Section 4.2 Contents

4.2 Watershed Management Mitigation and Conservation Strategies

4.2.1 Introduction to Watershed Management Mitigation and Conservation Strategies

Intent and Coverage

The Watershed Management Mitigation and Conservation Strategies cover the City's land management activities in the Cedar River Municipal Watershed (Map 2). These strategies are intended to provide the following:

- Comprehensive, long-term protection for the watershed ecosystem, encompassing commitments not to harvest timber for commercial purposes in the watershed, effectively placing all forest outside limited developed areas in reserve status;
- Measures to protect and restore stream, riparian, and upland forest habitats;
- Removal of a large part of the existing road network;
- Guidelines for watershed operations designed to minimize and mitigate impacts of those operations; and
- Additional measures to protect species of greatest concern and their habitats.

For the purposes of this HCP, the combination of the above measures are described as *managing the watershed as an ecological reserve*. References in this chapter to a *watershed reserve* or *reserve status* refer to this set of commitments, but do not infer that the municipal watershed will not be managed for water supply and hydroelectric generation. As described in detail below in this section, these watershed management activities include water supply, hydroelectric, and general watershed operations, ecosystem restoration, research, monitoring of habitat and species, educational activities, recreation in designated areas, and a variety of other activities.

Background and Context

Regional Context and Significance of the Municipal Watershed

Although logging has occurred within the land area encompassed by the current municipal watershed for over 100 years, the watershed represents a very important element and opportunity in any regional effort directed at protecting salmonid fishes and species dependent on mature, late-successional, and old-growth conifer forests. A wide variety of animal species in the Pacific Northwest is dependent on mature, late-successional, and old-growth conifer forests, including many species that use aquatic and riparian habitats (Ruggiero et al. 1991a, b; FEMAT 1993). As a result of substantial and widespread loss, fragmentation, and general degradation of old-growth forest habitats, as well as urbanization and removal of forests in the lowlands, these fish and wildlife species collectively represent one of the greatest at-risk groups in the region (Thomas et al. 1993).

The Cedar River Municipal Watershed contains the headwaters of the major river that discharges into Lake Washington. The watershed is important not only as the region's primary water supply but also as the major source of downstream river flows necessary to maintain habitat for anadromous salmonids (sections 3.2.5 and 3.3.2). Finally, it is also a very large tract of land – about 90,546 acres – in an area of key importance to many at-risk species (sections 3.4-3.6).

Virtually all of the low-elevation, old-growth forest in the Puget Sound region has now been logged and much has been developed. The municipal watershed offers one of the few significant opportunities to reestablish a block of mature, late-successional, and old-growth forest below 3,000 ft in a manner that could effectively link this forest block to existing old growth in other areas of the Cascade Mountains.

Logging activity within the municipal watershed began in the 1880s at low elevations in the west end of the watershed, and, over time, progressed eastward and to higher elevations. Although railroad-caused forest fires frequently occurred in many regenerating stands harvested near the turn of the twentieth century (Section 3.2.2), many of these stands in the watershed have been growing without interruption since the 1930s – some even longer. Map 5 spatially depicts the existing age distribution of forest stands in the municipal watershed, and Figure 1.2-1 graphically displays acreages in different age classes.

Although early harvest practices often entailed logging all or nearly all forest adjacent to streams, much of the riparian forest at lower elevations, especially in the western portion of the watershed, is now on its way to recovering its natural functions. Partly because the watershed has been managed primarily as a municipal water supply for nearly a century, about 60 percent of the watershed as a whole now has forest over 50 years of age (Figure 1.2-1). As Map 5 indicates, the second-growth forest in most of the lower watershed is now relatively mature, mostly about 60-79 years old. Many streams flowing through the conifer forests at the lower elevations of the watershed, including the mainstem of the Cedar River between Cedar Falls and Landsburg, represent some of the better stream and riparian habitat in the entire Cedar River Basin (sections 3.2.2 and 3.2.3).

Existing habitats within the watershed are shown on Map 6 and discussed in Section 3.2.2, and cover types are shown on Map 7. Nearly 14,000 acres (16 percent) of the watershed's original native conifer forest remains today, but most is fragmented and isolated in several locations. All of this native forest is over 189 years, most of it is over 250 years old, and some of it is as much as 800 years of age. For perspective, this acreage equals about one-third of the remaining forest over 150 years of age on the 1.1 million acres of state land in western Cascades planning units covered by the Washington Department of Natural Resources' HCP (WDNR 1997).

Ranging from about 540-ft elevation at the Landsburg Diversion Dam to about 5,400-ft elevation near the Cascade crest, the watershed provides a corridor from low to high elevation, from the Douglas-fir and western hemlock forests of the Cascade foothills to the Pacific silver fir forests of middle elevations and the mountain hemlock forests and subalpine parklands of the higher mountains. To the northwest of the watershed is Tiger Mountain State Forest. A recently established natural area on Rattlesnake Ridge that is managed by the WDNR abuts the watershed on its northern boundary near Cedar Falls.

