5 Vegetative Resources

5.1 General Vegetation Description

Over 70% of the Clearwater subbasin is made up of forested communities (Table 30), generally classified as mesic, xeric, or subalpine. Mesic or moist conifer forests are largely found on mid-elevation montane slopes where precipitation patterns allow the formation of grand fir forests, or along river systems characterized by maritime climatic influences such as occur along the North Fork Clearwater River and parts of the Selway River. Under these unique climatic conditions grand fir gives way to western red cedar and hemlock (*Tsuga heterophylla*) stands. Cedar forests often contain unique plant species, including two focal plant species, crenulate moonwort and mountain moonwort. Xeric or dry forests are characteristically dominated by ponderosa pine at the lower elevations, and grade into Douglas-fir and dry site grand fir as elevation increases (Cooper et al. 1987). Subalpine fir and lodgepole pine dominate forests at middle and high elevations within the subbasin. At the very highest sites, subalpine fir stands also contain whitebark pine (*Pinus albicaulus*), which is an important wildlife food source.

Table 30. General vegetation types in the Clearwater subbasin (grouped Idaho GAP2 data)

Vegetation Category	% Area	Area (km^2)
Forest	71.4%	16,955.58
Agriculture	10.2%	2,425.48
Shrubland	7.7%	1,835.25
Grassland	4.0%	951.21
Other	2.3%	536.88
Subalpine/Alpine Meadow	2.1%	487.02
Riparian	1.7%	407.04
Water/Streamside	0.5%	111.11
Urban	0.1%	31.23

Shrublands and grasslands currently make up 12% of the subbasin's vegetation. The majority of the grasslands occur in the foothills and breaklands as canyon bunchgrass communities. These grasslands provide winter range for big game animals, livestock forage, and habitat for unique plant species. The broadfruit mariposa lily (*Calochortus nitidus*), is a focal species associated with the canyon grassland habitats. These habitats are also utilized by the proposed Threatened Spalding's catchfly. Shrubland communities tend to be warm and mesic in the subbasin.

The Clearwater subbasin contains several unique or disproportionately important plant communities. Most notable are the prairie grasslands, wetland and riparian areas, and coastal disjunct communities. The grasslands are characterized by a rich assemblage of bunchgrasses, forbs, and shrubs (Daubenmire 1942; Davis 1952). Wetter, poorly drained sites supported camas (*Camassia quamash)* meadows with more upland sites containing either Idaho fescue (*Festuca idahoensis*) or a mixture of Idaho fescue and bluebunch wheatgrass (*Pseudoroegneria spicatum*). Camas meadows were important gathering sites for ancestral Nez Perce Indians who dug camas bulbs and prepared them as a winter food staple. Present day Nez Perce continue to gather these edible bulbs for subsistence and ceremonial purposes, although gathering sites are scarce due to conversion of the prairie grasslands for commercial agricultural uses. Conversion to commercial agricultural uses has also contributed to the decline of native prairie forbs such as Jessica's aster (*Aster jessicae*) and Palouse goldenweed (*Haplopappus liatriformis*), both of which are focal plant species in the Clearwater subbasin.

Wetlands and riparian areas cover only a small portion of the subbasin, but offer some of the most diverse and unique habitats available. Wetlands occur as small ponds filled by spring runoff, wet meadows, springs and seeps, bogs, small lakes, and riverine and streamside riparian areas. These are important to the ecologic and economic welfare of the subbasin because they provide high quality wildlife habitat, water storage, flood abatement, pollution filtration, livestock forage, and water for domestic use (U.S. Geological Survey 1996). They also harbor unique plant species such as Clearwater phlox (*Phlox idahonis*), which is endemic to only a few wet meadows within the Clearwater subbasin. Impacts to wetland and riparian communities are difficult to quantify, but some estimates suggest that 56% of Idaho's wetlands have been lost since 1860 (Dahl 1990), largely due to agricultural conversion and urban development (Idaho Department of Parks and Recreation 1987). Within the Clearwater subbasin, large expanses of palustrine wetlands in the Reubens, Craigmont, and Ferdinand areas have been converted to croplands (U.S. Geological Survey 1996). Remaining wetland communities are often degraded by livestock grazing, road development, urban expansion, and altered hydrologic regimes.

Within the North Fork Clearwater and at the confluence of the Selway and Lochsa Rivers are areas containing many plant species more typically found in the Oregon and Washington coastal rainforests. These communities have been referred to as a "refugium ecosystem" because of their unique distribution and species composition (Lichthardt and Moseley 1994). Elements from the moist coastal area intermingle with more typical Rocky Mountain species. Many species associated with this community are considered rare or sensitive (Moseley and Groves 1992). The ecosystem has been impacted by inundation behind Dworshak Dam, recreational development, roads, and timber harvest (Lichthardt and Moseley 1994).

The grand fir mosaic is a unique community type found only in the Clearwater River drainage of northern Idaho and in the Blue Mountains of northeast Oregon. Within the Clearwater, this community type occupies approximately 500,000 acres between the Selway and South Fork Clearwater rivers (Ferguson and Byrne 2000). It occurs on all aspects in all topographic positions between 4,200 feet and 6,000 feet elevation. As the name implies, the dominant tree species is grand fir interspersed with natural openings dominated by Sitka alder (*Alnus sinuata*), bracken fern (*Pteridium aquilinum*), and fool's huckleberry (*Menziesia ferruginea*; Ferguson and Byrne 2000). Managers have become interested in this community because of the lack of conifer regeneration following disturbance. Research has shown that four primary factors contribute to poor conifer regeneration on these sites: competition, allelopathy from bracken fern and western coneflower (*Rudbeckia occidentalis*), acidic soils, and pocket gopher (*Thomomys talpoides*) herbivory (Ferguson and Boyd 1988, Ferguson 1999, Ferguson and Byrne 2000).

5.2 Past and Present Vegetation

Data generated by two GIS vegetation mapping efforts were used to supplement research and site specific findings to characterize the current and historic vegetative communities of the Clearwater subbasin. The Interior Columbia Ecosystem Management Project (ICBEMP) mapped both current and historical cover type and structural stage data across the Columbia Basin at a resolution of 1 kilometer^2. Due to the large areal extent of the project, the coarse resolution of the data and the scarcity of available historic vegetation information the cover type data generated by the ICBEMP project should be viewed as providing a general picture of conditions and not necessarily exact locations or extent of cover type distributions . The Idaho GAP Analysis Program's GAP 2 data is the second iteration of an effort to map the land cover of Idaho as part of the National GAP Analysis Program administered by the USGS. No historic cover type or structural stage data has been generated by the project to date, but the current cover type data is available at a 30 meter^2 resolution, much finer than that available from ICBEMP. For these reasons ICBEMP data was used to illustrate land cover and vegetative community, while GAP 2 data was employed to discuss current conditions. Data use is cited throughout the following discussion and the reader should keep in mind the strengths and weaknesses of each source.

The distribution and abundance of vegetative cover types within the Clearwater subbasin has changed over the last 100 years, in some cases significantly (Figure 45 and Figure 46). Many changes result from European settlement and associated changes in land use practices and management activities: or example, changes have occurred due to fire management, land conversion, and nonnative species introductions. Agricultural coverage has increased approximately 12% compared to the historical condition, while grasslands and early and late seral forests have declined (Figure 47). In some parts of the subbasin, fire suppression has resulted in an absence or reduction of early seral species or communities compared to historical ranges (Thompson 1999). Timber harvest has also impacted the extent and composition of some forest types such as open ponderosa pine (Nez Perce National Forest 1998). The introduction of blister rust caused western white pine, previously dominant in some parts of the subbasin, to largely disappear (Clearwater National Forest 1997). Blister resistant planting stock has the potential to return western white pine to vegetation communities in the Clearwater subbasin (Clearwater National Forest 1997).

The most significant change has occurred in the wetland and native bunchgrass cover types. These two cover types have declined by 98% according to ICBEMP data (Table 31). Other noteworthy changes include a 47.5% reduction in ponderosa pine coverage and a 53.6% decline in Douglas-fir coverage. Some cover types have increased in extent including western larch (2.8 fold increase) and shrub or herb/tree regeneration (13 fold increase).

Mesic forests currently cover slightly over a quarter of the subbasin and historically covered 20% of the subbasin (Table 31). With the arrival of blister rust, grand fir/white fir communities have increased their range to areas previous containing western white pine. Western red cedar communities grade into grand fir communities with decreasing moisture and shade (Cooper et al. 1991). The mesic forest habitats contain greater floristic diversity than other forest habitat in the subbasin (Cooper et al. 1991). The cedar forests provide habitat for two focal plant species: crenulate moonwort and mountain moonwort. The fisher uses grand fir/white fir/western red cedar habitat.

Douglas-fir and mixed conifer forests currently cover 7% of the subbasin. This is over a 50% loss compared to historic vegetation (Table 31). Douglas-fir stands occur on sites with moisture regimes intermediate to the higher moisture environment occupied by grand fir communities and the lower moisture environment occupied by ponderosa pine communities (Cooper et al. 1991). Douglas-fir stands with multiple canopies are one of two kinds of stands regularly inhabited by the flammulated owl (Groves et al. 1997a).

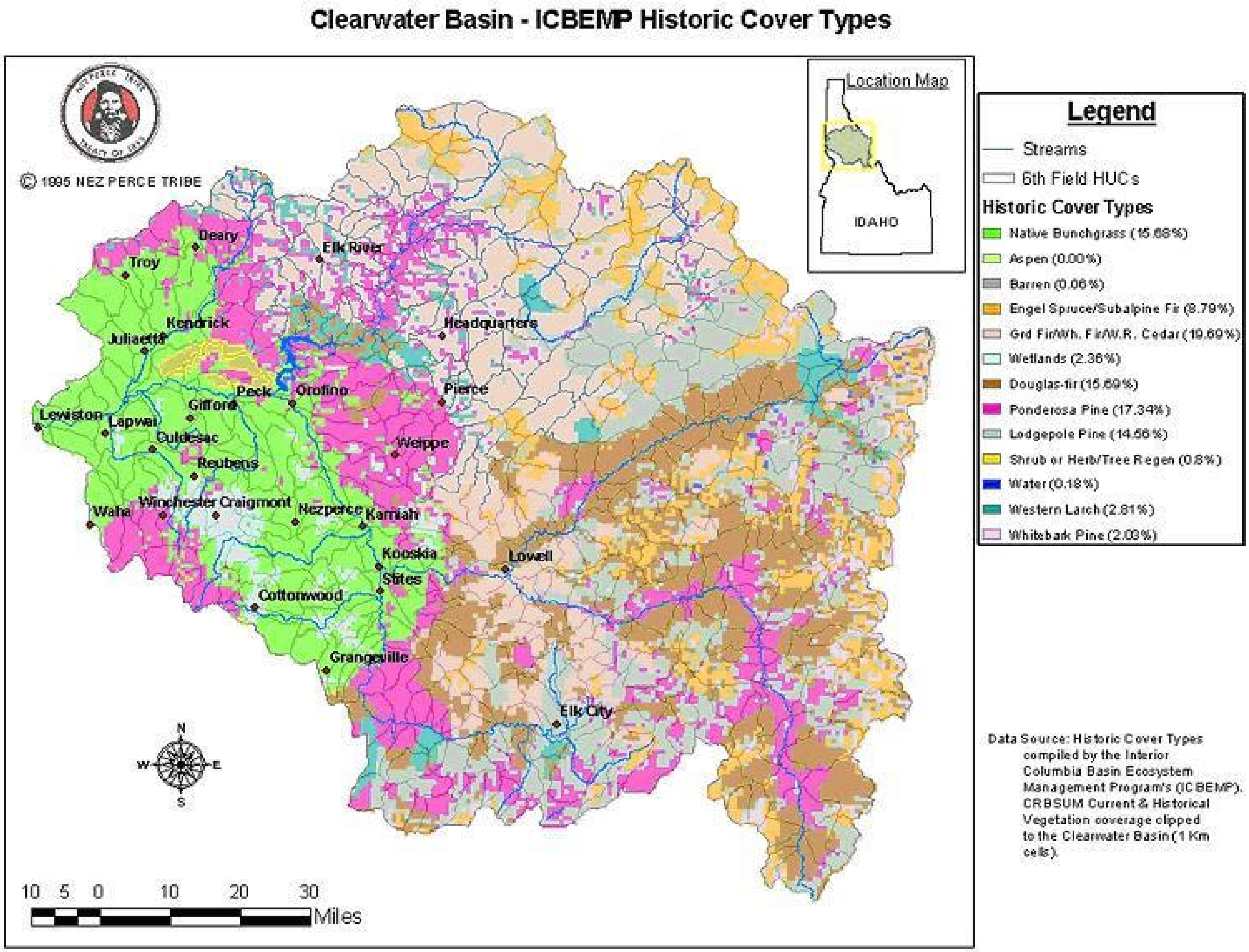

Figure 45. Historic vegetation within the Clearwater subbasin as defined by ICBEMP

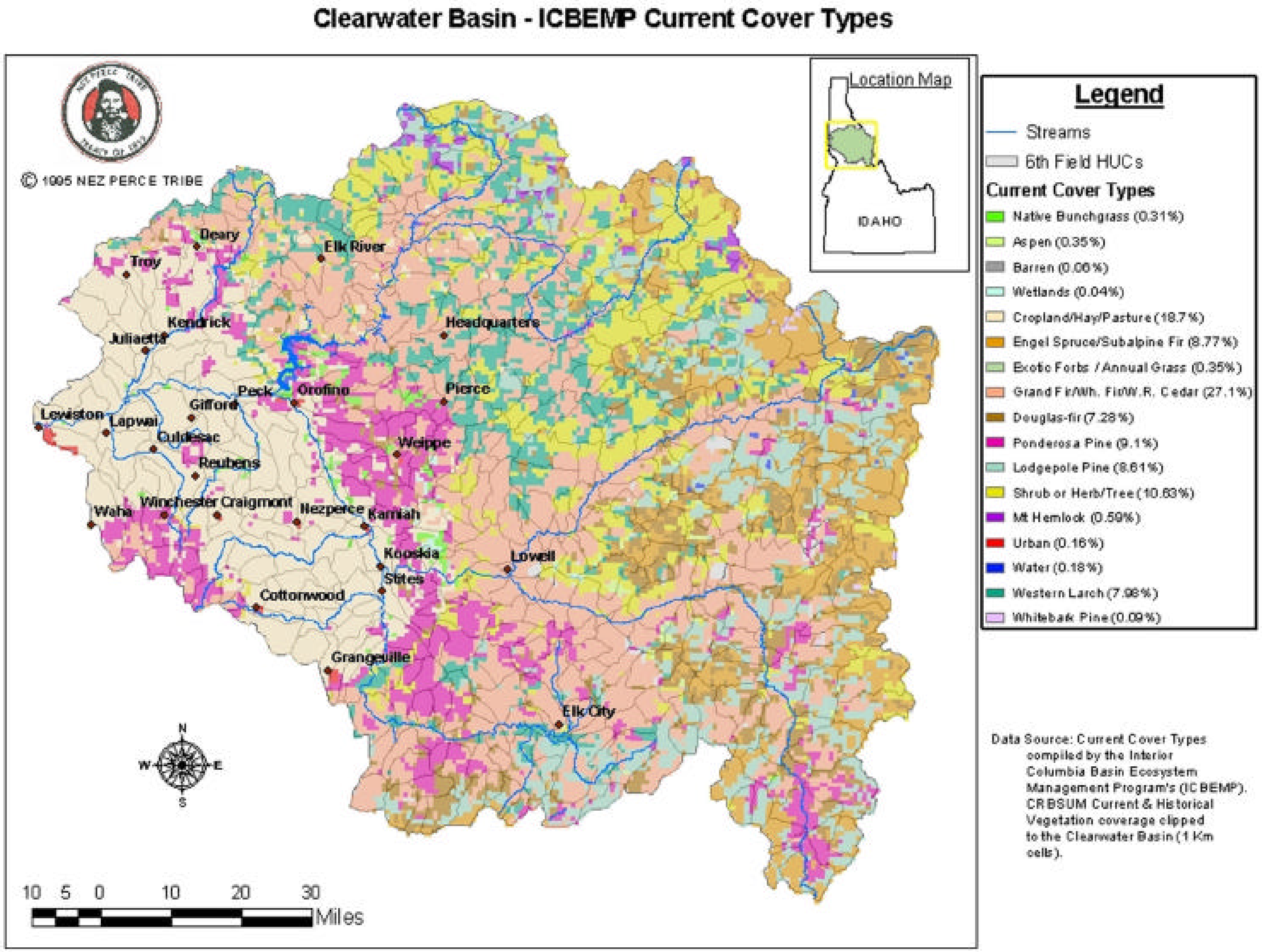

Figure 46. Current vegetation within the Clearwater subbasin as defined by ICBEMP

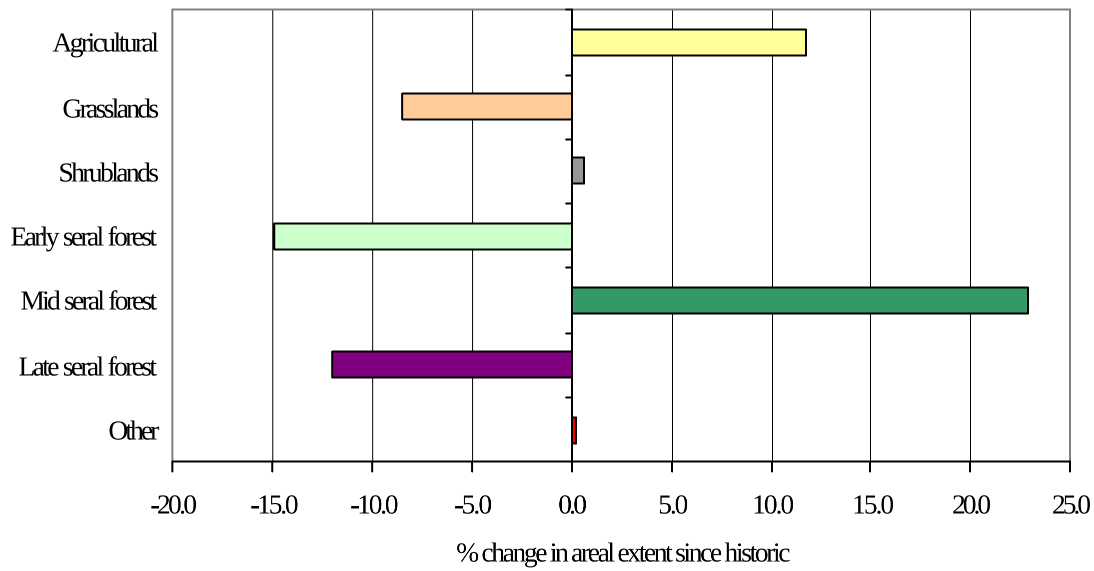

Figure 47. Percent change in specific structural stages (as defined by ICBEMP) from 1900 to 1995 for the Clearwater subbasin

Table 31. Changes in vegetative coverage in the Clearwater subbasin based on ICBEMP data

Cover Type Name	Historic Coverage (km^2)	% Historic Cover of Subbasin	Current Coverage (km^2)	% Current Cover of Subbasin	Change from Historic Cover (km^2)
Grand Fir/White Fir/Western Red Cedar	4,771	19.69%	6,567	27.10%	+1,796
Ponderosa Pine	4,201	17.34%	2,205	9.10%	-1,996
Douglas-fir	3,801	15.69%	1,763	7.28%	-2,038
Native Bunchgrasses	3,799	15.68%	75	0.31%	-3,724
Lodgepole Pine	3,528	14.56%	2,086	8.61%	-1,442
Engelmann Spruce/Subalpine Fir	2,131	8.79%	2,124	8.77%	-7
Western Larch	680	2.81%	1,933	7.98%	+1,253
Wetlands	572	2.36%	10	0.04%	-562
Whitebark Pine	493	2.03%	23	0.09%	-470
Shrub or Herb/Tree Regen	195	0.80%	2,575	10.63%	+2,380
Water	43	0.18%	43	0.18%	0
Barren	14	0.06%	14	0.06%	0
Aspen	1	0.00%	86	0.35%	+85
Cropland/Hay/Pasture	0	0.00%	4,532	18.70%	+4,532
Exotic Forbs/Annual Grass	0	0.00%	12	0.05%	+12
Mt Hemlock	0	0.00%	142	0.59%	+142
Urban	0	0.00%	38	0.16%	+38

Estimates of current ponderosa pine cover range from 4.6% to 9.1% of the subbasin. Either estimate is less than that historically present. Loss has resulted from timber harvest, conversion to agriculture, and encroachment by Douglas-fir and other conifers following fire suppression. Ponderosa pine habitat is very important for three wildlife focal species: flammulated owl, white-headed woodpecker, and black-backed woodpecker (Nez Perce National Forest 1998, Groves et al. 1997b, Marshall et al. 1996).

The Engelmann spruce and subalpine fir cover type occurs on 8.8% of the subbasin (Table 31). This is similar to what was available historically. This kind of habitat exists in colder and higher elevation portions of the subbasin (Cooper et al. 1991). Lynx utilize Engelmann spruce and subalpine fir habitat, requiring a matrix of young and old stands to provide denning and foraging habitat (Nez Perce National Forest 1998).

Whitebark pine communities historically covered 2% of the subbasin, but today cover roughly 0.10-0.15% (Table 31). Tomback et al. (2001) estimate that a 45% decline in whitebark pine cover has occurred in the last 100 years in the interior Columbia River Basin and the Bob Marshall Wilderness Complex. They blame the combination of fire exclusion, blister rust, mountain pine beetles, and succession for the cover decline.

Lodgepole pine habitat is found at middle and high elevation sites in the subbasin. Available lodgepole pine habitat has decreased from 14.6% historically to 8.6% of the subbasin currently (Table 31). Old growth lodgepole pine stands provide habitat for black-backed woodpeckers (Nez Perce National Forest 1998). Early seral stands containing lodgepole pine provide foraging habitat for lynx (Nez Perce National Forest 1998).

Mountain hemlock habitat currently occupies 0.6% of the subbasin. ICBEMP did not recognize it as an historical habitat (Table 31). This type of habitat occurs in high elevation, subalpine environments in portions of the subbasin north of the southern part of the Middle Fork Clearwater watershed (Cooper et al. 1991).

Native bunchgrass habitat historically covered 15.7% of the subbasin (Table 31). Today, little of this habitat remains. Native bunchgrass habitat has decreased the most in area of the 11 habitat groups. Estimates of native grassland cover range from 0.3% to 4.0% of the subbasin. Remnant grasslands are often small in size, and the GAP current cover of 4.0% is likely more accurate than ICBEMP's coarse-scale estimate, although neither database is well suited for examining small areas. Native bunchgrass communities provide habitat for two focal plant species: Jessica's aster (*Aster jessicae*), and Palouse goldenweed (*Haplopappus liatriformis*). The proposed threatened plant Spalding's catchfly (*Silene spaldingii*) also inhabits these habitats. Rocky Mountain bighorn sheep, bison and sharp-tailed grouse historically inhabited grassland habitat.

Both GAP and ICBEMP identify an agricultural cover class occupying the second largest amount of area in the subbasin. The GAP agriculture cover type covers 10.2% of the subbasin (Table 30) and the ICBEMP cropland/hay/pasture cover type covers 18.7% of the subbasin (Table 31). Much land currently in agricultural cover types previously was in the native bunchgrass cover type. Some wildlife species inhabit agricultural areas. One terrestrial focal species, the western toad, is able to inhabit agricultural areas so long as they contain a water source such as an irrigation canal (Csuti et al. 1997).

Riparian and wetland habitat is important for many wildlife species. The ICBEMP data shows a decrease in wetland habitat from 2.36% of the subbasin historically to 0.04% of the subbasin currently (Table 31). The finer scale GAP data, though, shows slightly less than 2% current wetland or riparian cover. Wetlands are an essential component of habitat for two terrestrial focal species—the western toad and the Coeur d'Alene salamander. Open wetland areas provided habitat for an extirpated species, the sandhill crane.

The regeneration cover class historically covered 0.8% of the subbasin; today it covers 10.6% of the subbasin (Figure 47). Regeneration habitat provides forage for wildlife species. Early seral communities and shrubfields provide forage areas required by elk. Regenerating forests with abundant forage also can provide habitat for prey species like snowshoe hare. Predators, like lynx, use young seral stands as hunting habitat.

5.3 Disturbance & Successional Processes

The Clearwater and Nez Perce National Forests are "clearly the regional focus of lightning fires" both in number per unit area and annual area burned," at a rate two to ten times greater than on adjacent forested land (Cooper et al. 1991). Extensive fires occurred in 1889, 1910 (990,000 acres burned on the Clearwater and Nez Perce National Forests), 1919, 1926, and 1934 (Figure 48). Natural (lightning-caused) fires are a primary factor perpetuating natural forest ecosystems and landscape diversity in the Clearwater subbasin (Cooper et al. 1991). Planned and unplanned burning by Native Americans had an extensive impact on maintaining stand composition and structure. The high frequencies in some of the fire-scar samples may have resulted from Indian caused fires (Barrett and Arno 1982 *in* Cooper et al. 1991). Prospectors and settlers also set fires to expose mineral outcrops (Space 1964 in Cooper et al. 1991) and improve range. Field sampling has revealed that only wet sites or unproductive, high-elevation sites occasionally lacked fire evidence (Cooper et al. 1991).

Fire-free intervals can be inferred to some extent by climax tree series and habitat type. *Pinus ponderosa-Pseudotsuga menziesii*/bunchgrass types have a mean fire-free interval of six years compared to *Abies lasiocarpa* habitat types with an interval of over 40 years (Arno and Peterson 1983 in Cooper et al. 1991). The *Tsuga-Thuja* zone, *A. lasiocarpa* habitat types have fire-free intervals of over 250 years. The longest fire-free intervals are 400 to 500 years (Daubenmire and Daubenmire 1984). Modern fire suppression has, however, resulted in plant communities that have greater biomass and less vigorous vegetative growth, with increased susceptibility to pathogens and wildfires of greater severity and size (Johnson 1998).

Years of fire suppression in forested areas, and changes in vegetative composition of grassland areas in the subbasin have resulted in dramatically altered fire regimes (Figure 49). There has been a significant reduction in the extent of the nonlethal and mixed fire regimes. These fire regimes maintained late seral single layer types by thinning shade tolerant tree species in early, mid, and late seral multi layer types. Reductions in fire frequency have increased fuel loads and resulted in hotter burning more intense fires and a shift from nonlethal to lethal fire regimes in many areas (Quigley and Arbelbide 1997).

Successional processes following wildfire and logging have been described for some northern Idaho habitat types (Lyon and Stickney 1976, Arno et al. 1985, Green and Jensen 1991). In general, the composition of postdisturbance plant communities is dependant on environmental site conditions, existing vegetation, severity of disturbance, life history characteristics of individual species, and to some degree chance (Morgan and Neuenschwander 1984). Research by Lyon and Stickney (1976) has shown that immediately following a fire, forest plant communities were composed largely of species present prior to the event. Even five years postdisturbance, species composition was 80% similar to the prefire community, and all species had established during the first year. This suggests that many local plant species are well adapted to surviving and propagating after fires.

The most abundant trees in the Clearwater subbasin are seral species adapted to periodic fire disturbance. Adaptations to fire include thick, corky, fire resistant bark (*Larix occidentalis, Pinus ponderosa, Pseudotsuga menziesii*), light or winged seeds (*L. occidentalis, Pinus ponderosa, P. menziesii, P. monticola*), serotinous cones (*Pinus contorta*), and rapid initial height growth (Cooper et al. 1991). As evidenced by even-aged stand structure, a considerable amount of viable seed survives even catastrophic fires.

Successional processes in riparian areas, shrub fields, and grasslands have been less well studied than in the coniferous forest types of the subbasin. Fire is a common occurrence within low elevation grasslands and shrub fields. Within bluebunch wheatgrass communities, light to moderate fires can enhance cover of wheatgrass but severe fires can be detrimental to bunchgrass survival (Johnson 1998). Cheatgrass and other annual grasses can increase following severe fires in the wheatgrass zone. The timing and intensity of livestock grazing can also influence the composition of successional plant communities following disturbance. Idaho fescue is more sensitive to damage from fire than some other native bunchgrasses (Johnson 1998). Even moderate fires can result in significant decreases in Idaho fescue coverage for several years following the event.

Shrubland plant communities vary widely in their response to fire. Dryland shrub communities like ninebark often respond favorably to moderate fires (Johnson 1998) due to their ability to resprout from root crowns (Lyon and Stickney 1976). Vigorous re-growth following fire can create highly palatable forage for elk, deer, rabbits, and other browsers.

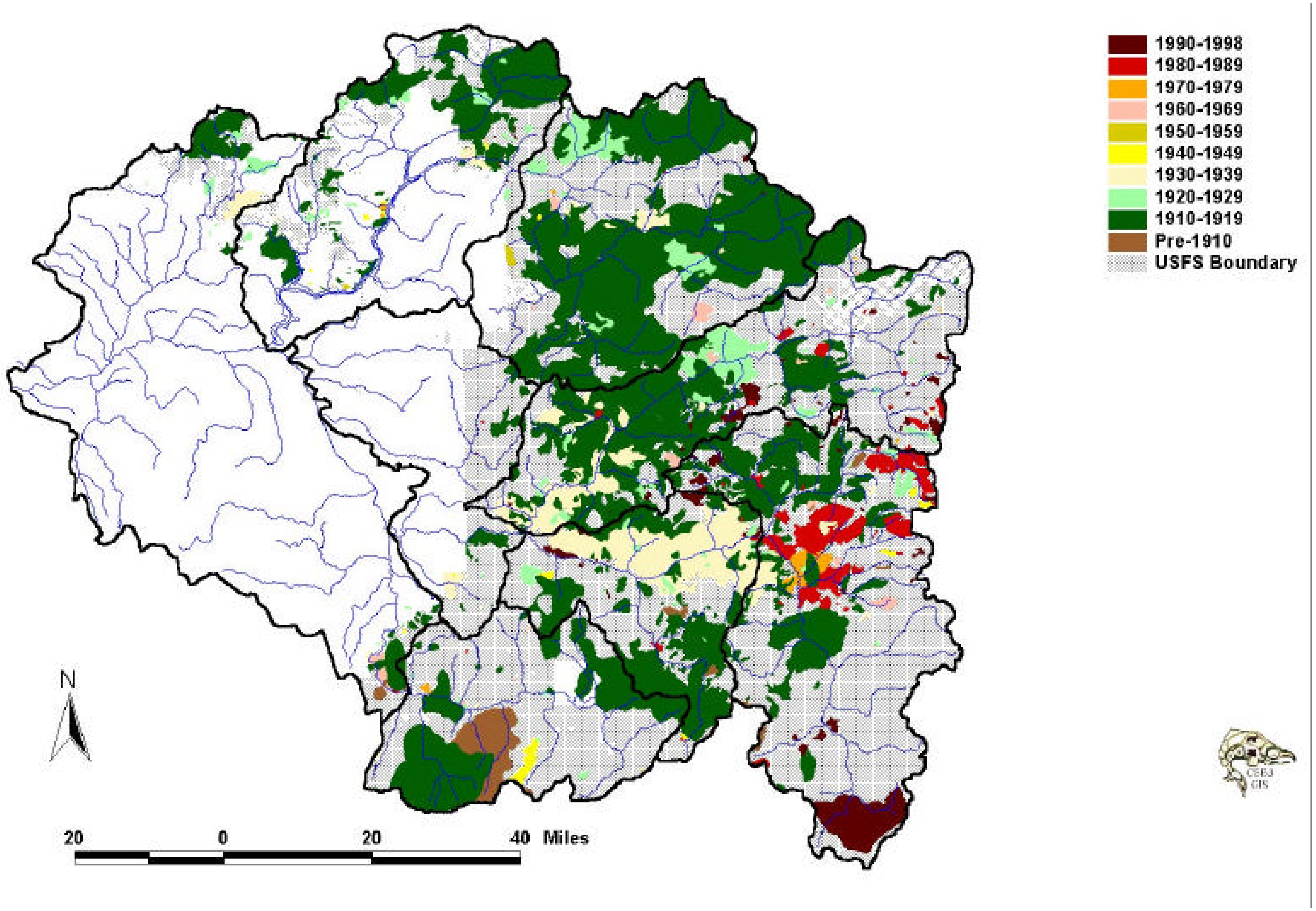

Figure 48. Decadal fire history of USFS lands within the Clearwater subbasin. Decadal information is stacked on the map, resulting in only the most recent burn period being shown

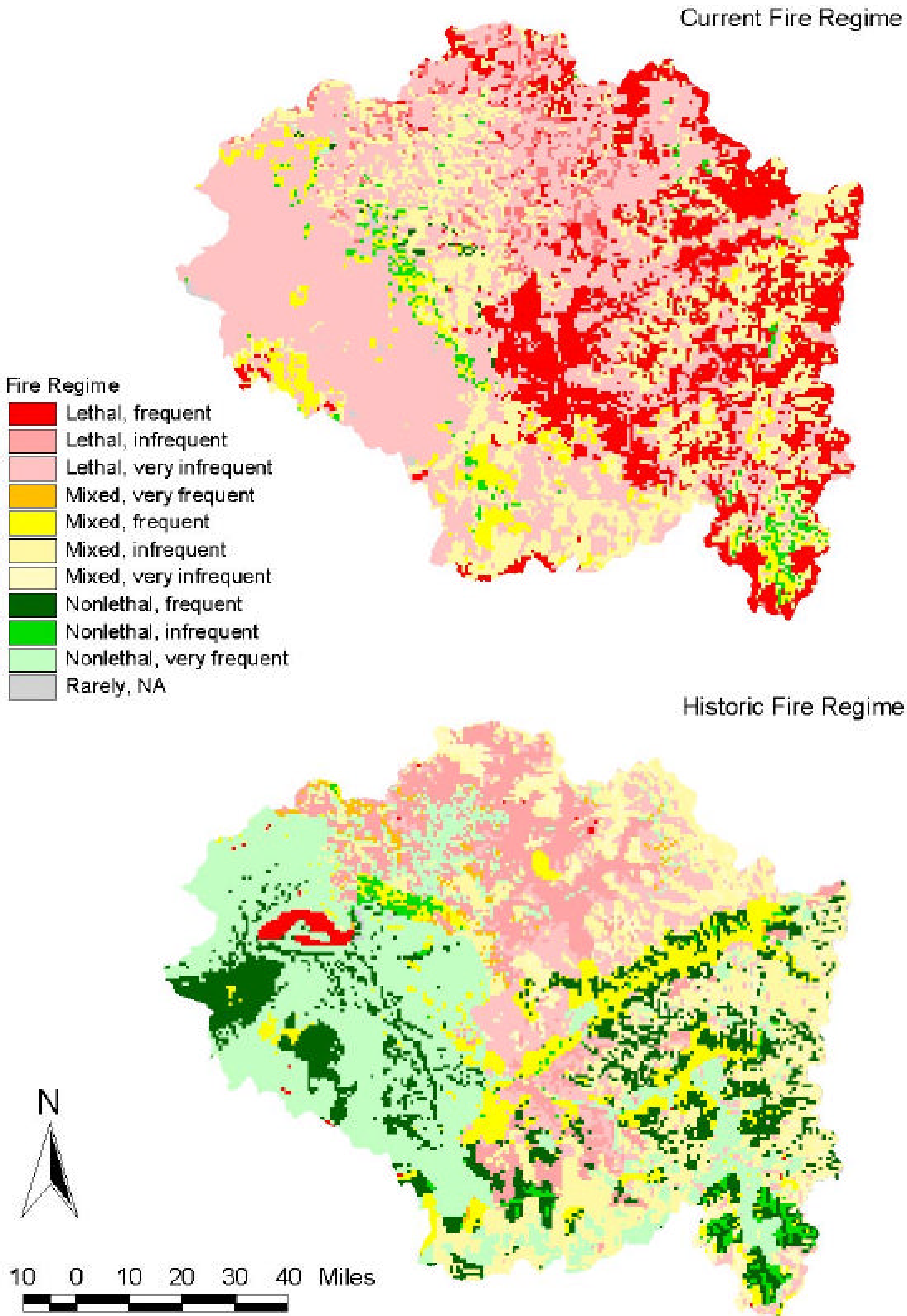

Figure 49. Historic and current fire regimes in the Clearwater subbasin (ICBEMP data)

Table 32. Tree species characteristics and tolerance to fire (Fischer and Bradley 1987)

Species	Bark Thickness of old trees	Root Habit	Resin in old bark	Branch habit	Stand habit	Relative inflammability of foliage	Lichen growth	Degree of fire resistance
Western Larch	Very thick	Deep	Very little	High and very open	Open	Low	Medium to heavy	Most resistant
Ponderosa Pine	Very thick	Deep	Abundant	Moderately high and open	Open	Medium	Medium to light	Very resistant
Douglas-fir	Very thick	Deep	Moderate	Moderately low and dense	Moderate to dense	High	Heavy medium	Very resistant
Grand Fir	Thick	Shallow	Very little	Low and dense	Dense	High	Heavy medium	Medium
Lodgepole Pine	Very thin	Deep	Abundant	Moderately high and open	Open	Medium	Light	Medium
Western White Pine (also Whitebark Pine)	Medium	Medium	Abundant	High and dense	Dense	Medium	Heavy	Medium
Western Red Cedar	Thin	Shallow	Very little	Moderately low and dense	Dense	High	Heavy	Medium
Engelmann Spruce	Thin	Shallow	Moderate	Low and dense	Dense	Medium	Heavy	Low
Mountain Hemlock	Medium	Medium	Very little	Low and dense	Dense	High	Medium to heavy	Low
Western Hemlock	Medium	Shallow	Very little	Low and dense	Dense	High	Heavy	Low
Supalpine Fir	Very thin	Shallow	Moderate	Very low and dense	Moderate to dense	High	Medium to heavy	Very low

Idaho fescue associated with ninebark communities, however, often responds poorly following fire because the greater fuel loads in shrub fields result in hotter, longer duration fires that damage or kill the plants (Johnson 1998).

