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The Northern Goshawk in Utah: Habitat Assessment and Management Recommendations

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Abstract

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This assessment describes northern goshawk (*Accipiter gentilis*) habitat in the State of Utah. Because of fire exclusion, insect and disease epidemics, timber harvest, livestock grazing, or a combination of these factors the forests and woodlands of Utah have changed drastically since the early 1900's. Forests are now dominated by mid- and late successional species (Douglas-fir, white fir, and subalpine fir) rather than the early successional species (lodgepole and ponderosa pine). Along with these changes came suspected declines in goshawk populations. Goshawk habitat in Utah was assessed using potential vegetation types, current vegetation types, and expert knowledge. Subalpine fir (17 percent) and quaking aspen (10 percent) potential vegetation types were the most common forest types in the State. Nearly 95 percent of the subalpine fir potential vegetation type was rated as high or medium for nesting habitat, while nearly 90 percent of the quaking aspen potential vegetation type was rated as high or medium for nesting. Similarly, combining nesting and foraging preferences 70 percent of the subalpine fir potential vegetation type is rated as either high value or optimum habitat. In addition, throughout Utah all of the high value habitats are well connected. The present conditions of the forests and woodlands of Utah are prone to insect and disease epidemics in addition to the risk of stand replacing fires. To ensure the goshawk's continued existence in Utah will require the restoration of these degraded habitats and the protection of native processes.

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Contents

Page

Executive Summary i
Issue i
Questions i
Northern Goshawk and Its Habitat ii
Habitat Assessment ii
Recommendations v
Assessment Questions vi
Introduction 1
Background 2
General Taxonomy and Distribution 2
Historical Distribution in Utah 2
Characteristics of Occupied Habitats in Utah 2
Nesting Habitat 2
Nest Site Characteristics 3
Foraging Habitat 5
Nonbreeding Season Habitat 6
Factors Influencing the Species 7
History of Goshawk Conservation Efforts 7
Livestock Grazing 7
Fire Suppression 8
Timber Harvest 8
Insect and Disease Outbreaks 8
Competition, Predation, and Disease 9
Status and Distribution of Habitat in Utah 9
Habitat Assessment 9
Potential Vegetation Type Descriptions 10
White Fir 10
Subalpine Fir 11
Lodgepole Pine 11
Engelmann Spruce 11
Ponderosa Pine 12
Douglas-fir 12
Quaking Aspen 12
Pinyon/Juniper 12
Delineation of Potential Vegetation Types 13
Current Habitat 13

Page

Habitat Valuation Process 15
Nesting Habitat 15
Foraging Habitat 18
Combined Habitat Rankings 20
Habitat Connectivity 24
Trends and Risks to Habitat 26
Natural Threats 26
White Fir 26
Subalpine Fir 26
Lodgepole Pine 30
Engelmann Spruce 30
Ponderosa Pine 30
Quaking Aspen 31
Douglas-fir 31
Pinyon/Juniper 31
Administrative Threats 32
Threats From Management Activities 32
Recommendations 38
State of Utah Recommendations 38
Nest Sites 39
Foraging Areas and General Home Range 39
Potential Vegetation Type Recommendations 39
Subalpine Fir 39
Lodgepole Pine 39
Engelmann Spruce 40
Ponderosa Pine 40
Quaking Aspen 40
Douglas-fir 40
White Fir 40
Pinyon/Juniper 41
Assessment Questions 41
References 42
Appendix A 47
Northern Goshawk Interagency Technical Team 47
Northern Goshawk Technical Contributors 47
List of Reviewers 48

Executive Summary

This assessment describes northern goshawk (*Accipiter gentilis*) habitat in the State of Utah. It can be used in both regional and sub-regional level planning. At these levels, this assessment should (1) provide information on the location and connectivity of habitat that can be used to make more informed decisions for managing both public and private lands; and (2) complement other regional assessments such as the Interior Columbia Basin (Quigley and others 1996) or the USDA Forest Service Intermountain Region's Proper Functioning Condition assessment (USDA Forest Service 1997).

At the local level (forest level and lower) this assessment outlines a process that should be used to describe goshawk habitat, proper functioning condition, or other forest or woodland characteristics of interest. At this level, fine resolution data should be used to describe these characteristics, and this assessment can be used to provide context. In addition, at this level, the management recommendations for the northern goshawk in the Southwestern United States (Reynolds and other 1992) should be used to help prepare site prescription. Data in this assessment are too coarse for making site specific prescriptions and should only be used to provide context and describe processes when used at these levels. In addition, this assessment does not prescribe implementation methods. It describes desired conditions, with managers needing to decide how and if they will be used. This assessment describes goshawk habitat and does not describe goshawk demographics, nor does it directly address goshawk population viability.

Issue

Changes in forest structure, large tree removal, and other forest developments singly or in combination may negatively affect northern goshawk populations (Crocker-Bedford 1990). These changes in habitat could be associated with timber harvest, changes in fire regimes, insect and disease epidemics, or with livestock grazing or all these activities. Perhaps one of the greatest impacts on habitat loss is the lack of fire within the ecosystem. Successful fire exclusion, by altering native successional pathways, has dramatically altered forested ecosystems exemplified by ingrowth of shade-tolerant tree species throughout Utah. With these changes in habitat came suspected declines in goshawk populations in much of the Southwestern United States (Bloom and others 1986; Herron and others 1985; Kennedy 1989). Because of these suspected declines in goshawk population in July 1991, the USDI Fish and Wildlife Service announced a 90 day finding for a petition to list the northern goshawk in Utah, Colorado, New Mexico, and Arizona as endangered and to include critical habitat (USDI Fish and Wildlife Service 1997). Since this petition's acceptance, the USDI Fish and Wildlife Service determined that listing the northern goshawk as endangered was not warranted. Through court action in 1992 and 1997, the USDI Fish and Wildlife Service was ordered to revisit its decision, and ordered the agency to address the status of the goshawk in the Western United States.

Questions

To address the issue of declining goshawk habitat in Utah, the technical team, in consultation with forest managers, developed the following questions to guide the assessment:

1. Is there adequate nesting habitat available?
2. Is there adequate foraging habitat available?
3. Are northern goshawks able to move freely between habitat patches?
4. Is the population viable at the State level?
5. Where is the high value habitat?
6. How are current management policies affecting goshawks?
7. What are the important habitat trends and their implications for goshawks:

This assessment will attempt to address these questions.

Northern Goshawk and Its Habitat

Distribution of the goshawk is Holarctic with three recognized subspecies breeding in North America: the northern goshawk (*A.g. atricapillus*), Queen Charlotte (*A.g. laingi*), and the Apache (*A.g. apache*) (USDI Fish and Wildlife Service 1997). The northern goshawk—hereafter referred to for the sake of brevity as "goshawk"—is the largest and most widespread of the three subspecies of the genus *Accipiter* in North America. The goshawk lives in a variety of forest cover types throughout the State of Utah ranging from the subalpine environments typified by Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*) to pinyon/juniper (*Pinus edulis*/*Juniperus osteosperma*) woodlands bordering the grass and shrub lands. The forests in which goshawks forage and nest have been impacted by effective wildfire suppression throughout the West (Dieterich 1983; Keane and others 1990; McCune 1983; Stein 1988; Weaver 1961). Large numbers of seedlings and saplings in many forests have created "ladder" fuels that carry fires from the surface into the crowns (Madany and West 1980). This condition combined with a build-up of surface fuels, produces severe and intense crown fires.

Habitat Assessment

This assessment describes goshawk habitat for the State of Utah, the area in which recommendations and inferences as to the status of goshawk habitat were requested by the involved and cooperating parties. To understand the processes influencing goshawk habitat in Utah, and to disclose more immediate threats and risks to goshawk habitat in the State, a smaller geographic area was required. This geographic unit needed to provide interpretive power and be spatially explicit across the forest and woodlands of Utah, independent of ownership or administrative boundary. The geographic unit that was chosen was defined by potential vegetation. This classification system integrates a variety of physical and biological components including climate, soils, geology, and vegetation. For the assessment of goshawk habitat in Utah, we chose eight potential vegetation types.

Potential vegetation types were not delineated for Utah. Therefore, using Geospatial Analysis Processes data to identify patches of vegetation, 1,112 vegetative polygons of the forest and woodlands of Utah were identified. To each of these polygons, the potential vegetation type was assigned using inventory plot data points located near or in the polygon, and by local knowledge supplied by resource managers familiar with the area (table E1). Inventory points were random plots sampled by the Forest Inventory and Analysis (FIA) group of the Rocky Mountain Research Station. To each of the potential vegetation type polygons current vegetation was determined using a combination of potential vegetation type, Geospatial Analysis Processes, and FIA data along with expert knowledge (table E1).

Each vegetative polygon is the State was evaluated by wildlife biologists, as to their value for goshawk foraging and nesting. Each polygon was rated as high, medium, or low quality in four categories: goshawk nesting habitat, small to medium-sized mammal habitat, woodpecker habitat, and habitat for other medium-sized birds. These ratings were used to produce a combined goshawk rating for each of the polygons in the State. Areas were rated as high value habitat if they were rated high for nesting as also rated high for at least one prey group. This combined habitat rating would include areas where populations of one or two of the prey groups are expected to be abundant.

Habitat is connected and available to goshawks if it is accessible from existing population centers. If every patch can be reached and subsequently occupied, then all areas could be considered connected. Connectivity has positive implications for population viability because it allows individuals to emigrate to new areas with their current habitat declines in value. Connected habitat patches ensures that individuals will be available to re-colonize habitats or emigrate to new breeding territories throughout the State.

Although goshawks are clearly capable of traveling long distances to find suitable habitat, information available indicates that 20 to 60 mile movements are typical. Therefore, a maximum distance of 60 miles between patches of high value habitat would represent a conservative method of defining connectivity. This definition ensures that goshawks will be able to disperse freely throughout the State, always finding high value habitat (map E1).

The forests and woodlands of Utah are dominated by late seral species (table E2). Depending on the potential vegetation type, white fir (*Abies concolor*), subalpine fir (*Abies lasiocarpa*), Douglas-fir (*Pseudotsuga menziesii*), pinyon pine, and juniper often dominate the forests. In addition, most forests

Table E1—Proportion of the forests and woodlands in Utah in each potential vegetation type and the proportion of the forests and woodlands in Utah currently in different current cover types.

Potential vegetation type[a]		Current cover type[b]	
	Percent		*Percent*
White fir	7	White fir	6
Subalpine fir	17	Subalpine fir	8
Pinyon/juniper	50	Pinyon/juniper	51
Lodgepole pine	1	Lodgepole pine	2
Engelmann spruce	1	Lodgepole pine/quaking aspen	2
Ponderosa pine	5	Engelmann spruce	2
Quaking aspen	10	Engelmann spruce /subalpine fir	2
Douglas-fir	9	Engelmann spruce/lodgepole pine	4
		Ponderosa pine	4
		Cottonwood	1
		Quaking aspen	9
		Douglas-fir	2
		Douglas-fir/quaking aspen	6
		Gambel oak/big tooth maple	1

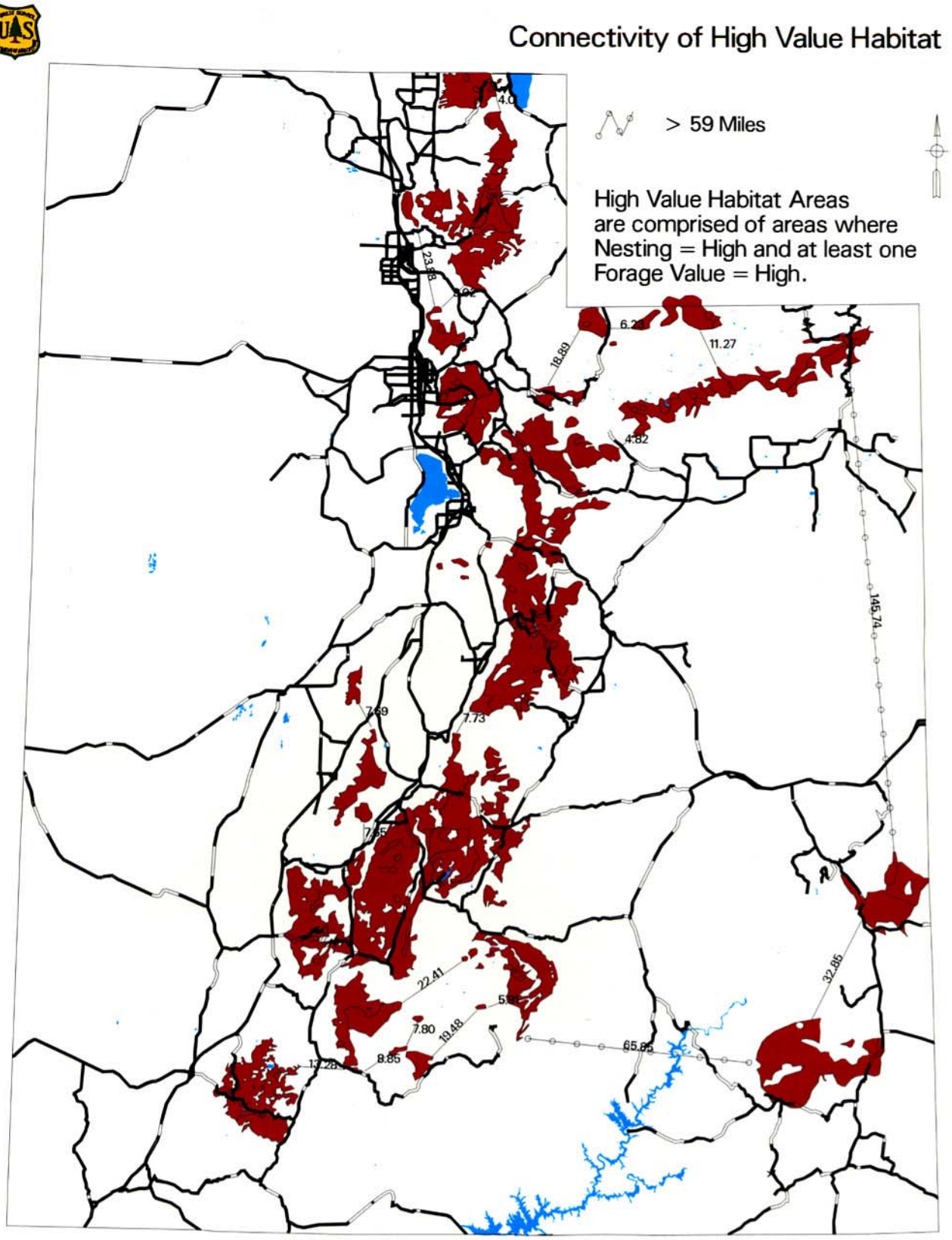
[a]Potential vegetation type: Defined as a classification system that integrates a variety of physical and biological components including climate, soil, geology and vegetation. These are identified by species indicative of similar conditions (Hann and other 1997)
White fir = *Abies concolor*
Subalpine fir = *Abies Lasiocarpa*
Lodgepole pine = *Pinus contorta*
Engelmann spruce = *Picea engelmannii*
Ponderosa pine = *Pinus ponderosa*
Quaking aspen = *Populus tremuloides*
Douglas-fir = *Pseudotsuga menziesii*
Pinyon/juniper = *Pinus edulis*/*Juniperus oesteosperma*
[b]Cover type: Defined as a plurality of one species or a mixture of two or more species in a particular forest or stand.
Cottonwood = *Populus* spp.
Gambel oak = *Quercus gambelii*
Big tooth maple = *Acer grandidentatum*

contain many seedlings and saplings, creating dense forests prone to insect, disease, and stand replacing fires. Ponderosa pine (*Pinus ponderosa*), quaking aspen (*Populus tremuloides*) and lodgepole pine (*Pinus contorta*), which are early and mid-seral species in most potential vegetation types, are often poorly represented. Moveover, quaking aspen is one of the most important cover types supporting goshawks in Utah. Forests dominated by late seral species in general are more unstable in both the short- and long-term than forests dominated by early and mid-seral species. In addition to being unstable and at risk to stand replacing fires because of dense stands with many canopy layers, these same conditions make them undesirable for both nesting and foraging by goshawks.

No other potential vegetation type is so dominated by late seral species as pinyon/juniper (table E2). With this condition and the indeterminate successional pathways present, the short-term prognosis for the type is a continued dominance of pinyon and juniper. Throughout the State, attempts to convert stands to early and mid-seral stages have had limited success. The introduction of exotics (cheat grass, *Bromus tectorum*) also changes successional pathways and alters fire regimes.

Owners or administrators of the forests and woodlands of Utah include these entities: the USDI National Park Service, USDI Bureau of Land Management, USDA Forest Service, private, State of Utah and Native Americans. By far, the USDA Forest Service administers the majority of the forests and woodlands in Utah. Also, these lands contain the majority of the high and medium valued nesting habitat, and the majority of the high value combined foraging and nesting habitat.

The USDA Forest Service manages lands for a variety of objectives ranging from intensive forest management to recreation. Range management is emphasized on 17 to 23 percent of the forest and



Map E1—Connectivity of high value habitat patches (Lands considered high value for nesting and high value for at least one of the prey groups—mammals, woodpeckers, or other birds—were considered high value) showing connections. High value habitat was considered connected if an adjacent patch was within 60 miles.

Table E2—Proportion of each potential vegetation type currently in various forest cover types.

Current cover[b]	Potential vegetation type[a]							
	White fir	Subalpine fir	Lodgepole pine	Engelmann spruce	Ponderosa pine	Pinyon/ juniper	Quaking aspen	Douglas-fir
	Percent							
White fir	84	2	-	-	-	-	-	-
Subalpine fir	1	45	-	2	6	-	3	2
Pinyon/juniper	-	-	-	-	-	99	-	-
Lodgepole pine	-	-	14	2	-	-	-	16
Lodgepole pine/ quaking aspen	-	3	51	12	-	-	2	-
Engelmann spruce	-	12	1	18	-	-	-	-
Engelmann spruce/ subalpine fir	-	8	-	49	-	-	-	-
Engelmann spruce/ lodgepole pine	-	20	6	14	-	-	-	-
Engelmann spruce/ Douglas-fir	-	-	-	-	-	-	2	-
Ponderosa pine	1	1	-	1	84	-	1	2
Cottonwood	-	-	2	-	-	1	-	-
Quaking aspen	2	4	11	2	9	-	84	-
Douglas-fir	3	3	2	-	-	-	-	18
Douglas-fir/ponderosa pine/quaking aspen/ lodgepole pine	1	-	13	-	-	-	-	-
Douglas-fir/subalpine fir	-	-	-	-	-	-	1	-
Quaking aspen/ subalpine fir	-	-	-	-	-	-	1	-
Douglas-fir/quaking aspen	-	-	-	-	-	-	-	61
Gambel oak	-	1	-	-	-	-	4	2
Gambel oak/ big tooth maple	10	-	-	-	-	-	-	-
Gambel oak/quaking aspen	-	-	-	-	-	-	3	-

[a]See table E1 for potential vegetation descriptions.
[b]See table E1 for current vegetation descritions.

woodlands, and timber is emphasized on up to 58 percent, depending on the potential vegetation type. Also, much of the lands in which range is emphasized are rated high or medium for nesting (table E3). In terms of overall habitat, 34 percent of the lands with a range emphasis were rated as high value habitat and 43 percent of the mixed use areas were rated as high quality habitat (table E3). These management directions can decrease prey habitat by removing cover and food for prey species. Also, indirectly, they can interfere with fire regimes and native forest succession. Depending on the intensity and duration, grazing could be detrimental to goshawk habitat and to quaking aspen stands.

Recommendations

The forest and woodlands of Utah providing goshawk habitat are diverse in species composition and structure. The history of land-use in Utah is highly variable, ranging from domestic livestock grazing to tourism and snow skiing. With these land uses came the desire to protect forests and woodlands from fire. Effective fire exclusion began in the mid-1900's. As a result, the forests and woodlands of Utah are now dominated by dense stands of late seral species, which are prone to epidemics of diseases and insects and stand replacing fires.

Table E3—Proportion of management area categories rated as high, medium and low nesting habitat and the proportion of each management category rated as high for combined nesting and foraging.

Management area category[a]	Nesting habitat			Combined habitat
	High	Medium	Low	High
	Percent			
Wilderness	33	50	16	23
Administrative areas	41	42	19	31
Mixed use	53	26	21	43
Recreation emphasis	66	7	27	10
Timber emphasis	47	49	5	39
Range emphasis	48	41	11	34
Private interface	50	32	18	41
Special Use	75	17	7	67
General direction (Dixie)	24	24	52	20

[a]Management categories (USDA Forest Service 1998):
Wilderness—designated and proposed wilderness areas.
Administrative areas—variety of areas, from guard stations to municipal watersheds; usually in small parcels.
Mixed uses—currently achieving a variety of management goals, no change desired.
Recreation emphasis—concentrated recreation use and development.
Timber emphasis—provide opportunities for commodity production within ecological constraints.
Range emphasis—provide opportunities for livestock grazing within ecological constraints.
Private land interface—lands influenced by nearby private lands and managed cooperatively to meet resource objectives.
Special uses—activities conducted under special use permits, such as mining and summer homes, and administrative sites such as guard stations or municipal watersheds.
General direction (Dixie)—management for a variety of resource conditions based on local objectives and priorities.

The conservation of the northern goshawk will require the restoration and protection of degraded habitats and native processes. The following recommendations describe actions aimed at sustaining habitat for the goshawk and selected prey in the forests and woodlands of Utah. The applicability for meeting these recommendations is the responsibility of the specific land owner or administrator. Because these recommendations are directed at habitat and native processes, they will also benefit a myriad of other plant and animal species.

- Increase early and mid-seral species using mechanical means or fire or both.
- Evaluate activities near the edges of high value habitat as to how they may impact the connectivity of habitat, irrespective of ownership.
- Increase the numbers and distribution of large trees in the landscape.
- Maintain large trees in nest sites.
- Develop properly functioning systems at both the regional and landscape level.
- Ensure that in lodgepole stands a seed source is present when applying treatments.
- Recognize that long persistent quaking aspen can successfully regenerate under an existing canopy.
- Recognize that the successional pathways of pinyon/juniper potential vegetation types are indeterminate, and in general most of the conditions after disturbance are less stable than the present late seral condition.