The easternmost portion of the Cedar River Municipal Watershed is also a major north-south link in the federal late-successional reserve system in the Cascade Mountains that was created by the Northwest Forest Plan (Tuchmann et al. 1996). The northern spotted owl Critical Habitat Unit (CHU # WA-33) (Fed. Reg. Vol. 57, Pp. 1796-1838) is also an important element in that reserve system. Federal and state biologists concerned about species dependent on late-successional and old-growth forests, such as the northern spotted owl and marbled murrelet, identified the I-90 corridor area of the Central Cascade Mountains as very important to the well being of such species (WAC 222-16-086; also see sections 2.3.4, 3.5.2, and 3.5.3). Also, the Wilderness Society recently identified the Central Cascade Mountains – containing the municipal watershed – as one of the 15 most “endangered” wild lands in the U. S. (Seattle Times, June 21, 1999), largely because of the fragmentation and loss of old-growth forest.

The I-90 corridor area has two features that make it of great significance with respect to landscape connectivity for species dependent on late-successional and old-growth forests. First, historic checkerboard (intermingled) ownership of federal and private land has resulted in a large degree of forest fragmentation overall and a substantial reduction of old-growth habitat on private lands, on which nearly all old-growth forest has been logged. Second, the federal ownership in the national forests has a relatively narrow east-west width in this area, restricting species dependent on old-growth forest to a very narrow north-south corridor for migration and dispersal (see Map 4).

In view of these landscape-level considerations, federal biologists classified the I-90 corridor, including the eastern portion of the watershed, as an area of critical importance for species dependent on late-successional or old-growth forests and a Special Emphasis Area for the northern spotted owl in Washington (USDI 1995a; see also Section 2.3.4). In essence, this area links habitats in the northern Cascades with those in the southern Cascades of Washington. This area of the I-90 corridor has been identified with repeated emphasis as being very important relative to dispersal of juvenile northern spotted owls and sustaining populations of spotted owls, as discussed in the Draft Recovery Plan for the Northern Spotted Owl (USDI 1992b).

Although the Cedar River Watershed was not identified as a key watershed for anadromous salmonids and resident bull trout in the report of the federal Forest Ecosystem Management Assessment Team (FEMAT 1993) because it was not all federally owned land, the watershed is clearly of great importance for these species. The FEMAT report reviewed a number of options for forest ecosystem management and strategies to protect key watersheds, as well as other watersheds on federal land, all with a focus on restoring ecosystem processes important in old-growth forests. The strategies reviewed included different options for:

- Establishment of a late-successional reserve system;
- Measures to protect and restore riparian areas through riparian reserves, management guidelines, and buffers for streams and other aquatic habitats;
- Implementation of silvicultural methods to restore natural forest processes and habitat;
- Guidelines for timber harvest; and
- Guidelines for forest roads.

After a comprehensive review of these strategy options, FEMAT recommended Option 9, which was ultimately adopted in the Northwest Forest Plan (Tuchmann et al. 1996). These recommendations formed the basis of many of the conservation and mitigation strategies presented in the Draft HCP, although many of the recommended standards are exceeded substantially in this final HCP with the City's commitment not to harvest timber for commercial purposes.

To summarize, the Cedar River Municipal Watershed has regional significance in five respects that are important for species addressed by this HCP. The municipal watershed:

(1) Is the major source of water to Lake Washington and for riverine habitat important to anadromous fish species in the Lake Washington Basin;

(2) Has some of the healthiest streams and streamside habitat in King County;

(3) Has several large blocks of old-growth forest in a region in which such habitat has largely been either removed or highly fragmented by past logging, and also has large areas of relatively mature second-growth forest at low to middle elevations;

(4) Is an important protected east-west corridor from the Puget Sound lowlands to the crest of the Cascade Mountains; and

(5) Is an important north-south link for species dependent on late-successional or old-growth ecosystems in the Cascade Mountains, and contains a unit of the federal late-successional reserve system (Tuchmann et al.1996), which is also a Critical Habitat Unit (CHU WA-33) for the northern spotted owl (Fed. Reg. Vol. 57, Pp. 1796-1838).

Not only the species that use the municipal watershed itself but also the aquatic species that use the river downstream of the Landsburg Diversion Dam will benefit by long-term City commitments to protect and restore aquatic habitats and water quality in the municipal watershed, which is two-thirds of the Cedar River Basin by area and includes the headwaters of the Cedar River. Thus, the Watershed Management Mitigation and Conservation Strategies are also an important element in the regional strategies to protect and restore anadromous fish populations in the Lake Washington Basin that are addressed by this HCP (sections 4.3 and 4.4).

