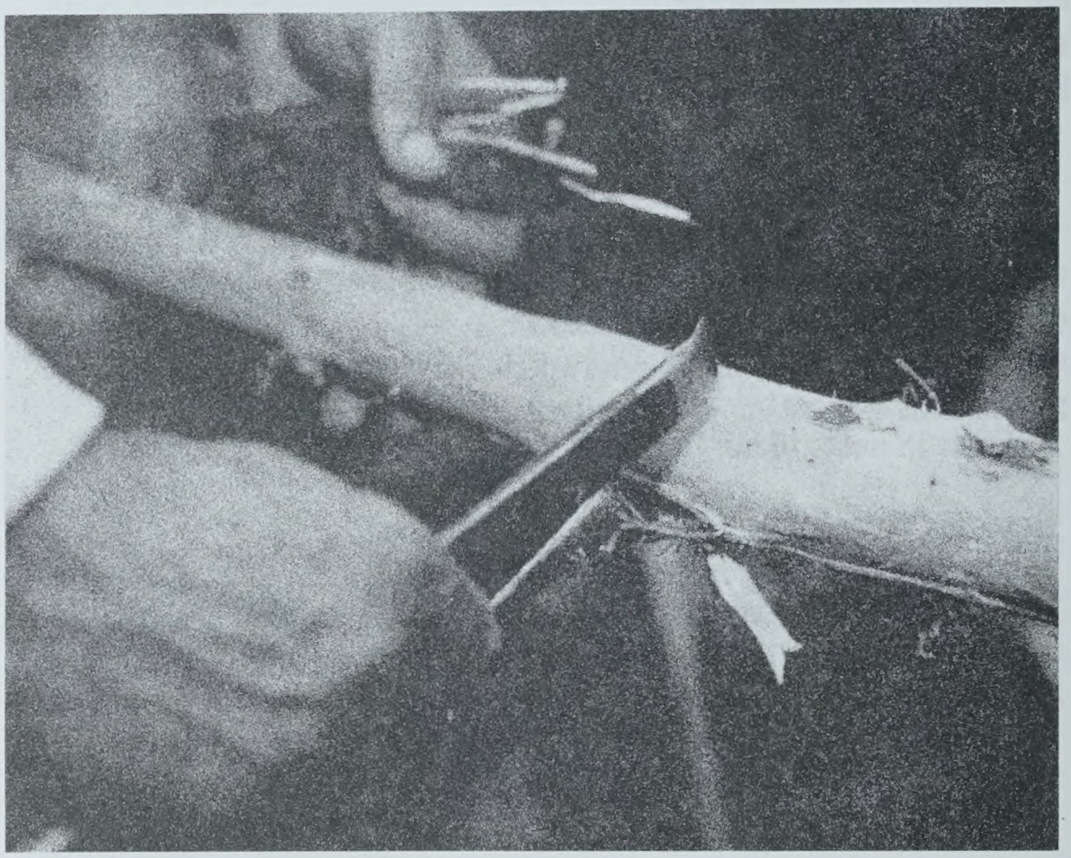
Three parts of the wild yew tree could be used to produce taxol: the bark, the needles, and the heartwood (in nursery grown seedlings even the roots may be used). In this EIS we will look at the effects of harvesting yew. Currently, production of taxol depends on the bark; in the future, researchers may perfect processes to extract taxol from needles and heartwood. Up-to-date information indicates that extraction of taxol from heartwood is not feasible.

Bark Collection

Bark collectors fell yew trees in order to strip the bark. The bark is peeled from the bole of the tree in the spring and summer months when the sap is moving and the bark peels easily. Peelers use a variety of small hand tools to cut and peel. Peelers strip the bark from the limbs of the tree according to current Forest Service and BLM requirements of peeling limbs down to the size of two inches in diameter.

Harvesting bark in a dense forest setting

Harvesting bark from a small branch



The bark is collected in bags, tagged, weighed, and trucked to the bark processing facility where it is ground, dried, boxed, and shipped to the extraction facility.

Another way to collect yew bark is to partially strip the bark from a living tree. Bark collectors are not pursuing this method because: (1) scientists say the effect on yew trees of partial bark stripping is unknown (the tree may die or become unhealthy), and (2) more trees over a wider land base would be affected by partial bark stripping than by felling to gather the same amount of bark.

Sacks of harvested bark

Bark ground to a uniform size, ready for drying

A worker loads ground bark onto a conveyor belt leading to the dryer

Needles

Information about needle collection comes from NaPro BioTherapeutics, Inc., a company that is working to produce taxol from needles. NaPro sampled branches selectively and also needles from the whole crown of a tree. NaPro estimates needles and twigs less than one inch in diameter to weigh about 80 pounds on a tree of about 400 pounds. Testing suggests that there is about 0.017 gram of taxol in a pound of dried needle material; however, the amount that could actually be produced would depend on factors such as harvesting, preservation, and extraction procedures.

Wood

Forest Service and BLM directions in February of 1992 called for all yew wood to be stored in a secure place after the bark was removed, in the eventuality that taxol could be extracted from the heartwood.

Stripped yew logs

Researchers at the Forest Products Laboratory in Madison, Wisconsin, in cooperation with the National Cancer Institute, determined that there is approximately one-fifth the taxol concentration in the heartwood as in the corresponding bark. Because the

heartwood is many times greater in mass than the thin bark, the initial results of studies suggested that up to ten times more taxol is present in the heartwood than in the bark of a yew tree.

Ends of stripped logs show typical irregularities

Further research has shown, however, that there are many problems associated with the extraction of taxol from heartwood, and that these problems are not likely to be resolved in time to impact the supply of taxol prior to its availability from alternate sources. Therefore, the direction to save yew heartwood was subsequently rescinded in September of 1992.

Bark Collection and Processing

Jobs

The interest in processing taxol from the bark of the Pacific yew tree has created jobs. Most of these jobs have been in the collection, harvest, or processing of yew bark. Hauser Chemical Research, Inc. of Boulder, Colorado, currently has an agreement with Bristol-Myers Squibb to collect bark and process it into taxol. Hauser has developed a four-level network for the collection and initial processing of bark. The network employs bark harvesters, collectors, processors, and logger-processors, who function as follows:

Level 1 **Bark Harvesters:** Bark harvesters form a network in a designated harvest area and remove bark from trees under supervision. Most of the work is done between May and August. Bark harvesters gather an average of 100 pounds of wet bark daily.

Level 2 **Bark Collectors:** Collectors are assigned to specific geographic areas. Collectors supervise bark harvesters. They collect the peeled bark on a schedule and deliver it to a processor.

Level 3 **Bark Processors:** Processors receive bark from collectors and prepare it for extraction and shipment. To prepare bark, the processor chips, sizes, and dries it, then ships it to Hauser's processing plant in Colorado.

Level 4 **Logging Operation/Bark Processors:** Operators prelog Pacific yew in timber sales, salvage logs, and purchase logs from independent timber contractors, remove the bark, and process it as in Level 3 above.

Table III-14: *Pacific Yew Bark Harvesting Employment in Oregon, Washington, Idaho, and Montana, 1991 (Total Jobs)*

Level	Total Jobs
1	550
2	14 (approximately)
3	7
4	unknown

Three workers harvesting yew bark

Labor Force and Earnings

All of these jobs are filled by residents of the local communities where the work is located. These are mostly small rural towns where employment in natural resource industries is very important to the economic base. The average bark harvester earns $100 to $150 a day. Table III-14 shows employment by level during the 1991 harvesting season.

Needle Collection and Processing

Needle collection has not occurred either on a commercial or large-scale experimental basis. Therefore, we have no information on which to base an analysis of needle collection on jobs.

Inventory Employment

The interest in harvesting Pacific yew bark created the need to do a detailed inventory of the species. The Forest Service and BLM carried out this inventory with funding from Bristol-Myers Squibb. Short-term employment was created for inventory crews during the summers of 1991 and 1992. Over 150 people were employed on these crews. Some crew members came from local communities, while many were college students or others in search of temporary employment.

Cancer and Taxol

Public Health

Background

This discussion owes much to the assistance of Linda Anderson of the National Cancer Institute (NCI). The drug taxol was thrown into the spotlight because of its apparent effectiveness in stopping certain types of cancers. Cancer is the second leading cause of death among Americans; 1,130,000 people are diagnosed with cancer each year, and 520,000 die of cancer.

Definition

Cancer is a general term that covers over 100 different diseases, usually characterized by unregulated cell growth. This cell growth creates tumors that move into organs of the body, destroying those organs and ultimately causing death.

Detecting and Treating

Some cancers are relatively easy to detect and treat, while others are more difficult. For example, many leukemias (cancer of the blood system) have high remission rates. Other cancers, including those for which taxol has shown much promise, are difficult to detect until the disease is in a late stage. This makes treatment difficult. Some cancers are easily detected through screening tests (such as colorectal, breast, and testicular cancer). Early detection is often crucial to successful cancer treatment.

Taxol and Ovarian Cancer

Taxol

The focus on taxol as an anticancer drug has been as a treatment for ovarian cancer, which affects women only. Other cancers may respond to taxol, and the drug has been tested on them to varying degrees. These include advanced breast cancer, head and neck cancer, gastro-intestinal cancer, lung cancer, and certain childhood cancers.

Detecting and Treating

Each year 21,000 American women are diagnosed with ovarian cancer; each year 13,000 die from this disease. Women over 60 are at greatest risk of being diagnosed with ovarian cancer. There is no effective screening technique for ovarian cancer, therefore, a woman often does not know she is ill until symptoms appear. When diagnosed after the disease has spread, the five-year survival rate is 19 percent.

Ovarian cancer is linked to heredity

A woman who has a close female relative who had the disease has a greater chance of getting it herself. Women who are over 35 and who have never had children are also at greater risk.

Approved Treatments

There are a number of federally approved treatments for ovarian cancer; these vary in their effectiveness. Taxol is considered a promising treatment for ovarian cancer because in clinical tests, women who had not responded to other treatments responded to taxol treatment in about one-third of the cases.

Status of Taxol

FDA Drug Approvals

All drugs for human and veterinary use are approved for particular uses by the United States Food and Drug Administration, an agency of the Department of Health and Human Services. Taxol produced from the bark of the Pacific yew tree has been approved for commercial use in the treatment of ovarian cancer. (See the section on taxol and taxol pharmacology in this part of Chapter III and Appendix K for more information about taxol, sources of taxol, and FDA processes.)

Current Uses and Clinical Trials

Right now the drug is being used for treatment of ovarian cancer as well as in clinical trials for other cancers. Clinical trials are used to establish a drug's effectiveness, and also to study possible side effects. In that way, health providers know how to safely use a drug after it is approved.

Efficacy and Availability

For information about demand, see the section addressing market and nonmarket-demand in this part of Chapter III and in Chapter IV.

Cultural Resources

Traditional Uses

American Indian

Native Americans have used the yew wood and foliage extensively in utilitarian, medicinal, religious and spiritual dimensions of their daily lives. Probably the greatest use occurred along the coastal zones of Washington and British Columbia. It was here that uses were recorded for the manufacture of bows, arrows, harpoons, spear handles, paddles, war clubs, digging sticks, wedges, boxes, drums, spoons, dishes, cups, and bowls (Gunther, 1973; Hartzell, 1991; Heizer, 1978). Pacific yew is renowned for its value in making bows in native cultures from northern California to Canada and was formerly referred to as "bow plant" by the Salish People. Bows made from Pacific yew tended to be broad, short, and flat.

The foliage was used for tonics used medicinally by many peoples of the Pacific Northwest. Some Native American tribes in Washington also used the yew boughs and needles for symbolic building of body strength. Several tribes also have dried the needles for smoking, either in combination with other products or later tobacco (Gunther, 1973). Although yew seeds are poisonous, the fleshy portions surrounding them were sometimes eaten. (For further information see Appendix L.)

Modern Uses

Landscaping

Pacific yew has not been used extensively used as an ornamental; in its best form, the foliage of *T. brevifolia* doesn't compete with *T. baccata*. A shrubby form of Pacific yew (often associated with serpentine soils) is generally considered the most desirable ornamental form. Once established in the garden, Pacific yew grows well in partial shade or full sun.

Woodworking

Pacific yew is still used to craft some of the finest wooden archery bows. The best bows are made from wood which has been cured for several decades, and are, not surprisingly, quite costly.

This attractive wood is also used to make canoe paddles, tool handles, poles, lutes, and fence posts. It is valued as a wood for boat construction. It is sometimes used in carving, cabinet-making, and for turned articles, but up until its cancer-fighting properties were discovered, the tree had little commercial importance. For related information, see Market and Nonmarket Considerations in this chapter and in Chapter IV.

Medicinal

Pacific yew is used medicinally as a source for teas and tinctures in modern folk remedies and by naturopathic practitioners (see Appendix L).

American Indian

Use of the Pacific yew by American Indians has been extensive. In the NEPA scoping process for timber sale or bark collection projects consultation with local tribes is essential. Implied treaty rights for gathering "forest products" on open and unclaimed lands or sites eligible for protection under the National Historic Preservation Act may exist in local areas.

American Indians consulted may not always be forthcoming with information for various reasons. Religious practices may require secrecy about sources of materials. In some cases, Indians may feel that divulging information could result in plant materials becoming unavailable to them in the future.

Yew has been and continues to be important to a number of California Indian tribes. Yew is a significant source of medicine and raw material for the construction of tools such as bows. Traditionally, for the Karuk, the principal weapon was made of yew. The Mattole, Sinkyone, Nongatl, Lassik and Waliki also constructed bows of yew. Yew is also used by American Indian artists.

Recreation

Settings

Who Went Where

In 1991, around 150 to 170 million people visited national forests and Bureau of Land Management districts and resource areas within the natural range of the Pacific yew. The yew plays a small but important role in contributing to habitat, floral, and visual diversity. *T. brevifolia* has an in situ value, particularly in tree-form.

Within the yew's range, the geographic settings people chose for their recreation varied dramatically, from the dunes of the Pacific coast to the rugged North Cascades; from the rain forest to the high desert fringe. Within this range of sites, they may have chosen quiet, private activities in remote places such as designated wilderness, or more social, accessible recreation at visitor centers and developed campgrounds.

Definition of Setting

A recreation "setting" results from a combination of the biological and physical surroundings, the social environment, and the management applied to an area. By altering the combinations of these three elements, it is possible to provide a continuum or spectrum of settings for recreationists that range from primitive, in Congressionally designated wilderness, to nearly urban, near metropolitan centers.

Pacific yew is an important midlevel component of the forests providing these recreational settings and contributes an important visual element in the diversity of settings.

Relevance of Setting

Research has shown that people choose a recreation setting from this continuum in order to realize a desired set of experiences. For example, camping in a large undeveloped setting with difficult access and few facilities offers a sense of solitude, challenge, and self-reliance. In contrast, camping in a setting having easy access and highly-developed facilities offers more comfort, security, and social opportunity.

Naturalness

Whatever the category, naturalness of setting, including the Pacific yew, is important across the spectrum. While some level of alteration is acceptable in settings approaching the urban end of the spectrum (or which may be viewed from a distance or while traveling at some speed), in general, recreationists have shown a clear preference for natural conditions, and the value of the setting is usually ranked in direct proportion to its naturalness.

In addition, recent research in national forests is showing that naturalness and high visual quality are important. They are key factors in improving and maintaining the physical and mental well-being of visitors to public lands.

Congressionally Designated Areas

Direction and Legislation

Within the range of Pacific yew, a number of national recreation areas, national volcanic monuments, and an impressive selection of wild and scenic rivers and wildernesses have been designated by Congress. All are managed in accord with the establishing legislation. (See the section on Geographical Range in Chapter III, Part One: The Yew, for general information about land allocations and management direction.)

National Recreation Areas and Monuments are managed in accord with the establishing legislation, which typically sets aside an area with unique features — such as the sand dunes of the Oregon Dunes National Recreation Area or the volcanic landscape at Mount St. Helens National Volcanic Monument — for recreational and other values.

Depending on the intrinsic values of the area, and the scenic quality and type of recreation settings desired, harvest of yew trees and shrubs might be acceptable, depending on recreation settings desired, and the sensitivity of the scenic quality of the area.

Wildernesses and Wild or Scenic Rivers are managed according to direction established in the original Congressional legislation, and comprehensive management plans.

Wildernesses are managed in accord with direction provided by the 1964 Wilderness Act: "in order to assure that an increasing population, accompanied by expanding settlement and growing mechanization, does not occupy and modify all areas within the United States... leaving no lands designated for preservation and protection in their natural condition..."

Harvesting yew bark, wood, or needles is not allowed in designated wilderness.

Wild and Scenic Rivers are managed in accord with The Wild and Scenic Rivers Act, which declares that it is the policy of the United States that certain selected rivers should be designated to preserve the river and the immediate environs in a "free-flowing condition," in contrast to the national policy of dams and other construction on rivers of the nation. Further, the "outstandingly remarkable values" and water quality of these rivers will be protected and enhanced.

Wild and scenic rivers are classified in one of three categories according to the level of development and modification of the river and its immediate environment. These categories are Wild, Scenic, and Recreational.

In a "Wild" river corridor, management emphasis is on maintaining natural conditions and visual quality.

Under most conditions, the harvest of yew bark, wood, or needles is not acceptable within this river classification.

In a "Scenic" or "Recreational" river corridor, a higher level of modification is permitted.

In these corridors, the harvest of yew trees or shrubs might be acceptable, depending on river management plan objectives and the need to protect the river and its immediate environment.

Research natural areas "...are part of a national network of ecological areas designated in perpetuity for research and educa-

tion and/or to maintain biological diversity on National Forest System lands. Research natural areas are for nonmanipulative research, observation, and study. They also may assist in implementing the provisions of special acts, such as the Endangered Species Act and the monitoring provisions of the National Forest Management Act". (Forest Service Manual 4063.)

In research natural areas, no harvest of yew wood, bark, or needles is allowed.

Values and Activities

Traditional Values — Free Access

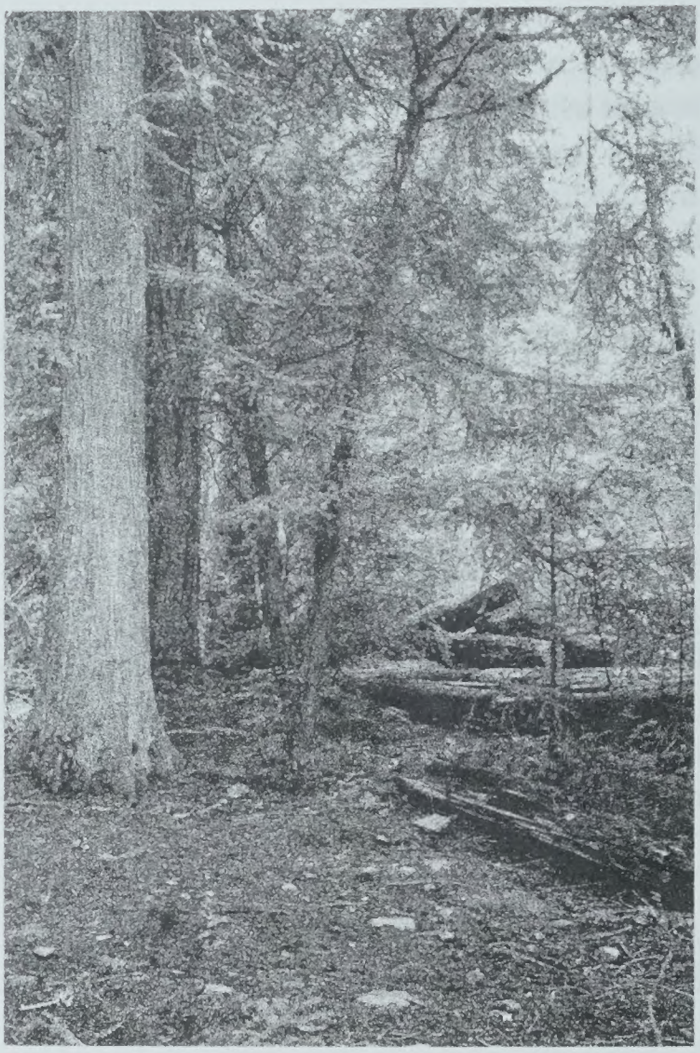
Access on roads and trails to national forests, Bureau of Land Management (BLM) districts, and other public lands for recreation is a highly valued tradition, especially in the West. As the nation becomes more urban, these outdoor recreation opportunities, by virtue of their contrast with everyday life, become increasingly important to urban residents.

Forest visual quality, including the presence or absence of yew, can influence the quality of experience of traveling on these roads and trails.

Traditional Values — Gathering

Among the activities that might be considered recreational are a group of activities that might be described as gathering activities. They include looking for and collecting yew for native plant material for landscaping, for florist greens, medicinal uses, wooden musical instruments, turned work, kitchen utensils, furniture, boat building, bows, and carving/sculpture.

Gathering activities may also have spiritual implications for both Native and non-native Americans (see the Market and Nonmarket and Cultural Resources sections in this Chapter).



Individuals involved in these gathering activities are often passionately interested in their activities which may be more of an avocation than a commercial activity. They tend to be very selective about the material they collect. For example, woodworkers who gather Pacific yew depend on finding the "right" tree with specific characteristics, such as a fine grain with few knots. These characteristics are found only in larger-sized, older trees (see Appendix L).

Conflicts

All Kinds of Sites and Users

Sometimes recreation or other resource activities — such as the harvest of Pacific yew — may conflict with what is needed to maintain a resource. For example, during breeding seasons for some species of wildlife, areas may be temporarily closed to vehicles or other forms of access.

Chapter IV

Environmental Consequences

Changes Made Since the Draft EIS

Chapter IV-Part One: The Pacific Yew

Rewrote and reformatted the subsection "Sustainability of Pacific Yew," to clarify and emphasize the difference between "sustainability of the species" and "sustained yield." It was moved ahead of the section on Inventory and Population.

Eliminated the calculation of an "even flow harvest volume" since the historical information needed to make an accurate calculation or prediction does not exist.

Updated inventory numbers for the Northern Region, which resulted in changes to all the tables showing combined inventory figures for the BLM, the Pacific Northwest Region, and the Northern Region.

Chapter IV-Part Two: The Forest

Removed statements regarding favorable effects under the "Water Resources and Aquatic Habitat" section, "Direct Effects" subsection.

Drew out "Disturbance" effects into separate subsections under "Wildlife," and integrated "Logs" subsections into the "Forest Structure and Composition" subsections.

Chapter IV-Part Three: The Yew and People

Rewrote "Treatment" subsection for clarification.

Added paragraph in "Demand" subsection for clarification.

Rewrote "Stumpage Values" subsection for clarification.

Chapter IV

Environmental Consequences

Part One: The Pacific Yew

Contents

Chapter IV
Environmental Consequences

How This Chapter is Organized

Environmental consequences (or effects, or impacts — we use the terms interchangeably) occur when ecosystems are changed through management action or inaction. Chapter IV addresses the environmental consequences that could occur if the alternatives presented in this Environmental Impact Statement (EIS) are implemented. (The alternatives are presented in detail in Chapter II.) Under each alternative, the harvest of Pacific yew trees and shrubs on federal land would be managed in a different way. This chapter provides the basis for comparing effects in a summary presented in Chapter II.

This chapter opens with a discussion on the assumptions used to make these estimates.

After the opening, this chapter is arranged in three parts like Chapter III:

Part One: The Pacific Yew,
Part Two: The Forest, and
Part Three: The Yew and People

Note: Several Chapter III, Part Three sections have been merged under the main heading of "Social and Economic Effects" for Chapter IV.

These three major parts are followed by the Summary of Irretrievable and Irreversible Effects.

Within the three major parts, the description of consequences is organized by resource. The resource sections each open with an introduction providing background information, a brief discussion of related issues (see Chapter II and Appendix A), and an explanation of how the section is arranged if it deviates from the standard

format. These introductions are followed by a discussion of what the direct, indirect, and cumulative effects would be under each alternative for that particular resource.

Direct, indirect, and cumulative effects are defined under the National Environmental Policy Act (40 CFR 1508.8 Effects) as follows:

> **Direct effects** are caused by the action and occur at the same time and place.
>
> **Indirect effects** are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable.
>
> **Cumulative effects** are the impacts on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7).

Assumptions Forming the Basis for Estimating Environmental Effects

Environmental effects were estimated in many ways. Each interdisciplinary team member was responsible for estimating effects in their area of expertise. This analysis was based on scientific principles, research literature (which is limited at this point for the Pacific yew tree), and each team member's field experience. Team members also consulted with many experts in the Forest Service, BLM, National Cancer Institute, other agencies, and at universities and private consulting firms (see List of Preparers). Conclusions or statements that are not specifically referenced are professional opinions of the interdisciplinary team members responsible for that section.

Information about the Pacific yew is limited due to its previous low commercial value. Because of this, our analysis is based on several assumptions and guidelines.

Assumptions and Guidelines

The following assumptions and guidelines were used to develop the analyses in this EIS.

Predictions of Effects

Predictions of potential effects of the alternatives are based on current conditions, laws, policies, and trends, and represent a best professional estimate of reasonable foreseeable future actions. Unforeseen changes in these factors could result in different outcomes than those projected for this analysis.

Yew Bark Emphasis in this Analysis

In our analysis we concentrate more on the potential effects of yew bark harvest as opposed to needle harvest because this is the only raw material currently approved by the Food and Drug Administration as a source for taxol for cancer treatment.

Past, Present, and Future Timber Harvest

Our analysis assumes that timber harvest levels have dropped significantly in the past 20 years and will continue to fall over the next five years, particularly for federal agencies; that clearcut size will continue to be relatively small in the foreseeable future; that

timber harvest, especially within the central portions of the range of Pacific yew, will not completely remove yew from the site; and that yew will be regenerated and protected as a recognized tree species under forest and resource management plans.

Timber Sales

The amount of yew material available from timber sales is dependent on the federal timber sale program. The impact analysis for each alternative, as well as the calculations of amount of yew available, assumes a timber sale program equal to that described in forest plans and adjusted according to the FEIS for Management for the Northern Spotted Owl in the National Forests.

Influence of Fire on Yew

Historic fire patterns have affected the distribution of yew locally within its range; control of wildfire in the past fifty years, however, has probably allowed yew to extend its range. The reduced use of hot broadcast burns currently and in the foreseeable future will allow yew to better survive. Also, survival will improve on sites where cool burning is used for fuels reduction, vegetation management, and habitat conversion.

Effectiveness of Mitigation Measures

It is assumed that all mitigation measures are effective; they are based on the recommendations of the Pacific Yew Technical Committee, the group of scientists who wrote "An Interim Guide to the Conservation and Management of Pacific Yew," using the most current and accurate information available (USDA Forest Service, 1992a).

Harvest of Yew on State and Private Lands

The Pacific yew population on state and private lands in Oregon, Washington, and California is estimated to be about 10 million trees over one inch diameter breast height. These lands have provided an unspecified amount of yew bark, but probably in excess of 0.5 million pounds dry bark a year since 1991. There are no overall protection and regeneration measures for yew on non-federal lands, other than that afforded by NFMA, although some companies or states may have individual guidelines for yew con-

servation. We would expect more yew would be harvested from state and private lands if federal agencies do not have a bark harvest program. Otherwise, harvest of yew on nonfederal lands is projected to be similar to present harvest levels.

Other Forest Service and Bureau of Land Management Activities Affecting Yew

Outside of yew harvest itself, timber harvest and the use of fire for site preparation or habitat modification are the activities that have had or will have the largest impact on Pacific yew. Other activities, such as road construction or the use of herbicides for vegetation control, will have minor or negligible impacts on yew overall. (The majority of road construction has been and will be associated with timber harvest).

Past Yew Harvest

Pacific yew has been harvested for taxol production in significant quantities only since 1991; prior to 1991, relatively insignificant amounts were taken from the woods for such things as fenceposts, firewood, woodworking, and Native American uses. The total amount removed from federal lands in 1991 and 1992 was approximately 1.7 million pounds of dry bark; the amount removed from state and private lands is estimated to be 1.3 million pounds dry bark. The yew inventories, completed in August 1992, accounted for yew harvested on federal lands prior to 1992.