Assessment Questions

1. Is there adequate nesting habitat available?

Presently there appears to be adequate nesting habitat in Utah to maintain a breeding population of goshawks.

2. Is there adequate foraging habitat available?

Based on prey habitat, it appears that foraging habitat is presently available throughout the State.

3. Are northern goshawks able to move freely among all available habitat patches?

Yes, goshawks appear to be able to move freely among habitat patches throughout Utah.

4. Is the population viable at the State level?

This assessment cannot answer the question of population viability directly because there are inadequate demographic data available. In general, existing habitat appears to be capable of supporting a viable population of goshawks at the State spatial scale. However, even though high quality habitat

does not appear to be lacking, Statewide, habitat deficiencies may be present at the local level.

5. Where is the high value habitat?

High value habitat is distributed throughout the State (map E1).

6. How are current management policies affecting northern goshawks?

Current management policies are affecting northern goshawks in a variety of ways. On USDA Forest Service administered lands, 20 percent of the high value habitat is being managed with a timber emphasis, 35 percent with mixed uses, and 27 percent with a range emphasis. Each of these management categories allows for activities that either can degrade or improve goshawk habitat. Information in this assessment does not reveal any substantial deficiencies in habitat quality in any management category. There are two possible explanations for these results: (1) management activities are having no negative effect on goshawk habitat, or (2) management activities are having some negative effects on goshawk habitat, but the effects are not detectable at either scale used in this assessment. We currently have no data available to determine which is true. Current management policies have the potential to degrade habitat if any one activity is over-applied or mis-applied. Thus current management policies provide for a wide range of implementation options, with a correspondingly wide range of possible effects on goshawk habitat. The critical decisions are those being made on individual project level analyses, because this is where managers can use the best available information in ensure that projects are providing for goshawk habitat needs.

7. What are the important habitat trends and their implications for goshawks?

The most obvious trend in Utah forests and woodlands is the lack of early and mid-seral species in all of the potential vegetation types. If forest management stresses proper functioning conditions, the importance of large trees, maintaining native processes, using adaptive management, and recognizing the role of fire, the habitat outlook could be favorable for the goshawk and its prey. Urbanization and more intensive uses of the forests by humans could degrade goshawk habitat, especially on private lands. This trend could also affect the connectivity of the habitat across the State.

The Northern Goshawk in Utah: Habitat Assessment and Management Recommendations

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Introduction

This habitat assessment and the management recommendations for the northern goshawk (*Accipter gentilis*) are an interagency effort applicable for the State of Utah. This document is a cooperative effort by the Utah Division of Wildlife Resources, USDA Forest Service, USDI Fish and Wildlife Service, USDI Bureau of Land Management, and USDI National Park Service (appendix A). It will describe habitat and develop recommendations to provide for long-term sustainable goshawk habitat throughout Utah. In addition, this effort will provide consistency in management of goshawk habitat. This should reduce threats to the species or its habitat and lower the priority for its listing as a threatened or endangered species by the USDI Fish and Wildlife Service in the future.

Changes in forest structure, especially large tree removal, and other forest management activities singly or in combination may negatively affect goshawk populations (Crocker-Bedford 1990). These changes in habitat are associated with some or all of the following: timber harvest, fire (wild or prescribed), insect and disease epidemics, and livestock grazing. Perhaps one of the greatest influences on habitat is fire exclusion from forest and woodland ecosystems. Successful fire exclusion has altered native successional pathways, resulting in ingrowth of shade-tolerant tree species throughout Utah. With these changes in habitat came suspected declines in goshawk populations in much of the Western United States (Bloom and others 1986; Herron and others 1985; Kennedy 1989).

In July 1991, the USDI Fish and Wildlife Service announced a 90 day finding for a petition to list the northern goshawk in Utah, Colorado, New Mexico, and Arizona as endangered and to include critical habitat (USDI Fish and Wildlife Service 1997). In September 1991, a coalition of conservation organizations requested to amend the petition already under consideration by the USDI Fish and Wildlife Service. This revised petition requested expansion of the geographic region to include the contiguous United States west of the 100th meridian and was accepted by the USDI Fish and Wildlife Service (1997). Since this petition's acceptance, the USDI Fish and Wildlife Service determined that listing as endangered was not warranted. Through court action in 1992 and 1997, the USDI Fish and Wildlife Service was ordered to revisit their decision and emphasized the need to address goshawk habitat in the Western United States. The status of the goshawk and its population size within Utah was unknown except for a few locations on USDA Forest Service System administrated lands. Intensive surveys in southern Utah on the Dixie National Forest and in northern Utah on the Ashley National Forest identified nesting locations in a wide range of forest cover types. However, information was limited because survey efforts were targeted at proposed project areas.

In 1991, the goshawk was also designated as a sensitive species in the USDA Forest Service, Intermountain Region. As a result of this designation, special management was emphasized to ensure the goshawk's viability (USDA Forest Service 1988a). The Utah Division of Wildlife Resources classified the goshawk as a sensitive species in March 1997. The purpose of this designation was to identify species in the State that are most vulnerable to population declines or habitat loss and to stimulate management actions for the conservation of this species.

To address the issue of declining goshawk habitat in Utah, the technical team (appendix A) developed the following questions:

1. Is there adequate nesting habitat available?
2. Is there adequate foraging habitat available?
3. Are northern goshawks able to move freely between habitat patches?
4. Is the population viable at the State level?
5. Where is the high value habitat?
6. How are current management policies affecting goshawks?
7. What are the important habitat trends and their implications for goshawks?

This assessment will attempt to address these questions.

Background

General Taxonomy and Distribution

Distribution of the goshawk is Holarctic with three recognized subspecies breeding in North America: the northern goshawk (*A.g. atricapillus)*, Queen Charlotte (*A.g. laingi)*, and the Apache (*A.g. apache*) (USDI Fish and Wildlife Service 1997). The northern goshawk is the most widespread of the three subspecies. This subspecies nests from the boreal forests of north central Alaska and northern Canada to western montane forests in the United States and Northern Mexico (Brown and Amadon 1968). The Queen Charlotte goshawk occurs along the coast and on islands of the Pacific Northwest and on the Olympic Peninsula (Brown and Amadon 1968). The Apache goshawk lives in southern Arizona and Mexico (Brown and Amadon 1968). Goshawks are known to winter throughout their breeding range and as far south as southern California, northern Mexico, Texas, and the northern portions of the Gulf states (Johnsgard 1990).

The goshawk is the largest of the three species of *Accipiter* in North America. Members of the genus inhabit coniferous, deciduous, and mixed forests. In North America, goshawks vary from deep grey to slate grey and deep neutral grey on their upper parts. The top of the head is often slate black with the sides heavily mottled with white. Adult goshawks have an orange-red eye which becomes deeper red to mahogany in older birds. The female goshawk is larger than the male weighing as much as 3.0 lb with a wing span ranging from 41 to 45 inches. The male weighs up to 2.4 lb with a wing span of 38 to 41 inches (Squires and Reynolds 1997; Wheeler and Clark 1995). Both sexes have short, rounded wings and a long square tail making them well adapted for maneuvering in forested conditions (Reynolds and others 1992).

Historical Distribution in Utah

Little information exists on the historical distribution of goshawks in Utah. Early records indicate that it was an uncommon permanent resident, primarily found in montane conifer and quaking aspen (*Populus tremuloides*) habitats throughout the State (Behle and others 1985). But occasionally it nests in cottonwood (*Populus* spp.) cover types in lower valleys (White 1965). Studies and surveys over the past 20 years indicate that the goshawk occurs across the State in a wide variety of forest types.

Characteristics of Occupied Habitats in Utah

Nesting Habitat—The northern goshawk nests in a wide range of forested habitats, from small clumps of quaking aspen intermixed with sagebrush (*Artemisia* spp.) in Nevada (Younk and Bechard 1994a) to ponderosa pine (*Pinus ponderosa*) and mixed conifer forests in northern Arizona (Reynolds and Joy 1998), to temperate rain forests dominated by western hemlock (*Tsuga heterophylla*) and spruce (*Picea* spp.) in southeastern Alaska (Iverson and others 1996).

In Utah, most of the 421 known nests located during project level surveys occur in mid-elevation (6,000 ft) to high-elevation (10,000 ft) sites which are currently occupied by mature quaking aspen or coniferous forest. Few nests were found in high elevation Engelmann spruce (*Picea Engelmannii*)/subalpine fir (*Abies lasiocarpa*) forests in northeastern Utah. The greatest proportion of the known nests occurs in mixed lodgepole pine (*Pinus contorta)* and quaking aspen forests (table 1). Engelmann spruce alone or mixed with lodgepole pine is also frequently used for nesting. Goshawk use these forest types even when there is substantial insect-related mortality in the overstory. On the Ashley National Forest in northeastern Utah, many nests occur in lodgepole pine forests where up to 80 percent of the overstory trees are dead as a result of a mountain pine beetle (*Dendroctonus ponderosae*) outbreaks in the early 1980's (Ashley National Forest 1998a; Dewey 1996; White 1992). The number of young that fledged on these territories from 1989 to 1996 was comparable to the numbers fledged over the same time period for many other populations in the Western United States (Dewey 1996; Kennedy 1997). Similarly, on the Dixie National Forest in southwestern Utah, nesting territories located on areas with high mortality caused by spruce bark beetle (*Dendroctonus rufipennes*) remained active (Dixie National Forest 1997).

There are some regional differences in goshawk use of certain forest cover types in Utah. In southern Utah,

Table 1—Proportion of nest stands by potential vegetation type and cover type.

Proportion of nests by potential vegetation type	
Potential vegetation type[a]	**Proportion of nests**
	Percent
White fir	9
Subalpine fir	38
Lodgepole pine	17
Engelmann spruce	2
Ponderosa pine	10
Quaking aspen	10
Douglas-fir	14
Pinyon pine/Utah juniper	0

Proportion of nests by cover type	
Cover Type[b]	**Proportion of nests**
	Percent
White fir	9
Subalpine fir	9
Lodgepole pine	8
Engelmann spruce	12
Ponderosa pine	12
Quaking aspen	10
Douglas-fir	7
Lodgepole pine/quaking aspen	20
Engelmann spruce/subalpine fir	1
Engelmann spruce/lodgepole pine	9
Douglas-fir/ponderosa pine/ quaking aspen/lodgepole pine	1
Douglas-fir/lodgepole pine	1
Quaking aspen/Engelmann spruce	1

[a]Potential vegetation type: Defined as a classification system that integrates a variety of physical and biological components including climate, soil, geology and vegetation. These are identified by species indicative of similar conditions (Hann and others 1997)
White fir (WF) = *Abies concolor*
Subalpine fir (SAF) = *Abies Lasiocarpa*
Lodgepole pine (LPP) = *Pinus contorta*
Engelmann spruce (ES) = *Picea engelmannii*
Ponderosa pine (PP) = *Pinus ponderosa*
Quaking aspen (QA) = *Populus tremuloides*
Douglas-fir (DF) = *Pseudotsuga menziesii*
Pinyon pine/Utah juniper (P/J) = *Pinus edulis*/*Juniperus osteosperma*
[b]Cover type: Defined as a plurality of one species or a mixture of two or more species in a particular forest or stand.
Cottonwood = *Populus* spp.
Gambel oak (GO) = *Quercus gambelii*
Big tooth maple (M) = *Acer grandidentatum*

Engelmann spruce and subalpine fir cover types are used frequently for nesting, while in northern Utah these types are only rarely used, except where Engelmann spruce is mixed with lodgepole pine (table 1). Squires and Ruggiero (1996) suggest that in south-central Wyoming, lodgepole pine is preferred over Engelmann spruce/subalpine fir cover types. Both Douglas-fir (*Pseudotsuga menziesii*) and white fir (*Abies concolor*) are only moderately used by nesting goshawks, compared to other cover types in the State. Douglas-fir cover types are used somewhat more for nesting in southern Utah compared to northern Utah.

Goshawks only moderately use ponderosa pine for nesting in Utah (table 1), even though it is used extensively by goshawks in northern Arizona (Reynolds and others 1994). Limited use of this type in Utah may be due to the current forest conditions. Many ponderosa pine forests in Utah were partially cut following mountain pine beetle outbreaks in the 1970's. As a result, many large trees were removed, which reduced nesting habitat for goshawks. In northeastern Utah, historical nests were observed in ponderosa pine forests but no active nests have been located since the forests were harvested in the 1980's (Ashley National Forest 1998a). Southern Utah ponderosa pine forests were also partially harvested in the 1980's resulting in large areas of low density, relatively small diameter forests (Dixie National Forest 1997). In these forests there is little evidence of goshawk nesting activity.

Cottonwood, pinyon/juniper (*Pinus edulis*/*Juniperus* spp.), Gambel oak (*Quercus gambelii*) and maple (*Acer* spp.) woodlands are not known to be used for nesting in Utah. However, Bloom and others (1986) have observed nests in Utah juniper (*Juniperus osteosperma*) in northeastern California, but noted that ponderosa pine was also present. Oak and oak/maple woodlands in Utah are used by other accipiters, but seem to be avoided by goshawks (Fischer and Murphy 1986; Hennessy 1978). The few nests in cottonwood trees were located in mixed deciduous/coniferous forests not pure cottonwood groves. Although the woodland cover types do not appear to be important for nesting, they may be valuable to goshawks for foraging and roosting during the nonbreeding season.

Nest Site Characteristics—Goshawks nest in sites with similar structural characteristics within each cover type. In general, goshawks nest in mature to old forests with relatively large trees, high canopy closure (relative to surrounding areas), sparse ground cover and open understories. Nests are often located near the bottom of moderately steep slopes, close to water, and often adjacent to a canopy break (Squires and Reynolds 1997). Important internal components of forests in Utah include snags, multiple canopies, and down woody debris (Reynolds and others 1992). In Utah, these components tend to vary across forest type (table 2). For

Table 2—Characteristics of known nest sites in Utah by forest cover type (based on descriptiong provided by Natorthern Goshawk Interagency Technical Team members and other listed technical contributors; appendix A).

Forest Types[a]	Patch size/ heterogeneity	Stand structure	Landscape features	Degree of use for nesting
ES/SAF ES/LLP ES ES/DF SAF	Small (0.25 to 0.50 acre) openings in large matrix of predominantly mature to old forest habitat; stand sizes 100s to 1000s of acres	Moderately dense to dense stocking; trees with interlocking crowns; multistoried stands; large trees; occasional patches of Aspen; clumpy tree distribution; sparse understory vegetation; abundant large woody debris; large snags present.	Usually on benches adjacent to drainages or near other water sources. Often near natural openings such as wet meadows.	High
LPP LPP/QA	100s to 1000s of acres, mostly homogeneous	Green stands have simple, single-storied structures; stocking varies from dense to very dense ("doghair"); sparse understory vegetation; little down woody debris; closed canopies; few snags. Mature and old stands often much different due to insect activity; many snags, abundant woody debris, open canopies.	Limited to the Uinta Mountains of northeastern Utah. Occupies benches, plateaus, moderate slopes along drainages at mid-elevations. Seral aspen often present, especially on moister sites. Most nests near drainages or small meadows.	High
QA	10s to 100s of acres, often as forested islands mixed with open habitats such as sagebrush.	Moderately dense to dense stands; interlocking crowns; multistoried; large trees present; stout forks form nest platforms; diverse, highly productive understory; moderate amounts of down woody debris.	Mesic sites on flat to moderate slopes, often near natural openings. Occupies elevational zone between sage/grasslands and beginning of coniferous forest.	Moderate to high
DF/QA DF/SAF DF WF	Small (1/4 to 1/2 ac) openings scattered throughout mature forest. Stand size varies; 100s of acres in southern Utah, 10s to 100s in north and west.	Dense stands; complex, multistoried structure; high tree species diversity; large trees present; interlocking crowns; abundant down woody debris	Limited to shady aspects, high elevations in dry habitats and to limestone sites in Uintas. Widespread in southern Utah at appropriate elevations.	Moderate to high where patch size large; low elsewhere
PP	Small (1/4-1/2 acre) openings mixed with patches of varying sizes and ages of trees. Stand size 100s of acres.	Two size classes, one with large trees; sometimes mixed with Q. aspen or D. Fir; clumpy tree distribution; more open stands than in other types; large snags present.	Found on benches, foothills, plateaus; dry sites but nests often near drainages with perennial water.	Moderate
Cottonwood DF /PP/QA/LPP	Small patch size, high variability in tree size and density. Cottonwood often present as small inclusions along drainages in P/J cover types.	Multistoried; high tree species diversity; diverse and productive understory; mix of coniferous and deciduous trees when occuring in shady canyon bottoms, dominated by cottonwoods in broader, lower elevation valleys.	Narrow, linear stands along perennial streams	Moderate in canyon bottoms, low for exposed valley locations (possible winter habitat?)

Table 2—Con.

Forest Types[a]	Patch size/ heterogeneity	Stand structure	Landscape features	Degree of use for nesting
P/J	Large, homogeneous stands (100s to 1000s of acres) when on P/J sites. More variable, often mixed with small amounts of P. Pine, D. Fir or Cottonwood when on W. Fir or D. Fir sites.	Uniform tree distribution; little decadence (snags or down woody material) except in very old stands (200-400 yrs); untreated stands have fairly dense stocking levels and very sparse understory vegetation.	Hot, dry sites with poor soils; often on south and west facing slopes.	Low (possible winter habitat?)
GO/M GO/M GO	Small patches in a highly variable mix of open habitats, aspen and conifer stands depending on location	Dense stands; shrubby growth form	Often on steep south or west facing hillsides, sometimes along stream courses	Low

[a]Refer to table 1 footnotes for cover type definitions.

example, spruce/fir forests have complex forest structures with multiple canopies and large amounts of down woody debris. Lodgepole pine forests have simple forest structures, single canopies and have small amounts of down woody debris except in very old forests.

Foraging Habitat—Goshawks prefer to forage in closed canopy forests with moderate tree densities as compared to young open forests (Fischer and Murphy 1986; Squires and Reynolds 1997). Goshawks take prey from openings, although they usually hunt these areas from perches near the edge (Younk and Bechard 1994b). Medium to large-sized birds (woodpeckers, robins, grouse, or jays) and mammals (ground and tree squirrels and hares) tend to dominate breeding season diets (Squires and Reynolds 1997) (fig. 1). The particular species taken varies regionally, but the species groups represented in goshawk diets are usually consistent throughout the Western United States. For example, the red squirrel (*Tamiasciurus hudsonicus*) and tassel-eared squirrel (*Sciurus aberti*) group are important prey in the Southwestern United States and a similar group consisting of the Douglas squirrel (*Sciurus douglasi*) and northern flying squirrel (*Glaucomys sabrinus*) are important in eastern Oregon and Washington (Reynolds and Meslow 1984; Reynolds and others 1992; Watson and Hayes 1997). Species listed as common prey, regardless of location, include the American robin (*Turdus migratorius*), Steller's jay (*Cyanocitta stellari*), northern flicker (*Colaptes auratus*), blue grouse (*Dendragapus obscurus*), red squirrel, and golden-mantled ground squirrel (*Citellus lateralis*) (Reynolds and Meslow 1984; Reynolds and others 1992; Titus and others 1994; Younk and Bechard 1994a). The important prey species identified in Utah from field observations made during the breeding season are similar to those discussed above (table 3). However, due to the lack of data based on direct observations, the variety of mammals in goshawk diets in Utah may be underestimated (Boal and Mannan 1994). However, this list includes several mammals identified as "dominant prey" by Squires and Reynolds (1997), and we feel it is a reasonable representation of goshawk diets in Utah.

Reynolds and others (1992) defined desired conditions for foraging habitat on the basis of prey ecology. Their "food web" approach to habitat management received support from technical reviewers (Braun and

Figure 1—Fledgling goshawks waiting to be fed.

Table 3—Prey species used by nesting goshawks in Utah. (based on descriptions provided by Northern Goshawk Interagency Technical Team members and others listed technical contributors; appendix A).

Species	Northern Utah	Southern Utah
Mammals		
Snowshoe hare	Observed[a]	Observed
Cottontail rabbit	Suspected	Observed
Red squirrel	Observed	Observed
Uinta ground squirrel	-	Observed
Abert's squirrel	-	Suspected
Flying squirrel	-	Suspected
Woodpeckers		
Northern flicker	Observed	Observed
Three-toed woodpecker	Observed	Observed
Other woodpeckers[b]	Observed	Observed
Other birds		
Gray jay	Observed	Suspected
Black-billed magpie	Observed	Suspected
American kestrel	Observed	-
Common raven	Observed	-
Clark's nutcracker	Observed	Suspected
Steller's jay	Observed	Observed
Grouse (ruffed and/or blue)	Observed	Observed
American robin	Observed	Observed
Townsend's solitaire	Observed	-
Mourning dove	-	Observed
Mountain bluebird	Observed	Observed
Dark-eyed junco	Observed	-
Mallard	Observed	Suspected
Unidentified blackbird	Observed	-

[a]Observed: biologists report identifying prey remains near an active nest; suspected: present in habitats used by goshawks but no prey remains identified to date.

[b]Includes downy and hairy woodpeckers, red-naped and Williamson's sapsuckers.

others 1996). We used this same approach to characterize foraging habitats in Utah, which is based on prey species observed Statewide (table 4).

Nonbreeding Season Habitat—Braun and others (1996) noted that reproduction is less important than other factors governing population dynamics. Far more important are mortality and dispersal that occur primarily outside of the breeding season. Unfortunately, little is known about goshawk habitat use in the nonbreeding season. Reynolds and others (1994) radio-tagged adult and juvenile goshawks in northern Arizona and tracked them during fall and early winter. All but one of the adults stayed on their summer ranges during this time. One adult female was relocated in pinyon/juniper woodlands approximately 10 miles from her nest. Most fledglings remained near their natal sites. However, transmitters from two fledglings were recovered in pinyon/juniper woodlands, apparently shed after dispersing from their natal site. Squires and Ruggiero (1995) followed four adult goshawks from their breeding areas in south central Wyoming to wintering areas up to 116 miles away in northern and central Colorado. Habitats used by these goshawks ranged from quaking aspen/mixed-conifer forests to small cottonwood groves surrounded by sagebrush.