Shrub species that respond poorly to fire include big sagebrush and mountain mahogany. Both of these species are often killed by even moderate fires, although mountain mahogany seed germination increases following light fires (Johnson 1998). These shrub species are relatively minor components within the Clearwater subbasin.

5.4 Noxious Weeds

The introduction of nonnative plant and animal species to the Clearwater subbasin has reduced the its ability to support native wildlife and plant species. Introduced plants in the subbasin often outcompete native plant species and alter ecological processes, reducing habitat suitability (Quigley and Arbelbide 1997). Introduced plant species reduce wildlife habitat suitability. Spotted knapweed infested range in Montana was used by elk 98% less frequently than an adjacent uninfested area (Sheley and Petroff 1999). Because it completes its growth and dries early in the season, cheatgrass provides less nutrition to herbivorous wildlife species than native species (Quigley and Arbelbide 1997). Eurasian watermilfoil (*Myriophyllum spicatum*) is the only plant on Idaho's Noxious Weed List not yet identified in the Clearwater subbasin. However, since this perennial aquatic grows from 4-12" per day and tolerates large variations in environmental conditions, it has the potential to severely impact the subbasin's waterways (Daniel 2001).

Noxious weeds have infested grasslands and transportation corridors in the subbasin and negatively impacted plant and animal biodiversity, natural ecological processes (fire, hydrology, soil development), and the quality and availability of livestock and wildlife forage (Olson 1999). They may also invade riparian areas, competing with desirable vegetation. The Idaho's Oneplan web site (2001) was used to summarize the distribution of noxious weed species by county throughout the Clearwater subbasin (Table 33).

Table 33. Noxious weeds documented to occur in counties that are wholly or partly in the Clearwater subbasin (Idaho OnePlan 2001, Clearwater Weed Management Group 1999).

Scientific Name	Common Name	Clearwater	Idaho	Latah	Lewis	Nez Perce	Shoshone
Aegilops cylindrica	Jointed Goatgrass			X			
Ambrosia tomentosa	Skeletonleaf Bursage					X	
Cardaria draba	Hoary Cress	X	X	X	X	X	
Carduus nutans	Musk Thistle		X			X	X
Centaurea diffusa	Diffuse Knapweed	X	X	X		X	X
Centaurea maculosa	Spotted Knapweed	X	X	X	X	X	X
Centaurea pratensis	Meadow Knapweed	X		X			
Cenaturea repens	Russian Knapweed		X	X	X	X	
Centaurea solstitialis	Yellow Starthistle	X	X	X	X	X	
Chondrilla juncea	Rush Skeletonweed	X	X	X		X	X
Cirsium arvense	Canada Thistle	X	X	X	X	X	X
Conium maculatum	Poison Hemlock	X	X	X		X	
Convolvulus arvensis	Field Bindweed		X	X		X	
Crupina vulgaris	Common Crupina	X	X		X	X	
Cytisus scoparius	Scotch Broom		X	X			X
Euphorbia dentata	Toothed Spurge		X				
Euphorbia esula	Leafy Spurge	X	X	X	X	X	
Hieracium aurantiacum	Orange Hawkweed	X	X	X	X		X
Hieracium pratense	Meadow Hawkweed	X	X	X			X
Hyoscyamus niger	Black Henbane			X		X	
Isatis tinctoria	Dyer's Woad		X				
Lepidium latifolium	Perennial Pepperweed					X	
Linaria dalmatica	Dalmatian Toadflax	X	X	X	X	X	X
Linaria vulgaris	Yellow Toadflax	X	X	X	X	X	X
Lythrum salicaria	Purple Loosestrife	X	X	X			
Milium vernale	Spring Millet Grass		X	X			
Nardus stricta	Matgrass			X			
Onopordum acanthium	Scotch Thistle	X	X	X	X	X	X
Senecio jacobaea	Tansy Ragwort		X				
Solanum elaeagnifolium	Silverleaf Nightshade		X				
Solanum rostratum	Buffalobur	X	X	X		X	
Sonchus arvensis	Perennial Sowthistle					X	X
Sorghum halepense	Johnsongrass		X				
Tribulus terrestris	Puncturevine		X	X		X	
Zygophyllum fabago	Syrian Beancaper					X	

Weed management goals within the Clearwater subbasin are to prevent introduction, reproduction and spread of noxious weeds. Priority standards have been established to eradicate, control, contain, or reduce noxious weeds while at the same time preventing establishment of potential invaders.

The most pronounced problems occur in lower elevation dry sites where Eurasian invaders have become well established. Some of the more common invaders are cheatgrass, yellow starthistle, spotted knapweed (*Centaurea maculosa*), and common crupina (*Crupina vulgaris*). New invaders include rush skeleton weed (*Chondrilla juncea*), orange hawkweed (*Hieracium auratiacum*), and meadow hawkweed (*Hieracium pratense*). The majority of the noxious weed infestations in the Clearwater subbasin occur in localized patches; two notable exceptions are yellow starthistle and spotted knapweed. Both of these invader species are native exotic plants from the Mediterranean that have thrived in the subbasin due to similarities in climate between the two locations (Quigley and Arbelbide 1997). Current biology and status of the five top noxious weeds in the subbasin are detailed below. These species were selected because of their extremely aggressive habits, extent of infestation, and potential to disrupt ecological integrity of local plant communities (C. Kuykendal, Nez Perce Bio-control Center, personal communication, 2001).

Yellow starthistle is particularly problematic. It will invade overgrazed ranges, abandoned fields, rights-of-ways, and waste areas. It spreads exclusively by seed, which may lie dormant for as long as ten years. Yellow starthistle will grow wherever cheatgrass grows and causes chewing disease and death in horses (Hastings and DiTomaso 1996). Yellow starthistle is widely scattered throughout the U.S., but is a severe problem only in the west. In Idaho, populations have existed for several years south of Lewiston, but recently infestations have been found as far north as Coeur d'Alene. In the Clearwater River drainage, this weed forms near monocultures for thousands of acres (Figure 50). It is very uncommon on Forest Service lands but occasional plants have shown up along Highway 12 and on the Palouse Ranger District. Current estimates suggest that 500,000 acres of starthistle occur in Idaho with the largest infestation centered around Clearwater, Latah, Idaho, Lewis and Nez Perce Counties; the heart of the Clearwater subbasin (Jette et al. 1999). There are 870 square kilometers (214,756 acres) of this noxious weed currently infesting the Clearwater subbasin (Clearwater Weed Management Group 1999). Despite control efforts, yellow starthistle continues to expand at an estimated rate of 6% per year (Jette et al. 1999).

Spotted knapweed, a native to Europe, is now widely distributed in North America. It was introduced as a contaminant of alfalfa and clover seed, and in many areas of the west it ranks as the number one weed problem. In Idaho, it has a wide environmental range and moderate shade tolerance. Each plant can produce up 25,000 seeds that are dispersed by wind, animals and people. The seeds remain viable for eight years. As this species spreads, it causes a drastic reduction in native plant communities. Infected areas often form monocultures. Some evidence exists that knapweeds release chemical substances that inhibit surrounding vegetation. Knapweeds readily establish themselves on any disturbed soil, and their early spring growth makes them competitive for soil moisture and nutrients. The flowering period extends from June to October. The estimated areal extent of spotted knapweeds is 35 square kilometers (Figure 51; Clearwater National Forest 2001).

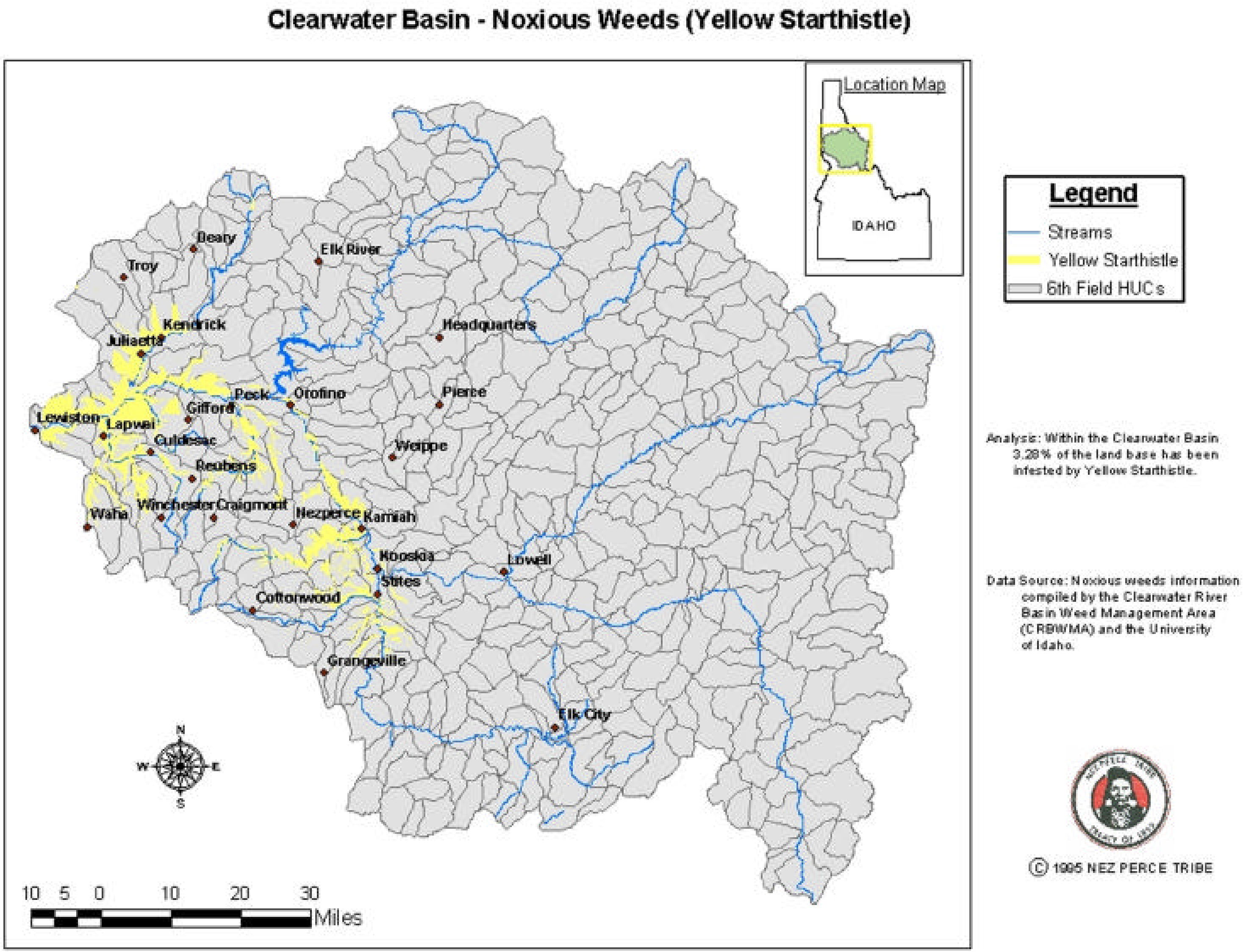

Figure 50 Yellow starthistle distribution within the Clearwater subbasin

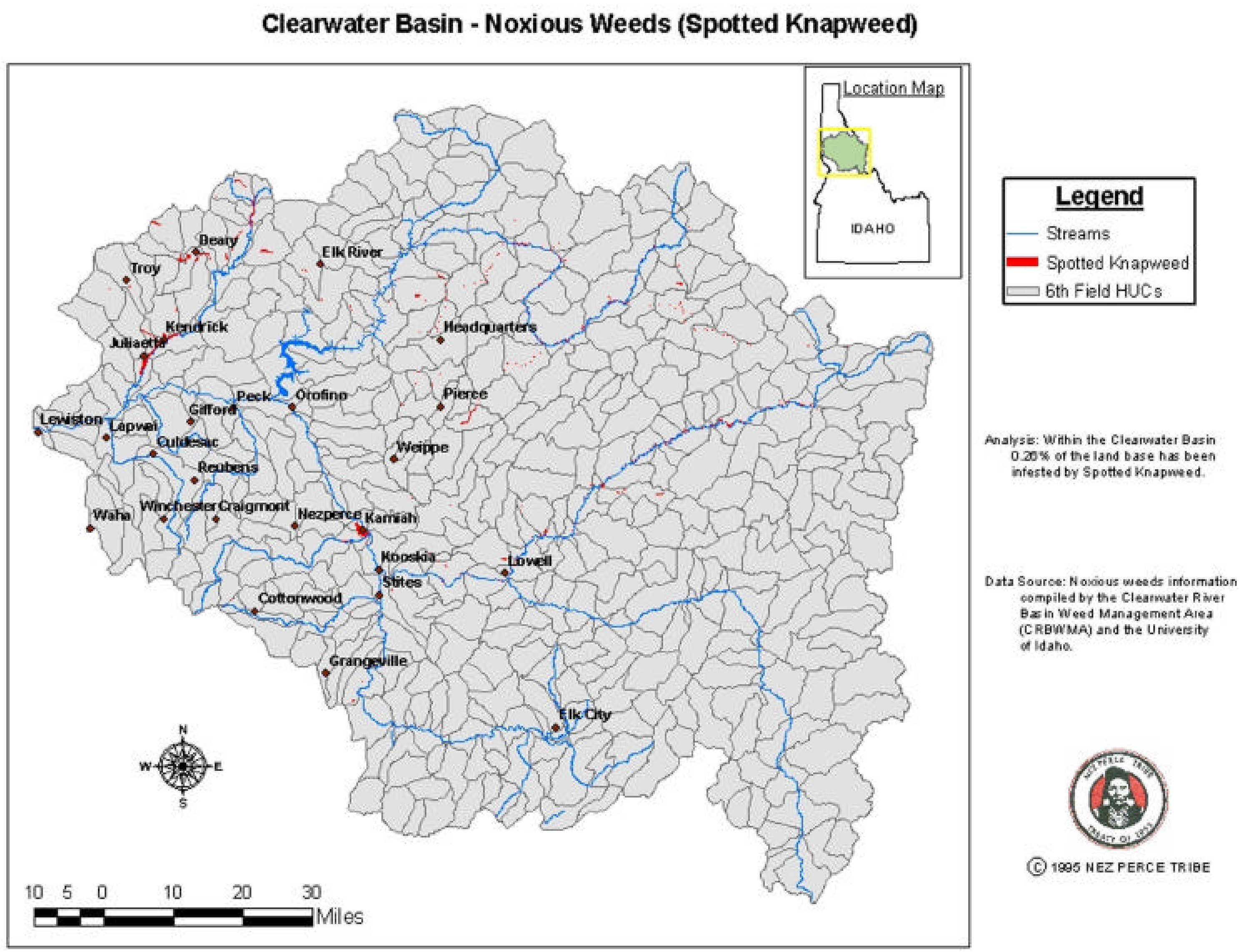

Figure 51. Spotted knapweed distribution within the Clearwater subbasin

Rush skeletonweed (*Chondrilla juncea*) generally prefers well-drained, light soils. The plant spreads primarily by seed, but roots scattered by cultivation can aid in spread. Typical sites include roadsides, railroad beds, logged areas, woodcutting areas, rangeland, grain fields, and pastures. The extensive, deep root system makes skeletonweed difficult to control. Flowering and seed production occur from mid-July through frost. This weed infests several millions of acres in the Pacific Northwest and California, and approximately 3 million acres in Idaho. Rush skeletonweed is not widespread in the Clearwater subbasin (Figure 52), but populations are increasing. It inhabits nearly 500 acres (2 square kilometers), with the bulk of the populations in Latah County (Clearwater National Forest 2001).

Orange hawkweed (*Hieracium auratiacum*) and Meadow Hawkweed (*Hieracium pratense*) spread by seeds, stolons, and rhizomes, and can invade many different habitats, including urban sites, meadows, pasture, hay fields, roadsides, tree plantations and riparian areas. Both invasive weeds form extensive mats that practically eliminate other vegetation. Distribution of orange hawkweed has likely been assisted by flower enthusiasts due to its attractive flowers. Several small outbreaks have occurred on the Clearwater National Forest, almost all along roads (Figure 53). Meadow hawkweed first appeared in Benewah County and rapidly spread to all north Idaho counties. It spread south to the Clearwater National Forest, where it has become widespread in just a few years. Orange hawkweed's distribution range is estimated to be around 8080 acres (33 square kilometers; Clearwater National Forest 2001).

Although not officially recognized as a "noxious" weed, cheatgrass has had a significant impact on the ecological integrity of the canyon grassland ecosystem within the Clearwater subbasin. It quickly invades after disturbance, and once established can outcompete native species. It has some value as forage for wintering big game species (it is often green and palatable when native species are still dormant in early spring) it provides poor forage during mid- to late summer and is an unreliable source of food during drought years (Roberts 1991). It often precedes other invasive species such as yellow starthistle and rush skeletonweed. It can alter fire regimes because its fine textured leaves provide fuel for larger, more frequent fires (Mosley et al. 1999). Shorter fire return intervals in cheatgrass dominated sites can negatively impact other more desirable grasses, forbs and shrubs. No biocontrol agents are available for the species and control options are limited.

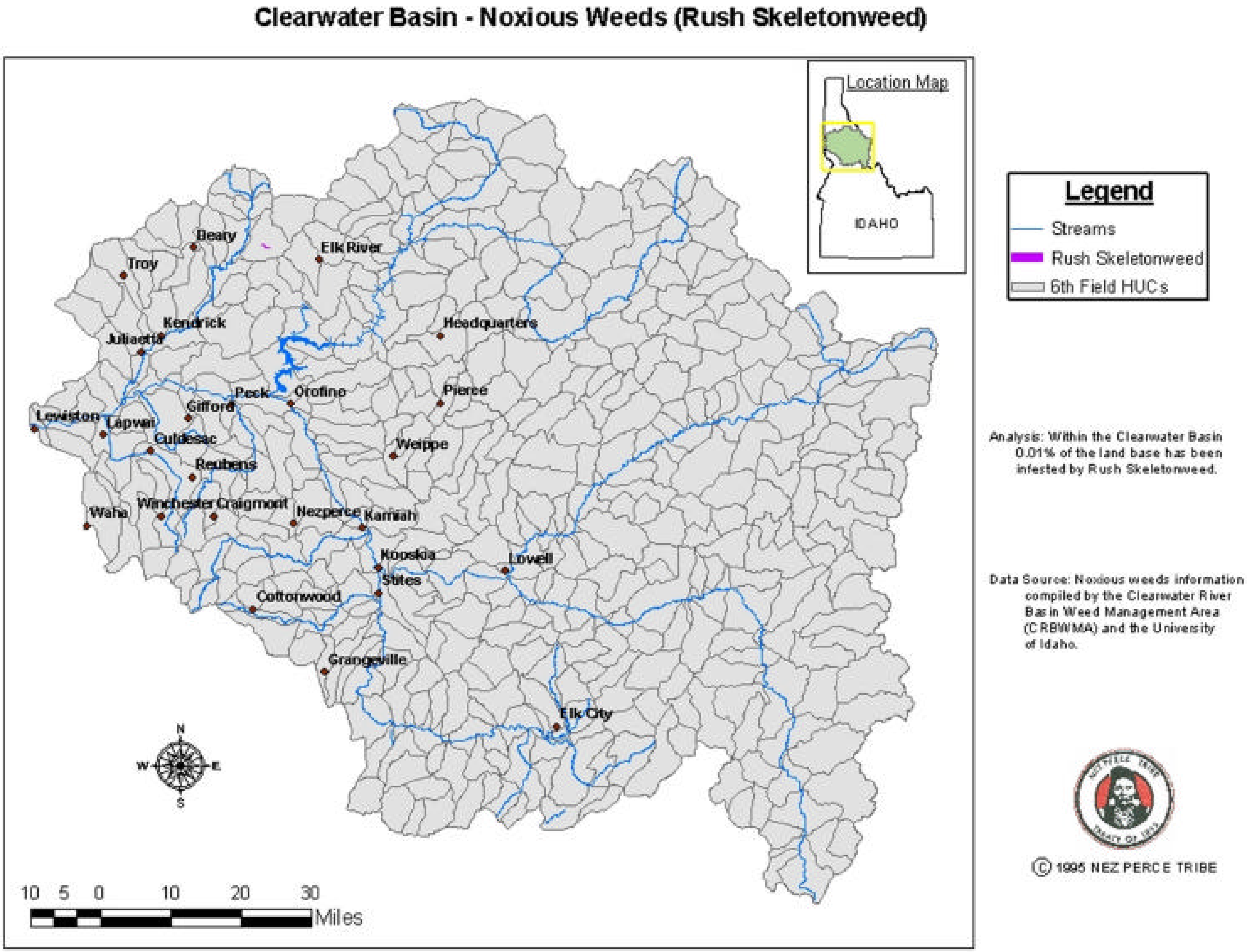

Figure 52. Rush skeletonweed distribution within the Clearwater subbasin

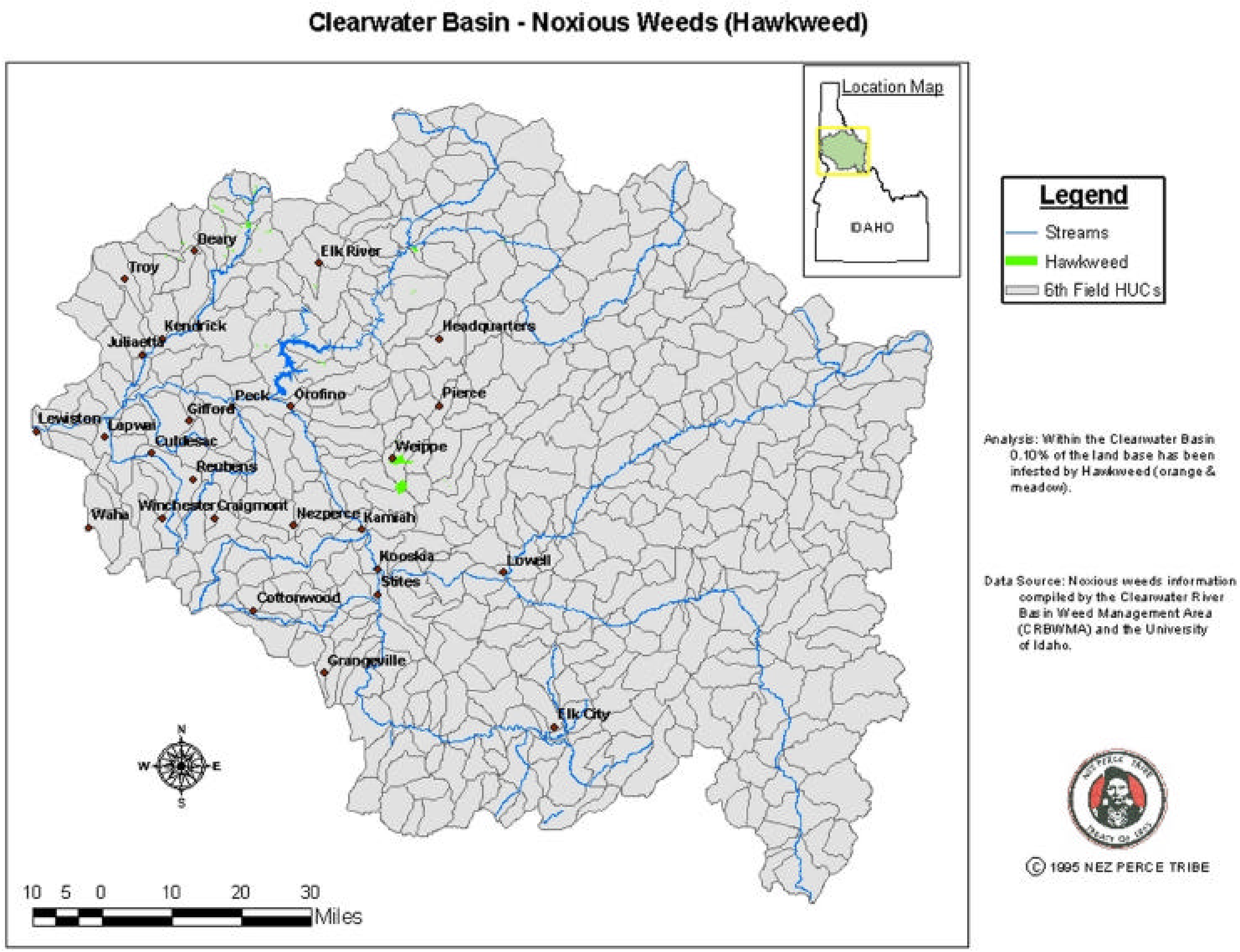

Figure 53. Meadow and orange hawkweed distribution within the Clearwater subbasin

5.5 Cover Types

Vegetation type descriptions are based on *Forest Habitat Types of Northern Idaho: A Second Approximation* by Cooper, Neiman, and Roberts (1991) and on *Plant Associations of the Wallowa-Snake Province* by Johnson and Simon (1987). Spatial representation of cover types utilized the Idaho GAP2 data. To facilitate discussion GAP2 codes have been grouped into cover types based on similar vegetative composition (Table 34). Square kilometers of each cover type within the AUs is displayed in Table 34; refer to Appendix C for acreage in 4th, 5th and 6th HUCs.

5.5.1 Western Hemlock

Physical Description

Tsuga heterophylla has a long slender trunk, frequently becoming fluted when large, and a short, narrow crown of slightly drooping or horizontal branches (Tesky 1992c). Even on large trees, the bark is thin (1 to 1.5 inches [0.39-0.59 cm]). Young trees have scaly bark, old trees have hard bark with furrows separating wide flat ridges. *Tsuga heterophylla* lacks a taproot; roots are shallow and commonly most abundant near the surface. Maximum ages are typically between 400 and 500 years; the maximum age recorded is over 700 years. Diameters of old growth trees can exceed 3.3 feet (100 cm); the maximum is 9 feet (275 cm; Tesky 1992c). Height is typically 160 to 200 feet (49-61 m), though trees up to 259 feet have been reported.

Ecology and Distribution

Tsuga heterophylla is extremely shade tolerant; *Taxus brevifolia* (Pacific yew) is the only other species in the Clearwater subbasin with equal or greater tolerance of shade (Tesky 1992c). *Tsuga heterophylla* is a climax species either alone or in association with other shade tolerant species; it occurs in all stages of succession. Shade tolerance allows this species to invade later seral stages of forest succession. Fast growth in full overhead light and the ability to survive on diverse seedbed conditions make *T. heterophylla* an aggressive pioneer species. If no major disturbances occur over several hundred years, a climax of self-perpetuating, virtually pure *T. heterophylla* can result. *Tsuga heterophylla* rarely replaces *T. plicata* completely; a *Tsuga-Thuja* climax will slowly replace *Pinus monticola* stands. *Tsuga heterophylla* occurs as a dominant or codominant on low- to mid-elevation moist, moderate temperature sites within the maritime influenced climatic zone of the northern Rocky Mountains (Tesky 1992c; Cooper et al. 1991).

In the Clearwater subbasin, *T. heterophylla* occurs north of the North Fork Clearwater River and in the Potlatch River drainage (Figure 54). *Tsuga heterophylla* has the most restrictive environmental requirements of northern Idaho conifers; it grows in areas with a mean annual precipitation greater than 30", is shade tolerant, intolerant of drought or excessive moisture, and not very frost hardy. As a climax dominant, *T. heterophylla* can occur from 2,500 to 5,500 feet (760-1,680 m) on all sites except wet bottomlands where it is codominant with or replaced by *Thuja plicata* (western redcedar). At the lower ends of its elevational range, *T. heterophylla* is replaced by *T. plicata*; at the upper ends it is replaced by *Tsuga mertensiana* (mountain hemlock), or *Abies lasiocarpa* (subalpine fir). Based on GAP data, approximately 102 km^2 of the *T. heterophylla* cover type occurs in the Clearwater subbasin (Table 34).

Tsuga habitat type sites are highly productive (Cooper et al. 1991). Early to mid-seral stands have closed canopies and sparse undergrowth; old growth stands are open, two- or multi-storied. Major seral species include all endemic tree species except *T. mertensiana, Pinus albicaulis, P. ponderosa,* and *Larix lyallii.*

Table 34. Cover type distribution in square kilometers,Clearwater subbasin (based on Idaho GAP 2 data)

Cover Type	GAP2 Codes	South Fork AU	Lower Selway AU	Upper Selway AU	Lochsa AU	Lolo- Middle Fork AU	Upper North Fork AU	Lower North Fork AU	Lower Clearwater AU	Total Subbasin
Western Red Cedar/ Mixed Mesic Forest	4210, 4221, 4226, 4227	497.5	435.0	534.3	643.3	700.0	888.7	897.3	659.9	**5,256**
Douglas-fir/ Mixed Xeric Forest	4212, 4222, 4223, 4225	275.1	319.4	765.6	456.6	479.0	574.2	658.6	663.3	**4,192**
Agricultural	2000	0.0	0.0	0.0	0.0	53.4	0.0	6.5	2,365.6	**2,426**
Subalpine fir/ Englemann Spruce	4201, 4208, 4218, 4220	308.8	242.3	702.1	571.7	16.0	327.7	179.2	1.2	**2,349**
Shrubs	3202, 3301, 3305, 3306, 3307, 3308, 3312	63.6	157.0	108.4	279.3	152.1	541.4	251.4	282.1	**1,835**
Lodgepole pine	4203	254.2	131.4	423.2	407.9	22.3	280.1	79.1	32.6	**1,631**
Grand fir	4207	356.1	150.3	128.4	144.9	201.7	174.8	272.0	137.1	**1,565**
Ponderosa pine	4206	67.1	32.8	105.4	74.0	147.1	101.0	158.5	407.3	**1,093**
Native bunchgrasses	3101	21.3	14.2	46.2	11.8	121.6	26.9	93.3	554.2	**890**
Rock, snow and water	5000, 7300, 7800, 7900, 9100,	32.8	29.6	220.9	85.0	27.4	35.7	99.0	117.6	**648**
Western larch	4215, 4228, 4229	66.8	52.8	112.6	106.2	2.9	119.9	103.0	14.8	**579**
Mountain meadow	3104, 8100	41.5	41.9	151.9	85.4	8.9	69.1	44.0	44.2	**487**
Riparian non-forest	6201, 6202, 6203	14.2	13.6	11.2	22.3	24.9	29.7	24.2	79.0	**219**
Riparian forest	6101, 6102, 6103, 6104	15.7	11.5	19.2	16.7	18.9	21.7	36.0	48.4	**188**
Western Hemlock	4211	0.0	0.0	0.0	0.0	0.0	3.0	49.1	50.3	**102**
Aspen and conifer	4301	1.4	14.8	6.7	21.6	9.1	20.0	8.1	12.6	**94**
Exotic Forbs/ Annual grasses	3102	0.8	0.4	9.2	0.6	2.4	0.9	0.5	46.8	**62**
Cottonwood	4102	14.4	1.0	2.6	7.0	10.5	6.8	6.2	1.4	**50**
Whitebark pine	4217, 4219	3.7	3.5	21.2	10.1	0.0	3.1	0.0	0.0	**42**
Urban	1000	0.0	0.0	0.0	0.0	2.0	0.0	0.1	29.1	**31**
Burnt timber	4401	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	**2**

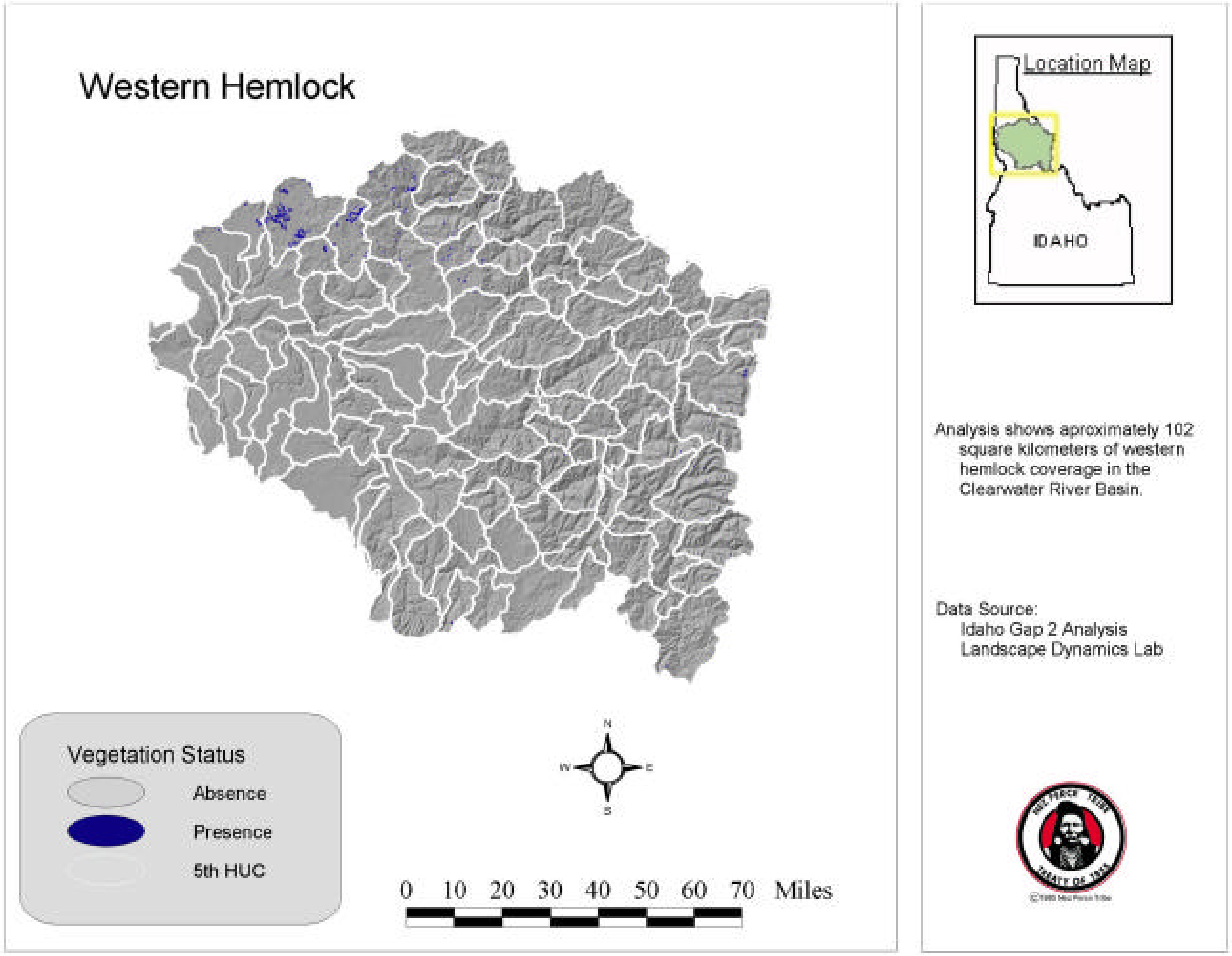

Figure 54. Distribution of the western hemlock cover type within the Clearwater subbasin

Undergrowth vegetation includes four major communities corresponding to a moisture gradient (wet to dry):

1. *Gymnocarpium dryopteris* (oak fern; widespread in the Coeur d'Alene National Forest)
2. *Asarum caudatum* (wild ginger; widely distributed in northern Idaho)
3. *Clintonia uniflora* (queencup beadlily; widely distributed in northern Idaho)
4. *Menziesia ferruginea* (false huckleberry; incidental, occurring above 5000 feet in Selkirk range in Bonner County)

Pachistima myrsinites (myrtle boxwood) occurs in all *T. heterophylla* habitat types along with *Oplopanax horridum* (devil's club), *Athyrium filix-femina* (ladyfern), *Adiantum pedatum* (maidenhair fern), *Coptis occidentalis* (western goldenthread), *Smilacina stellata* (false solomon's seal), *Disporum hookeri* (Hooker's fairybell), *Galium triflorum* (sweet scented bedstraw), and *Viola orbiculata* (round-leaved violet).