Short-term Demand

Demand for Pacific yew from federal lands will taper off over the next five years as alternative sources are developed and become capable of meeting the demand for taxol.

Processing Capacities

Pacific yew processing plants currently have the capacity to process approximately 1,950,000 pounds of bark per year.

Funding

The Forest Service will have the funding and workforce to implement the proposed action.

Part One: The Pacific Yew

This part of Chapter IV discusses environmental consequences of yew harvest on Pacific yew, from its sustainability to its insects and disease pests. Other topics include impacts on population, genetics, regeneration, and the role of fire.

Sustainability of Pacific Yew

Sustainability of Pacific yew can be defined in two ways: sustainability of the species; and sustained yield of the product, in this case, yew bark or needles used to make taxol.

Sustainability of the Species/Population

The ability of Pacific yew to maintain a viable dynamic population depends on its ability to successfully reproduce and to adapt to changes in its environment (see the Biology, Ecosystem and Genetics sections in this Chapter). Forest management directly influences yew survival through efforts to protect and regenerate it. This EIS incorporates most of the protection measures from the Interim Guide which was designed to protect the yew and ensure its sustainability.

Sustained Yield

Sustained yield is defined as "the achievement and maintenance in perpetuity of a high-level annual or regular periodic output of various renewable resources of the national forests without impairment of the productivity of the land." All of the alternatives meet the criteria for sustained yield as it is defined here. Because each alternative proposes harvesting all of the yew available under the alternative over the next five years (see Chapter II), any subsequent harvest should not occur until the harvested volume has been replaced through growth of uncut or newly established trees.

The time it takes the stands to recover enough of the harvested volume to allow for re-entry depends on:

- the amount of the existing stand left uncut and how fast the remaining trees grow;
- the success rate of regenerating trees replacing those harvested and then how fast those replacement trees grow; and
- the rate of mortality in both the residual stand and the newly planted trees.

Even and Uneven-Flow Harvest

A subject frequently discussed in conjunction with sustained yield is the flow of the yield over time. That flow can be even or uneven. With an even-flow scenario, equal amounts are harvested every year or every few years throughout a cycle of growth (rotation). With an uneven-flow scenario, a larger amount is harvested early in the growth cycle, and then little or none is harvested in the remaining years of the cycle. Both scenarios come under the definition of a sustained yield harvest.

This EIS addresses a five-year uneven-flow program. Until other sources can provide sufficient quantities of taxol, the harvest of Pacific yew in the wild can provide a short-term source of taxol for the treatment of various cancers.

A long-term even-flow alternative was not fully analyzed in this EIS (see Chapter II Alternatives Considered but Eliminated). In the draft EIS, a simple calculation was used with the intention of providing an idea of what an even-flow harvest level would be. The total harvestable volume of yew trees was divided by the number of years in a 100-year rotation providing a crude estimate of an even-flow volume.

For the Final EIS, an attempt was made to improve the calculation. A more accurate calculation of an even-flow harvest level requires historical information about growth, mortality, and reforestation success. This type of historical information has not been gathered for Pacific yew; therefore, computer simulations were designed to predict even-flow harvest levels using the trees per acre (and corresponding bark volume) after implementation of each of the alternatives; basic growth data collected last year; and best estimates of mortality and survival. The computer simulation results varied dramatically depending on the mortality factor used. For example, under Alternative C for the Mt. Hood National Forest, with a baseline of 97 pounds of bark left per acre, even-flow harvest projected for 100 years varied from 57 pounds of bark per acre (using high mortality estimates) to 760 pounds of bark per acre (using low mortality estimates). Better predictions of even-flow harvest levels can be made when long-term data for mortality, survival, and growth is available.

Pacific Yew Population and Inventory

This section relates most directly to the issue of analyzing and establishing a suitable and sustainable level of harvest for taxol production. Here we present the best estimates of how much yew is present, what impact different harvest levels will have on the yew population, and how much material will be available for taxol production.

This section is organized somewhat differently than the other sections. It has a large amount of material that is displayed in tables — the numbers of yew trees available for harvest, the pounds of bark and needles that can be obtained from those trees, and the number of harvestable acres — for each of three inventoried areas. These tables and accompanying discussions are presented first and then the direct, indirect, and cumulative impacts for each alternative are summarized towards the end of the section.

Population Estimation Methods

Population estimates were developed from inventories conducted in seven national forests in Oregon and Washington, one national forest in Idaho, and the six BLM districts in western Oregon. These estimates were used as the basis for modeling the maximum number of trees that would be available for harvest and, therefore, the amount of available bark and needles for each alternative. For more information about the inventory and the modeling process see the "Pacific Yew Population and Inventory" section in Chapter III and Appendix F.

The inventory modeling reduces the availability of the total estimated number of yew trees by two factors:

1. harvest area restrictions under each alternative and the percentage of harvest allowed, and
2. forest and area plan restrictions.

Reductions resulting from the alternatives include items such as: the percentage (0%, 50%, 75%) of yew that can be harvested on a given acre in non-sale areas; leave tree requirements; genetic reserve requirements; and areas where harvest is not allowed according to the alternative (for example, owl conservation areas in Alternative B through G1 and non-sale areas in Alternative B).

Reductions resulting from forest and area plans include: areas where harvest activities are restricted such as wilderness, research natural areas, special interest areas, and the wild portion of wild and scenic rivers. Typically these types of restrictions have been mapped and/or quantified during the forest and area planning process. As a result, we were able to include them directly as constraints in the modeling process.

The site-specific analysis which will occur during project implementation is expected to make further reductions on the number of acres and trees that are available for yew harvest. Such things as raptor nests, threatened and endangered plants, and cultural sites will be located and must be protected. Also, fewer areas could be available due to timber sale injunctions, accessibility, areas with lower trees per acre than expected, and further restrictions from the spotted owl recovery plan. Previous forest and area plans did not quantify these reductions and consequently we cannot include them as constraints in the modeling process. However, they would likely be in the range of 50 percent to 25 percent. To display the fact that until site-specific analysis occurs we cannot guarantee how much bark will be available, we have chosen to show our estimates of final outputs in the form of a range.

Impact of Yew Harvest on Yew Populations

The following tables show: (1) an estimate of the maximum yew trees available for harvest according to each alternative; and (2) the corresponding percent of yew trees that would be harvested from the total number of inventoried trees.

Table IV-1: The Impact of the Alternatives on the Estimated Yew Population—Combined National Forests and BLM Districts

Alternatives	Total Trees in Inventoried Area*	Trees Available for Harvest with each Alternative	Trees Available for Harvest with each Alternative 50%-25% Reduction	Percent of Total Trees Harvested 50%-25% Reduction
A	49.85 MM	0	0	0
B	49.85 MM	.53 MM	.26-.39 MM	.53-.79%
C	49.85 MM	3.03 MM	1.51-2.27 MM	3.03-4.55%
D	49.85 MM	5.26 MM	2.64-3.94 MM	5.27-7.91%
F	49.85 MM	8.47 MM	4.23-6.35 MM	8.49-12.74%
G1	49.85 MM	6.28 MM	3.14-4.71 MM	6.30-9.45%
G2	49.85 MM	8.44 MM	4.22-6.33 MM	8.49-12.70%

* > 1" Diameter Breast Height (DBH) on R-6 FS & BLM
> 3" DBH on R-1 FS

Table IV-2: The Impact of the Alternatives on Yew Populations in the Nez Perce National Forest, Idaho

Alternatives	Total Trees in Inventoried Area*	Trees Available for Harvest with each Alternative	Trees Available for Harvest with each Alternative 50%-25% Reduction	Percent of Total Trees Harvested 50%-25% Reduction
A	6.36 MM	0	0	0
B	6.36 MM	0 .091 MM	0.05-0.07 MM	0.07-1.07%
C	6.36 MM	0.60MM	0.30-0.45 MM	4.72-7.08%
D	6.36 MM	1.11 MM	0.56-0.84 MM	8.76-13.15%
F	6.36 MM	1.62 MM	0.81-1.22 MM	12.76-19.14%
G1	6.36 MM	1.11 MM	0.56-0.84 MM	8.76-13.15%
G2	6.36 MM	1.11 MM	0.56-0.84 MM	8.76-13.15%

* > 3" Diameter Breast Height (DBH)

Table IV-3: The Impact of the Alternatives on Yew Populations in Seven National Forests in Washington and Oregon

Alternatives	Total Trees in Inventoried Area*	Trees Available for Harvest with each Alternative	Trees Available for Harvest with each Alternative 50%-25% Reduction	Percent of Total Trees Harvested 50%-25% Reduction
A	41.40 MM	0	0	0
B	41.40 MM	0.39 MM	0.2-0.29 MM	0.47-0.71%
C	41.40 MM	2.32 MM	1.16-1.74 MM	2.8-4.2%
D	41.40 MM	3.98 MM	1.99-2.99 MM	4.81-7.21%
F	41.40 MM	6.59 MM	3.3-4.94 MM	7.96-11.94%
G1	41.40 MM	4.95 MM	2.48-3.71 MM	5.98-8.97%
G2	41.40 MM	6.88 MM	3.44-5.16 MM	8.31-12.46%

* > 1" Diameter Breast Height (DBH)

Table IV-4: The Impact of the Alternatives on Yew Populations in BLM Districts, Western Oregon

Alternatives	Total Trees in Inventoried Area*	Trees Available for Harvest with each Alternative	Trees Available for Harvest with each Alternative 50%-25% Reduction	Percent of Total Trees Harvested 50%-25% Reduction
A	2.09 MM	0	0	0
B	2.09 MM	0.044 MM	0.02-0.03 MM	1.05-1.58%
C	2.09 MM	0.105 MM	0.05-0.08 MM	2.51-3.77%
D	2.09 MM	0.163 MM	0.08-0.12 MM	3.90-5.85%
F	2.09 MM	0.255 MM	0.13-0.19 MM	6.10-9.15%
G1	2.09 MM	0.218 MM	0.11-0.16 MM	5.22-7.82%
G2	2.09 MM	0.449 MM	0.22-0.34 MM	10.74-16.11%

* > 1" Diameter Breast Height (DBH)

Projected Harvest of Yew Bark and Needles

The following tables show the maximum estimated amount of dry bark and needles that could be collected if each of the alternatives were implemented. The total tree numbers come from the inventory estimates. Available dry bark is based on estimates of pounds of bark produced by trees of given diameters. Needle amounts come from a conversion formula that relates pounds of needles to pounds of bark; this is based on a small sample and may be refined in the future.

The numbers presented in the tables below do not represent a target for the Forest Service or BLM; they only represent a maximum potential under the conditions of the alternatives, forest plans, and BLM resource management plans.

Table IV-5: Maximum Bark Available for Harvest in National Forests and BLM Districts, Combined

Alternatives	Total Trees in Inventoried Areas*	Maximum Trees Available for Harvest	Maximum Pounds Dry Bark	Maximum Pounds Dry Bark with 50%-25% Reduction
A	49.85 MM	0	0	0
B	49.85 MM	0.53 MM	2.57 MM	1.29-1.93 MM
C	49.85 MM	3.03 MM	11.16 MM	5.58-8.37 MM
D	49.85 MM	5.26 MM	18.82 MM	9.41-14.12 MM
F	49.85 MM	8.47 MM	31.74MM	15.87-23.81 MM
G1	49.85 MM	6.28 MM	30.69 MM	15.35-23.02 MM
G2	49.85 MM	8.44 MM	37.77 MM	18.89-28.33 MM

* > 1" Diameter Breast Height (DBH)

Table IV-6: Maximum Bark Available for Harvest in the Nez Perce National Forest in Idaho

Alter-natives	Total Trees in Inventoried Areas*	Maximum Trees Available for Harvest	Maximum Pounds Dry Bark	Maximum Pounds Dry Bark with 50%-25% Reduction
A	6.36 MM	0	0	0
B	6.36 MM	0.091 MM	0.427 MM	0.21-0.32 MM
C	6.36 MM	0.60 MM	2.95 MM	1.48-2.21 MM
D	6.36 MM	1.11 MM	5.47 MM	2.74-4.10 MM
F	6.36 MM	1.62 MM	8.0 MM	4.0-5.99 MM
G1	6.36 MM	1.11 MM	5.47 MM	2.74-4.10 MM
G2	6.36 MM	1.11 MM	5.47 MM	2.74-4.10 MM

* > 3" Diameter Breast Height (DBH)

Table IV-7: Maximum Bark Available for Harvest in Seven National Forests in Washington and Oregon

Alter-natives	Total Trees in Inventoried Area*	Maximum Trees Available for Harvest	Maximum Pounds Dry Bark	Maximum Pounds Dry Bark with 50%-25% Reduction
A	41.40 MM	0	0	0
B	41.40 MM	0.389 MM	1.90 MM	0.95-1.43 MM
C	41.40 MM	2.32 MM	7.49 MM	3.75-5.62 MM
D	41.40 MM	3.98 MM	12.43 MM	6.22-9.32 MM
F	41.40 MM	6.59 MM	22.38 MM	11.19-16.79 MM
G1	41.40 MM	4.95 MM	23.72 MM	11.86-17.79 MM
G2	41.40 MM	6.88 MM	29.06 MM	14.53-21.8 MM

* > 1" Diameter Breast Height (DBH)

Table IV-8: Maximum Bark Available for Harvest in BLM Districts in Western Oregon

Alter-natives	Total Trees in Inventoried Area*	Maximum Trees Available for Harvest	Maximum Pounds Dry Bark	Maximum Pounds Dry Bark with 50%-25% Reduction
A	2.08 MM	0	0	0
B	2.08 MM	0.044 MM	0.247 MM	0.12-0.19 MM
C	2.08 MM	0.105 MM	0.715 MM	0.36-0.54 MM
D	2.08 MM	0.162 MM	0.922 MM	0.46-0.69 MM
F	2.08 MM	0.255 MM	1.37 MM	0.69-1.03 MM
G1	2.08 MM	0.218 MM	1.50 MM	0.75-1.13 MM
G2	2.08 MM	0.449 MM	3.24 MM	1.62-2.43 MM

* > 1" Diameter Breast Height (DBH)

Table IV-9: Maximum Needles Available for Yew Harvest in National Forests and BLM Districts, Combined

Alternatives	Maximum Pounds Dry Bark	Maximum Pounds Dry Needles*		Maximum Pounds Dry Needles*	
		From whole tree harvest in sale & non-sale areas	From whole tree harvest in sale areas & as only product in non-sale areas	From whole tree harvest in sale & non-sale areas 50%-25% Reduction	From whole tree harvest in sale areas & as only product in non-sale areas 50%-25% Reduction
A	0	0	0	0	0
B	2.57 MM	6.86 MM	6.86 MM	3.43-5.15 MM	3.43-5.15 MM
C	11.16 MM	29.80 MM	18.33 MM	14.90-22.35 MM	9.16-13.75 MM
D	18.82 MM	50.25 MM	28.56 MM	25.12-37.69 MM	14.28-21.42 MM
F	31.74 MM	84.75 MM	45.80 MM	42.37-63.56 MM	22.90-34.35 MM
G1	30.69 MM	81.94 MM	44.40 MM	40.97-61.46 MM	22.20-33.30 MM
G2	37.77 MM	100.85 MM	53.85 MM	50.42-75.63 MM	26.93-40.39 MM

***Based on a ratio of 2.67 lbs. of needles to 1 lb. bark obtained from a 50-tree trial conducted in 1992 by Joe Earp, Yew Biomass Coordinator, NaPro, Eugene, Oregon.**

Acres Available for Yew Harvest

The following tables show the maximum number of acres that would be entered for yew harvest according to each alternative. The differences between alternatives reflect whether the alternative allows yew harvest in timber sale areas only, includes non-sale areas, includes owl conservation areas, and account for reductions of acres available for harvest according to forest and area plans.

Table IV-10: Maximum Acres Available for Yew Harvest in National Forests and BLM Districts, Combined

Alternatives	Total Acres in Inventoried Area	Maximum Acres Available for Harvest	Maximum Acres Available for Harvest 50%-25% Reduction
A	7.60 MM	0	0
B	7.60 MM	0.157 MM	0.078-0.118 MM
C	7.60 MM	2.93 MM	1.47-2.2 MM
D	7.60 MM	2.93 MM	1.47-2.2 MM
F	7.60 MM	2.93 MM	1.47-2.2 MM
G1	7.60 MM	2.93 MM	1.47-2.2 MM
G2	7.60 MM	4.62 MM	2.31-3.47 MM

Table IV-11: Maximum Acres Available for Yew Harvest in the Nez Perce National Forest in Idaho

Alternatives	Total Acres in Inventoried Area	Maximum Acres Available for Harvest	Maximum Acres Available for Harvest 50%-25% Reduction
A	134,357	0	0
B	134,357	3,070	1,535-2,303
C	134,357	67,870	33,935-50,903
D	134,357	67,870	33,935-50,903
F	134,357	67,870	33,935-50,903
G1	134,357	67,870	33,935-50,903
G2	134,357	67,870	33,935-50,903

Table IV-12: Maximum Acres Available for Yew Harvest in Seven National Forests in Washington and Oregon

Alter-natives	Total Acres in Inventoried Area	Maximum Acres Available for Harvest	Maximum Acres Available for Harvest 50%-25% Reduction
A	5.43 MM	0	0
B	5.43 MM	0.092 MM	0.045-0.069 MM
C	5.43 MM	2.18 MM	1.09-1.64 MM
D	5.43 MM	2.18 MM	1.09-1.64 MM
F	5.43 MM	2.18 MM	1.09-1.64 MM
G1	5.43 MM	2.18 MM	1.09-1.64 MM
G2	5.43 MM	3.14 MM	1.57-2.36 MM

Table IV-13: Maximum Acres Available for Yew Harvest in BLM Districts in Western Oregon

Alter-natives	Total Acres in Inventoried Area	Maximum Acres Available for Harvest	Maximum Acres Available for Harvest 50%-25% Reduction
A	2.03 MM	0	0
B	2.03 MM	0.062 MM	0.031-0.046 MM
C	2.03 MM	0.680 MM	0.34-0.51 MM
D	2.03 MM	0.680 MM	0.34-0.51 MM
F	2.03 MM	0.680 MM	0.34-0.51 MM
G1	2.03 MM	0.680 MM	0.34-0.51 MM
G2	2.03 MM	1.410 MM	0.71-1.06 MM

Effect of Inventory Error

The sampling errors associated with the inventories are fairly large for individual plot data, due primarily to the unevenness of yew stocking and distribution over the inventoried landscape. There is also error associated with modeling the available acres, trees, bark, and needles but it cannot be statistically quantified. Therefore the amount of available needles and bark that are presented in the tables above may, in reality, be greater or less because of both sampling and modeling error.

The Alternatives

We are basing the analysis of effects on the maximum allowable number of yew trees that, according to each alternative, would be harvested and removed from the ecosystem. The numbers of acres, trees, bark, and needles are presented in tables in this section and are summarized below for each alternative:

Alternative A

Direct Effects

Minor—Pacific yew is not harvested for taxol in this alternative. However, some yew in timber sales, though not harvested, could be killed. Therefore, there is some reduction of the yew population from Alternative A; the level of reduction would be similar or lower to the direct reduction from harvesting yew in timber sales in Alternative B.

Indirect and Cumulative Effects

See all other effects sections, especially the sections on range, yew biology, yew genetics, landscape, wildlife, social, and economics for the indirect and cumulative effects of removing given amounts of yew from the ecosystem.

Because there would be no harvest of yew on federal lands, the demand for bark from state and private lands would increase significantly, possibly endangering some yew populations on those lands.

Alternative B

Direct Effects

Minor— For this alternative, the following would be available:

- 1.29 to 1.93 million pounds of bark for the next five years;
- 3.43 to 5.15 million pounds of needles for five years;
- 0.26 to 0.39 million yew trees; and
- 0.078 to 0.118 million acres.

The actual amount of yew harvested each year will vary depending on the amount of yew present in the scheduled timber sales.

Indirect and Cumulative Effects

See all other effects sections.

Alternative C

Direct Effects

Minor— For this alternative, the following would be available:

- 5.58 to 8.37 million pounds of bark for the next five years;
- 9.16 to 22.35 million pounds of needles for five years;
- 1.51 to 2.27 million yew trees; and
- 1.47 to 2.20 million acres.

Alternative C describes an uneven-flow rate of harvest. All yew that is available for harvest under this alternative could be harvested in the five-year period covered by this EIS.

Indirect Effects

For other indirect effects, see all other effects sections, especially the sections on range, yew biology, yew genetics, landscape, wildlife, social, and economics.

Cumulative Effects

See all other effects sections.

A = No Action
B = Timber Sales Only
C = 25%, 5 TPA
D = 50%, 5 TPA
F = 75%, 2 TPA
G1 = 50%, 1 TPA
G2 = 50%, 1 TPA, OCAs

TPA is the minimum number of trees left standing per acre

Alternative D

Direct Effects

Moderate— For this alternative, the following would be available:

- 9.41 to 14.12 million pounds of bark for the next five years;
- 14.28 to 37.69 million pounds of needles for five years;
- 2.64 to 3.94 million yew trees; and
- 1.47 to 2.20 million acres.

Alternative D describes an uneven-flow rate of harvest. All yew that is available for harvest under this alternative could be harvested in the five-year period covered by this EIS.

Indirect Effects

For other indirect effects, see all other effects sections.

Cumulative Effects

See all other effects sections.

Alternative F

Direct Effects

Moderate— For this alternative, the following would be available:

- 15.87 to 23.81 million pounds of bark for the next five years;
- 22.9 to 63.56 million pounds of needles for five years;
- 4.23 to 6.35 million yew trees; and
- 1.47 to 2.20 million acres.

Alternative F describes an uneven-flow rate of harvest. All yew that is available for harvest under this alternative could be harvested in the five-year period covered by this EIS.

Indirect Effects

For other indirect effects, see all other effects sections, especially the sections on range, yew biology, yew genetics, landscape, wildlife, social, and economics.

Cumulative Effects

See all other effects sections.

Alternative G1

Direct Effects

Moderate— For this alternative, the following would be available:

- 15.35 to 23.02 million dry pounds of bark for the next five years;
- 22.20 to 61.46 million pounds of needles for five years;
- 3.14 to 4.71 million yew trees; and
- 1.47 to 2.20 million acres.

Alternative G1 describes an uneven-flow rate of harvest. All yew that is available for harvest under this alternative could be harvested in the five-year period covered by this EIS.

Indirect Effects

For other indirect effects, see all other effects sections.

Cumulative Effects

See all other effects sections.

Alternative G2

Direct Effects

Moderate— For this alternative, the following would be available:

- 18.89 to 28.33 million dry pounds of bark for the next five years;
- 26.93 to 75.63 million pounds of needles for five years;
- 4.22 to 6.33 million yew trees; and
- 2.31 to 3.47 million acres.

Alternative G2 describes an uneven-flow rate of harvest of yew. All yew that is available for harvest under this alternative could be harvested in the five-year period covered by this EIS.

Indirect Effects

For other indirect effects see all other effects sections.

Cumulative Effects

See all other effects sections.

Biology of Pacific Yew

This section relates to the issue of protecting yew by planting and providing for natural regeneration. People who commented agreed with harvesting yew trees for taxol as long as sound reforestation practices that allow for natural regeneration are in place (see Chapter II).

This section analyzes the effects of implementing the alternatives on the biology of Pacific yew. The aspects of biology that we examine in this analysis are:

seed production and seedling establishment;
seedbed conditions where the seeds and seedlings will grow;
vegetative reproduction (primarily stump sprouting); and
needle and strobili regeneration following needle harvest.

Harvest factors affecting yew biology include the method and level of harvest, post-harvest regeneration efforts (planting, natural regeneration, and stump protection), and the presence and abundance of yew within and adjacent to the harvest unit.

Effects Common to All the Alternatives

Seedbed conditions would not be negatively impacted under any of the alternatives. In sale units where all overstory species are removed, harvest of remaining yew would not alter seedbed conditions or seed germination. In most non-sale areas, seedbeds would be virtually unchanged following yew harvest; soil, temperature, moisture, and light conditions would change very little. In pure stands of yew, or in stands where yew is very abundant, harvest of 25 to 75 percent of the yew would open the stand to varying degrees, resulting in less shade and moisture and somewhat higher temperatures. Germination can occur without shading, at least in some locations.

All alternatives, except Alternative A, include planting yew as a means of regenerating and maintaining yew populations. Planting is required, along with protection of residual stumps, seedlings, and saplings, in timber sale units where all yew of utilization size is removed. Seed for nursery production of seedlings can be obtained from on-site yew that is scheduled for harvest, from yew in adjacent stands, and from yew in genetic reserves in the local management area or seed zone.

The Alternatives

Alternative A

Direct Effects

Moderate—In timber sale units, some yew in the area would be destroyed or damaged, thus reducing the number of individuals capable of producing seed. However, not all yew would be killed and residual yews within the activity area, as well as yew on the edges of units, would be able to produce seed. Additionally, seed from past years is present in the duff for many years and germinates when conditions are favorable. Less seed would be produced in areas where yew is sparse and little or no yew exists adjacent to the unit.

Alternative A would also have some impact on vegetative reproduction of yew in timber sale areas because there would be no special provisions for protecting and shading yew stumps to encourage sprouting. On harsher sites and on burned sites, sprouting from unprotected and unshaded stumps might be reduced. However, on most sites a proportion of the stumps would sprout, as would some injured or pushed over trees or shrubs (which may layer, as well).

Indirect Effects

Minor— Yew populations on some units may be reduced slightly from preharvest levels, due to reduced seed production and sprouting. Seed to seedling ratios depend on a number of factors: the number of microsites available for seedling establishment in each stand, temperature and moisture conditions at critical times during germination and seedling development, good versus bad seed crop years, and populations of seed-eating birds and rodents.

Cumulative Effects

Minor to Moderate— Lack of protection of yew on both federal and nonfederal lands in the past and in the next five years under this alternative, combined with the potential increase in harvest on state and private lands to compensate for no yew harvest on federal lands, may result in reduced yew regeneration in portions of the yew range.

Alternative B Direct Effects

Minor— Harvest of yew in timber sale units would remove some of the seed-producing yew. Seed production would be delayed until residual yew or planted yew grows to reproductive size. In many cases, adequate seed would be produced in the interim by yew adjacent to the unit, yew that is retained in the green tree reserve, or yew retained as seed trees in either shelterwood or seed tree harvests. Yew seed already present in the duff would be another source of seed not affected by timber harvest.

Vegetative reproduction of yew would be greater with this alternative than with Alternative A (no yew harvest/no protection of yew); some of the yew stumps would be protected and shaded following the timber harvest so that the survival and sprouting would be enhanced. Recent data suggests that an estimated 70 percent of the stumps left after harvest should resprout (Minore, 1992). Planting of seedlings or rooted cuttings would supplement on-site regeneration to achieve desired population numbers.

Indirect Effects

Minor with some unknown aspects— Maximum seed production capability would be delayed until residual or planted yew reach sexual maturity, but the seed production potential would not be lost in timber sale units. The long-term success of vegetative reproduction, both in sale and non-sale areas, is unknown; at this time we do not know if sprouts on surviving stumps would survive for more than a few years and, if they do, how long until they would be able to produce seed or are of a sufficient size to contribute structurally to the stand.

Cumulative Effects

Minor to Moderate— Cumulative impacts on yew regeneration would be less than for Alternative A since yew regeneration would be ensured on federal lands. However, yew harvested from state and private lands still may be relatively high to compensate for a relatively low level from federal lands.

Alternatives C and D

Direct Effects

Minor— As for Alternative B, harvest of yew in sale areas would remove some of the seed-producing yew. Seed production would be delayed until residual yew or planted yew grows to reproductive size. In many cases, adequate seed would be produced in the interim by yew adjacent to the unit, yew that is retained in the green tree reserve, or yew retained as seed trees in either shelterwood or seed tree harvests.