The six of 10 female goshawks radio tracked in the Uinta Mountains relocated to pinyon/juniper woodlands near patches of cottonwood during the winter (Ashley National Forest 1998b). These woodlands were located 60 miles from the nest area. However, one female moved to pinyon/juniper woodlands near the LaSal Mountains in southeastern Utah, approximately 190 miles from her nest area (Squires 1997). Four females remained in their nest areas, or in similar habitat less than 10 miles away. Not all radio-tagged females were located, so it is not known if these locations are truely representative of winter habitat use for most goshawks breeding in the Uinta Mountains (Ashley National Forest 1998b; Squires and Ruggiero 1995).

Overwintering strategies for goshawks may be related to food availability. Doyle and Smith (1994) observed goshawks on their Yukon study area year-round during periods of high snowshoe hare (*Lepus americanus*) populations, but noted that goshawks almost disappeared during winters when hare numbers were low. McGowan (1975) also speculated that cyclic prey abundance accounted for observed fluctuations in goshawk numbers in interior Alaska, especially during the winter. However, this may be less important in the Western United States where the goshawk's primary mammalian prey are less cyclic (McGowan 1975). Populations of snowshoe hares appear to be considerably more stable in the Central Rocky Mountains than in Canada (Dolbeer and Clark 1975). Because red squirrels are able to avoid starvation during food shortages by caching food, their populations also remain relatively stable (McGowan 1975). The diversity of prey taken in the Western United States may buffer goshawk populations against extreme fluctuations in individual prey species (Boal and Mannan 1994).

Weather may also be a factor in determining when and how far goshawks migrate to winter ranges. Squires and Ruggiero (1995) noted that a long distance movement of goshawks coincided with a major snowstorm. Severe weather conditions may increase the importance of thermal cover for goshawks, and deep snow cover may limit the kind and amount of prey available. Either situation may cause goshawks to seek out different habitats in the winter.

Table 4—Important habitat attributes for maintaining populations of selected goshawk prey in Utah (based on descriptions provided by Northern Goshawk Interagency Technical Team members and others listed technical contributors; appendix A).[a]

Prey species	Large down woody debris	Snags	Large trees	Understory vegetation	Openings	Mix of structural stages	Interlocking tree crowns	Most common in these cover types[b]
Mammals								
Snowshoe hare	Low	None	None	High	Low	High	None	LPP, SAF, ES
Red squirrel	High	High	High	Med	None	Low	High	ES, LPP, DF
Woodpeckers								
Northern flicker	High	High	High	Med	Low	High	None	PP, QA
Three-toed Woodpecker	Med	High	High	None	None	Med	None	LPP, ES
Hairy Woodpeckers/ Williamson's sapsucker	Med	High	High	Med	None	Med	None	QA, LPP, ES, DF, SAF
Downy Woodpecker	Med	High	High	Med	None	Med	None	QA
Red-naped sapsucker	Med	High	High	Med	None	Med	None	PP
Other Birds								
Steller's jay	Low	Low	High	Low	None	Low	Low	PP, P/J
Ruffed grouse	High	None	Low	High	High	High	Low	QA
Blue grouse	Med	None	High	High	High	High	Low	DF
American robin	Low	None	Low	High	Med	High	Med	PP, QA
Mountain bluebird	Low	High	High	High	High	High	None	QA, PP, P/J

[a]After Reynolds and others 1992. Information on ruffed grouse and mountain bluebird from DeGraaf and others 1991, Ehrlich and others 1988. Additional information on bird use of forest cover types from Forest Service breeding bird surveys (Ashley National Forest 1995). Information on snowshoe hare from Dolbeer and Clark 1975; Koehler 1989; Koehler and Brittell 1990. Dominant tree species alone or in mixed stands.
[b]For full name description see table 1, footnotes.

Factors Influencing the Species

History of Goshawk Conservation Efforts—As a result of studies conducted on nesting habitat in the 1970's (Bartelt 1977, Hennessy 1978) several threats facing the goshawk were recognized (Reynolds 1989). In the 1980's, the USDA Forest Service designated the goshawk as a national indicator of mature and old-growth forests. Subsequently, at least 49 National Forests selected the goshawk as a management indicator species used in Land Management Plans (Patla 1990; Sidle and Suring 1986).

This led to the development of management recommendations for western coniferous forests to protect nest sites (Reynolds 1983). These recommendations proposed that a 20 acre buffer of uncut habitat be left in timber sale areas around two active and two replacement nest sites per nest area. In Arizona, an evaluation of the 20 acre buffer indicated that these small areas were not protecting nest areas adequately when implemented (Crocker-Bedford 1990; Crocker-Bedford and Chaney 1988). In 1992, more comprehensive management recommendations for the goshawk were developed for the USDA Forest Service, Southwestern Region (Reynolds and others 1992). This effort recommended managing for 6,000 acre territories to protect nests and provide adequate foraging habitat. During this same time period, Kennedy and Stahlecker (1993) developed and tested a calling protocol for locating breeding goshawks.

Livestock Grazing—Domestic livestock have grazed Southwestern ponderosa pine and mixed-species forests since the mid 1800's (Cooper 1960; Rasmussen 1941) and has affected both forest structure and composition. Within ponderosa pine forests, dense grass cover can decrease seedling establishment and survival (Brawn and Balda 1988). However, heavy livestock grazing reduced ground cover, which encouraged the establishment of dense stands of saplings (Covington and Moore 1991; Reynolds and others 1992; Stein 1988). Fire suppression also allowed trees to encroach into openings, subsequently reducing forage production. Grazing in high elevation meadows and open parklands has changed plant community composition and structure. These changes most likely

have affected goshawks, but the extent of that effect is poorly documented.

In Nevada, livestock grazing resulted in the deterioration and loss of some goshawk nesting habitat (Herron and others 1985; Lucas and Oakleaf 1975). Annual grazing by concentrated livestock removed young stems and reduced quaking aspen's ability to regenerate (Mueggler 1989). Surveys in Nevada indicate that 85 percent of the known goshawk nests in the Humboldt/Toiyabe National Forest were found in quaking aspen forests. In addition, 70 percent of all quaking aspen in Nevada is located on USDA National Forest System administered lands and the majority of these forests have minimal regeneration (USDA Forest Service 1993). Grazing also alters both the structure and species composition of the grass, forb and shrub layers of quaking aspen forests which also modifies goshawk foraging habitat (Reynolds and others 1992).

Riparian areas are the most productive and valuable wildlife habitats wherever they occur. During the past century, 70 percent of the wetland/riparian areas have been negatively impacted throughout the West (Lee and others 1989). Continued loss of forested riparian wetlands in the Rocky Mountain States averages 1 percent per year or more (Lee and others 1989). Because goshawks use riparian areas for both nesting and foraging, reductions caused by livestock grazing can negatively affect habitat for goshawk prey and reduce or eliminate foraging habitat potential (Hargis and others 1994; Patla 1994; Reynolds and others 1992).

Fire Suppression—Goshawk foraging and nesting habitat has also been impacted by fire suppression. Throughout Western North America, prior to European settlement, ponderosa pine forests burned every 2 to 15 years. These fires were typically low-intensity, lightning caused, noncatastrophic surface fires (Avery and others 1976; Cooper 1960, 1961; Covington and Moore 1991; Dieterich 1980a, 1983; Gruell and others 1982; McCune 1983; Reynolds and others 1992; Swetnam 1988; White 1985). Both stand replacing and surface fires occurred in mixed-conifer forests at 5 to 22 year intervals (Ahlstrand 1980, Weaver 1951, Wright 1988). Effective wildfire suppression since the 1900's has changed fire regimes, and in some areas, entirely eliminated them (Dieterich 1980b, Keane and others 1990, McCune 1983, Stein 1988, Weaver 1961).

Low intensity surface fires typically maintained open conditions in dry forests by continually cleaning the forest floor of small trees and lower vegetation, allowing for easy hunting access. The lack of fire in ponderosa pine forests has resulted in stands dominated by multiple canopies containing one or more cohorts of Douglas-fir, white fir, or ponderosa pine. Likewise, the lack of fire has resulted in the failure of seral quaking aspen stands to regenerate; instead they are being replaced by firs and spruce (Bradley and others 1992). As stocking levels increase, "ladder" fuels that carry fires from the surface into the crowns develop (Madany and West 1980). This condition, combined with a build-up of surface fuels, produces severe and intense crown fires. Prior to European settlement, large stand replacing events were thought to be rare, especially in ponderosa pine forests and possible other forest types (Brawn and Balda 1988; Covington and Moore 1991).

Timber Harvest—Goshawks can breed successfully in forests where timber harvesting has occurred (Reynolds and others 1994; Woodbridge and Detrich 1994) but they appear to prefer stands of mature and over-mature trees for nesting and foraging (Bright-Smith and Mannan 1994). Also, occupancy of the nest stand has been positively associated with patch size (Woodbridge and Detrich 1994). However, the effects of reducing the number and size of mature trees on existing goshawk densities or productivity is unknown. Population models for species in fragmented forest landscapes suggest that sharp declines in viability can occur if habitat decreases over the long-term (Franklin and Forman 1987; Lamberson and others 1992). The removal of suitable nesting habitat through timber harvesting or other management activities can be a threat to the goshawk (McCarthy and others 1989; Moore and Henny 1983; Reynolds 1989). Evidence suggests that timber harvesting on the North Kaibab Ranger District in Arizona caused goshawks to decline from an estimated 260 nesting pairs to 60 nesting pairs (Crocker-Bedford 1990). Due to commercial timber and fuel wood harvesting, snags and large trees are less abundant in present-day forests.

Insect and Disease Outbreaks—The history of Southwestern forests, particularly fire suppression and timber harvesting, has altered the forest structure and composition in a manner that facilitates insect and disease outbreaks (Parker 1991; Reynolds and others 1992). Insects and diseases, along with fire, are among the more important regulators of forest density, composition, and structure. Observations on the distribution and the severity of insects and disease outbreaks prior to the past few decades are limited. Evidence indicates that dwarf mistletoes (*Arceuthobium* spp.) and root diseases (*Armillaria* spp., *Heterbasidian* spp.) are increasing in Southwestern forests (Parker 1991) due to high stand densities and species composition changes. As a result of these changes, the potential for large scale epidemic outbreaks of bark beetles (*Dendroctonus* spp.) is present in many ponderosa pine and mixed species forests (Gardner and others 1997; Hedden and others 1981; Rogers and Conklin 1991). Endemic levels of insects and pathogens can play significant ecological roles by

causing tree mortality, defoliation, decay, or deformity, that are often important attributes for goshawk nesting or foraging.

The composition and structural changes in the forests of Utah have increased epidemic frequencies of insects. For example, the Engelmann spruce forests on the Dixie and Manti-LaSal National Forests are currently experiencing spruce bark beetle epidemics. As a result, trees 4 inches and larger are being killed in 5 to 10,000 acre patches. In northern Utah, similar epidemics of mountain pine beetle occurred in 10,000 acre patches in lodgepole pine, affect about 100,000 acres total. Goshawk continue to nest successfully in these beetle-killed forests (Ashley National Forest 1998b; Dewey 1996; Dixie National Forest 1997).

Competition, Predation, and Disease—Nesting habitat structure with open conditions may allow for the predation of goshawks, and especially their nestlings, by great horned owls (*Bubo virginianus*) (Boal and Mannan 1994; Crocker-Bedford 1990; Moore and Henny 1983; Woodbridge and Detrich 1994). Nestling mortality may increase during periods of low food availability (Crocker-Bedford 1990; Moore and Henny 1983; Rohner and Doyle 1992; Woodbridge and Detrich 1994; Zachel 1985). Moreover, the pine marten (*Martes americana*) and fisher (*Martes pennanti*) can also be predators (Patla 1990).

Open habitat may lead to the replacement of nesting goshawks by red-tailed hawks (*Buteo jamaicensis*) and great horned owls (Crocker-Bedford 1990; Moore and Henny 1983). Great horned owls and the long-eared owls (*Asio otus*) can use goshawk alternate nests (Buchanan and Erwin 1997; Bull and others 1988; Dewey 1996; Dixie National Forest 1997; Patla 1992; Woodbridge and Detrich 1994). In northern California, goshawks moved after their nests were occupied by spotted owls suggesting possible competition for nest sites (Woodbridge and Detrich 1994).

Goshawks will attack red-tailed hawks, short-eared owls (*Asio flammeus*), and great horned owls when near nests (Cranell and Destefano 1992; Lindberg 1977). Raptors killed by goshawks include long-eared owls, tawny owls (*Strix aluco*), nestling honey buzzards (*Pernis apivorus),* nestling and adult common buzzards, nestling and adult sparrowhawks (*Accipiter nisus*), other goshawks, and red-tailed hawks, American kestrel (*Falco sparverius*), Cooper's hawk (*Accipiter cooperii*) and sharp-shinned hawk (*Accipiter striatus*) (Kostrzewa 1991; Reynolds and others 1994; White 1998). On the Dixie and Uinta National Forests, goshawks have been observed defending nest territories against both red-tailed and Swainson's hawks (*Buteo swainsoni*) (Dixie National Forest 1997).

Goshawks have several diseases and body parasites that may impact nesting and brooding success. Tuberculosis and fungal diseases are typically found in goshawks (Squires and Reynolds 1997). Goshawks are plagued by ectoparasites such as lice, and internal blood parasites such as *Leucocytozoon*, *Haemoproteus*, *Trypanosoma*, and microfilariae. Approximately 56 percent of North American goshawks suffer from such internal parasites (Greiner and others 1975) but how they impact goshawk populations is unknown.

Status and Distribution of Habitat in Utah

Habitat Assessment

The goshawk has been located in a variety of forest cover types throughout Utah. As interpreted from Geospatial Analysis Processes (GAP, USGS 1995), they range from the subalpine environments typified by Engelmann spruce and subalpine fir to pinyon/juniper woodlands bordering the grass and shrub lands. In general, the elevations of these forests range from 4,000 to 11,000 ft, with rugged and broken topography. In addition to major mountain ranges, such as the Uinta and Wasatch, Utah contains major plateaus such as the Markagunt and Tavaputs. The climate, and therefore the vegetation of Utah, is highly influenced by elevation and latitude. In general, precipitation on forest lands ranges from 12 to 42 inches annually. With this variation in topography, climate, soils, and geology a wide range of forest compositions and structures are typical.

The forests of Utah are and have been occupied by humans for centuries. Native Americans used and settled in many forests. European settlement of the valleys started in earnest during the mid 1800's. Along with the disturbances caused by human presence (harvesting, burning), natural disturbances from flood, wind, fire, snow, and ice all shaped successional pathways and current vegetation. Since the early-to-mid 1900's, effective fire exclusion has prevented fire from playing its historical role of maintaining and regenerating many of these forests. Also, with European settlement, forests in and along valley bottoms were extensively harvested to supply materials for construction, mining, and the railroad industries. Timber harvesting, mining, domestic livestock grazing, recreation, and fire exclusion continue to impact Utah forests. The historic and current uses and diversity of Utah forests, necessitated the development of a carefully structured assessment for goshawk habitat.

Effective assessments of natural resources require a balance between data resolution and geographic extent. Both are referred to as scale often leading to confusion. Resolution refers to the intensity or graininess of the data. Geographic extent refers to the area (spatial scale) to be addressed (Graham and others in press; Haynes and others 1996). Both must be

appropriate to the questions being asked and the issue being addressed. By definition, this assessment will address goshawk habitat throughout Utah.

Another important component of assessments is to conduct them across two or more spatial and temporal scales (Graham and others in press). By conducting assessments at multiple scales, the large geographic extents can set context for the small. Similarly, the long time frames provide context for the short. Conducting assessments at two scales assures processes identifiable at one scale will not be overlooked if they are not observable or easily addressed at the other. For example, the migration or dispersal of the goshawk could not easily be addressed by examining only nest stands, and nest stand characteristics could not easily be addressed using only landscape or subregional assessments. Population trends also cannot be easily addressed using nesting success for a single year, but multiple year observations allow for meaningful descriptions of population trends.

Utah was the largest geographic area used for assessing goshawk habitat. It would have been useful to look at a regional scale to set the Utah assessment in context to explore how the habitat in Utah is related to habitat in adjacent states. But, time, budget, and personnel constraints, did not permit the wider analysis. Only recommendations and inferences on the status of goshawk habitat within Utah were requested by the involved and cooperating parties (appendix A). This assessment is designed to provide general habitat trends for the next 25 years for Utah.

To fully understand influences of goshawk habitat in Utah, and to disclose immediate threats and goshawk habitat risks to the State, a smaller geographic area was required. Counties, watersheds, National Forests, or other political or geographic delineations could have been applied. An important component of choice was using a geographic unit that would provide interpretive power and be spatially explicit across the forests and woodlands of the State, and be independent of ownership or administrative boundaries. The most useful geographic unit was potential vegetation. This classification system integrates a variety of physical and biological components including climate, soil, geology and vegetation. Potential vegetation types are identified by species indicative of similar conditions. For example, pinyon/juniper indicates a warmer and drier environment than ponderosa pine. Due to growth, mortality, and disturbance, many other kinds of vegetation can occur on this type through time (fig. 2). In some cases the indicator species may not be present, due to disturbance. Pinyon/juniper is simply a vegetative indicator, and a name, for a physical and biological environment stratification system useful for predicting response to disturbance (Hann and others 1997). For this assessment of goshawk habitat, we defined eight potential vegetation types. These potential vegetation types cover the most representative and important environments in Utah, from the warm and dry pinyon/juniper type to moist and cool subalpine fir type. We will use potential vegetation type to describe components such as different seral stages, the range of cover types, successional pathways, disease and insect relations, and fire regimes on a given geographic unit. Seral stages are different vegetative communities that occur through time and in response to different disturbances. These stages should not be confused with vegetative structural stages (young, mid-aged, mature, etc.) as defined by Reynolds and others (1992).

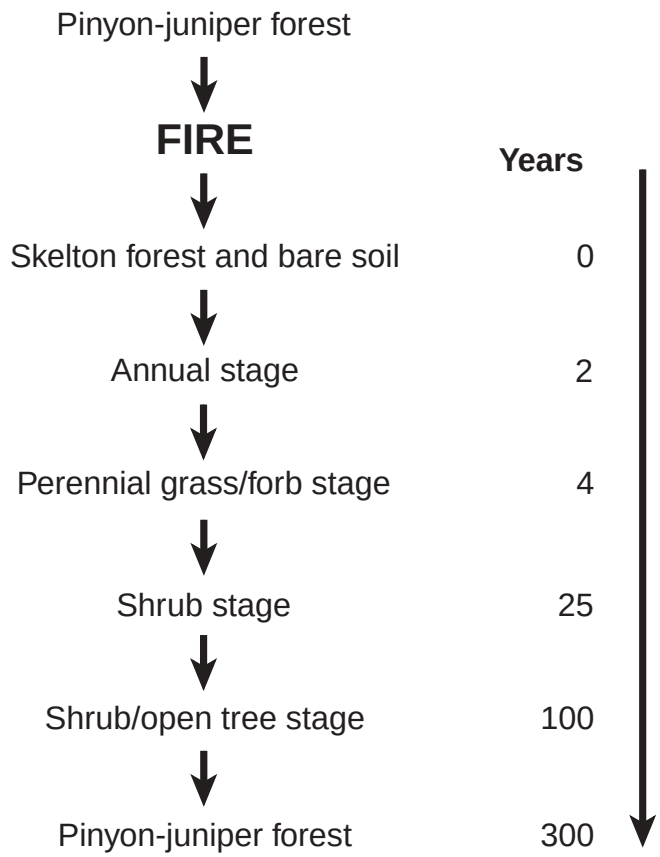


Figure 2—The successional pathway of pinyon/juniper. Pinyon/juniper is the indicator of the potential vegetation type, but depending on the disturbance frequency, pinyon and juniper trees may never occur on a given site.

Potential Vegetation Type Descriptions

White Fir—Forest lands with white fir as the potential dominant vegetation species are probably too dry and warm for subalpine fir (*Abies lasiocarpa)* or Engelmann spruce *(Picea engelmannii)* to be dominant. This potential vegetation type occupies about

7 percent of the forested land in the State in montane sites between 5,000 and 9,200 ft, depending on the location within the State (table 5). This potential vegetation type usually occurs on gravelly soils that are well drained and derived from a variety of parent materials. In the north, this type is often associated with colluvium and in the south it is often associated with limestone and sandstone. Including white fir, a variety of other species can also occur in this type such as juniper, pinyon pine (*Pinus edulis*), quaking aspen, ponderosa pine, Douglas-fir, limber pine (*Pinus flexilis)*, bristle cone pine (*Pinus longaeva*), blue spruce (*Picea pungens*), Engelmann spruce, subalpine fir, and Gambel oak. Historically, fire intervals were indeterminate for the type (Bradley and others 1992), but likely ranged between 8 and 18 years. In addition, large volumes of ponderosa pine and Douglas-fir were removed from this type in the early 1800's. Root diseases such as *Fomes annosus* and insects such as spruce budworm (*Choristoneura occidentalis*) are only two of the insects and pathogens common in this type, especially in the tension zones.