Importance of Reserves in the Conservation of Biodiversity

Development of a system of reserves, preserves, and refugia has long been recognized as an essential component of any effort to save at-risk species and to preserve biodiversity (Primack 1993; Frissell and Bayles 1996; Moyle and Yoshiyama 1994; Sedell et al. 1990; Franklin 1990; FEMAT 1993). At a landscape level, one designing a reserve must consider the minimum habitat patch size needed for individuals and populations, the spatial relationship among patches, and the habitat needed for effective movement of organisms and dispersal of their offspring or propagules among patches of habitat used for reproduction or other essential functions (Morrison et al. 1992). Effective dispersal among patches of habitat in a reserve system depends on both the distance between patches and the nature of the intervening habitat.

Although it is recognized that reserve designs need to be tailored to specific objectives and situations (Ehrenfield 1989 and Franklin 1985, both as cited in Primack 1993), scientists have proposed several general rules or principles for the design of ecological reserves. There is general agreement that, all else being equal, habitat patches in any reserve design are more likely to contribute to the conservation of species and biodiversity if they are relatively large, more round than linear (minimizing edge), closer together, and connected by corridors (Primack 1993; Payne and Bryant 1994).

For example, smaller, more linear patches have relatively more edge and less *interior* habitat, and are generally of less value to interior forest species (Wilcove et al. 1986; Lehmkuhl and Ruggiero 1991; Primack 1993), and the success of dispersal can be expected to decline with increasing distance between patches (Harris 1984). By committing not to harvest timber for commercial purposes in the municipal watershed, the City will minimize edge effects, maximize beneficial forest interior conditions, and make the greatest contribution to successful dispersal of forest organisms.

There is a debate about the effectiveness of habitat corridors, and some scientists have argued that corridors may not always provide for successful movement of organisms or may sometimes even have adverse effects (Simberloff et al. 1992). By committing to no timber harvest for commercial purposes, the City will minimize reliance on corridors within the watershed to achieve successful dispersal and migration of forest organisms and will make a major contribution to regional habitat protection and restoration, as well as dispersal for many species.

City Policies and Decisions Related to an Ecological Reserve and to Timber Harvest

As noted in Section 2.4, the City had several planning objectives for the HCP that guided development of the Watershed Management Mitigation and Conservation Strategies. The Seattle City Council initially directed that City staff develop an ecological reserve for the HCP consistent with a 1989 City ordinance (Ordinance #114632), which directed designation of a large ecological reserve, but allowed timber harvest outside the reserve to generate revenues that could be used for specific environmental purposes (see Section 2.3.10).

Ordinance #114632 also directed the Seattle Water Department (now Seattle Public Utilities) to negotiate an exchange with the USFS to acquire all of the federal land in the watershed and the “valuable” old-growth forest habitat on that federal land. As described in Section 2.3.11, in 1992, Congress directed an exchange between the City and USFS. This exchange, completed in 1996, transferred to the City all of the federal land in the municipal watershed (nearly 17,000 acres), including many thousands of acres of old-growth forest. As a result of deed restrictions on the land exchanged to the City, the City cannot harvest timber on about 90 percent of the land acquired from the USFS. On the former federal land, no old growth can be harvested, and commercial timber harvest is not allowed on former federal lands within the northern spotted owl CHU in the eastern portion of the watershed (CHU WA-33: Fed. Reg. Vol. 57, Pp. 1796-1838), although some thinning can be done in second-growth forest under exceptions related to safety, water quality, and biological diversity. This deed-restricted land, thus, becomes a *de facto* part of any ecological reserve within the municipal watershed.

The Watershed Advisory Committee that developed the policies codified in the 1989 ordinance recommended a reserve of 55 percent of City-owned land in the municipal watershed at the time the ordinance was passed. At the direction of the Seattle City Council in 1996 and 1997, City staff developed a reserve proposal for this HCP that included this 55 percent of land in the municipal watershed that the City owned in 1989 and the deed-restricted former USFS land. Together, these two areas total approximately 64 percent (56,223 acres) of the land in the municipal watershed. Ordinance #114632 also specified the development of a timber management program, and the Seattle City Council directed City staff to provide flexibility for a carefully controlled timber harvest program to generate revenue for funding environmental efforts, including implementation of the HCP.