Harvest of yew trees or yew foliage at the 25 percent and 50 percent levels in partial-cut and non-sale areas would not adversely affect the Pacific yew's ability to produce seed and seedlings. Sufficient numbers of trees or amount of foliage would exist following harvest to ensure adequate numbers of male and female strobili for pollen and seed production (USDA Forest Service, 1992a). Removal of individuals from the same clone during harvest may, in fact, be beneficial by reducing gene exchange between closely related individuals and increasing gene exchange between less related individuals. The result would be improved exchange and mixing of genetic material, provided that remaining yew are well distributed in the stand and distances between individuals do not exceed pollen dispersal distances.

In sale areas, vegetative reproduction of yew would be greater under these alternatives than under Alternative A (no yew harvest/no protection of yew); some of the yew stumps would be protected and shaded following the timber harvest so that survival and sprouting would be enhanced. Recent data suggests that an estimated 70 percent of the stumps left after harvest should resprout (Minore, 1992). Planting of seedlings or rooted cuttings would supplement on-site regeneration to achieve desired population numbers.

A	=	**No Action**
B	=	**Timber Sales Only**
C	=	**25%, 5 TPA**
D	=	**50%, 5 TPA**
F	=	**75%, 2 TPA**
G1	=	**50%, 1 TPA**
G2	=	**50%, 1 TPA, OCAs**

TPA is the minimum number of trees left standing per acre

In partial-cut and non-sale areas, yew stumps remaining after harvest would be shaded by other species or other yew, optimizing good sprout survival.

Foliage can be harvested from trees already cut for bark removal in sale units or from standing live trees in non-sale areas. For foliage-only harvest, Alternatives C and D would allow for the

removal of half the foliage from 25 percent or 50 percent of the yew trees in partial-cut and non-sale stands. The removal of no more than half the foliage would preserve some sexual buds on each tree. Shearing of foliage is common with cultivated yew and does not adversely affect the tree or shrub's ability to regenerate foliage or reproductive structures. Similarly, we do not expect 50 percent foliage removal to adversely affect wild yew trees, although the regrowth experienced by each individual yew would depend on a number of factors, including initial amounts of foliage, age and size of the tree, vigor and health of the tree, light conditions, etc.

Indirect Effects

Minor with some unknown aspects— On timber sale units, maximum seed production capability would be delayed until residual or planted yew reach sexual maturity, but the potential would not be lost for these areas. The long-term success of vegetative reproduction, both in sale and non-sale areas, is unknown; at this time we do not know if sprouts on surviving stumps would survive for more than a few years and, if they do, how long until they would be able to produce seed or are of a sufficient size to contribute structurally to the stand. On non-sale areas and partial-sale units, adequate numbers of trees are retained to ensure continued regeneration of Pacific yew in harvested areas.

Cumulative Effects

Minor— The cumulative effects of these two alternatives on yew regeneration would be minor. Yew regeneration on federal timber sales would be ensured; other federal activities such as burning for site preparation or road construction would not significantly impact yew regeneration. Yew harvest on state and private lands, and the impacts on yew regeneration on those lands would probably be less than that predicted for Alternative A.

Alternatives F, G1, and G2

Direct Effects

Minor to moderate— Harvest of yew in sale areas for these alternatives would remove some of the seed-producing yew. Seed production would be delayed until residual yew or planted yew grows to reproductive size. In many cases, adequate seed would be produced in the interim by yew adjacent to the unit, yew that is retained in the green tree reserve, or yew retained as seed trees in either shelterwood or seed tree harvests. Yew seed, already present in the duff, would be another source of seed not affected by timber harvest. The potential for successful vegetative reproduction following timber sales would be identical to that of Alternatives B, C, and D. Similarly, planting seedlings and rooted cuttings to supplement natural regeneration would achieve desired yew densities.

In non-sale areas, removal of 75 percent of the yew in each of the three diameter classes under Alternative F could adversely affect seed production. Two yew trees per acre in each of the three diameter classes would be left unharvested. Similarly, for Alternatives G1 and G2, removal of 50 percent of the yew in each diameter class in the stand could affect seed production in stands where yew is relatively sparse. For Alternatives G1 and G2 at least one yew tree would be left on each harvested acre. Yew stumps remaining after harvest would be shaded by other species or other yew, allowing for optimal sprout survival.

Foliage can be harvested from trees already cut for bark removal in sale units or from standing live trees in non-sale areas. For foliage harvest only, Alternatives F, G1, and G2 would allow for the removal of half the foliage from 75 percent or 50 percent of the yew trees in partial-cut and non-sale stands. As with Alternatives C and D, the regrowth experienced by each individual yew would depend on a number of factors, including initial amounts of foliage, age and size of the tree, vigor and health of the tree, light conditions, etc. Seed production in the stand would be impacted to some extent.

Alternatives F, G1 and G2

Indirect Effects

Minor with some unknown aspects— On timber sale units, maximum seed production capability would be delayed until residual or planted yew reach sexual maturity, but the potential would not be lost for these areas. The long-term success of vegetative reproduction, both in sale and non-sale areas, is unknown; at this time we do not know if sprouts on surviving stumps would survive for more than a few years and, if they do, how long until they would be able to produce seed or are of a sufficient size to contribute structurally to the stand. On non-sale areas and partial-sale units, adequate numbers of trees are retained to ensure continued regeneration of Pacific yew in harvested areas.

Cumulative Effects

Minor— The establishment of fewer seedlings each year would probably not result in an overall lower population of yew. Over a five-year period, vegetative regeneration (sprouting and layering) could help maintain existing populations, although the long-term success of vegetative reproduction, both in sale and non-sale areas, is unknown. Maximum seed production potential would not be reached until stump sprouts, existing seedlings and saplings, and planted seedlings reached sexual maturity.

In Alternative G2, the impacts on both sexual (seed) and vegetative (sprouts) reproduction within owl conservation areas would be identical to that described in Alternative D. Both call for harvest of 50 percent of the yew with a minimum of five yew trees retained on each acre. Effects on reproduction of Pacific yew would be minor.

The cumulative effects of these three alternatives on yew regeneration would probably be about the same as those predicted for Alternatives C and D.

Genetics of the Pacific Yew

This section relates directly to the issue of protecting and maintaining the genetic diversity of Pacific yew. People are concerned about careful management to protect the gene pool and balancing short versus long-term needs for taxol. People also want studies of yew in order to understand how to provide a viable gene pool for the future.

Terms to Know

Allele— *one of a series of alternative forms of a given gene, differing in DNA sequence, and affecting the functioning of a single product (RNA and/or protein).*

Gene migration— *the movement of alleles between populations. In plants this is accomplished by pollen and/or seed movement.*

Genetic drift— *chance fluctuations in allele frequency due to small numbers of parents contributing to the next generation.*

Genetic variation— *genetic differences resulting from different combinations of alleles and their frequencies occurring among individuals in different populations.*

Gst values— *an indication of the proportion of genetic diversity due to differences among different populations.*

Heterozygosity— *the condition of having one or more pairs of dissimilar alleles at a locus.*

Locus (plural, loci)— *the location of a gene on a strand of DNA.*

Direct effects are changes which would happen to the structure and amount of genetic variation (levels of heterozygosity, Gst values, number of alleles) of existing populations. These changes would be noticed if sampling to determine genetic variation was carried out immediately prior to bark harvest and then a short period of time after bark harvest.

Indirect effects are changes which would happen to levels of genetic variation in future generations of Pacific yew derived from the populations where harvest has occurred. This genetic variation is crucial to the ability of Pacific yew to adapt and survive to changing environments. It is also a potential resource for use in breeding and hybridization programs, as well as having intrinsic, aesthetic, educational and scientific value.

Cumulative effects are gradual changes to the structure and amounts of genetic variation which are the result of many management activities over a long period of time.

The direct effects of needle harvest on genetic variation would be minor because individual trees would not be killed. Indirect effects (minor) would temporarily reduce the foliage area available for reproductive buds, reducing aril production; however, the foliage area would probably recover in less than five years.

Table IV-14: Potential effects on the genetic resource under the different alternatives

Alter-natives	Direct effects on existing levels of genetic variation	Indirect effects on levels of genetic variation in future generations	Cumulative effects
A	Risk of losing small populations at edge of range, thereby reducing existing levels.	Risk of losing small populations at edge of range, thereby reducing future levels.	Risk of genetic erosion at edge of range.
B	None	None	Would negate risk to small populations and halt genetic erosion.
C	Risk of slightly reducing levels within population of genetic variation for some populations. No effect on overall variation.	Risk of slightly reducing some populations. No effect on overall variation or values.	Would enhance gene conservation.
D	Within population levels could be reduced more than in Alt. C. No effect on overall genetic variation.	Could be reduced more than in Alternative C for some populations. No overall effect.	Same as Alt. C.
F	Within population levels could be reduced more than in Alt. D. Overall levels of variation would be reduced slightly.	Could be reduced more than in Alt. D. Potential significant reduction in adaptability of some populations and some reduction in values.	Same as Alt. C.
G1	Same as Alt. D.	Same as Alt. D.	Same as Alt. C.
G2	Same as Alt. D.	Same as Alt. D.	Gene conservation would not be well served because of fewer reserves.

The Alternatives

Alternative A

Direct Effects

Minor— Under this alternative no effort would be made to maintain individual yew trees, breeding populations, or genetic diversity. Some of the small populations on the periphery of the species range (e.g. the Sierra Nevada Mountains in southern California) may be lost due to inadequate natural regeneration and/or reduction of stump sprouting in severe climates. Loss of populations containing unique genetic combinations could decrease levels of genetic variation in this species, particularly since there is more among-population variation in this species compared to other widely distributed conifers.

Indirect Effects

Minor— The ability of Pacific yew to adapt to changing environments could be impaired if populations containing unique genetic combinations are lost. Similarly, loss of rare alleles and/or unique genetic combinations could degrade its potential for use in breeding programs.

Cumulative Effects

Minor— The cumulative effects of this alternative would reflect conditions prior to the 1991 harvest season. There could be continued erosion of some genetic variation at the peripheries of the species range because some populations may be lost.

Alternative B

Direct Effects

None— Protection for yew stumps will encourage stump sprouting, giving individual genotypes a greater ability to survive and contribute to future reproduction. This alternative would have less impact on the genetic diversity of Pacific yew than Alternative A because fewer populations would be reduced below critical levels.

Indirect Effects

None— The indirect effects on potential contributions to breeding and hybridization programs, as well as the aesthetic, educational

and scientific value of genetic diversity of Pacific yew would be less than Alternative A. Also, the ability of Pacific yew to adapt to changing environments would be higher under this alternative due to higher survival of successful genotypes in populations.

Cumulative Effects

None— The cumulative effects for this alternative would be to halt the erosion of genetic variation at the peripheries of the species range.

Direct Effects

Minor to Moderate— Under these alternatives the following activities would maintain individual trees and populations. Artificial regeneration is used to maintain populations in timber sale areas and harvested yew stumps are protected and encouraged to sprout in non-sale areas. However, artificial regeneration is not done in non-sale areas. In spite of efforts to protect stumps, there will be mortality of individual trees from harvesting, perhaps as high as 50 percent of the trees harvested for bark. If individual trees die because of bark harvest, it is important they are not all the largest or fastest growing individuals. Harvesting should be spread out over all size classes to ensure these 'best' genotypes are not severely depleted.

Effects Common to Alternatives C through G2

As harvest levels and potential mortality increase, levels of within-population genetic variation could decrease and probabilities of losing low frequency alleles in harvested populations would increase. We know that alleles occur in some yew populations at frequencies of as low as 0.033. At this frequency, 274 individual genotypes would be needed to prevent an average loss of one allele at any of 100 loci (Namkoong, 1988). Individuals may have only a few hundred such loci with alleles at such a low frequency. As population census numbers drop below this level, the probabilities of losing low frequency alleles increase proportionately.

A = No Action
B = Timber Sales Only
C = 25%, 5 TPA
D = 50%, 5 TPA
F = 75%, 2 TPA
G1 = 50%, 1 TPA
G2 = 50%, 1 TPA, OCAs

TPA is the minimum number of trees left standing per acre

Under these alternatives genetic reserves are established in areas where yew harvest occurs. These reserves are in addition to other administratively withdrawn areas and riparian areas where yew harvest is prohibited. The genetic reserves sample and protect

representative levels of within-population genetic variation within a 10,000 to 20,000-acre management unit. A mosaic of genetic reserves over a landscape provides redundancy and offers the greatest species-wide protection for allelic diversity.

Indirect Effects

Minor to High— The indirect effects of these harvest activities could reduce the amount of genetic variation as measured by heterozygosity in the next generation of the populations harvested. This happens because the breeding population size is reduced, increasing 'chance' variations in allele frequency, or genetic drift. Gene migration, in the form of pollen flow which normally reduces genetic drift effects, would also be reduced. The amount of reduction in genetic variation would be proportional to the level of harvest. As genetic variation decreases, the ability of these populations to adapt and persist in the ecosystem decreases also. This has a negative effect on the value to hybridization programs and aesthetic, educational and scientific features.

Cumulative Effects

Positive— Cumulative effects of these alternatives would be to slightly reduce risks to survival of small populations in marginal environments as under Alternative B. The establishment of genetic reserves would actually enhance gene conservation and protection for this species.

Alternative C

Direct Effects

Minor— This alternative would harvest 25 percent of the yew in partial-cut and non-sale areas. Owl conservation areas are not entered under this alternative and would function as additional in situ reserves. Stump protection and sprouting will enable from one-half to two-thirds of harvested individuals to survive, reducing mortality to about 13 percent. Levels of within-population genetic variation could be reduced slightly, however, overall genetic variation would not be reduced due to the continued survival of genetically variable populations.

Indirect Effects

Minor— The effects on subsequent generations would be slight, the least of any alternatives harvesting in non-timber sale areas. Leaving a minimum of five trees per acre in each diameter class serves to keep a minimum population size for pollen dispersal and gene migration. There would not be a reduction in overall adaptability or values to either future breeding programs or aesthetic, educational and/or scientific values.

Cumulative Effects

Positive— The cumulative effects of this alternative would be to slightly reduce risks to survival of small populations in marginal environments as under Alternative B. The establishment of genetic reserves would actually enhance gene conservation and protection for this species compared with current practices.

Alternative D

Direct Effects

Minor— Under this alternative 50 percent of the yew would be harvested in partial-cut and non-timber sale areas, in addition to that harvested from timber sale areas. Owl conservation areas are not entered in this alternative and would function as in situ reserves. Maximum mortality would be about 25 percent of the population. Levels of within-population genetic variation would be reduced more than in Alternative C; however, overall genetic variation would not be reduced significantly because of the continued survival of many populations.

Indirect Effects

Minor— Effects on within-population genetic variability in future generations could be more than in Alternative C. The breeding population would be reduced by 50 percent until surviving sprouts were able to contribute to sexual reproduction. Leaving five trees per acre in each size class assures a minimum population is left for pollen dispersal and gene migration. Overall genetic variation would not be significantly affected in this alternative, nor would values to other uses of the gene pool.

Cumulative Effects

Positive— Same as for Alternative C.

Alternative F

Direct Effects

Moderate— Under this alternative 75 percent of the yew would be harvested in partial-cut and non-sale areas, in addition to that harvested from timber sale areas. Maximum mortality would be about 38 percent of the population. Owl conservation areas are not entered in this alternative and would function as in situ reserves. Levels of within-population genetic variation would be reduced for those populations where harvest occurs. More low frequency alleles would be lost under this alternative than under others. Overall genetic variation would not be significantly reduced because of the continued survival of many populations.

Indirect Effects

High— This alternative would significantly reduce levels of within-population genetic variation in future generations by removing 75 percent of the breeding individuals. This would occur only in harvested populations; however, decreasing the minimum number of trees per acre to two increases the number of acres where harvest will occur. Pacific yew is an understory tree and probably has limited pollen dispersal distance. Two trees per acre may not be enough to ensure much gene flow or successful pollination between trees within populations. This could lead to increased levels of inbreeding which could result in an increase of among-population variation. As surviving stump sprouts started contributing to sexual reproduction, within-population genetic variation would increase and among-population genetic variation would be reduced. Indirect effects of this alternative would be to reduce the overall genetic variation in future generations and the ability of Pacific yew to adapt to changing environments. Values to breeding programs, education, aesthetics and science would also be reduced.

Cumulative Effects

Positive— Same as for Alternative C.

Alternatives G1 and G2

Direct Effects

Minor— Same as Alternative D except owl conservation areas are entered in this alternative and would not function as in situ reserves in Alternative G2.

Indirect Effects

Minor— Same as Alternative D except that only one tree per acre would be left. This would result in indirect effects similar to those in Alternative F for populations where only two trees per acre are left. However, overall genetic variation would not be significantly affected in this alternative, nor would values to other uses of the gene pool.

Cumulative Effects

Positive— reserves would be established wherever harvest occurs. Alternative G2 would not have the owl areas for large additional in situ reserves.

Role of Fire

This area relates to the issue of protecting the ecosystem and regenerating yew.

This section looks at two aspects of fire and yew:

1. How risk of wildfire is influenced by the alternatives; and
2. The effect of the alternatives on the ability of yew to survive or regenerate following a slash fire, wildfire, or prescribed burn.

Risk of Fire from Yew Harvest

The risk of wildfire can be influenced by:

1. The amount of fuels generated by wood or bark harvest under each alternative, and
2. The risks from people working in the woods (fires started from machinery, chainsaws, cigarettes, arson, etc.) for any type of harvest (wood, bark, or needle).

The Alternatives

Alternatives A and B

Direct, Indirect, and Cumulative

Minor— There would be no increased risk of fire over current levels with these two alternatives, due primarily to treatment of yew slash (unused portions of the yew tree) along with other fuels on sale units.

The amount of slash created and the number of people working in the woods would vary with the level of harvest and the density of yew. Where yew is very abundant or exists in pure stands, larger amounts of slash would be generated for bark harvest and large numbers of workers may be employed for both needle and bark harvest.

Alternatives C through G2

Direct Effects

Minor to moderate— Risk of fire occurrence would vary for all alternatives, but would generally be higher for those alternatives that harvest higher levels of yew (Alternatives F and G2).

Indirect Effects

Minor to moderate— Fire incidence may increase in areas where yew is abundant and harvest is occurring.

Cumulative Effects

None— Fire risk would be lower as fuels decay over time.

Survival of Yew Following Fire

The impacts of yew harvest on the survival and regeneration of yew following fire would depend upon the level of harvest as well as the density of yew present initially in the stand. Together these factors would determine the amount of slash created and the distribution of fuels in relation to the yew on the site. In areas where large quantities of slash are produced, yew stumps and unharvested yew trees could be damaged or destroyed by fire, due to the proximity of fuels to stumps and trees. This would reduce both the vegetative (stump sprouting), layering, and reproductive (seed-producing) capability of the yew in that stand. Diminished reproduction could result in fewer seedlings, and subsequent decrease in certain yew populations over time.

This portion of the analysis would only be affected by harvest of trees for their bark or wood, rather than by harvest of needles. Needle harvest in all alternatives would have negligible impact on the yew's ability to survive following fire. There is very little slash associated with needle harvest and, to the best of our knowledge, removal of half the needles does not affect the yew tree's ability to survive fire.

The Alternatives

Alternative A

This alternative would not allow for harvest of yew and would have no special provisions for protecting yew. On sale units where there is yew, there would be no attempt to pull slash away from yew trees, stumps, or seedlings. Survival of the yew on these sites following any type of fire could be quite poor. Yew has thin bark and is not considered fire-resistant. Intense heat would kill the cambium and dormant buds, greatly reducing the ability of a severely burned stump to sprout. Survival of yew following fire would be dependent on the intensity of the fire and distribution of fuels in relation to the yew on the site.

Direct Effects

Moderate to High— Lack of special protection of yew would result in poor survival of yew in sale units or other areas where fire occurs.

Indirect Effects

High— Poor survival of yew stumps and sexually mature trees would reduce the amount of regeneration on the site.

Cumulative Effects

Minor to high— The cumulative effect of implementing this alternative would depend, to a large degree, on the federal timber sales in the northwest: more timber sales would result in larger cumulative effects than fewer sales. Lack of protection during and after fire could result in a decrease in the yew population and could impact the extent of its range. However, fire is being used less often as a site-preparation method due to air quality restrictions; therefore, damage to yew by fire may be decreased.

Alternative B

Protection of yew in sale units is an integral part of this alternative. A portion of the residual yew (yew stumps, trees, and seedlings remaining on the site following harvest of both yew and other tree species) would be protected from site preparation fires. However, due to lack of knowledge and experience with yew protection and survival following fire, some damage would be possible.

Direct Effects

Minor to moderate— Yew may be damaged or killed by site preparation fire due to lack of knowledge and experience in protecting yew from fire.

Indirect Effects

None to minor— There would be little or no impact on regeneration since yew must be planted where residuals survival is poor.

Cumulative Effects

None— There should be no cumulative effects.

Alternatives C through G2

The impact of these alternatives on survival of yew in sale areas would be the same as for Alternative B. The impact on survival in non-sale areas would be dependent on the level of harvest (25 percent, 50 percent, or 75 percent) as well as the amount of yew present initially. Harvest in stands that have very high densities of yew would create large amounts of yew slash. Fire-caused mortality of yew stumps and unharvested yew trees would increase as the amount of slash increased due to the proximity of fuels to stumps and trees. The amount of mortality, of course, would vary with the intensity of the fire: light burns may kill only a portion of the stumps and none of the standing trees; very hot burns may kill all stumps as well as all standing trees. For the purposes of this analysis, we have assumed that stumps are less likely to survive fire than standing green trees.

An indirect effect on survival is the ability to regenerate. Regeneration following fire can occur from the sprouting of surviving stumps, or seed production from surviving standing yew trees. Alternatives that leave a higher proportion of standing trees versus stumps would probably have more regeneration following fire.

Direct Effects

Minor to moderate— The effects of Alternatives C and D on the survival of yew following fire in non-sale areas would vary depending on the amount of yew present initially in the stand, but would generally be small. For Alternatives F, G1, and G2, the effect in non-sale areas would also vary depending on the amount of yew present initially. Overall, however, less yew would survive with Alternatives F, G1 and G2 than with Alternatives C and D, due to greater harvest intensities and the potential for large quantities of slash in close proximity to yew stumps and trees.

Survival in owl conservation areas under Alternative G2 would be similar to survival in Alternative D (because harvest levels are identical in Alternative D and owl areas).

A = No Action
B = Timber Sales Only
C = 25%, 5 TPA
D = 50%, 5 TPA
F = 75%, 2 TPA
G1 = 50%, 1 TPA
G2 = 50%, 1 TPA, OCAs
TPA is the minimum number of trees left standing per acre

Indirect Effects

Minor to moderate— Regeneration following a moderately severe fire would depend primarily on standing trees and the seed that they provide rather than stump sprouting. Alternatives C and D would have very small impacts on regeneration, since Alternative C would retain at least 75 percent of the yew as standing trees and Alternative D would retain at least 50 percent. The impacts on regeneration would be somewhat higher for Alternatives F, G1, and G2, since less yew is retained as standing trees — at least 25 percent for Alternative F and at least 50 percent with Alternatives G1 and G2 — resulting in less seed and possibly fewer seedlings. See also effects on Alternatives C through G2 in the Biology section.

Cumulative Effects

Minor to moderate— In individual stands, many stumps and some trees could be destroyed by fire, reducing both the vegetative and sexual reproductive capability of the yew in that stand. Collectively, diminished yew reproduction in adjacent stands could result in reduced size of certain yew populations. The potential for cumulative effects would increase from Alternative C to Alternative G2.

Insect and Disease Pests of Pacific Yew

This section relates to the issue of protecting the Pacific yew.

This section deals with the potential impacts of a special group of organisms called forest pests. This group is composed of arthropods, fungi, bacteria, viruses, and higher plants. Forest pests are singled out as a special group because the effects of their natural activities, such as growth loss and mortality in trees, often result in impacts that conflict with human goals and objectives for a particular area. This analysis evaluates the effects of various harvest levels on populations of potential yew pests. Because specific pest population levels do not always translate directly into equal levels of damage, estimates of pest impact on yew populations are described in general terms. The impacts of various alternatives on populations of insects, plants, and microorganisms are discussed in the Ecology section of Chapter IV.

Two types of yew harvest were evaluated for this analysis; needle harvest and whole tree or bark harvest. Whole tree harvest has the greater potential for increasing forest pest activities because stumps created during the harvest may provide root disease and decay fungi with means of entry into yew stems, trees, and stands. Needle harvest may reduce the vigor of individual trees and make them more susceptible to attacks by pests. The only disease of Pacific yew we know that might be increased by harvest activities is a root disease caused by the fungus *Phytophthora lateralis*. As described in Chapter III, this fungus has been found infecting yew only within the range of infected Port-Orford-cedar in southern Oregon and northern California. Yew outside the natural range of Port-Orford-cedar is not considered at risk to this disease.

This section is arranged according to alternatives, beginning with Alternative A. Each of the alternatives is followed by a discussion of the direct, indirect, and cumulative effects. Because Port-Orford-cedar root disease is an effect common to all of the alternatives, an in-depth discussion of the disease is included at the end of the section.

The Alternatives

Alternative A

Direct Effects

Minor— There would be no change in what are considered insignificant levels of impact by insects and diseases. Since yew would not be harvested for taxol production under this alternative, no yew stumps would be created and tree vigor would not be decreased by needle harvest.

Indirect Effects

Minor— No change would be expected. Past harvest activities within the range of Pacific yew have not altered the ecological balance between pests and the tree. An increase in pest populations and activity would be due to changes in stand conditions caused by harvest of other species. Because most pests are host specific and the potential crossover to yew is small, there would be no significant impacts.

Cumulative Effects

Minor— The major impact to yew under this alternative would depend on the number, size, and location of harvest units for other tree species. The planned reduction in timber harvests on yew-bearing lands, as well as the move away from clearcutting as the most common harvest method, should mitigate any potential impacts by insects and/or disease.

Alternatives B through G2

All alternatives proposing harvest of yew would have an unknown, but probably minor impact on insect and disease populations. Insects and diseases reported on yew are not host specific; that is, they attack a wide range of conifers found in Pacific northwest forests. The interactions between various kinds and levels of tree harvest on populations of these pests, and the subsequent risk to trees, has been studied for years. We are quite knowledgeable about these effects on other species. The most significant potential impact is that of changing the structure of existing vegetation in such a way as to make the trees more susceptible to attack and damage by pests.

Direct Effects

Minor— By creating stumps and sprouts as potential areas of infection by diseases, yew harvest could increase the amount of root disease and stem decay in stands. This increased risk of disease infection would be restricted to stumps of harvested trees and sprouts from those stumps. Seedlings would not be affected. Harvest of needles could reduce the vigor of trees and, especially under adverse environmental conditions, make them more susceptible to attack by pests.

Indirect Effects

Minor— The removal of yew as a component, however small, from forested stands may result in the species becoming more susceptible to pest activity. None of the alternatives, however, propose to completely eliminate yew from the ecosystem. All of the alternatives include provisions for protecting and regenerating yew.

Cumulative Effects

Minor— There could be potential for an increase in root disease, stem decay, bark beetle, and defoliator activity in harvested areas. Alternatives having the highest levels of harvest would have the highest risk of increased activity.

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G1 = 50%, 1 TPA
G2 = 50%, 1 TPA, OCAs

TPA is the minimum number of trees left standing per acre

Port-Orford-Cedar Root Disease

The effects to yew and Port-Orford-cedar caused by Port-Orford-cedar root disease, *Phytophthora lateralis,* would be minor for all alternatives.

Our ability to analyze the risk posed by this disease depends on how accurately we can predict two unknowns: How susceptible yew is to this disease; and how much harvest would take place in the forests where the natural range of the two species overlap. The results of inoculation tests and field observations support the conclusion that Pacific yew is much less susceptible to infection by *P. lateralis* than is Port-Orford-cedar. Only seventeen Pacific yew trees have tested positive for infection. All were located in areas where the fungus has been established on Port-Orford-cedar for many years and where the inoculum load (number of spores responsible for infection) is considered to be very high. At this time, Pacific yew is considered to be "at risk" to this disease only in areas where Port-Orford-cedar has been infected for many years. Yew outside these areas, including all yew outside the natural range of Port-Orford-cedar, is considered to be safe from infection.