Subalpine Fir—At the higher elevations throughout the State, the forest landscape is dominated by the subalpine fir potential vegetation type. It covers approximately 17 percent of forest land in Utah and it occurs between 6,000 and 11,000 ft, depending upon the location (table 5). Pure stands of subalpine fir are rarely found, but mixed conifer stands with Douglas-fir and Engelmann spruce are much more common. Quaking aspen, along with lodgepole pine, are common seral species with various amounts of ponderosa pine, limber pine, blue spruce, and Gambel oak. Because this type can occur on all parent materials found in the State, soils range from coarse to fine. The climate can be characterized as cool, with frequent summer frosts and deep snow packs (Lawton 1979). Fire intervals have been estimated as low as 40 years in some areas, to over 300 years in others (Bradley and others 1992). In combination with harvesting, fire has created many stands dominated by quaking aspen (Mauk and Henderson 1984). Spruce beetle, *Armilaria* root disease, and balsam bark beetle (*Dendroctonus confusus*) are common disturbance agents as are snow, ice and wind. All of these agents, singly and in concert, can create a variety of different successional pathways producing a variety of stand structures and compositions.

Table 5—Proportion of Utah forested land in each potential vegetation type.

Potential vegetation type[a]	Percent
White fir	7
Subalpine fir	17
Pinyon pine/Utah juniper	50
Lodgepole pine	1
Engelmann spruce	1
Ponderosa pine	5
Quaking aspen	10
Douglas-fir	9

[a]Refer to footnotes in table1 for potential vegetation type definition.

Lodgepole Pine—This is the only potential vegetation type where lodgepole pine persists with no evidence that another species is the potential climax (Pfister and others 1977). This type occurs between 7,600 and 10,300 ft in the Uinta Mountains and represents about 1 percent of the forest lands in the State (table 5). Exposures are relatively warm and usually quite arid with well drained soils (Mauk and Henderson 1984). Soils are primarily derived from quartzite with a wide range of depths. Lodgepole pine in this type has both endemic and epidemic levels of dwarf mistletoe, depending on the location. Also Comandra blister rust (*Cronartium commandrae*), and western gall rust (*Endocronartium harknessii*) occasionally kill trees. Root and stem decays can kill older trees and are often more damaging than rusts (Krebill 1975). Within this type, there are small amounts of quaking aspen, Engelmann spruce, subalpine fir, Douglas-fir, white fir, and common juniper. For the most part, fires are either the smoldering type where the surface fuels are slowly burned at 22 year intervals (Arno 1976), or severe stand replacing events occurring at intervals as great as 300 years (Romme 1982). Stand development is a combination of insect and disease mortality, fuel accumulation, and fire (Brown 1975). Dwarf mistletoe and bark beetles (*Dendroctonus ponderosae*) can work singly or in concert to kill trees. Forests thinned by surface fires are susceptible to mistletoe because well spaced trees allowing easier dispersment of mistletoe seeds on residual trees and new seedlings (Parmeter 1978). Mountain pine beetles have caused extensive mortality in the type (Hutchinson and others 1965).

Engelmann Spruce—The Engelmann spruce potential vegetation type occurs at elevations from 9,000 to over 11,000 ft and occupies around 1 percent of the forest and woodlands of Utah (table 5). In addition to Engelmann spruce, which often lives 300 years, Douglas-fir, blue spruce, lodgepole pine and subalpine fir are found in the type. At lower elevations, lodgepole pine and quaking aspen are major seral species (Mauk and Henderson 1984). Soils of this type are usually gravelly and derived from quartzite in the northern Utah, or weathered andesitic flows in the southern Utah (Youngblood and Mauk 1985). Extensive winds on these sites diminish the snow pack and tip over trees. Fire is frequent at low elevations, but its effect

may be severe at higher elevations where infrequent stand replacing events occur.

Ponderosa Pine—In northern Utah, the ponderosa pine potential vegetation type is mostly limited to the eastern and southern Uinta Mountains, but it is found throughout the southern part of the State. This type occurs at elevations ranging from 6,800 to 9,000 ft. It represents about 5 percent of the forests and woodlands of Utah (table 5). Important seral trees include quaking aspen and Gambel oak. Other species include pinyon pine, limber pine, Rocky Mountain juniper (*Juniperus scopulorum*), or Utah juniper. Soils in the north are usually well drained, gravelly and shallow when over bedrock. In southern Utah, parent materials can include basalt, andesetic flows, intrusive granitoids and others (Youngblood and Mauk 1985). In general, this type, especially in southern Utah, receives considerable precipitation during the summer with total amounts near 15.6 inches. Historically, fire was a frequent disturbance in the type, often occurring every other year in some areas, but with 48 year intervals in others (Dieterich 1980a). Historically, throughout Utah the ponderosa pine potential vegetation type burned at a frequency of less than 20 years (Bradley and others 1992). The intensities of these fires were low, but they thinned and cleaned stands of regeneration and surface fuels. Without fire, this type is prone to both live and dead fuel accumulations, increasing the potential for stand replacing fires. Historically, lightning, beetles and diseases constantly killed large trees which were burned, creating a site well suited for regeneration. Domestic livestock grazing, along with fire exclusion, has disrupted fire cycles and created conditions that were rare or nonexistent in primeval forests (Bradley and others 1992). Along with these structural changes, *Armillaria*, bark beetles, dwarf mistletoe, and other pathogens and insects attack, stress or kill trees.

Douglas-fir—The Douglas-fir potential vegetation type covers a small portion of the south, while in the north it is well represented. This type occurs from 5,000 to 8,800 ft in the north and up to 9,700 ft in the south (Mauk and Henderson 1984, Youngblood and Mauk 1985) and covers approximately 9 percent of the forest and woodlands of Utah (table 5). This type occurs on a variety of soils and parent materials but in the Uintas it is restricted to calcareous substrates and areas where the soils are at least weakly calcareous. Soils are well drained and all textures are possible for the surface, but most are loamy or finer. Forests on this type range from scattered to dense depending on exposure. Douglas-fir is the most common conifer but ponderosa pine, quaking aspen, and lodgepole pine are frequent seral species. Also, on the edges of the type, white fir, juniper, limber pine and Engelmann spruce occur occasionally. Root diseases, spruce budworm, and Douglas-fir beetle are endemic in the type, with occasional epidemic eruptions on local levels. Historically, in drier portions of the type, stands were open allowing frequent (4 to 7 years) low intensity fires to promote the establishment and dominance of seral ponderosa pine. Higher severity and stand replacing fires are possible when Douglas-fir ladder fuels allow fires to reach the overstory crowns, especially at the longer return intervals (50 years plus). In the moist areas of the type, a more variable fire regime historically occurred, with both surface and stand-replacing fires common. As a result, a mosaic of stand structures and compositions existed. Fire return intervals were probably in the range of 15 to 30 years (Bradley and others 1992). This type was harvested heavily after European settlement, with extensive removal of both large Douglas-fir and ponderosa pine.

Quaking Aspen—Quaking aspen similar to lodgepole pine is a seral species growing on other potential vegetation types. Only on the quaking aspen potential vegetation type does this tree appear to be long persistent or climax. Quaking aspen vigorously regenerates by root suckers following fire (Mueggler 1988) and it is able to dominate a site rapidly after a disturbance. The environmental conditions determining quaking aspen's role as a seral or climax species remain ill-defined (Mueggler 1989). An occasional subalpine fir, Douglas-fir, lodgepole pine, or Engelmann spruce might occur along with quaking aspen even when the latter is persistant. Quaking aspen occurs at elevations ranging from 5,500 to 10,500 ft on a variety of soils that are derived from sandstone, limestone, quartzite and granitics. It covers about 10 percent of the State (table 5). In southern Utah, it occurs primarily on volcanics. Historically, livestock grazing and fire were the primary disturbances. Even-aged stands of quaking aspen usually originate from fire and may occur on other potential vegetation types. In contrast, climax stands of this tree tend to be uneven-aged where regeneration is a gradual but continual process. Quaking aspen is sensitive to fire because of its thin bark, and fire scarred trees usually contain heart rot (Jones and Debyle 1985). Fire appears to stimulate suckering by killing most or all of the clonal stems (Brown and Debyle 1987). Quaking aspen is the dominant tree species in this type with most successional changes occurring in the forb, shrub, and grass layers, as they respond to different disturbances.

Pinyon/juniper—The pinyon/juniper potential vegetation type occupies approximately 50 percent of the forest and woodlands in Utah (table 5). By far it is the driest potential vegetation type growing at elevations from 4,500 to 7,500 ft. It occurs on a variety of soils that are derived from granites, limestones, volcanics, and

mixed alluvium (Evans 1988). Lower limit is set by available water and upper limit by unfavorable temperatures. Douglas-fir and ponderosa pine potential vegetation types border this type at high elevations and grass/shrub dominated communities border it at lower elevations. Pinyon pine usually dominate higher elevations while juniper occupy lower elevations. Fires open stands and create a mosaic of structures and compositions (Bradley and others 1992). Fire return intervals range from 8 and 50 years (Burkhardt and Tisdale 1976; Moir 1982). Domestic livestock grazing occurred on some sites in the Southwest for as long as 400 years (Tausch and others 1981). Succession after fire begins with annuals and continues with mixes of perennial grasses, forbs, and shrubs, culminating with pinyon/juniper (Evans 1988) (fig. 1). In mature stands, most trees are pinyon pine, and low-severity fires will remove understory. Because of the scarcity of fuels to carry a fire in closed stands, fires become rare (Bradley and others 1992) but when fires invade from adjacent types, especially if driven by wind, stand-replacing fires can occur.

Delineation of Potential Vegetation Types

No map of potential vegetation types for Utah was available. Using Geospatial Analysis Processes data to identify patches of vegetation, 1,112 vegetative polygons of forests and woodlands of Utah were identified (USGS 1995). To each of these polygons, a potential vegetation type was assigned using inventory plot data points located near or in the polygon, and by local knowledge supplied by resource managers familiar with the area. Inventory points were random plots sampled by the Forest Inventory and Analysis (FIA) group of the USDA Forest Service, Rocky Mountain Research Station. In addition to the potential vegetation type, data for each plot included slope, aspect, elevation, current vegetation, and other site-specific information. This auxiliary information helped identify the potential vegetation type within each polygon. Often, more than one point would be located in a vegetation polygon, further strengthening the potential vegetation type assignment. All polygons in Utah were assigned to one of eight potential vegetation types (map 1).

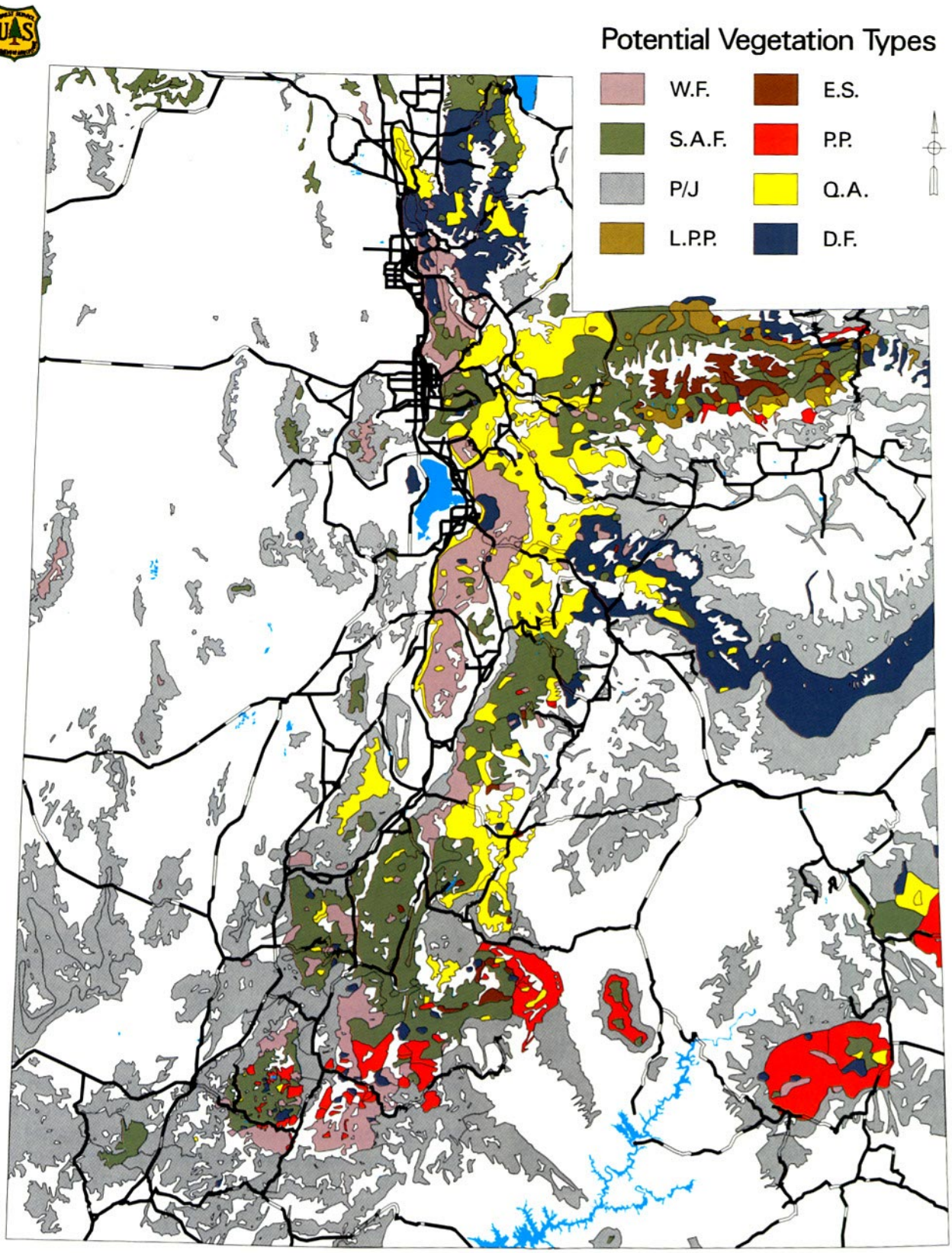
Current Habitat

Current vegetation was determined using a combination of potential vegetation type, Geospatial Analysis Processes, and FIA data, along with expert knowledge of resource managers working in Utah. Current forest cover type, structural stage (seedling, sapling, young forest, middle-aged forest, mature forest or old growth), stand size, and understory composition were identified for each potential vegetation type polygon. Coarse woody debris, snags, water, large trees, and multiple canopies within in each polygon were also determined. These variables described attributes believed to be important for one or more of the primary prey species (table 4). When necessary to describe current conditions accurately, some potential vegetation type polygons were divided into two or more subpolygons.

Potential vegetation types in Utah currently support various forest cover types ranging from pure ponderosa pine to complex mixtures of Douglas-fir, ponderosa pine, quaking aspen, and lodgepole pine (table 6). The pinyon/juniper cover type is most common, covering 51 percent of Utah's forests and woodlands (table 7). Spruce and fir cover types are common over the State's forested lands. However the ponderosa pine cover type represents only 4 percent of the forest and woodlands. The trend across the entire State is for late seral species to be better represented than early seral species (map 2).

Quaking aspen occupies 9 percent of Utah's forests and woodlands (table 7). It dominates 84 percent of the quaking aspen potential vegetation type (table 8) but is underrepresented in many potential vegetation types where it is a major seral species. For example, in the Douglas-fir, white fir and subalpine fir potential vegetation types it represents less than 6 percent (table 8). Most of these stands are located in central and north-central Utah, and in the mountains of southeastern Utah (map 2). Quaking aspen also occurs as a component of mixed species stands on 51 percent of the lodgepole potential vegetation type and 61 percent of the Douglas-fir potential vegetation type (table 8). Goshawk nests are often associated with mixed lodgepole pine and quaking aspen forests in northeastern Utah (table 1). Mixtures of Douglas-fir and quaking aspen are common in the Tavaputs Plateau of east-central Utah and in the Bear River Range east of Logan, UT. Few goshawk nests have been located in these forests and the importance as habitat is unclear (map 2).

The cover types most often occupied by goshawks (based on sightings and nest locations) are Engelmann spruce, subalpine fir, lodgepole pine and quaking aspen, either in single or mixed species forests (table 1). Ponderosa pine can also be locally important, particularly in riparian areas where the species is mixed with quaking aspen. Subalpine fir and Engelmann spruce are late seral species dominating their respective potential vegetation types. Lodgepole pine or a lodgepole pine mix occurs on over 75 percent of the lodgepole pine potential vegetation type but occupy less than 20 percent of the subalpine fir and Engelmann spruce potential vegetation types. Subalpine fir, Engelmann spruce, quaking aspen, and lodgepole pine



Map 1—The distribution of potential vegetation types in Utah as derived from Geospatial Analysis Processes data, forest inventory and analysis data, and local knowledge. WF = White fir, SAF = Subalpine fir, P/J = Pinyon juniper, LPP = Lodgepole pine, ES = Engelmann spruce, PP = Ponderosa pine, QA = Quaking aspen, DF = Douglas-fir.

Table 6—Possible forest cover types for each of the potential vegetation types.

Potential vegetation types[a]							
WF	**SAF**	**P/J**	**LPP**	**ES**	**PP**	**QA**	**DF**
Cover Types[b]							
PP	QA	P/J	LPP	ES	PP	QA	DF
QA	DF		LPP/QA	ES/LPP	QA		DF/QA
QA/M	ES/LPP			ES/SAF	LPP		LPP
DF	ES			QA			PP
WF	SAF			SAF			QO
LP	LPP			LPP/QA			QA
	LPP/QA						LP
	ES/SAF						GO/QA
	LP						DF/PP/QA/LPP
							CW
							GO/M

[a]Refer to footnotes in table 1 for potential vegetation type for definition.
[b]Refer to footnotes in table 1 for cover type definition.

Table 7—The proportion of the current cover types found in Utah forests and woodlands.

Current cover type	Percent
White fir	6
Subalpine fir	8
Pinyon pine/Utah juniper	51
Lodgepole pine	2
Lodgepole pine/quaking aspen	2
Engelmann spruce	2
Engelmann spruce/subalpine fir	2
Engelmann spruce/lodgepole pine	4
Ponderosa pine	4
Cottonwood	1
Quaking aspen	9
Dougalas-fir	2
Douglas-fir/ponderosa pine/ Quaking aspen/lodgepole pine	0
Douglas-fir/quaking aspen	6
Gambel oak/big tooth maple	1

[a]Refer to footnotes in table 1 for cover type definitions.

(either alone or in mixed species stands) dominate the tall forests in Utah and are all commonly used by goshawks for nesting.

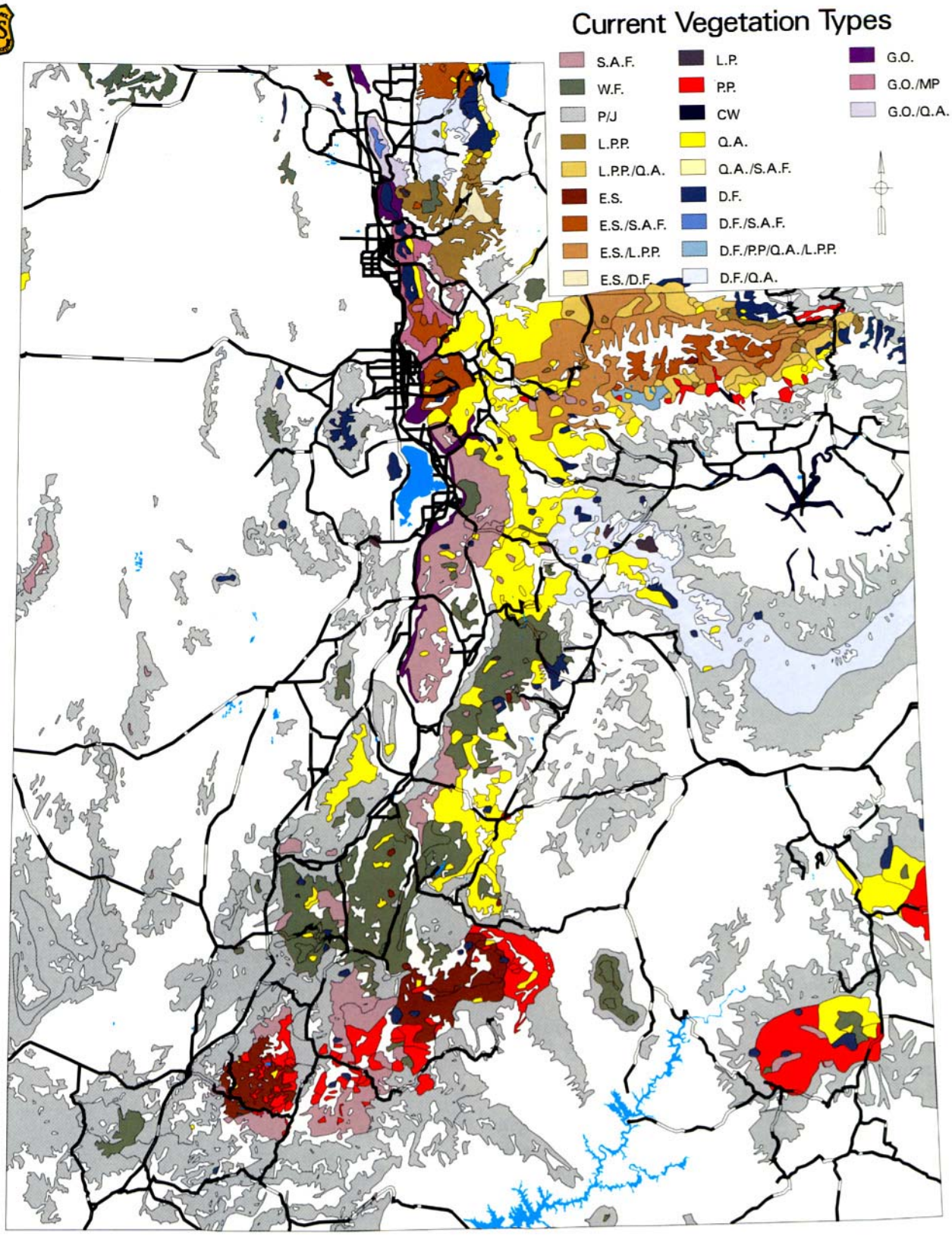
Other cover types used by goshawks include ponderosa pine, white fir and Douglas-fir. Ponderosa pine, an important early seral species in many of the potential vegetation types, is currently under-represented in the white fir and Douglas-fir potential vegetation types (table 8). As a late seral species, it covers 84 percent of the ponderosa pine potential vegetation type but is rarely found on any other. White fir dominates the white fir potential vegetation type, even though ponderosa pine, quaking aspen, Douglas-fir, and lodgepole pine are major seral species that can exist on this potential vegetation type (Mauk and Henderson 1984). In all potential vegetation types, late seral species have greatest representation. With the exception of lodgepole pine, ponderosa pine, and quaking aspen potential vegetation types, these conditions are unstable (Harvey and others in press) (see section on "Trends and Risks to Habitat").