During the public review of the Draft HCP, many who commented on the HCP indicated concern about timber harvest in the municipal watershed, and asked the City to commit to no commercial harvest. In the past, public concerns about timber harvest have included the systematic logging of late-successional or old-growth forests, the impacts of forest practices on riparian and aquatic ecosystems, and the overall impacts on species dependent on both old-growth forests and aquatic habitats. There has been considerable public concern regarding the potential impacts on forests and aquatic habitats from what could be termed industrial tree farming. Such past practices in the Pacific Northwest have resulted in the following effects:

- Visual scarring of hillsides caused by very large clearcuts (Curtis 1993);
- Forest fragmentation from multiple clearcuts and roads (Franklin and Forman 1987);
- A significant decrease in the amount of old-growth forest (Bolsinger and Waddell 1993);
- A loss of forest habitat structure and diversity (Franklin 1989);
- Damage to streams and to salmon and trout habitat from landslides and erosion associated with logging or forest roads (Sidle et al. 1985; Bisson and Sedell 1984); and
- Property impacts that have occurred during recent storms from landslides and flooding associated with clearcuts.

In response to the comments received during the public review of the Draft HCP in early 1999, the Mayor and City Council made a decision to forgo opportunities for revenues from a commercial timber harvest program in the municipal watershed and to commit to no timber harvest for commercial purposes in the watershed, effectively placing all watershed forests outside of developed areas in reserve status.

The watershed management strategies included in the Draft HCP were developed with the help of leading regional scientists to allow conservative timber harvest that would sustain the aquatic and upland ecosystems of the watershed over the long term. While a commitment not to harvest timber for commercial purposes could not be construed to be a *requirement* of the ESA, the elected officials of the City of Seattle have chosen to do so as a matter of policy. The City made this decision in response to public comments on the Draft HCP. The commitment in this HCP not to harvest timber for commercial purposes will be described hereafter as managing the watershed as an ecological reserve or the designation of forests outside developed areas to reserve status. This commitment will clearly maximize protection for both aquatic and upland habitats of value to most species addressed in this HCP.

As described below in the section entitled “Administration of the Municipal Watershed and Applicable Management Guidelines,” the commitment not to harvest timber for commercial purposes does not prevent the City from cutting trees to protect the drinking water supply, to provide drinking water and hydroelectric power, to meet ecological objectives, to protect the watershed from catastrophic damage, or for general administration of the watershed and management of its facilities. In short, the commitment does not in any way prevent the City from conducting operations and activities associated with water supply, hydroelectric power generation, watershed management, and general administration of the municipal watershed other than timber harvest for commercial purposes.

Landscape Integration: from the Watershed to the Region

To be effective, conservation and mitigation strategies for forest land management must address natural processes and anthropogenic disturbances at a variety of spatial and temporal scales, and site- or stand-based strategies must be integrated at both local and regional scales. Recent attention among conservation biologists has focused on watersheds as appropriate units at which to integrate conservation strategies, particularly for aquatic species (e.g., see Montgomery et al. 1995).

Many scientists have argued that watersheds should be the focus of efforts to protect and restore ecological systems (e.g., Naiman 1992; Reeves and Sedell 1992; Frissell and Bayles 1996). Carey and Johnson (1995) stated that “Streams and drainages...provide the template for landscape management systems for maintaining biodiversity,” and Karr (1991) has argued that watershed management should focus on maintaining the “biotic integrity” of stream ecosystems. Both within and among watersheds, protection of key habitats and maintaining connectivity among these habitats are of critical importance in efforts to conserve at-risk species (see Franklin 1990; Frissell and Bayles 1996).

It is widely recognized that a system of reserves, refugia, and key watersheds is important for protecting those species that depend on late-successional and old-growth forests, including salmonids (Franklin 1990; Sedell et al. 1990; FEMAT 1993; Moyle and Yoshiyama 1994; Frissell and Bayles 1996). Connectivity of lotic systems entails maintaining the linkage among stream corridors (Frissell 1993), allowing the free and safe passage of fish upstream and downstream. This is challenging in an urbanizing environment, where many kinds of impedance to passage are present and habitats can often be hostile to fish. However, maintaining connectivity among upland habitats, as compared to aquatic systems, can be even more challenging, as these systems can lack the unifying features and potential continuity provided by stream corridors in lotic systems (i.e., systems with running water).

Conservation biologists have recently realized that even the combination of reserves and corridors between them cannot always ensure habitat connectivity and the long-term sustainability of populations in upland habitats (Franklin 1990; Morrison et al. 1992), and they have argued that landscapes should be managed as a whole (Franklin and Forman 1987; Jensen et al. 1996). A habitat corridor is only one way to achieve connectivity of habitats at the landscape scale, and corridors may not always achieve the desired result or may sometimes even have adverse effects (Simberloff et al. 1992).

By committing to place forests in the watershed in an ecological reserve will make the greatest possible contribution to this regional connectivity, and the City will not rely on strategies involving designed corridors or "matrix" land management within the municipal watershed. Because the watershed will be managed as an ecological reserve, the quality of water released downstream, of critical importance to anadromous fish and other aquatic organisms in the lower Cedar River and Lake Washington, will be protected. Further, the quality of the water will be improved over time as sediment loading to streams is reduced through restoration efforts in the HCP.