At present, all activities in areas that include Port-Orford-cedar must follow the standards and guidelines specified under the Port-Orford-cedar action plan (Appendix C). The purpose of these standards and guidelines is to reduce or prevent the spread of the disease into uninfected areas, and to prevent disease intensification in areas already infected. Future harvest activities, including harvest of yew bark and/or yew needles, would also follow these same procedures. Because of the mitigating measures already in place, the low level of disease susceptibility of yew, and the relatively small number of yew at risk, we conclude that the impacts of this disease under all of the proposed alternatives would be minor.

Chapter IV

Environmental Consequences

Part Two: The Forest

Contents

Part Two: The Forest

This part of Chapter IV describes the effects that Pacific yew harvest may have on the big picture in terms of landscape, biodiversity, and forest health. It also addresses soils, water resources, wildlife, and access for harvest.

Landscape Patterns

In this section we analyze the effects of the alternatives on landscape connectivity and distribution of Pacific yew. As we discussed in Chapter III, yew does not exist within a uniform landscape, and is not distributed evenly across it. While the species has an unusually broad habitat occurrence and distribution, it is generally found in small, localized populations.

The two primary issues concerning the landscape pattern of Pacific yew are the effect of the alternatives on the geographic range of the species and on population connectivity. Connectivity is important in facilitating gene flow and maintaining the genetic variability of the species. Connections between yew populations also allow for the movement of any organisms that may depend on Pacific yew, or on the kind of habitat it creates. For the purposes of this analysis, we assumed that the continued presence of Pacific yew throughout its range is essential to maintaining the viability of the species and its ability to adapt and survive in changing environments.

The Alternatives

Alternative A

Direct Effects

Low-risk— There would be no harvest of yew bark or needles under this alternative. Some Pacific yew trees and shrubs could potentially be destroyed on 0.157 million acres over the next five years in timber sale units that contain Pacific yew. Under this alternative, yew would not be protected from site preparation activities or from damage during logging.

The effects of this alternative depend on three major factors:

How many of the timber sale areas over the next five years contain Pacific yew?

How much of the yew survives and regenerates after timber harvest and site preparation activities?

How many of the timber sales occur in areas with sparse yew distribution or in unique habitats?

There would be a low risk of impact on landscape connectivity and the geographic range of Pacific yew. Undisturbed yew populations would be distributed throughout the landscape in management areas set-aside from timber harvest. Riparian areas are largely removed from regeneration harvest methods leaving a network of connecting corridors for Pacific yew gene flow and possible movement of some yew-dependent species.

Due to the small size of the harvested areas, some loss of yew in timber sale areas over the next five years should have a low risk of impact on the overall landscape connectivity within areas of relatively abundant yew distribution. Some yew would remain following harvest activities and yew would be retained in sale units that contain green tree reserves. There is more potential risk to the landscape distribution of yew when timber sales occur in areas of sparse yew distribution, especially at the peripheries of the species range. The risk of impact should still be relatively low due to the fact that some yew will remain following timber harvest.

Indirect Effects

Low-risk— Although not specifically required by this alternative, Pacific yew would be planted in most sale units as part of the natural species mix. The long-term landscape distribution of yew would be maintained. Artificial regeneration would be especially important in areas of sparse yew distribution where natural regeneration may be impacted by a reduction in the population following timber harvest activities. There is a risk that loss of some of the yew population at the peripheries of the species' range or in areas with unusual ecosystems could reduce yew's genetic variability (see Genetics section in this chapter). This could reduce the ability of Pacific yew to adapt to changing environments, and could impact future yew distribution across the landscape.

A = No Action
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F = 75%, 2 TPA
G1 = 50%, 1 TPA
G2 = 50%, 1 TPA, OCAs
TPA is the minimum number of trees left standing per acre

Cumulative Effects

Low-risk— The effects of this alternative over the five-year planning period must be considered together with the effects of past

and future management of the yew resource. Past timber harvest activities have undoubtedly reduced the distribution of Pacific yew, and have had the greatest impact in areas of already sparse yew distribution. These effects may be offset, however, by decades of fire suppression (see Role of Fire section in Chapter III). Fire suppression has probably allowed yew to maintain itself on sites where it may not have survived under the natural fire regime. Under ecosystem management practices yew will be retained throughout its range. Harvest practices which retain green trees in sale units, cooler and spatially modified prescribed burns, and regeneration of the natural mix of species would retain yew in present and future timber sale units.

Alternative B

Direct Effects

Low-risk— Yew would be harvested from an estimated 0.157 million acres (0.078 to 0.118 million acres after reductions for potential site-specific and other restrictions) over the next five years in timber sale units that contain Pacific yew. There would be no effect on yew populations in management areas removed from regeneration timber harvest (wilderness, RNAs, most riparian areas), leaving populations and connecting networks of Pacific yew distributed throughout the landscape. Some yew would also be retained in sale areas with green tree reserves.

Yew would be planted in sale areas, and a portion of the residual trees and stumps would be protected. There would be a temporary reduction in the distribution of large, reproductively mature yew trees and shrubs scattered throughout the landscape. Due to the small size and scattered occurrence of timber sale units, there should be only a low risk of adversely affecting the landscape distribution of yew. Yew harvest in areas of sparse distribution could have impacts on landscape connectivity, gene flow, and the dispersal of yew-dependent organisms.

Indirect Effects

Low-risk— Yew would be regenerated, through both planting and encouragement of stump sprouting. There would be a low risk of impact on the long-term landscape distribution and geographic range of the species. Until regrowth of the trees occurs, movement

of any organisms dependent on large Pacific yew trees or the habitat they create may be disrupted. This would primarily impact only areas of sparse yew distribution. Yew harvest in unique ecosystems could influence the future ability of the species to adapt to changing environments.

Cumulative Effects

Low-risk— Long-term yew population connectivity should not be impacted, due to the relatively small area involved over the five-year harvest period. There could be a potential for impacts on population connectivity in extremely cut over or burned landscapes, where Pacific yew distribution may have already been greatly reduced. A continuation of past harvest practices could affect the connectivity of yew populations. After the five-year bark harvest period, however, regeneration and retention of Pacific yew in green tree reserves would continue, maintaining yew throughout the landscape. There is risk to landscape RNAs if large quantities of yew are harvested from private ownerships adjacent to federal land. This is a special concern on BLM land due to the "checkerboard" ownership pattern. There are also potential effects of other management activities, especially the reintroduction of fire into fire dependent ecosystems. Ecosystem management decisions must be made on a site-specific basis to integrate the requirements of all species. Some individual trees or shrubs may be lost but their presence in the landscape will be retained. Some yew populations on the edges of its range may have been established under more favorable climates and future environmental conditions may not be suitable for their survival. The future range of the species could possibly be reduced.

Elements Common to Alternatives C through G2

The following are major elements in the landscape distribution of Pacific yew common to Alternatives C, D, F, G1, and G2.

Set-asides

Yew would not be harvested in designated wilderness or other management areas that have been set aside from harvest for a variety of specific purposes (see Recreation section in Chapter III). These areas are spread throughout the five-state area covered by this EIS, and ensure protection of a significant portion of the yew resource throughout the landscape.

Riparian Areas

No yew harvest would be allowed within 75 to 150 feet (slope distance) of any perennial stream. This would ensure a network of mature Pacific yew populations throughout the landscape, and would facilitate gene flow and possible dispersal of yew-dependent organisms across the landscape and between the set-aside areas.

Genetic Reserves

Genetic reserves would be established throughout all areas where yew is harvested. No harvest would be allowed in these reserves, leaving additional populations of yew undisturbed throughout the range of the species. These reserves, coupled with areas already removed from harvest and riparian corridors, would maintain connectivity between yew populations throughout the landscape.

Areas of Sparse Distribution

No yew harvest would be allowed within local management areas where yew genetic reserves could not be established either within or outside of timber sale units (see exceptions in Chapter II Mitigation Measures section). This would retain yew population structure and distribution in areas with very sparse yew populations. Harvest in these areas would have the highest likelihood of severing connections for gene flow and species dispersal.

Unique Ecosystems

No yew would be harvested from areas with unique ecosystems.

Physiographic Provinces

Restricting harvest from riparian areas and areas of sparse yew distribution (where genetic reserves cannot be established), would greatly limit harvest in some of the physiographic provinces described in Chapter III. The Sierra Nevadas, the southern portion of the Siskiyou region, and much of the Blue and Wallowa Mountains, would be largely reserved from harvest. Most of the yew in these areas is found in riparian areas, with a small amount sparsely distributed upslope. Areas in the coast ranges of California, Oregon, Washington, and the High Cascades would also have limited yew harvest, due to the sparse distribution of the species.

Harvest Pattern

Yew harvest would be evenly distributed throughout each harvest area, as much as is possible with a species such as yew, which tends to grow in clumps.

Sale Areas

There would be small, temporary breaks in the continuity of yew distribution due to 100 percent harvest in sale areas. Some yew would be retained, however, in sale areas with green tree reserves. Yew would not be harvested in timber sale units in areas where genetic reserves could not be established unless they are in danger of being destroyed. Yew would only be harvested in areas where it is relatively abundant and connections across the landscape would be maintained after harvest in sale areas. Because yew tends to grow in clumps, it is unlikely that small breaks in population continuity would greatly affect any yew-dependent organisms. The following discussion, therefore, focuses on the impacts of yew harvest outside of timber sale units.

Direct Effects

Alternative C

Low risk— There are an estimated 2.93 million acres on which yew occurs in harvestable management allocations (1.47 to 2.20 million acres after reductions for potential site-specific and other restrictions). No yew harvest would be allowed in areas where genetic reserves could not be established, either within or outside of timber sale units (unless in danger of being destroyed). There would be no yew harvest in riparian areas, in the set-aside areas described below, or in the genetic reserves. Yew could be harvested from all other areas where there are more than five yew trees or shrubs per acre in each harvested diameter class (<11, 11-20, >20 inches stump diameter).

Under this alternative, 75 percent of the yew trees (or shrubs) or five trees per acre (whichever is greater) in each of the diameter classes would be retained. This alternative allows harvest only in areas where yew is abundant, and leaves a significant portion of the trees. Yew population connectivity would be maintained.

A = No Action
B = Timber Sales Only
C = 25%, 5 TPA
D = 50%, 5 TPA
F = 75%, 2 TPA
G1 = 50%, 1 TPA
G2 = 50%, 1 TPA, OCAs

TPA is the minimum number of trees left standing per acre

Needle harvest would have no direct effects on the landscape distribution of Pacific yew. No more than half of the foliage would be removed from 25 percent of the trees. No trees would be killed, and reproduction would not be affected (see Biology section in Chapter III).

Indirect Effects

Low risk— An estimated 70 percent of the stumps left after harvest should resprout (Minore, 1992). Sprouting success will vary and it is unknown how many sprouts will survive to maturity. There would be a slight reduction in the yew population, but long-term connectivity across the landscape should be maintained.

Cumulative Effects

Low risk— There is a low risk of negative impact on landscape connectivity and the geographic range of yew under this alternative. There would be potential impacts on population connectivity in extremely cut-over or burned landscapes, where the distribution of Pacific yew may already have been significantly reduced. This impact would primarily be associated with yew harvest in timber sale units. Connectivity outside of timber sale units would be maintained. There are potential risks of further population reductions in areas where past yew harvest has occurred for fenceposts. Cumulative impacts could also occur if adjacent private ownerships are harvested extensively. Reintroduction of fire into the ecosystem could impact some yew populations, but its presence in the landscape will be retained.

Alternative D

Direct Effects

Low risk— This alternative impacts the same acreage as Alternative C. The only difference between this alternative and Alternative C is that only 50 percent of the trees (or five trees per acre, whichever is greater) instead of 75 percent, would be left after harvest. This alternative retains a significant portion of the yew population throughout the forest matrix. Distribution across the landscape would be maintained. There is a very low risk of impacting the species range. No harvest will occur in areas of sparse distribution at the species periphery.

Needle harvest would have no direct effects on the landscape distribution of Pacific yew. No more than half of the foliage would be removed from 50 percent of the trees. No trees would be killed, and reproduction would not be affected (see Biology section in Chapter III).

Indirect Effects

Low risk— An estimated 70 percent of the stumps left after harvest should resprout. Sprouting success will vary, and it is unknown how many sprouts will survive to maturity. There would be a reduction in the yew population (more than under Alternative C), but long-term connectivity across the landscape would still be maintained.

Cumulative Effects

Low risk— There is a low risk of negative impacts on landscape connectivity and the geographic range of yew. As with previous alternatives, there would be some potential cumulative effects on population connectivity in extremely cut-over or burned landscapes, and where there is extensive yew harvest on adjacent ownerships.

Alternative F

Direct Effects

Moderate risk— This alternative has the same numbers of acres available for harvest as Alternative C. This alternative would retain 25 percent of the yew trees or two trees (or shrubs) per acre (whichever is greater). The two trees per acre minimum allows harvest in areas of more sparse yew distribution, and would impact more acreage than the previous alternatives. A larger portion of the yew trees and shrubs would be harvested under this alternative, leaving more sparse populations of Pacific yew throughout the landscape. There would also be more harvest in the larger diameter classes, which inventory results indicate rarely exceed five trees per acre.

Under this alternative, landscape connectivity should be maintained because some yew trees and shrubs would be retained throughout the entire landscape. This alternative allows no har-

vest in areas with the most sparsely distributed yew populations (where genetic reserves cannot be established), which would protect the peripheries of the species range.

Until regrowth of reproductive buds occurs, needle harvest from 75 percent of the yew trees and shrubs could affect short-term natural regeneration of the species. However, overall landscape distribution of Pacific yew should not be affected.

Indirect Effects

Moderate risk—A proportion of these trees should eventually sprout and regrow, but the future population throughout the landscape would be reduced. Harvesting in areas of sparse yew distribution would leave these areas vulnerable to breaks in yew population connectivity.

Cumulative Effects

Moderate risk— Harvesting 75 percent of the yew population could lead to a slight reduction in the genetic variation of the species (see Genetics section in Chapter III), which may impact the future distribution by reducing its ability to adapt to changing environments. As with the previous alternatives, there may be some potential cumulative effects on population connectivity in extremely cut-over or burned landscapes, and where there is extensive yew harvest on adjacent ownerships.

Alternative G1

Direct Effects

Moderate risk— This alternative allows harvest on the same numbers of acres as Alternatives C, D, and F. The 50 percent harvest should not impact the overall connectivity between yew populations in areas of abundant yew distribution. There would be a reduction in large Pacific yew trees and shrubs throughout the landscape. There would be a moderate risk to landscape connectivity in areas of sparse yew distribution. Harvest would still not be allowed, however, in areas where genetic reserves could not be established. This would protect the peripheries of the species range.

Needle harvest would have no direct effects on the landscape distribution of Pacific yew. No more than half of the foliage would be removed from 50 percent of the trees, no trees would be killed, and reproduction would not be affected (see Biology section in Chapter III).

Indirect Effects

Moderate risk— A proportion of yew trees and shrubs should eventually sprout and regrow. There would be a reduction in the population, but connectivity should not be threatened in areas of abundant yew populations. Harvesting in areas of sparse yew distribution, however, would leave these areas vulnerable to breaks in yew population connectivity.

Cumulative Effects

Moderate risk— Overall landscape connectivity would be maintained, except for possible breaks in areas of sparse yew distribution. As with the previous alternatives, there may be some potential cumulative effects on population connectivity in extremely cut-over or burned landscapes, and where there is extensive yew harvest on adjacent ownerships.

Alternative G2

Direct Effects

Moderate risk— This alternative would impact the largest area. Yew could potentially be harvested from an estimated 4.62 million acres over the next five years (2.31 to 3.47 million acres after reductions for potential site-specific and other restrictions). The 50 percent harvest under this alternative, while occurring over the largest acreage of all the alternatives, should not impact the overall connectivity between yew populations. There would be a reduction in larger yew trees throughout the landscape.

There would be a moderate risk to landscape connectivity in areas of sparse yew distribution. Harvest would still not be allowed, however, in areas where genetic reserves could not be established. This would protect the peripheries of the species range.

A = No Action
B = Timber Sales Only
C = 25%, 5 TPA
D = 50%, 5 TPA
F = 75%, 2 TPA
G1 = 50%, 1 TPA
G2 = 50%, 1 TPA, OCAs

TPA is the minimum number of trees left standing per acre

Harvest in owl conservation areas would mean that more of the landscape would be impacted in Oregon, Washington, and northern California. There would not be as many large blocks of undisturbed yew populations for gene flow or species dispersal. Fifty percent harvest in OCAs (retaining a minimum of five trees per acre) should not adversely affect landscape connectivity between yew populations.

Needle harvest would have no direct effects on the landscape distribution of Pacific yew. No more than half of the foliage would be removed from 50 percent of the trees, no trees would be killed, and reproduction would not be affected (see Biology section in Chapter III).

Indirect Effects

Moderate risk— A proportion of yew trees and shrubs should eventually sprout and regrow. There would be a reduction in the population, but connectivity should not be threatened in areas of abundant yew populations. Harvesting in areas of sparse yew distribution, however, would leave these areas vulnerable to breaks in yew population connectivity.

Cumulative Effects

Moderate risk— Overall landscape connectivity would be maintained, except for possible breaks in areas of sparse yew distribution. As with the previous alternatives, there may be some potential cumulative effects on population connectivity in extremely cut-over or burned landscapes, and where there is extensive yew harvest on adjacent ownerships.

Ecosystem

In this section we analyze the effects of the proposed alternatives on the ecological relationships between Pacific yew and other ecosystem components. We assess the effects of the different harvest levels on ecosystem structure and function. For the purpose of this analysis, we assumed the continued presence of Pacific yew as a stand component is essential for maintaining healthy, resilient ecosystems.

Terms to Know

Epiphytic— *Living on the surface of plants.*

Microclimate— *The local climate of a small site or habitat.*

Light Regime— *The amount of sunlight reaching various levels of the forest canopy.*

Nutrient Cycling— *A continuous series of natural processes by which nutrients pass through successive stations in water, soil, and organisms.*

This analysis focuses on the effects of the alternatives on six primary areas of ecological concern:

- the amount of old growth forest that is impacted;
- stand structure;
- light regime and microclimate;
- snags and woody debris;
- nutrient cycling; and
- invertebrates, fungi, epiphytic plants, microorganisms, and other "less understood" components of the ecosystem.

Old Growth

The amount of old growth that could be impacted under each of the alternatives is difficult to assess. While yew does occur in young stands, it is more abundant in old growth (See Ecology section in Chapter III). Certainly, old growth stands contain more of the

larger diameter yew trees. Yew harvest is already restricted in many old growth set-aside areas. Outside of these areas, individual management units will prioritize stands for yew harvest, excluding areas from harvest after site-specific analysis. Areas valued for extraordinary characteristics such as unique old growth stands (unique due to either their structural characteristics or their position in the landscape) will be avoided. The potential effect on old growth will therefore depend on how much other mature forest (present and future old growth) will be impacted under each of the alternatives.

Ecosystem Structure and Function

The effect of yew harvest on ecosystem structure and function will vary from site to site. The more yew there is in an area, the greater is the species role in the existing ecosystem. The magnitude of impact in each area would vary depending on whether there are substitute species or structures in the stand that could fulfill yew's role in the ecosystem. Other tolerant midstory species (chinkapin, madrone, dogwood, and vine maple are a few examples) may be able to substitute for yew structurally.

Whether there are substitute species that may be able to fulfill yew's functional role in the ecosystem is unknown. Pacific yew has a unique biochemistry and we know very little about its role in ecosystem processes. It is assumed that removal of increasing amounts of yew will have increasing negative impacts on ecosystem function.

Further discussion concerning ecosystem protection may be found in the Wildlife, Soils, Water and Fish Habitat, Recreation, Biology, and Role of Fire sections of Chapters III and IV.

The Alternatives

Direct Effects

Alternatives A and B

Low Risk— Alternatives A and B only affect Pacific yew within timber sale units. One-hundred percent of the yew will be harvested in sale areas under Alternative B. There will be no yew harvest under Alternative A, but some yew will be lost due to timber harvest and site preparation activities. The direct effects of yew harvest or loss on ecosystem structure would be minimal compared to the effects of the timber harvest itself.

A timber harvest unit located in an old growth area would directly impact the amount and distribution of old growth. Whether or not yew is retained within the area would not affect the amount of old growth that would be impacted.

There may be some impacts on ecosystem function. Soil chemistry, nutrient cycling and other ecosystem processes may be affected.

Impacts of the 100 percent yew harvest under Alternative B would be reduced by leaving yew trees and shrubs as part of green tree reserves in the sale units. Any organisms (invertebrates, fungi, epiphytic plants, etc.) dependent on Pacific yew or the habitat that it creates could be impacted by these alternatives. Effects would vary by the amount of yew retained on the site (either in green tree reserves or left after timber harvest in Alternative A).

The risk of impact to dependent species and ecosystem processes under these alternatives should be low due to both the relatively small size of the areas impacted and the presence of Pacific yew in stands adjacent to the sale units. The impacts should also be temporary until Pacific yew regrows in the sale areas.

Note: The above described effects of yew harvest in timber sale units are common to the remaining alternatives.

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D = 50%, 5 TPA
F = 75%, 2 TPA
G1 = 50%, 1 TPA
G2 = 50%, 1 TPA, OCAs
TPA is the minimum number of trees left standing per acre

Indirect Effects

Low Risk— The spatial distribution and structural contribution of Pacific yew in the regenerated stand will vary by how much yew is retained in green tree reserves. If little residual yew was retained in the timber sale units then there would be more of an impact on the future stand. Yew would be regenerated, but until the regrowth of the slow-growing species, structural diversity and the presence of large yew trees for snags and woody debris would be reduced. Reduction of the midstory stand component could also increase light to the understory and impact the microclimate in the stand. Degree of impact would be affected by the amount of yew retained in green tree reserves and their spatial distribution, by the amount of yew retained after harvest in Alternative A, and by the presence of substitute species and structures.

Cumulative Effects

Low Risk— If many of the timber sale units were located in areas of very sparse yew distribution, any organism or ecosystem function dependent on larger yew trees would be more severely impacted. There could also be more impact in heavily cut-over or burned areas, where the local yew population has already been reduced. There may also be more impact in areas where the yew population has already been significantly reduced due to past harvest for fenceposts.

The reintroduction of fire into the ecosystem in many areas could impact yew in the future. These fires will be light, patchy burns and a significant portion of yew populations will be retained. Prescribed burning will reduce the risk of hotter wildfires in the future, which could potentially eliminate yew from some sites.

Note: The effects described below address yew harvest outside of timber sale units. See the previous discussion of Alternatives A and B for the impacts within sale units.

Alternative C

Direct Effects

Low Risk— A retention level of 75 percent of the yew trees (and shrubs) or five trees per acre (whichever is greater) in each designated size class, should provide for the structural and functional role of yew in the ecosystem. By harvesting a percentage of the trees (rather than leaving a specified number), more yew is retained in areas where it makes up a significant portion of the stand and therefore plays a greater role in the existing ecosystem.

Alternative C would maintain yew stand structure. It would retain a large portion of the yew population, and most of the larger trees. Inventory results indicate that there are rarely more than five trees per acre in the 11 to 20 inch diameter class, and even less frequently in the greater than 20 inch class (See Inventory section in Chapter III). Yew harvest would primarily occur in the 3 to 11 inch diameter class.

Alternative C would have the least impact on the light regime and microclimate of any of the alternatives that harvest yew outside of timber sale areas (Alternatives C, D, F, G1 and G2). A 50 percent needle harvest from 25 percent of the trees (evenly distributed throughout the crown) would have negligible effects on the amount of light reaching the understory.

Alternative C would impact less acreage than alternatives F, G1, and G2 and would, therefore, have less potential impact on old growth. Harvesting a portion of the Pacific yew would not destroy an old growth stand, but it would change the character of the stand, and could impact ecosystem function. Alternative C would have less impact than D, F, G1, and G2, although site-specific effects would vary, depending on the presence of substitute species and structures.

Indirect Effects

Low Risk— Alternative C would retain most of the larger diameter yew trees for future snags and down woody debris. It is difficult to assess the effect of the different harvest levels on nutrient cycling and other ecosystem processes or on the "less understood" components of the ecosystem. Alternative C would

most likely have less impact than D, F, G1 and G2 because it would retain a higher proportion of the yew population.

Cumulative Effects

Low Risk— There would be more of an impact in stands where the yew population has already been reduced due to past harvest for fenceposts, or where the local area has been heavily cut over and/or burned.

Alternative D

Direct Effects

Low Risk— Alternative D would have slightly greater impacts than Alternative C on stand structure and light regime. The same amount of acreage would be impacted, but only 50 percent of the trees (rather than 75 percent) would be left after harvest. The larger diameter trees, which have the largest crowns and provide the most cover, would not be harvested. Sufficient yew would remain in the ecosystem to ensure maintenance of its functional role.

Alternative D would impact the same amount of acreage as Alternative C, therefore having the same potential impact to old growth.

Indirect Effects

Low to Moderate Risk— In areas where Pacific yew is a major midstory component, removal of 50 percent of the trees may greatly alter light and temperature conditions on a site. The amount of light in a stand helps determine the understory vegetation, which, in turn, influences animal use of the stand.

A dense yew midstory buffers temperature extremes in a stand, and helps intercept snow. Harvest in the dense yew stands found in the Nez Perce National Forest, which have only a scattered conifer overstory, would have the greatest impact on light regime and microclimate. These areas may be negatively impacted by a 50 percent harvest.

Needle harvest on 50 percent of the trees could have more of an impact on light conditions than Alternative C, but harvest would

be evenly distributed throughout the crown and the effects would be very minor.

Future production of snags and coarse woody debris would be similar to Alternative C, because most of the trees in the larger diameter classes would be retained, along with a significant percentage of the smaller trees.

Alternative D would most likely have more impact on nutrient and other ecosystem processes and on "less understood" components of the ecosystem than Alternative C because it removes more yew trees and shrubs. It would have less of an impact than Alternatives F, G1 and G2.

Cumulative Effects

Moderate to High Risk— There would be more of an impact in stands where the yew population has already been reduced due to past harvest for fenceposts, or where the local area has been heavily cut over or burned. If harvest were to occur in landscapes with many dense yew stands (such as on the Nez Perce National Forest), cumulative impacts from stand structural changes could result. The large amount of acreage impacted under this alternative has more potential than the other alternatives for long-term cumulative effects.

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F = 75%, 2 TPA
G1 = 50%, 1 TPA
G2 = 50%, 1 TPA, OCAs
TPA is the minimum number of trees left standing per acre

Alternative F

Direct Effects

High Risk— Harvesting 75 percent of the yew trees (and shrubs) and leaving a minimum of two trees per acre in each size class would not maintain yew as a significant stand component in many areas. There would be more harvest in the larger diameter classes than under Alternatives C and D. Ecosystem function could be affected.

Some stumps would resprout and Pacific yew would continue to exist in harvested areas, but it is unknown how many stump sprouts will survive to maturity. Yew would be concentrated in the smaller size classes. It would take from 100 to 200 years for regenerating yew to reach the larger diameter size classes.

This alternative would have moderate to high impacts on light regime and microclimate, especially in stands dominated by yew. Temperature and decomposition rates could be impacted. Needle harvest of 75 percent of the trees could also increase the amount of light that reaches the understory.

Alternative F would impact more acreage than Alternatives C and D, because it would allow harvest in areas of sparse yew distribution (where there are only three to five trees per acre in each harvestable diameter class). This alternative could impact more old growth areas, and could have greater effects on old growth structural characteristics.

Indirect Effects

High Risk— Alternative F would have more impact on future snag and down log supply than C and D, because more of the larger diameter trees would be harvested. A 75 percent harvest in the smaller diameter classes could produce a lag period in the future when there would be a shortage of larger diameter yew trees.

Alternative F would probably have more of an impact on nutrient cycling and other ecosystem processes and on "less understood" components of the ecosystem than Alternatives C and D, because it would allow removal of more yew trees and shrubs.