Habitat Valuation Process

Forest cover type alone does not determine habitat suitability for nesting goshawks or goshawk prey. Stand structure, patch size, landscape features, woody debris, snags, understory vegetation, openings, and interlocking crowns are some of the habitat attributes that are important for the goshawk and its prey (tables 1, 2, 4). Abundance of important prey species varies with potential vegetation type (tables 3, 9). Each vegetative polygon was evaluated by resource managers, as to its value for goshawk foraging and nesting based on the presence or absence of these prey and habitat characteristics. Each polygon was rated as high, medium, or low quality in four categories: goshawk nesting habitat, small to medium-sized mammal habitat, woodpecker habitat, and other medium-sized bird habitat.

Nesting Habitat

Most high quality nesting habitat across all potential vegetation types occurs on the subalpine fir and quaking aspen potential vegetation types (table 10; fig. 3) . As would be expected, very little high quality nesting habitat occurs on the pinyon/juniper potential vegetation type. Within individual potential vegetation types, the subalpine fir, lodgepole pine, ponderosa pine and quaking aspen are primarily composed of



Map 2—The distribution of current vegetation types in Utah as derived from Geospatial Analysis Processes data, forest inventory and analysis data, and local knowledge. WF = White fir, SAF = Subalpine fir, P/J = Pinyon juniper, LPP = Lodgepole pine, ES = Engelmann spruce, DF = Douglas-fir, CW = Cottonwood, GO = Gambel oak, MP = Maple, PP = Ponderosa pine, LP = Limber pine, QA = Quaking aspen.

Table 8—Proportion of each potential vegetation type currently in various forest cover types.

Current Cover type	Potential vegetation type[b]							
	WF	SAF	ES	LPP	PP	DF	QA	P/J
	Percent							
White fir	84	2	-	-	-	-	-	-
Subalpine fir	1	45	-	2	6	-	3	2
Pinyon pine/Utah juniper	-	-	-	-	-	99	-	-
Lodgepole pine	-	-	14	2	-	-	-	16
Lodgepole pine/quaking aspen	-	3	51	12	-	-	2	-
Engelmann spruce	-	12	1	18	-	-	-	-
Engelmann spruce/subalpine fir	-	8	-	49	-	-	-	-
Engelmann spruce/lodgepole pine	-	20	6	14	-	-	-	-
Engelmann spruce/Douglas-fir	-	-	-	-	-	-	2	-
Ponderosa pine	1	1	-	1	84	-	1	2
Cottonwood	-	-	2	-	-	1	-	-
Quaking aspen	2	4	11	2	9	-	84	-
Douglas-fir	3	3	2	-	-	-	-	18
Douglas-fir/ponderosa pine/ quaking aspen/lodgepole pine	1	-	13	-	-	-	-	-
Douglas-fir/subalpine fir	-	-	-	-	-	-	1	-
Quaking aspen/subalpine fir	-	-	-	-	-	-	1	-
Douglas-fir/quaking aspen	-	-	-	-	-	-	-	61
Gambel oak	-	1	-	-	-	-	4	2
Gambel oak/big tooth maple	10	-	-	-	-	-	-	-
Gambel oak/quaking aspen	-	-	-	-	-	-	3	-

[a]Refer to footnotes in table 1 for potential vegetation type definition.
[b]Refer to footnotes in table 1 for cover type definition.

Table 9—Occurrence of selected prey species in Utah potential vegetation types.[a]

Prey species	Potential vegetation type[b]							
	WF	SAF	ES	LPP	PP	DF	QA	P/J
Mammals								
Snowshoe hare	-	X	X	X	-	X	X	-
Red squirrel	X	X	X	X	X	X	-	-
Woodpeckers								
Northern flicker	X	X	X	X	X	X	X	X
Three-toed woodpecker	-	X	X	X	-	X	-	-
Hairy woodpeckers and Williamson's sapsuckers	X	X	X	X	X	X	X	X
Downy woodpecker	-	-	-	X	X	-	X	-
Red-naped	-	-	-	X	-	-	X	-
Other birds								
Steller's Jay	X	X	X	X	X	X	X	X
Ruffed grouse	X	-	-	X	X	X	X	-
Blue grouse	X	X	X	X	X	X	X	-
American robin	X	X	X	X	X	X	X	X
Mountain bluebird	X	X	X	X	X	X	X	X

[a]Bird habitat information based on DeGraaf and others 1991; Red squirrel information based on Reynolds and others 1992; Snowshoe hare information based on Dolbeer and Clark 1975, Koehler 1990, Koehler and Brittell 1989.
[b]Refer to footnotes in table 1 for potential vegetation type definitions.

Table 10—Proportion of high, medium, or low nesting habitat among the potential vegetation types.

Potential vegetation type[a]	High	Medium	Low
	- - - - - -	*Percent*	- - - - - -
White fir	10	17	2
Subalpine fir	40	29	2
Pinyon pine/Utah juniper	0	0	91
Lodgepole pine	3	2	0
Engelmann spruce	1	2	1
Ponderosa pine	11	7	1
Quaking aspen	27	11	2
Douglas-fir	8	32	1

[a]Refer to footnotes in table 1 for potential vegetation type definitions.

Table 11—Proportion of each potential vegetation type in high, medium, or low nesting habitat.

Potential vegetation type[a]	High	Medium	Low
	- - - - - -	*Percent*	- - - - - -
White fir	31	52	17
Subalpine fir	55	39	6
Pinyon pine/Utah juniper	0	0	0
Lodgepole pine	58	34	8
Engelmann spruce	25	46	29
Ponderosa pine	54	32	13
Quaking aspen	64	25	11
Douglas fir	21	73	6

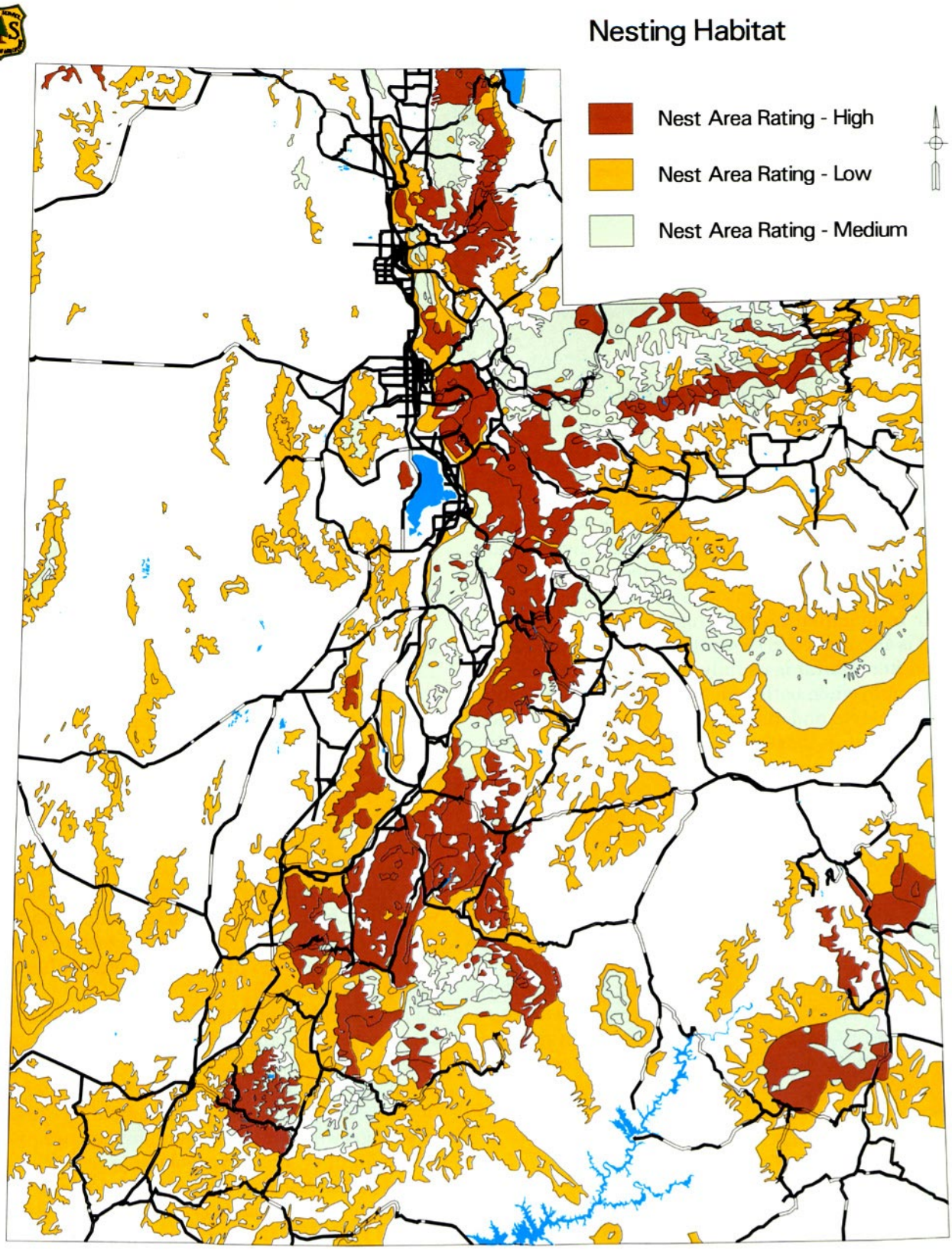
[a]Refer to footnotes in table 1 for potential vegetation type definitions.

Figure 3—Quaking aspen is one of the more important forest types supporting goshawks in Utah both as a seral species and a long-term persistent.

high value nesting habitat (table 11). Although nesting habitat is found in most potential vegetation types, forests occurring on the subalpine fir and quaking aspen potential vegetation types appear to be particularly suited for nesting. As would be expected, the pinyon/juniper potential vegetation type was rated as low value for nesting. No nests are known to occur in pinyon/juniper habitats in Utah. The central mountains of the State have the greatest concentration of high rated nesting habitat interspersed with medium rated forest lands and bordered by the low rated pinyon/juniper woodlands (map 3).

Foraging Habitat

Forests occurring on ponderosa pine, subalpine fir, and quaking aspen potential vegetation types provide most of the high valued habitat for mammals (table 12). With the exception of the pinyon/juniper potential vegetation type, most of the forests and woodlands of Utah were rated high or medium for mammal habitat. For both woodpeckers and other birds, the quaking aspen potential vegetation type supports mostly high rated habitat with only small amounts of low rated habitat for any of the prey groups. The Engelmann spruce potential vegetation type was rated medium for woodpeckers and low for other birds. Fifty percent of the forests on the ponderosa pine potential vegetation type were rated high for woodpeckers and 60 percent had a medium rating for other birds. Forests growing on the white fir and Douglas-fir potential vegetation types rated mostly medium as habitat for each prey group.



Map 3—Distribution of high, medium, or low value goshawk nesting habitat in Utah.

Table 12—The proportion of each prey habitat group rated high, medium, or low for each potential vegetation type.

Potential vegetation type[a]	Mammals			Woodpeckers			Other birds		
	High	Medium	Low	High	Medium	Low	High	Medium	Low
	Percent								
White fir	44	53	2	58	27	15	9	71	19
Subalpine fir	79	18	2	57	36	6	22	41	37
Pinyon/Utah juniper	31	49	21	7	15	79	20	43	37
Lodgepole pine	57	42	1	50	48	2	62	25	12
Engelmann spruce	34	66	-	21	79	-	4	22	75
Ponderosa pine	76	24	0	50	27	23	21	60	19
Quaking Aspen	76	20	4	70	21	10	76	21	3
Douglas-fir	30	67	3	25	69	6	25	69	6

[a]Refer to footnotes in table 1 for potential vegetation type definitions.

High value mammal habitat is well distributed throughout the forests of the State especially through the central mountains (map 4). This habitat quality is likely related to the amount of cone producing trees available and the amount of woody debris that occurs in these forests. Forests and woodlands with a medium rating for mammal habitat are well distributed across the State. Minor amounts of low value habitat are located in east-central and southwestern Utah. Similar to mammal habitat, high value woodpecker habitat is also located in the central mountains (map 5). Woodpecker habitat is usually good when snag densities are high, when both endemic and epidemic occurrences of insects and diseases are high. In contrast to mammal habitat, there is much more low rated woodpecker habitat in pinyon/juniper woodlands. The largest concentration of medium valued woodpecker habitat was located in northeastern Utah. High value habitat for medium-sized birds (other than woodpeckers) is distributed north to south across the State (map 6). High value habitat is interspersed with both low and medium valued habitat throughout the State. A large block of medium habitat for other birds is located in east-central Utah. Forest grouse inhabit primarily Douglas-fir and quaking aspen forests throughout the State. Both quaking aspen and ponderosa pine forests contain high numbers of songbirds. Engelmann spruce, white fir, Douglas-fir, and lodgepole pine forests generally have lower numbers of songbirds except when quaking aspen is present.

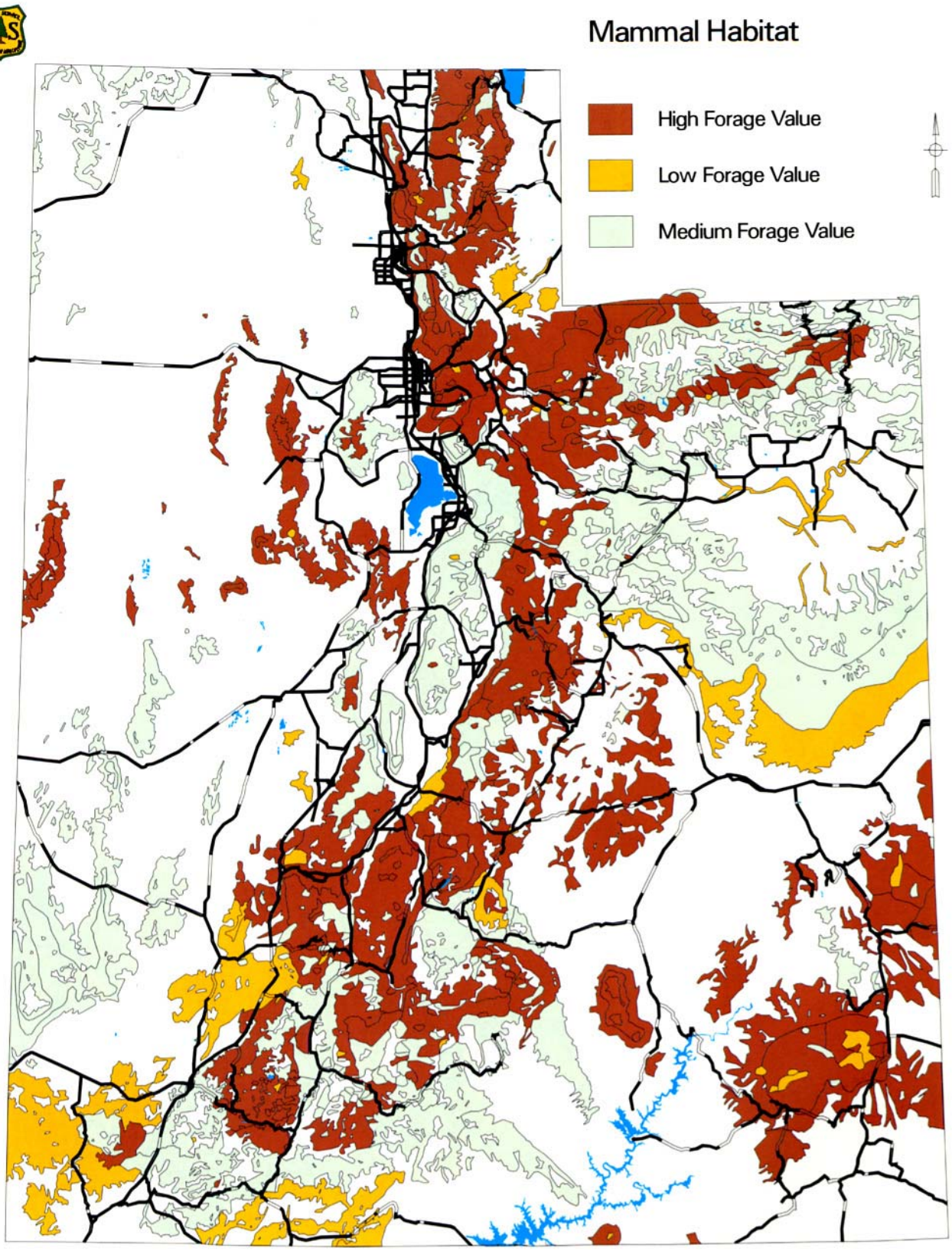
Combined Habitat Rankings

Nesting and foraging habitat ratings were used to produce a combined goshawk rating for each of the 1,112 vegetative polygons in the State. Optimal habitat represents areas in the State in which mammal, woodpecker, other bird, and nesting habitat were all rated high. Optimal habitat would be expected to consistently support breeding goshawks. If nests occurred in these areas, it is expected that they would likely fledge young, even when annual fluctuations in weather or prey reduce nest success in lower quality habitats.

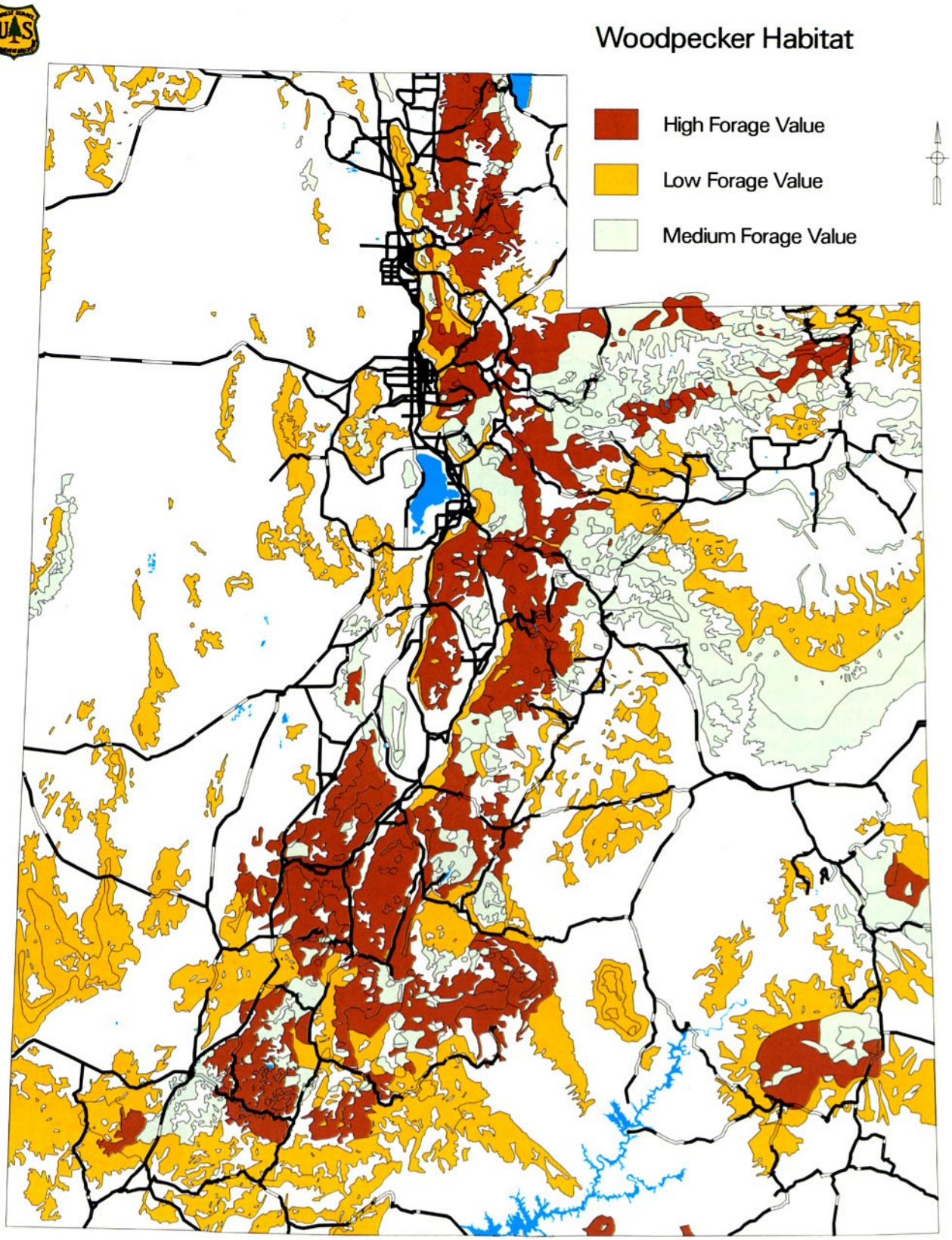
Goshawks are opportunists and able to adapt their diet to take advantage of whatever prey species is abundant in a given habitat and year (Squires and Reynolds 1997). Therefore, to reflect this adaptability we rated areas as “high value” if they were rated high for nesting and also high for at least one prey group. This combined habitat rating includes those areas rated as “optimal” and areas where populations of one or two of the prey groups are expected to be abundant. While it seems intuitive that a variety of abundant prey would be optimal, variety may be less important than abundance. Therefore, habitats in which prey are abundant but not necessarily diverse can still support high densities of goshawks. Average nest productivity may vary more from year to year in high value habitats than in optimum habitats, since it includes some areas where the prey base is limited to one species group. However, long-term averages in goshawk densities and nest success in optimum and high value habitats may differ minimally.