Wildlife and Cultural Values

Big game forage production is good in early seral stages, fair in mature stands, and poor in the closed canopy seral stages (Cooper et al. 1991). Stands with high coverages of shrubs (i.e., *T. brevifolia* (Pacific yew) and *Vaccinium globulare* (blue huckleberry)) provide significant habitat for moose, elk and grizzly bear. Old growth stands provide thermal and hiding cover for many wildlife species. In the southern Selkirk Mountains grizzly bear have been reported to use heavily timbered *T. heterophylla* forests (Layser 1978). *Tsuga heterophylla* also provides cavity-nesting birds (e.g., yellow-bellied sapsucker and northern three-toed woodpecker) with nest trees (McClelland 1980). Windthrow provides habitat for species such as goshawk prey species, that utilize downed woody debris.

Threats and Limiting Factors

Shallow roots, thin bark, highly flammable foliage, and a low branching form leave *T. heterophylla* very vulnerable to fire (Tesky 1992c). Dense stands of trees with lichen covered branches are even more susceptible to fire damage. Because *Tsuga* stands are commonly in cool mesic habitats, fire frequency tends to be low. In the Clearwater subbasin, the mean fire interval is 50 to 150 years, with highly variable fire intensity. Stands that occupy steep montaine slopes favor more intense burning and are thus more likely to be destroyed by stand replacing fires. Following any type of disturbance, tremendous regeneration occurs of *T. heterophylla*, *Abies grandis*, and *P. monticola* (Cooper et al. 1991). *Armillaria mellea*, *Heterobasidion annosum*, *Phaeolus schweinitzii*, *Laetiporus sulphureus*, *Inenotus tomentosus*, *Poria subacida*, *Phellinus weiri*, and *Echinodontium tinctorium* (Indian paint fungus) are the dominant root and butt pathogens of *T. heterophylla* (Tesky 1992c). *Arceuthobium campylopodum* (Dwarf mistletoe), a common parasite on *T. heterophylla*, causes mortality in old growth stands.

Lambdina fiscellaria lugubrosa (western hemlock looper), *Tetropium velutinum* (western larch borer), *Acleris gloverana* (western blackheaded budworm), *Melanolophia imitata* (green striped forest looper), *Ectropis crepuscularia* (saddleback looper), *Neodiprion tsugae* (hemlock sawfly), and *Steremnius carinatus* (a weevil), are the primary insects besetting *T. heterophylla* (Tesky 1992c). *Lambdina fiscellaria lugubrosa* causes more mortality of *T. heterophylla* than any other insect pest. Outbreaks on any single site can last two to three years.

Mortality caused by *L. f. lugubrosa* is highest in old growth stands; severe damage can also occur in vigorous 80 to 100 year old stands.

The roots, especially the fine roots, are most abundant near the soil surface and are easily damaged by harvesting equipment and fire. (Tesky 1992c). Top dieback is common on droughty sites, and in especially dry years, whole stands of *T. heterophylla* saplings may die (Tesky 1992c). Following thinning, seedlings and saplings are susceptible to sunscald. Sunscald lesions frequently become infected with decay organisms. Pole-sized and larger stands of western hemlock are prone to severe windthrow. Increased uprooting occurs on sites with an impenetrable soil layer or high water table that result in shallow rooted trees (Te sky 1992c).

5.5.2 Western Red Cedar

Physical Description

Thuja plicata is a prolific seed producer and long-lived (500-1,000 years). Typically, mature *T. plicata* are 70 to 100 feet tall though some reach heights of 130 feet (Tesky 1992a). Tapered trunks are two to four feet diameter, though some exceed six feet diameter.

Ecology and Distribution

Thuja plicata is one of the most shade tolerant species growing in Clearwater subbasin *Thuja-Tsuga* ecosystems (Tesky 1992a). Although typically considered a climax or near climax species, it occurs in all stages of forest succession. *Thuja plicata* invades disturbed sites as broadly distributed seeds; in undisturbed areas it regenerates vegetatively. Soil and moisture conditions strongly influence the successional status of *T. plicata*. In the Clearwater subbasin, *P. monticola* stands are slowly superseded by a *Tsuga-Thuja* climax.

Thuja plicata occurs as a riparian dominant on moist benches, toe slope seepages, and wet bottoms adjacent to streams (Tesky 1992a). *Thuja plicata* habitat types occur between 1500-5500'; this species grows best on toe slopes and bottomlands where soil moisture is high (Cooper et al. 1991). In terms of narrow environmental tolerances, *T. plicata* ranks second to *T. heterophylla*. *T. plicata* tolerates both higher and lower temperatures, excess soil moisture, and short summer drought; thus *T. plicata* dominates on both lower elevational *T. heterophylla* habitat types, and on upper elevation moist sites in the Clearwater subbasin. Wet sites co-dominated by *T. plicata* and *T. heterophylla* are classed within the *Thuja* habitat types. While *T. heterophylla* occurs as far south as the North Fork Clearwater drainage, *T. plicata* occurs as far south as the Selway drainage. There is a direct relationship between the areal extent of *Thuja* habitat types and *Pinus monticola* types in North Idaho; in the Clearwater subbasin, *P. monticola* is most common along moist creek bottoms, lower benches, and northerly slopes.

Psuedotsuga menziesii, *Abies grandis*, *Pinus monticola*, *Picea engelmannii*, and *Larix Occidentalis* are major seral species in *Thuja* habitat types (Cooper et al., 1991). *Abies grandis* and *P. engelmannii* may occur on higher elevation *Thuja* sites; sites with well drained soils may support P. *monticola*. Understory species include *Clintonia uniflora*, *Coptis Occidentalis*, *Smilacina stellata*, *Disporum hookeri*, *Galium triflorum* and *Viola obiculata*.

Cooper, et al. (1991) recognizes six different habitat types in the *T. plicata series*.

1. *Oplopanax horridium* (devil’s club; located in valley bottoms in moist conditions)
2. *Athyrium filix-femina* (lady fern; stream terraces, toe slopes, and lower slopes)
3. *Adiantum pedatum* (maidenhair fern; mostly found between St. Joe and Selway
4. Rivers)

5. *Gymnocarpium dryopteris* (oak fern; driest association; mostly found between St. Joe and Selway Rivers)
6. *Asarum caudatum* (wild ginger; common throughout northern Idaho)
7. *Clintonia uniflora* (queencup beadlily; most common habitat type)

Other species most always present in mature *T. plicata* stands are *Coptis occidentalis* (western goldenthread), *Smilacina stellata* (false solomon's seal), *Disporum hookeri* (Hooker's fairybell), *Galium triflorum* (sweet scented bedstraw), and *Viola orbiculata* (round-leaved violet).

A moist, warm variant of the *T. plicata*/*Oplopanax horridum* (western redcedar/devil's club) habitat type occurs on the north end of Dworshak Reservoir and up the North Fork Clearwater River to Isabella Creek in a coastal disjunct area (Steele 1971 *in* Cooper et al. 1991). *Thuja plicata* and *T. heterophylla* are the major seral and climax species (alone or as co-dominants) on these sites. *T. plicata/Adiantum pedatum* (western redcedar/maidenhair fern) habitat types in this area also support disjunct, relict populations of coastal plant species due to the persistent locally intensified expression of a maritime environment.

Wildlife and Cultural Values

Thuja plicata habitat types provide high value wildlife habitat in terms of food, cover and water. Ungulates eat *Oplopanax* leaves and flower heads in late summer and fall; sites with *T. brevifolia* have very high values for big game year-round, especially moose. Big game, snowshoe hares and livestock have been reported to eat significant quantities of *Thuja* reproduction (Cooper et al. 1991). Minore (1983) reported that *Thuja* foliage made up 5 percent of the total winter diet by weight analysis of 69 elk stomach samples from elk harvested along the lower Selway and Lochsa rivers between January 1 and April 1 from 1960 through 1970.

Old growth stands provide many species with dens in cavities in *T. plicata* (Tesky 1992a). Grizzly bears have been reported using heavily timbered *T. plicata* forests in the southern Selkirk Mountains; cavity-nesting birds (e.g., yellow-bellied sapsuckers, hairy woodpeckers, tree swallows, chestnut-backed chickadees, and Vaux's swifts) also use old growth *T. plicata* trees to nest in. Isolated old growth stands in the wetter habitat types provide valuable recreational and botanical interest sites as well.

Threats and Limiting Factors

Historically, fire was a major disturbance in drier *T. plicata* habitat types. Fire scarred trees are common in the Clearwater subbasin. *Thuja plicata* is less susceptible to fire than *T. heterophylla*, *P. engelmanni*, and *A. lasiocarpa*. Fire frequency of *T. plicata* stands tends to be low; at streamside and seepage sites the mean fire interval is greater than 200 years, while on lower and middle slopes it is 50 to 150 years (Tesky 1992a). *Thuja plicata* has a shallow root system, thin bark, highly flammable foliage, and low, dense branching habit, which make it vulnerable to fire damage (Tesky 1992a). However, because of its large size, *T. plicata* frequently survives fire if not completely girdled by fire (Fisher and Bradley 1987). Roots just under the duff layer are frequently scorched when the duff layer burns, which can lead to death. Fire injury to roots can result in fungal infection and chronic stress (Tesky 1992a). Common causes of fire mortality are crown scorching and root charring. Offsite wind dispersed seeds will readily establish on bare mineral soil seedbeds after fire.

Thuja plicata is a host for several insect species, including *Mayetiola thujae* (gall midge), *Steremnius carenatus* (weevils), *Phloeosinus sequoiae* (bark beetles), and *Trachykele* *blondeli* (western redcedar borer; Minore 1990). Over 200 fungi grow on *T. plicata*, often resulting in large hollow trees. *Didymascella thujina* (a leaf blight) infects second and third year nursery seedlings; up to 97 percent of natural *T. plicata* regeneration may die when this blight reaches epidemic proportion (rare in North America). *Poria asiatioa* and *Phellinus weiri* (root butt and trunk rots) are the most important fungi attacking *T. plicata*.

Thuja plicata is prone to windthrow on wet sites (Minore 1990). Logging in wetter *T. plicata* habitat types can cause considerable damage due to wet, highly compactible soils vunerable to mass wasting (Cooper et al., 1991). Extensive disturbance of bottomland sites may result in irreparable damage (Tesky 1992a). Downed woody material should not be removed because it serves as a seedbed for *Thuja* and *Tsuga* regeneration (Parker 1979 *in* Cooper et al. 1991). On drier *T. plicata* habitat sites, shrub and forb invasion after logging attracts large and small herbivores.

5.5.3 Mountain Hemlock

Physical Description

Open stands of *T. mertensiana* have strongly tapered trunks, slender branches drooping almost to the ground and a narrowly conical crown with a characteristic slender drooping leader (Tesky 1992b). In dense stands, trunks are less tapered; the crown is proportionally shorter, and near the ground the trunk is virtually clear of branches. The bark on young trees is rough and broken, and on old trees it is deeply creased into scaly plates. Roots are shallow and wide spreading.

Ecology and Distribution

Tsuga mertensiana is a shade tolerant dominant or co-dominant in subalpine or high elevation alpine forests, sometimes living to 800 years of age (Tesky 1992b). It often succeeds *P. contorta* when pioneering on drier sites and frequently replaces *P. engelmannii*. *Tsuga mertensiana* is very frost tolerant. At timberline, it reproduces vegetatively by layering, effectively sheltering the saplings by the growth of the parent tree and spreading nutrients via the established root system of the older tree. Prior to 1991, *Tsuga mertensiana* series was included in the *A. lasiocarpa* series (Cooper et al. 1991). However, Cooper et al. (1991) "identified significant acreages where *T. mertensiana* is potentially the climax dominant, making its recognition worthwhile at a higher taxonomic level." Furthermore, *T. mertensiana* seems associated with a maritime influence, (although absent on forests where the inland maritime influence seems the strongest) while also occurring within *A. lasiocarpa* stands as discontinuous tracts. Cooper et al. (1991) state that where the *T. mertensiana* series is widespread it may be locally absent without an apparent environmental explanation.

Within the Clearwater subbasin, *T. mertensiana* habitat types occur as far south as the southern part of the Middle Fork Clearwater River drainage, and White Sand Creek drainage of the Lochsa River (Cooper et al. 1991). It ranges northward, in a fairly continuous zone above 4,800 to 5,100 feet, and uncommonly occurs in frost pockets below 2,800 ft. Specific locations cited in Cooper et al. (1991) include Saddle Camp and an area east of Indian Post Office (on the Lewis and Clark Trail), near Aquarius Research Natural Area, Sheep Mountain Range and an area above Papoose Saddle (on the Clearwater National Forest), Mullan Pass (on the Coeur d'Alene National Forest), and Little Joe Pass (on St. Joe National Forest).

GAP data does not recognize a *T. mertensiana* vegetation type, but rather groups it within the *A. lasiocarpa* vegetation type, (of which there are 548 km^2). ICBEMP data classifies 144 km^2 as *T. mertensiana* cover type (Table 31). No map is available of mountain hemlock distribution within the Clearwater subbasin.

The *T. mertensiana* series is distinguished from the *A. lasiocarpa* series where *T. mertensiana* is at least a climax co-dominant with *A. lasiocarpa* (Cooper et al. 1991). Between 1889 and 1919, much of the *T. mertensiana* zone between Lolo Pass and Thompson Pass was severely burned and is either treeless or still populated by early seral stands, and the habitat type cannot currently be determined.

Cooper et al. (1991) separates the *T. mertensiana* series into five habitat types:

1. *Streptopus amplexifolius* (twisted stalk; contains a *Luzula hitchcockii* and a *Menziesia ferruginea* phase)
2. *Clintonia uniflora* (queencup beadlily; contains a *Menziesia ferruginea* and a *Xerophyllum tenax* phase)
3. *Menziesia ferruginea* (false huckleberry; contains a *Luzula hitchcockii* and a *Xerophyllum tenax* phase)
4. *Xerophyllum tenax* (beargrass; contains *Luzula hitchcockii, Vaccinium scoparium,* and *Vaccinium globulare* phases)
5. *Luzula hitchcockii* (smooth woodrush; high elevation; severe environments)

Seral tree species in order of decreasing importance are *P. engelmannii*, *Pinus contorta* (lodgepole pine), *Larix occidentalis* (western larch), *P. monticola*, and *Pseudotsuga menziesii* (Douglas-fir). Understory species are dominated by *Menziesia ferruginea* (false huckleberry) on cold, moist exposures, *Vaccinium globulare* (blue huckleberry), and *Xerophyllum tenax* (beargrass); the latter an indication that *T. mertensiana* sites have greater protective snowpack, are less windy, and more influenced by the maritime climate than *A. lasiocarpa* habitat types.

Tsuga mertensiana is important for watershed protection (Tesky 1992b). Following overstory removal, water tables rise and restrict timber options in some habitat type phases (Cooper et al. 1991).

Wildlife and Cultural Values

Tsuga mertensiana stands provide summer range for deer, elk and bear, and seeds are a food source for grouse and crows (Tesky 1992b). Sites that border mountain grasslands and herbaceous meadows provide thermal and hiding cover for many wildlife species (Cooper et al. 1991; Tesky 1992b).

Threats and Limiting Factors

Tsuga mertensiana's relatively thick bark provides some resistance to fire, but its tendency to grow in dense groups, low-hanging branches and highly flammable foliage make it very prone to fire injury (Fischer and Bradley 1987). Fire occurrences are low (400-800 years) since *T. mertensiana* sites are usually moist with average precipitation greater than 50 inches (127 cm). In the Pacific Northwest, the pre-logging fire regime is estimated at is 611 years in *T. mertensiana* forest types. Fires thus typically occur as either infrequent crown fires or severe stand-replacing fires. Fire injury makes *T. mertensiana* especially vulnerable to insects and disease (Tesky 1992b). Old growth mountain hemlock stands over 460 years old are quite susceptible to stand-replacing fires.

In the high Cascades *T. mertensia* is most vulnerable to a fungus called laminated root rot (*Phellinus weiri*). Low levels of nitrogen in the forest floor increase the tree's susceptibility to the fungus (McCauley and Cook 1980).

5.5.4 Subalpine Fir

Physical Description

Abies lasiocarpa trees have a very dense and narrow crown with short branches (Uchytil 1991). In open conditions, trees retain their lower branches, which frequently droop and reach down to the ground. Overstory trees may lack lower branches for 20 to 30 percent of the tree's height. At timberline a flag form tree is common; these have an upright trunk growing above a krummholz-like mat, and branches are generally limited to the leeward side of the trunk. Young trees have thin, gray, smooth bark, with numerous resin vesicles; bark on older trees is scaly and shallowly fissured. Root systems are generally shallow; under favorable conditions roots may develop comparatively deep laterals.

Ecology and Distribution

Abies lasiocarpa is a shade-tolerant climax species with long fire-free intervals (Uchytil 1991). Pure stands of *A. lasiocarpa* are common at climax. *Picea engelmannii*, a longer-lived seral species to *A. lasiocarpa*, may also be present as a codominant in climax conditions. Timberline *A. lasiocarpa* often reproduce via layering, which frequently results in clusters of trees. Layering is negligible under closed forest canopies.

In the Clearwater subbasin, the *Abies lasiocarpa* habitat type occurs as a broad subalpine zone (Figure 55). Above the northern portion of the Middle Fork Clearwater River it is somewhat displaced by *T. mertensiana* (Cooper et al. 1991). In the Lochsa, Selway, upper Middle Fork Clearwater, and South Fork Clearwater drainages, the lower limits of the *A. lasiocarpa* series overlap the upper limits of the *A. grandis* series. Either *A. grandis* or *A. lasiocarpa* may occur as the seral or climax component of the opposing series. The relatively moderate climate and scarcity of high elevations limit distribution of the *A. lasiocarpa* series. Based on GAP data, there are 2,349 km^2 of the *A. lasiocarpa* cover type in the Clearwater subbasin (Table 34).

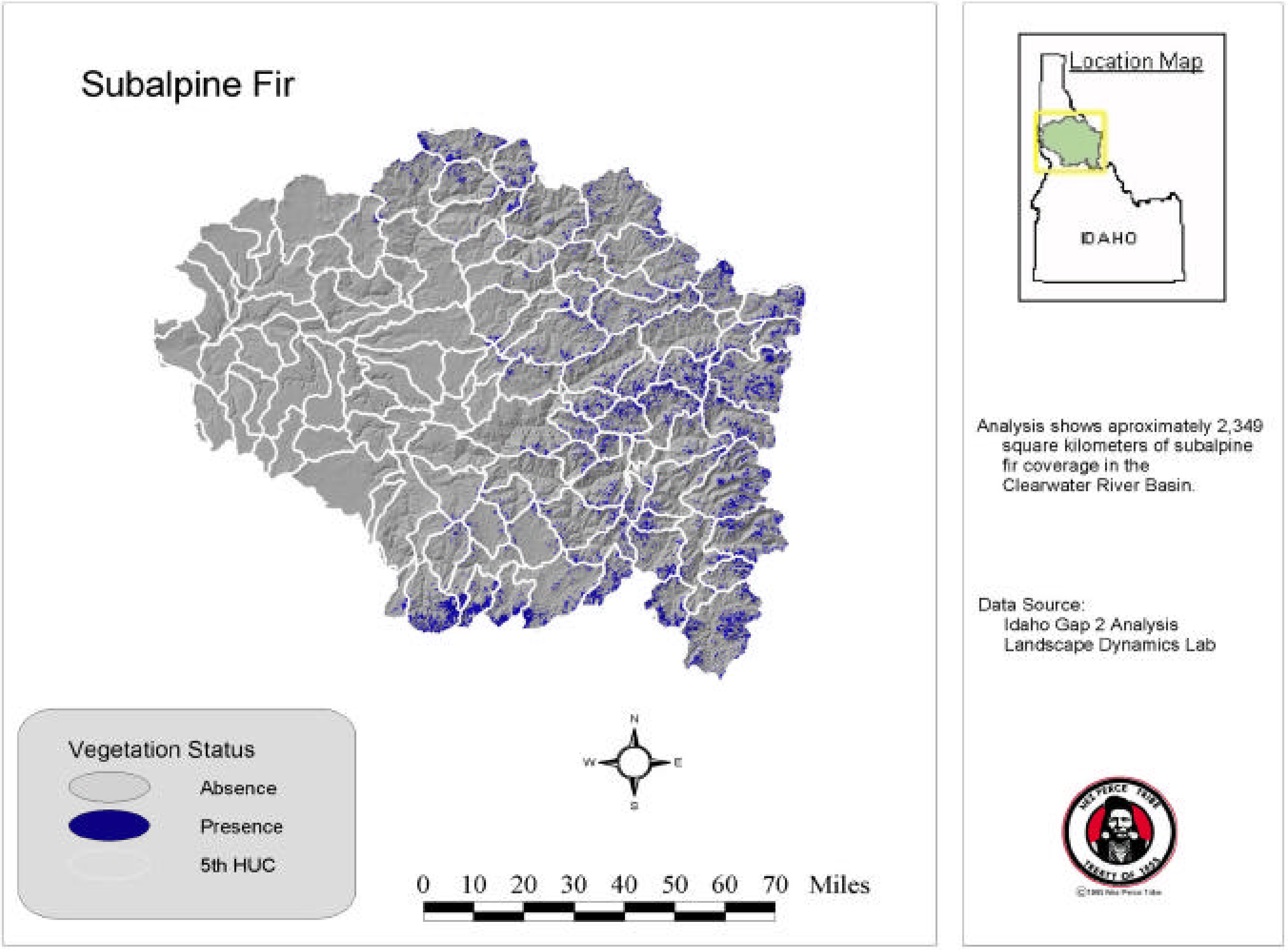

Figure 55. Distribution of the subalpine fir cover type within the Clearwater subbasin

Picea engelmannii is a major, persistent seral component on moist, cool sites; scattered climax stands consisting entirely of *P. engelmannii* are often restricted to wet or cold habitats (Uchytil 1991). *A. lasiocarpa* and *P. contorta* become more dominant on colder and drier sites (Cooper et al 1991). *Larix occidentalis* and *P. monticola* can occur as nearly pure, persisting, even-aged stands given the right conditions. *P. contorta* is more persistent on upper elevation sites than on more productive sites. *Pseudotsuga* develops considerable coverages on lower, warmer slopes with free drainage. *Pinus ponderosa* is rare on all sites. Understory conditions vary from open park-like sites to dense tall shrubs, and from lush forbs (wet sites) to depauperateness (dry sites; Cooper et al. 1991).

A. lasiocarpa habitat types can be classed by elevation range as timberline, upper-elevation, and mid- to upper-elevation (Cooper et al. 1991). Timberline sites are rare in northern Idaho and limited to three vegetation communities: *Pinus albicaulis /A. lasiocarpa, A. lasiocarpa /L. lyallii* (uncommon), and *A. lasiocarpa* /*Luzula hitchcockii* (smooth woodrush; Cooper et al. 1991). Seral species able to become established here are limited to *P. albicaulis*, *P. engelmannii,* and *P. contorta. Abies lasiocarpa* and *P. engelmannii* at the highest elevation are stunted (krummholz form) and typically don't exceed 50 and 65 feet tall respectively. Severe winds and cold temperatures result in dwarfed trees, that are often much broader than tall, forming shrubby mats along the ground (Uchytil 1991). Small tundra-like herbaceous communities, extensive grassy balds, and heaths dominated by *Cassiope mertensiana* (mountain heather) and *Phyllodoce empetriformis* (red mountain-heath) border the highest peaks of *A. lasiocarpa* habitat types (Cooper et al. 1991). Timberline sites are indicative of heavy snow accumulations, drying winds, or excessive subsurface rockiness. Upper-elevation sites are too severe to support *P. menziesii*, *L. occidentalis*, and *P. monticola* (Cooper et al. 1991). *Picea engelmannii* occurs on all sites as a major seral component, and *P. albicaulis* is also common. *Pinus contorta* occurs on warmer, drier sites and *Luzula hitchcockii* is common in the understory. *Abies lasiocarpa* on these sites typically take over 200 years to grow to a height of 50-70 feet. Mid- to upper-elevations *A. lasiocarpa* sites are associated with dry, grassy parks or late-melt areas (Cooper et al. 1991). The parks are dominated by *Festuca idahoensis* (Idaho fescue), *Pseudoroegneria spicatum* (bluebunch wheatgrass), *Festuca viridula* (green fescue), and *Arenaria capillaris* (mountain sandwort); while the late-melt areas have forbs such as *Carex nigricans* (black alpine sedge), *C. tolmiei* (showy sedge), *Deschampsia atropurpurea* (mountain hairgrass), *D. cespitosa* (tufted hairgrass), and *Sibbaldia procumbens* (creeping sibbaldia). Seral species supported on lower-elevation sites include *P. menziesii*, *L. occidentalis,* and *P. monticola*, while the major seral species on wetter sites is *P. engelmannii*.

Within the *A. lasiocarpa* series, there are eight distinct habitat types (Cooper et al.1991).

1. *Calamagrostis canadensis* (bluejoint grass; has *Ledum glandulosum, Vaccinium caespitosum, Ligusticum canbyi,* and *Calamagrostis canadensis* phases)
2. *Streptopus amplexifolius* (twisted stalk; contains *Menziesia ferruginea* and *Ligusticum canbyi* phases)
3. *Clintonia uniflora* (queencup beadlily; *Menziesia ferruginea, Xerophyllum tenax, and Clintonia uniflora* phases)
4. *Menziesia ferruginea* (false huckleberry; *Luzula hitchcockii, Vaccinium scoparium, Coptis occidentalis,* and *Xerophyllum tenax* phases)
5. *Vaccinium caespitosum* (dwarf huckleberry; south and west Nez Perce National Forest)

6. *Xerophyllum tenax* (beargrass; *Luzula hitchcockii, Vaccinium scoparium, Coptis occidentalis,* and *Vaccinium globulare* phases)
7. *Vaccinium scoparium* (grouse whortleberry; southern Nez Perce National Forest)
8. *Luzula hitchcockii* (smooth woodrush; harshest sites at high elevation)

Wildlife and Cultural Values

Abies lasiocarpa stands provide excellent hiding cover for bear, moose, mountain goats, elk and deer (Uchytil 1991). Dense stands provide summer thermal cover for big game animals. Moose, elk, mule deer, black bear, and grizzly bear use *A. lasiocarpa* habitats as summer range. Many *A. lasiocarpa* habitat types, particularly those containing huckleberry, provide critical habitat for grizzly bears. Moose use mature subalpine fir stands with thick sub-canopies at lower elevation during the winter (Peek et al. 1987). Elk may use low elevation stands during calving, while bighorn sheep use high stands throughout lambing and lamb rearing. Lynx, fisher, snowshoe hare, and several woodpeckers also inhabit *A. lasiocarpa* forests.

Mule deer, elk, bighorn sheep, and snowshoe hares browse on the young growth of *A. lasiocarpa* but it is not an important food item (Uchytil 1991). *A. lasiocarpa* can be a major food source for mountain goats in the winter and spring, as well as an important winter food for moose and blue grouse. Many small mammals and birds eat the high energy seeds.

Small *A. lasiocarpa* trees provide good year-round security cover for many small mammals and birds such as snowshoe hare, flying squirrels, red squirrels, porcupines, pine martens, fishers, lynx, and several species of mice, voles, chipmunks, and shrews (Daubenmire and Daubenmire 1984). Dense thickets of these trees are often nearly impenetrable and provide hiding places for small mammals such as snowshoe hares and porcupines. Blue grouse often over-winter in subalpine trees and rely almost exclusively on them for escape cover. Many cavity nesting birds use *Abies lasiocarpa* snags, but snags of the associated conifers are generally preferable. Birds such as the white-crowned sparrows, woodpeckers, flycatchers, kinglets, nuthatches, juncos, thrushes, chickadees, crossbills, the pine siskin, owls, and grouse are characteristic summer residents which feed or nest on the tree (Scott et al. 1982).

Subalpine fir stands also provide browse and cover for larger wildlife species. Throughout much of Montana, Idaho, and Wyoming, subalpine fir provides important winter food for mule deer, elk, moose (Peek 1974), woodland caribou, black bear, and grizzly bear.

Subalpine fir seeds are eaten by several species of small mammals and birds. Red squirrels eat seeds from cached subalpine fir cones. Fir seeds are also eaten by chipmunks and mice. Several birds, including chickadees, nuthatches, crossbills, pine siskins, and Clark's nutcrackers remove and eat the seeds from fir cones (Halvorson 1986).

Native Americans used various parts of subalpine fir. A hair tonic was prepared by mixing powdered needles with deer grease. Finely ground needles were also sprinkled on open cuts. Sticky resin collected from the bark was boiled and used as an antiseptic for wounds or as a tea for colds. Boughs were placed in rooms for their aroma, and pulverized needles were used as a body scent or as perfume for clothing (Uchytil 1991).

Threats and Limiting Factors

Several factors contribute to *A. lasiocarpa's* very low resistance to fire: thin bark which ignites readily, low growing branches, highly flammable foliage, a tendency to grow in dense stands, moderate to heavy lichen growth, and shallow roots vulnerable to soil heating (Uchytil 1991). The cool, moist environments of *A. lasiocarpa* sites retard the decomposition of organic matter resulting in a rapid accumulation of fuels. Highly destructive crown fires occur at 100 year or longer intervals and are typically stand replacing. Surface fires are usually lethal due to a concentration of fine fuels under mature trees that burn slowly and girdle the thin barked bole. In subalpine habitats, scattered *A. lasiocarpa* trees often escape fire because of discontinuous fuels, broken and rocky terrain, and a moist and cool environment.

Following large fires, *P. contorta* and *P. tremuloides* are the most common seral species, frequently forming pure stands that completely dominate middle and low elevation stands (Uchytil 1991). Following fire and the development of seral *P. contorta* stands, *A. lasiocarpa* may be suppressed for several decades, and 100 year old trees may be only 3 feet (0.9 m) tall. Substantial *A. lasiocarpa* establishment under dense lodgepole pine stands may take 50 to 150 years after a fire. Following fires near treeline, it may take over 100 years to establish seedlings. *P. contorta* frequently forms even aged dense stands, dominating up to 300 years if established immediately after stand destroying fires. Shade tolerance allows *A. lasiocarpa* to establish under the *P. contorta* canopy, normally within 100 years.

Past stand replacing wildfires burned vast expanses, and together with subsequent burns have nearly eradicated seed sources of climax species and postponed succession to shade intolerant conifers (Cooper et al. 1991; Uchytil 1991). Almost pure, fire created stands of *P. contorta* occupy extensive areas within the Clearwater subbasin, especially in the southern portions (Cooper et al. 1991). *L. occidentalis* also occurs similarly as localized pure, even aged stands on old burns. Following disturbance, revegetation and recovery is slow due to a short growing season and low temperatures (Cooper et al. 1991).

Stand replacing fires often result in pure, even aged stands that may be overstocked and potential centers for insect and disease epidemics. Numerous insects attack *A. lasiocarpa*: the most destructive are the balsam woolly aphid, western spruce budworm, and western balsam bark beetle (Uchytil 1991). The western spruce budworm generally attacks low and middle elevation *A. lasiocarpa* forests. Additional pests include the fir engraver beetle, Douglas-fir tussock moth, and western black headed budworm.

Heterobasidion annosum causes annosus root disease in *A. lasiocarpa*, resulting in root and butt decay (Uchytil, 1991). Several other wood rotting fungi that cause heart, trunk, butt, or root rots (e.g., brown stringy rot, red heart rot, red ring rot, shoestring rot, brown cubical rot, white spongy root rot, and white pocket rot) also affect *A. lasiocarpa*. Trees compromised by wood rots frequently become infested with fir engraver beetles, often resulting in windfall and breakage. In *Picea/ A. lasiocarpa* stands fir broom rust is a common problem, causing wind breakage, bole deformation, and spike tops, resulting in trees more susceptible to decay fungi (Uchytil 1991).

Abies lasiocarpa are very vulnerable to heart rots and thus rarely live over 250 years (Uchytil, 1991). Non even aged silviculture practices can pose a problem because residual subalpine fir trees damaged during thinning operations are susceptible to attack by decay fungi.

5.5.5 Grand Fir

Physical Description

Abies grandis typically has a wide crown and a low, dense branching habit (Howard and Aleksoff 2000). Mature tree heights range from 131 to 164 feet (40-50 m) tall with boles usually measuring 20 to 40 inches DBH. (51-102 cm). Young trees have thin bark (averaging 0.9 cm for a 20 cm diameter tree) and mature trees have fairly thick bark (averaging 1.7 cm for a 40 cm diameter tree). *A. grandis* taproots are well developed and on dry sites grow to moderate depths, whereas on moist sites shallow lateral roots may replace the taproot altogether. Older trees often have pervasive rotting fungi, but commonly reach 250 years of age, occasionally living beyond 300 years (Howard and Aleksoff 2000).

Ecology and Distribution

Prior to 1900, repeated underburns maintained open, seral species stands in *Abies grandis* habitat types (Cooper et al. 1991). While disturbance is not required for *A. grandis* to establish and persist on many sites, it needs fire or some other periodic disturbance to maintain itself on sites where either *T. plicata* or *T. heterophylla* is the climax dominant (Howard and Aleksoff, 2000). *A. grandis* does not establish under closed canopies; succession to a *A. grandis* overstory is faster on sites where it developed under an open forest canopy than on shrubfields (Daubenmire and Daubenmire 1984).

Understory composition undergoes major changes with overstory tree canopy closure which initiates the beginning of the "stagnation stage" in the *A. grandis* series(Zamora 1982; Steele and Geier-Hayes 1982; Antos and Habec 1981 *in* Cooper et al. 1991). In this stage shade intolerant species are eliminated, and changes in understory species are limited to changes in relative abundance rather than loss or displacement (Daubenmire and Daubenmire 1984). *Abies grandis* is correlated with an inland maritime climate (Cooper et al. 1991), and indicates productive forest sites (Howard and Aleksoff 2000).

Mature *A. grandis* stands are normally floristically diverse. *A. grandis* habitat types occur beyond the ecological and geographical limits of the more moisture dependent and shade tolerant *Thuja plicata* and *Tsuga heterophylla* habitat types. The Clearwater subbasin contains an area of *A. grandis* importance, specifically the Nez Perce National Forest and the southern portions of the Clearwater National Forest (Figure 56). *A. grandis* habitat types occur between 1,500-6,300 feet elevation in the Clearwater subbasin, grading into *A. lasiocarpa* series on cooler sites and into *Psudotsuga menziesii* series on warmer, drier sites. Based on GAP data, 1,565 km^2 of the *A. grandis* cover type occur in the Clearwater subbasin (Table 34).