Cumulative Effects

High Risk— There would be more of an impact in stands where the yew population has already been reduced due to past harvest for fenceposts, or where the local area has been heavily cut over or burned. If harvest were to occur across large land areas, and in landscapes with many dense yew stands (such as on the Nez Perce National Forest), cumulative impacts from stand structural changes could result.

Alternative G1

Direct, Indirect, and Cumulative Effects

Moderate Risk— The risk of impact on ecosystem structure and function under Alternative G1 would be similar to Alternative G2. Excluding owl conservation areas from yew harvest would mean

that less total acreage would be impacted, that there would be less impact on old growth, and the risk of cumulative impacts across the landscape would be reduced.

Alternative G2

Direct Effects

Moderate Risk— This alternative would allow the harvest of more yew in the larger size classes than Alternatives C and D. Like Alternative D, it allows harvest of 50 percent of the trees. Unlike Alternative D, harvest would be allowed where there are less than five trees per acre. Harvesting the larger trees would decrease structural diversity, and would increase light to the understory. There would be a moderate risk to ecosystem structure and function.

Fifty percent of the yew would still be retained. In areas where there are at least ten trees per acre this alternative is no different than Alternative D. Areas of sparse yew distribution, however, could be impacted under this alternative. Again, degree of impact would depend on the presence of substitute species or structures.

This alternative would have the most effect on old growth. It would impact the largest area, allowing harvest in areas of sparse yew distribution and in owl conservation areas, which contain a large proportion of the total old growth area in Oregon, Washington, and northern California.

Indirect Effects

Moderate Risk— Alternative G2 would have more impact on future snag and down wood supply. It would also leave more down woody debris on-site after harvest than the alternatives with a minimum retention level of five trees per acre.

In areas of sparse yew distribution there would be more of an impact on ecosystem processes and "less understood" components of the ecosystem than under Alternatives C and D. There would be less of an impact than Alternative F which allows 75 percent harvest.

Cumulative Effects

Moderate to High Risk— There would be more of an impact in stands where the yew population has already been reduced due to past harvest for fenceposts, or where the local area has been heavily cut over or burned. If harvest were to occur in landscapes with many dense yew stands (such as on the Nez Perce National Forest), cumulative impacts from stand structural changes could result. The large amount of acreage impacted under this alternative has more potential than the other alternatives for long-term cumulative effects.

Biodiversity

In this section we analyze the effects of the various alternatives on biodiversity. In Chapter III, biodiversity is defined as the variety of life and its processes, in all forms, and at all levels of organization. Biological diversity is critical for maintaining the natural resiliency of ecosystems, and serves as a source for previously undiscovered foods and raw materials for creating new medicines (see Biodiversity section in Chapter III).

There is a concern that harvest of yew in areas where yew is already sparse could threaten genetic and species diversity, due to the potential loss of unique populations. Direct effects on biodiversity are changes that would occur to its components in the immediate or near future (less than five years). Indirect effects are changes that would occur further in the future (greater than five years). Cumulative effects are gradual changes to the components of biodiversity which result from many management activities over a long time period.

The Alternatives

Direct Effects

Alternative A

Moderate— Under this alternative no actual bark or foliage harvest would take place. However, yew trees and shrubs would continue to be damaged and/or killed by timber harvest activities. No efforts would be made to replace the individual trees lost. This type of management could reduce the genetic and species diversity of areas where yew is relatively rare, such as at the peripheries of the species range (see Genetics and Ecology sections in Chapter III). Where yew is not a major component of biologic communities, the functions and structures it provides could possibly be shifted to other species. However, Pacific yew may provide some unique functions and structures because of its extremely decay resistant wood and unusual array of biologically active chemicals. It is not known if losing yew in areas where it is rare would have significant effects on biodiversity at the landscape level.

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D = 50%, 5 TPA
F = 75%, 2 TPA
G1 = 50%, 1 TPA
G2 = 50%, 1 TPA, OCAs
TPA is the minimum number of trees left standing per acre

Indirect Effects

Moderate— The equilibrium of systems where Pacific yew is harvested could be altered. Ecological equilibrium refers to the

balance that exists between living organisms and their environment. After disturbance, these systems would reach a different equilibrium. If the same functions, habitats, and structures provided by yew could be provided by a well-adapted alternate species, the equilibrium may become more stable.

Cumulative Effects

Minor— Cumulative effects from this alternative would be to continue current trends in biodiversity due to present forest management activities.

Alternative B

Direct Effects

Minor— The effects of removing bark from sale areas would be to locally reduce those species (fungi and/or small insects) which depend on the bark as a food source and habitat. If these species were able to utilize other food sources or habitat structures, competition for these alternate sources would increase. By ensuring that Pacific yew census numbers remain at preharvest or prescribed levels (through protection and planting), this alternative would protect and enhance species and genetic diversity at the edges of the yew species range (see Genetics and Landscape sections in Chapter III).

Indirect Effects

Minor— The equilibrium of systems where Pacific yew is harvested could be altered. These systems would reach a different equilibrium after disturbance. As the planted yew trees and shrubs become large enough to provide food and habitat for other species, populations of those species would increase in the local area.

Cumulative Effects

Minor— Cumulative effects of this alternative on biodiversity would be slight when considered in light of the effects from timber harvesting.

Direct Effects

Minor to moderate— The effects of harvesting bark from sale and non-sale areas would be similar to those in Alternative B. The effect of cutting whole trees would be to remove some individuals from the population completely and remove the habitat and structure provided by the cut trees to other species (see Genetics and other sections in this chapter). Competition for remaining habitat would increase, and if species or individuals depending on Pacific yew were not able to find alternate sources, their numbers would decline. Because yew is not being completely removed from the ecosystem in these alternatives, the presence or absence of yew-dependent species probably would not change. If yew does have an allelopathic* effect on some species, however, local abundance of these species could increase. Ecosystem processes which depend on long-term woody debris could be enhanced due to an increase in Pacific yew wood on the ground.

* A plant that produces chemical compounds that are released into the soil environment and are harmful to other nearby plants or germination of seeds is allelopathic.

Indirect Effects

Minor to moderate— The equilibrium of systems where Pacific yew is harvested could be altered. The more yew removed, the more the equilibrium would be changed. These systems would reach a different equilibrium after disturbance. As surviving stump sprouts begin to grow, and abundance of yew increases, the contributions of Pacific yew to genetic, species, and community diversity would increase.

Cumulative Effects

Minor to moderate— The cumulative effect of these alternatives in timber sale areas would be the same as for Alternative B. This may be the first management activity in non-sale areas, and in these areas the cumulative effects would be the same as the direct and indirect effects.

Forest Health

This section deals with the effects of the various alternatives on forest health. In Chapter III, forest health was defined as the forest's ability to return to a desired equilibrium after experiencing "events of change," both natural and human-caused. For the purposes of this analysis, that desired equilibrium is described as a diversity of existing species of trees, including yew, on an ecosystem scale with the harvest of yew as the change event. The underlying assumption is that the presence of yew, at or near existing levels in northwest ecosystems, provides the diversity needed for resilient, healthy forests. Reductions in the number and distribution of yew populations below some threshold level would seriously impair its ability to continue as a species. It is also assumed that the diversity analyzed in this section is at the ecosystem scale, not the landscape or species level (see discussion on ecosystem management below). More specific analyses of effects of the alternatives on diversity at other spatial scales are discussed in the Biodiversity and Genetics sections in this chapter.

Ecosystem Management

While the Forest Service is committed to managing both ecosystems and individual species, management strategies designed to improve or maintain forest health and diversity may sometimes conflict with the forest and resource management plans standards and guidelines recommended for the management of a single species. In these cases, the overall ecosystem strategy may take precedence over the more species-specific strategy. For example, specific standards and guidelines for the protection of Pacific yew populations on national forest lands in eastern Oregon may conflict with plans to reintroduce fire as an ecosystem component. In this example, individual yew trees and shrubs may be killed or damaged by an activity that favors the health of the ecosystem as a whole, as well as the survival of the larger yew population in the northwest. Such conflicts cannot be addressed in this EIS and must be resolved during site-specific analyses.

The issue of protecting the ecosystem relates directly to forest health, because individual stands of trees and their respective ecosystems are related in ways such that the health of one depends on the health of the other.

The Alternatives

Direct Effects and Indirect Effects

Alternative A

Minor— While no bark or foliage harvesting would take place, yew trees and shrubs would continue to be damaged or killed by harvest activities, site preparation, and burning. It is possible, but unlikely, that specific populations of yew would lose enough individuals to lose viability as breeding populations. We expect that the numbers of yew trees and shrubs in timber sale harvest areas would decline, but distinct populations of yew would not disappear.

Cumulative Effects

Minor— The long-term effects of the loss of individual yew in stands is unknown. If all stands in the natural range of yew were harvested, the resulting reduction in ecosystem diversity could have a detrimental effect on the health of the forest at the stand and area level. However, existing harvest levels and patterns, as well as the amount needed to meet projected demand, would eliminate the need to enter all stands. This alternative would not threaten ecosystem health.

Direct and Indirect Effects

Alternatives B through G2

Minor— The harvest levels proposed in all of the alternatives would have no direct impact on forest health. Each of the alternatives that proposes harvest of yew includes mitigation measures requiring some combination of genetic reserves, protection of residual trees, and regeneration of yew. Each of the alternatives would ensure a diverse and well-distributed yew population.

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D	=	**50%, 5 TPA**
F	=	**75%, 2 TPA**
G1	=	**50%, 1 TPA**
G2	=	**50%, 1 TPA, OCAs**

TPA is the minimum number of trees left standing per acre

Cumulative Effects

Minor— The risk of reducing ecosystem diversity to levels below some acceptable threshold would increase with the amount of yew harvested and the acres entered. This threshold would depend on the amount of yew harvested, and the amount of yew originally present. The risk to forest health would increase if yew harvest were to continue beyond the five-year planning period.

Soils

Forest soils are protected by management direction in the regional guides and more specifically by management under the standards and guidelines of the forest plans (Forest Service) or resource management plans (BLM). These standards and guidelines, their effectiveness, and the environmental consequences of management under them, are disclosed in the environmental impact statements accompanying the forest plans and other direction.

The major differences, within the alternatives discussed, will be impacts associated with increased harvest levels due to potential harvest in non-sale areas and owl conservation areas. The degree of impact will depend largely on the resiliency of the soil and the vegetative recovery rate of the site. This is largely a function of the past and present erosional factors as well as the climate and inherent capacity of the soils. Each physiographic province is a reflection of the major erosional processes, parent materials, and climate.

Terms to Know

Increased Soil Temperature— *Soil is exposed to the sun's radiant energy when plants no longer shade or insulate it. Steep slopes, facing southward, receive the greatest amount of radiant energy. They can be temporarily heated to temperatures lethal to plant growth. Vegetative recovery rates are strongly affected by this action.*

Increased Susceptibility to Erosion— *Two types of erosion are considered in this impact:*

1. *water erosion (sheet, rill, and gully); and*
2. *wind erosion.*

A site becomes vulnerable to one or both of these erosional forces when vegetation and plant litter are removed.

Induced Soil Compaction— *Soil is compacted, that is, made denser, when weight is exerted against it by foot or other traffic. Compaction reduces pore space and, therefore, restricts air and water movement through soil to the plant root system. The site then becomes less productive. Compaction also changes soil hydrologic characteristics and, in severe cases, may induce overland flow. Typically, compaction from foot pressure is about five pounds per square inch, while the pressure exerted by a skidder with rubber tires is usually more than 13 pounds per square inch (static weight).*

Induced Soil Displacement— *Soil displacement is the removal or rearrangement of surface soil and plant litter. Coarse-textured soils are the most susceptible to displacement since they are loosely aggregated and lack sufficient organic matter as a binder. When soil is disturbed, the most nutrient-rich portion of the soil is often involved. As a result, the site would be less productive or vegetation would recover at a slower rate.*

Physiographic Province— *A region where all parts are similar in geologic structure and climate, and where the geomorphic history, consequently, has been unified. Provinces differ significantly in the pattern of relief features or landforms.*

Water Quality Degradation— *This is the alteration of chemical, physical, and biological properties of water. Sediment production is the most frequently mentioned indicator of water quality degradation.*

The Alternatives

Alternative A

Direct, Indirect, and Cumulative Effects

None—Alternative A ("no action") has minimal yew harvest involved (historic levels for posts, poles, carving, and bows). This harvest would usually come from areas clearcut for timber harvest. Alternative A would have no impact on soils.

Alternatives B through G2

Magnitude of Effects

The combined effects of each alternative can be ranked:

Alternative A	-	No Impact
Alternative B	-	1st (least)
Alternative C	-	2nd
Alternative D	-	3rd
Alternative F	-	4th
Alternative G1	-	5th
Alternative G2	-	6th (Most)

Please note that these effects will vary by province, vegetation zones, land slope and amount of activity.

With the exception of Alternative A ("no action") protection of the perennial stream systems is afforded since yew harvest is restricted within 75 feet on either side of the high-water level. In addition, there will be no harvest of yew in areas with unusual or uncommon parent rock, geology, or vegetation (e.g., ultramafic rock, sand dunes, or pygmy forests). Harvesting of yew will be considered on clearcuts, shelterwood cuts and seed tree cuts within harvest unit boundaries. Yew harvest in these areas would follow the mitigation measures for timber sale units (Chapter II).

Table IV-15 (next page) provides an indication of the types of impacts that could occur within the physiographic provinces, vegetation zones, and land slope categories. Definitions of these types of impacts are discussed below the Table:

Physiographic Province	Vegetation Zones	Slope Groups		
		0-30%	30-60%	60%+
Olympic	Sitka Spruce	A	A	A,D,E
	Hemlock	A	A	A,C,D,E
	Subalpine	A,B,E	A,B,E	A,B,E
Coast Range	Sitka Spruce	A	A	A,D,G
	Hemlock	A	A	A,D,E
Siskiyou	Mixed Conifer	A	A,C,D,E	A,C,D,E
	Mixed Evergreen	A	A,C,D,E	A,C,D,E
Puget Sound	Hemlock	A	A	A,C,D,E
Western Cascades	Mixed Conifer	A	A	A,C,D,E
	Subalpine	A,B,C	A,B,C	A,B,E
Northwestern Cascades	Hemlock	A	A	A,C,D,E
	Subalpine	A,B,E	A,B,C,E	A,B,E
	Hemlock	B	B	B,C,D,E
	Mixed Conifer	B	B,C,D,E	B,C,D,E
	Subalpine	B,C,E	B,C,E	B,E
Recent (High) Cascades	*Douglas Fir/Grand Fir	A,C	A,C	A,D,E
	**Douglas Fir/Grand Fir	B,C,E	B,C,E	B,C,E
	*Ponderosa Pine/Lodgepole P.	A,C,E	A,C,D,E	A,C,D,E
	**Ponderosa P./Lodgepole P.	B,C,E	B,C,E	B,C,E
Modoc Plateau	*Douglas Fir/Grand Fir	A,C	A,C	A,C,E
	**Douglas Fir/Grand Fir	B,C,E	B,C,E	B,C,E
	*Ponderosa P./Lodgepole P.	A,C	A,C,D,E	A,C,D,E
	**Ponderosa P./Lodgepole P.	B,C,E	B,C,E	B,C,E
Sierra Nevadas	Subalpine	B,C,E	B,C,E	B,C,E
	*Douglas Fir/Grand Fir	A,C,E	A,C,E	A,C,E
	*Ponderosa P./Lodgepole P.	A,C	A,C	A,C,D,E
	Subalpine	A,E	A,C,E	A,E
Northeastern Cascades	*Douglas Fir/Grand Fir	A,C	A,C	A,D,E
	**Douglas Fir/Grand Fir	B,C,E	B,C,E	B,C,E
	*Ponderosa P./Lodgepole P.	A,C,E	A,C,D,E	A,C,D,E
	**Ponderosa P./Lodgepole P.	B,C,E	B,C,E,	B,C,E
Okanagon Highlands	Subalpine	B,C,E	B,C,E	B,E
	*Douglas Fir/Grand Fir	A,C	A,C	A,D,E
	*Ponderosa P./Lodgepole P.	A,C,E	A,C,D,E	A,C,D,E
	Subalpine	A,B,C	A,B,C	A,B,C,E
Blue Mountains	*Douglas Fir/Grand Fir	A,C	A,C	A,D,E
	*Ponderosa P./Lodgepole P.	A,E	A,C,D,E	A,C,D,E
Wallowas	*Douglas Fir/Grand Fir	A,C	A,C	A,C,D,E
Northern Rocky Mountains North Part	Subalpine	A,B,C	A,B,C	A,B,C,E
	*Douglas Fir/Grand Fir	A,C	A,C	A,C,E
	Ponderosa P./Lodgepole P.	A,C	A,C	A,C,D,E
Northern Rocky Mountains Central Part	Subalpine	B,C	B,C,	B,C,E,
	*Douglas Fir/Grand Fir	B,C,	B,C	B,C,D,E
	*Western Red Cedar/W.Hemlock	B,C	B,C	B,C,D,E
	*Ponderosa P./Lodgepole P.	B,C,	B,C	B,C,D,E

Table IV-15: Types of Potential Impacts on Physiographic Provinces, Vegetation Zones, and Land Slope Categories

* = Non-Pumice Soils

** = Pumice Soils

A = Induced Compaction

B = Induced Displacement

C = Increased Soil Temperatures

D = Water Quality Degradation

E = Increased Susceptibility to Erosion

Alternatives B through G2, continued

Direct Effects

None to Minor— The effects of yew harvest include the possibility of increased road traffic, foot path development, soil compaction, displaced soil horizons and forest floor (litter and duff) around the base of the yew tree. Another effect would be the loss of the shading effect and organic material contribution of the tree itself.

Indirect Effects

None to Minor— The effects of yew harvest include the possibility of increased road and foot trail erosion, ultimate sediment production, and loss of water quality; a reduction of water infiltration into the soil; a disruption of the nutrient regime; and a slight increase in soil temperature by virtue of the altered physical and biological soil surface characteristics.

Cumulative Effects

None to Minor— The cumulative effects include the potential for loss of water quality and a reduction in the nutrient cycling process. It would be expected that these effects would not persist for more than a few years.

The harvest of yew needles, rather than bark, will have the greatest impact on soils if economics dictate the use of machines designed to harvest needles. Some soil compaction, responding to foot traffic and machinery around the trees, can be expected.

Water Resources and Aquatic Habitat

The following section is directly related to the issue of protecting the ecosystem. People who commented expressed concern about the protection and understanding of riparian zones, watersheds, and aquatic habitat.

The harvest of Pacific yew will have little adverse effect on water yield or quality of forest streams.

Yew occurs as an understory species either as a tree or as a shrub. It rarely occurs as a dense stand, rather, it is scattered throughout other tree and shrub species. Felling and bucking yew into strippable logs causes little disturbance to other understory and groundcover species. Its bark is hand-carried to a landing for weighing and packing for shipment to the processing plant. Soil disturbance is nil; therefore, the potential for erosion and the delivery of erosion products to a stream is minimal to none.

Because of the relatively small size of Pacific yew and its scattered nature in the forest, it has little or no measurable effect on the water resources of most timber sale areas. The harvest of yew will most likely occur as an adjunct to an intermediate or final timber harvest, whether confined to the timber harvest unit or expanded to the timber sale area boundary. Therefore, the timber harvest, including road construction and reconstruction, maintenance and use, not the harvest of yew, may impact the area's water resources.

Over the total geographic range, the effects of yew harvest on the water resources and aquatic habitat would be imperceptible due to the large size of the yew range and the scattered nature of its occurrence. However, the overall effects of each alternative would be the same in terms of water resources. While harvesting yew would not affect them, roads or landings associated with timber sales may.

The Alternatives

Alternatives A through G2

Direct Effects

None to minor— Some short-term adverse effects may occur from possible road construction and reconstruction. Those effects would be minor because they would be unnoticeable within a couple of years.

Yew logs left in a larger stream or on its floodplain could add to moving material. This could marginally increase the risk to the stream and to facilities (roads, bridges, houses, other buildings, water and sewer lines, power and telecommunication lines, etc.) during floods.

The risk to streams would take the form of increased erosion and decreased streambank stability. Channel widening could occur as the added logs divert and strengthen streamflow against the banks, causing them to be undercut and collapse. The adverse effects of individual logs could be magnified when they become part of other unstable debris jams in streams.

The risk of damage to facilities would be mostly from accumulated sediment and moving debris jams. However, yew logs would be an inconsequential component of this debris and the damage it causes.

Indirect Effects

None to minor— The harvest of Pacific yew could increase the amount of litter on the ground. This would help to better regulate infiltration, while decreasing the chance of overland flow.

Foot travel along paths could increase compaction from the harvest site to the weighing site by crews carrying bark filled bags. This could increase the chance of overland flow and the transport of erosion products to nearby streams, seeps, springs, ponds, and other forested wetlands. Where the soils are non-cohesive, overland flow could lead to rilling and gullying of the path's surface.

Cumulative Effects

None— The harvest of yew needles, rather than bark, would have the least impact on the water resource.

Farther downstream from the yew harvest area, the effects of the harvest on the water resource and aquatic habitat could quickly become masked by natural variation. Effects could become diluted by the influence of size of the area at any given point and by land management activities in the intervening area.

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F = 75%, 2 TPA
G1 = 50%, 1 TPA
G2 = 50%, 1 TPA, OCAs
TPA is the minimum number of trees left standing per acre

Wildlife

Many of the effects of the yew harvest alternatives on wildlife are related to changes in forest structure and composition resulting from the removal of yew trees and shrubs of various sizes. Harvest activities may result in some shifts of species composition and population densities.

The following is a brief comparison of the alternatives as they relate to wildlife and other plant species of concern. The section, "Environmental Consequences for Animals and Plants," located in Appendix J describes in greater detail the kinds of direct, indirect, and cumulative effects on wildlife and special status plants that could occur as a result of yew harvest.

The issue of protecting the ecosystem relates directly to this section. Those who commented want protection for the yew's ecosystem in order to ensure forest diversity. People expressed concern regarding the protection of such ecosystem components as wildlife, riparian zones, and plants.

This section is divided into the following segments:

- species associated with late-successional forests;
- species associated with early-successional forests; and
- species associated with riparian areas.

Within each segment is a discussion of the direct, indirect, and cumulative effects of each of the alternatives.

Terms To Know

Snow Interception— *Overstory and mid-level forest vegetation catches falling snow, reducing snow depths on the forest floor. This allows for easier movement for wildlife and helps make food more available. This function is especially important in some moose winter range areas.*

Multilevel Canopy— *A forest stand structure in which several levels of shrub and tree branches are present. Pacific yew, for example, is an understory and midstory canopy level species. Douglas-fir and western hemlock are overstory canopy level species.*

Seral— *Of, relating to, or constituting a series of ecological communities.*

Down Woody Material— *Fallen trees, branches, etc., which contribute to the organic layer of the forest floor.*

Species Associated with Late-Successional Forests

The yew harvest program would not change the amount of late-successional forest habitat. Harvesting yew in late-successional forests would change the character of the habitat and could affect some species. Most of the harvest in "non-sale" areas would probably be in late-successional forests.

The Alternatives

Direct and Indirect Effects

All Alternatives

Snags and large trees

None— Wildlife associated with snags and large trees would not be greatly affected by yew harvest. All of the alternatives would retain some yew snags. Live yew trees remaining in an area would have the potential to become snags. Because Pacific yew is a smaller understory tree species, the large tree habitat component would not be affected by yew harvest.

Deer and elk

Minor— The effects of the alternatives on food and cover used by deer and elk are likely to be small unless new roads are built or closed roads are opened. None of the alternatives are expected to affect their populations. There may be instances where the removal of food and cover by yew harvest would have significant effects or where yew browse would be made more available by stump-sprouting. Material left after harvest could interfere with animal movements. Yew harvest occurring in fawning or calving areas could result in increased fawn or calf mortality rates.

Cumulative Effects

Snags

Minor— The cumulative effects on wildlife species associated with snags are expected to be low for all alternatives.

Deer and elk

Minor— The overall effects of any of the alternatives on food and cover used by deer and elk are likely to be small unless new roads are built or a significant number of previously closed roads are opened. None of the alternatives are expected to affect deer and elk populations. If many roads are built or opened to traffic, the availability of food and cover would be reduced according to the density of open roads in an area.

Direct and Indirect Effects

Alternatives A and B

Forest Structure and Composition

None— In Alternatives A and B, yew would not be harvested outside of timber sales units; there would be more yew distributed across the landscape than in Alternatives C through G2. The contribution of yew to habitat features, such as multilayered canopies and plant species diversity, would be greatest with Alternatives A and B. Animal species that use these habitat features would be expected to be the most abundant. Animal species diversity within late-successional forest should be greatest under these alternatives.

The risk of physical damage to plant species of concern (see Chapter III) and other plant species found in late-successional forests would be least with these alternatives.

There would be no yew logs left in areas outside of timber sales in Alternatives A and B. These alternatives would provide the least amount of habitat for species associated with down woody material. It is unknown if species abundance or diversity would be significantly different between these two alternatives.

Moose

None— Alternatives A and B least affect moose populations using old growth grand fir/Pacific yew forests on winter range areas in northern Idaho. These alternatives would be subject to current forest plan direction for moose winter range and would have similar effects on moose habitat. They would not cause an overall decline in winter range suitability or populations, and would not provide any significant improvements to winter range.

Disturbance

None to minor— There would be slight increase in human activity due to yew harvest on timber sale areas under Alternative B. This could result in short-term disturbance that would be a minor effect for most species. This effect would not occur under Alternative A.

Roads and Wildlife

None to minor— Deer, elk, and moose would probably have the greatest potential for being affected by changing road access to accommodate yew harvest. Additional roads would probably not be necessary under either alternative. In Alternative A, closed roads would not need to be opened. There would be no additional effects on wildlife from open roads, beyond those resulting from other activities. Under Alternative B, some closed roads may be opened. This could limit effective use of existing habitat for some species or make animals more susceptible to poaching.

Fruit and Wildlife

None— Species that feed on the fruit of Pacific yew would be least affected by Alternatives A and B, as yew would not be harvested outside of timber sale units.

Cumulative Effects

Forest Structure and Composition

Minor to moderate — There would be few short-term cumulative effects from yew harvest in Alternatives A and B compared to the other alternatives. Timber harvest, not yew harvest, would have more effect on the vegetative structure and plant species diversity. Under Alternative A no special provisions would be made to regenerate yew after any project. This could lead to changes in the midstory vegetation structure and plant species diversity in all subsequent seral stages. Animal species diversity in future late-successional forests could be reduced over time because of the loss of yew from the understory of many former timber sale units. Across the landscape the combined effects of shorter average forest ages and potentially reduced structural complexity in some stands, could result in a regional reduction in the diversity of animal species associated with late-successional forests. Efforts to

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TPA is the minimum number of trees left standing per acre

regenerate yew (Alternatives B through G2) would somewhat counteract this effect. Changes in animal species distribution and abundance could also occur as a result of changed environmental conditions. The magnitude of these potential changes are difficult to assess due to the lack of knowledge about such complex ecological interactions. The risks to plant and animal species distribution and abundance are probably low for these alternatives.

Disturbance, Fruit and Wildlife

Minor— The effects of yew harvest on species associated with disturbance (animals that come in after a disturbance) and yew fruit would probably be low.

Moose

None— There would be no cumulative effects on moose in northern Idaho beyond those caused by other activities such as timber sale harvest.

Roads and Wildlife

Minor— Alternative A would have no cumulative effects on wildlife from increased road densities needed to accommodate yew harvest. Under Alternative B, the cumulative effects of opening roads to accommodate yew harvest would probably be low.

Alternatives C through G2

Direct and Indirect Effects

Forest Structure and Composition

Minor to high— Yew harvest under Alternatives C through G2 could result in changes in the structure and composition of late-successional forest habitats. There would be less yew in all size classes distributed across the landscape. The contribution of yew to habitat features such as multilayered canopies and plant species diversity would decrease as yew harvest increases in Alternatives C through G2. The alternatives differ in the number of acres available for harvest; the risks of physical damage to plant species of concern would generally increase with yew harvest acres. These risks would be substantially reduced with site-specific restrictions.