Forty percent of the high value habitat and 25 percent of the optimum habitat is located on the subalpine fir potential vegetation type (table 13). The quaking aspen potential vegetation type also contains high proportions of high value and optimum habitat. In contrast, forests growing on the Engelmann spruce, white fir, pinyon/juniper, and lodgepole pine potential vegetation types all had minimal amounts of high and optimum habitat. The majority of the high value habitat is located in the central portion of the State (map 7).

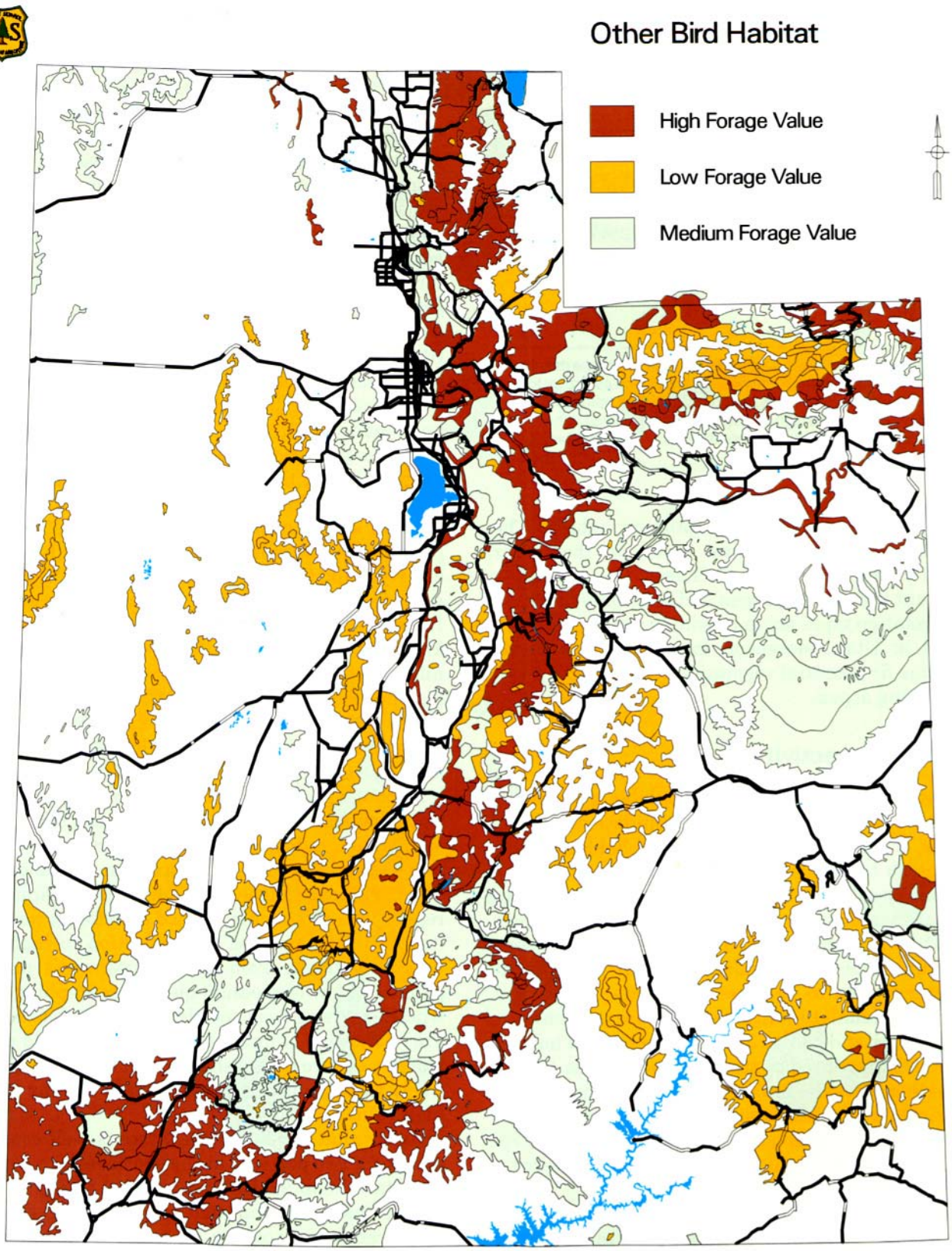
Within the subalpine fir potential vegetation type, 54 percent is rated as high value habitat and 16 percent rated optimum (table 14). Similarly, large proportions of the quaking aspen and lodgepole potential vegetation



Map 4—Distribution of high, medium, or low value small mammal habitat in Utah.



Map 5—Distribution of high, medium, or low value woodpecker habitat in Utah.



Map 6—Distribution of high, medium, or low value habitat for medium sized birds other than woodpeckers in Utah.

Table 13—Proportion of northern goshawk nesting habitat rated as high and optimum in each potential vegetation type.

Potential vegetation type[a]	High[b]	Optimum[c]
	- - - - - *Percent*	- - - - -
White fir	6	5
Subalpine fir	40	25
Pinyon/juniper	7	1
Lodgepole pine	3	5
Engelmann spruce	1	0
Ponderosa pine	10	7
Quaking aspen	26	44
Douglas-fir	8	13

[a]Refer to footnotes in table 1 for potential vegetation type definitions.
[b]High: Areas rated high as nesting habitat and high as habitat for one or more prey groups (mammals, woodpeckers, and other birds).
[c]Optimum: Areas rated high as nesting habitat and high as habitat for all three prey groups (mammals, woodpeckers, and other birds).

types were rated as high or optimum habitat. The majority of optimum habitat occurs in the center portion of the State (map 8). These data show how important the quaking aspen and subalpine fir potential vegetation types are in providing quality goshawk habitat in Utah. Moreover, larger amounts of the subalpine fir potential vegetation type could be growing quaking aspen.

Habitat Connectivity

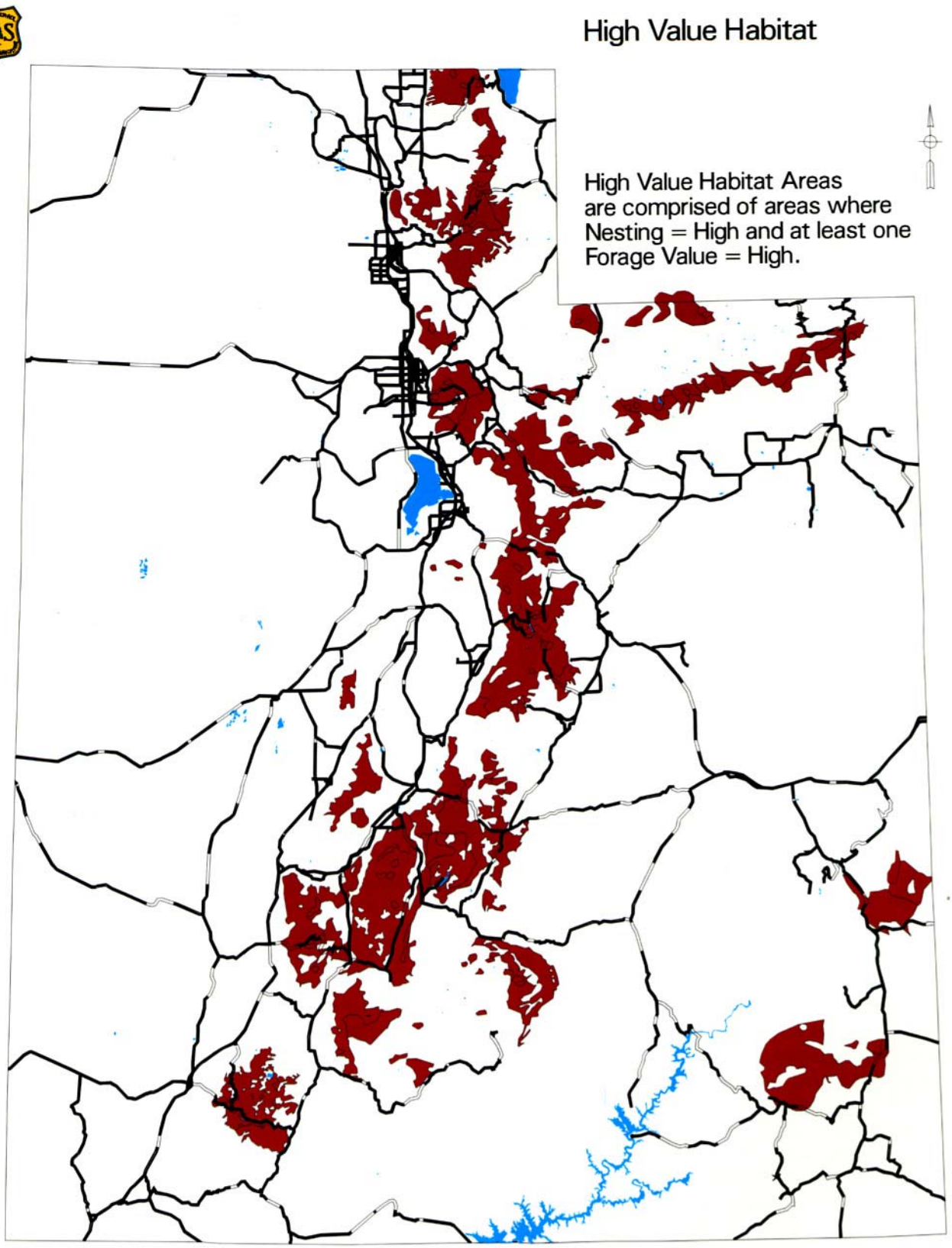
Habitat is only connected and available to goshawks if it is accessible from existing population centers. That is, if the spatial distribution of habitat allows each patch to be reached by individuals dispersing from one or more adjacent patches. If every patch can be reached and subsequently occupied, then all areas would be considered connected. Connectivity has positive implications for population viability because it allows juveniles to disperse from natal areas, and allows individuals to emigrate to new areas when their current habitat declines in value. Declines in habitat value could be caused by stand-replacing fires, timber harvesting, periodic lows in prey abundance, urban encroachment, or other disturbances. Connected habitat ensures that individuals will be available to recolonize habitats or emigrate to new breeding territories throughout the State.

Distances involved in goshawk dispersal and habitat selection need to be determined prior to evaluating connectivity (Keitt and others 1997). Perhaps the best indication of connectivity is the distance goshawks move from natal areas to adult breeding territories. These distances can be determined by color-banding nestlings or fledglings and then relocating them as nesting adults. Several reports indicate that the dispersal distances of young goshawks range from 6 to 20 miles (Reynolds and Joy 1998; Woodbridge and Detrich 1994). Often, several years elapse between fledging and relocation of adult birds, so the distances may be the cumulative result of successive movements. In addition, one banded female who fledged on the north slope of the Uinta Mountains was found nesting 17 miles from her natal site (Ashley National Forest 1998b). Dispersal can also be estimated by observing adults who breed on two or more spatially distinct territories. Of the 19 reports of territory switching in the contiguous Western United States, the distance moved averaged less than 6 miles for both sexes (Reynolds and Joy 1998; Woodbridge and Detrich 1994; Younk and Bechard 1994b). In Alaska, female goshawks relocated to territories 27 miles apart (Iverson and others 1996).

Winter movements of goshawks are considerably longer. During the winter, female goshawks in the Uinta Mountains usually move about 60 miles from the last known nest site, but one female moved approximately 180 miles (Squires 1997). Adults in southern Wyoming were observed to winter in Colorado 116 miles from the nest sites (Squires and Ruggiero 1995). In Alaska, after the breeding season, males have been known to move 59 miles, females 34 miles, and juveniles up to 101 miles, with an average maximum distance moved by juveniles of 39 miles (Iverson and others 1996). These studies probably underestimate winter movements because not all birds were relocated and some may have traveled beyond the search radius.

Although goshawks are clearly capable of traveling long distances to find suitable habitat, the previous information indicates that 20 to 60 mile movements are typical. Therefore, a maximum distance of 60 miles between patches of high value habitat would represent a reasonable method of defining connectivity. We also restricted our definition to high value habitat patches, even though goshawks may use patches of low or medium quality as stepping stones when dispersing from one high value patch to another. This definition of habitat connectivity would conservatively ensure that goshawks will be able to disperse freely throughout the State, always finding at least high value habitat.

High value habitat in the State is well connected except for two portions in the southwestern corner of the State (map 9). Habitat in the LaSal and Abajo Mountains were connected to each other. However, they were separated by 66 miles from other high valued habitat. Our analysis did not consider potential habitat in western Colorado, northern Arizona, or northwestern New Mexico. It is likely these areas could be well connected to these adjacent regions.



Map 7—Distribution of high value goshawk habitat in Utah. Lands considered high value for nesting and high value for at least one of the prey groups (mammals, woodpeckers, or other birds) were considered high value.

Table 14—Proportion of the potential vegetation types with high and optimum northern goshawk nesting habitat ratings.

Potential vegetation type[a]	High[b]	Optimum[c]
	- - - - - *Percent*	- - - - -
White fir	19	7
Subalpine fir	54	16
Pinyon/juniper	3	0
Lodgepole pine	51	42
Engelmann spruce	22	2
Ponderosa pine	52	16
Quaking aspen	61	47
Douglas-fir	20	14

[a]Refer to footnotes in table 1 for potential vegetation type definitions.
[b]High: Areas rated high as nesting habitat and high as habitat for one or more prey groups (mammals, woodpeckers, and other birds).
[c]Optimum: Areas rated high as nesting habitat and high as habitat for all three prey groups (mammals, woodpeckers, and other birds).

Trends and Risks to Habitat

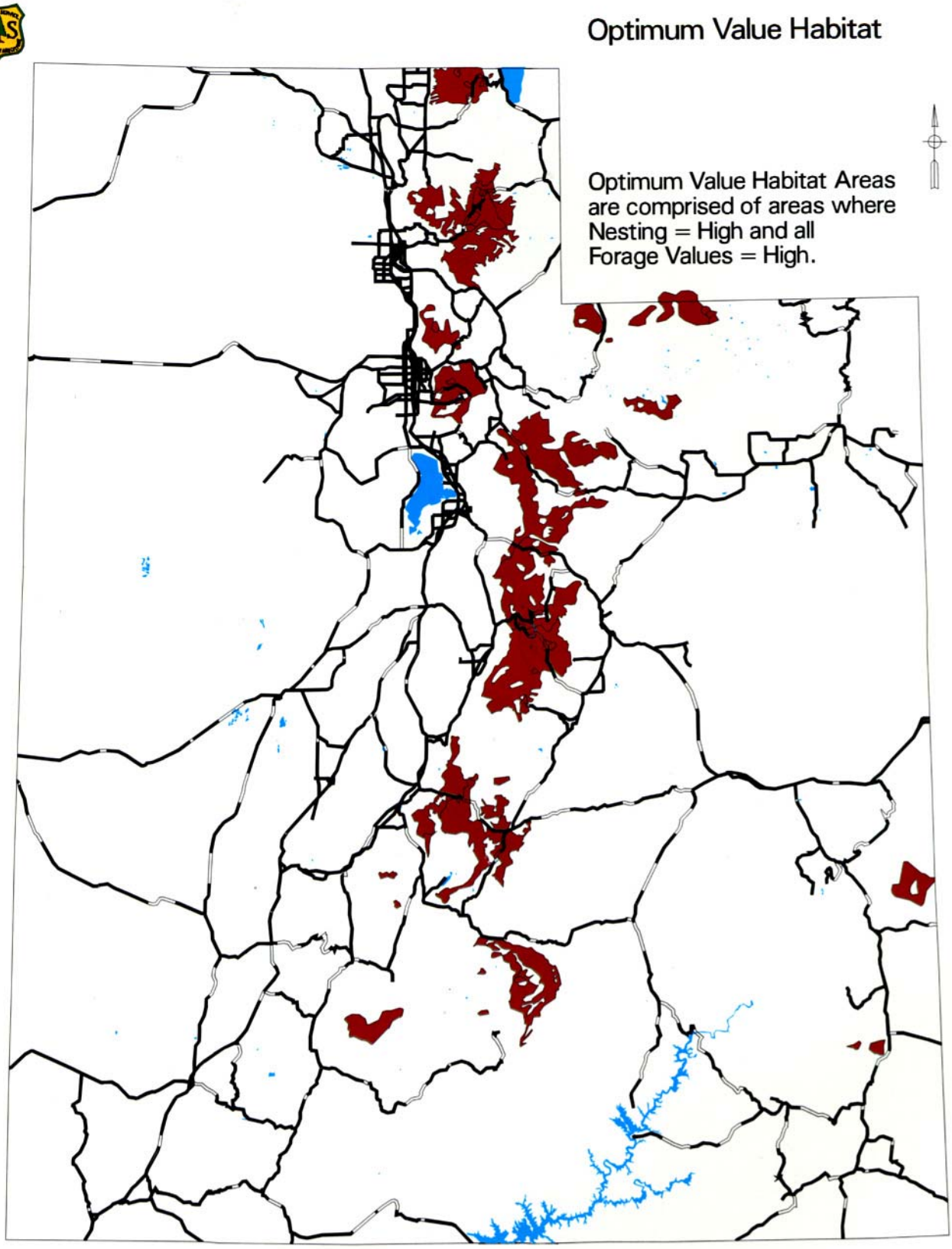
Natural Threats

Forests are complex and dynamic. The potential vegetation types of Utah range from subalpine fir to pinyon/juniper. Each of these potential vegetation types have a wide range of biophysical attributes that result in a variety of stand structures and compositions influenced by a wide range of disturbance factors. These range from those induced by wind, snow, ice, and fire to those that are human-caused. Landscapes of Utah are widely used by human habitation, timber extraction, recreation, livestock grazing, and are important sources of water. Because of these current and potential disturbances, lands classified by each of the potential vegetation types present their own unique threats to the goshawk and to its habitat.

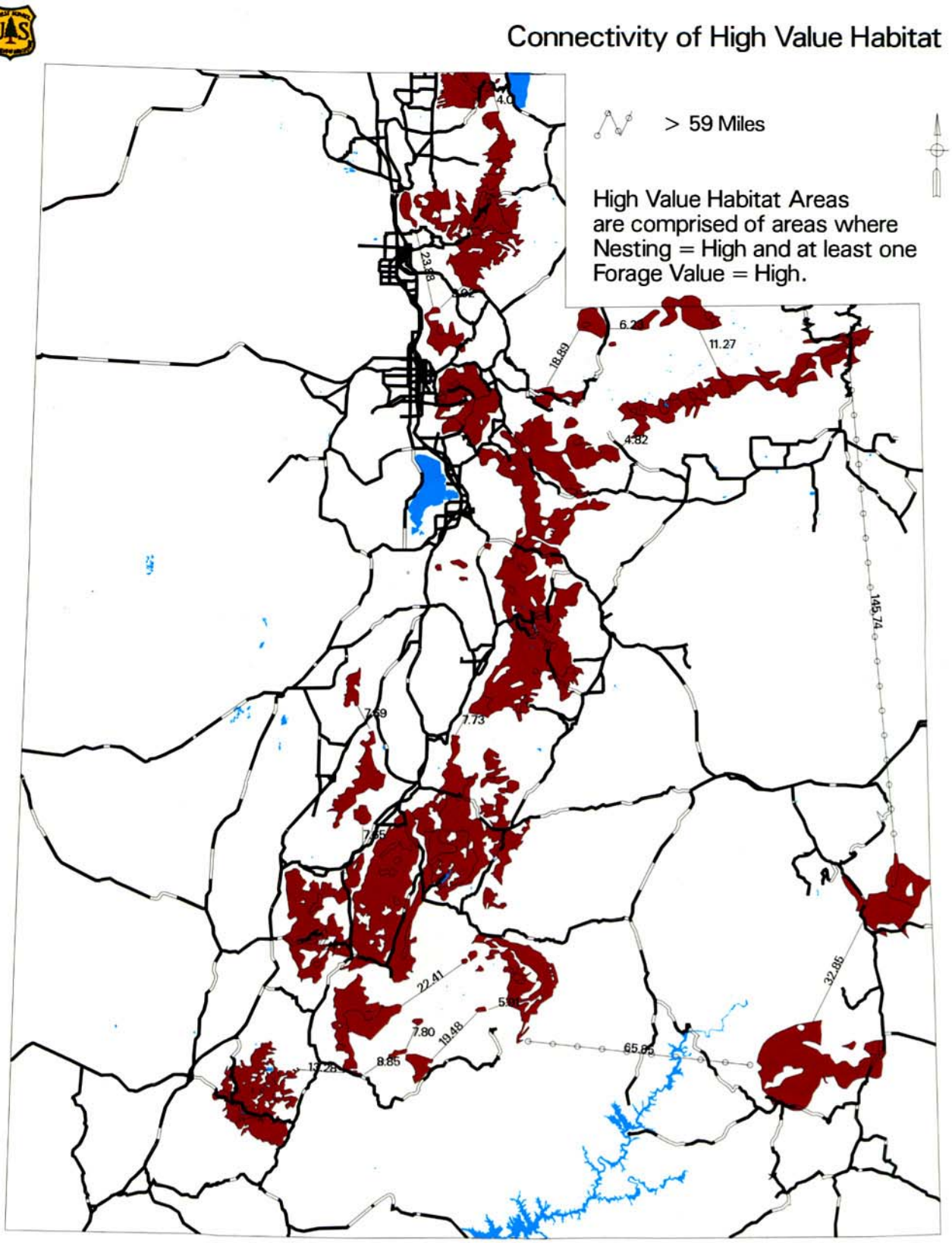
White Fir—The white fir potential vegetation type is dominated by late seral species with over 80 percent of the type occupied by white fir (table 8) (fig. 4). Even though this type is capable of supporting ponderosa pine and quaking aspen, only 3 percent of the potential vegetation type was occupied by these early seral species. Douglas-fir and ponderosa pine, also early seral species, were highly prized lumber species and many were removed in the late 1800's and early 1900's. Fires that historically burned in these forests at intervals of 20 years or less now have potential to be stand replacing. If the forests in this potential vegetation type were open and dominated by early seral species, the fires would likely be of low intensity and severity. Relatively shade tolerant late seral species tend to be more shallow rooted than early seral species. Therefore, more of the nutrient and microbiological capital of the soil is now close to the surface. In addition, the crowns of late seral species are nutrient rich and usually extend to the ground. Because of this, compression of the nutrients and microbiological attributes accumulate near the soil surface where they are at risk when these forests burn. In contrast, ponderosa pine is deep rooted and has high crowns with relatively lower nutrient content. So there is less risk to the microbes and nutrients even if the forest is replaced. Forests dominated by early seral species (especially the pines) are, in general, more stable in both the short- and long-term (Harvey and others in press).