Abies grandis is a canopy dominant and major recolonizer on moist sites, although due to slow initial establishment and growth it normally constitutes a subordinate layer to seral species (Cooper et al. 1991). Seral species include *Picea engelmannii* and *Pinus contorta* on colder habitat types, *Pinus ponderosa* on warmer habitat types, *Larix occidentalis* on previously burned sites, and *Psuedotsuga* on almost all habitat types. Depending on disturbance type and degree, time since stand initiation, seed source, and initial composition, a wide variety of seral communities can develop. Within the Clearwater subbasin, fire has been a primary influence, resulting in domination by *P. contorta* on cold sites and *Pseudotsuga* and *P. ponderosa* on warm, dry sites.

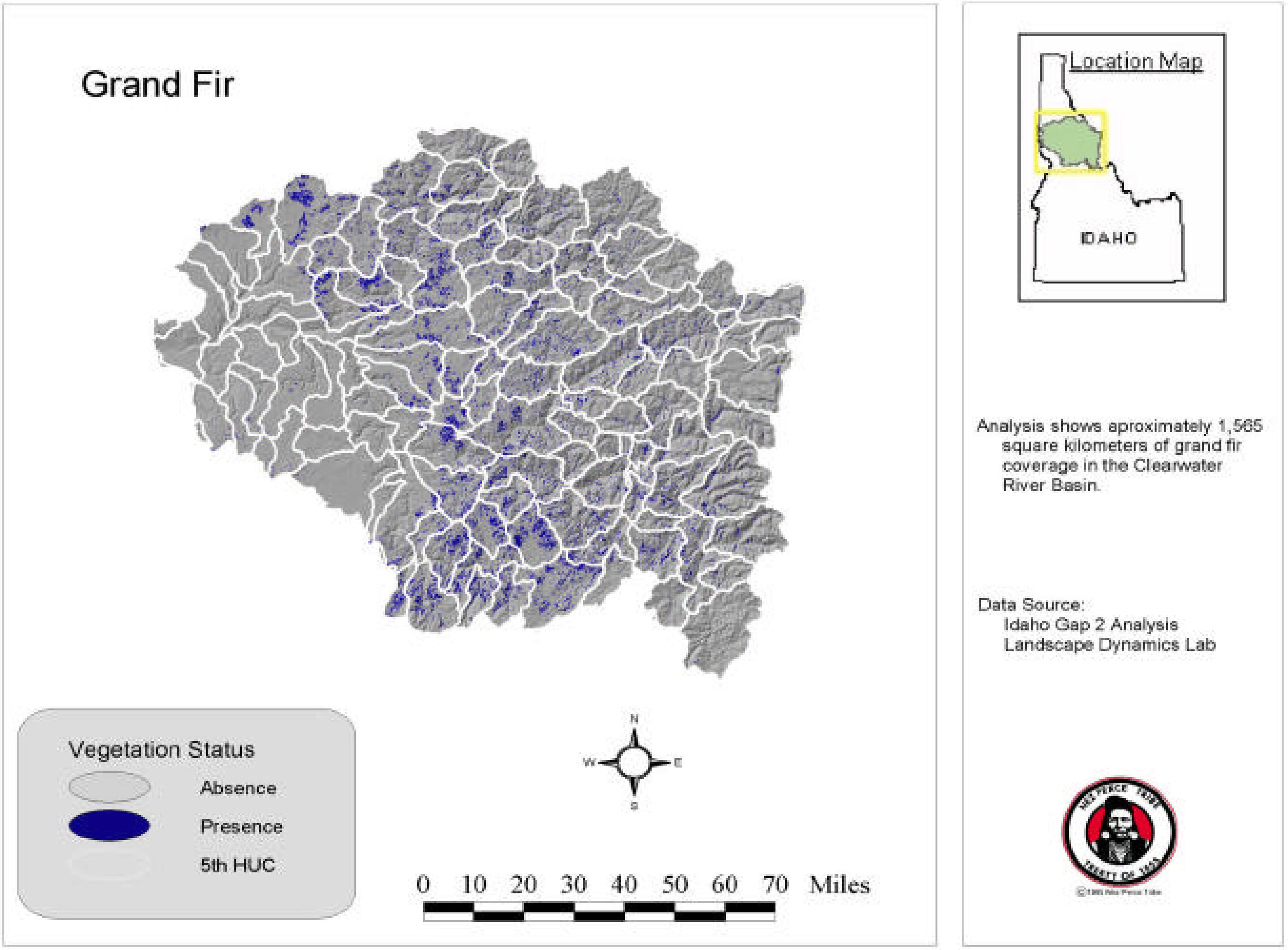

Figure 56. Distribution of the grand fir cover type within the Clearwater subbasin

Abies grandis habitat types are not associated with a unique assemblage of species (Cooper et al. 1991), except in the *Abies grandis*/*Taxus brevifolia* association (Crawford and Johnson 1985) where it is associated with pacific yew (*Taxus brevifolia*). This plant association is unique to the Clearwater subbasin because *T. brevifolia* actually reaches canopy dominance. On most sites, *T. brevifolia* is restricted to the sub-canopy. Approximately 16,000 ha of this association exists in the South Fork AU, with an additional 4,000 ha already eliminated through commercial timber harvest.

Floristic composition is similar to the understories of the *A. lasiocarpa*, *Pseudotsuga*, *T. plicata*, and *T. heterophylla* series. Shrub species in earlier successional stages include *Acer glabrum*, *Amelanchier alnifolia*, *Ceonothus spp.*, *Holodiscus discolor*, *Rubus parviflorus*, and *Symphoricarpos albus*. Forbs range from steppe species such as *Balsamorhiza sagittata* to species typical of saturated soils such as *Athyrium filix-femina* and *Senecio triangularis*. The habitat types for the Abies grandis series are listed below (Cooper et al. 1991).

1. *Abies grandis/Senecio triangularis* (Grand fir/arrowleaf groundsel; occurring on bottomlands
   and toe slopes from 2,600 – 4,600 feet (790 – 1,400 meters)).
2. *Abies grandis/Asarum cadatum* (Grand fir/wild ginger; occupying drainages of the Clearwater
   River)
4. *Abies grandis/Clintonia uniflora* (Grand fir/queencup beadlily; dominant south of the Middle Fork of the Clearwater River drainage)
5. *Abies grandis/Linnaea borealis* (Grand fir/twinflower; occupying Nez Perce National Forest and southern Clearwater National Forest)
6. *Abies grandis/Xerophyllum tenax* (Grand fir/beargrass; occupying eastern Nez Perce National Forest and southeastern Clearwater National Forest)
7. *Abies grandis/Vaccinium globulare* (Grand fir/blue huckleberry; located in central Idaho)
8. *Abies grandis/Physocarpus malvaceus* (Grand fir/ninebark; located throughout northern Idaho)
9. *Abies grandis/Spiraea betulifolia* (Grand fir/birchleaf spirea; found in southwestern Nez Perce National Forest)

Wildlife and Cultural Values

Fisher use old growth *A. grandis* stands for nesting and foraging (Howard and Aleksoff 2000). Young *A. grandis* trees provide good thermal cover, and fir needles are a major dietary item for sharp-tailed grouse (Howard and Aleksoff 2000). Flammulated owls may select large diameter *A. grandis* trees with broken tops and extensive *Echinodontium tinctorium* (Indian paint fungus) decay for nesting (Bull et al. 1990; Thomas 1979). Flammulated owls also forage in mature *A. grandis* stands. Elk prefer early seral, grass or shrub/grass *A. grandis* habitats for spring foraging (Irwin and Peek, 1983). They tend to use adjacent *P. contorta* and *T. heterophylla* stands for shade and resting cover instead of *A. grandis*.

This species provides good thermal and hiding cover for big game species (Howard and Aleksoff 2000). Some early *A. grandis* successional stages provide high quality browse for deer and elk; south slopes and lower elevation sites provide winter range (Cooper et al. 1991). Keay and Peek (1980) found that mule deer avoided mature *A. grandis* stands and white-tailed deer avoided both old seral and mature *A. grandis* sites. Moose, however, prefer old growth *A. grandis* habitat types; using the wetter *A. grandis* stands with *Taxus brevifolia* as critical winter habitat and *T. brevifolia* as a major winter food item (Pierce and Peek 1984). Dense, multistory grand fir forests provide good snow interception as well as ample moose forage in the form of bark and twigs (Peek et al. 1987). Moose prefer mature *Abies grandis* habitats for foraging, while elk and deer use seral stage habitats instead (Howard and Aleksoff 2000). Moose, elk and deer may eat fir needles in winter (Martin et al. 1951).

Young *A. grandis* trees provide cover for grouse, pikas, chipmunks and squirrels (Martin et al., 1951). Thick boughs provide thermal cover and roosting sites for red crossbill, Vaux's swift, pygmy nuthatch, pileated woodpecker, Williamson's sapsucker, and grouse (Thomas, 1979). Woodpeckers typically select *P. ponderosa*, *P. contorta*, *L. occidentallis*, and *P. menziesii* rather than *A. grandis* for foraging and nesting (Bull et al., 1986). Large *Abies grandis* snags and trees are used by weasels, squirrels, spotted skunks, American martens, bushy-tailed woodrats, deer mice, owls, and sapsuckers (Thomas 1979). Downed logs and hollowed trunks provide dens for bears, weasels, squirrels and rats.

Stands of *Abies grandis* containing pacific yew have provided a valuable chemical resource in the fight against cancer. Pacific yew bark contains a chemical formerly used to make the drug Taxol, which is now made primarily through synthetic means.

Threats and Limiting Factors

Due to selective harvesting of *Pinus* spp. and *L. occidentalis* at the turn of the century and fire exclusion, an unprecedented abundance of *A. grandis* exists in the Clearwater subbasin and other areas in the interior west (Turner 1985 *in* Howard and Aleksoff 2000). Fir dominated stands have more disease and mortality than stands dominated by seral species; thus many late-successional stands are dominated by dead, suppressed or diseased *A. grandis* (Mutch et al.1993 *in* Howard and Aleksoff, 2000). Commercial logging has resulted in fragmentation of previously contiguous grand fir forests.

Although *Pinus ponderosa* is the fastest growing seral species on *A. grandis* habitat types, fire suppression and advancing succession currently limit its importance to only the warmest sites (Cooper et al. 1991). Within the Clearwater subbasin, *Pteridium aquilinum* (bracken fern) or *Rudbeckia occidentalis* (western coneflower) invasions and browsing of young trees by northern pocket gopher delayed succession to a woody overstory on some *A. grandis* habitats (Ferguson 1991).

Morphological characteristics of *A. grandis* contributing to its relative flammability include low and dense branching, the tendency toward dense stands, foliage with a higher surface-to-volume ratio than affiliated conifers, and longer retention of needles on the tree (e.g., average of seven years; Howard and Aleksoff 2000).

Moist *Abies* sites may have rampant trunk rots, especially *Echinodontium tinctorium* (Indian paint fungus) (Cooper et al. 1991). Mechanical injury (logging) reactivates dormant infections and is often the reason given against practicing uneven-aged management on moist *A. grandis* sites. Important root rot pathogens are *Poria weirii* and *Armillaria mellea*, which occur on moist, moderate temperature sites.

5.5.6 Douglas-fir

Physical Description

Rocky Mountain Douglas-fir is a medium-sized, coniferous, evergreen tree. Adapted to a drier, colder climate, it grows much slower than the coastal variety, and seldom exceeds 130 feet (40 m) in height and 5 feet (152 cm) in diameter. Trees 200 to 300 years old trees are commonly 100 to 120 feet tall (30-37 m) and between 15 and 40 inches (38-102 cm) DBH. Growth is extremely slow past 200 years of age, and trees rarely live longer than 400 years. Open-grown trees often have branches over the length of the bole, while trees in dense stands lack lower limbs. The bark on saplings is smooth, grayish-brown, and covered with resin blisters; mature individuals have thick, deeply furrowed, corky bark. Bark thickness in the northern Rockies is about 1 inch (2.5 cm) on 12 inch (30 cm) diameter trees, and 2.5 inches (6 cm) on 24 inch (60 cm) diameter trees (Hemstrom et al. 1987 cited in Uchytil 1991).

Ecology and Distribution

Rocky Mountain Douglas-fir grows in lower, middle, and upper elevation forests. It is a shade-tolerant climax species in dry to moist lower and middle elevation forests but is shade intolerant in wetter forests of the upper montane zone. In the absence of disturbance it tends to replace ponderosa pine, lodgepole pine (*Pinus contorta*), and western larch (*Laryx occidentalis*) in the northern Rockies. In the upper montane zone, Rocky Mountain Douglas-fir is less shade tolerant and is replaced by western red cedar, western hemlock, spruces, and true firs. It is often a persistant seral species in grand fir and subalpine fir habitat types in the northern Rockies (Uchytil 1991).

Mature Rocky Mountain Douglas-fir is generally more fire resistant than spruces and true firs, equally or slightly less fire resistant than ponderosa pine, and less fire resistant than western larch. Mature trees can survive moderately severe ground fires because the lower bole is covered by thick, corky bark that insulates the cambium from heat damage. It takes about 40 years for trees to develop fire resistant bark on moist sites in the northern Rockies.

Forests in which *Pseudotsuga menziesii* is the indicated climax are widespread throughout the northern Rocky Mountains and the Clearwater subbasin (Figure 57). The Douglas-fir series forms a broad forest belt between bunchgrass, ponderosa pine (*Pinus ponderosa*), or limber pine (*P. flexis*) habitat types at lower elevations and subalpine fir (*Abies lasiocarpa*) or grand fir (*A. grandis*) habitat types at higher elevations (Tesky 1992). Based on GAP data, there are 4,192 km^2 of the *P. menziesii*/ mixed xeric forest cover type in the Clearwater subbasin (Table 34).

Rocky Mountain Douglas-fir exhibits great ecological extent. It grows at lower elevations adjacent to bunchgrass communities and is also found in upper elevation subalpine forests. In Idaho, Douglas-fir is found in all forest habitat types except ponderosa pine. It tends to be most abundant in low and middle elevation forests, where it grows over a wide range of aspects, slopes, landforms, and soils (Cooper et al. 1991).

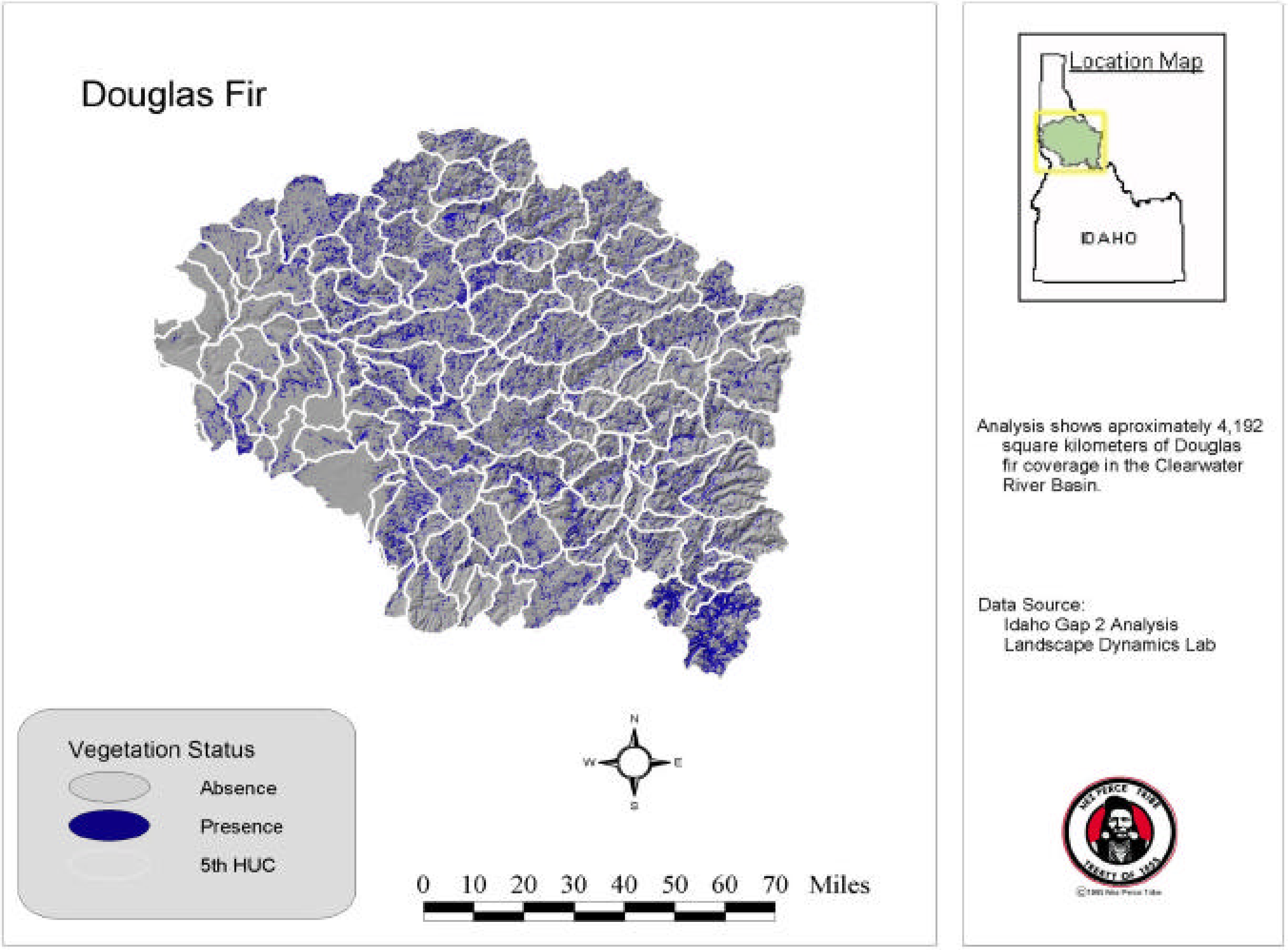

Figure 57. Distribution of the Douglas-fir/ mixed xeric forest cover type within the Clearwater subbasin

Principal habitat types in the Douglas-fir series are (Cooper et al. 1991):

1. *Physocarpus malvaceus* (ninebark; generally occurring on southwest to west aspects at elevations between 2,000 and 3,700 feet (600 to 1,130 meters)
2. *Vaccinium caespitosum* (dwarf huckleberry; occupies frost pocket sites on all aspects)
3. *Vaccinium globulare* (blue huckleberry; South to west aspects on eastern edge of the Red River ranger District on the Nez Perce National Forest)
4. *Symphoricarpos albus* (common snowberry; incidental habitat type with most occurences north of Orofino)
5. *Spiraea betulifolia* (white spiraea; South aspects in northern Idaho; Selway Bitterroot Wilderness)
6. *Calamagrostis rubescens* (pinegrass; high and low elevational phases; has an *Arctostaphylos uva-ursi* phase)
7. *Carex geyeri* (elk sedge; incidental; in minor amounts in Nez Perce National Forest; southern aspects)
8. *Festuca ovina ingrata* (Idaho fescue; incidental; in minor amounts in Nez Perce National Forest)
9. *Pseudoroegneria spicatum* (bluebunch wheatgrass; incidental; limited to Salmon River drainage and lower Clearwater River drainage)

Wildlife and Cultural Values

Rocky Mountain Douglas-fir is valueable to big game as both cover and habitat, and provides excellent hiding and thermal cover for deer, elk, and bighorn sheep (Cooper et al. 1991). Low elevation and south facing Douglas-fir types often serve as deer and elk winter range (Tesky 1992c). Use of Douglas-fir as browse by ungulates is generally light. Use is typically in the winter or early spring when other preferred forage is lacking. Mule deer browse this species more than elk, but it is not important forage for either (Gaffney 1941 from Uchytil 1991). These areas are an important food source for moose (Gordon 1976 cited in Tesky 1992a), and moose will winter in low elevation Douglas-fir where willow thickets (preferred winter habitat types) are lacking. Most livestock avoid eating this species, but sheep occasionally browse young plants (Wasser 1982 cited in Uchytil 1991).

Conifer seeds are the staple food of the red squirrel. These animals cut great quantities of Douglas-fir cones and cache them for later use. Chipmunks, mice, voles, and shrews eat large quantities of conifer seeds from the forest floor (Halvorson 1986 cited in Uchytil 1991). The most common are the Clark's nutcracker, black capped chickadee, mountain chickadee, boreal chickadee, red breasted nuthatch, pigmy nuthatch, red winged crossbill, white winged crossbill, dark eyed junco, and pine siskin (Halvorson 1986 cited in Uchytil 1991). Numerous species of songbirds extract seeds from Douglas-fir cones and forage for seeds on the ground. Crops of seeds and newly germinated seedlings have been decimated locally by migrating flocks of dark eyed juncos (Krauch 1956 cited in Uchytil 1991). Douglas-fir needles are an important winter food of blue grouse (Martin et al. 1951 cited in Uchytil 1991). Many species of songbirds nest in Douglas-fir foliage or cavities within old snags. In central Idaho, the Douglas-fir/pinegrass (*Calamagrostis rubescens*) and Douglas-fir/white spiraea (*Spiraea betulifolia*) habitat types are important to nesting Steller's jays, pine siskins, western tanagers, red-breasted nuthatches, and Cooper's hawks (Stark 1977 cited in Uchytil 1991).

Threats and Limiting Factors

Low growing branches and flammable foliage that make trees susceptible to crowning often offset protection offered by thick bark (Fischer and Bradley 1987). Dry Douglas-fir habitat types in the northern Rocky Mountains experienced low to moderate intensity ground fires at less than 30 year intervals (Arno 1980). Where ponderosa pine is a major associate, fires at 10 year intervals were common (Lotan et al. 1981 cited in Tesky 1992). These frequent ground fires maintained relatively open stands of Douglas fir or, more frequently, seral stands of ponderosa pine since pine saplings are more fire resistant then Douglas-fir saplings (Fischer and Bradley 1987; Arno 1983). Fire suppression has resulted in long fire free periods, which have allowed Douglas-fir regeneration to become well established. In some areas, dense thickets have formed, which provide a continuous fuel ladder to the crown of overstory trees. Thus, fire suppression has increased the potential for severe, stand destroying wildfires. The effects of fire on Rocky Mountain Douglas-fir vary with fire severity and tree size. Surface fires often kill saplings because their low branching habit allows fire to spread to the crown. Photosynthetically active bark, resin blisters, closely spaced flammable needles, and thin twigs and bud scales are additional characteristics that make saplings vulnerable to surface fires (Fischer and Bradley 1987). Rocky Mountain Douglas-fir saplings are more susceptible to mortality from surface fires than ponderosa pine saplings .

Grazing by domestic livestock has contributed to increasingly dense western forests and to changes in tree species composition. Livestock can alter forest dynamics by reducing the biomass and density of understory grasses and sedges which otherwise outcompete conifer seedlings and prevent dense tree recruitment. In addition, livestock reduce the abundance of fine fuels, which previously carried low intensity fires quickly through forests (Belsky and Blumenthal 1997). In northern Idaho, Douglas-fir was more susceptible to fire damage in stands subjected to years of livestock grazing than in ungrazed stands. Ungrazed stands remained open and park-like, and had a nearly continuous distribution of small fuels(Weaver 1968 cited in Uchytil 1991). Prescribed fires had flame lengths up to 36 inches (91 cm) but spread rapidly and only scorched the lower portions of large trees. On grazed sites open stands were converted to dense pole stands with sparse understories and numerous sapling thickets. These stands had a greater accumulation of duff and large woody fuels that contributed little to fire spread. This resulted in a slow spreading fire which was more damaging to trees, probably because of the long residence time, which can kill trees through cambial heating (Peterson and Arbaugh 1986 cited in Uchytil 1991). On the grazed site, numerous trees up to 4 inches (10 cm) DBH, and a few more than 6 inches (15 cm) DBH were killed.

Various species of fungi such as shoestring root rot (*Armillaria mellea*), and laminated root rot (*Phellinus weirii*) have caused significant damage to young Douglas-fir stands in plantations. Trees die or are so weakened that they are blown over. Red ring rot (*Phellinus pini*), a heart rot fungi, is the most damaging and widespread fungi (Foiles 1965). Several needle diseases occur on Douglas-fir. The most conspicuous, a needlecast, is caused by *Rhabdocline pseudotsugae.* The most damaging stem disease affecting Douglas-fir is *Arceuthobium douglasii.* This dwarf mistletoe occurs throughout most of the range of Douglas-fir (Society of American Foresters 1980). The most destructive insects include the Douglas-fir seed chalcid (*Megastigmus spermotrophus)*, which matures in the developing seed and gives no external sign of its presence. The Douglas-fir cone moth (*Barbara colfaxiana*), the fir cone worm (*Dioryctria abietivorella*), the Douglas-fir cone gall midge (*Contarinia oregonensis*), and cone scale midge (*C. washingtonensis*) destroy some seed but prevent harvest of many more by causing galls that prevent normal opening of cones (Foiles 1965).

Consumption of Douglas-fir seeds by small forest mammals such as white-footed deer mice, creeping voles, chipmunks, and shrews, and birds such as juncos, varied thrush, blue and ruffed grouse, and song sparrows further reduces seed quantity. Browsing and clipping by hares, brush rabbits, mountain beaver, pocket gophers, deer, and elk often injure seedlings and saplings. In pole-sized timber, bears sometimes deform and even kill young trees by stripping off the bark and cambium (Foiles 1965).

5.5.7 Lodgepole Pine

Physical Description

Pinus contorta is a small to medium sized, coniferous, evergreen tree. Mature tree heights range from 50 to 100 feet (15-30 m) and bole diameters occasionally reach 24 inches (61 cm; Critchfield 1980). Mature trees have remarkably straight, branch-free boles and small, open crowns on the upper 25 to 60 percent of the tree. The trees are short-lived compared to other conifers. Lodgepole pines older than 200 years are rare (Lotan and Perry 1983).

Ecology and Distribution

Pinus contorta grows across a wide range of environments in montane and subalpine forests of the West. With a broad range of moisture and temperature tolerances, it occupies forests spanning a range of envirnomental conditions from relatively low elevation, warm and dry forests to relatively high elevation, cold and moist forests (Pfister and Daubenmire 1975). In Nez Perce and Clearwater National Forests (Figure 58), lodgepole pine is characterized by nearly pure stands with little evidence of other seral tree species (Cooper et al 1991). Based on GAP data, 1,631 km^2 of the *P. menziesii* cover type occurs in the Clearwater subbasin (Table 34). Three community types associated with *P. contorta* (Cooper et al. 1991)

1. *Vaccinium caespitosum* (Dwarf Huckleberry; higher valley floors of the Nez Perce National Forest)
2. *Xerophyllum tenax* (Beargrass; Nez Perce National Forest at mid to high elevations, incidental)
3. *Vaccinium scoparium* (Grouse Whortleberry; southern and eastern Nez Perce National Forest)

Because of its tolerance of a wide range of environmental conditions, lodgepole pine grows in association with many understory species. The most common understory associates include pinegrass (*Calamagrostis rubescens*), elk sedge (*Carex geyeri*), Ross sedge (*C. rossii*), pachystima (*Pachystima myrsinites*), twinflower (*Linnaea borealis*), beargrass (*Xerophyllum tenax*), huckleberry or whortleberry (*Vaccinium* spp.), serviceberry (*Amelanchier alnifolia*), oceanspray (*Holodiscus discolor*), bitter cherry (*Prunus emarginata*), buffaloberry (*Shepherdia canadensis*), curlleaf mountain mahogany (*Cercocarpus ledifolius*), bitterbrush (*Purshia tridentata*), and juniper (*Juniperus* spp.; Steele et al. 1983). An association between lodgepole pine and *Vaccinium* is especially common, and thrives in cool, moist sites on infertile, granitic soils (Lotan and Perry 1983).

P. contorta is an intolerant, seral species. It possesses several attributes that allow it to aggressively invade and persist in burned areas: these include (1) serotinous cones that contain a large seed bank released by fire; (2) abundant and early seed production; (3) small seeds that disperse efficiently; (4) high seed viability; (5) rapid juvenile growth; and (6) adaptability to a wide variety of sites (Critchfield 1980). Most of the larger lodgepole forests of the Rocky

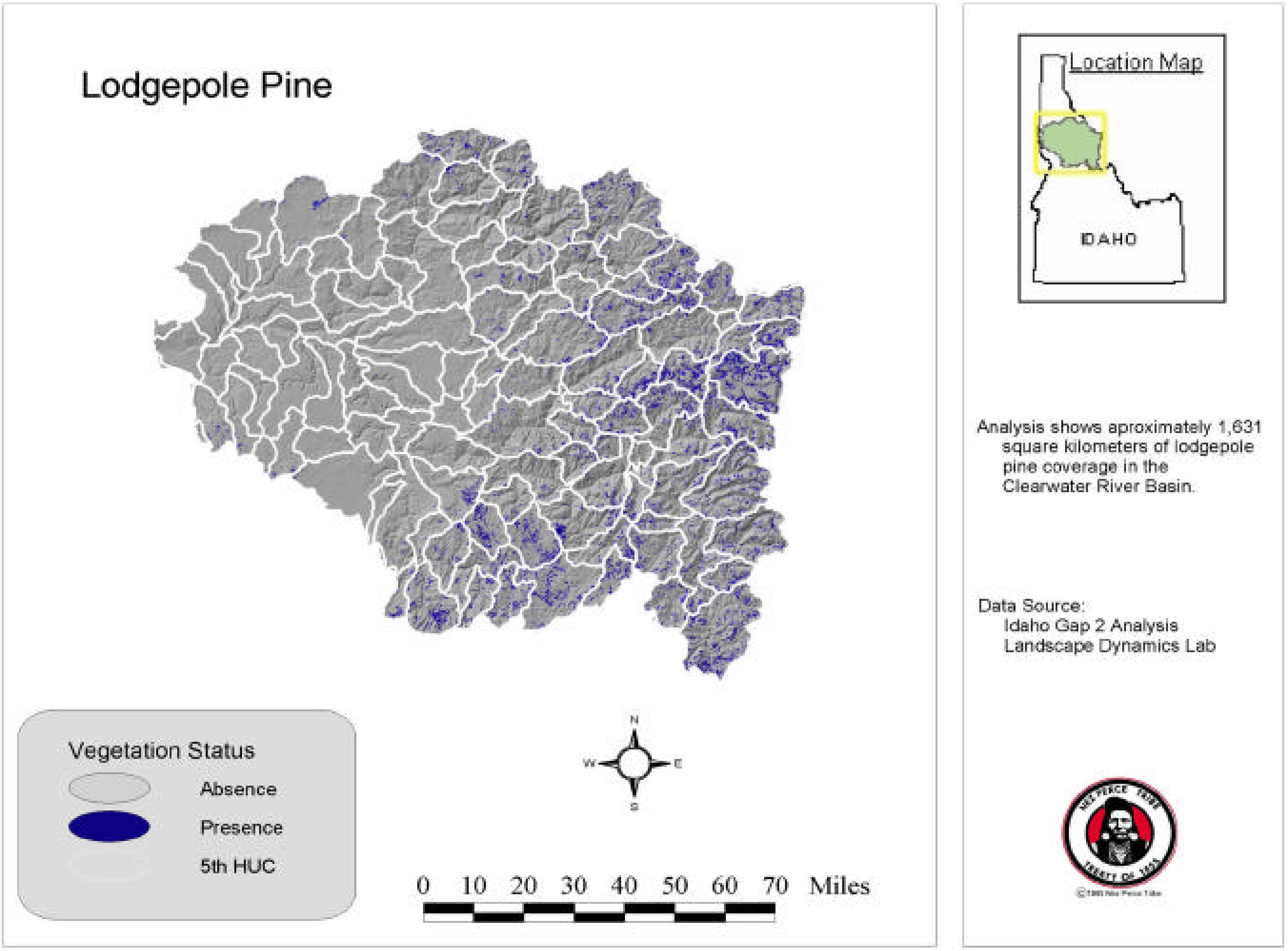

Figure 58. Distribution of the lodgepole pine cover type within the Clearwater subbasin

Mountains are seral and were created by fire. These stands are typically even-aged, establishing within 10 to 20 years after fire (Volland 1985). *P. contorta* cannot reproduce in the shade of its own canopy. Without another fire, lodgepole stands begin to breakup between 100 and 200 years of age and are eventually replaced by shade tolerant conifer associates, most commonly subalpine fir and Engelmann spruce (*Picea engelmannii*) at upper elevations, and Douglas-fir at lower elevations (Day 1972).

Under certain situations, lodgepole forests can be persistent or climax. This occurs where shade tolerant conifers are unable to grow and *P. contorta* remains as the dominant tree. Factors that allow *P. contortus* to be the exclusive tree on a site include (1) frequent, widespread, stand replacing wildfires that eliminate the seed source of shade tolerant competitors (prolonged seral stages), (2) frequent, light ground fires that remove shade tolerant competitors (prolonged seral stages), (3) exclusively dense *P. contorta* stands that competitively exclude the regeneration of shade tolerant competitors (prolonged seral stages), and (4) sites environmentally unsuitable for the establishment of other conifers (Cooper et al. 1991).

Wildlife and Cultural Values

P. contorta is important to big game animals for cover and habitat. *P. contorta* stands cover extensive areas that serve as deer and elk summer ranges. Although these forests typically have sparse vegetation in the understory and provide very little forage, they provide important cover for ungulates that forage in associated nonforested communities (Urness 1985). Wild ungulates seldom browse lodgepole pine, except in winter when it is sometimes used as an emergency food. Lodgepole pine seeds are an important food of pine squirrels, chipmunks, and songbirds. The needles are an important winter food source for blue grouse and spruce grouse (Uchytil 1991). Large *P. contorta* are a critical habitat feature for black-backed woodpeckers.

Grazing appears to benefit lodgepole pine growth by reducing competition from both native and seeded understory species. However, good grazing management is required to ensure even use of forage and to minimize seedling injury by livestock (McLean et al. 1986).

Threats and Limiting Factors

Ocasionally, *P. contorta* stands get too dense or overstocked. These stands are succeptible to stagnation, snow breakage, windthrow, and fire (Fischer and Bradley 1987). Parasitic plants, such as *Arceuthobium americanum* (dwarf mistletoe), can infest these stands causing mortality, and attacks from the mountain pine beetle (*Dendroctonus ponderosae*) occur when the lodgepole stands get large enough to sustain brood populations (Agee, 1993). Fungal pathogens can cause stem cankers leaving the wood virtually useless for lumber, posts and poles (Lotan and Critchfield 1990).

Timber harvest activities in this cover type have fragmenteed previously continuous forest stands. Typically, *P. contorta* has an infrequent, severe stand replacing fire regime resulting in large expanses of even-aged trees. Timber harvest of small patches less than 40 acres in size disrupts this pattern.

Pinus contorta produces serotinous cones that do not open at maturity because they are sealed shut by a resinous bond between the cone scales. These cones remain on the tree for years and require temperatures between 113 and 140 degrees F (45-60 C) to melt the resin and release the seed (Lotan and Critchfield 1990). In nature, only forest fires generate temperatures of this magnitude within a tree’s crown.

5.5.8 Ponderosa Pine

Physical Description

P. ponderosa has the potential to achieve large dimensions. Diameters at breast height reach from 30 to 50 inches (76-127 cm) and tree heights of 90 to 130 feet (27.4-39.6 m) are common (Brockman 1979). Trees often reach ages of 300 to 600 years (Oliver and Ryker 1990). Needles are typically in bundles of three. They are 5 to 10 inches (12.5-25.0 cm) long and form tufts at the end of each branch. Cones are oval and 3 to 6 inches (7.5-15.0 cm) long. The bole is typically straight and at maturity is clear of lower branches. The bark of mature trees is composed of broad, irregular scaly plates that fit together like jigsaw puzzle pieces. The crown is conical and composed of stout branches (Lackschewitz 1991).