Animal species using these habitat features would be expected to be less abundant than under Alternatives A and B. As yew harvest increases, in Alternatives C through G2, species abundance decreases. Animal species diversity would also be expected to show the same pattern, however, the degree to which this would happen is unknown. The Interim Guide assumes that 30 to 50 percent of the yew midstory could be removed without a significant risk of reducing the abundance and fitness of vertebrates using the area. This information is based on findings from a study in the Oregon coast range. The study found that removing approximately 30 percent of the Douglas-fir overstory in half-acre patches did not have appreciable short-term effects on small birds or mammals (USDA Forest Service, 1992a). Removing 25 percent of the yew in an area (Alternative C) most likely would have a low probability of reducing or removing species from that area. Removing 50 percent of the yew (Alternatives D, G1, and G2) presents a higher, but probably still fairly low risk of reducing or removing wildlife species from an area. Where 75 percent of the yew is removed from an area (Alternative F), there is moderate probability of reducing or removing a few species from areas with low yew densities and a high probability for areas where yew is dense. In site-specific cases, such as in areas important to threatened or endangered species, the consequences of reducing or removing one of these species are much greater and therefore the risks are also increased.

In areas where dense patches of yew make up a higher proportion of the midstory layer, effects on animal and other plant populations and communities may be greater. At the harvest level of Alternative C, it may be possible to maintain the functionality of some dense patches of yew. Under Alternatives D, G1, and G2 a few dense patches of yew would remain, but in fewer areas. Dense patches of yew would be largely eliminated under Alternative F.

If yew logs are left on non-timber sale sites after bark harvest, there would be more logs than in Alternatives A and B, with increasing numbers of logs in Alternatives C through G2. These additional logs would be unlike naturally occurring logs in that they will be peeled, cut into pieces and, possibly, piled. If peeled yew logs are removed from non-timber sale sites, this source of

coarse woody debris would be reduced. The effects of these changes to wildlife are unknown, but the abundance of some species may increase with increasing numbers of yew logs. Where yew is abundant, large quantities of woody material left on the ground could impede movements of some species. The role of yew logs in streams and riparian areas is discussed below, as well as in the water quality section.

Moose

Minor— Moose winter range, located in areas where Pacific yew is an important ecosystem component, would be managed in accordance with the goals presented in the forest plans. In most cases, this would limit yew harvest to fairly light levels and on fewer acres than would otherwise be permissible under Alternatives C through G2. Decisions about yew harvest in particular areas would be based on site-specific analysis.

Yew harvest under these alternatives would not result in an overall decline in winter range quality, and could possibly improve it. On areas where thermal cover and snow interception are not the primary concerns, moose using old growth grand fir/Pacific yew forests as winter range in northern Idaho could be somewhat benefited by light yew harvest in selected areas where yew has grown out of reach of the moose. Harvest needs to leave enough vegetation remaining in the overstory and the yew layer to provide for snow interception. More forage would be available approximately two years after harvest. The potential habitat quality of moose winter range could be slightly better with these alternatives compared to Alternatives A and B. However, at this time, the level of understanding of moose habitat relationships with respect to Pacific yew is such that we are unable to determine precisely what yew harvest levels should be in order to obtain this result. Monitoring of moose and yew response would be necessary before proceeding with yew harvest on a substantial scale on this type of moose winter range. Monitoring would need to encompass a variety of winter weather conditions and winter range characteristics.

Disturbance

None to minor— Human activity would increase with increasing yew harvest levels and acres available for yew harvest. This could have a minor to moderate effect on wildlife species that are sensitive to human activity. Disturbance from yew harvest in fawning and calving areas could result in increased fawn and calf mortality.

Roads and Wildlife

Moderate— Additional road building and/or opening of closed roads occurring in connection with yew harvest could subject deer, elk, and moose to increased stress. Their distribution could become more restricted and their abundance could decline. This could occur with any alternative that allows yew harvest outside of existing timber sale units (Alternatives C through G2). The degree to which this would affect wildlife would depend on the open road densities and the amount of traffic that would result from these activities. Open road densities would likely increase slightly with increasing yew harvest levels and acres available for yew harvest, and could have a moderate affect on wildlife use. Based on this assumption, habitat quality for species affected by open road densities would be worse under these alternatives than under Alternatives A and B, with habitat quality declining in order of Alternatives C through G2. Disturbance from yew harvest in fawning or calving areas could result in increased fawn and calf mortality.

Fruit and Wildlife

Minor to high— Species that feed on the fruit of Pacific yew would have less fruit available under these alternatives than under Alternatives A and B. As yew harvest increases in Alternatives C through G2, the amount of available fruit would decrease. Since none of the species known to eat yew fruit are thought to rely heavily on it, Alternatives C, D, G1 and G2 probably would not reduce or remove species from most areas. However, Alternatives D through G2 could result in population reductions for some plant and animal species in areas where fruiting yew is particularly abundant.

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D = 50%, 5 TPA
F = 75%, 2 TPA
G1 = 50%, 1 TPA
G2 = 50%, 1 TPA, OCAs

TPA is the minimum number of trees left standing per acre

Cumulative Effects

The most serious potential cumulative effects for wildlife are changes to the midstory layer of vegetation, moose winter range habitat in northern Idaho, and disturbance from open roads and human activity.

Forest Structure and Composition

Moderate to high— The cumulative effects on forest structure would reduce the amount of yew in dense patches throughout its range. In areas where yew makes up a greater proportion of the midstory vegetation layer, yew harvest could have greater effects on wildlife and other plant species than in areas where other tree species contribute more to that layer. The same principle holds for shrub-form yew.

Under Alternative C, harvest at the 25 percent level on all available acres may change the multilayered character of some areas enough to affect the distribution and abundance of some species. Most areas would probably not be altered enough to cause significant changes.

Harvest at the 50 percent level on all available acres under Alternatives D, G1, and G2 would change the multilayered character of more areas, but some areas would still not be altered enough to cause significant changes to species distribution and abundance. These changes would occur on more acres with Alternatives G1 and G2 than with Alternative D. There may be moderate risks associated with unforeseen effects at this harvest level. Site-specific restrictions could greatly reduce but not eliminate the risks to species distribution and abundance. The short time frame of this program increases the chances of unforeseen effects if applied on a broad scale.

Under Alternative F, harvest at the 75 percent level on all available acres could affect the distribution and abundance of some species. There may be high risks associated with unforeseen effects.

Yew logs left on the harvest site would remain for a long time due to the decay-resistant nature of yew wood. The degree to which

this would benefit species associated with down woody material is unknown, as is the rate of accumulation of down yew wood in the absence of yew harvest. Cumulative benefits in space, and possibly over time, would be greatest for Alternative F, and would decrease for Alternatives G2, G1, D, and C. If yew logs are removed from harvest sites, there would be a cumulative loss of this type of down woody material.

Moose

Minor— Management that would meet forest plan goals to favor important moose winter range quality would limit yew harvest to fewer acres than would otherwise be permitted under Alternatives C through G2. If these limitations were not instituted, and yew was harvested everywhere on moose winter range in northern Idaho, winter range quality would probably decline to some degree, even under fairly light harvest levels (such as in Alternative C). Although yew harvest would provide additional forage two years after the harvest, the snow interception ability of some areas would be reduced if harvest was not limited, resulting in a net decline in habitat quality. The degree to which this would affect current or potential population levels is unknown at this time. However, factors other than winter range are considered to be the current limiting factors (Blair, 1992).

Disturbance, Roads, and Wildlife

Moderate— The increased human activity that would occur if yew is harvested on all available acres in a few years could substantially increase the negative effects on ungulates and other species sensitive to human disturbance. Yew harvest on that scale would require opening many closed areas to traffic. Animal distribution and abundance could decline. Based on these assumptions, habitat quality for species affected by human disturbance and open road densities would be worse under these alternatives than under Alternatives A and B. Habitat quality would become increasingly worse in Alternatives C through G2 as more roads are opened for longer periods.

Fruit and Wildlife

Minor to high— Effects due to the reduction in yew fruit would probably be low for Alternative C, but could be moderate for Alternatives D-G2 in regions with relatively high yew densities. Species that feed on the fruit would have the least fruit available in Alternative F. There could be moderate population reductions for some species in local areas where fruiting yew is abundant.

Species Associated with Early-Successional Forests

The yew harvest program would not create early-successional forests, but would affect the structure of early-successional forests created by timber harvest in areas where Pacific yew occurs.

Disturbance caused by yew harvesters traveling through or working adjacent to early-successional forests or open areas could temporarily displace or disturb wildlife species using those areas. Effects would increase with increasing yew harvest levels and acres available for yew harvest.

The Alternatives

Alternative A Direct and Indirect Effects

Forest Structure and Composition

Minor— Alternative A would have the least effect on habitat structural complexity and plant species diversity. There might be less suitable habitat for some early-successional species and more suitable habitat for others. The magnitude of the effects are likely to be small in most cases.

Compared to the quantity and piece sizes of down woody material that could be contributed by timber harvest activities, the amount that could be contributed if yew logs were left on the site would be minimal.

Deer and Elk

Minor—There would be less forage and cover for ungulates in some cut over units under Alternative A than in the other alternatives, but the effects on populations would not be significant in most cases.

Yew regenerating in winter range areas may not reach full-size, due to the browsing of ungulates. Where yew is a major component of the snow intercept canopy, browsing could increase the amount of time before yew would return to its original position in the ecosystem.

Cumulative Effects

Forest Structure and Composition

Minor— Under Alternative A, no special provisions would be made to regenerate yew after any project. This could lead to changes in the midstory vegetation structure and plant species diversity in all subsequent seral stages. There could also be changes in animal and plant species distribution and abundance. Animal species diversity across the landscape might be reduced over time because of the loss of yew from the understory of many former timber sale units. The magnitude of these potential changes are likely to be minor.

Direct and Indirect Effects

Alternatives B through G2

Forest Structure and Composition

Minor— Habitat structural complexity and plant species diversity in sale units containing Pacific yew would be greater in Alternatives B through G2 than in Alternative A. Some early-successional species might benefit from the remaining vertical structure that would offer perching sites and hiding cover, but the magnitude of the effects are likely to be small.

Compared to the quantity and size of woody debris left from timber harvest activities, the amount that could be contributed if yew logs were left on the site would be minimal.

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F = 75%, 2 TPA
G1 = 50%, 1 TPA
G2 = 50%, 1 TPA, OCAs

TPA is the minimum number of trees left standing per acre

Deer and Elk

Minor— Alternatives B through G2 would provide more forage and cover for ungulates in some cut over units. Yew harvest effects on populations would not be significant in most cases.

Cumulative Effects

Forest Structure and Composition

Minor— Under Alternatives B through G2, yew would be regenerated in timber sale units and partial-cut units. Animal species diversity across the landscape might be greater over time compared with Alternative A because yew would be retained in the understory of former timber sale units. This would lead to increased complexity in the midstory vegetation structure and greater plant species diversity in all subsequent seral stages. The effects on animal and plant species distribution and abundance in early-successional forests would probably be small in most areas.

Species Associated with Riparian Areas

Most of the potential effects of yew harvest on species associated with riparian areas would involve yew harvest close to perennial streams. Species dependent on stream shading and water cooling would be affected by yew harvest in riparian areas.

Disturbance caused by yew harvesters in uplands adjacent to riparian areas could temporarily displace or disturb wildlife species using those riparian areas.

The Alternatives

Alternatives A through G2

Direct and Indirect Effects

Stream Shading, Water Cooling, Pool Formation

None— If yew is not harvested within 75 feet (slope distance) of the average high water level of perennial streams, there would be little impact, in most cases, from any alternative on species associated with riparian areas. Stream shading and water cooling by yew would be unaffected for all of the alternatives, as would the contribution of yew logs to pool formation in streams.

Cumulative Effects

None— Cumulative effects would not be significant in most riparian areas. Riparian habitats not within 75 feet of perennial streams would be affected in the same manner as described for late and early-successional forest species.

Direct and Indirect Effects

Alternatives A and B

Disturbance, Sensitive Plants

Minor— There would be less disturbance caused by yew harvesters in adjacent upland areas compared to the other alternatives. Plant species of concern found in riparian areas within the range of Pacific yew would not be affected by these alternatives beyond the effects of the timber sales.

Cumulative Effects

None to minor— In most cases, cumulative effects would not be significant.

Direct and Indirect Effects

Alternatives C through G2

Disturbance, Sensitive Plants

Minor— If yew is not harvested within 75 feet (slope distance) of the average high water level of perennial streams, there would be little effect from any alternative on species associated with riparian areas. Disturbance by yew harvesters in adjacent uplands could have small, temporary effects on wildlife using riparian areas (especially in Alternatives C through G2). Several plant species of concern are found in riparian areas within the range of Pacific yew (e.g. *Dryopteris filix-mas* [male fern], and *Ribes oxyacanthoides cognatum* [Umatilla gooseberry]). In individual cases where these species are located more than 75 feet from a perennial stream, adverse effects could be avoided by modifying the harvest unit layout. Riparian habitats not within 75 feet of perennial streams would be affected in the same manner as described for late and early-successional forest species.

Cumulative Effects

None to minor— In most cases, cumulative effects would not be significant.

Threatened and Endangered Species

All management activity on Federal lands is governed by a complex set of guidelines (forest plans, resource area management plans, Endangered Species Act, state water quality standards, National Environmental Policy Act, National Forest Management Act, etc.). Some of the guidelines provide direction, others are laws and must be adhered to.

For all alternatives it is assumed:

- No federal laws will be broken.
- If no federal laws are broken, there will be no adverse impacts to any threatened, endangered, or proposed species.
- There will be beneficial and adverse effects from any alternative.
- Human disturbance will increase according to the amount of yew harvested.
- The lower the minimum number of yew trees left per acre, the more acres available for yew harvest.

For the purpose of this analysis, any species proposed as threatened or endangered will be analyzed as if it is listed as such.

The Forest Service and BLM have completed a biological assessment and obtained concurrence from the U.S. Fish and Wildlife Service and National Marine Fisheries Service (see the biological assessment in Appendix J).

The issue of protecting the ecosystem relates directly to this section. Major concerns among those who commented were protection for and understanding of threatened or endangered species.

The Alternatives

Alternative A

Direct Effects

Minor—Alternative A has minimal yew harvest involved (historic levels for posts, poles, carving, and bows). This harvest would usually come from areas that have been clearcut for timber harvest. The direct effects from this level of yew harvest would be

minimal compared to the effects of the timber harvest. Human disturbance, soil compaction, soil erosion, water quality changes, and local vegetation changes are expected to be almost zero. Very little yew is being removed, and the effects of the timber harvest would overshadow these effects. When yew is removed from areas that are not clearcut, the effects may be marginally higher but they would still be near zero. At this level of harvest, direct effects are expected to be close enough to zero as to be unmeasurable.

Indirect Effects

None— A minimal amount of yew would be harvested under this alternative, and most would come from clearcut areas. There would be no expected indirect effects.

Cumulative Effects

Minor— Yew harvest under this alternative would have minor cumulative effects. Clearcutting activities and site preparation and/or fuel reduction (burning) activities in clearcut and planting areas, could reduce the number and vigor of residual Pacific yew. Where yew is the predominate forage species in winter range areas, a reduction in yew could cause a decline in ungulate (deer, elk, moose, and caribou) populations. A decline in the number of these species could reduce the number of predators (wolf, grizzly bear). However, any reduction in habitat over time would be caused more by timber harvest and planting of non-yew species than by yew harvest.

A = No Action
B = Timber Sales Only
C = 25%, 5 TPA
D = 50%, 5 TPA
F = 75%, 2 TPA
G1 = 50%, 1 TPA
G2 = 50%, 1 TPA, OCAs
TPA is the minimum number of trees left standing per acre

Alternative B

Direct Effects

Minor— Additional human disturbance from harvesting yew would have minor effects on the species listed in sections B and C in Appendix J (compared to Alternatives C through G2). Site-specific disturbance may have significant effects on some animals and plants.

Disturbance to the physical habitat (soil compaction, soil disturbance, soil erosion, vegetation damage, etc.) is expected to be minor. The direct effects from this alternative would be minimal compared to the effects of timber harvest.

Indirect Effects

Minor— Clearcutting activities, site preparation, and fuel reduction (burning) activities in clearcut and planting areas could reduce the number and vigor of residual Pacific yew. Where yew is the predominate forage species in winter range areas, a reduction in yew could cause a decline in ungulate (deer, elk, moose, and caribou) populations. A decline in the number of these species could ultimately reduce the number of predators (wolf, grizzly bear). Additional human disturbance associated with yew harvest could result in increased stress for ungulates and potentially, wolves. If the increased stress caused winter die off of non-threatened/endangered ungulates, this could be a food source for wolves, grizzly bear, bald eagles, and wolverines. This food source would be a short-term food source (lasting only for the winter). Because this alternative would protect some yew and other plants remaining in timber sale areas after harvest, it would have fewer effects than Alternative A.

Cumulative Effects

Minor— Across the geographic range of the Pacific yew (during the five-year planning period covered by this EIS), this alternative is expected to have fewer effects on yew-dependent and yew-related species than Alternative A. Protection of some of the existing yew, and planting to preharvest or prescribed levels, would provide for future yew trees. A reduction in the number and distribution of yew could cause a reduction in the number and distribution of yew-dependent species.

Because of the present restrictions on where timber harvest activities may occur, the cumulative effects of the yew harvest and human disturbance on threatened and endangered species would probably be minor.

Alternatives C through G2

Magnitude of Effects

By leaving at least 75 percent of existing yew or five trees per diameter class per acre (whichever is greater), Alternative C has low potential of impacting threatened and endangered species.

Alternative D has moderate potential, and Alternatives F, G1, and G2 have increasing potential, with G2 having the greatest. The nature of effects likely to occur as a result of yew harvest are the same for Alternatives C through G2, and are described below.

Direct Effects

Minor— Additional human disturbance from harvesting and regenerating yew could have some of the following effects on the species listed in sections B and C in Appendix J: wolf dens could be abandoned; ungulates could be stressed for lack of adequate winter range; ungulates, wolves, and grizzly bears could change use patterns; people could be attacked by grizzly bears; eagles and murrelets could abandon nest sites; and any changes in water quality could affect fish (see Appendix J).

More yew would be harvested under these alternatives, resulting in more impacts from human disturbance, than in Alternatives A and B. In addition, there would be impacts from yew harvest in non-sale areas. Because of the many variables involved, the effects from human disturbance are difficult to quantify in this EIS. These effects will need to be discussed in site-specific environmental assessments. Site-specific disturbance could have significant effects on some animals and plants. For instance, additional human disturbance associated with yew harvest could ultimately result in increased stress among ungulates, and could result in displacement. This local absence of ungulates may cause predators to leave their traditional hunting grounds in search of food. Buffer zones and timing restrictions could reduce these kinds of impacts.

Disturbance to the physical habitat (soil compaction, disturbance, and erosion, vegetation damage, and water quality) is expected to be minor in areas where yew is not a major stand component. In stands where yew is a major stand component, these effects would

be greater and would vary in magnitude according to the amount of yew harvested, and the techniques used to haul yew bark and logs. Without the mitigation measure requiring that no yew harvest take place within 75 feet of perennial streams, disturbance could also contribute to a reduction in water quality, which would affect the fish species listed in sections B and C in Appendix J.

Impacts on the soil from these alternatives could potentially affect listed plants. Soil compaction, seedbed disruption, and soil erosion could affect seed germination, plant vigor, and asexual reproduction in site-specific areas. These impacts would need to be covered in site-specific documents.

Because these alternatives would permit harvest in extensive areas of currently suitable owl habitat, they have the potential to impact spotted owl prey habitat and the quality of spotted owl roosting habitat. The extent of the impact would depend on the proportion of yew in the stand and the amount of yew harvested. (For more information see Appendix J.)

Indirect Effects

Minor to high— Except for areas where yew is the predominate forage species, the harvest of yew bark and foliage in winter range is not expected to impact ungulates using it. Site management plans include protective measures which provide for adequate forage and thermal cover. There may be minor impacts to specific portions of winter range sites, but this is not expected to affect the ungulates or predators associated with them.

In those winter range areas where yew is the predominate forage species, a reduction in yew could cause a similar reduction in ungulate (deer, elk, moose, and caribou) populations. A decline in the number of ungulates could ultimately reduce the number of threatened and endangered predators (wolf and grizzly bear).

Cumulative Effects

Minor to high— Across the geographic range of the Pacific yew (during the five-year harvest period covered by this EIS), these

alternatives would be expected to have fewer effects on yew-dependent/related species than Alternatives A and B. The creation of genetic reserves, protection of a specified percentage of the existing yew, and re-planting yew in clearcuts and shelterwood units, would ensure long-term sustainability for Pacific yew. The reduction in the number and distribution of yew may cause a reduction in the number and distribution of dependent species. We know of no species totally dependent on yew, however, if there is such a species, the reduction of yew could cause it to become threatened or endangered. The protection and regeneration of yew may allow yew and this species to return to present levels.

A = No Action
B = Timber Sales Only
C = 25%, 5 TPA
D = 50%, 5 TPA
F = 75%, 2 TPA
G1 = 50%, 1 TPA
G2 = 50%, 1 TPA, OCAs

TPA is the minimum number of trees left standing per acre

Access for Yew Harvest

Access to any particular area in national forests or BLM districts is always governed by the standards and guidelines for each management area. Any access project would require site-specific environmental analysis. Areas already accessible by road systems would most likely be considered first for any yew harvest because of time and cost efficiency.

This section discusses how the alternatives would affect access needs for yew harvest. Under those alternatives in which increased access is a possibility, the relevant issues are wildlife disturbance and changes in recreational use.

The Alternatives

Direct, Indirect, and Cumulative Effects

Alternatives A and B

None— There would be no yew harvested for taxol production under Alternative A, and none harvested outside of timber sale units under Alternative B. Therefore, there would be no change in access to the forest.

Direct Effects

Alternatives C through G2

None to minor— Under all of the alternatives, construction could be required to create or improve access to the yew harvest area. This could include road construction, reconstruction, or upgrading, as well as trail construction and upgrading. It is possible that helicopter pads could be required for yew removal in unroaded areas, although this is unlikely.

Road and trail construction and reconstruction could result in increased sedimentation, dust, and noise. These effects would usually be temporary.

Indirect Effects

None to minor— Creating or improving access to an area usually results in increased use. If access to an area improves because of road and trail construction or enhancement, those roads and trails could receive more use than in the past. This could result in increased sedimentation, dust, and noise which would continue as long as the increased use occurs.

Other indirect effects of increased access to an area might include wildlife harassment and changes in recreational use (see Wildlife and Recreation sections in this chapter).

Cumulative Effects

Minor— If access to an area was changed to make opportunities for both yew harvest and timber harvest, then the effects outlined above would have to be considered for both of these activities in conjunction with each other. Typically, the effects would be similar for both types of projects, although the effects associated with the timber sale would be greater in magnitude.

Effects of Pacific Yew Harvest on Timber Harvest

This section relates directly to the issue of the economic effect of yew harvest on the timber supply. The types of possible effects are listed first and then followed by a discussion of the direct, indirect, and cumulative effects for Alternative A and for Alternatives B through G2, as a group.

Pacific yew harvest may impact or conflict with timber harvest in various ways:

1. Pacific yew harvest may delay timber harvest if the yew is not harvested first in a timely manner.
2. The ability to establish new timber stands may be impacted due to yew protection measures, especially those that limit fire as a tool for site preparation for replanting timber species.
3. Some harvest operations, such as timber falling, may be hindered by additional measures necessary to leave and protect residual yew trees.
4. The genetic reserve areas established for the protection of the Pacific yew species may remove some acres from timber production.
5. The time period to grow an acceptable size yew tree may conflict with the rotation length for timber species.

The Alternatives

Alternative A

Yew would not be harvested, so timber harvest will not be impacted. There are no direct, indirect, or cumulative effects.

Alternatives B through G2

Direct Effects

Minor— Yew harvest may conflict with or impact commercial timber harvest directly because if the yew is not harvested first in a timely manner the harvest of the commercial species may be delayed. (The Pacific Yew Act of 1992 requires yew to be harvested before the commercial timber harvest.) Some harvest operations may be physically hindered, delayed or complicated by additional measures required to leave and protect residual yew trees and shrubs.

Indirect Effects

Minor— Yew harvest may conflict with or impact commercial timber harvest indirectly by changing the composition of future stands somewhat. The ability to establish new timber stands may be impacted due to yew protection measures, especially those that limit fire as a tool for site preparation for replanting timber species. Also, for Alternatives C through G2, the genetic reserve areas established for the protection of the Pacific yew species may remove some acres from timber production.

Cumulative Effects

Minor— Yew harvest may conflict with or impact commercial timber harvest over time by reducing the acres available because of the establishment of yew reserves. Protection and regeneration of yew may change the composition of timber stands over time, and the rotation periods for timber harvests may conflict with the period required to grow Pacific yew of a desirable size.

Roadless Areas

It is unlikely that any roadless areas would be entered for the purpose of yew harvest. However, the effects of timber harvest and related activities (road building, re-opening previously closed roads, site preparation activities) in or adjacent to roadless areas can include impacts on:

- roadless character (natural integrity, apparent naturalness, remoteness, and solitude);
- recreation setting and experience;
- big game habitat quality;
- and available access to future forest management activities.

These effects can be quantified and interpreted based on various factors:

- roadless acres harvested;
- miles of new road constructed and total road density;
- acres retaining roadless character; and
- cumulative effects in combination with past and future activities.

The Alternatives

Alternative A

Direct, Indirect, and Cumulative Effects

None— There would be no yew harvested under Alternative A and therefore no change in roadless areas or related resources.

Alternatives B through G2

Direct, Indirect, and Cumulative Effects

None— Each forest plan contains outlines for the percent of roadless area available for entry and the rate at which these areas may be developed. Should entry into an available roadless area for yew harvest be proposed at any time during implementation, a site-specific analysis would be required for all ground disturbing activities, and any potential effects on roadless characteristics would be analyzed according to forest-wide standards and guidelines.

Chapter IV

Environmental Consequences

Part Three: The Yew and People

Contents

Part Three: The Yew and People

This part of Chapter IV addresses the effects of the alternatives in terms of people, values, and uses. Although Market and Nonmarket Considerations, Jobs, Public Health, Social Setting, and Cultural Resources were separate sections in Chapter III, they were merged under the heading of Social and Economic Effects in this chapter. The two other sections in this part are Recreation and The Summary of Irreversible or Irretrievable Commitment of Resources.

Social and Economic Effects

Issues related to the social and economic effects of yew collection on resources, economies, and future options are varied. People are concerned that maintaining a sustained forest ecology is essential for ensuring the future of taxol and other important drugs yet to be discovered. Many people think that the agreement with Bristol-Myers Squibb Company is monopolistic, and that many companies, not just one, should benefit from taxol production. Several people suggested that yew harvest take place only in active timber sale areas. Also, some expressed concern about whether yew would provide jobs, especially for displaced timber workers. People with cancer view taxol as a life-saving drug treatment.

Here we discuss how the alternatives affect peoples' lives and the local economy, as well as the availability of yew bark for different purposes. Needle collection is not included in most of these discussions because there is no information available on which to base conclusions about the effects. However, the discussions of cultural values, traditional uses, and geographic areas do apply to needle harvest as well as bark harvest. The social and economic effects of the alternatives (Alternatives B through G2) are described in terms of:

- Government direction and expenditure
- Bark pricing
- Bark theft and safety
- Patient treatment
- Taxol production
- Job creation
- Local employment (from harvesting)
- Cultural values
- Traditional use
- Affected geographic areas
- Returns to the government

Alternative A is fundamentally different than the other alternatives because it is the only alternative under which there would be no formal bark harvest program from federal lands; it has minimal yew harvest activities for such specialized uses as fenceposts, poles, carving, lutes, and bows. Harvest of Pacific yew for these uses usually occurs on timber harvest units.