In addition to forests in this potential vegetation type being potentially unstable and at risk to fire, their structural attributes make them undesirable for the goshawk compared to more open ponderosa pine, Douglas-fir, or quaking aspen forests. As a result of currently dense stocking levels and multiple canopy layers, large trees for nesting would be limited. In addition, dense, multistoried canopies would likely hinder foraging opportunities by obstructing flight and sight lanes.

Subalpine Fir—The current vegetation of the subalpine fir potential vegetation type is dominated by late seral species primarily subalpine fir and Engelmann spruce mixed with lodgepole pine (table 8). These late seral species mixes are highly susceptible to insect and disease epidemics, as exemplified by the spruce beetle and balsam bark beetle mortality visible in much of the potential vegetation type. Insect surveys conducted in 1996 indicate a large proportion of the large trees in the potential vegetation type were killed by beetles (Gardner and others 1997) (fig. 5). This trend will likely continue, especially in areas with a high dominance of Engelmann spruce. Without some form of stand replacing disturbance, quaking aspen and lodgepole pine, the two major early seral species of the type, will continue to decline from their already low representation. Quaking aspen occupies less than 4 percent of the potential vegetation type and lodgepole pine occurs on less than 1 percent of the area. Quaking aspen is one of the most important cover types supporting the goshawk in Utah. If quaking aspen continues to decline in this potential vegetation type, it will likely impact goshawks. Stand replacing wildfires are an infrequent event in this potential vegetation type but, with the large amount of dead and down material found in this potential vegetation type, intense and severe wildfires are an increasingly likely possibility. Similar to the white fir potential vegetation type, wildfires in this type (because of the dominance of late seral species) would likely damage the soil resource and might impair long-term productivity. In the absence of wildfire in this potential vegetation type late seral vegetation will likely increase beyond 45 percent of this area that it already occupies.



Map 8—Distribution of optimum goshawk habitat in Utah. Lands that were considered high value for nesting and high value for all of the prey groups (mammals, woodpeckers, or other birds) were considered optimum.



Map 9—Connectivity of high value habitat patches (Lands considered high value for nesting and high value for at least one of the prey groups (mammals, woodpeckers, or other birds) were considered high value) showing connections. High value habitat was considered connected if an adjacent patch was within 60 miles.

Figure 4—A dense forest of white fir and Douglas-fir growing on a white fir potential vegetation type. These conditions are prone to stand replacing fires and epidemics of insects and diseases.

Figure 5—A typical stand of Engelmann spruce killed by spruce bark beetles. These conditions are of low value for both goshawk nesting and foraging.

These subalpine fir dominated forests would provide poor to marginal habitat as a result of cluttered multistoried stands and lack of prey (except for the snowshoe hare).

Lodgepole Pine—Lodgepole pine potential vegetation type covers only 1.3 percent of the State but it is unusual in that, because lodgepole pine is normally a seral species, there are only certain conditions that allow it to persist over the long-term. There are few other conifers that grow with lodgepole pine on this potential vegetation type, making any threat to that species a threat to forest cover. However quaking aspen is a frequent seral species. Since the 1960's bark beetles have been very active in this potential vegetation type, killing large areas and opening many stands. A large proportion of the potential vegetation type is currently occupied by mid- to old-aged trees (table 15); therefore the risk of additional insect related mortality is still high. In addition, some lodgepole pine stands on this potential vegetation type are prone to develop with high densities of slow growing trees. Historically, lodgepole pine in this potential vegetation type was affected by dwarf mistletoe and bark beetles, with fire periodically regenerating the species. Much of this potential vegetation type has been opened up by bark beetles but it is regenerating to lodgepole pine under the dead overstory. The present condition of the potential vegetation type appears to be part of normal cycle and most stands will continue to develop naturally. Surface fires that have frequented these forests could once again thin the even-aged structure. In their present form, most forests in this potential vegetation type, with dead overstory trees and a dense young understory, are good goshawk habitat. As the standing dead trees fall, they will decrease the habitat value.

Engelmann Spruce—Engelmann spruce and subalpine fir mixed stands dominate this potential vegetation type. Similar to the white fir and subalpine fir potential vegetation types, it is also dominated by late seral species, subalpine fir and Engelmann spruce. Also similar to other potential vegetation types where quaking aspen is seral, only 2 percent of the type is covered by quaking aspen but there is 12 percent of the potential vegetation type covered by a mix of lodgepole pine and quaking aspen. There is also a fair representation of lodgepole pine mixed with Engelmann spruce, covering 14 percent of the potential vegetation type. This potential vegetation type has a good mix of early and late seral species. The current high proportion (79 percent) of mid- and old-aged trees (table 15) make these stands highly susceptible to infestations of spruce bark beetles. Bark beetles tend to attack and kill large trees within infested stands. As a result, nesting habitat would likely be adversely affected. As the bark beetle kills Engelmann spruce, however, there may be enough of a seed source for the early seral species to regenerate. It appears that, depending on the spatial arrangement of the seral species in the long-term, these forests will regenerate to a mixture of Engelmann spruce and early seral species. In the short-term, forests growing on this potential vegetation type will be susceptible to damaging wildfires but because of their elevation, wildfires are likely to be infrequent.

Ponderosa Pine—Ponderosa pine dominates this potential vegetation type even though Gambel oak, and quaking aspen are important seral species (table 8). Ponderosa pine is highly prized for its lumber; as a result, the majority of the ponderosa pine potential vegetation type has been partially cut, removing mature trees. Domestic livestock grazing, along with the exclusion of fire, has disrupted native fire cycles and probably contributed to the decrease of early seral species. Ingrowth of small trees has created high, large fuel loads in some areas, along with thick layers of needles on the forest floor. However, this ingrowth has not occurred to the same extent that it has occurred in other potential vegetation types. When fires

Table 15—Proportion of each potential vegetation type with various stand structures.

	Current forest cover type[a]			
	Mid to old-aged[c]		Interspersed old[d]	
Potential Vegetation Type[b]	ES	LPP	ES	LPP
	Percent			
Subalpine fir	35	24	1	1
Lodgepole pine	7	79	5	7
Engelmann spruce	79	33	-	-
Quaking aspen	2	2	-	-
Douglas-fir	-	16	-	-

[a]Refer to footnotes in table 1 for current cover type definitions.
[b]Refer to footnotes in table 1 for potential vegetation type definitions.
[c]Mid to old-aged forests with small patches.
[d]Old-aged forest nterspersed with other structural stages.

burn in these forests, trees can be killed and limited soil damage is possible depending on the duration and intensity of the fire. Stand-replacing fires are more likely now, compared to the time prior to successful fire exclusion. In some areas, root disease and bark beetles are likely to stress and kill trees as a result of the dense forest conditions. In the short-term, forests growing on this potential vegetation type will probably continue to become more dense and more prone to fire and disease, likely to adversely altering goshawk foraging habitat. In addition, if large trees are not produced, future nesting opportunities will be limited. In the long-term, this type has the greatest potential of all of the potential vegetation types in Utah for the introduction of restorative mechanical and fire treatments. These treatments can clean stands, making them more insect, fire, and disease resistant and better goshawk habitat.

Quaking Aspen—The quaking aspen potential vegetation type covers 10 percent of Utah. Quaking aspen stands dominate this potential vegetation type, occupying 84 percent of it. In addition, this potential vegetation type and the quaking aspen it supports, are some of the most valuable goshawk habitat in the State. Many successional changes occur in the forb, shrub, and grass layers as they respond to different disturbances. But these changes are probably not a great influence on habitat quality for goshawks. Since quaking aspen is normally an early seral species, the environmental conditions that make quaking aspen a persistent species are unknown, but major disturbances might alter the environment, disrupting the gradual and continuous regeneration. An important characteristic of this potential vegetation type is that the stands tend to be uneven-aged; quaking aspen growing on other potential vegetation types tends to be even-aged. The primary threats to quaking aspen stands growing on this type are browsing by domestic livestock and wild ungulates and stand-replacing fires that are ignited from adjacent types. Without a major disturbance or overgrazing, both in the short- and long-term, these stands should remain relatively stable and resilient.

Douglas-fir—Forests growing on the Douglas-fir potential vegetation type are dominated by Douglas-fir or Douglas-fir mixed with other species (79 percent) (table 8). Less than 2 percent of the type is occupied by ponderosa pine. The mixed species condition, as with the other potential vegetation types, compresses nutrient and microbiological processes near the soil surface making them vulnerable to loss from wildfires and some management activities. Because of multiple canopies, live fuel loadings in many of these stands are high and the structure facilitates the initiation and spread of stand replacing wildfires. In addition to the lack of ponderosa pine in this potential vegetation type, there is an absence of quaking aspen, highly important for goshawk habitat. Since European settlement, large ponderosa pine and Douglas-fir were frequently harvested in this type. Multiple canopies, dominated by Douglas-fir, make the current conditions of this type very susceptible to root diseases and insects. In the short-term, forests growing on this potential vegetation type are relatively unstable and prone to a wide range of stand replacing disturbances including epidemics of insects and diseases. Similar to stands growing on the ponderosa pine potential vegetation type, these too are good candidates for the introduction of fire and restoration of seral species. In the long-term, under active management to introduce ponderosa pine and quaking aspen into the system, these forests will become more stable and resilient. If Douglas-fir continues to be the dominant species, stands will continue to be unstable and decrease in value for the goshawk.

Pinyon/Juniper—The pinyon/juniper potential vegetation type covers approximately 50 percent of the forests and woodlands of the State and is totally (100 percent) occupied by pinyon and juniper trees. No recognizable amounts of early seral forbs, grasses, or shrubs were evident from our assessment. No other potential vegetation type is so dominated by the late successional species. With this condition and the indeterminate successional pathways present in this type, the short-term prognosis is a continued dominance of pinyon and juniper. Throughout the State there have been various attempts to transform many of these woodlands to earlier successional stages with limited success. Mechanical, chemical, and fire treatments have been used to convert late seral pinyon/juniper to grass, forb, and shrub communities (Everett 1987). Post-treatment plant communities do not follow any standard successional pathway and if a species is not on the site at the time of disturbance, it will not be there after the treatment (Everett 1987) (fig. 1). Moreover, these communities are susceptible to the introduction of exotics either intentionally or accidently. The introduction of exotics also changes successional pathways and makes future trends even more indeterminate. The introduction of cheatgrass (*Bromus tectorum*) into this potential vegetation type has made fires more intense, severe, and frequent. The resulting fire cycle decreases the perennial shrubs, grasses, and trees and increases the annuals that degrade the site (West and Van Pelt 1987). Similar to the other potential vegetation types that are dominated by late seral vegetation, the pinyon/juniper potential vegetation type is unstable in the long-term, in this case because of exotics and unknown successional pathways. In Utah, there are no documented nests occurring in this potential vegetation type but, because it occupies so much of the State, it may be important to the goshawk, especially as winter foraging habitat.

Administrative Threats

Owners or administrators of the forests and woodlands of Utah include the USDI National Park Service, USDI Bureau of Land Management, USDA Forest Service, State of Utah, and private and Native Americans. Lands owned and managed by the different entities are distributed throughout the State (map 10). By far, the USDA Forest Service administers the majority of the lands in these potential vegetation types (table 16). Also, these lands contain the majority of the high and medium valued nesting habitat (table 17). The majority of the lands controlled by the USDA Forest Service are important foraging habitat for mammals and woodpeckers (table 18). The largest proportion of high (60 percent) and optimum (56 percent) value habitats are managed by the USDA Forest Service with State, private, and Native American entities managing smaller amounts (table 19). Lands administered by the Federal agencies are managed by laws, policies, and regulations that provide for the protection and enhancement of wildlife habitat. Conversely, lands managed by State, private, and Tribal entities are not controlled by such laws. Of the lands administered by the State, 34 percent are rated as high value habitat and 9 percent are rated as optimum (table 20). On non-Federally administered lands there is no assurance that they will be managed in a manner which will be favorable to goshawks and their habitats. Activities on these lands that alter forest vegetation, such as timber harvest, fire, and livestock grazing, if not properly executed, could adversely affect goshawk habitat at least for the short-term, and likely for the long-term.

Threats From Management Activities

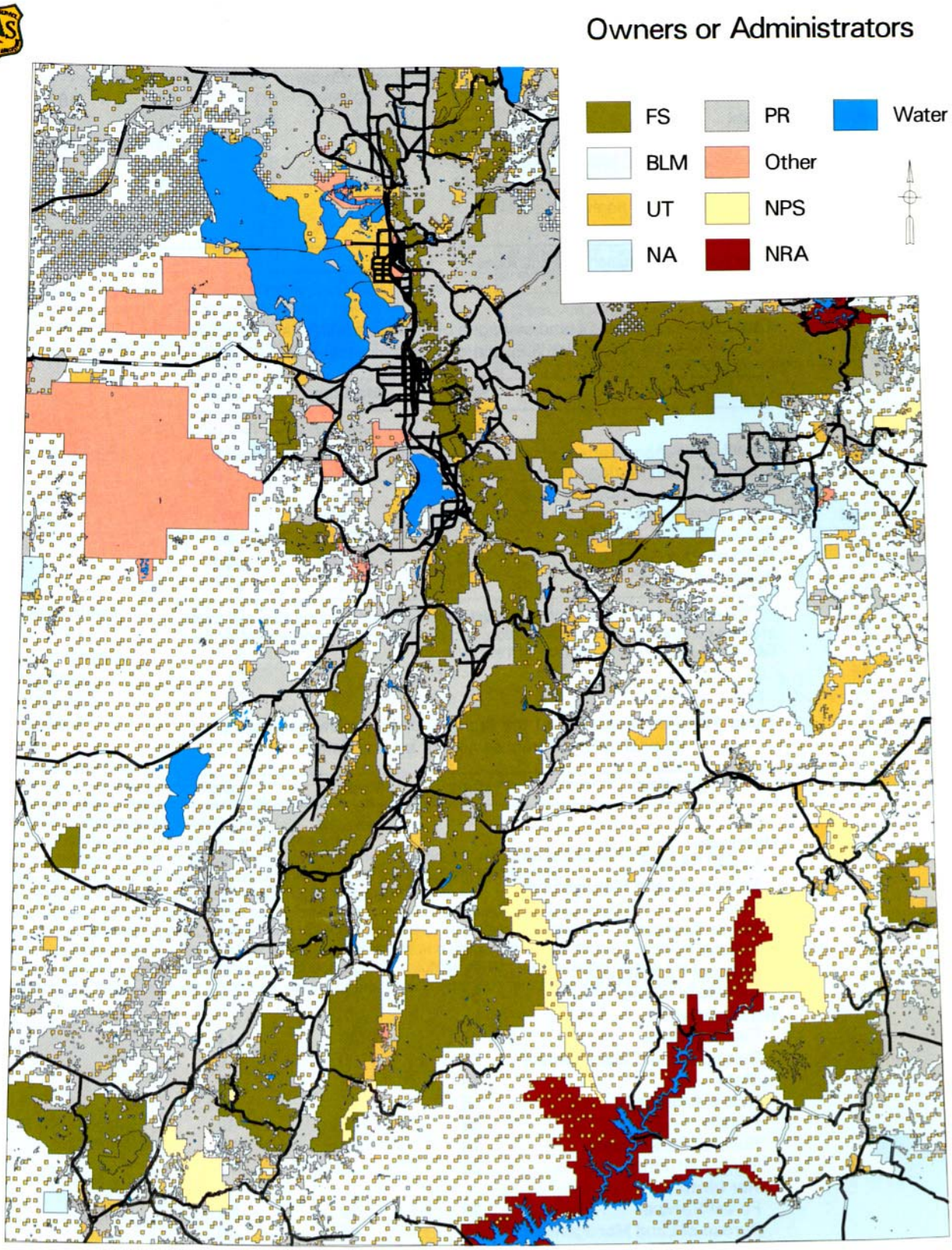
The subalpine-fir, white fir, lodgepole pine, ponderosa pine, and Engelmann spruce potential vegetation types are primarily administered by the USDA Forest Service (table 16). Private land owners control limited amounts of the potential vegetation types, with the exception of the white fir, quaking aspen, and Douglas-fir potential vegetation types where over 26 percent is controlled by private land owners. Because there are minimal restrictions on the use of private land, there are no assurances that goshawk habitat will be sustained on these lands. Moreover, these potential vegetation types are dominated by late seral species prone to fire, insects, and disease. These are all endemic processes that can have both positive and negative effects to goshawk habitat. It is likely that these lands will not be managed to reduce these natural risks nor will they be managed to perpetuate goshawk habitat.

The USDA Forest Service manages its forested lands for a variety of objectives ranging from intensive forest management to recreation (table 21). The largest block of wilderness is in the Uinta Mountains in the northeastern Utah (map 11). Range management is emphasized (featured use or priority use) on 17 percent of the subalpine fir potential vegetation type and 4 percent of the white fir and Engelmann spruce potential vegetation types. The majority of lands in which range is emphasized are rated high or medium for nesting (table 22). These lands are also good mammal habitat and rated medium for woodpeckers (table 23). In terms of overall habitat, 34 percent of lands with a range emphasis (feature or priority use) were rated as high value habitat and 17 percent were rated as optimum (table 24). Of the high value habitat managed by the USDA Forest Service, 27 percent has a range emphasis (table 25). This management direction potentially can decrease prey habitat by removing cover and food for prey species. Indirectly it can interfere with fire regimes and native forest succession. Depending on the intensity and duration, grazing could be detrimental to goshawk habitat and in particular to aspen stands.

In general, timber management is emphasized on 25 percent or less of the subalpine fir, white fir, and Engelmann spruce potential vegetation types (table 21). Similar to where range is emphasized, the majority of the lands where timber is emphasized is rated either high or medium nesting habitat (table 22). These lands are also excellent mammal habitat and moderately important for woodpeckers or other birds (table 23). Of the high valued habitat on USDA Forest Service lands, timber is emphasized on only 20 percent of the high value habitat and 18 percent of the optimum habitat (table 24).

Over 20 percent of subalpine fir and Engelmann spruce potential vegetation types is in the mixed uses management category. A variety of uses can occur on these lands such as timber harvesting, livestock grazing and recreation. On these lands, the general standards and guides of the National Forest Plan applies, and there is no single management emphasis. These forests are managed within regulations and policies that direct conservation and management of sensitive species. Therefore, if proper management strategies are implemented within these potential vegetation types, forest management actions are not likely to adversely affect goshawk habitat in the long-term.

The lodgepole pine, quaking aspen, and ponderosa pine potential vegetation types are the only potential vegetation types in Utah where the primary tree species and the late successional species for the type are the same. For the most part, lodgepole pine dominates the lodgepole pine potential vegetation type and



Map 10—Principle owners or administrators of the forest and woodlands of Utah. NRA = National Recreation Area, NPS = National Park Service, Other = Other federal, PR = Private, NA = Native American, FS = Forest Service, BLM = Bureau of Land Management, UT = State of Utah.

Table 16—Proportion of each potential vegetation type managed by various administrative entities.

Entity	Potential vegetation type[a]							
	WF	SAF	LPP	ES	P/J	PP	QA	DF
	Percent							
Forest Service	55	61	77	60	10	54	48	28
Bureau of Land Management	8	10	2	-	60	21	4	19
State Of Utah	5	4	2	-	9	5	7	11
Native American	1	-	3	-	4	1	1	12
Private	26	15	4	-	12	8	38	28
National Park Service	2	-	-	-	3	5	-	-
National Recreation Areas	-	-	1	1	1	1	-	-

[a]Refer to footnotes in table 1 for potential vegetation type definitions.

Table 17—Proportion of land managed by various administrative entities rated as high, medium, and low goshawk nesting habitat in Utah.

Entity	High	Medium	Low
	percent		
Forest Service	40	44	16
Bureau of Land Management	10	12	78
State	32	18	50
Native American	6	36	58
Private	26	30	44
National Park Service	9	7	83
Bankhead Jones[a]	23	-	77

[a]These lands were set aside to correct maladjustments in land use and thus assist in control of erosion, reforestation, and protection of fish and wildlife by the Bankhead-Jones Farm Tenet Act of 1937.

Table 18—The proportion of the high, medium, or low goshawk prey habitat in for different owners or administrators.

Species	High	Medium	Low
	percent		
Mammals			
Forest Service	58	37	5
Bureau of Land Management	35	46	19
State	31	59	10
Native American	10	80	11
Private	7	40	53
National Park Service	39	61	-
Bankhead Jones	64	36	-
Woodpeckers			
Forest Service	47	40	14
Bureau of Land Management	72	20	9
State	18	34	47
Native American	5	53	42
Private	39	23	39
National Park Service	14	15	72
Bankhead Jones	23	5	72
Other birds			
Forest Service	29	39	21
Bureau of Land Management	15	45	40
State	25	55	20
Native American	11	86	3
Private	40	43	17
National Park Service	45	25	30
Bankhead Jones	23	-	77

Table 19—Proportion of high and optimum value habitat managed by various administrative entities.

Entity	High[a]	Optimum[b]
	- - - - - *percent* - - - - -	
Forest Service	60	56
Bureau of Land Management	12	5
State	6	7
Native American	1	0
Private	19	29
National Park Service	1	2
Bankhead Jones[c]	0	0

[a]High: Areas rated high as nesting habitat and high as habitat for one or more prey groups (mammals, woodpeckers, and other birds).
[b]Optimum: Areas rated high as nesting habitat and high as habitat for all three prey groups (mammals, woodpeckers, and other birds).
[c]See table 17 footnotes.