Ecology and Distribution

Pinus ponderosa stands range from southern British Columbia south through the mountains of Washington, Oregon, to southern California. In the northeastern part of its range it extends east of the Continential Divide in Montana and south to the Snake River Plain in Idaho (Oliver and Ryker 1990). In the Clearwater subbasin (Figure 59), *P. ponderosa* occupies narrow environmental strips between steppe vegetation and Douglas-fir communities. The *P. ponderosa* series is the driest forest zone, occupying elevations generally below 4,000 feet (1,220 meters). At higher elevations it intermixes with *Pseudotsuga menziesii*, and at lower elevations it borders the xeric steppe vegetation (Cooper, et al. 1991). Based on GAP data, there are 1,093 km^2 of the *Pinus ponderosa* cover type in the Clearwater subbasin (Table 34).

P. ponderosa pine forms climax stands that border grasslands and is also a common member in many other forested communities (Steele et al. 1981). *P. ponderosa* is the most drought tolerant tree, and it usually occupies the transition zone between grassland and forest. Climax stands are characteristically warm and dry, and occupy lower elevations throughout their range. Key understory associates in climax stands typically include grasses such as bluebunch wheatgrass (*Pseudoroegneria spicata*) and Idaho fescue (*Festuca ovina ingrata*), and shrubs such as bitterbrush (*Purshia tridentata*) and common snowberry. At higher elevations, Pacific ponderosa pine is seral to trees more shade tolerant and moisture demanding. In the Pacific Northwest this generally includes Douglas-fir, grand fir, and white fir (Howard 2001). *P. ponderosa* associations can be separated into three shrub dominated and three grass dominated habitat types.

Four community types are associated with *P. ponderosa* (Cooper et al. 1991):

1. *Physocarpus malvaceus* (ninebark; limited; northeast to northwest aspects)
2. *Symphoricarpos albus* (common snowberry; sporadic from Coeur d'Alene south along western forest edge in northern Idaho
3. *Festuca ovina ingrata* (Idaho fescue; most prevalent along Clearwater, Snake, and Salmon River drainages)
4. *Pseudoroegneria spicatum* (bluebunch wheatgrass; steep south-facing slopes overlooking the Snake and Salmon Rivers)

Daubenmire and Daubenmire (1984) recognize two more habitat types within the *P. ponderosa* series

1. *Stipa comata* (needlegrass)
2. *Purshia tridentata* (bitterbrush)

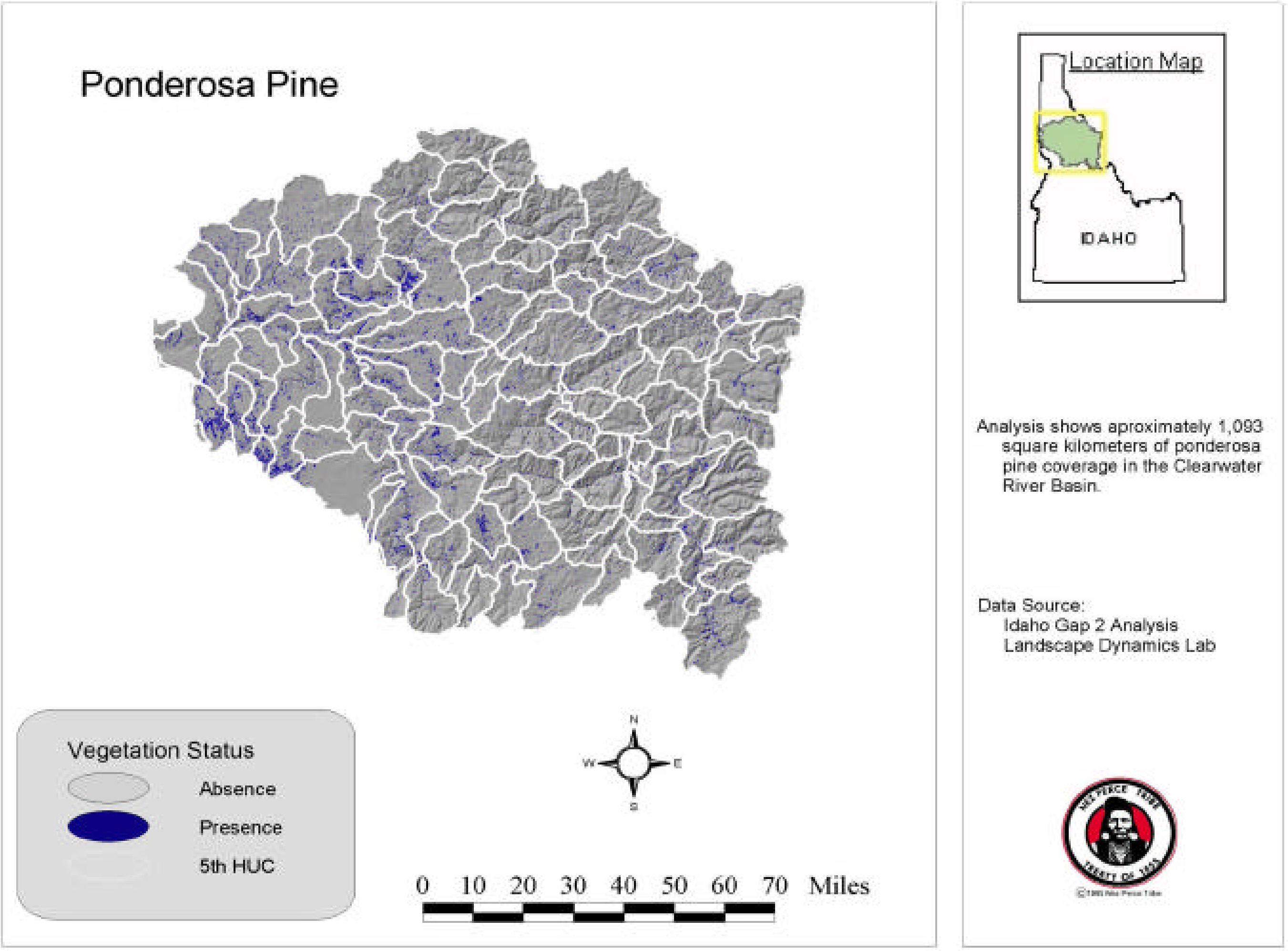

Figure 59. Distribution of the ponderosa pine cover type within the Clearwater subbasin

The successional status of *P. ponderosa* can be expressed by its successional role, which ranges from seral to climax depending on specific site conditions. It plays a climax role on sites toward the extreme limits of its environmental range and becomes increasingly seral with more favorable conditions. On more mezic sites, *P. ponderosa* encounters greater competition and must establish itself opportunistically, and it is usually seral to Douglas-fir and true firs (mainly grand fir and white fir). On severe sites it is climax by default because other species cannot establish. On such sites, establishment is likely to be highly dependent upon the cyclical nature of large seed crops and favorable weather conditions (Steele 1988).

Ponderosa pine has many fire resistant characteristics. Seedlings and saplings are often able to withstand fire. Pole sized and larger trees are protected from the high temperatures of fire by thick, insulative bark, and meristems are protected by the surrounding needles and bud scales. Other aspects of the pine's growth patterns help in temperature resistance. Lower branches fall off the trunk of the tree, and fire caused by the fuels in the understory will usually not reach the upper branches. *P. ponderosa* is more vulnerable to fire at more mesic sites where other conifers as *Pseudotsuga menziesii*, and *Abies grandis* form dense understories that can carry fire upward to the overstory. Ponderosa pine seedlings germinate more rapidly when a fire has cleared the grass and the forest floor of litter, leaving only mineral rich soil. (Fischer and Bradley 1987)

Wildlife and Cultural Values

Pacific ponderosa pine needles, cones, buds, pollen, twigs, seeds, and associated fungi and insects provide food for many species of birds and mammals (Evans 1988). Small mammals that eat stems and roots include deer mice, chipmunks, shrews, voles, and tree and ground squirrels. Large browse mammals including elk, deer, bighorn sheep, porcupines, hares, and rabbits will occasionally browse on stems and bark during times of food or water scarcity. Many bird species eat pacific ponderosa pine seeds. These include the junco, Cassin's finch, pine siskin, evening grosbeak, varied thrush, Clark's nutcracker, and a host of sparrows, chickadees, and other passerines (Howard 2001).

At each stage of growth, *P. ponderosa* provides numerous species of birds and mammals with shelter. As seedlings they provide low ground cover for small birds and mammals. Upon reaching pole size, stands provide good windbreaks and thickets important as hiding cover for larger mammals such as elk and deer. Mature trees and standing snags house arboreal species, while fallen logs and stumps provide many cavity dwelling species with adequate shelter (Hessel 1988).

Threats and Limiting Factors

P. ponderosa is shade intolerant and grows most rapidly in near full sunlight (Franklin and Dyrness 1973; Atzet and Wheeler 1984). Logging is usually done by a selection-cut method. Older trees are taken first, leaving younger, more vigorous trees as growing stock. This effectively regresses succession to earlier seral stages and eliminates climax, or old growth, conditions. Logging also impacts understory species by machine trampling or burial by slash. Clearcutting generally results in dominance by understory species present before logging, with invading species playing only a minor role in post logging succession (Atzet and Wheeler 1984).

Approximately 200 insect species may affect *P. ponderosa* from its cone stage to maturity (Schmid 1988 cited in Howard 2001). The effects of insect damage are decreased seed and seedling production, reforestation failures or delays, and reduction of potential timber productivity (Schmid 1988 cited in Howard 2001). Several insect species destroy seeds before they germinate, the most damaging being the ponderosa pine cone beetle (*Conophthorus ponderosae*) and the pine seed chalcid (*Megastigmus albifrons*). Seedlings and saplings are deformed by tip moths (*Rhyacionia bushnelli*), shoot borers (*Eucosma sonomana*), and budworms (*Choristoneura lambertiana*). Two major lepidopteran pests, the pine butterfly (*Neophasia menapia*) and Pandora moth (*Coloradia pandora*), severely defoliate their hosts causing growth reductions. Extensive mortality in defoliated stands usually results from simultaneous infestations by bark beetles. Bark beetles, primarily of the genus *Dendroctonus* and *Ips*, kill thousands of pines annually and are the major mortality factor in commercial saw timber stands. (Schmid 1988 cited in Howard 2001).

Many diseases affect Pacific ponderosa pine. Parasites, root diseases, rusts, trunk decays, and needle and twig blights cause significant damage. Dwarf mistletoe causes the most damage. A major root disease of pine is caused by white stringy root rot (*Fomes annosus*) and is often found in concert with bark beetle infestations. Western gall rust (*Endocronartium harknessii*), limb rust (*Peridermium filamentosum*), and comandra blister rust (*Cronartium comandrae*) cause damage only in localized areas. Various silvicultural treatments can minimize damage caused by dwarf mistletoe. Clearcutting is used only if regeneration is not a problem. The pruning of branches and witches brooms, fertilization, watering, and the planting of nonsusceptible species also aid in combating dwarf mistletoe (Hawksworth et al. 1988 cited in Howard 2001).

Domestic livestock heavily graze *P. ponderosa* stands at the edge of grassland communities. Heavy grazing induces effects opposite those of fire. Removal of the grass cover by grazing tends to favor shrub communities. Eventually, cheatgrass (*Bromus* spp.) will move in on the disturbed site along with invading shrubs (Agee 1993), eventually changing the fire regime of these stands.

5.5.9 Whitebark Pine

Physical Description

P. albicaulis is a slow growing, long lived, ectomycorrhizal, native conifer and grows on dry rocky sites on high mountains between 6,000 and 10,000 feet (1,800 and 3,030 m). Characteristic of treeline vegetation, it forms dense krummholz thickets and grows in isolated cushions of "alpine scrub" where the trees are usually dwarfed or contorted (Arno and Huff 1990). Cool summers and cold winters with deep snowpack characterize the climate. Trees have high frost resistance and low shade tolerance and often reach 400 to 700 years of age. Trees in well developed stands are 50 to 70 feet (15-20 m) tall and 24 to 36 inches (60-90 cm) in DBH. (Forcella 1978; Forcella and Weaver 1977).

Ecology and Distribution

Pinus albicaulis is a hardy subalpine conifer that tolerates poor soils, steep slopes, windy exposures and treeline environments. Eastern populations occur southward from central Alberta, Canada, and follow the northern Rocky Mountains south into western Montana and central Idaho, and finally into the Wyoming Basin range. Whitebark pine does not occur south of the Wyoming Basin (Tomback et al. 2001). In the Clearwater subbasin, *P. albicaulis* is confined to the higher altitudes and is present in patches on the subbasin's perimeter (Figure 60). Based on GAP data, 42 km^2 of the *P. albicaulis* cover type occur in the Clearwater subbasin (Table 34).

In western North America, *P. albicaulis* is a dominant or co-dominant species in many high elevation forests. In the Rocky Mountains, eastern Cascades, and Blue Mountains, it is a minor component in mixed stands of Engelmann spruce and subalpine fir.

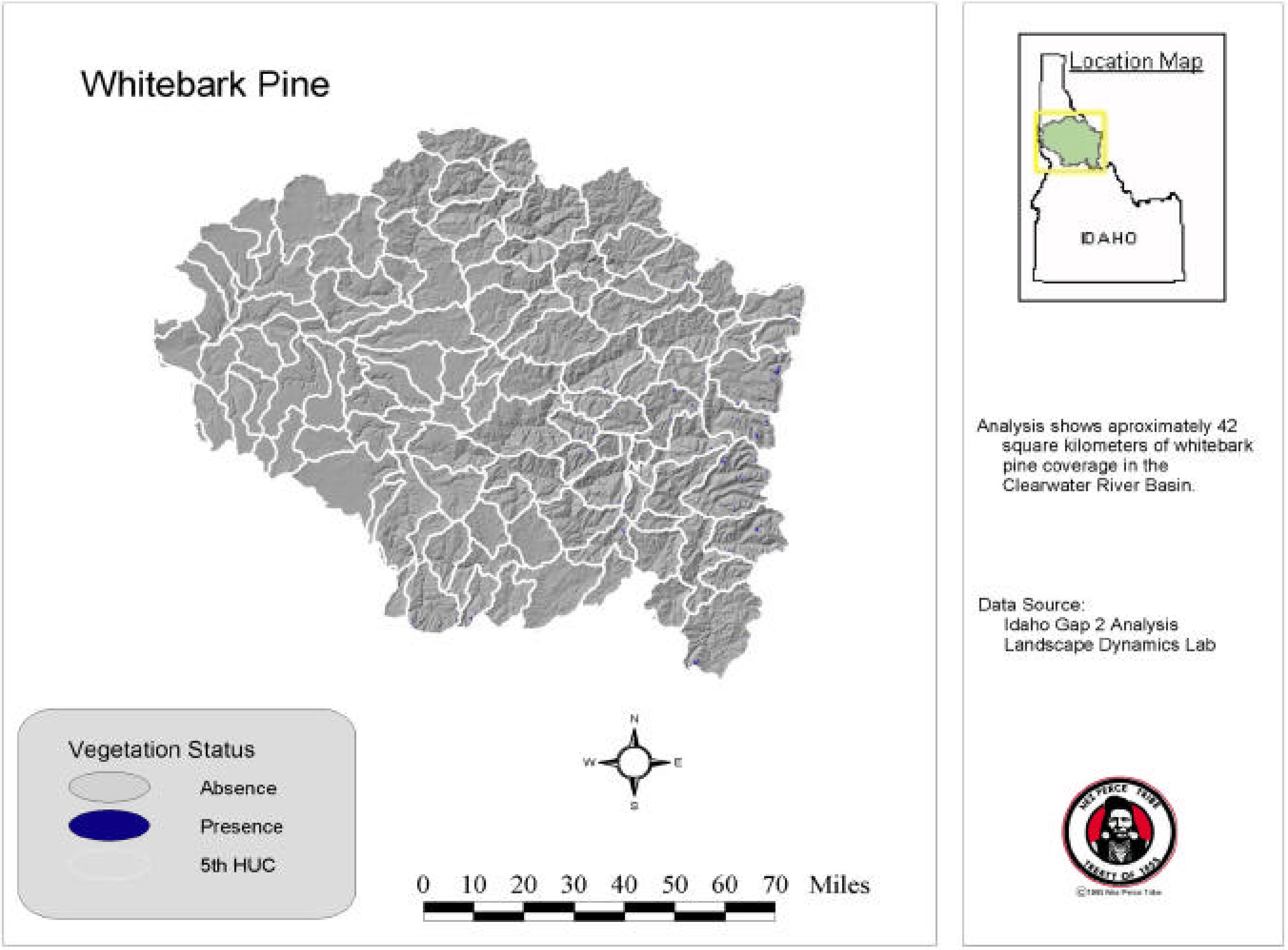

Figure 60. Distribution of the whitebark pine cover type within the Clearwater subbasin

Cooper, et al. (1991) groups *P. albicaulus* with *Abies lasiocarpa* communities because of lack of data. They recognize differences in undergrowth as related to aspect. On windward, dry sites the undergrowth is dominated by grasses, *Juncus parryi* (Parry's rush), and scattered forbs. On sites protected from the wind and moist slopes, the undergrowth consists of *Arnica latifolia* (mountain arnica), *Vaccinium scoparium* (grouse whortleberry), *Luzula hitchcockii* (smooth woodrush), with *Phyllodoce empetriformis* (red mountain heather) and *Cassiope mertensiana* (western moss heather) becoming more dominant north of the Nez Perce National Forest.

In upper elevation subalpine forests, *P. albicaulis* is generally seral and is replaced by more shade tolerant trees. Subalpine fir, a very shade tolerant species, is the most abundant associate and most serious competitor of whitebark pine. Although whitebark pine is more shade tolerant than lodgepole pine and subalpine larch (*Larix lyallii*), it is less shade tolerant than Engelmann spruce and mountain hemlock. Whitebark pine is the potential climax species on high exposed treeline sites and exceptionally dry sites. It sometimes acts as a pioneer species in the invasion of meadows and burned areas. On dry, wind exposed sites, the regeneration of whitebark pine may require several decades, even though it is often the first tree to become established (Ahlenslager 1987).

The resilient seedlings of *P. albicaulis* are more tolerant of exposed sites and droughts than other associated conifers. The seedlings have thick stems and develop deep taproots rapidly. The distribution of seral whitebark pine is strongly affected by the dispersal of seeds by Clark's nutcrackers into disturbed, open areas such as burns and clearcuts. The fact that bird dispersion of seed can occur 8 kilometers from the seed source (Tomback et al. 2001), allows whitebark pine to be widespread as a seral species (Steele et al. 1983).

The vulnerability of whitebark pine to fire is reduced by the open structure of its stands and the dry, exposed habitats with meager undergrowth where it grows. Whitebark pine is favored by severe, stand replacing fires that burn shade-tolerant associated trees. Where succession to shade-tolerant species is relatively rapid, fires are important in moist sites for whitebark pine perpetuation. With the lengthening of fire intervals, older stands become more susceptible to pine beetle epidemics, which advance succession toward dominance by shade tolerant species. In addition, fire may stimulate the growth of currents and gooseberries, the alternate hosts for white pine blister rust, spreading of the rust into whitebark pine trees (Arno 1986).

In the last 100 yrs, there has been a 45% loss of habitat types where whitebark pine is a seral species. Historically, fires used to create the mosaic openings that this species thrives in. In recent times ponderosa pine and whitebark pine communities have burned less than half of presettlement wildfire acreages. In the Clearwater National Forest most of the whitebark pine communities are located in the North Fork Ranger District and in the Powell Ranger District. Two historic whitebark pine sites were destroyed in the Clearwater National Forest after the fire of 1910. The fire was so extensive that not enough trees were left to supply a seed bank for regeneration (USFS 1997). Whitebark pine distribution in the Selway-Bitterroot Wilderness was greatly reduced between 1909 and 1940 due to a mountain pine beetle infestation. A 45% decline has occurred in whitebark pine distribution from historical coverage. About 98% of historical whitebark pine seral cover is now occupied by lodgepole pine and subalpine fir (Keane 1995). Current levels of coverage are estimated at 20-40% of historic levels (USFWS 2000c).

Wildlife and Cultural Values

The distribution of whitebark pine is strongly influenced by Clark's nutcrackers, which are important in the dispersal of seeds and establishment of seedlings (Ahlenslager 1987). Whitebark pine trees commonly have two or more trunks,often partially fused at the base. Electrophoretic evidence reveals that two or more trunks of what appears to be a single tree are indeed separate trees with distinct genotypes. This supports the idea that several mature trees can arise from single seed caches and that seeds cached by Clark's nutcrackers are instrumental in the establishment of trees (Weaver and Dale 1974). Clark's nutcrackers are also effective dispersers of seeds because of the amount of seed they carry. A nutcracker may carry as much as 150 seeds in its sublingual throat pouch and can store 850 seeds per day, usually in caches of four to five seeds. Over a 42 day period one bird may cache 32,000 seeds. They bury the seeds to 1.2 inches (3 cm) in depth, which is suitable for germination. Nutcrackers store three to five times their energetic requirements, so more seeds are buried than are recovered. These seeds, along with abandoned caches, can germinate and produce new trees (Tomback 1981).

Besides Clark's nutcrackers, other vertebrates also harvest, feed on, and cache whitebark pine seeds. However, they do not possess the behavior to systematically disperse and cache the seeds. Rodents disperse fewer seeds than nutcrackers, in shorter distances from parent trees and in sites less suitable for germination. Also, seed caches of rodents are larger and have lower potential for successful tree establishment. In addition, not many seeds are left to germinate from rodent caches because the olfactory sense of rodents allows them to find and use caches more efficiently than nutcrackers (Arno and Huff 1990, Tomback 1981).

Bears in the Yellowstone area regularly eat pine seeds in the spring and fall. Most whitebark pine seed eaten by grizzly and black bears are from red squirrel cone caches. Rodents, such as red squirrels, Douglas squirrels, ground squirrels and chipmunks, store large quantities of intact cones in middens at the base of trees or underground in caches. Although deer mice cannot gnaw the cones, they eat and cache loose seeds (Tomback 1982).

The foliage of whitebark pine is not browsed to any extent by animals. Blue grouse do eat the buds and needles of *P. albicaulis* in the winter (Ahlenslager 1987).

Whitebark pine survives where tree growth is limited and provides hiding and thermal cover for wildlife (Kendall and Arno 1990). Cavity-nesting birds use tree trunks and snags. Mule deer, elk, and predatory animals also use whitebark habitat (Tomback 1981).

Threats and Limiting Factors

Fire exclusion has reduced the frequency of fires in subalpine areas, resulting in the successional replacement of *P. albicaulis* by more shade tolerant tree species. Species of dwarf mistletoe that parasitize whitebark pine can kill healthy trees. Fire exclusion provides the means for dwarf mistletoe to disperse, affecting other trees (Tomback et al. 2001).

Mountain pine beetles attack mature whitebark pine leading to the mortality of healthy trees with inner bark thick enough to support beetle larvae. Infestation occurs from an upward dispersal of beetles after takeover of *P. contortus* stands (Tomback et al. 2001).

White pine blister rust has probably caused heavy *P. albicaulis* mortality in some areas. Extensive “ghost forests” on the wettest sites have weathered, large diameter *P. albicaulis* snags that are likely remnants of the 1911-1942 mountain pine beetle outbreak. Blister rust damage has caused a reduction in whitebark pine populations in Idaho and Washington. The rust kills the branches of pine trees, ending any cone production, and causing widespread mortality (Tomback et al. 2001). Heartrot (i.e., *Echinodontium tinctorium*) is high in stands over 100 years old (Cooper et al. 1991).

Regeneration of whitebark pine is sporadic. Eggers (1986), reported that in the Rocky Mountains seeds that do survive have low germination rates.

5.5.10 Aspen

Physical Description

Quaking aspen is a native deciduous tree. It is small to medium sized, typically less than 48 feet (15 m) in height and 16 inches (40 cm) dbh (Hickman 1993). It has spreading branches and a pyramidal or rounded crown (Gleason and Cronquist 1981). The bark is thin. Leaves are orbiculate to ovately shaped, with flattened petioles (Kay 1993). The fruit is a tufted capsule bearing six to eight seeds. A single female catkin usually bears 70 to 100 capsules. The root system is relatively shallow, with widespreading lateral roots and vertical sinker roots descending from the laterals. Laterals may extend over 100 feet (30 m) into open areas (Jones et al. 1985).

Ecology and Distribution

Quaking aspen (*P. tremuloides*) is the most widely distributed tree in North America (Muegler 1988). It occurs from the eastern coastline to Alaska, and south through the Rocky Mountains. In the west, aspen grows on mountainous and high plateaus in mesic sites, and primarily in riparian areas in more xeric sites. Distribution is patchy, with trees confined to suitable sites, except in Colorado where 75% of all the aspen coverage occurs (Bartos 2001).

In the Clearwater subbasin, aspen intermixes with conifers in various moist sites (Figure 61). Aspen exists in three different conditions. The first is a stable condition, where the aspen sites consist of healthy, reproducing trees called clones. Representative stable sites have mature trees usually surrounded by younger regeneration. In the second condition, aspen are successional to conifers. Because aspen is considered a disturbance species, conifers will eventually take over in the absence of disturbance such as fire or disease. The third condition of aspen existence consists of decadent clones, where little regeneration occurs and the mature trees are deteriorating.

Aspen is a major cover type in North America and it is listed as a dominant species in over 100 habitat, plant community, and vegetation typings. Aspen also occurs in a large number of other forest cover types over its extensive range. In one association occurring in the west, aspen alternates dominance with Douglas hawthorn (*Crataegus douglasii*) and grows through the Douglas hawthorn overstory, resulting in reduced vigor of Douglas hawthorn. Quaking aspen eventually dies back, releasing Douglas hawthorn in the understory (Franklin and Dryrness 1973). Aspen/conifer associations comprise of over 94 square kilometers in the Clearwater subbasin according to GAP data (Table 34).

Quaking aspen forms clones connected by a common parent root system. It is typically dieocious, with a given clone being either male or female. Some clones produce both stamens and pistils, however (Jones et al. 1985). Quaking aspen stands may consist of a single clone or aggregates of clones (Welsh et al. 1987). In the West, quaking aspen stands are often even-aged, originating after a single top-killing event. Aboveground stems may live up to 150 years (Johnston and Hendzel 1985). Clones are generally limited to fringes around meadows or as islands on ridgetops where sufficient moisture sustains them in the growing season (Johnson and Simon 1987).

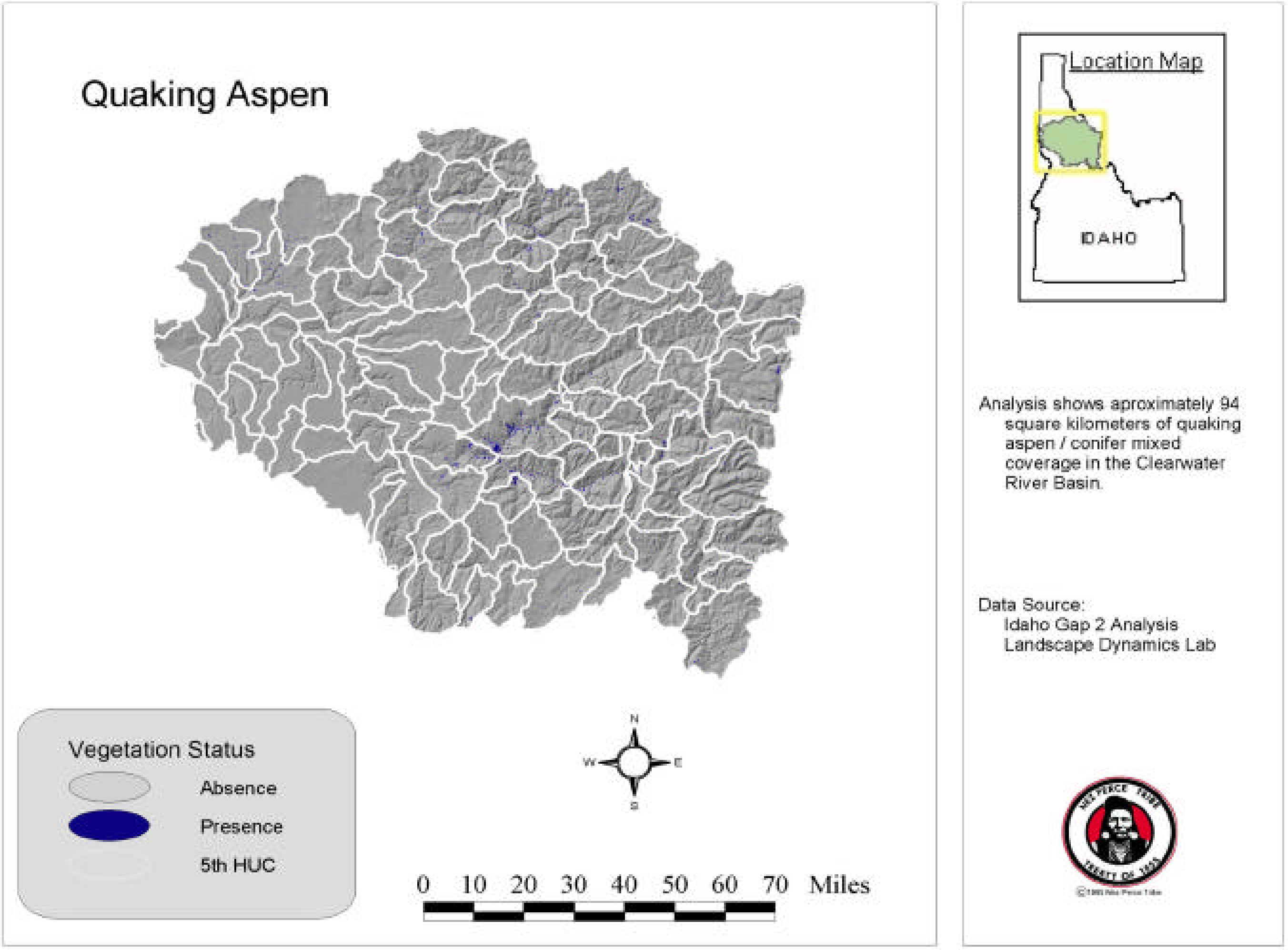

Figure 61. Distribution of the aspen/conifer mixed cover type within the Clearwater subbasin

Aspen is shade intolerant and cannot reproduce beneath its own canopy (Brinkman and Roe 1975). Beyond that, no single, generalized pattern of succession occurs. Quaking aspen is seral to conifers in most of its range in the West, and in some portions of its eastern range. Where it is seral, quaking aspen usually persists as a minor tree in late seral stages (Lavertu et al. 1994). The most apparent climax conditions are stands that occur below the lower limits of conifers and occupy the concave slopes of low hills. These sites can be found in small vicinities bordering the Camas Prairie (Steele et al. 1981).

If quaking aspen does not remain stable, rate of succession to other species varies with with soil, site, and invading species (Harniss 1981). Succession to conifers may occur in a single generation, or take longer than 1,000 years (Mueggler 1985). Quaking aspen is apparently stable on some sites, especially in parts of Canada and the West. Some stands, however, remain stable for decades but eventually deteriorate. Deteriorating stands are often succeeded by conifers, but shrubs, grasses, and/or forbs gain dominance on some sites. Succession to grasses and forbs is more likely on dry sites and is more common in the West than in the East (Harniss 1981). The abundance of aspen in the west is believed to be the result of prevalent, historic fire activity (Muegler 1988). Quaking aspen readily colonizes after fire, clearcutting, or other disturbance (Perala 1990).

Wildlife and Cultural Values

Quaking aspen forests provide important breeding, foraging, and resting habitat for a variety of birds and mammals. Wildlife and livestock utilization of quaking aspen communities varies with species composition of the understory and relative age of the quaking aspen stand. Young stands generally provide the most browse. Quaking aspen crowns can grow out of reach of large ungulates in 6 to 8 years (Patton and Jones 1977). Although many animals browse quaking aspen year round, it is especially valuable during fall and winter, when protein levels are high relative to other browse species (Tew 1970). Aspen is important as cover and forage for elk, moose, mule deer and white-tailed deer. Deer browse quaking aspen year round in much of the West, feeding on bark, branch apices, and sprouts. In some areas, elk use it mainly in winter (Patton and Jones 1987). Moose utilize it on summer and winter ranges for browse and cover. Deer consume the leaves, buds, twigs, bark, and sprouts. New growth on burns or clearcuts is especially palatable to deer (DeByle 1985). Wild and domestic ungulates use quaking aspen for summer shade, and quaking aspen provides some thermal cover for ungulates in winter. Seral quaking aspen communities provide excellent hiding cover for moose, elk, and deer. Deer use quaking aspen stands for fawning grounds in the West (Howard 1996).

Black bears and grizzly bears feed on forbs and berry producing shrubs in quaking aspen understories. Quaking aspen forests in Alberta provide excellent denning and foraging sites for black bear (DeByle 1985).

Rabbits and hares feed on quaking aspen in summer and winter. In winter, snowshoe hare and cottontail rabbits eat quaking aspen buds, twigs, and bark. Snowshoe hare use it for hiding and resting cover in summer (DeByle 1985). Pikas also feed on quaking aspen buds, twigs, and bark. Lagomorphs may girdle suckers or even mature trees (Howard 1996). Small rodents such as squirrels, pocket gophers, mice, and voles feed on quaking aspen during at least part of the year, and can frequently consume quaking aspen bark below snow level, and can girdle suckers and small trees (DeByle 1985). Small mammal populations in quaking aspen generally fluctuate widely with stand age and annual variation in animal population size. Highest densities typically occur in mature quaking aspen stands. Field mice (*Peromyscus* spp.), for example, are most abundant in mature quaking aspen communities (Howard 1996).

Quaking aspen provides food for porcupine in winter and spring. In winter, porcupines eat the smooth outer bark of the upper trunk and branches. Porcupine girdling of quaking aspen can kill large tracts of merchantable trees. In spring, porcupines eat quaking aspen buds and twigs (DeByle 1985).

Beavers comsume the leaves, bark, twigs, and all diameters of quaking aspen branches. They use quaking aspen stems for constructing dams and lodges. At least temporarily, beavers can eliminate quaking aspen from as far as 400 feet (122 m) from waterways. An individual beaver consumes 2 to 4 pounds (1-2 kg) of quaking aspen bark daily, and it is estimated that as many as 200 quaking aspen stems are required to support one beaver for a 1-year period.

Quaking aspen communities provide important cover, feeding and nesting sites for a diverse array of birds (DeByle 1981). Bird species using quaking aspen habitat include sandhill crane, western wood pewee, six species of ducks, blue, ruffed, and sharp-tailed grouse, band-tailed pigeon, mourning dove, wild turkey, red-breasted nuthatch, and pine siskin. Quaking aspen is host to a variety of insects that are food for woodpeckers and sapsuckers (DeByle 1985). Many bird species utilize quaking aspen communities of only a particular seral stage. Research at a northern Utah site suggests that blue grouse, yellow-rumped warbler, warbling vireo, dark-eyed junco, house wren, and hermit thrush prefer mature quaking aspen stands. The MacGillivray's warbler, chipping and song sparrows, and lazuli bunting occurred in younger stands. Bluebirds, tree swallow, pine siskin, yellow-bellied sapsucker, and black-headed grosbeak favor quaking aspen community edges (DeByle 1981).

The ruffed grouse depends on quaking aspen for cover, foraging, courting, breeding, and nesting sites. Through most of its range, it uses quaking aspen communities of all ages. Ruffed grouse chicks find protection in dense, young aspen suckers as early as 1 year after fire or other disturbance. Quaking aspen buds, catkins, and leaves provide an abundant and nutritious, yearlong food source for ruffed grouse (Gullion and Svovoda 1972). Snow tends to accumulate earlier and deeper in quaking aspen than in adjacent conifer stands, and ruffed grouse use the deep snow for burrowing cover in winter (Perala 1977).

Aspen's undergrowth vegetation is considered prime grazing for domestic livestock. Some sources consider aspen to be a keystone species, suggesting that it is an indicator of range conditions and important for the ecological integrity of a landscape (Bartos 2001).