The combination of watershed restoration and protection commitments included in the HCP will incorporate approaches recommended by scientists for restoring and sustaining those natural processes that foster natural biological diversity across watershed landscapes (Franklin and Forman 1987; Franklin 1992; FEMAT 1993; Carey and Curtis 1996). Scientists have identified some of the key ecological processes in Northwest forests that are central to the development and maintenance of late-successional and old-growth forest ecosystems. These processes include "(1) tree growth and maturation, (2) death and decay of large trees, (3) low to moderate intensity disturbances (e.g., fire, wind, insects, and disease) that create canopy openings or gaps in the various strata of vegetation, (4) establishment of trees beneath the maturing overstory trees either in gaps or under the canopy, and (5) closing of canopy gaps by lateral growth or growth of understory trees" (FEMAT 1993).

Avoiding, Minimizing, and Mitigating the Impacts of Allowed Incidental Take

The avoidance, minimization, and mitigation measures applying to the municipal watershed were developed on a long-term, integrated, landscape basis. The City recognizes that certain land management activities in the municipal watershed will create site-specific impacts, which need to be mitigated, although the commitment not to harvest timber for commercial purposes should make such impacts minor and limited. The minimization and mitigation measures are designed to both minimize impacts of such activities on a site-specific basis and produce landscape-level changes that mitigate for any such effects, as well as avoid adverse cumulative impacts. The City expects that the measures included in this HCP will be more than sufficient to support an incidental take permit, by avoiding, minimizing, or mitigating for potential taking in the municipal watershed as a consequence of City operations during the term of the HCP.

The Watershed Management Mitigation and Conservation Strategies (Section 4.2.2) constitute the minimization and mitigation measures for any City land management activities that could occur within the watershed, activities that relate to restoration efforts and general watershed operations. The strategies also serve as mitigation for impacts of reservoir operations on aquatic species within the municipal watershed that are potentially affected by such operations, especially those species such as bull trout and pygmy whitefish that use tributaries to the reservoir during their life cycles.

The conservation measures applied to previously harvested forests are designed to restore structural and biological diversity to conditions similar to what would be present as a result of certain types of natural disturbances and other natural processes. On a landscape level, these conservation measures will result in the following:

- Recruitment of substantial additional late-seral forest habitat through maturation,
- Acceleration of development of late-successional forest characteristics through silvicultural interventions,
- Reduction of anthropogenic sediment input to streams through road improvements and removal, and
- Restoration of aquatic connectivity by replacement, upgrades, or redesign of culverts that impede or block fish passage at road crossings.

All watershed activities will meet or exceed the standards in any Washington State Forest Practice Rules not encompassed by exemptions for the HCP.

Measures that include active intervention, including thinning for ecological reasons and culvert changes at stream crossings, involve some short-term habitat disturbance but will be designed to produce long-term habitat benefits. Thus, these measures, by their nature, are mitigated. When there is some question about short-term impacts of such activities, these concerns are discussed in the applicable text and provisions are made to minimize such impacts. All guidelines presented in this section are also designed to provide protection and to contribute to mitigation for activities with potential to cause impacts to species addressed in the HCP.

Development of the Watershed Management Mitigation and Conservation Strategies

In developing the Watershed Management Mitigation and Conservation Strategies for this HCP, the City integrated recent scientific perspectives on watershed protection and forest management. This integration was accomplished through:

- A review of the scientific literature;
- Consultation with regional experts;
- Coordination with state and federal resource biologists;
- A series of workshops with other agencies and outside scientists;
- An extensive database on watershed conditions and habitats;
- Studies of particular species in the municipal watershed;
- Various other studies and analyses; and
- A policy decision to forgo the opportunity for generating revenues from harvesting timber for commercial purposes (see above).

The City conducted a watershed assessment (Section 3.3.3 and Appendix 15) that was patterned after the State of Washington's watershed analysis process (Washington Forest Practices Board 1993) to characterize current conditions, attempt to identify problems and their causes, and develop strategies for protecting and restoring the aquatic environments in the municipal watershed. The assessment identified these major problems relative to aquatic habitats:

(1) Sediment loading to streams from past and current road failures;

(2) A lack of large woody debris in streams as a result of past removal of riparian vegetation;

(3) Poor recruitment of large woody debris from riparian forests into streams in areas of recent or significant past disturbance; and

(4) A lack of stream connectivity, caused by poorly designed culverts where roads cross streams.