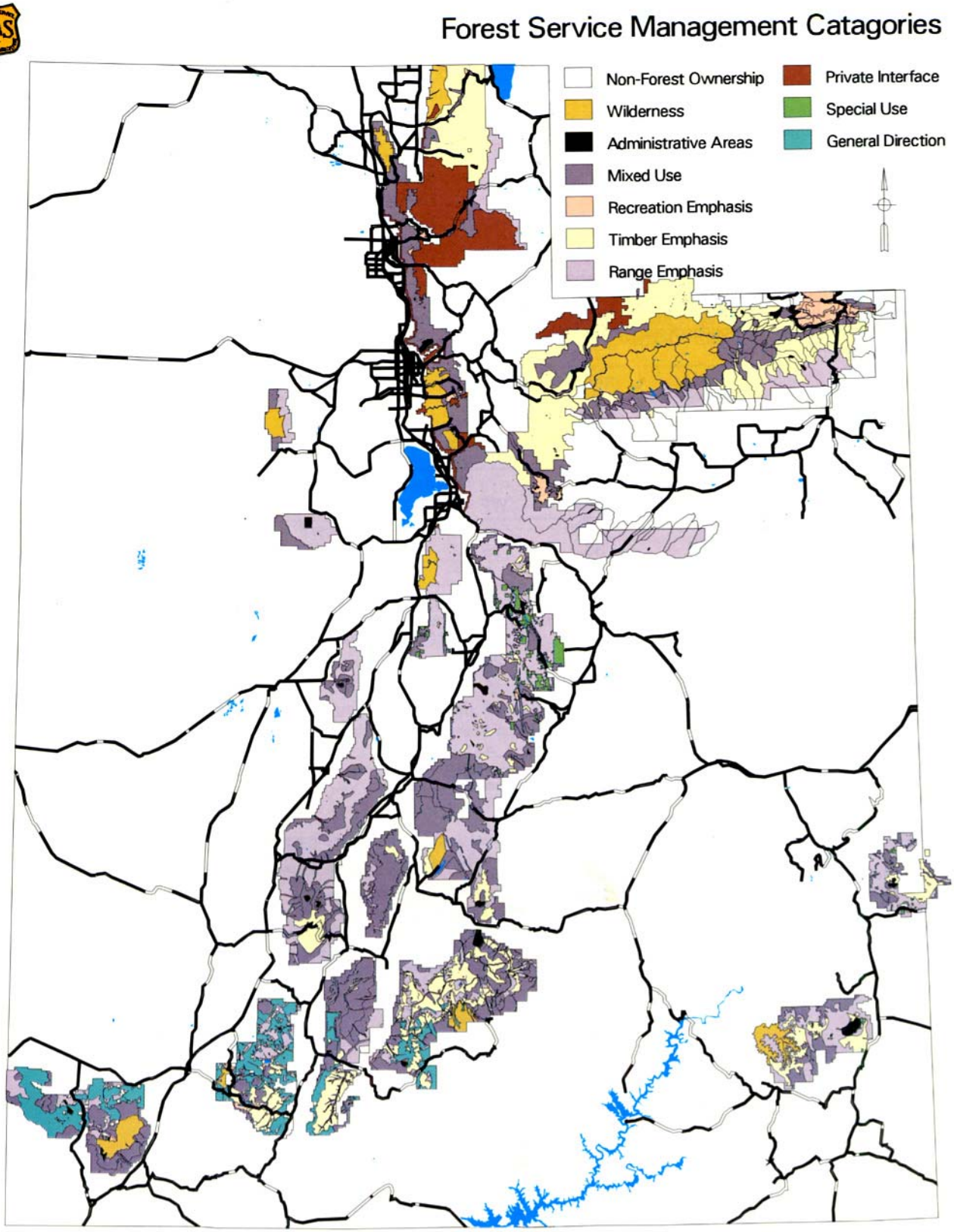
Table 20—Proportion of land managed by various administrative entities rated as high value and optimum goshawk habitat.

Entity	High[a]	Optimum[b]
	- - - - - *percent* - - - - -	
Forest Service	57	24
Bureau of Land Management	3	0
State	34	9
Native American	2	0
Private	7	5
National Park Service	4	4
Bankhead Jones	10	10

[a]High: Areas rated high as nesting habitat and high as habitat for one or more prey groups (mammals, woodpeckers, and other birds).
[b]Optimum: Areas rated high as nesting habitat and high as habitat for all three prey groups (mammals, woodpeckers, and other birds).

Table 21—Proportion of potential vegetation type in various Forest Service management categories.

Management area category[b]	Potential vegetation type[a]							
	PP	QA	WF	SAF	P/J	ES	LPP	DF
	- - - - -



Map 11—The major management categories for Forest Service administered lands in Utah.

Table 22—Proportion of land in various management Forest Service categories rated as high, medium, and low goshawk nesting habitat.

Management area category[a]	High	Medium	Low
		percent	
Wilderness	33	50	16
Administrative areas	41	42	19
Mixed use	53	26	21
Recreation emphasis	66	7	27
Timber emphasis	47	49	5
Range emphasis	48	41	11
Private interface	50	32	18
Special use	75	17	7
General direction (Dixie)	24	24	52

[a]See footnotes, table 21, for management category definitions.

Table 23—Proportion of land in various Forest Service management catagories rated as high, medium, and low goshawk foraging habitat.

Management area category[a]	Mammals			Woodpeckers			Other birds		
	High	Med.	Low	High	Med.	Low	High	Med.	Low
					percent				
Wilderness	54	44	2	38	50	12	28	32	40
Administrative areas	54	44	2	44	38	18	33	40	27
Mixed use	68	25	7	56	26	18	33	39	28
Recreation emphasis	32	68	0	26	26	48	74	24	22
Timber emphasis	75	22	3	55	42	3	34	46	20
Range emphasis	75	22	3	55	35	10	28	46	26
Private interface	54	41	5	60	22	18	68	30	2
Special use	86	13	1	80	13	7	65	22	13
General direction (Dixie)	38	25	37	34	15	51	39	51	10

[a]See footnote, table 21, for management catagory definitions.

quaking aspen dominates the quaking aspen potential vegetation type. These attributes make these potential vegetation types unique. Similarly, quaking aspen is the only early seral species on the ponderosa pine type. The USDA Forest Service administers 77 percent of the lodgepole pine potential vegetation type, over 45 percent of the quaking aspen and ponderosa pine potential vegetation types, and private owners control about 38 percent of the quaking aspen potential vegetation type (table 16, Map 10). On the proportion controlled by private owners there are minimal restrictions on land uses so there are no assurances that goshawk habitat will be sustained. Over 75 percent of the lodgepole pine potential vegetation type is administered by the USDA Forest Service with 58 percent managed with a timber emphasis. In the quaking aspen and ponderosa pine potential vegetation types, less than 15 percent are managed with a timber emphasis but over 15 percent of the types are in the mixed use category. Of the lands managed for a variety of uses, 53 percent are rated high for nesting habitat and 68 percent high value for mammals (tables 22, 23). Both mixed use and timber categories are managed within the standards and guides of the Forest Plans; if proper management strategies are implemented, the impact on goshawks should be minimal. In the ponderosa pine and quaking aspen potential vegetation types, range use was emphasized in over 15 percent of the area. Similar to the fir and spruce potential vegetation types, livestock grazing can change successional pathways and change fire regimes. In particular, livestock and wild ungulate grazing could retard and damage regeneration in the quaking aspen potential vegetation type which depends on continual regeneration. This potential vegetation type is important because quaking aspen is the only cover type and this tree species is widely used by goshawks.

Table 24—Proportion of land in various Forest Service management categories rated as high and optimum goshawk habitat.

Management area category[a]	High	Optimum
	- - - - - *percent*	- - - -
Wilderness	23	8
Administrative areas	31	22
Mixed use	43	18
Recreation emphasis	10	4
Timber emphasis	39	18
Range emphasis	34	17
Private interface	41	39
Special use	67	54
General direction (Dixie)	20	0

[a]See footnotes, table 21, for management catagory definitions.

Table 25—Proportion of high and optimum goshawk habitat within Forest Service management categories.

Management area category[a]	High	Optimum
	- - - - - *percent*	- - - - -
Wilderness	6	4
Administrative areas	0	1
Mixed use	35	30
Recreation emphasis	2	2
Timber emphasis	20	18
Range emphasis	27	28
Private interface	7	14
Special use	1	3
General direction (Dixie)	2	0

[a]See footnotes, table 21, for management catagory definitions.

The majority (60 percent) of the pinyon/juniper potential vegetation type is administered by the Bureau of Land Management with 15 percent or less privately owned, administered by the State, or administered by the USDA Forest Service. Because the successional pathways are so indeterminate in this type, and the majority of the type is occupied by late successional species, management actions could easily cause declines in habitat quality. Exotic grasses have changed the native successional pathways and disrupted the native fire frequencies, severities, and intensities. All these conditions indicate that the pinyon/juniper potential vegetation type will continue to experience instability and invasion of exotics.

Recommendations

In North America, goshawks nest in nearly every forest type. Populations in Utah are similar in that they nest in a broad range of vegetation types ranging from subalpine fir to ponderosa pine. The forests and woodlands of Utah that provide goshawk habitat are diverse in species composition and structure. The history of land-use is also highly variable with domestic livestock grazing occurring for 100 to 150 years and timber harvest beginning in the late 1800's. Tourism and snow skiing have also become important land uses along with timber and water production. With such land uses came the desire to protect the forests and woodlands from fire; effective fire exclusion began in the mid-1900's. As a result, the forests and woodlands of Utah are now dominated by dense stands of late seral species that are prone to epidemics of diseases and insects. More important, many of the forests and woodlands of Utah are prone to large-scale, stand-replacing fire events. The condition of present day forests is far different than those that occurred before European settlement.

Conservation of the northern goshawk will require the restoration and protection of degraded habitats and protection of native processes. The following recommendations describe actions and long-term management strategies aimed at sustaining the habitat of the goshawk and selected prey species for the forests and woodlands of Utah. Synthesis of these attributes can be used to define a desired habitat condition on a particular site or landscape. The decision to apply these recommendations is up to the specific private land owner or administrator. Because these recommendations are directed at both habitat and native processes, they will benefit a myriad of other plant and animal species, not just goshawks. The recommendations are presented in two spatial scales. The first spatial scale is the entire State of Utah and contains general recommendations for achieving long-term goals related to maintenance of goshawk habitat. The second spatial scale contains goals and recommendations for specific potential vegetation types.

State of Utah Recommendations

The forests and woodlands of Utah are dominated by unstable stands of late seral species. Early and mid-seral species should be increased using both mechanical means and fire.

Goshawk habitat throughout the State is well connected. These connections should be maintained and

strengthened. Activities near the edges of the high value habitat should be designed to maintain or enhance goshawk habitat values, irrespective of ownership.

Numbers and distribution of large trees in the landscape should be increased. Policies should be adopted to manage for the production of large early seral species through cleanings, thinnings, and weedings, using mechanical means or fire. For a properly functioning system, approximately 40 percent of the landscape should be in large trees (relative to average for the cover type and potential vegetation type) of a variety of species (Quigley and others 1996; Reynolds and others 1992; USDA Forest Service 1997).

It should be recognized that stands with a large numbers of dead trees still have high habitat value for goshawks in the short-term. Management activities should be designed to maintain these structural attributes while facilitating the development of future stands. Group selection or other similar treatments might be preferred over clearcutting in order to maintain habitat values while decreasing the risk of loss from windthrow or other similar disturbances.

Nest Sites—Both short- and long-term management activities should be planned to ensure that nest sites contain large trees (relative to average for the cover type and potential vegetation type) with open understories and dense canopies (relative to average for the cover type and potential vegetation type). Sites near water are preferred and should be over 30 acres (Reynolds and others 1992). Occupancy rate of nest stands is positively correlated with stand size (Woodbridge and Detrich 1994).

Foraging Areas and General Home Range—Landscapes should include all of the attributes important for the goshawk and its prey such as: hunting perches, large trees, grasses, forbs, shrubs, and interspersion of forest age/size classes (Reynolds and others 1992) in a variety of seral stages. A properly functioning systems incorporates all these attributes (USDA Forest Service 1997).

Potential Vegetation Type Recommendations

In general, when the potential vegetation types of Utah are in a proper functioning condition (USDA Forest Service 1997) they will provide excellent habitat for the goshawk and its prey. The following recommendations highlight the necessity of managing forest landscapes within their biophysical limits, and understanding how disturbances influence the resulting stand compositions and structures.

Subalpine Fir—The subalpine fir potential vegetation type is capable of providing high quality goshawk and prey habitat. It is currently dominated by late seral species throughout the State. Habitat should be improved by promoting early seral species such as quaking aspen, Douglas-fir, and lodgepole pine in a forest mosaic with Engelmann spruce and subalpine fir. These mixed forest cover types (especially mixes with quaking aspen) would be highly used by the goshawk and would have lower risk of epidemics of insects and diseases, and stand-replacing fire. Fire or mechanical treatments or both should be used to create conditions favorable to lodgepole pine and quaking aspen. Treatments will be most effective if initiated where lodgepole pine and quaking aspen are still present. Patch size can be variable in this type, tending to be large (10 to 100 acres) at lower elevations but small (tree length in diameter) at the upper elevations.

Lodgepole Pine—Although the lodgepole potential vegetation type has a limited distribution in the State, it is of high value to the goshawk (fig. 6). The persistent lodgepole cover on this type is probably an interaction of insects, diseases, and fire. Fires historically occurred at low frequencies, but over large areas (hundreds to thousands of acres) (Bradley and others 1992). Treatments should be planned to ensure that a lodgepole seed source is present to ensure rapid regeneration. Most likely, no other tree species with the

Figure 6—An active goshawk nest located in a lodgepole pine stand experiencing high mortality.

exception of quaking aspen will be available to regenerate the sites. Where quaking aspen is a seral species, it should be maintained. Openings can be large (up to hundreds of acres) where serotinous cones are present, but need to be small (25 acres) when nonserotinous cones are present.

Engelmann Spruce—The Engelmann spruce potential vegetation type is similar to the subalpine fir potential vegetation type, and mixed stands of early and mid-seral species are excellent habitat. At the higher elevations, openings for regeneration should be small (tree length in opening diameter) being cognizant of the potential for wind damage. At the lower elevations, patch size should be appropriate for effective regeneration of quaking aspen and lodgepole pine, given site conditions and the availability of seed source or clone.

Ponderosa Pine—Stands of ponderosa pine located on the ponderosa pine potential vegetation type are often overly dense, containing numerous small trees. Treatments should be planned to convert these stands, occupied by small crowded stems, into open stands dominated by large fire resistant trees (fig. 7). Cleanings, weedings, and thinnings through mechanical means or fire could be used to create these conditions (fig. 8). Nonuniform, irregular tree spacing should be encouraged. Quaking aspen regeneration should be encouraged in this potential vegetation type to add diversity and promote stability. The goshawk recommendations developed for ponderosa pine by Reynolds and others (1992) are applicable to this potential vegetation type.

Quaking Aspen—Quaking aspen is the only cover type that occurs on this potential vegetation type. Unlike seral quaking aspen on other potential vegetation types, long persistent versions of this tree can successfully regenerate under an existing canopy of mature trees; therefore it often occurs in uneven-aged stands. Treatments designed to stimulate quaking aspen regrowth should take this into account, perhaps by creating successive small openings rather than large-scale overstory removals through fire or mechanical means. However, if stands are basically healthy, there should be no need to treat quaking aspen stands on this potential vegetation type.

Douglas-fir—The Douglas-fir potential vegetation type supports a variety of forest cover types, including lodgepole pine, quaking aspen, and ponderosa pine. All are important to goshawks and they should be regenerated in this type. Both fire and mechanical means are appropriate for managing the array of early and mid-seral species that are possible. This potential vegetation type is currently dominated by dense, multistoried stands of Douglas-fir that are unstable or prone to epidemics of insects and diseases, and prone to stand replacing fires. Treatments need to be planned to rejuvenate stands without destroying the forest structure important to the goshawk. For example, group selection, group shelterwoods and variable spaced shelterwoods along with stand maintaining fires are all feasible options.

Figure 7—A stand containing large ponderosa pine well suited for both goshawk nesting and foraging.

White Fir—The white fir potential vegetation type is capable of supporting a wide variety of tree species, including many that are important to goshawks (for example, quaking aspen, ponderosa pine, Douglas-fir). It has high potential as goshawk habitat. However, most of the type is presently occupied by multistoried stands dominated by white fir. These stands, cluttered with many small limbs, reduce flight lanes without providing perches or nest platforms for the goshawk. Fire and mechanical means are also appropriate in this type for managing the array of early and mid-seral species that are possible. Similar to the Douglas-fir type, treatments should be planned to introduce and maintain the seral species, yet not eliminate the mature forest structure important to the goshawk.

Figure 8—Cleaning a ponderosa pine using prescribed fire.

Pinyon/Juniper—Although no nests have been located in Utah, this potential vegetation type may be important as winter foraging habitat. Currently, the pinyon/juniper potential vegetation type is predominantly covered by late seral pinyon pine and juniper trees. This potential vegetation type is prone to stand-replacing fires and the introduction of exotic species. The successional pathways of this potential vegetation type are indeterminate, and usually conditions after disturbance are less stable than the current late seral condition. It is believed to be useful for prey to increase the other seral stages (for example, the open shrubby stage). Early and mid-seral stages are productive and support many of the birds taken by goshawks, along with black-tailed jackrabbits (*Lepus californicus*) and ground squirrels.

Assessment Questions

This assessment has attempted throughout these pages to answer the questions initially posed in the "Introduction" section. These questions are repeated below with brief answers that synthesize the substantial, comprehensive information contained herein.

1. Is there adequate nesting habitat available?

Presently there appears to be adequate nesting habitat in the State to maintain a breeding population of goshawks. Based on the presence of habitat features and cover types that are important to goshawks, nearly all the montane forests of Utah are of either high or medium value for nesting (map 3). The only areas consistently rated as low value for nesting were pinyon/juniper woodlands.

2. Is there adequate foraging habitat available?

Based on habitat features important to selected prey used by goshawks, it appears that foraging habitat is presently available throughout the State. Nearly all the forested lands in the State contained medium-rated or better habitat for two or more prey groups. Even much of the pinyon/juniper woodland type has good prey habitat.

3. Are northern goshawks able to move freely among all available habitat patches?

Goshawks appear to be able to move freely among habitat patches throughout Utah. Using a conservative estimate of 20 to 60 miles as the distances over which goshawks explore habitats annually, all patches of high value habitat are likely to be detected from one or more adjacent high value patches (map 9). In most cases, the patches are contiguous or separated by distances of less than 20 miles. The longest distance between patches occurs in southeastern Utah, where high value habitat in the La Sal and Abajo Mountains is more than 60 miles from the nearest high value

habitat elsewhere in Utah. These areas are likely connected to habitat in Colorado.

4. Is the population viable at the State level?

This assessment cannot answer the question of population viability directly because there are inadequate demographic data available. Most of the currently forested lands were rated as medium or high value for both nesting and foraging habitat. Where surveys have been conducted, goshawks are present and are nesting successfully. Furthermore, all available habitat patches are connected, and no known population is isolated. In general, existing habitat appears to be capable of supporting a viable population of goshawks at the State spatial scale. However, even though high quality habitat does not appear to be lacking at the State spatial scale, on the local landscape, habitat deficiencies may be present.

5. Where is the high value habitat?

High value habitat is distributed throughout the State, with 60 percent controlled by the USDA Forest Service (map 7, table 19).

6. How are current management policies affecting northern goshawks?

Current management policies are affecting northern goshawks in a variety of ways. On National Forest Service administered lands, 20 percent of the high value habitat is being managed with a timber emphasis, 35 percent with mixed uses, and 27 percent with a range emphasis. Each of these management categories allows for activities that either can degrade or improve goshawk habitat. The information in this assessment does not reveal any substantial deficiencies in habitat quality in any management category (tables 22, 23, 24, 25). There are two possible explanations for these results: (1) management activities are having no negative effect on goshawk habitat; (2) management activities are having some negative effects on goshawk habitat, but the effects are not detectable at either scale used in this assessment. No data are available to determine which is the true explanation. Current management policies have the potential to degrade habitat if any one activity is overapplied or misapplied. For example, timber harvesting can convert mature stands to younger structures, which can negatively impact goshawks. Range management can affect goshawks when it removes cover and food for prey and when it interferes with the regeneration of quaking aspen stands. Both wild ungulates and domestic livestock can browse suckers, and if repeated frequently, quaking aspen clones can be replaced by other vegetation. In contrast, current management policies provide latitude for improving goshawk habitat if applied within reasonable ecological constraints. For example, partial cutting systems used to maintain or improve stand characteristics for goshawks and their prey would have an overall positive effect on goshawk habitat. In addition, timber harvesting has the potential to convert cover types to earlier seral vegetative communities, which is generally good for goshawks. Thus current management policies provide for a wide range of implementation options, with a correspondingly wide range of possible effects on goshawk habitat. The critical decisions are those being made on individual project level analyses, because this is where managers can use the best available information to ensure that projects are providing for goshawk habitat needs.

7. What are the important habitat trends and their implications for goshawks?

The most obvious trend in Utah forests and woodlands is the lack of early and mid-seral species in all of the potential vegetation types. Existing stands on the Douglas-fir and white fir potential vegetation types are highly unstable and stands on the ponderosa pine potential vegetation type are at high risk to stand-replacing fire events. If forest management stresses properly functioning condition, importance of large trees, maintaining native processes, using adaptive management, and recognizing the role of fires, the habitat outlook could be favorable for the goshawk and its prey. Development of procedures and techniques to protect large trees during restoration treatments, and to grow them at accelerated rates, will also help improve the outlook for structural aspects of goshawk habitat, especially in the ponderosa pine potential vegetation type.

Urbanization and more intensive uses of the forests by humans could degrade goshawk habitat, especially on private lands. Private lands in Utah will continue to be developed, making the lands administered by Federal entities increasingly important for goshawks. This trend could also affect the connectivity of the habitat across the State.

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