Threats and Limiting Factors

Aspen regeneration depends on the amount of disturbance and the time between disturbances in a certain area. Fire establishes new stands of aspen by burning forest litter and exposing mineral soil for aspen seeds. In the exclusion of fire, sprouting shoot numbers remain low and most are consumed by domestic and wild ungulates (Manier and Laven 2001). The decline in acreage of aspen in some areas of the western United States is reported to be 50%, and up to as high as 95% in some areas (Bartos 2001, Table 35).

Table 35. Historical/Current acres of aspen in interior west (Rocky Mountain Research Station)

Area	Current Aspen	Historical Aspen	Decline (%)
Colorado	1,110,764	2,188,003	49
Utah	1,427,973	2,930,684	51
New Mexico	140,227	1,141,677	88
Wyoming	203,965	436,460	53
Arizona	29,009	720,880	96
Idaho	621,520	1,609,547	61
Montana	211,046	590,674	64
Nevada	118,768	-	-
Total	3,863,272	9,617,925	60

Abiotic factors, animals, and insects easily wound Aspen's soft bark, allowing disease organisms to invade. In some areas of the Rocky Mountains, for example, elk gnaw extensively on the bark, leading to rapid deterioration of the stand. However, canker diseases are by far the most serious causes of tree mortality. Canker diseases are among the primary agents in creating snags and creating infection sites for decay fungi. In turn, standing "dead and down" woody material provides biological diversity in stands and serves as habitat for cavity-nesting animals and birds. Endemic levels of infection by these organisms are essential to maintaining a balanced ecosystem and serve an important role in the dynamics and ecology of aspen stands (Walters et al. 1982). Some of the major cankers infesting quaking aspen are sooty-bark canker (*Encoelia pruinosa*), cryptosphaeria canker (*Cryptosphaeria populina*), black canker (*Ceratocystis fimbriata*), cytospora canker (*Cytospora chrysosperma*), and hypoxylon canker (*Hypoxylon mammatum*)(Hawksworth et al. 1985).

5.5.11 Black Cottonwood

Physical Description

Black cottonwood (*Populus trichocarpa*) is a native, deciduous tree. It typically has a straight, branch-free trunk for more than half its length and a broad, open crown (Arno and Hammerly 1977). Black cottonwood is the largest American poplar and the largest hardwood tree in western North America. Maximum height and size at maturity (60 to 75 years of age) vary according to geographic location. Heights up to 98 feet (30 m) in the North Central Plains, up to 164 feet (50 m) in southwestern Montana, and up to 197 feet (60 m) in California and the Pacific Northwest have been recorded. Trunks may reach 5 feet in diameter. The grey bark of mature trees is deeply furrowed; young bark is smooth and greenish yellow to grey (Arno and Hammerly 1977).

Ecology and Distribution

The range of black cottonwood extends from Kodiak Island in Alaska, south through Oregon, and into the mountains of southern California and northern Baja California. Its eastern reaches include Utah, Nevada, Wyoming, and North Dakota (Lanner 1983). In the Clearwater subbasin, black cottonwood often forms extensive stands on alluvial sites, riparian habitats, and moist woods on mountain slopes (Figure 62). On riparian and bottomland sites it is often associated with willows, such as Pacific willow (*Salix lasiandra*), Scouler willow (*S. scouleriana*), northwest willow (*S. sessilifolia*), and river willow (*S. fluviatilis*).

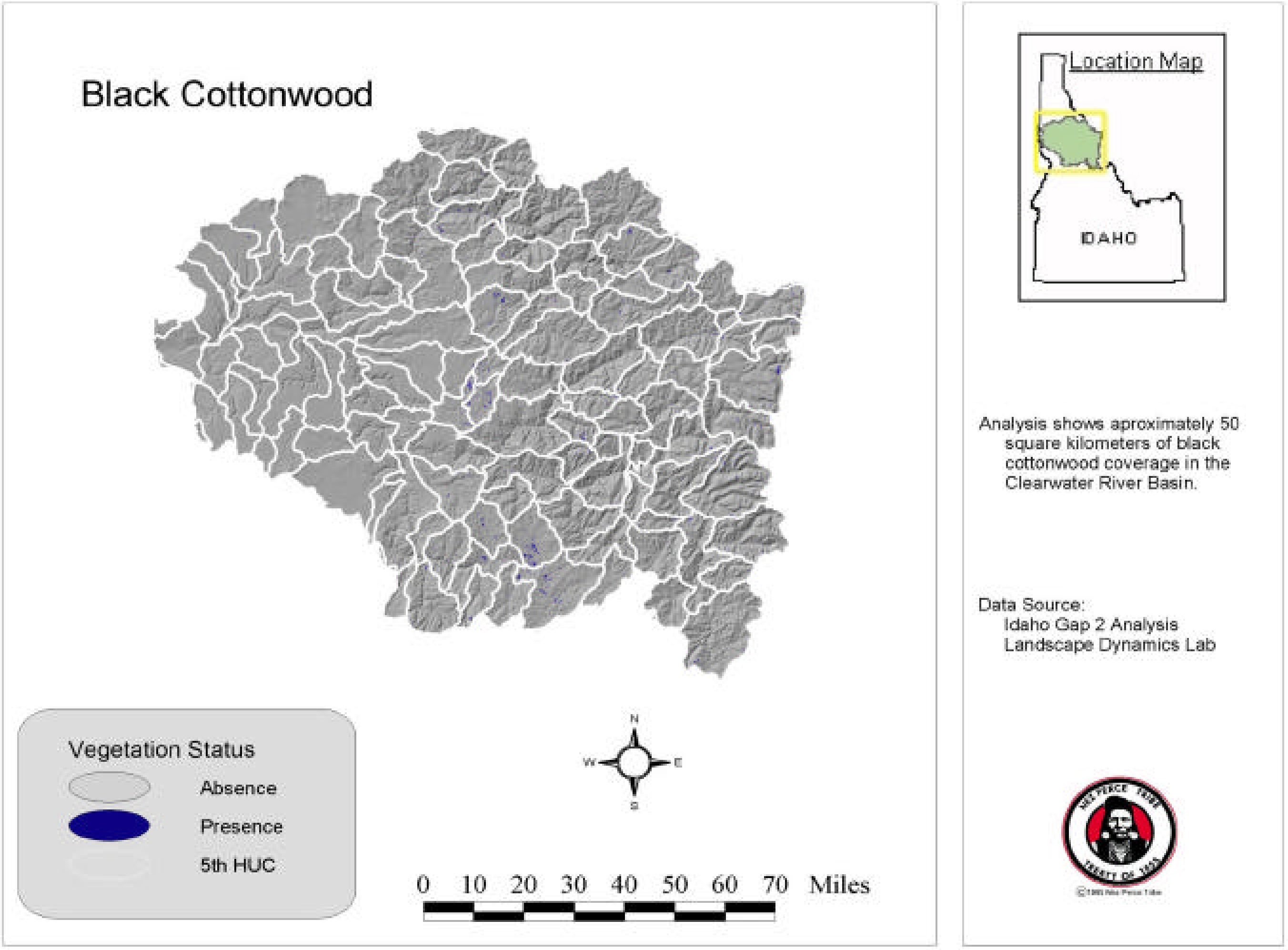

Figure 62. Distribution of the black cottonwood cover type within the Clearwater subbasin

In interior forests, overstory associates may include ponderosa pine, western white pine, white fir, and western larch (Roe 1958). Most black cottonwood sites are characterized by salmonberry (*Rubus spectabilis*), nettles (*Urtica* spp. and *Stachys* spp.), swordfern (*Polystichum munitum*), ladyfern (*Athyrium filix-femina*), beaked hazel (*Corylus cornuta*), and elder (*Sambucus* spp.). Red osier dogwood (*Cornus stolonifera*), honeysuckles (*Lonicera* spp), and common snowberry are common on medium quality sites. Poor sites are usually subject to prolonged flooding with horsetails (*Equisetum* spp.) as a dominant.

Asherin and Orme (1978) suggest that a *P. trichocarpa/Rosa woodsii* community type occurs on the lower Clearwater River and at the mouths of the major tributaries, and intermittently in riparian vegetation between. The tributaries create broad, flat flood plains consisting of a sand and gravel substrate ideal for cottonwood growth. Black cottonwood is the dominant overstory tree with white alder present as a seral species in some areas. The usually disturbed understory can consist of Woods rose (*Rosa woodsii*), poison ivy (*Toxicodendron radicans*), black hawthorn (*Crataegus douglasii*) as a shrubby layer, with grasses such as cheatgrass and Kentucky bluegrass (*Poa pratensis*), and forbs such as stalky berula (*Berula erecta*), miner's lettuce (*Montia perfoliata*), red sorrel (*Rumex acetosella*), and goldenrod (*Solidago canadensis*). Based on GAP data, around 50 square kilometers of *P. trichocarpa* coverage occurs in the Clearwater subbasin (Table 34).

Black cottonwood is a pioneer species that commonly establishes on recently disturbed alluvium. It is classed as very intolerant of shade and grows best in full sunlight. On moist lowland sites, initial growth of black cottonwood is rapid, which allows it to survive competition from slower growing associated species. Maintainence of communities dominated or co-dominated by cottonwood depends on periodic flooding or other types of soil disturbance. In the absence of disturbance, succession proceeds, and black cottonwood is eventually replaced by more shade tolerant species (Maini 1968).

Wildlife and Cultural Values

Black cottonwood stands provide forage for livestock, and provide food, cover, and shade for a variety of wildlife species. Deer and elk use of black cottonwood may be high, depending on site and season (Hansen et al. 1989). The crowns of black cottonwood provide nesting sites for bald eagles, ospreys, and blue herons. Woodpeckers, great horned owls, wood ducks, flying squirrels, raccoons, and a variety of songbirds nest in black cottonwood trunk cavities. Beavers use black cottonwood for food and building materials. The rotten trunks of black cottonwood are also important as wildlife habitat, especially east of the Cascades where other large rotten trees may be scarce (Arno and Hammerly 1977).

Streamside black cottonwoods contribute to favorable fish habitat by reducing streambank erosion and siltation, maintaining low water temperatures through shading, and periodically adding debris to the stream (Hansen et al. 1989). Black cottonwood has been used successfully in the restoration of riparian areas. The roots of established plants are effective soil stabilizers and provide valuable streambank and erosion protection (Hansen, et al. 1988).

Threats and Limiting Factors

Black cottonwood is highly susceptible to fire damage because of its thin bark and shallow root system. After 10 to 20 years, the bark may become thick enough to afford some fire protection. Seedlings and saplings are usually killed by fire of any intensity. Mature trees may survive low-intensity fires, and portions of the plant may survive fires of moderate intensity. Trees of all ages are killed by high intensity fire. Fire wounds on mature trees, acting as points of entry, may facilitate the onset of heartwood decay, which can lead to substantial mortality (Roe 1958). Black cottonwood can sprout from the stump following top-kill by fire. Fire can create conditions favorable for seedling establishment. It thins the overstory, allowing light to penetrate, and exposes bare mineral soil. Postfire establishment via offsite seed is possible if soil moisture is adequate (Roe 1958).

Like most riparian species, black cottonwood is susceptible to grazing impacts. Several insects attack black cottonwood, but none has yet been reported as a pest of economic significance (Furniss and Carolin 1977). At least 70 fungal species cause decay in cottonwood, but only six fungi cause significant losses. Two of these, *Spongipellis delectans* and *Pholiota destruens*, cause 92 percent of the loss (Hepting 1971). A leaf rust (*Melampsora* spp.) has been observed in young plantations and susceptibility to the rust appears to vary greatly across the geographic range of the species. This disease limits photosynthesis and causes leaves to fall prematurely, thus decreasing tree growth and vigor. Black cottonwood is also subject to the condition known as wet wood, which leads to wood collapse during drying. Black cottonwood saplings are often injured and sometimes killed by unseasonably early or late frosts. When dormant, however, it is one of the most frost resistant trees in the northwestern United States. Ice storms, heavy snow, and wind can cause considerable damage to black cottonwood (Roe 1958).

5.5.12 Mountain Meadows

Physical Description

Mountain meadows are found throughout the Pacific Northwest and exist amid mixed conifer forest habitats and alpine regions. In the Clearwater subbasin, meadows can be characterized as either a complex of well-drained areas, or as areas of periodically high water tables (Figure 63). The ground layer consists of low matted subshrubs, grasses and sedges, forbs, or soils covered with moss or lichens. The tree layer can be made up of either one dominant species or a mixture of several different tree species (IBIS 2001). Grasses and grasslike species historically dominated in most meadow cover types. A meadow may consist of bunchgrasses (*Festuca* and *Pseudoroegneria* spp.), alpine timothy, bluegrasses, cheatgrasses, squirreltails (*Sitanion* spp.), and sedges such as the *Carex* species. This results in a forest structure that includes an interspersion of wet meadows with forested stands. Mountain meadow habitats consist of tree overstories between 10-30%. A mountain meadow cover type is not recognized in some literature, identifying it as a seral stage in forest cover types (Franklin and Dyrness 1973).

Ecology and Distribution

Based on GAP data, there are 487 square kilometers of mountain meadow cover type in the Clearwater subbasin (Table 34). The climate is cool in the summer, with cold winters characterized by deep snowpacks (IBIS 2001). Western Red Cedar is the dominant overstory component in some stands (Lichthardt 1997). At higher elevations, extensive moist meadow communities persist intermixed with subalpine fir stands. These communities are often referred to as 'parklands' because of their physical appearance. The composition of grassland species within meadow communities varies with landscape conditions (Table 36). Johnson and Simon (1987) classified meadow associations in the Wallowa–Snake province into four types depending on the meadow's attributes.

1. *Ridgetop meadows.* This meadow type is located on flat plateaus. Idaho Fescue and Prairie Junegrass (*Koeleria macrantha*) normally dominate this meadow type, starting out

moist early and drying in the summer. Meadows are rich with forbs and succeptible to grazing from wild and domestic ungulates. This type of meadow usually does not advance past the early seral stages.

2. *Tufted hairgrass/moist sedge meadows.* Can be found near waterways with a vernal moisture supply to roots underground. Tufted hairgrass (*Deschampsia cespitosa*) meadows are often overgrazed because of their nearness to water and richness in preferred forage species. This meadow type is often difficult to identify because it has lost its native sedges and grasses to disturbance.
3. *Tufted hairgrass/wet sedge meadows.* Can be found near waterways with a surface moisture supply present most of the summer. Several species of sedges dominate, with varying forbs present depending on the elevation.
4. *Wet sedge meadows.* Water is present most of the year with only hydric plants surviving. Grasses are infrequent, as are the presence of forbs.

Table 36. Some common vegetation found in mountain meadows in eastern Oregon and Washington, depending on the type of meadow community (Franklin and Dyrness 1973).

Grasses	Sedges, Rushes and Horsetails	Forbs	Shrubs
Deschampsia caespitosa	*Carex scopulorum*	*Ranunculus populago*	*Artemesia tridentata*
Deschampsia atropurperea	*Carex rostrata*	*Polygonum spp.*	*Potentilla fruiticosa*
Phleum pratense	*Carex aquatilis*	*Aster foliaceus*	*Ribes spp.*
Phleum alpinum	*Carex pachystachya*	*Senecio streptanthifolius*	*Phyllodoce empetriformis*
Pseudoroegneria spp.	*Carex misandra*	*Eriogonum spp.*	*Vaccinium scoparium*
Festuca spp.	*Carex geyeri*	*Potentilla glandulosa*	
Danthonia californica	*Carex hoodii*	*Arnica sororia*	
Poa pratensis	*Carex limnophila*	*Wyrthia spp.*	
Bromus carinatus	*Equisetum arvense*	*Trifolium eriocephalum*	
Stipa lettermanii	*Juncus tenuis*	*Senecio vulgaris*	
Stipa occidentalis		*Veratrum californicum*	
Trisetum spicatum		*Gilia nuttallii*	
		Penstemon spp.	
		Phlox spp.	
		Lupinus spp.	
		Arenaria formosa	
		Hieracium gracile	
		Erigeron speciosus	

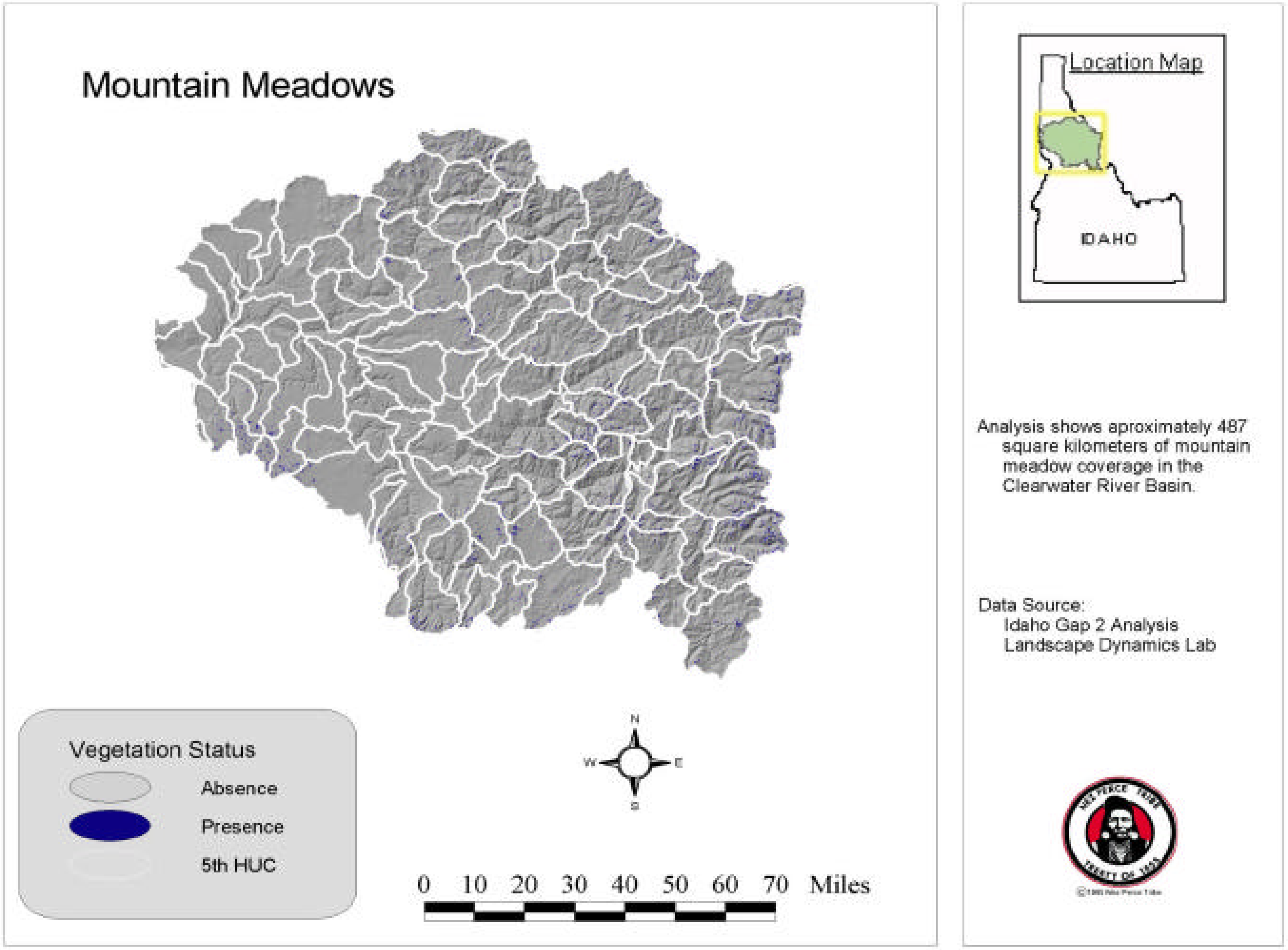

Figure 63. Distribution of the mountain meadow cover type within the Clearwater subbasin

Fire is considered to be an important factor in the creation and maintenance of mountain meadows. Fire can eliminate stands of trees and return the area back to the previous meadow stage. Other historical and environmental factors are also responsible for the present vegetative conditions in mountainous areas (Franklin and Dyrness 1973). Fire is rare in mountain meadow-wetland habitat due to the wet conditions present. The average interval for lethal fires is very infrequent, estimated to be over 300 years, and nonlethal burns occur between 50 to 150 years. Meadow conditions can stop the spreading of severe fires due to their moisture content.

Wildlife and Cultural Values

Mountain meadows provide a rich environment ranging in extent from small glades to extensive grasslands covering thousands of acres, and they provide habitat for a wide range of plant and animal species. High mountain meadows produce abundant wildflowers in late spring and summer. Many insect species take advantage of the tremendous flower bloom. Meadows are rich with forbs and grasses highly palatable to wild ungulates. The largest western mammals such as grizzly bear, black bear, elk, and deer also frequent meadows to forage. Smaller mammals like the meadow mouse (*Microtus* sp.) have populations that sometimes reach densities of several hundred per acre. Predators keeping mice populations in check include hawks, owls, fox, skunks, weasels, minks, badgers, coyotes, and snakes. Yellow-bellied marmots and pikas may be found in and around the outskirts of meadows. Gray wolves utilize mountain meadows extensively for rendezvous sites during mid- to late summer when the pups are still too young to travel great distances.

Threats and Limiting Factors

Succession of meadows occurs gradually through invasion of trees and the upward movement of timberline. The rate of invasion and the overall likelihood of takeover depend on the meadow cover type, as well as climatic factors and disturbance (Franklin and Dyrness 1973). Succession is usually the result of drastic shifts in climate, violent disturbances, and plant species interactions. Changes in temperature, amount of precipitation, and seasonal distribution of precipitation will result in changes in vegetation from year to year (Johnson and Simon 1985).

Most grass dominated meadows have deteriorated due to overgrazing, which leads to mixed grass and weed communities along with a more populated forb layer (Franklin and Dyrness 1973). Leege et al. (1981) found that heavy livestock grazing (season long) resulted in lower productivity and retarded plant succession. The degeneration of meadow vegetation can be expressed in four stages of dominance: perennial grass, mixed grass and forbs, perennial forbs, and annual forbs (Johnson and Simon 1985). Hoof action and compaction may also contribute to long-term changes in hydrology within mesic and wet meadows subjected to overgrazing. Some high elevation meadows have been impacted by recreational activities. Compaction and trampling from camping, recreational vehicle use, and overgrazing by pack and saddle stock have all impacted meadows in heavily used areas.

5.5.13 Herbaceous Wetlands and Riparian Areas

Physical Description

In wetlands, water saturation determines the nature of soil development and the types of plant and animal communities living in the soil and its surface. Wetlands occur as small ponds filled by spring runoff, wet meadows, springs and seeps, bogs, small lakes, and riverine and streamside riparian areas. These areas provide high quality wildlife habitat, water storage, flood abatement, pollution filtration, livestock forage, and water for domestic use (U.S. Geological Survey 1996).

Ecology and Distribution

Wetlands cover only a small portion of the subbasin, but offer some of the most diverse and unique habitats available. They also harbor unique plant species such as Clearwater phlox, which is endemic to only a few wet meadows within the Clearwater subbasin. Historically, the subbasin contained much more herbaceous wetland habitat than it does currently. Analysis by ICBEMP indicated that a large wet meadow complex existed within the Lower Clearwater AU near the present towns of Craigmont, Winchester and Ruebens (Figure 64). These wetlands have been converted to agricultural uses. Present day wetlands are often small and widely scattered (Figure 64).

Wildlife and Cultural Values

Riparian and wetland habitat is extremely important for many wildlife species. The ICBEMP data shows a decrease in wetland habitat from 2.36% of the subbasin historically to 0.04% of the subbasin currently (Table 31). The finer scale GAP data, though, shows slightly less than 2% current wetland or riparian cover. Wetlands are an essential component of habitat for two terrestrial focal species--the western toad and the Coeur d'Alene salamander. Open wetland areas could provide habitat for the extirpated sandhill crane.

Wet meadows provide ideal habitat for camas (*Camassia quamash*), an important staple food for the Nez Perce Indians. Camas bulbs are high in starch and easily stored for winter use. Camas was probably the most widely traded staple food item (besides salmon) among the tribes of the Pacific Northwest (Gunther, 1973). With the loss of wet meadow complexes throughout the prairie grassland region of the Clearwater subbasin, camas has become increasingly difficult to obtain.

Threats and Limiting Factors

Impacts to wetland and riparian communities are difficult to quantify, but some estimates suggest that 56% of Idaho's wetlands have been lost since 1860 (Dahl 1990), largely due to agricultural conversion and urban development (Idaho Department of Parks and Recreation 1987). Within the Clearwater subbasin, large expanses of palustrine wetlands in the Reubens, Craigmont, and Ferdinand areas have been converted to croplands. Remaining wetland communities are often degraded by livestock grazing, road development, urban expansion, and altered hydrologic regimes (U.S. Geological Survey 1996).

Remnant wet meadows are often used as late summer or fall pasture for livestock. Impacts from such use are difficult to qualify but may include soil compaction, reduction in native plant diversity, and noxious weed encroachment.

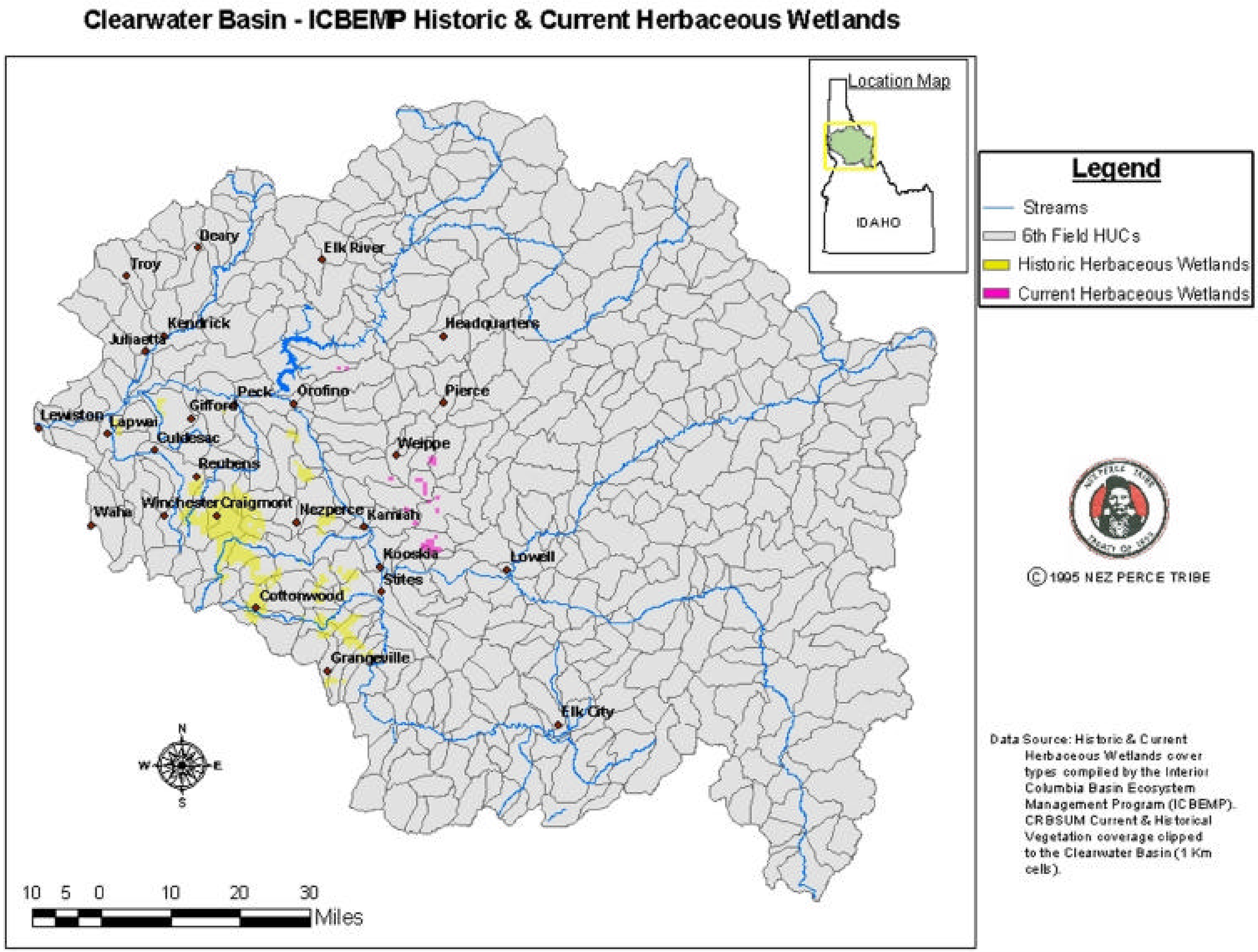

Figure 64. Comparison of historic and current herbaceous wetland cover types within the Clearwater subbasin

5.5.14 Native Bunchgrass

Physical Description

Grasslands are characterized by a rich assemblage of bunchgrasses, forbs, and shrubs (Daubenmire 1942; Davis 1952). The Clearwater subbasin contains two distinct grassland communities. Palouse prairie communities occur on the relatively flat rolling plateaus while canyon grasslands occur in the steeper breaklands of major river canyons. Prairie grasslands have deeper soils with less rock. Plant communities consisted of native bunchgrasses such as bluebunch wheatgrass, Sandberg's bluegrass (*Poa sandbergii*), and Idaho fescue were interspersed with low shrub communities dominated by rose and snowberry. Canyon grasslands contain similar communities, but reside in areas with shallower, rockier soils. These moisture-limited systems have minimal tree encroachment. Daubenmire (1970) speculated that steepe vegetation of this region resulted from climatic and edaphic conditions and not from fire.

Ecology and Distribution

The Palouse Prairie of southeastern Washington, adjacent Idaho and Oregon, has been almost entirely converted to agriculture and is one of the most endangered ecosystems in the United States. Since the turn of the century, 94% of the Palouse grasslands have been converted to crops, hay, or pasture lands. In addition to extensive grasslands and prairie plants, the Palouse also supported wetlands and associated riparian vegetation. Today, only 1% of the original habitats remain. Those remaining areas of original habitat are highly fragmented, with most sites smaller than 10 acres. Based on GAP data, 890 square kilometers of native bunchgrass cover types occur in the Clearwater subbasin (Table 34). Current distribution of grasslands in the Clearwater subbasin is represented in Figure 65.

A recent collaborative effort between the Bureau of Land Management, Cottonwood Resource Area, and the Palouse Land Trust established protection priorities for 308 Palouse or canyon grassland remnants in Idaho, Oregon and Washington. Prioritization was based on the size of the remnant, its proximity to other remnants, the rarity of species and other community elements, and remnant quality. Nine of the twenty sites identified as having a high conservation value are located in the lower Clearwater subbasin (Weddell and Lichthardt 1998).

Native grassland communities, once in climax condition, are slowly being replaced by seral habitat types. Asherin and Orme (1978) suggest alternate cover types for the Dworshak Reservoir area and lower Clearwater River sites that are a product of disturbance. Listed below are some of the native grassland associations pertaining to the Clearwater subbasin (Johnson and Simon 1987).

Festuca ovina ingrata (Idaho fescue) major associations.

1. *Koeleria macrantha* (Prairie junegrass) occurs at low elevations on slopes with deep soil and a northerly aspect, on dissected basalt ridgetops, on raised mounds separated by scabland, or high elevations, where it is the most extensive grassland association. *Symphoricarpos albus* (Common snowberry) is widespread on steeper slopes.
2. *Pseudoroegneria spicatum* (bluebunch wheatgrass); occurs on steep canyon slopes and on ridgetops. *Lupinus sericeus* (silky lupine), *Balsamorhiza sagittata* (arrowleaf balsamroot), and *Phlox idahonis* (Clearwater phlox) are present depending on aridity of the site.

Pseudoroegneria spicatum (Bluebunch wheatgrass) major associations.

1. *Eriogonum heracleoides* (Wyeth's buckwheat) occurs at the highest elevations on low loess levels.
2. *Poa sandbergii* (Sandberg's bluegrass) occurson gravelly, shifting colluvium on steep canyon slopes. *Scutellaria angustifolia* (narrow-leaved skullcap), *Astragalus cusickii* (Cusick's milkvetch), *Erigeron pumilus* (shaggy fleabane), *Phlox colubrina* (Snake River phlox), and *Opuntia polycantha* (prickly pear) can be present depending on soil type and depth, and whether there is a pretertiary granite or basalt substrate.

Grass species will respond differently to fire. Typically, survival of native grasses will depend on the severity of the fire, the moisture present in the soil and duff, and the phenological stage of the plant (Fischer and Bradley 1987). Idaho fescue can survive light-severity fires, but is usually harmed by more severe fires. Fires tend to burn within the accumulated fine leaves at the base of the plant and may produce temperatures sufficient to kill some of the root crown (Agee 1996).

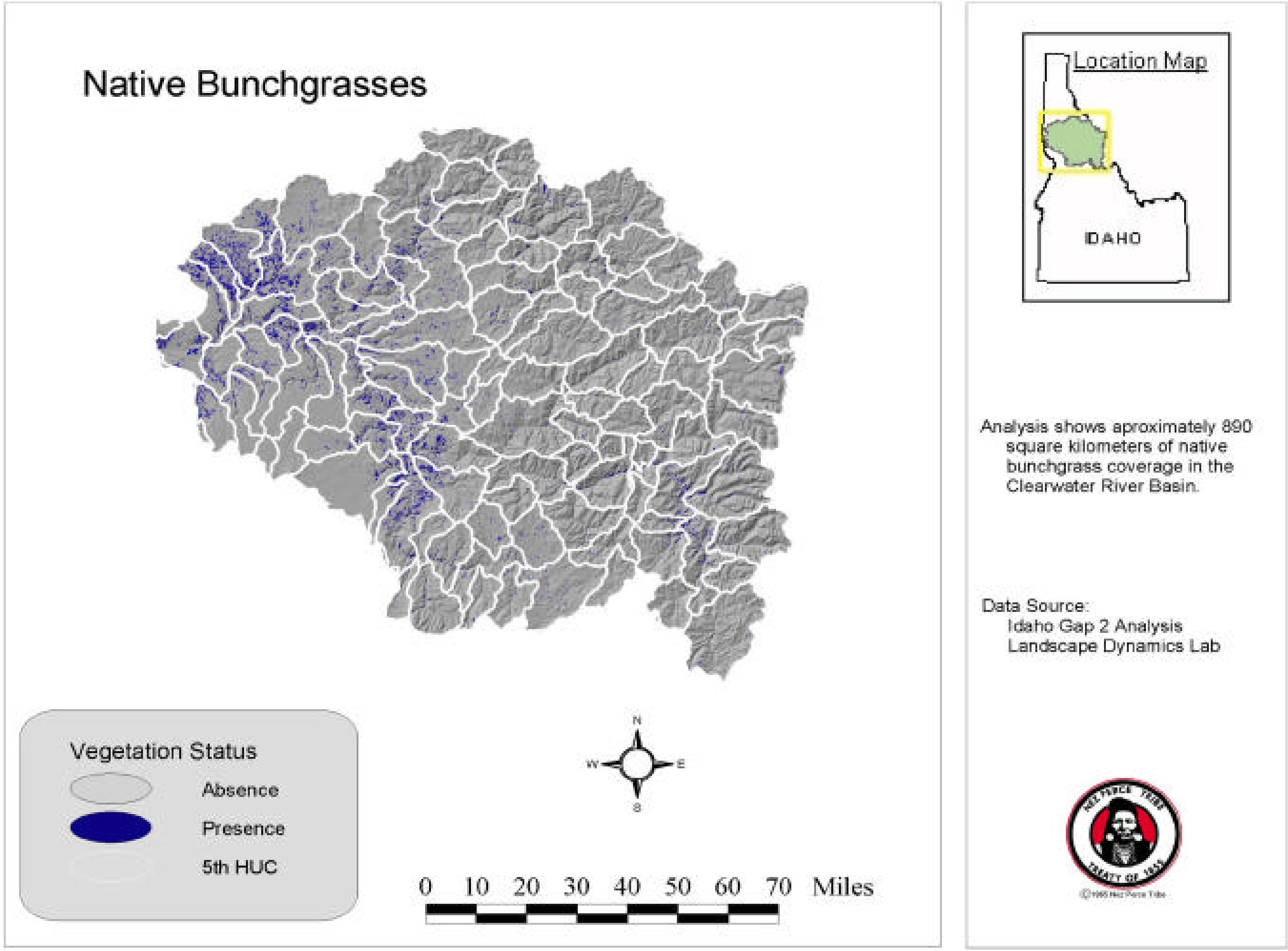

Figure 65. Distribution of the native bunchgrass cover type within the Clearwater subbasin

Bluebunch wheatgrass usually survives fires because its buds are protected by soil and/or plant material (Bunting et al. 1994), and burning will stimulate flowering and seed setting (Agee 1996). In cases where the level of disturbance, whether from heavy grazing pressure or severe fire, is detrimental enough that cover of native grasses decrease, they will generally succeed to various native and nonnative species through successional processes. Some examples of invaders are bluegrasses, sagebrush (*Artemisia* spp.), rubber rabbitbrush (*Chrysothamnus nauseosus*), broom snakeweed (*Gutierrezia sarothrae*), needlegrasses (*Achnatherum* and *Hesperostipa* spp.), lupines (*Lupinus* spp.), phlox (*Phlox* spp.), spotted knapweed, yellow starthistle, timothy (*Phleum pratense*), and cheatgrass (Mack and Pyke 1983).