The Alternatives

Alternative A

Direct Effects

None

Demand

Alternative A may not meet the demand for Pacific yew bark from federal land. See Table IV-16 for quantity of bark harvested and taxol supplied under each alternative. The price of bark from other ownerships would increase due to a reduction in total supply.

Government Expenditures

Under this alternative, there would be no government expenditures for the management of yew bark.

Government Direction

There would be no agreements, mitigation measures, or other government commitments concerning Pacific yew.

Bark Theft

There would be no special protection for the Pacific yew, other than that afforded under normal agency law enforcement. The effect this would have depends on demand for bark. If demand is high, without procedural checks, we could see a substantial increase in yew bark theft.

Safety

There would be no increase in injuries associated with yew bark collection.

Alternative A, cont.

Indirect Effects

None

Returns to the Government

Under this alternative, there would be no harvest of Pacific yew bark from federal lands. This alternative would not be responsive to the need to provide bark for taxol production. There would be no returns to the government from the sale of bark.

Secondary Market and Jobs

Traditional users would continue to be able to use Pacific yew bark, needles, and wood. There would be no impact to the secondary yew wood market from sale of yew bark, or restrictions on use of other portions of the tree.

There would be no effects to timber harvest from Pacific yew mitigation measures, nor would there be any jobs created as a result of yew bark harvest from federal lands.

Cumulative Effects

Minor

Government Direction

The cumulative effects of this alternative would reflect conditions prior to the 1991 harvest season. There would be no effects associated with Pacific yew harvest mitigation measures because there would be no guides.

Jobs

It is difficult to estimate what the effects would be on jobs created or taxol produced. If this alternative were selected and the demand for Pacific yew bark to produce taxol still existed, it would be reasonable to assume that some yew bark would be harvested. This may occur legally on private lands, or illegally from Forest Service and BLM lands. If demand for Pacific yew bark continues and this alternative was implemented, some jobs would be created due to increased bark harvest from private and state lands.

Treatment

Taxol would continue to be produced, although probably at a lower initial level than under other alternatives. The effect this would have on patient treatment depends on bark availability from non-federal lands, as well as technology. If demand for taxol cannot be met through other sources or production methods or through bark harvest from private land, then there might not be enough taxol to meet patient demand.

Affected Groups

(This discussion assumes that taxol production capacity is not an impediment to taxol supply.) Several groups could be adversely affected under this alternative. Cancer patients currently in clinical trials, as well as patients with ovarian and breast cancers who are not in clinical trials, could be denied access to taxol therapy under this alternative. Women who are at risk for developing these cancers would also see a potential treatment option limited.

Job-Related

This alternative would not create bark harvesting or processing jobs and would therefore not create job opportunities for woodworkers. Woodworkers and others who wished to purchase Pacific yew logs would still be able to do so.

Recreation and Cultural Values

Implementing this alternative would have no effect on recreational or Native American uses of the Pacific yew or the forest.

Women and Minorities

Since taxol therapy is targeted at cancers that mostly affect women, women as a group would be adversely impacted if taxol therapy were limited or not available. Information was available on cancer rates for African-Americans, but not for any other ethnic groups. The breast and ovarian cancer rates among African-Americans are similar to those of whites, and thus they would be affected in the same way.

Alternatives B through G2

Many of the social and economic effects are very similar among all alternatives except A. This occurs either because the scope of the effect, spread across the five-state region, is very small, or because there is no measurable difference in the effect among alternatives.

Direct Effects

Minor to Moderate

Demand

It is difficult to state exactly how the alternatives respond to demand as demand is expected to fluctuate over the five-year harvest period. All action alternatives would meet the demand identified for 1993. The remainder of this discussion of demand is in terms of processing capacity. This is not meant to equate demand with processing capacity. Since capacity would represent an upper limit on production, we have used it in this discussion to show whether an alternative would meet the maximum possible taxol production.

Alternative B does not meet the current annual processing capacity of 130 kilograms of taxol, given the assumed 500,000 pounds yew bark production rate from other landowners. (See Figure IV-16 for potential quantities of bark harvested and taxol supplied under each alternative.) Alternatives C through G2 meet current processing capacity at the low end of the production range given the bark production from other sources. Alternatives D through G2 satisfy the future production capacity of 200 kilograms of taxol, and Alternatives F through G2 supply sufficient yew bark to meet future capacity even if no bark is harvested from other sources.

Government Expenditures

There would be government expenditures to manage the yew bark harvest program. Any of the action alternatives would have annual expenditures to include yew bark sale preparation, issuing special use permits, management associated with these sales or permits, and oversight of on-the-ground operations (see Table IV-16). This level of expenditure would not result in any additional government employment. There may be a small number of injuries associated with bark collection.

Government Direction

Under any of the action alternatives, the federal government would operate under a cooperative agreement, sale contract, or some other form of agreement with individuals or companies obtaining federal yew bark or other yew products. Mitigation measures (see Chapter II) would also be followed to guide yew bark and needle harvest activities. Field experience has shown that leave tree requirements increase harvesting costs.

Indirect Effects

Minor to Moderate

Returns to the Government

Under these alternatives, bark and needle harvest would be allowed. The amounts permissible under each alternative are shown in Table IV-16. Returns to federal and state treasuries would vary only minimally among alternatives. (See Figure IV-16 for potential returns to the government.)

The Forest Service and the BLM are required to return a percentage of the revenues they generate to county governments. On lands formerly owned by the Oregon and California Railroad (O&C lands), this percentage is 50 percent. On other federal lands, the portion is 25 percent. The amount of potential revenue returned to the counties from the yew bark program would be small (see Figure IV-16). These payments would not be expected to have a substantial impact on county governments since they would be distributed between all counties associated with National Forest land and yew harvest. Not enough site-specific information is available currently to estimate returns to each county from which bark might be harvested.

Secondary Markets and Jobs

Under these alternatives, yew trees and shrubs, including bark and needles, would be available for taxol production. Generally, the wood left over from bark and needle gathering would be

Alternatives B through G2, Cont.

available for other uses. The secondary market for yew logs would potentially be expanded as a result of yew operations. This could have a positive impact on local employment. The bulk of these jobs would be seasonal, with employment lasting from late spring to early fall (see Table IV-16 for information on person-hours of employment). However, this market has been so small in recent years that any positive impact would be about the same as the jobs created for bark processing.

Traditional users would continue to be able to use Pacific yew wood. Access to the wood may be somewhat restricted, however, as timing would have to be coordinated with bark harvest.

Under the action alternatives, jobs would be created for bark collectors and others in the processing and taxol production areas.

Cumulative Effects

Minor

Stumpage Values

The mitigation measures could have the effect of decreasing stumpage values of non-yew trees. Purchasers' costs may increase due to leaving higher stumps and taking greater care to protect yew during yarding. However, increased harvesting costs should be minimal. The biggest impact on stumpage price will be from the increase in site prep and fuel reduction costs.

Bark Pricing

There may be variations in the price of bark and taxol over the five-year harvest period. Bark price would be subject to market forces and would most likely fluctuate with changes in supply and demand. If demand drops because synthesized taxol becomes available, bark prices would most likely decrease.

Treatment

Taxol production and the number of patients who could be treated vary by alternative (see Table IV-16).

Affected Groups

Cancer patients would benefit under any of the action alternatives because taxol would be available for clinical trials, and eventually for cancer therapy. This availability may vary by alternative, and is discussed in the section for each alternative. In general, any of the action alternatives would benefit women because breast and ovarian cancer treatment options would be expanded.

Job-Related

The action alternatives would also potentially benefit woodworkers through job creation. This is also discussed in more detail under each alternative.

Cultural Values

Effects on Native American uses of the forest under these alternatives would be localized and could only be determined by local consultation. For most utilitarian uses, effects would be minor due to measures taken to protect the yew.

Affected Geographic Areas

Communities where bark processing facilities are located (Cottage Grove, OR; Centralia, WA; Orofino, ID; and Noxon, MT) would experience slight employment increases under any of the action alternatives. These communities would also experience positive feelings associated with a project that is perceived as useful and socially beneficial.

Population in the involved states and counties should be minimally affected under any of the action alternatives. In the few cities and towns where processing facilities are located (i.e., Cottage Grove), there may be a slight population increase of fewer than 50 people who are directly or indirectly associated with Hauser Northwest's operations.

Bark Theft

During the 1991 harvest season, there were reports of Pacific yew bark being harvested illegally. New administrative controls have

Alternatives B through G2, Cont.

been instituted by Hauser Northwest and federal agencies, and have substantially reduced bark theft. These controls are the same for all alternatives.

Recreation Expenditures

Yew bark harvest could impact recreation experiences, including hunting. The loss of yew trees may diminish the value of the recreational setting and possibly the quality of wildlife habitat, especially where bark is harvested outside of timber sale areas. There is no evidence that these impacts would result in any decrease of recreationist expenditures.

Women and Minorities

Since taxol therapy is targeted at cancers that mostly affect women, women as a group would benefit from the alternatives which allow Pacific yew bark harvest for taxol production. Information was available on cancer rates for African-Americans, but not for any other ethnic groups. The breast and ovarian cancer rates among African-Americans were similar to those of whites, and thus they would be affected in the same way. All action alternatives create some job opportunities. These jobs have been filled by men and women, and by members of ethnic groups representative of the area's population.

Table IV-16: Social and Economic Effects Under Each Alternative

SUGGESTION: Consider Socioeconomic Concerns	ALTERNATIVES						
	A (No Action)	B (Preferred) Timber Sales Only	C 25%, 5 TPA	D 50%, 5 TPA	F 75%, 2 TPA	G1 50% 1 TPA	G2 50% 1 TPA, OCAs
a. Public Health and Safety							
--bark availability in pounds from federal lands per year	0	0.3-0.4 MM	1.1-1.7 MM	1.9-2.8 MM	3.2-4.8 MM	3.2-4.6 MM	3.8-5.7 MM
--taxol available for clinical trials, per year, in kilograms, based on bark from federal lands (15,000 lbs. bark= 1 kilogram)	0	17.3-26.0 kilos	73.3-113.3 kilos	126.6-186.7 kilos	213.3-320.0 kilos	213.3-306.7 kilos	253.3-380.0 kilos
--potential patients treated per year, based on bark from federal lands (assuming 1 kilogram treats 480 patients)	0	8,300-12,400	35,184-54,384	60,768-89,616	102,384-153,600	102,384-147,216	121,584-182,400
--injuries to forest workers	none	0-5	0-10	0-15	0-25	0-25	0-30
b. Social Setting-- Groups Affected	*Jobs-Related*						
--bark harvester jobs (seasonal)	no job creation	75-113	347-521	566-849	937-1,406	909-1,363	1,113-1,669
--traditional woodworkers and yew log purchasers	no effect	<----------minor effect---------->					
	Recreationists						
--hikers, campers, hunters	no effect	<----------minor effect---------->					
	Native Americans						
--ceremonial, cultural, traditional use of wood	Effects on uses would be minor. Spiritual and medicinal value effects must be assessed after local consultation.						
c. Women and Other Minorities	slight negative	<----------positive if demand met---------->					
d. Social Setting -- Geographic Areas Affected							
--areas where yew is processed	no effect	<----------small benefit----------> (some jobs created spread throughout a five-state area; positive community feelings associated with beneficial activity)					
--areas where yew is not processed	<----------no effect---------->						
e. Economics (average annual)							
--government expenditures associated with bark harvest	$0	$0.3 MM	$5.9 MM	$5.9 MM	$5.9 MM	$2.9 MM	$4.6 MM
--stumpage values of other commercial species	no effect	<----------possible decrease---------->					
--potential receipts to government	none	$0.1-0.2 MM	$0.3-0.7 MM	$0.6-1.1 MM	$1.0-1.9 MM	$0.9-1.8 MM	$1.1-2.3 MM
--potential returns to counties	none	<$0.1 MM	$0.1-0.2 MM	$0.1-0.3 MM	$0.2-0.5 MM	$0.2-0.4 MM	$0.3-0.4 MM

MM=millions M=thousands

Recreation

The harvest of yew bark, cutting of yew trees and shrubs, and leaving the stripped logs where they have fallen, could have the effect of lowering the quality of the visual resource and the setting for recreational activities. The harvest of yew trees and shrubs would result in the loss of a component of the natural and natural-appearing forests of the region. The magnitude of the effects would be determined by the extent and location of the yew harvest and the character of the recreational setting where the harvest would take place.

The harvest of yew in non-sale areas would be most sensitive in foreground (300 feet deep) adjacent to recreation sites, water bodies, trails and roads. In retention and partial retention zones it is critical that forest plan visual quality objectives be met. Sensitivity level analysis should suggest the appropriate level of yew harvest.

Similarly, it is critical that established BLM Visual Resource Management Class objectives be met. The results of visual contrast ratings would suggest appropriate levels of yew harvest.

If yew trees and shrubs are felled and stripped in recreation areas, we may need to remove or relocate the slash. Slash could be an obstacle to some forms of recreation, particularly trail use. It could also be a negative visual impact in sensitive areas. In areas where yew is concentrated and recreation use is heavy, removal of logs could be important.

Effects are very difficult to measure with any degree of accuracy at the program level of analysis; however, impacts would most likely be relatively minor. Site-specific analysis would be required to closely examine effects on the trends and values listed above.

Harvest of yew foliage would have only short-term insignificant impacts on recreation or visual resources in any of the alternatives being considered. The Interim Guide provides direction on foliage harvest that is intended to reduce potential impacts to a minimum.

The effects of bark harvest are of greater concern. The array of alternatives being considered here range from no effect in Alternative A to greatest effect in Alternative G2.

The Alternatives

Direct, Indirect, and Cumulative Effects

Alternative A

None— With no harvest of yew, there would be no direct or indirect effects on recreation settings and no cumulative effects.

Direct, Indirect, and Cumulative Effects

Alternative B

Minor— Only minor unmeasurable direct or indirect effects. Most of the areas scheduled for clearcut or shelterwood harvest provide little scenic value during harvest and would have such a modified appearance after harvest that not much would be lost in terms of recreation settings. Areas of planned harvest are generally not where people would spend much time recreating.

Direct, Indirect and Cumulative Effects

Alternatives C and D

Minor— Yew provides an important element in the forest landscape that more people are specifically aware of—as a result of media attention on taxol and the yew bark from which it is being produced. Under these alternatives, the effects on recreation settings would increase with the extent of harvest. Alternative D would have greater impacts than C, especially in non-sale areas. The greatest effects would occur in areas where people would be recreating or where they would be viewing the foreground of a forest landscape, as opposed to driving through an area quickly. For the purposes of this analysis, it is assumed that forest plan and resource management plan guidelines would apply to areas where scenic values would be most sensitive.

Direct Effects

Alternatives F, G1, and G2

Minor— These alternatives would increase the harvest of yew in non-sale and partial cut areas. These areas are more likely to accommodate recreation use, and yew harvest would have increasing potential for affecting the quality of recreation settings.

Indirect Effects

Minor— Most of the effects of these alternatives would be indirect, and would boil down to the appearance of the settings after yew harvest. Of greatest concern would be the loss of tree-form yew in the understory in foreground areas as seen from recreation sites, water surfaces, trails or roads. Of these two alternatives, F would result in the lighter touch, while effects of G2 would be more noticeable.

Slash accumulation from yew harvest, could be another indirect effect. It could, be moderated through cleanup of yew slash which accumulates on trails in the heavy harvest alternatives.

Cumulative Effects

Minor— The primary cumulative effect would involve the appearance of the area over the time after yew harvest is completed. The magnitude of the cumulative effect would depend primarily on the loss of tree form yew in the heavier harvest alternatives (Alternatives C through G2 and especially F, G1, and G2). Harvest cycles may not provide adequate time for stump sprouts to grow into tree form. Planted seedlings or cuttings may not reach the target size in 75 to 100-year rotations.

Cleanup could be a cumulative impact if too many logs, tops, or limbs were to be left in a sensitive area and removal activities disturbed soil, plants, or animals in that area.

Congressionally Designated Areas and Other Special Areas

Congressionally designated areas (wildernesses, national volcanic monuments, and national recreation areas) and Research Natural Areas would not be affected by any alternative. No yew harvest would take place in these areas.

Yew would not be harvested in wild river segments of the national wild and scenic river system rivers. Scenic and recreational segments of wild and scenic rivers may yield small quantities depending on local management objectives. Impacts under such circumstances would be minor.

Summary of Irreversible or Irretrievable Commitment of Resources

This section discusses the potential irreversible and irretrievable effects associated with the implementation of the various proposed alternatives. These effects, listed below, are defined as follows:

Irreversible— Applies primarily to the use of nonrenewable resources, such as minerals or cultural resources, or to those factors, such as soil productivity, that are renewable only over long time periods. Irreversible also includes loss of future options.

Irretrievable— Applies to losses of production, harvest, or use of renewable natural resources. For example, some or all of the timber production from an area is irretrievably lost during the time an area is used as a winter sports site. If the use is changed, timber production can be resumed. The production lost is irretrievable, but the action is not irreversible.

Irreversible Effects

1. If all yew available for harvest under each alternative is harvested within the five-year period covered by this EIS, the option to harvest additional yew would be lost until the yew has regenerated and grown to previous levels and sizes. (This effect applies to Alternatives B through G2.)

2. The continued erosion of species range due to the loss of small, peripheral populations is an irreversible loss. (This effect applies to Alternative A only.)

3. There is a potential for an irreversible loss of genetic and ecosystem diversity if populations containing unique genetic combinations are lost. (This effect applies to all alternatives except Alternative C.)

Irretrievable Effects

1. The loss of timber production is an irretrievable loss in genetic reserve areas that are established in areas not previously designated or set aside for wilderness, owl conservation areas, etc. (Reserve areas are established adjacent to certain harvest areas for the purpose of maintaining and protecting representative yew populations. Timber harvest is not per-

mitted in these reserve areas.) (This effect applies to Alternatives C through G2.) Also, the loss of timber production which could result from protecting yew would be an irretrievable effect.

2. The delay of seed production and genetic contribution in certain harvest areas would be an irretrievable loss, until residual or planted yew reach reproductive size. (This effect applies to Alternatives B through G2.)

3. The loss of yew in specialized habitat, such as old growth and suitable owl habitat, is an irretrievable loss for associated species. This would be true for the duration that it remains unsuitable due to yew removal. (This effect applies to Alternatives B through G2.)

4. The loss of a treatment option for cancer patients due to limited access to taxol would be an irretrievable loss until other means of producing taxol are developed. (This effect applies to Alternatives A and B.)

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List of Individuals and Organizations Consulted

List of Preparers

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Sally Campbell is a nursery and regeneration pathologist with the Forest Service in Portland, Oregon. She has a B.S. in biology from Pitzer College, and an M.S. in plant pathology from Oregon State University. Sally is the EIS interdisciplinary team leader for the Pacific yew EIS project and for the Nursery EIS and Seed Orchard EIS projects. She has worked for the Forest Service for 12 years.

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Bernard Smith is currently the recreation facilities group leader for the Forest Service's Pacific Northwest Region. He has a B.S. in botany from California Polytechnic at San Luis Obispo and a Masters of Forestry from Utah State University. He has worked for the Forest Service for 24 years, most of which has been within the natural range of the Pacific yew. He is also a serious woodworker and has harvested yew wood during the past decade to convert it to furniture, boats and carvings.

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BBEP, EAD, Hyattsville, MD
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Rural Electrification Administration, Washington, DC
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Lewis and Clark
Lolo

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Lassen
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Six Rivers

National Forest Nurseries

Chico Tree Improvement Center, Mendocino National Forest, CA
Humboldt, Six Rivers National Forest, CA
Placerville, Eldorado National Forest, CA
Coeur d'Alene, Idaho Panhandle National Forest, ID
Lucky Peak, Boise National Forest, ID
J. W. Toumey, Ottawa National Forest, MI
W. W. Ashe, National Forests in Mississippi, MS
Bessey, Nebraska National Forest, NE
Bend Pine, Deschutes National Forest, OR
Dorena Tree Improvement Center, Umpqua National Forest, OR
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Wind River, Gifford Pinchot National Forest, WA

Experiment Stations

Intermountain	Pacific Northwest	Southeastern
North Central	Pacific Southwest	Southern
Northeastern	Rocky Mountain	Forest Products Lab

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NOAA Ecology and Conservation Division, Washington, DC

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US Navy, Environment Protection Division, Washington, DC

Department of Energy

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Washington, DC
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Department of Interior

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Bureau of Indian Affairs, Washington, DC; Sacramento, CA; Portland, OR
Bureau of Land Management, Offices in the states of California, Idaho, Oregon, and Washington
Fish and Wildlife Service, Sacramento, CA; Portland, OR; Olympia, WA
National Park Service, Friday Harbor, Seattle, WA; Crater Lake, OR

Department of Labor

Mine Safety and Health, Arlington, VA
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Environmental Division, Washington, DC
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Federal Highway Administration, Washington, DC; Northwest Mountain Region, Portland, OR
Office of Pipeline Safety, Washington, DC
US Coast Guard, Water Resources Coordination, Washington, DC

Environmental Protection Agency

Federal Agency Liaison Division, Washington DC; Region 10, Seattle, WA

General Services Administration

Environmental Staff, Washington, DC

Nuclear Regulatory Commission

Environmental Projects Office, Washington, DC
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Idaho
Montana
Oregon
Washington

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California
Idaho
Montana
Oregon
Washington

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Trinity County Board of Supervisors, Weaverville, CA

Oregon:

Jackson County Planning Department, Medford, OR
Lane County Board of Commissioners, Eugene, OR
Lincoln County Board of Commissioners, Newport, OR
Tillamook County Board of Commissioners, Tillamook, OR

City of:

Bend, OR
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Washington:

Benton-Franklin Regional Council, Richland, WA

City of:

Everett, WA
Grays Harbor Regional Planning Commission, Aberdeen, WA
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Other Agencies

Califomia:

California Department of Fish & Wildlife, Rancho Cordova, CA
California Department of Forestry & Fire, Davis, Santa Cruz, CA

Idaho:

Idaho Department of Lands/Insect/Disease, Boise, Orofino, ID
Idaho Department of Water Resources, Boise, ID

Oregon:

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Clackamas County Forest Program, Oregon City, OR
Confederated Tribes of Coos, Lower Umpqua & Siuslaw Indians, Coos Bay, OR
Josephine County Forestry, Grants Pass, OR
Oregon Department of Fish & Wildlife, Corvallis, OR
Oregon Department of Forestry, North Bend, OR
Oregon Health Division, Portland, OR

Washington:

Washington Department of Fisheries, Olympia, WA
Washington Department of Natural Resources, Olympia, WA
Washington Department of Wildlife, Olympia, WA
Washington Department of Transportation, Bellview, Seattle, WA

Other States:

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VNT: Water Research Field Station, Denton, TX
Department of Natural Resources, Madison, WI

Other Countries:

Alberta Forest Service, Edmonton, Alberta, Canada
British Columbia Forest Service, Burnaby, Victoria, British Columbia, Canada
Council of Forest Industries of British Columbia, Vancouver, Canada
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Ministry of Forests, Burnaby, Victoria, British Columbia, Canada
Pacific Forestry Centre, Victoria, British Columbia, Canada

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Califomia:

SRI International, Menlo Park, CA

Oregon:

The Research Group, Corvallis, OR

Other States:

John Hopkins Hospital Oncology Center, Baltimore, MD
National Institutes of Health, Bethesda, MD
National Cancer Institute, Bethesda, Frederick, MD
Program Resource Inc/NCI-Frederick, Frederick, MD
The Upjohn Company, Kalamazoo, MI
Lederle Laboratories, Pearl River, NY
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Georgia Pacific Corporation, Atlanta, GA
Hawaii Biotechnology Group Inc., Aiea, HI
Zelenka Nursery Inc, Grand Haven, MI
Bristol-Myers Squibb Co, New Brunswick, Syracuse, NJ
Dr. Madis Laboratories, Inc., So. Hackensack, NJ
Union Camp Corporation, Princeton, NJ
Xechem, Inc., New Brunswick, NJ
Health Science Communication, New York City, NY
Medisperse LP, Rush, NY
Nursery Building Products Co, Enon Valley, PA
Rhone Poulenc Rorer, Collegeville, PA
Rogers Services, Beaver, PA
Rhode Island Nurseries, Middletown, RI
Garnay Inc, Sumpter, SC
Bio West Inc., Logan, UT
Labat-Anderson Inc., Arlington, VA
STRA Inc, Arlington, VA

Other Countries:

Ag-West Biotech, Saskatoon, Saskatchewan, Canada
Forestry Canada, Victoria, British Columbia, Canada
Pacific Forestry Centre, Victoria, British Columbia, Canada
TL Pacific Lumber LTD, Gabriola, British Columbia, Canada
The Atul Products Limited, Gujarat, India
Indena SPA, Milano, Italy

Interest Groups

Califomia:

Butte Environmental Council, Chico, CA
California Forestry Association, Sacramento, CA
Klamath Forest Alliance, Etna, CA
Karuk Tribe of California, Orleans, CA
Mendocino Environmental Center, Ukiah, CA
Northcoast Environmental Center, Arcata, CA
Sierra Club Legal Defense Fund, San Francisco, CA

Idaho:

Boundary Backpackers, Moyie Springs, ID
Kaniksu Bio Regional Council, Sandpoint, ID

Montana:

Alliance for the Wild Rockies, Missoula, MT
Coalition for Canyon Protection, Hungry Horse, MT
Friends of the Wild Swan, Swan Lake, MT
Montana Ecosystems Defense Council, Kalispell, MT
Montanans for Multiple Use, Hungry Horse, MT

Oregon:

Audubon Society, Ashland, Eugene, Portland, OR
Cascade Geographic Society, Rhododendron, OR
Chemeketans, Salem, OR
Citizen Advocates For Better Government, Eugene, OR
DHA, Estacada, OR
Dirt First, Veneta, OR
Forest Conservation Association, Coquille, OR
Headwaters, Ashland, OR
Izaak Walton League, Roseburg, OR
Labor Coalition For Environmental Responsibility, McMinnville, OR
Leopold Club, Brookings, OR
LM Christiansen Association, Corvallis, OR
Michael's Garden, Cascadia, OR
Molalla Timber Action Committee, OR
Native Plant Society of Oregon, Eugene, OR
Native Yew Conservation Committee, Portland, OR
Native Yew Conservation Council, Corvallis, OR
Northwest Forestry Association, Eugene, OR
Oregon Association of Nurserymen, Milwaukee, OR
Oregon Natural Resources Council, Eugene, OR

Oregon Shores Conservation Coalition, Portland, OR
Oregon Wildlife Federation, Portland, OR
Perpetual Forest Resources, Blue River, OR
Public Forestry Foundation, Eugene, OR
R & E Plant Project, Lake Oswego, OR
Retree International, Wilsonville, OR
Selma Citizen Advocates for Responsible Forestry, Selma, OR
Sierra Club, Ashland, Eugene, Portland, OR
Southern Willamette Earth First!, Eugene, OR
The Wilderness Society, Portland, OR
Western Mining Council, Inc, Merlin, OR
Wyeast Climbers, Beaverton, OR

Washington:

Audubon Society, Tacoma, WA
Entheos Mountain Agriculture, Seabeck, WA
Greater Ecosystem Alliance, Bellingham, WA
Forests and Streams Northwest, Seattle, WA
Lumni Indian Business Council, Bellingham, WA
Native Yew Conservation Committee, Bainbridge Island, WA
North Cascades Conservation Council, Seattle WA
Northwest Indian Fisheries Commission, Olympia, WA
NOTAC, Port Angeles, WA
Olympic Wilderness Evergreens, Port Angeles, WA
Pilchuck Audubon Society, Stanwood, WA
Quilcene Ancient Forest Coalition, Port Townsend, WA
Sierra Club, Sea Tac, Spokane, WA
Washington Native Plant Society, Seattle, Tacoma, WA
YMCA Earth Corps, Bremerton, WA

Other States:

American Botanical Council, Eureka Springs, AR
Glen Canyon Environmental Studies, Flagstaff, AZ
American Forest and Paper Association, Washington, DC
Breast Cancer Resource Committee, Washington, DC
National Wilderness Institute, Washington, DC
The Wilderness Society, Washington, DC
Idaho Assoc. of Soil Conserv. Dist., Buhl, ID
FDC Reports, Chevy Chase, MD
Society of American Foresters, Bethesda, MD
Columbia-Presbyterian Medical Center, New York, NY
National Council Air/Streams Imprv., New York, NY
Strang-Cornell Breast Center, New York, NY

Other States(cont.):

M D Anderson Cancer Center, Houston, TX
N Shenandoah Valley Audubon Society, Boyce, VA

Other Countries:

Rainforest Medical Foundation, Heemstede, The Netherlands

Schools

Califomia:

California State University, Chico, CA
College of The Redwoods, Eureka, CA
Fresno City College, Fresno, CA
Humboldt State University, Arcata, CA
San Francisco State University, Cazadero, CA
Stanford University, Stanford, CA
University of California, Davis, Irvine, Santa Barbara, CA

Idaho:

University of Idaho, Orofino, Moscow, ID

Oregon:

Chemeketa Community College, Salem, OR
Cleveland High School, Portland, OR
Lane Community College, Eugene, OR
Northwestern School of Law, Lewis & Clark College, Portland, OR
Oregon Institute of Technology, Klamath Falls, OR
Oregon State University, Astoria, Corvallis, OR
Rogue Community College, Grants Pass, OR
University of Oregon, Eugene, OR

Washington:

University of Washington, Seattle, WA
Washington State University, Bellingham, WA
Western Washington University, Bellingham, WA

Other States:

Arizona State University, Tempe, AZ
University of Connecticut, Storrs, CT
Yale University, New Haven, CT
George Washington University, Washington, DC
University of Florida, Gainesville, FL
University of Illinois, Chicago, IL
Indiana University, Bloomington, IN

Purdue University, West Lafayette, IN
University of Kansas, Lawrence, KS
Murray State University, Murray, KY
University of Kansas, Lawrence, KS
Northwestern State University, Natchitoches, LA
Harvard University, Jamaica Plain, MA
Massachusetts Institute of Technology, Cambridge, MA
University of Massachusetts, Amherst, MA
Johns Hopkins University, Baltimore, MD
Ferris State University, Big Rapids, MI
Northern Michigan University, Marquette, MI
University of Michigan, Ann Arbor, MI
University of Minnesota, Minneapolis, MN
Vermilion Community College, Ely, MN
Mississippi State University, Mississippi St., MS
University of Mississippi, University, Oxford, MS
University of North Carolina, Chapel Hill, NC
North Dakota State University, Fargo, ND
University of New Hampshire, Durham, NH
Rutgers University, Piscataway, NJ
William Patterson College, Wayne, NJ
Albert Einstein College of Medicine, Bronx, NY
Cornell University, Ithaca, NY
State University of New York, Stony Brook, NY
Bowling Green State University, Bowling Green, OH
Kent State University, Kent, OH
University of Akron, Akron, OH
Eastern Oklahoma State College, Wilburton, OK
Oklahoma State University, Stillwater, OK
Bryn Mawr College, Bryn Mawr, PA
Pennsylvania State University, University Park, PA
University of Pennsylvania, Philadelphia, PA
University of Tennessee, Knoxville, TN
Texas A & M University, College Station, TX
University of Texas, Austin, Houston, San Antonio, TX
Utah State University, Logan, UT
Johnson State College, Johnson, VT
University of Wisconsin, Madison, WI

Other Countries:

Universite Libre De Bruxelles, Bruxelles, Belgium
Acadia University, Wolfville, Nova Scotia, Canada
BC Institute of Technology, Burnaby, British Columbia, Canada
University Du Quebec A Chicoutimi, Chicoutimi, Ontario, Canada
University of Toronto, Toronto, Ontario, Canada
University of Victoria, Victoria, Canada
University of Joseph Fourier De Grenoble, Grenoble Cedex, France
School of Pharmacy, Dublin, Ireland
Kyoto University, Kyoto, Japan
University of Nijimege, Toernooiveld, The Netherlands
Wolfson Institute of Biotechnology, University of Sheffield, Sheffield, United Kingdom

Libraries

California:

Del Norte County Library, Crescent City, CA

Oregon:

Douglas County Library, Roseburg, OR
Humboldt County Library, Eureka, OR
Lake Oswego Public Library, Lake Oswego, OR
Lavola Bakken Research Library, Roseburg, OR
Oregon State Library, Salem, OR
Sheridan Public Library, Sheridan, OR

Washington:

Camas Public Library, Camas, WA
Research Library, Duvall, WA
Seattle Public Library, Seattle, WA
Spokane Public Library, Spokane, WA
Vashon Library, Vashon Island, WA
Weyerhaeuser Company Library, Centralia, WA

Other States:

Tall Timbers Research Station Library, Tallahassee, FL
Missouri Botanical Garden Library, St. Louis, MO
Nevada State Library, Carson City, NV

Media

Califomia:

Record Searchlight, Redding, CA
The Times Standard, Eureka, CA
Wall Street Journal, San Francisco, CA

Oregon:

Argus Observer, Ontario, OR
Aspect Productions, Eugene, OR
Associated Press, Portland, Grants Pass, OR
Business Journal, Portland, OR
Health Magazine, Portland, OR
Hulogosi Publishers, Eugene, OR
KOPB-FM, Portland, OR
KVAL-TV, Eugene, OR
Random Lengths Publications, Eugene, OR
The Bulletin, Bend, OR

Washington:

Loggers World Publication, Chehalis, WA
Tacoma News Tribune, Tacoma, WA

Other Countries:

Times-Colonist, Victoria, British Columbia

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Everett Peterson, Roseburg, OR
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Tim Scullen, Gold Beach, OR
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Howard E Smith, Eugene, OR
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Donald Steiner, Portland, OR

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Don & Peg Townsend, Salem, OR
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Anthony D Warren, Albany, OR
Floyd Weitzel, Eugene, OR
Stephanie Weise, Tigard, OR
G Greeley Wells Jr, Jacksonville, OR
George Williams, McMinnville, OR
Clarence A Williams, Jacksonville, OR
Donna P Wooley, Drain, OR
Toni Y Wyatt-Kirkeby, Coos Bay, OR
Ron Yochim, Roseburg, OR
Arthur Zimmer, Alvadore, OR
Keith Zimmerman, Lyons, OR

Washington:

Sydney Abrams, Mercer Island, WA
Phil Andrus, Chimacum, WA
Robert Bacus, Roy, WA
Ron & Nettie Barca, Vancouver, WA
Matthew Bergvall-Mensor, Republic, WA
Barney Bernhard, Bremerton, WA
Maurice Bernier, Randle, WA
Carol Bordin, Sequim, WA
Kalman Brauner, Seattle, WA
Robert Brockhaus, Seattle, WA
John Brugman, Toutle, WA
Lois & George Bruhn, Glenoma, WA
Leland L Bull Jr, Seattle, WA
Le Roy Burns, Vancouver, WA
Eva M Campbell, Bellingham, WA
Shari Campbell, Yelm, WA

Walter Carriveau, Spokane, WA
Ralph K Coon, Olympia, WA
Robert Corbett, Tacoma, WA
Paul & Deborah Crosetti, Ashford, WA
Ruth Deery, Longview, WA
Charles Delp, Camas, WA
Jennifer Evans, Bellevue, WA
William J Giberson, Seattle, WA
Mike Gillett, Seattle, WA
Jerry Gorsline, Port Townsend, WA
Al Graft, Shelton, WA
Liz Greenhagen, Seattle, WA
Donald W Hack, Longview, WA
Ben Hayward, Yakima, WA
R Gary Henry, Packwood, WA
Jacquelin M Hoffman, Vancouver, WA
Brenda Noelani Hong, Bellingham, WA
Howard K Hopkins, Longview, WA
Lawrence M Jacobson, Olympia, WA
Ralph Jaszkowski, Oak Harbor, WA
Susan Jenny, Ashford, WA
Helen Johnson, Cook, WA
Katherine Johnson, Lake Stevens, WA
Arnie Kubiak, Bainbridge Island, WA
Mark Lange, Sequim, WA
Mike Lazzari, Friday Harbor, WA
John A Lee, Seattle, WA
Mrs Joe Leonard, Lilliwaup, WA
Rosemary Lhursen, Shelton, WA
Phil Loe, Seattle, WA
Bill Maguire, Redmond, WA
Everett J Martin, Spokane, WA
Kuno Masterson, Everett, WA
Louis W Messmer, Aberdeen, WA
Linda Moore, Everett, WA
Peter Morrison, Seattle, WA
Ms Justine Nagel, Vashon, WA
Beth Nelson, Everson, WA
Steve Ness, Shelton, WA
Harold Nyberg, Poulsbo, WA
Catherine O'Donnell, Vashon, WA

Paul Peterson, Mossyrock, WA
Peter Reisert, Packwood, WA
Sylvia E Retherford, Home, WA
Judith Roan, Mercer Island, WA
Tim Robbins, Everett, WA
Meg Roellich, Newport, WA
Geraldine Sabotta, Olympia, WA
Mrs Walter Schultz, Vancouver, WA
Dennis Sherwood, Gig Harbor, WA
Hilda Skott, Steilacoom, WA
Arnold C Slater, DVM, Olympia, WA
Sandra Smith, Quilcene, WA
George A Smith, Twisp, WA
Ira Spring, Edmonds, WA
Del J Staff, Kent, WA
Albert Suter, Mineral, WA
Barbara Tarilton, Seattle, WA
Judy Teitzel, Carson, WA
Dr. John L Thompson, Carbonado, WA
Dennis Tomkins, Sumner, WA
Joan Tracy, Cheney, WA
Gary Westerlund, Kent, WA
Stanley G & S Anne Willard, Granite Falls, WA
Benton G Williams, Port Orchard, WA
Douglas & Carol Williscroft, Seattle, WA
Harry E Wilson, Bremerton, WA
Gene Wirsig, Clarkston, WA
Edward Wolf, Seattle, WA
Neil Woolman, Randle, WA
Richard & Elsie Zarnowitz, Bellingham, WA

Other States:

Thomas R Boutin, Anchorage, AK
Christine Heady, Craig, Ak
Eva Daniels, Phoenix, AZ
Kurt Flynn, Glendale, AZ
Bill Gershar, Phoenix, AZ
Jerry Gonzales, Flagstaff, AZ
Lynn Briggs, Grand Junction, CO
Louis A Lepry, Englewood, CO
Charles P Van Epps, Broomfield, CO

Paul Friesema, Evanston, IL
Gerhard & Dorothy Pilz, Alton, IL
Tricia R Sears, Lawrence, KS
Penelope Scott, Baltimore, MD
Ken & Susan Ulrey, Ann Arbor, MI
Michelle Hove, Minneapolis, MN
Edward M Croom, Oxford, MS
John Geddie, Albuquerque, NM
Donald Carpenter, Mountain City, NV
Michael Colavito, Chappaqua, NY
Rustin R Howard, Freeville, NY
Miss Elsie Grapentin, Parma, OH
Mark Treece, Dayton, OH
Carla L Phillips, Lititz, PA
Wallace McIntyre, Hilton Head Island, SC
Paige Muchmore, Carrollton, TX
Elizabeth Summers, Fort Worth, TX
Kevin Holladay, Moab, UT
Andrew McKnight, Middleburg, VA

References Cited

References Cited

All documents cited are available at universities, libraries, or from Federal agencies such as the USDA Forest Service.

In the text of this document, references are cited in parentheses using the author-year system of citation. When an organization (such as a governmental agency or scientific society) is listed as the author in the parenthetical citation, an acronym or an abbreviation form of that organization's name generally is used in place of its full title. Below is a list of acronyms and abbreviations that are used in citations, along with the corresponding full titles that are used in this reference section:

PNW	Pacific Northwest
USACE	U.S. Army Corps of Engineers
USDA, FS	U.S. Department of Agriculture, Forest Service
USDC	U.S. Department of Commerce
USDE	U.S. Department of Energy
USDI	U.S. Department of the Interior
USDI, BLM	USDI, Bureau of Land Management

In addition, three other abbreviations are used. FSM is used to cite Forest Service Manuals, while FSH is used to cite Forest Service Handbooks. For example, FSM 2109.11 refers to Forest Service Manual 2109.11. These manuals and handbooks are located in most Forest Service offices. The abbreviation CFR refers to the Code of Federal Regulation. A parenthetical reference such as (29 CFR 1910.1200) cites book 29, section 1910.1200 of the Code of Federal Regulation. These are available at many federal government offices, and some public and university libraries. Citation for FSM and CFR are not included in the following literature cited section since the parenthetical reference provides all the information needed to locate the document.

A

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B

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C

Carey, A.B. 1991. The biology of arboreal rodents in Douglas-fir forests. In: Huff, M.H.; Holthausen, R.S.; Aubry, K.B., tech. coords. 1991. Biology and management of old growth forests. Gen. Tech. Rep. PNW-GTR-276. Portland, OR: USDA, FS, PNW Research Station. 46 p.

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Glossary

Glossary

A

Abundance: An estimation of the numbers of individuals in an area.

Adventitious: Plant organs produced in an unusual or irregular position, or at an unusual time of development.

Allele: One of a series of possible alternative forms of a given gene, differing in DNA sequence, and affecting the function of a single product (RNA and/or protein).

Allelopathy: The biochemical inhibition between organisms caused by the release of metabolic substances into the environment.

Apical dominance: The influence exerted by a terminal bud in suppressing the growth of lateral buds that usually results in stem elongation.

Aquatic: Living or growing naturally in or under water.

Aril: The fleshy, berry-like structure that encases the seeds on female yew trees.

Axil: The angle between the stem and a branch, or any appendage attached to it.

B

Bark stripping: The mechanical removal of the bark from a stem on live standing trees or logs.

Broadcast burn: A prescribed fire that is spread uniformly over an area.

C

Cambium: The layer of growing cells located between the inner bark and the wood which is responsible for the increase in girth of stems or trunks.

Canopy cover: The horizontal projection of the upper vegetation layer onto the ground.

Cervil: A member of the deer family (deer, elk, caribou, moose).

Clearcut: A type of harvest where an entire stand of trees is removed in one cutting operation, leading to the establishment of an even-aged stand.

Climax plant community: A mature, highly stable, self-replacing plant community (Clements, 1916). It is the end result of the successional development of a plant community, in the absence of disturbance.

Clinal: A gradual change in a trait or in the frequency of a trait within a species over a geographical area.

Clone: A group of genetically identical individuals.

Common garden study: An investigation in which different seed sources are grown in a uniform environment to examine genetic variation in traits.

Community: All of the populations in a given area.

Complex of plant communities: The spatial arrangement of plant communities across the landscape.

Constancy: The frequency of occurrence of a species throughout a plant association or plant community type (not the same as the frequency within a particular plant community); it is the number of stands in which a species occurs expressed as a percentage of the total stands sampled and used to define a particular plant community type or plant association.

Coppice system: A silvicultural system in which trees are regenerated vegetatively from stump sprouts.

Cover: Vegetation used by wildlife for protection; see thermal cover and hiding cover.

Critical winter range: The portion of the area used by a species that is essential for survival of a population or a species during severe winter conditions.

Cytotoxic: A substance that kills cells.

D

Designated Conservation Area (DCA): See owl conservation areas.

Dioecious: Plants having male and female reproductive parts on different individuals; contrast with monoecious.

Double canopy: Forest stands with a tall overstory of trees over a second layer of shorter trees both providing cover to the ground.

Dominant: A species, due to its size and numbers, that determines the character of a plant community, typically the most abundant species in the tallest layer of vegetation.

Down woody material: Fallen trees, branches, etc., which contribute to the organic layer of the forest floor.

E

EA: Environmental Assessment; a document required by the National Environmental Policy Act because the proposed action might have significant environmental impacts.

Ecology: The study of the relationship between organisms and their environment.

Ecosystem sustainability: This concept represents a balance of all the interrelated aspects of an ecosystem that allows the system to maintain and perpetuate itself throughout time.

EIS: Environmental Impact Statement; a document required for major federal actions under Section 102 of the National Environmental Policy Act in which anticipated environmental effects of alternative courses of action are evaluated.

Electrophoresis: A laboratory technique used to distinguish biological entities by inspecting the differential movement of charged molecules through a porous medium in an electric field.

Endangered: Those species in danger of becoming extinct throughout all or a significant portion of their range.

Epicormic: Adventitious buds or shoots that develop laterally on the trunk of a tree.

Epiphytic: Living on the surface of plants.

F

Forest health: Describes the forest's ability to meet the goals of the land manager and the landowner. In a broader sense, it also describes the "relationship between biotic and abiotic influences, including the influence of human activities, on forests and their short and long-term impact on management objectives for a forest unit."

Forest plan: A summary of the analysis of the management situation for each national forest, which describes multiple-use goals and objectives and includes a description of the desired future condition of the forest. Each forest plan contains multiple-use prescriptions and associated standards and guidelines for each management area, as well as monitoring and evaluation requirements that will provide a basis for a periodic determination and evaluation of the effects of management practices.

Fuel ladder: Combustible materials that usually connect burnable ground vegetation and material to the crowns of trees, thus providing a means for a ground fire to climb into the canopy of trees.

G

Gamete: A reproductive cell. The female gamete and male gamete unite to form the cell that develops into a new individual.

Gene migration: The movement of alleles between populations. In plants this is accomplished by pollen and/or seed movement.

Genetic drift: Chance fluctuations in allele frequency due to small numbers of parents contributing to the next generation.

Genetic variation: The divergence among individuals or populations that is attributed to differences in their genetic constitution.

Genotype: The genetic constitution of an individual or group that may be either expressed or unexpressed, depending on the environmental effects of a given location; contrast with phenotype.

GIS: Geographic Information System, which is a means of storing, retrieving, and analyzing spatial (mappable) data.

GST values: Indicate the proportion of genetic diversity due to differences among different populations.

H

Habitat: The sum total of environmental conditions of the place where a population or species normally lives and grows.

Habitat Conservation Area (HCA): See owl conservation areas.

Habitat type: All land areas potentially capable of producing similar plant communities at climax or the same plant association.

Heterozygosity: The condition of having one or more pairs of dissimilar alleles at a locus.

Hiding cover: Any vegetation used by wildlife for security or to escape from danger.

Horizontal structure: The distribution and spatial arrangement of life forms and species.

I

Indicator species: Plant or animal species which signify certain environmental conditions.

Induced soil compaction: Whenever soil is compacted, that is, made denser, from weight exerted against it by foot or other traffic.

Induced soil displacement: The removal or rearrangement of surface soil and plant litter.

Intense fire: Fires which burn hot enough to consume much of the forest floor organic matter, along with most of the vegetation and surface fuels in a stand.

Internode: The length of stem between branches or leaf attachments.

Isozyme: Different forms of the same enzyme.

L

Late-successional forests: In this analysis, refers to mature and old-growth forests.

Layering: Adventitious rooting along a branch usually attached to the parent plant; see vegetative reproduction.

Leachates: Soluble constituents removed through percolation of water.

Light ground fire: A prescribed, often patchy fire, creating a mosaic of burned and unburned areas.

Light regime: The amount of sunlight reaching various levels of the forest canopy.

Local management area: For the Forest Service, management planning area generally not greatly exceeding 20,000 acres in a single National Forest System watershed (fourth or fifth-order stream basin.) For the Bureau of Land Management, a tree seed zone as established by the Western Forest Seed Tree Council.

Locus (plural, loci): Location of a gene on a strand of DNA.

M

Management area: An aggregation of areas which have common management direction and may be noncontiguous in the forest.

Mature tree: An individual plant that has or is capable of producing seed or pollen; sexually mature.

Metastatic: Cancers which tend to spread from one body part to another.

Microclimate: The climate in the immediate vicinity of an organism or of a local habitat.

Midstory: Portion of vegetation which forms the intermediate vertical structural position below the overstory canopy.

Monoecious: Plants with male and female parts in different structures but on the same individual; contrast with dioecious.

Morphological: The form and structure of an organism.

Multilevel canopy: A forest stand structure in which several levels of shrub and tree branches are present. Pacific yew, for example, is an understory and midstory canopy level species. Douglas-fir and western hemlock are overstory canopy level species.

Mycorrhizae: A symbiotic association between a root tip of a plant and one of several species of fungus. The mycorrhizal relationship aids a plant in absorbing water and minerals.

N

Node: The region on a stem where leaves or branches are attached.

Non-sale area: For this analysis, an area in a national forest or district where no timber sales are scheduled in the next five years, but where yew harvest is allowed according to land use plans.

Nutrient Cycling: A continuous series of natural processes by which nutrients pass through successive stations in water, soil, and organisms.

O

Old growth: A forest comprised of many large trees, large snags, and numerous large down logs with a multilayered canopy composed of several tree species, usually the final or a transitional stage of forest stand development.

Overstory: The portion of vegetation that forms the uppermost canopy later in a community.

Owl conservation areas: Those areas formally designated for protection of the northern spotted owl. They provide a contiguous block of habitat to be managed and conserved for breeding pairs, connection between blocks of habitat, and for proper distribution of the owls. **Habitat Conservation Areas** (HCAs), as described in the Final EIS on Management for the Northern Spotted Owl in the National Forests, will be the type of owl conservation area used on national forests. For BLM forest lands, owl conservation areas are defined as Old-Growth Emphasis Areas (OGEA), Connectivity Areas (CON), and Owl Pair Sites (OPS), as described in the preferred alternative of the BLM's draft resource management plans and Klamath Resource Area Management Plan.

P

Partial-cut sale unit: An area within a timber sale which has a silvicultural prescription to cut only part of a stand. Techniques which involve partial cutting include thinning, salvage operations, and prescriptions designed to produce an uneven-aged stand of trees.

Peridotite: A general term for essentially nonfeldspathic plutonic rocks consisting of olivine, with or without other mafic minerals. The mafic minerals may be amphiboles, pyroxenes, or in some examples micas. Minerals of the spinel group are common constituents.

Phase: A subdivision of habitat type or association that represents variation in geographic, environmental, floristic, historic, or structural differences in climax or mature vegetation.

Phenotype: The physical attributes of an organism that result from the interaction of its genetic composition and the environment; contrast with genotype.

Phenotypic variation: Total variation between phenotypes.

Phloem: The principle food-conducting tissue of a vascular plant; when located on the trunk it lies between the cambium and the bark and generally is called the inner bark.

Phylogenetic analysis: Analysis used to determine relationships among taxonomic groups.

Physiographic province: A region where all parts are similar in geologic structure and climate, and where the geomorphic history, consequently, has been unified. Provinces differ significantly in the pattern of relief features or landforms.

Pioneer: An organism that establishes itself on a relatively or completely bare area with little or no competition.

Plagiotrophic growth: The horizontal growth of branches, stems, and roots.

Plant association: A unit of plant community classification typically based on potential vegetation; consult each reference for specific definition.

Population: A group of individuals of any one kind of organism.

Prescribed burn: Fire deliberately set to reduce fuels in an area; boundaries carefully controlled to prevent spread to other areas.

Proembryology: Examination of the development of reproductive buds.

Proposed species: Those species that are under consideration for listing as endangered or threatened species.

Prostrate: For this analysis, refers to a branch or trunk growing flat on the ground.

R

Regeneration: Young trees arising from seed or from vegetative regrowth from stumps, branches, or roots.

Regeneration harvest: Any removal of trees intended to assist regeneration already present or to make regeneration possible.

Reserve: An area set aside for a particular purpose or condition.

Residual green tree reserve: Green trees left on a site to provide a local seed source or for other purposes. Where silvicultural prescriptions call for retaining green trees, the inclusion of yew trees in the green tree reserve provides a local seed source for natural regeneration.

Resource management plan: A land use plan prepared by the BLM under current regulations in accordance with the Federal Land Policy and Management Act.

Riparian: Pertaining to areas associated with or directly influenced by streams, ponds, or lakes.

S

Seedbed: The soil or other stratum onto which seed falls, overwinters, and germinates.

Seed tree cut: A type of harvest similar to a clearcut, except that a few of the better trees of the desired species are left scattered over the area to provide seed for regeneration.

Selection: The differential survival of genotypes under a particular environment that preferentially yields individual characteristics; a process of evolution (natural selection) or of selective breeding (artificial selection).

Sensitive: Those species designated by regional foresters or BLM state directors for which population viability is a concern. Sensitive species are not federally designated under the Endangered Species Act.

Seral stage: A defined transitory step in an ecological succession.

Series: A group of associations or habitat types with the same climax or potential tree species.

Serpentine: The name includes at least two distinct minerals, antigorite and chrysotile, very difficult to distinguish. Most asbestos is chrysotile. A common rock-forming mineral. ($Mg_3Si_2O_5(OH)_4$).

Set-aside areas: For this EIS, these are defined as lands where timber harvest is precluded by other resource management objectives.

Sexual reproduction: Reproduction involving the formation of gametes and fertilization to form a unique genotype; in trees, sexual reproduction results in formation of seed; contrast with vegetative reproduction.

Shelterwood cut: A type of harvest method where a portion of the mature stand is retained as a source of seed and/or protection during the period of regeneration. The mature stand is removed in two or more cuttings.

Site preparation: Any planned measure used to prepare a site for the establishment of artificial or natural regeneration.

Slash: Branches and other woody material left on a site after logging; often removed by burning or piling in one spot.

Snow interception: When overstory and mid-level forest vegetation acts to catch some falling snow, reducing snow depths on the forest floor. This allows for easier movement for wildlife, and helps make food more available. This function has been recognized as being especially important in some moose winter range areas.

Snowmelt-dominated stream flow regime: Typically has one peak flow period which commences with snowmelt and terminates with the onset of base flow, or the period when groundwater releases regulate flow levels.

Standard deviation: In statistics, a measure of dispersion in a frequency distribution; a measure of variability; the square root of the mean of squares of the deviations from the mean.

Standard error: In statistics, the standard deviation divided by the square root of the number of observations.

Stratification: A method for overcoming seed dormancy which usually involves varying temperature and moisture storage times.

Strobili: Cones; structures with spore-bearing (e.g. pollen) or ovule-bearing appendages concentrated on a common axis.

Succession: The sequence of change in communities during development of vegetation in an area; often broken into seral stages.

Subdominant: A species growing below the tallest layer of vegetation and, due to its abundance, has an important influence on the character of a community.

Suppressed: Plants whose growth and health are reduced by the presence of other plants, typically trees under a closed canopy and receiving very little or no direct sunlight.

Sustained Yield of Products and Services: The achievement and maintenance in perpetuity of a high-level annual or regular periodic output of the various renewable resources of the National Forest System without impairment of the productivity of the land.

T

Taxane: A chemical compound (such as taxol) found in yew species.

Thermal cover: Vegetative cover used by animals to modify the adverse effects of weather, usually temperature extremes.

Threatened: Those species that are likely to become endangered in the foreseeable future.

Timber sale unit: An area within a timber sale which has a silvicultural prescription for a (1) clearcut, (2) shelterwood, or (3) seed tree harvest method. It also refers to an area that is to be cleared for road or building construction.

Tree seed zones: These are used for BLM lands and refer to the areas established by the Western Forest Tree Seed Council; they delineate areas of similar climatic and geographic conditions.

U

Ultramafic: Some igneous rocks and most varieties of meteorites containing less than 45 percent silica and virtually no quartz or feldspar, and composed essentially of ferro magnesium silicates, metallic oxides and sulfides, and/or native metals.

Understory: Vegetation growing under the canopy of taller vegetation.

Ungulate: Hoofed mammals, for example, moose, elk, and deer.

V

Vegetative reproduction: The asexual formation of offspring by layering, sprouting, rhizomes, tubers, or other vegetative means that are genetically identical to the parent.

Vertical structure: The layering of vegetation, the vertical arrangement of herbs, shrubs, midcanopy and canopy trees, and snags.

W

Water quality degradation: The alteration of chemical, physical, and biological properties of water. Sediment production is the most frequently mentioned indicator of water quality degradation.

Winter range: See critical winter range.

X

Xenograft: A tissue graft carried out between members of different species.

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