Key to developing the Watershed Management Mitigation and Conservation Strategies were the four workshops held with agency biologists and other scientists on watershed conservation biology, old-growth restoration, and bull trout (Section 3.3.4). These workshops were valuable in identifying different, often competing, perspectives on conservation issues, some of which the City has incorporated into the overall conservation strategies. These perspectives included:

- The importance of reserves to protect both upland and aquatic habitats;
- The importance of stream and forest restoration in previously disturbed areas;
- The value of using silvicultural intervention, based on characteristics of individual site and stands of trees, to accelerate development of old-growth forest conditions; and
- The need for monitoring and research because of the uncertainties regarding the effects of reservoir management on bull trout.

Overall Conservation Objectives for Watershed Management

The mitigation and conservation strategies for watershed management are designed to avoid, minimize, or mitigate for the impacts of any taking of listed species, including the spotted owl and the marbled murrelet, and for the equivalent of taking of unlisted species addressed by the HCP. These strategies are also designed to provide a net benefit for the species addressed by the plan, contribute to recovery of these species, and contribute to the maintenance of natural biodiversity in the watershed and region. The strategies will also benefit many other fish and wildlife species inhabiting the biological communities and ecosystems of the watershed that are not specifically addressed by this HCP. Because this HCP focuses on species dependent on late-successional and old-growth forest, riparian, and aquatic habitats, those species that depend primarily on the earliest seral forest habitats, such as the grass-forb-shrub stage of succession, will receive relatively less benefit from the HCP or will lose habitat under the HCP, as these habitats will be less common that they are today.

The overall planning objectives of the City's HCP are given in Section 2.4. General conservation objectives that are more specifically relevant to the Watershed Management Mitigation and Conservation Strategies are listed and discussed below. More specific biological objectives are described below in Section 4.2.2. The general conservation objectives for watershed management are to:

- Develop strategies for watershed management, consistent with water supply functions, that protect and improve water quality, as well as aquatic and riparian habitats;
- Develop scientifically sound conservation strategies for the watershed that combine mitigation, protection, restoration, research, monitoring, and adaptive management to achieve the conservation objectives of the HCP;
- Develop strategies to restore and sustain the natural processes that create and maintain key habitats for species addressed by the HCP and that foster natural biological diversity of native species and their communities;
- Protect existing old-growth forest in the municipal watershed and promote development of additional mature and late-successional forest that will better support the native organisms characteristic of late-successional and old-growth forest communities;
- Develop an integrated, landscape approach that addresses the spatial relationship of habitats within the watershed and with regard to nearby areas to improve the ability of the watershed, over time, to support the species addressed by the HCP;
- Pursue land management approaches that, as practicable, help avoid catastrophic events such as forest fires that would jeopardize drinking water or habitats for species addressed by the HCP;
- Protect special habitats in the municipal watershed (described below); and
- Commit not to harvest timber for commercial purposes, effectively establishing the forests in the watershed as an ecological reserve that will protect existing old-growth forest, recruit a significant amount of mature and late-successional forest, and make a significant contribution to the support of regional populations of species that depend on late-successional and old-growth forests and/or aquatic and riparian ecosystems.

Additional, more specific conservation objectives are presented in Section 4.2.2, along with descriptions of the various minimization and mitigation measures.

Overview of Watershed Management Mitigation and Conservation Strategies

The Watershed Management Mitigation and Conservation Strategies have been designed to (1) provide a comprehensive program to mitigate for potential impacts from watershed management activities on species addressed in the HCP, (2) provide a net benefit for the species addressed in the HCP, and (3) contribute to the conservation of these species. The strategies integrate protection through a combination of the following:

- Placing all watershed forests in an ecological reserve,
- Rehabilitation and restoration activities,
- Species- and habitat-specific measures designed to protect species of concern,
- Management constraints and guidelines,

- Other measures that protect individual animals from disturbance, and
- Monitoring and research to ensure the conservation and mitigation strategies are effective.

One major component of these strategies is the set of Watershed Assessment Prescriptions that resulted from the comprehensive watershed assessment conducted in developing the HCP (Section 3.3.3). These prescriptions are referred to throughout Section 4.2, and can be found in their entirety in Appendix 16. These prescriptions were developed under the assumptions in the Draft HCP that timber harvest for commercial harvest would occur outside a designated ecological reserve, which would include buffers on aquatic habitats, old-growth forest stands, and Special Habitats. Because of the City's commitment not to harvest timber for commercial purposes in the municipal watershed, references in the prescriptions to commercial timber harvest and reserve buffers are not relevant to the final HCP.

The Watershed Management Mitigation and Conservation Strategies include two kinds of conservation and mitigation measures for land management activities within the municipal watershed: (1) *community-based conservation* measures that are focused on the ecosystems, biological communities, and habitats that are most important to the species addressed in the HCP; and (2) additional *species conservation* measures that also address protection of individuals of 14 species of greatest concern during sensitive periods of their life cycles.