Annual grasslands, noxious weeds, and exotic forbs have become established on grassland habitat types on low elevation, steep, south facing slopes (Figure 66). This has resulted in loss of bunchgrass community structure, diversity, and habitat for obligate wildlife populations. On the prairie, native bunchgrasses and shrublands have been largely replaced by annual cropland, hay, or pasture. Once extensive camas fields are now generally limited to nontillable areas. Based on GAP data, 62 square kilometers of annual grassland/exotic forb currently in the Clearwater subbasin (Table 34).

Wildlife and Cultural Values

Climax bunchgrass communities are dominant components of winter ranges, and provide important forage for many types of domestic livestock and several wildlife species such as the mountain goat, bighorn sheep, elk, deer, and grizzly bear (Riggs and Peek 1980). Bighorn sheep preferred the open structure of the canyon grasslands where they browsed on the abundant grasses and forbs (Valdez and Krausman 1999). The steep rocky terrain also provides escape cover from predators. Native grasslands also provide cover and forage for ground dwelling animals such as the northern pocket gopher and the sharp-tailed grouse. The availability of water in grass communities determines the ecology and the behavior of associated wildlife (Cederholm et al. 2001). In the Clearwater subbasin, native bunchgrass communities provide habitat for three focal plant species, Jessica's aster (*Aster jessicae*), Palouse goldenweed (*Haplopappus liatriformis*) and broadfruit mariposa lily (*Calochortus nitidus*) and the proposed Threatened species, Spalding's catchfly (*Silene spaldingii*), (Caicco 1988a, b; Lorain 1991a, b).

Threats and Limiting Factors

Most of these grasslands have been lost due to conversion to agricultural grain, hay, and pasture production. Ten percent of the subbasin is currently in agricultural production on areas formerly grasslands and forests (ICBEMP). Only small, scattered parcels remain of the Camas and Weippe Prairie grasslands (Figure 66). The vast ranges of *Festuca* and *Pseudoroegneria* bunchgrasses that dominated the lowland areas of the subbasin have been almost completely converted to agricultural areas. A comparison of coarse-scale historic vegetation with the current vegetation layer compiled by ICBEMP indicates that native bunchgrass coverage in the Columbia Basin has declined by 3,724 km^2 (Table 31).

Grasslands are subject to weed invasions and to drift of aerially applied pesticides (Washington State Department of Natural Resources 1997; Data Source: DNR and GAP Analysis/Univ. of Washington 1997). Dobler et al. (1996) found a negative correlation between the abundance of many native bird species and exotic grass coverage on Washington's shrub steppe grasslands. The massive loss of prairie grasslands in the subbasin has contributed to the decline of many grassland dependent species and the extirpation of the sharp-tailed grouse (Deeble 2000).

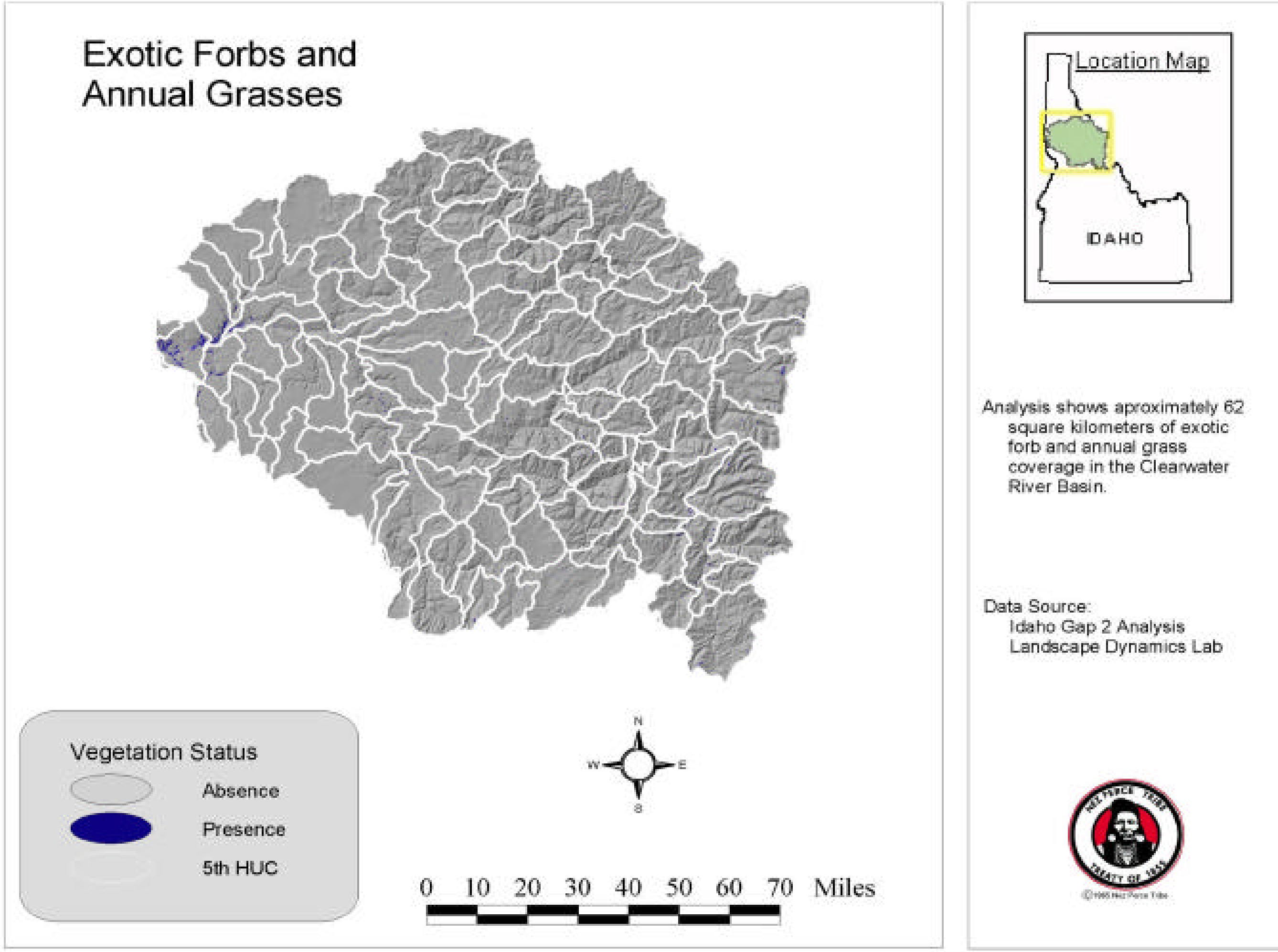

Figure 66. Distribution of the exotic forb/annual grass cover type within the Clearwater subbasin

Native grasslands in the Columbia Basin are thought to have evolved under less intense grazing pressure than those in the Great Plains region of the country, which made them more susceptible to damage when EuroAmerican settlers introduced large herds of sheep and cattle during the late 1800s and early 1900s. Removal of the original perennial grass cover left the soil vulnerable to erosion by wind and water, altered hydrologic regimes, and aided grassland colonization by annual grasses and noxious weeds (Quigley and Arbelbide 1997; Black et al. 1997). Today, grassland remnants continue to be used as livestock pastures.

Grazing in grassland-shrub communities can be used to reduce the decadent portions of perennial grass species. In addition, grazing can reduce closed herbaceous canopies to allow recruitment of forbs and shrubs highly palatable and nutritious to deer and elk, but which cannot compete with tall, established grasses.

5.5.15 Shrublands

Physical Description

Shrublands are characterized by total shrub dominance, without any tree associations or potential tree succession. Cover types and species composition vary depending on geographical elevation and climate. Shrublands include a wide range of different plant communities such as ninebark (*Physocarpus malvaceous*), rabbit brush, sagebrush (*Artemisia tridentata*), and curlleaf mountain mahogany, to name a few. All are generally associated with mesic to dry conditions.

Ecology and Distribution

The cover types listed below are from the Wallowa–Whitman National Forest (Johnson and Simon 1987) and Washington State (Daubenmire 1970). Cover types not pertaining to the Clearwater subbasin were omitted.

1. *Artemesia tridentata* (mountain big sagebrush) associations
    a. *Carex geyeri* (elk sedge)
    b. *Festuca ovina ingrata* (Idaho fescue)
    c. *Purshia tridentata* (bitterbrush)
    d. *Symphoricarpos oreophilus* (mountain snowberry)
2. *Purshia tridentata* (bitterbrush) associations
    a. *Festuca ovina ingrata*/*Pseudoroegneria spicatum* (Idaho fescue/bluebunch wheatgrass)
    b. *Pseudoroegneria spicatum* (bluebunch wheatgrass)
    c. *Stipa comata* (Tweedy's needlegrass)
3. *Physocarpus malvaceus*/*Symphoricarpos albus* (ninebark/common snowberry)
4. *Symphoricarpos albus*/*Rosa* spp. (common snowberry/rose)
5. *Cercocarpus ledifolius*/*Pseudoroegneria spicatum* (curlleaf mountain mahogany/bluebunch wheatgrass)
1. *Rhus glabra*/*Pseudoroegneria spicatum* (smooth sumac/bluebunch wheatgrass)

Asherin and Orme (1978) describe shrubland types on the lower Clearwater River as suffering from severe disturbances caused by urban sprawl, floods, agriculture, livestock grazing, and development. They describe additional cover types for the lower Clearwater.

1. Shrub steppe
    Chrysothamnus nauseosus/*Bromus tectorum* (rubber rabbitbrush/cheatgrass)

Celtis reticulata/*Bromus tectorum* (Douglas hackberry/cheatgrass)

2. Macrophyllous shrub and vine
   - *Salix exigua* (coyote willow)
   - *Rhus glabra*/*Bromus tectorum* (smooth sumac/cheatgrass)
   - *Crataegus douglasii*/*Montia perfoliata* (black hawthorn/miner's lettuce)
3. *Physocarpus malvaceus*/*Holodiscus discolor* (mallow ninebark/oceanspray)
4. *Philadelphus lewisii*/*Bromus tectorum* (mockorange/cheatgrass)
5. Mesic mixed deciduous shrub
   - Example: *Amelanchier alnifolia* (serviceberry), *Acer glabrum* (Rocky Mountain maple), *Rubus parviflora* (thimbleberry), *Spiraea betulifolia* (spiraea)
6. Xeric mixed deciduous shrub
   - Example: *Ribes aureum* (prickly currant), *Sambucus cerulea* (blue elderberry), *Rhus glabra* (smooth sumac), *Toxicodendron radicans* (poison ivy).

The composition and density of grasses and forbs in a shrub community varies considerably due to site differences. The effect of fire also varies according to site conditions. Based on GAP data, 1,835 square kilometers of shrubland currently occur in the Clearwater subbasin (Table 34). The extent of shrublands in the Clearwater subbasin is shown in Figure 67.

Wildlife and Cultural Values

Early seral communities and shrubfields provide forage areas critical to elk. Regenerating forests with abundant forage can provide habitat for prey species such as snowshoe hare, and benefit hare predators, such as lynx, that use young seral stands as hunting habitat (ICBEMP 2001). While providing food and cover for wildlife species, shrub fields also serve as a fuel source for wildfires (Gruell 1983). Highly valued big game browse such as the Rocky Mountain maple provide important habitat for ruffed and blue grouse and nesting sites for numerous songbirds.

In the Clearwater subbasin, maple is commonly found with willows, red osier dogwood, blue elderberry (*Sambucus glauca*) and thinleaf alder (*Alnus incana ssp. tenuifolia*). These brush communities provide essential nesting habitat for several perching birds, including the dusky flycatcher, MacGillivray warbler, orange-crowned warbler, broad-tailed hummingbird, white-crowned sparrow, and Lincoln's sparrow (Elliot and Flinders 1984). Less browsed species of shrublike ninebark (*Physocarpus malvaceus*) can form dense thickets that provide good shelter and cover for a variety of wildlife species from small birds to large mammals (Habeck 1992).

Mountain big sagebrush (*Artemesia tridentata)* is highly preferred and nutritious winter forage for mule deer (Johnson 2000). Ceanothus (*Ceanothus velutinus*) provides food and cover for a wide variety of wildlife species. It is eaten seasonally by elk and moose, and has variable forage value for mule deer and whitetail deer. Ceanothus provides good cover for many smaller birds and mammals. Rabbits and snowshoe hares often hide or rest beneath this shrub, and numerous songbirds nest in its dense thickets (Tirmenstein 1990). In some locations, elk find thermal cover in ceanothus, and deer reportedly bed in relatively open stands (Stanton 1974). Antelope bitterbrush (*Purshia tridentata*) is important browse for wildlife and livestock. Pronghorn, mule deer, elk, bighorn sheep, and moose seasonally browse antelope bitterbrush (Zlatnik 1999). Antelope bitterbrush and other shrubs provide important cover for Lewis's woodpeckers (Koehler 1981).

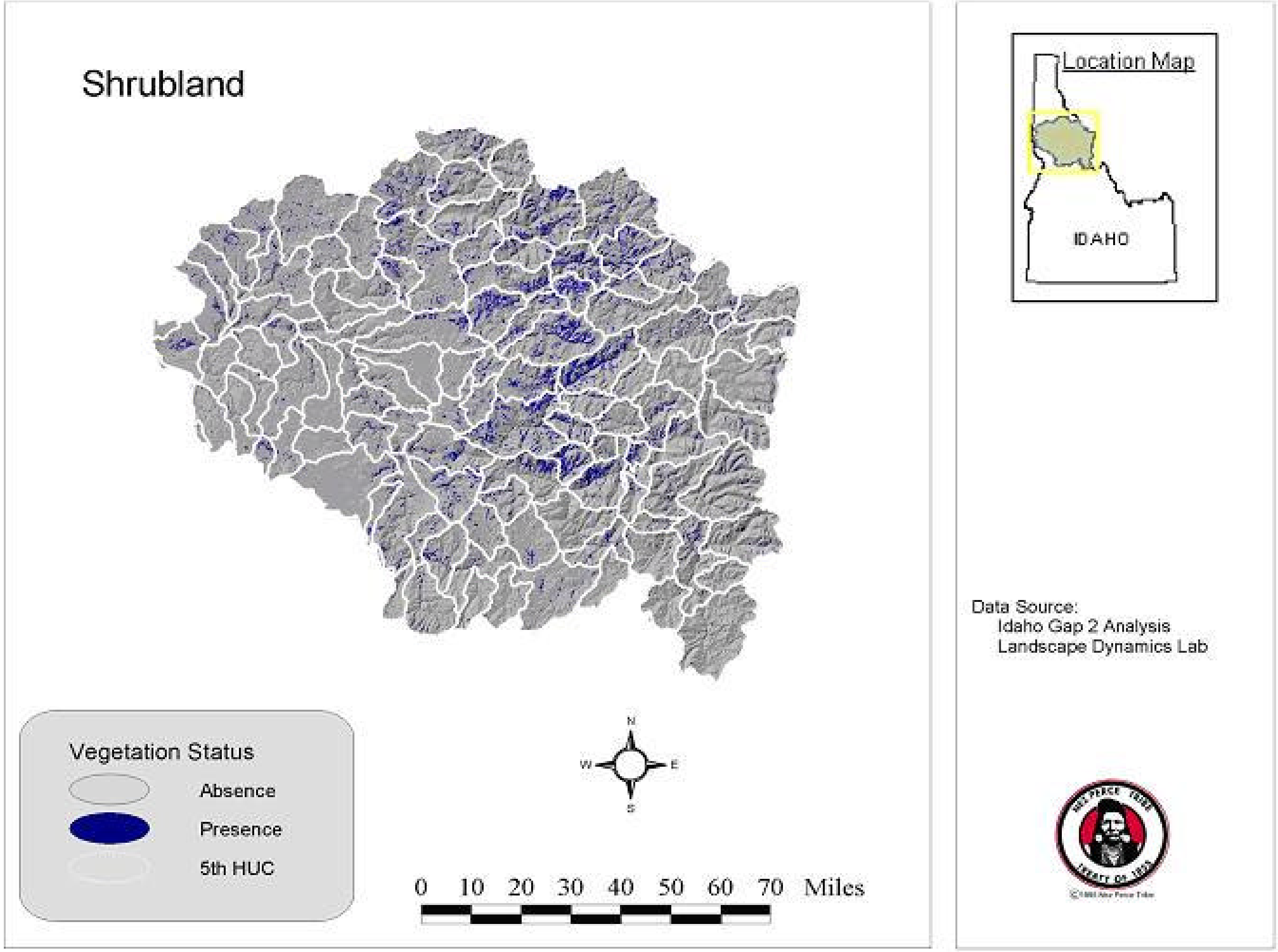

Figure 67. Distribution of the shrubland cover type within the Clearwater subbasin

Native peoples used big sagebrush leaves and branches for medicinal teas, and the leaves as a fumigant. Bark was woven into mats, bags and clothing (Parish et al. 1996). Native Americans also used Saskatoon serviceberry (*Amelanchier alnifolia*) wood to make arrow shafts, spears, and digging sticks. They made a tea, used for treating colds, by boiling the branches (Halverson 1986).

Threats and Limiting Factors

Shrub communities have been impacted by destruction, fragmentation, overgrazing, and fire suppression. Human habitation and development has had a significant impact on shrub communities at lower elevations, and on the prairies near human settlements. Shrubs were often seen as having little economic benefits and were systematically removed from rangelands and homesteads. Extensive destruction of current (*Ribes* sp.) stands was also undertaken earlier in the century in an attempt to control white pine blister rust (*Cronartium ribicola*), but those efforts proved fruitless (Hagle et al. 1989). Some shrub communities have been lost to successional processes due to fire suppression.

5.6 Focal Plant Species

The concept of a focal species was first described by Lambeck (1997) as a management tool to help people manage large areas and multiple species in a more efficient way. This approach identifies specific groups of species used to define landscape. If the requirements of these focal species are met then most other species will have their requirements met as well. The species with the most demanding requirements are usually selected to define the minimum acceptable values for each landscape parameter. This process was applied to key habitat attributes in the Clearwater subbasin to develop a list of focal plant and wildlife species.

Eight focal plant species have been selected for the Clearwater subbasin. These species are considered the most rare or imperiled taxa within the drainage because of habitat loss, threats, or inherent rarity: Clearwater phlox and spacious monkeyflower represent wet meadow, seeps, and riparian habitats; Jessica's aster and Palouse goldenweed represent prairie grasslands; salmon-flowered desert parsley and broadfruit mariposa lily represent canyon grassland and ponderosa pine habitats; and two moonwort species represent moist cedar-hemlock forests. All focal plant species are considered sensitive by the USFS or BLM and are tracked by the Idaho Conservation Data Center. Maps of species distributions are not provided due to the sensitive nature of that information. Resource managers with a specific need for accurate location information of maps may contact the Idaho Conservation Data Center at http://www2.state.id.us/fishgame/info/cdc/cdc.htm to obtain information. A complete list of sensitive vascular and non-vascular plants within the Clearwater subbasin can be found in Appendix D.

5.6.1 Clearwater Phlox

Life History

Clearwater phlox (*Phlox idahonis*) is approximately two feet tall and bears a cluster of blue, lavender, or pink flowers at the top of the stem, each with a pale yellow "eye". The flowers are about the size of a quarter (Johnson 1976). The rootstock is slender and shallowly buried, curving up at the tip into a simple remaculate stem 50 to 75 cm tall. The leaves are narrow, lanceolate and are up to 60 mm long and 15 mm wide (Wherry 1941). It is the only tall, leafy phlox in western North America (Johnson and Crawford 1978).

P. idahonis occurs in the area influenced by the Pacific storm tract and is associated with several disjunct coastal species (Johnson and Crawford 1978). It is generally found in grasslands surrounded by forest (Packard 1979), on stabilized creek banks, and in meadows (Johnson and Crawford 1978). *P. idahonis* can be found in 3 different habitat types: (1) open meadows dominated by herbaceous plants; (2) shrub communities dominated by *Alnus incana* or *Rhamnus alnifolia*; and (3) coniferous forest sites (Moseley and Crawford 1995). Their habitat elevation ranges from 2,800 to 3,275 feet (Johnson and Crawford 1978).

Threats
Factors affecting this species include destruction, modification, or curtailment of its habitat and range, overutilization for commercial, sporting, scientific or education purposes, disease, grazing, and the inadequacy of existing regulatory mechanisms (Johnson and Crawford 1978). Two rusts infect this species: *Uromycus plumarus* and *Puccinea douglasii*.

Limiting Factors
Phlox idahonis has a small, endemic population that could be subject to extirpation. This species is very specific in its climatic needs.

Historic/Current Distribution
Phlox idahonis is found in 3 sites in Clearwater County, Idaho (Packard 1979). It is the largest and most rare phlox in the Pacific Northwest (Johnson and Crawford 1978). The Clearwater Phlox probably had a wide distribution in the past, apparently having differentiated out of a Miocene species of broader distribution across northern North America (Packard 1979). It is thought that *Phlox idahonis* was part of a flora centering in the Keewatin area of north-central Canada that was exterminated in most of its range by Pleistocene ice sheets. The current range of this species is found south of the ice sheet, only in an area of peculiar climatic conditions. Range restriction in the Northwest probably followed post-Miocene climatic differentiation (Wherry 1941). *Phlox idahonis* is a narrow endemic known only from a series of populations and metapopulations within 2.5 km of Headquarters, ID (Schultz and Elliot 2000). Due to this restricted distribution, *P. idahonis* is considered the most rare member of Idaho's flora (Moseley and Crawford 1995). There are 8 occurrences of this species in the Clearwater subbasin documented in the Idaho Fish and Game's CDC.

P. idahonis is presently a Category 1 candidate for listing under the Endangered Species Act (ESA). It occupies a global rank of one set by the Biodiversity Information Network and International Association of Natural Heritage Programs and Conservation Data (Moseley and Crawford 1995).

5.6.2 Jessica's Aster

Life History
Aster jessicae is a robust, extensively rooted perennial, endemic to the Palouse region of Idaho and Washington. The species will grow to 1.5 meters tall, but averages about 1 meter. The foliage, particularly the upper part, is covered with a dense, uniform, soft pubescence. Leaves are abundant, broadly lanceolate, 6 to 13 cm long and 1.5 to 3.5 cm wide (Heidel 1979). The leaves get smaller as they get closer to the end of the stem (Lorain 1991a). The middle stem leaves generally partially clasp the stem at attachment and lower leaves tend to dry up and wither as the season progresses. Flowers are generally numerous, lavender in color, 1 to 1.5 in. in diameter. The flowers form a broad cluster at the top of the plant. *A. jessicae* flowers from late

July through September (Lorain 1991a). It is generally found in remnant prairie communities and the prairie/forest margins near canyon edges (Heidel 1979). Within these communities, *A. jessicae* grows on shoulders, banks, slopes, and at the top of draws. Such habitats have open or partially open exposures with variable slopes, and elevations vary between 1,600 and 3,850 feet. Substrates consist of productive silt/loams, which are moderately deep and sometimes gravelly (Lorain 1991a).

Threats

Threats to *Aster jessicae* include disease, grazing, collecting, introduced exotic species, and the destruction of its current habitat (Kennison and Taylor 1979).

Limiting Factors

Only small, endemic populations of *A. jessicae* remain after most native prairie habitat was lost to cultivation and grazing, which leaves this species vulnerable to genetic drift and localized extirpation. Small fragmented populations may also be at risk from low reproductive capacity due to poor pollen and seed dispersal.

Historic/Current Distribution

Aster jessicae occurs in the Palouse hills of southeast Washington and adjacent Idaho (Cronquist 1955). It was first collected in 1893 near Pullman, WA., but the species was not collected in Idaho until 1936, when it was found one mile south of Troy (Lorain 1991a). During 1990 a survey was completed to assess the range and extent of *A. jessicae* throughout Idaho. Nine of eleven historical sites were found, and twenty new populations were discovered (Lorain 1991a). Currently, 58 documented populations of *A. jessicae* occur in Idaho within Clearwater, Latah, Lewis, and Nez Perce Counties. Virtually all known populations occur on private land (Lorain 1991a). There are 64 occurrences of this species in the Clearwater subbasin documented in the CDC (2001). Three of these are on the Nez Perce Indian Reservation. In 1975, *Aster jessicae* was listed as a Candidate Threatened species (USFWS 1975), and in 1980 the species was listed as a Category 2 candidate species (USFWS 1990a).

5.6.3 Palouse Goldenweed

Life History

Palouse Goldenweed (*Haplopappus liatriformis*) is a perennial forb, endemic to the Palouse prairie region of Washington and Idaho (Kennison and Taylor 1979). Throughout its range, most communities are small (<100 individual plants) and often located on private property. The healthiest Palouse Goldenweed populations exist in grasslands or along grassland-forest edges. It can be found in stable floral communities dominated by bunchgrass with scattered patches of deciduous shrubs. Associated species are one flower helianthella (*Helianthella uniflora*), Canada goldenrod (*Solidago Canadensis*), prairiesmoke (*Geum triflorum*), and Nootka rose (*Rosa Nutkana*) (WA National Heritage Program 2000). Habitat sites are typically located on moderate slopes with skeletal silt/loams, at 1,900 to 3,000 feet (WA National Heritage Program 2000).

Threats

Existing threats include grazing, herbicide drift, and diminishing habitat quality. Due to small population sizes and occurrence near agricultural developments, much of the Palouse Goldenweed's habitat could be affected by erosion (Kennison and Taylor 1979). *H. liatriformis* is a serious conservation concern in Idaho because of its limited range, the nearly complete conversion of its prairie habitat to agriculture, the fragmented nature of the remaining habitat, the limited conservation options for private lands, and the small size of most populations (Mancuso 1997).

Limiting Factors

Competition with nonnative species may be a limiting factor (WA National Heritage Program 2000). *H. liatriformis* is extremely sensitive to disturbance and could be easily extirpated (Kennison and Taylor 1979). Small isolated populations may be at risk from genetic drift, inbreeding depression, or low reproductive capacity due to poor pollen and seed dispersal.

Historic/Current Distribution

In the early 1900s the taxon was fairly common in the Palouse Prairie and it is now restricted to a couple of relatively undisturbed sites (Kennison and Taylor 1979) within Idaho and Washington. There are 65 extant populations between the two states, with the majority of the communities located in Idaho. Craig Mountain, ID represents the southern range limit of the Palouse goldenweed, and because it is such a large community it is considered vital to the species' long-term conservation (Mancuso 1997). There are 29 reported occurrences of *Haplopappus liatriformis* in the CDC coverage of the Clearwater subbasin.

5.6.4 Spacious Monkeyflower

Life History

Mimulus ampliatus is a slender annual in the snapdragon family, with sticky glandular foliage and yellow flowers (Clearwater National Forest Terrestrial Resources 2001). It occurs in open grassland sites and forest openings. Plants usually grow in microsites with enhanced spring moisture or shade, at 2,600 to 6,900 feet, on volcanic or granitic soils (Clearwater National Forest Terrestrial Resources 2001). This species may be a good indicator of changes in local hydrology or increases in annual grasses (Meinke 1995).

Threats

The only threats likely to affect this species are livestock trampling and weedy invaders (Clearwater National Forest Terrestrial Resources 2001).

Limiting Factors

Spacious monkeyflower requires moist habitats such as wet meadows, trapped precipitation, or seepy rock outcrops (Clearwater National Forest Terrestrial Resources 2001, Meinke 1995).

Historic/Current Distribution

M. ampliatus is endemic to Idaho where it occurs in six scattered locations throughout Lewis, Nez Perce, Idaho, and Clearwater Counties. It is suspected to occur in Latah County (Clearwater National Forest Terrestrial Resources 2001). Historic samples collected in the Waha area of Nez Perce County suggest that this species may have once been locally plentiful, but much of the area is privately owned today, limiting access to conduct current surveys (Meinke 1995). There are 3 recorded observances of spacious monkeyflower in the CDC database.

5.6.5 Salmon-flowered Desert Parsley

Life History

Lomatium salmoniflorum is a perennial, parsley-like plant, 8-25 inches tall. Leaves are glabrous and pinnately dissected. *L. salmoniflorum* is one of the earliest species to begin flowering each year, and flowers are a salmon-yellow color. Flowers can be seen as early as February. Plants produce 1-9 umbels with 10-300 flowers per umbel. Seeds are dispersed by wind in April, followed by the senescence of the leafy, aboveground portion of the plant (Clearwater National Forest Terrestrial Resources 2001).

Habitat consists of steep basalt cliff faces, ledges, and stabilized talus. It occurs on all aspects, but the habitat is always open with very little cover of vascular plants. This species is seldom collected very far from canyon bottoms (Clearwater National Forest Terrestrial Resources 2001). Zonal vegetation of the surrounding areas ranges from lower grassland, shrubland, and ponderosa pine woodlands, to higher grassland, shrubland, and coniferous red cedar dominated forests. Elevations range from 800–2,300 feet in Idaho (Idaho Conservation Data Center 2001). This desert-parsley readily colonizes new ground, often flourishing in new road cuts.

Threats

Most habitats in Idaho occur on private land and the populations need to be better delineated. Many known populations are traversed by state and county right-of-ways and activities significantly impact the species (Clearwater National Forest Terrestrial Resources 2001). Management activities that could adversely affect *L. salmoniflorum* are roadside disturbance and gravel pit/quarry work where the plant is present (Clearwater National Forest Terrestrial Resources 2001).

Limiting Factors

L. salmoniflorum is restricted to basalt substrates rangewide (Idaho Conservation Data Center 2001). This species is attacked by weevils that lay their eggs within developing seeds to allow larvae to feed on the endosperm. Just before the seeds mature, the larval parasites exit by cutting a hole through the seed coat (Idaho Conservation Data Center 2001).

Historic/Current Distribution

L. salmoniflorum is regionally endemic, only occurring along a 100 mile stretch of the Snake and Clearwater Rivers. Idaho populations are found in two disjunct areas of the Clearwater River. The first is in the lower canyons between Lewiston and Cherrylane (Nez Perce County), and along a contiguous segment of the Potlatch River drainage (Latah County). The second population is located near Kooskia (Idaho County) along the Middle Fork and South Fork of the Clearwater River, and in the Clear Creek drainage (Clearwater National Forest Terrestrial Resources 2001). According to the CDC, there are 15 records of *L. salmoniflorum* in the Clearwater subbasin. It is a Global Priority 3 on the Idaho Native Plant Society list of rare flora in the state (Idaho Conservation Data Center 2001).

5.6.6 Broadfruit Mariposa Lily

Life History

The broadfruit mariposa lily (*Calochortus nitidus*) is a perennial herb that grows from a large, deep-seated bulb. The stem stands erect up to 18 inches tall with one reduced leaf near the midpoint of the stem, and a single large flat basal leaf that withers before flowering (Caicco

1992, Caicco 1987). Reproductive plants have between one and four large, showy, lavender to pink flowers with three petals. Each petal has three hairs and a deep purple crescent above a triangular lunate gland (Clearwater National Forest Terrestrial Resources 2001). *C. nitidus* produces most of its food during the growing season from its solitary basal leaf (Caicco 1988).

Threats

Calochortus nitidus and its habitat are threatened by grazing, trampling, land conversion to agriculture, competition with exotic species, and genetic uncertainty (Caicco 1988). Most of the areas where this species is found are used for grazing, and the present *C. nitidus* are at critically low numbers (Caicco 1988). The main factor influencing successful fruit production is herbivory of floral buds, flowers, and immature fruits by grazing animals. Deer and livestock lingering in a *C. nitidus* habitat for even a brief period of time can effectively eliminate a whole year's reproduction (Clearwater National Forest Terrestrial Resources 2001).

Limiting Factors

This mariposa lily reproduces by seed only, and not all plants capable of reproducing do so every year (Clearwater National Forest Terrestrial Resources 2001). *C. nitidus* undergoes great population fluctuations with no relationship between population density and the number of reproductive individuals. This causes population bottlenecks on a regular basis (Clearwater National Forest Terrestrial Resources 2001).

Historic/Current Distribution

Ownby described the historic range of *C. nitidus* as extending from the eastern border of the Palouse Prairie in Whitman County, WA., and Latah County, ID, to the Seven Devils Mts. above Riggins, ID (Hitchcock et al. 1969). Despite the previous extent of its coverage, the descriptions of the lily's former habitat suggest that this species has a diverse ecological range. *C. nitidus* was found in deep loess soils of the grassland prairie, and also in moist bottoms, rocky prairies, and open pine forests. Today it is common only at sites with thin rocky soils derived from a basaltic substrate and in areas within cropland too rocky to plow. In the past, low meadows and moist bottoms seemed to have been preferred locations. The Palouse Prairie, which was its historic habitat, has largely been converted to agricultural uses (Caicco 1988a, b). Presently this species is limited to nonagriculture areas on the periphery of its former range; mainly in open woodlands of the Clearwater River Canyon to the Northern Seven Devils Mountains (Bingham 1987, Caicco 1992). It is known to occur along the Middle Fork of the Clearwater River to within 10 miles of Lowell. These areas are steep, scattered small meadows in the canyon areas of Lewis, Nez Perce, and Idaho Counties (Clearwater National Forest Terrestrial Resources 2001). There are 51 occurrences of this species in the Clearwater subbasin documented in the Idaho Fish and Game's CDC.

Calochortus nitidus has been recommended to the U.S. Fish and Wildlife Service as a Category 1 candidate species for listing under the Endangered Species Act (Caicco 1988). Because sizable populations are extant on public lands, however, it was further recommended that a Habitat Management Plan (HMP) be developed for the species in lieu of formal listing.

5.6.7 Mountain Moonwort

Life History

Botrychium montanum is a small perennial fern with a single above ground frond. The frond varies in height up to about 12cm long, is a dull glaucous gray-green, somewhat succulent, and divided into two segments which share a relatively short common stalk (Wagner and Wagner 1981). The sterile segment is once pinnatifid with well-separated, irregular, angular, ascending lobes with the entire or toothed margins. The fertile segment is longer than the sterile segment, is branched and bears grape-like sporangia (Vanderhorst 1997).

This species almost always grows in organic substrates composed of cedar leaves or decomposed wood. It is usually associated with small hydrological features such as seeps, rivulets, draws, and swales. *B. montanum* is often the only plant growing in the dense litter of cedar leaves in deep shade, but also grows among mosses. It has been known to grow at elevations ranging from 2,960-6,000 feet (Vanderhorst 1997).

Threats

Threats to this species include timber harvest or any activity impacting or altering the hydrology of a habitat (Vanderhorst 1997).

Limiting Factors

B. montanum has an obligate mycorrhizal relationship with a fungus, and it cannot complete its life cycle without fungal infection. Nutrition supplied through a fungal symbiont may allow the fern to withstand repeated herbivory or prolonged dormancy (Vanderhorst 1997).

Historic/Current Distribution

The geographical range for *B. montanum* includes most of western North America: British Columbia, California, Montana, Oregon, Washington, and Idaho (Wagner and Wagner 1993). There are no occurrences of this species in the Clearwater subbasin documented in the Idaho Fish and Game's CDC.

The U.S. Forest Service currently lists *Botrychium montanum* as a sensitive plant. Most of the larger populations are in management areas designated as suitable timberland or are on forested slopes or at topographical and hydrological microfeatures not protected by standard riparian guidelines (U.S. Forest Service 1994).

5.6.8 Crenulate Moonwort

Life History

The crenulate moonwort is a thin, delicate, perennial plant with a pale yellow-green color that grows to about 10 cm tall. Plants arise from a single stem that divides into a single fertile frond and a sterile frond, which are attached near the middle of the plant from a 3-5 cm long common stem (Lorain 1990). The sterile leaf is attached to the main stem by a short (5mm) stalk, and singly divided into 2-5 pairs of lateral segments (pinnae) that are strongly flabellate with entire to shallowly scalloped outer margins. The fertile portion ranges from 2.5-9.5 cm long (Wagner and Wagner 1981; Wagner and Devine 1989; Lellinger 1985).

This species inhabits wet, swampy, low elevation sites near climax western red cedar communities (Lorain 1990). Plants are generally rooted around tress or shrubs or in depressions at the edges of marshes that dry out during the summer. It may occur either in sun or shade but does prefer partial shade (Clearwater National Forest Terrestrial Resources 2001). The nearest relative of crenulate moonwort is *B. lunaria*, which is frequently found growing in the same habitat (Lellinger 1985; Wagner and Devine 1989).

Threats
Timber harvest or any activity impacting the moisture of a site is expected to have a detrimental effect on the species, but these habitats are generally protected today (Clearwater National Forest Terrestrial Resources 2001).

Limiting Factors
Crenulate moonwort has an affinity for old growth western red cedar groves, and the rare distribution of this species leaves it in danger of localized extirpation (Clearwater National Forest Terrestrial Resources 2001).

Historic/Current Distribution
Botrychium crenulatum is very rare and localized, but demonstrates a rather extensive range. It is known to occur as far north as Oregon, Montana, and Alberta, and as far east as Utah (Wagner and Devine 1989). Two historical sites in northern Idaho have been identified - one in Boundary County, and the other in Clearwater County (Lorain 1990). The Clearwater site is located near Washington Creek on land between Potlatch Corp. property and the Clearwater National Forest (Clearwater National Forest Terrestrial Resources 2001). There is 1 occurrence of this species in the Clearwater subbasin documented in the Idaho Fish and Game's CDC. *Botrychium crenulatum* is a Category 2 candidate for federal listing (Lorain 1990).

5.7 Threatened & Endangered Plant Species

5.7.1 Spalding's Catchfly

Life History
Silene spaldingii is a long lived perennial herb with four to seven pairs of lance-shaped leaves and a spirally arranged inflorescence consisting of small greenish-white flowers. The stem is stout and the foliage is lightly to densely covered with sticky hairs (USFWS 1999a). The lower leaves are oblanceolate and the upper leaves are lanceolate (Atwood and Charlesworth 1987). Reproduction is by seed only (Lesica 1988). *S. spaldingii* is approximately 8-24 inches in height (Siddall and Chambers 1978). Spalding's catchfly is unusual in that it blooms late (July-August). Plants are extremely glandular and tend to be covered in wind blown fruits or spiderwebs (Lorain 1991b). The foliage is an unusual, pale green that tends to stand out against the straw colored grasses of last summer and early fall (Kagan 1989).

S. spaldingii grows on undisturbed slopes or flats in swales and drainages and in small, undisturbed vegetation strips surrounded by cultivated fields (Lorain 1991b). It is primarily restricted to mesic grasslands that make up the Palouse region in southeastern Washington, northwestern Montana, and adjacent portions of Idaho and Oregon (USFWS 1999a). Elevations range between 2,800 and 4,200 feet and the average temperature of the warmest month is less than 22 degrees C. The substrate is almost exclusively productive silt/loams (loess) that are moderately deep and sometimes gravelly (Lorain 1991b).

Threats
Spalding's catchfly and its habitat have been, and continue to be, threatened by a number of human-related factors. These include the invasion of nonnative species; the destruction, modification, or curtailment of its habitat and range; herbicidal drift; changes in land use, grazing practices, agricultural development and urbanization; disease and predation; and overutilization for commercial, recreational, scientific, or educational purposes (USFWS 1999a). The invasion

of yellow star thistle has highly impacted this species and locally extirpated small populations (USFWS 1999a).

Limiting Factors

This species is primarily restricted to slopes, flats, or swales in mesic grasslands (USFWS 1999a). The small populations of Spalding's catchfly are vulnerable to disturbances and may lose a large amount of genetic variability due to genetic drift.

Historic/Current Distribution

Spalding's catchfly was first collected by the missionary Spalding near Lapwai between 1836 and 1847 (USFWS 1999a, K. Gray, Idaho Native Plant Society, personal communication, June 10, 2002). It is currently known from a total of 52 populations in the United States and British Columbia, Canada. Of the 51 *S. spaldingii* populations in the U.S., 7 occur in Idaho (Idaho, Lewis, and Nez Perce Counties). The Nez Perce county population is one of the largest, containing more than 500 plants (USFWS 1999a).

Action by the federal government to protect *S. spaldingii* was initiated in 1975 when the Smithsonian Institute reported that this plant was considered threatened or endangered. The species' listing was found to be warranted in 1984, but was precluded by other pending listing actions. In 1995, a petition was received by the Service to list Spalding's catchfly as endangered. On October 22, 1999, the Federal Register published the Listing Priority Guidance to clarify the rule making in setting priorities with this species (USFWS 1999a). Spalding's catchfly was formally listed as Threatened by the USFWS in November 2001.

There are no known occurrences of this species in the Clearwater subbasin recorded by the CDC, although historical records suggest that a population once inhabited the Lawyer Creek drainage, but it is now thought to be extirpated (L. Lake, Nez Perce National Forest, Personal communication, April, 2001). Additional populations may be found if a concerted effort is made to survey suitable habitat within the Clearwater subbasin.

5.7.2 Macfarlane's Four O'Clock

Life History

Mirabilis macfarlanei is a long lived perennial plant with a deep-seated thickened root. The leaves are opposite and somewhat succulent, green above and whitish below (USFWS 1996). The flowers are conspicuous, up to 1 inch long by 1 inch wide (USFWS 2000b). The flowers are striking due to their large size and showy magenta color (USFWS 1996). They are funnel shaped in form with a wide expanding limb (USFWS 2000b). *M. macfarlanei* flowers from early May to early June, with mid-May being the usual peak flowering period (USFWS 1996).

M. macfarlanei is found on talus slopes in canyonland corridors where the climate is regionally warm and dry with precipitation occurring mostly in the winter and spring. It generally occurs as scattered plants on open steep (50 %) slopes of sandy or talus soils and generally having west to southeast aspects (USFWS 1996). *M. macfarlanei* populations range from approximately 300 to 900 meters (1,000 to 3,000 feet) in elevation (USFWS 2000b).

Threats

M. macfarlanei and its habitat have been, and continue to be, threatened by many factors such as: herbicide and pesticide spraying, landslides and flood damage, insect damage and disease, exotic plants, livestock grazing, off road vehicles, and possibly road and trail construction and maintenance.

Limiting Factors
The collecting of *M. macfarlanei* has been determined to be a limiting factor, as well as mining, competition for pollinators, and inbreeding depression (USFWS 2000b).

Historic/Current Distribution
M. macfarlanei was first described in 1936, and its historical distribution before that time is unknown (USFWS 1996). At the time of the original listing (USFWS 1979), *M. macfarlanei* was known from only three populations along the Snake River Canyon in Oregon and the Salmon River Canyon in Idaho, totaling approximately 25 plants on 10 hectares (USFWS 2000b). Currently, eleven populations of *M. macfarlanei* are known. Three of these populations are found in the Snake River Canyon area (Idaho County, Idaho and Wallowa County, Oregon), six in the Salmon River area (Idaho County, Idaho), and two in the Imnaha River area (Wallowa County, Oregon; USFWS 1985, USFWS 1996). There are no known occurrences of this species in the Clearwater subbasin recorded by the CDC.

The US Fish and Wildlife Service, after reviewing the species, initiated action to protect *M. macfarlanei* in 1975 by the publishing of a notice in the Federal Register. In 1979 the USFWS published a final ruling listing *M. macfarlanei* as an endangered species, and a recovery plan was developed and approved in 1985. In 1993 the USFWS proposed to reclassify *M. macfarlanei* from endangered to a threatened species. The number of individuals has increased two hundred sixty-fold: from 27 plants when listed, to approximately 7,212 plants in 1991 (USFWS 1996).

5.7.3 Water Howellia

Life History
Howellia aquatilis is an aquatic annual plant that grows 10-60 cm in height (USFWS 1994a). It has extensively branched, submerged or floating stems with narrow leaves 1-5 cm in length. It grows mostly submerged in the sediments of ponds and sloughs (Shelly and Mosely 1988). Two types of flowers are produced: small, inconspicuous flowers beneath the water's surface, and emergent white flowers which are 2-2.7 mm in length (USFWS 1994a). The plant is predominantly self-pollinating, and each fruit contains up to 5 large brown seeds (Shelly and Mosely 1988).

H. aquatilis grows in a firm blend of clay and organic sediments that occur in wetlands associated with brief glacial pothole ponds and former river oxbows (Shelly and Mosely 1988). These wetland habitats are filled by spring rains, snow runoffs, and depending on temperature and precipitation, exhibit some drying throughout the growing season (USFWS 1994a). Seed germination occurs in the fall in portions of the wetland edge where the water has receded (Shelly and Gamon 1996). The plants overwinter as seedlings (Lesica 1990).

Threats
H. aquatilis and its habitat have been, and continue to be, threatened by a number of human-related factors. These include timber harvest activities, livestock grazing, invasion by nonnative plant species, outright conversion of habitat to other uses, road construction and maintenance, military training exercises, and the overutilization for commercial, recreational, scientific or educational purposes (Shelly and Gamon 1996).

Limiting Factors

Seeds of *H. aquatilis* only germinate if its habitat dries out periodically and exposes the seed to the air. Climatic patterns of successive wet or dry years have a profound influence on abundance in any given year (Shelly and Gamon 1996). This species exhibits metapopulation characteristics. A metapopulation is a collection of interdependent populations affected by recurrent extinctions and linked by recolonization. The existence of multiple *H. aquatili* populations is critical for this species, because it inhabits patches in a shifting mosaic of habitats (Shelly and Gamon 1996).

Historic/Current Distribution

Water howellia historically occurred over a large area of the Pacific Northwest, but today is only found in specific habitats. It is currently known on a total of 13 sites: one in Idaho (Latah County); three in Washington, and nine in Montana (Shelly and Gamon 1996). The Idaho occurrence, currently under private ownership, has been willed to a conservation organization (Shelly and Mosely 1988). This species is believed to have been extirpated from at least one historical location in Idaho (Shelly and Mosely 1988). There are no known occurrences of this species in the Clearwater subbasin recorded by the CDC.

Action by the federal government to protect *H. aquatilis* was initiated on December 15, 1980 when the species was designated as a Category 2 candidate species (USFWS 1980). In 1990, the species category was changed to Category 1 (USFWS 1990b). In October 1991, the USFWS received a petition to list the species as endangered. The Service subsequently published a listing proposal in 1993 and a final rule listing the species as threatened in 1994 (USFWS 1994a).

5.7.4 Ute Ladies' Tresses

Life History

Spiranthes diluvialis is a perennial, terrestrial orchid with stems 20 to 50 centimeters tall arising from thick, tuberous roots. The flowers consist of 3 to 15 small white or ivory colored flowers clustered into a spike arrangement at the top of the stem (USFWS 1992). The species is characterized by stout, whitish, ringent (gaping at the mouth) flowers. It typically blooms from late July through August, in some cases through September (USFWS 1992). Blooms have been recorded as early as July and as late as October (Sheviak 1984).

S. diluvialis occurs primarily in areas where the vegetation is relatively open and not overly dense, overgrown, or overgrazed (Coyner 1990). Soils may be inundated early in the growing season, normally becoming drier but retaining subsurface moisture through the season (USFWS 2001a). Populations of *S. diluvialis* occur in relatively low elevation riparian meadows (USFWS 1992).

Threats

The riparian and wetland habitats that support this species have been heavily impacted by urban developments that degrade natural stream stability and diversity (USFWS 2001a). The conversion of riparian/floodplain land to agricultural uses has destroyed habitat for *S. diluvialis* in many places. Threats include grazing, changes in hydrology, recreation, exotic species invasions, pollinator impacts, herbicide and pesticide use, and habitat conversion.

Limiting Factors

S. diluvialis is endemic to moist soils in mesic or wet meadows near springs, lakes, or perennial streams.

Historic/Current Distribution

Historically, the species was known to exist in Colorado, Utah, and Nevada. Currently, *S. diluvialis* is found in its original habitats in addition to Idaho, Montana, Nebraska, Washington, and Wyoming (although it is possibly extirpated from Nevada). In Idaho, approximately 1,170 plants are known from a total of 20 occurrences in eastern Idaho along the South Fork of the Snake River (USFWS 2001a). These occurrences range in size from one plant to a few hundred individuals. Most of the Idaho sites are very small (less than one acre in size, based on the amount of occupied habitat), although additional potentially suitable habitat exists along the South Fork of the Snake River and elsewhere in the state (USFWS 2001a). There are no known occurrences of this species in the Clearwater subbasin recorded by the CDC.

Federal action on this species began on September 27, 1985 (Coyner 1990). On November 13, 1990, the Service published a proposal to list *S. diluvialis* as a threatened species (USFWS 1992).

5.8 Culturally or Economically Important Species

Many native plants have cultural and/or economic value to humans. While impossible to cover the vast number of species or uses of such plants in this document, we felt it was important to highlight a few of the more significant species within the Clearwater subbasin. Huckleberries were selected because of their commercial and cultural significance and because fire suppression activities may be posing a threat to healthy populations. Camas was once plentiful within the subbasin and was a staple food source for the Nez Perce people. Today, camas habitat has been significantly reduced due to agricultural land uses but the roots of the plant are still used by Nez Perce in feasts and ceremonies. The lomatiums are another important group of plants found in the subbasin.

5.8.1 Huckleberry

Life History

Big huckleberry (*Vaccinium membranaceum*) is a native, rhizomatous, frost-tolerant shrub. It occupies moist, moderately deep, well-drained soils and is rarely found in valley bottoms. Although tolerant of moderate shade, big huckleberry does best on cool mesic sites with minimal overstory, acidic soils, and a 25-40% slope. It may occur in early to late seral stages and is usually an understory dominant in subalpine climax communities. Big huckleberry is an early seral species in western red cedar-western hemlock communities, and in high elevation grand fir communities on north facing slopes. In spruce-fir forests big huckleberry has a significant presence 1-5 years after disturbances (Simonin 2000).

Reproduction through seed is rare, and populations are usually maintained through lateral expansion of vegetative clones. Big huckleberry is moderately tolerant of moisture deficiencies, but germination is extremely reduced by water stress (Simonin 2000). Some berry patches are considered the result of wildfires that occurred before recent fire suppression policies. Plants subjected to regular low intensity burns may be better suited to surviving fires than individuals that grew without frequent fire activity (Simonin 2000).

Threats/Limiting Factors

Big huckleberry can occupy a wide ecological range of moisture, acidity, slope and soil type, but lack of disturbance and an increase in canopy cover will eventually lead to the loss of the huckleberry component. Light grazing by sheep has been shown to be beneficial to huckleberries by reducing competition from understory grasses and adding nitrogen to the soil. Overgrazing by sheep caused a reduction in berry production for two years, but production increased the third year after treatment (Minore et al. 1979).

Wildlife/Historic Values

Native Americans used big huckleberry extensively and the patches were burned annually in the autumn, after berry harvest, to reduce encroachment by trees and shrubs (Simonin 2000). The yield of each site varied from season to season, and density of tribal camps would depend on abundance (Ames and Marshall 1980). Huckleberry stems, leaves and fruit are an important food source for bears, ungulates, small mammals and birds. Huckleberries serve as a primary food source for grizzly bears in the summer.

Historic/Current Distribution

Current fire suppression strategies have increased shrub and tree cover over many old huckleberry sites. Big huckleberry is usually an early seral plant and is moderately shade tolerant, but closed canopy cover has eliminated many historic huckleberry habitats.

5.8.2 Camas

Life History

Camas (*Camassia quamash*) grows in moist prairies and glades of pine forests in the Pacific Northwest. It is a liliaceous bulb one to two inches in diameter with narrow basal leaves and bright blue flowers (Scrimsher 1967). Camas prefers deep, rich soils, and grows best when the soil has been slightly broken up (Ames and Marshall 1980).

Threats/Limiting Factors

Tilling, grazing and agricultural practices have greatly reduced the abundance of this species on the Camas Prairie.

Wildlife/Historic Values

Lewis and Clark noted camas as being the leading staple of the Nez Perce diet and likened it to a sweet potato. It is harvested in mid-July through September, after the flowers and seeds have dropped. Only the younger bulbs are harvested and either eaten raw or prepared for later consumption. If the prepared camas is stored free of moisture it will keep almost indefinitely, and it was a major food source during the winter months when few plants were available (Scrimsher 1967).

Historic/Current Distribution

The Camas Prairie is bounded on the north and east by the Clearwater River, on the south by the Salmon River, and on the west by the Snake River. It covers approximately 200,000 acres and was once a major harvesting ground for camas bulbs by Native Americans. Before extensive tilling, the entire prairie would look like a blue lake when the camas was in bloom.

5.8.3 Lomatium Spp.

Life History

Lomatium (*Lomatium* spp.) is classified in the family Apiaceae and related to anise, hemlock, carrot, and celery. In general, this genus is characterized as a native perennial with thick taproot, pinnately dissected leaves, and umbel shaped inflorescences (Lackschewitz 1991). Various species of the genus Lomatium are found throughout the Clearwater subbasin, and the most widely used by Native Americans and local wildlife were *L. canbyi* (wild potato), *L. cous* (cous, kouse, or biscuitroot), *L. grayi* (wild celery) and *L. macrocarpum* (large-fruit lomatium). Common names vary by region and are not always given to the same species. Both *L. macrocarpum* and *L. cous* occur on rocky, dry soils on the open, flat slopes of foothills (Lackschewitz 1991).

Threats/Limiting Factors

Lomatium survives on scattered, barren patches of lithosol habitats by means of nutrients stored in a thickened root (Hunn and French 1981). Livestock grazing, intensive agricultural practices, and the widespread use of herbicides have negatively impacted this genus (Nez Perce National Historic Park 2001).

Wildlife/Historic Values

In the winter, the Nez Perce traditionally settled in lower elevations along drainages and subsisted on stockpiles of dried salmon and stored roots. The appearance of cous roots (*L. cous*) in early May was of critical importance as the first fresh food of the spring. While traveling down Alpowa Creek, Lewis and Clark noted that in early May many Nez Perce were distributing themselves throughout the plain to collect cous (Sappington 1989). Lewis and Clark mentioned the use of cous repeatedly as one of the main food sources of the Nez Perce and described it as being very valuable (Sappington 1989). Native Americans used many types of Lomatium as food or medicinal resources, and used approximately 10 species commonly. The average tuber of *L. canbyi* weighs 11g and provides 1080KCal/kg of energy. *L. cous* averages 10.5g and provides 1270KCal/kg of energy. In addition to providing an energy source, *L. nudicaule* stems provide vitamin C in the form of 66mg of ascorbic acid per 100g of stem material (Hunn and French 1981). Biscuitroot (*Lomatium cous*) is extremely important as a fall food source for both humans and grizzly bears because it is almost 30% starch and easily digestible (Mattson 1997)

Historic/Current Distribution

Historical distribution is unknown, but many species have become scarce due to farming, grazing, and pesticides (Nez Perce National Historic Park 2001).

5.9 Vegetation Limiting Factors

The driving force behind the decline of plant species in the Clearwater subbasin is due to destruction, degradation, and fragmentation of habitats. Loss of habitat occurs through a variety of environmental and anthropogenic processes that limit plant species' abundance. Limiting factors that restrict or hinder vegetation can be subdivided into three broad categories: physical, biotic, and human cultural limiting factors.

5.9.1 Physical Limiting Factors

Physical limiting factors encompass environmental aspects such as sunlight, temperature, and water. The amount of sunlight a species needs can limit the range of suitable habitat. In the conifer forests of the subbasin, some trees are intolerant of shade, thereby restricting their distribution. Ponderosa pine is shade intolerant, only growing in less dense and drier habitats (Cooper et al. 1991). Grand fir is also shade intolerant and does not establish itself under closed canopies (Daubenmire and Daubenmire 1984). Quaking aspen and black cottonwood stands do not persist in the absence of sunlight and are usually replaced by more shade tolerant species (Howard 1996), such as western hemlock and western red cedar. These species are very shade tolerant and their growth is correlated with valley bottoms and close growing stands (Tesky 1992 a,c). These same trees are also subject to temperature and water constraints, limiting their appearance to certain elevational gradients, where an increase in elevation correlates to a decrease in temperature. Species such as whitebark pine and subalpine fir occupy high elevations where deep winter snowpacks and cool summer temperatures are characteristic. If temperature and water gradients were to decrease, other species will eventually compete and take over (Tomback et al. 2001)

Understory vegetation is just as susceptible to physical limiting factors as the associated tree species. Shrubland and grassland cover types, as well as forbs, are respectively limited to growing in certain soil, moisture, and temperature regimes. Slight changes can affect the composition of an ecosystem. For example, mountain moonwort requires very moist, shady conditions to survive (Vanderhorst 1997). It is closely associated with western red cedar. Loss of cedar stands to logging result in a decreased canopy cover that directly affects populations of moonwort and similar understory vegetation by increasing the amount of sunlight, thereby altering temperature and moisture levels.

Duration, timing, frequency and intensity of climatic factors such as flooding and drought, have serious affects on vegetation. Some examples of vegetation limited by these factors are grasslands, which are impacted by debris accumulation, sediment deposition and scour erosion caused by flooding. Kentucky bluegrass is intolerant of prolonged flooding, high water tables, or poor drainage (Wasser 1982). Shrubs such as alder are sensitive to prolonged flooding above the root crown and disturbance from flooding seems to inhibit normal growth in black hawthorn (Habeck 1991). Chokecherry is intolerant of poor drainage and prolonged flooding. White alder seeds germinate rapidly on sunny, wet mineral sites exposed from receding flood waters. Alternately, black cottonwood persists on flood plains and has a low tolerance to drought (Holifield 1990).

5.9.2 Biotic Limiting Factors

Biotic limiting factors include natural processes such as herbivory, competition, disease, and insect damage that reduce a species' viability and hinder population growth. Consumption of vegetation by wildlife or livestock limits populations. Understory components are most vulnerable to herbivory, but certain tree species such as aspen are used as forage for many animals (Shepperd et al. 2001). High densities of deer have a detrimental effect on the regeneration of some conifer species, resulting in the growth and dominance of deciduous tree species (Augustine and McNaughton 1998). Grasslands are especially vulnerable to and limited by grazing impacts. The productivity, frequency, and cover of perennial bunchgrass species such as Idaho fescue and bluebunch wheatgrass have been reportedly reduced 50-100% in the Bitterroot Mountains because of grazing (Belsky and Blumenthal 1997).

Interspecific and intraspecific competition between plant species is a part of any natural habitat. Certain species are limited because they are not good competitors. Their living requirements are so specialized that any changes in habitat could lead to invasion of another species. Some tree species, such as the Douglas-fir, are good competitors, and are able to exist within a variety of tree cover types (Cooper et al. 1991). Cheatgrass is an aggressive competitor, and has displaced native perennial grasses over much of the Clearwater subbasin. In areas of disturbance, nonnative plant species compete with native species, resulting in the colonization of annual grasses and noxious weeds, which alter the makeup of a landscape (Quigley and Arbelbide 1997; Black et al. 1997). Idaho fescue and bluebunch wheatgrass are susceptible to competition from diffuse (*Centaurea diffusa*) and spotted knapweed (*C. maculosa*). Even under good range conditions, bunchgrasses offer little resistance to knapweed invasion (Agriculture Canada 1979). The distribution of whitebark pine is somewhat limited and strongly influenced by Clark's nutcrackers, which are important in the dispersal of seeds and establishment of seedlings (Tomback et al. 2001).

Firs are susceptible to several wood rotting fungi that cause heart, trunk, butt, or root rots,including brown stringy rot, red heart rot, red ring rot, shoestring rot, brown cubical rot, white spongy root rot, and white pocket rot (Fowells 1965). Hemlock dwarf-mistletoe (*A. tsugense*) infects grand fir occasionally (Noble and Ronco1978). The most important fungi attacking western red cedar are root, butt and trunk rots. *Poria asiatioa* and *Phellinus weiri* are problem fungi for cedar in the subbasin. Just as firs and cedar are susceptible to fungi, pines suffer from white pine blister rust, which kills the upper cone bearing branches of large trees and less commonly, the entire tree. Blister rust has a severe impact on saplings, often preventing regeneration. (Minore 1990). Dwarf mistletoe (*Arceuthobium campylopodum*) is a common parasite on western hemlock which decreases growth and increases mortality in old growth stands (Tesky 1992c). A common pathogen attacking aspen stands is stem canker (*Hypoxylon mammatum*). Several other types of canker are also detrimental to tree growth (Shepperd et al. 2001). Bluebunch wheatgrass seeds are susceptible to soilborne pathogens such as *Podosporiella verticillata* (Zlatnik 1999).

Trees weakened by wood rots often become infested by fir engraver beetles and usually succumb to windfall and breakage. Firs are attacked by numerous insects. The most destructive include western spruce budworm, western balsam bark beetle, and balsam woolly aphid (Alexander et al. 1986). The western spruce budworm generally attacks low and middle elevation fir forests, but is largely absent from high elevation forests. Other insect pests include the Douglas-fir tussock moth, western black-headed budworm, and fir engraver beetle. Pine trees are also killed by the mountain pine beetle (*Dendroctonus ponderosae*), usually after being weakened by blister rust. Western red cedar has several insects that cause harmful damage. The gall midge (*Mayetiola thujae*) attacks the seeds of cedar. Seedlings are occasionally damaged by weevils (*Steremnius carenatus*), and larger trees are often killed by bark beetles, (*Phloeosinus sequoiae*) and the western red cedar borer (*Trachykele blondeli*; Minore 1990). The western hemlock looper (*Lambdina fiscellaria lugubrosa*) has caused more mortality of western hemlock than any other insect pest. Bluebunch wheatgrass seeds are susceptible to wireworm damage (Zlatnik 1999).

5.9.3 Human Cultural Limiting Factors

Cultural limiting factors include urbanization, farming, logging, grazing, mining, road building, damming and channelizing of streams, pollution, the introduction of nonnative species, fire suppression, and recreation. All of these activities have contributed to the decline of forests, rangelands and aquatic habitats. Most of Idaho's rare, endangered, or focal plant species are threatened by various factors, including habitat destruction and fragmentation from agricultural and urban development, grazing and trampling by domestic livestock and wildlife, herbicide treatment, and competition from nonnative plant species.

Urbanization can fragment or entirely remove native habitats. Population growth and urban sprawl also affect plant species within the subbasin. As population size increases, so does the amount of land required for residential and commercial needs. Within the Clearwater subbasin, large expanses of palustrine wetlands in the Reubens, Craigmont, and Ferdinand areas have been converted to croplands. Remaining wetland communities are often degraded by livestock grazing, road development, urban expansion, and altered hydrologic regimes (U.S. Geological Survey 1996). Since the turn of the century, 94% of the Palouse grasslands have been converted to crop, hay or pasture lands, including areas of the lower Clearwater subbasin (Washington State Department of Natural Resources 1997, Data Source: DNR and GAP Analysis/Univ. of Washington 1997).

Roads promote the spread of invasive nonnative plants (Sheley and Petroff 1999) via three mechanisms: providing habitat by altering conditions, making invasions more likely by stressing or removing native species and allowing easier movement by wild or human vectors (Trombulak and Frissell 2000).

Livestock grazing changes the species composition of native ecological communities and significantly impacts riparian areas. Grazing can strip the banks of rivers and streams, leading to erosion and degradation of aquatic ecosystems. In Idaho's forests, grazing has been shown to negatively impact open forest and meadow vegetation. Heavy, season-long grazing by cattle changed species composition and lowered herbage production on dry and moist mountain meadows (Zlatnik 1999). While livestock grazing may lead to reduced plant cover, it also leads to the compaction of soil. Runoff from summer storms increases, as does erosion, resulting in the loss of sediment needed to sustain vegetation (Belsky and Blumenthal 1997).

Logging activities account for most of the fragmentation in the subbasin's forested areas. Fragmented habitats result in decreased species density. Fragmentation of habitat creates a barrier between intraspecific species and restricts plants that reproduce by pollination from spreading. Besides deforestation, roads built to access logged areas also serve as a source for fragmentation. Logging also causes erosion by destabilizing the soil. Past logging practices have triggered large landslides within the Clearwater subbasin, accounting for loss of native vegetation and the potential for invasion of noxious weeds. Logging can drastically alter native vegetation by decreasing canopy structure, thereby increasing the amount of aggressive sun tolerant species that will eventually outcompete shade tolerant species.

One of the most logged and cultivated tree species is Douglas-fir. This tree is a good competitor, which makes it valuable as a commercial resource. Ponderosa pine is the most commercially valuable and productive timber tree in the western United States. Western hemlock is valued for its qualities as a pulpwood for paper and paperboard products. Western red cedar wood is harvested for utility poles and fence posts. Harvest of pacific yew for Taxol production has impacted some grand fir forests.

Mining can impact ecosystems by destroying habitat, and polluting and degrading streams and waterways. Mining affects the turbidity levels and substrate quality of a stream, which affect nutrient levels for streamside vegetation. Mining disturbances may lead to invasion of noxious weeds and other nonnative plant species. Mining can lead to detrimental affects on vegetation through the disposal of wastes into streams or on land, the transport of ores, and pollution from refinement. Mining pollution damages ecosystems through the introduction of sulfur compounds, ozone, pesticides and heavy metals. Airborne pollutants such as ozone and acid precipitation often impact natural communities miles away from the source. A common process derived from the disturbance of ground materials through mining that results in dispersion of elements from a mining site is acid drainage, which is the formation and movement of highly acidic water rich in heavy metals. This acidic water forms through the chemical reaction of surface water (rainwater, snowmelt, pond water) and shallow subsurface water with rocks that contain sulfur-bearing minerals, resulting in sulfuric acid. Heavy metals can be leached from rocks that come in contact with the acid and the resulting fluids may be highly toxic. When mixed with groundwater, surface water and soil, they can have harmful effects on plants, as well as wildlife (EPA 2001).

Dams impact wildlife through the loss of vegetation, especially valuable riparian areas. They also affect the ability of drainages to support past and present animal species (USFWS 1962). The construction of Dworshak Dam formed a long, narrow lake nearly 54 miles long and inundated 16,970 acres. The vegetation existing before flooding consisted of open coniferous timber (7,300 acres), dense coniferous timber (6,100 acres), brush (1,190 acres), grass (510 acres), agricultural crops (170 acres), along with 1,700 acres of water and streambed (USFWS 1962). The open conifer woodland was composed mostly of Douglar-fir and pine associations. The dense conifer stands consisted largely of Douglas-fir and cedar-hemlock associations. Grand fir tended to replace western hemlock, and ponderosa pine replaced white pine in the lower or more exposed sites. Where little or no overstory occurred, deciduous trees, brush, and forbs assumed greater importance. A few of the drier slopes did not support trees and were covered with weeds, grasses, or shrubs, such as hawthorn and serviceberry. Shrub species occurring in the brush and open coniferous types at low elevations included willows (*Salix* sp.), redstem ceanothus (*Ceanothus sanguineus*), mountain maple, serviceberry, cascara (*Rhamnus* sp.), elderberry (*Sambucus* sp.), redosier dogwood, rose, spirea (*Spirea betulifolia*), snowberry (*Symphoricarpos* sp.), oceanspray (*Holodiscus* sp.), thimbleberry (*Rubus parviflorus*), ninebark, and syringa (*Philadelphus lewisii*; USFWS 1962).

Fire suppression has caused the ecological decline of grasslands, shrublands, and open forests. Fire is an integral part of many ecosystems, maintaining natural vegetation. Some plant species require fire to trigger the release of their seeds, such as lodgepole pine, which aggressively invades and persists in burned over areas. Fire also clears out the underbrush in forests, and the prevention of all forest fires actually leads to fires that burn hotter and longer due to the accumulation of underbrush. Grand fir stands need fire or some other periodic disturbance to maintain itself on sites (Howard and Aleksoff, 2000). Quaking aspen needs fire, clearcutting, or other disturbances to persist (Perala 1990). In the exclusion of fire, sprouting shoot numbers remain low and most are consumed by domestic and wild ungulates (Manier and Laven 2001). Fire suppression creates thick even-aged Douglas-fir stands that increase the potential for severe, stand destroying wildfires. For meadows, fire suppression likely will result in the extensive invasion of trees, and the upward movement of timberline (Franklin and Dyrness 1973). Fire suppression can also impact local populations of rare, endemic taxa.

Recreation affects vegetation by trampling, which initially bends and weakens leaves and branches and ultimately breaks them. Trampling directly damages plants by reducing photosynthetic surface area and loss of seed production, and eventually kills some vegetation species, changing the community composition (Luckenbach and Bury 1983). Trampling damage can occur from shrub steppe habitat, to meadows and forest by hikers, horses, motorcycles, and other off road vehicles, resulting in the destruction of habitat and the harassment of wildlife. Dale and Weaver (1974) showed that grass communities are more resistant to trampling than shrub communities. Significance of impact is related to rarity of the vegetation type, and to the value of the vegetation to wildlife species that depend on it (Cole and Landres 1995). A rare species in the Clearwater subbasin, the Clearwater phlox, resides in isolated locations subject to trampling from livestock and off-road vehicles.

Road building associated with agriculture, logging, mining, recreation, and urban development causes erosion, landslides, and degrade water quality in streams and rivers. Roads also contribute to the major threat to biological diversity: habitat fragmentation. Plant populations are then vulnerable to all the problems associated with rarity such as environmental catastrophes, and fluctuations in habitat conditions. Roads facilitate the invasion of weeds, pests, and pathogens, many of which are exotic. A road transforms the physical conditions of the environment, creating edge effects.

An overview of limiting factors for the major vegetative cover types within the Clearwater subbasin is provided in Table 37.

Table 37. Limiting factors of vegetative cover types within the Clearwater subbasin

LIMITING FACTORS	Western Hemlock	Western Red Cedar	Mountain Hemlock	Subalpine Fir	Grand Fir	Douglas-Fir	Lodgepole Pine	Ponderosa Pine	Whitebark Pine	Aspen	Black Cottonwood	Mountain Meadows	Herbaceous Wetlands	Native Bunchgrass	Shrublands
Habitat loss/ destruction/ modification															
Grazing						X		X		X		X	X	X	X
Agriculture								X					X	X	X
Urban sprawl								X			X		X	X	X
Human construction projects	X	X			X	X		X			X		X	X	X
Fire suppression							X	X	X	X				X	X
Logging/ forest fragmentation	X	X			X	X	X	X							
Erosion/ noxious weeds								X			X	X	X	X	X
Recreation											X	X			
Physical Factors															
Shading					X			X		X	X				
Moisture	X	X								X	X	X	X		X
Climate				X					X			X	X		
Biotic Factors															
Succession								X	X	X		X			
Limited/ specialized reproductive capabilities							X		X		X				
Herbivory/ Insect Damage		X	X		X	X		X	X	X					
Natural Processes															
Subject to/ dependent on natural disasters							X	X	X	X	X				X
Global or regional limitations			X							X			X		