The primary ecosystems, biological communities, and habitats addressed in the HCP are Late-successional and Old-growth Forest Communities, the Aquatic and Riparian Ecosystem, and Special Habitats important to some species addressed in the HCP. Three sets of community-based conservation and mitigation measures collectively cover the entire watershed landscape and include:

(1) *Establishment of a watershed ecological reserve*: the commitment not to harvest timber for commercial purposes, effectively placing watershed forests outside limited developed areas in ecological reserve status;

(2) *Habitat restoration*: active intervention to help restore more natural ecological conditions and functions in previously disturbed areas; and

(3) *Management guidelines*: guidelines for land and forest management, including control of watershed access and constraints on cutting trees and managing roads.

While protection and restoration of habitats are the most important strategies for protection of the species addressed in the HCP, additional measures are needed for some of the species of greatest concern, in part to address protection of individuals during critical periods of their life cycles, such as reproductive seasons. The HCP includes a fourth set of measures to protect the 14 species of greatest concern (Section 3.5):

(4) *Species Conservation Strategies*: measures to protect individuals and habitats of the species of greatest concern during sensitive periods of their life history.

In addition to a description of the conservation and mitigation strategies referenced above, Section 4.2 includes a discussion of the rationale for the conservation strategies, brief summaries of related monitoring and research (covered in detail in Section 4.5), and an evaluation of the general effects of the strategies. The effects of the Watershed

Management Mitigation and Conservation Strategies on all species addressed in the HCP are evaluated comprehensively in Section 4.6. Table 4.2-1 describes the organization of the remainder of Section 4.2 (Watershed Management Mitigation and Conservation Strategies).

Table 4.2-1. Organization of Watershed Management Mitigation and Conservation Strategies.

Section	Element of Conservation or Mitigation Strategies
4.2.2	**Watershed Management Mitigation and Conservation Measures**: This section includes four major parts. • Community-based strategies that include commitment not to harvest timber for commercial purposes (effectively creating an ecological reserve that includes all forest outside developed areas in the watershed); management guidelines; restoration activities in previously harvested areas collectively protecting, restoring, and reconnecting aquatic, riparian, and old-growth habitats, as well as additional habitats; an aggressive program to remove forest roads; and control of public access to minimize human disturbance. • Descriptions of City activities and operations in the municipal watershed, with guidelines for protecting habitats. • Species-specific strategies that build upon the community-based strategies, including specific commitments for some of the species of greatest concern designed to reduce risks by controlling disturbances and impacts to individuals, pairs, and habitat during critical activities, such as reproduction. • A rationale for the mitigation and conservation strategies, based on scientific understanding and integration of conservation and mitigation measures.
4.2.3	**Watershed Research and Monitoring**: Summary of comprehensive monitoring and research designed to track compliance and effectiveness of mitigation measures, test key assumptions, provide needed information, and support adaptive management under the HCP (described in Section 4.5).
4.2.4	**Summary of Effects of Watershed Conservation and Mitigation Measures**: Summary of the overall effects of the mitigation and conservation measures on species addressed in the HCP in terms of overarching objectives.

4.2.2 Watershed Management Mitigation and Conservation Strategies

Basic Approach

Introduction

The City's efforts to sustain and restore the natural functioning of the target biological communities, habitats, and ecosystems for the municipal watershed – aquatic, riparian, late-successional and old-growth forest, and special habitats – are accomplished by a combination of three community-based conservation and mitigation strategies for the 83 species addressed in the HCP: (1) the commitment not to harvest timber for commercial purposes – a commitment that places watershed forests in reserve status; (2) commitments to active intervention to restore previously disturbed habitats; and (3) commitments to management guidelines designed to protect species and habitats. In addition, the Watershed Management Mitigation and Conservation Strategies include Species Conservation Strategies for the 14 species of greatest concern (Section 3.5).

Components of the Watershed: Habitats, Communities, and Ecosystems

Makeup of the Watershed

Most of the species of concern addressed by this HCP (sections 3.4-3.7) depend on, or use in significant ways, one or more of three interrelated ecosystems in the municipal watershed: aquatic, riparian, and upland forest. In addition, a much smaller number of these species of concern use or depend on other habitat types that are much more limited in distribution and yet particularly important to those species for some aspect of their habitat needs. (Table 4.2-3, below, gives the primary habitat associations for all species addressed by this HCP.)

To address the habitat needs of the variety of species addressed by the HCP, measures for three major components of the undeveloped cover types in the municipal watershed were identified:

(1) A <u>Late-successional and Old-growth Forest Communities</u> component, with measures designed to protect existing old growth and recruit additional mature and late-successional forest in a pattern of habitat across the landscape that would improve conditions for species that rely on these plant communities, and designed to link to key areas outside the municipal watershed. The Late-successional and Old-growth Forest Communities component includes all existing old growth and all second growth, which has potential for developing into mature and late-successional forest.

(2) An <u>Aquatic and Riparian Ecosystem</u> component, with measures designed to protect and improve water quality and aquatic and riparian habitat in the aquatic/riparian ecosystem complex. The Aquatic and Riparian Ecosystem component of the watershed includes all ponds, lakes, wetlands, streams, wetland complexes, floodplain and riparian habitats, landslide prone areas associated with streams, and other areas adjacent to aquatic habitats.

(3) A <u>Special Habitats</u> component, with measures designed to protect limited, specific habitats used by some species of concern, and to contribute to overall protection of biodiversity in the municipal watershed. The Special Habitats component includes talus and felsenmeer slopes, rock outcrops and cliffs, upland grass-forb meadows, upland persistent shrub, and other undeveloped, non-forested habitats of value to species addressed in the HCP.

Existing developed areas within the watershed include parts of the Rattlesnake Lake Recreation Area (near Cedar Falls), the area that includes the administrative facilities at Cedar Falls and Landsburg, other areas associated with the Masonry Dam and reservoir complex, and such features as roads, trails, education sites, and power line rights-of-way.

The Rattlesnake Lake area contains the 111-acre lake and associated wetlands, and provides forest habitat connectivity with the Rattlesnake Ridge Natural Area on the northern boundary of the municipal watershed. The former town site of Taylor, in the western portion of the watershed, is now largely covered by deciduous forest and is an area of historic significance.

Database and Habitat Modeling Projections

To map existing habitats and project habitat change over time, spatially linked data sets containing geographical and environmental attribute information relative to the municipal watershed were developed from a number of sources. City staff conducted extensive field surveys of both forested and non-forested habitats and conducted analyses of aerial photographs. Additional supporting information was obtained from WDNR, USFS, WDFW, and King County. The data were incorporated into an extensive Geographic Information System (GIS) database for the watershed. Substantial information derived from the City's Watershed Assessment (Section 3.3.3 and Appendix 15) was also incorporated into the system.

The GIS was linked with the Forest Projection System, a computer software application that includes capabilities for forest database management, stand growth modeling, and harvest scheduling (Section 3.3.7). The combined capacity of the GIS and the Forest Projection System provided the means to spatially compare and depict environmental and forest stand information as well as to model future stand conditions.

Acreage of Major Components and Sub-elements in Watershed

The components and sub-elements of the watershed that were described above are shown on maps 6 and 7. Acreages of these components and sub-elements are given in Table 4.2-2 below.

Table 4.2-2. Areas of the three components of the watershed and their sub-elements (in acres).

Components and Sub-elements of the Watershed	Acreage of element	Acreage Contributed
Aquatic & Riparian Ecosystem		
• Reservoir complex	1,787	1,787
• Lakes and ponds	242	242
• Other open water	185	185
• Forested wetlands[1]	1,063	0
• Palustrine scrub-shrub wetlands	464	464
• Palustrine emergent wetlands	236	236
• Riparian habitat (by vegetation)[1]	4,223	0
• Sensitive soils (includes some floodplain)[1]	3,070	0
• Headwalls[1]	1,861	0
• Inner gorges[1]	2,364	0
Subtotal for Component		**2,914**
Late-successional & Old-growth Forest Communities		

Components and Sub-elements of the Watershed	Acreage of element	Acreage Contributed
• Old-growth conifer forest (>189 years old)	13,889	13,889
• Late-successional forest (120-189 years old)	91	91
• Mature forest (80-119 years old)	1,074	1,074
• Other second-growth forest (potential for recruitment)	70,223	70,223
Subtotal for Component		**85,4**77
Special Habitats		
• Unvegetated talus & felsenmeer & active landslides	1,190	1,190
• Vegetated talus & felsenmeer	329	329
• Rock outcrops & cliffs	54	54
• Upland grass-forb meadows	110	110
• Upland persistent shrub	93	93
• Non-forest (unclassified)	33	33
Subtotal for Component		**1,809**
Other Areas		
• Developed areas	346	346
Subtotal for Component		**346**
TOTAL OF WATERSHED COMPONENTS		**90,546**

1 Cover type is forested and is included under Late-successional and Old-growth Forest Communities

Input from Outside Scientists Regarding Watershed Management

As described in Section 3.3.4, the City hosted an old-growth restoration workshop with outside scientists and two watershed conservation biology workshops with agency biologists and other scientists. Although the scientists and agency biologists at the conservation biology workshops did not agree on a single approach to watershed management, they did agree that more of the mature, low-elevation second growth in the lower watershed should be included in an ecological reserve. While the scientists agreed that conservative timber harvest in the watershed could be conducted in a manner that would sustain species dependent on old-growth forest habitats, for policy reasons the City chose not to engage in commercial timber harvests to generate revenue. The scientists also agreed that two other commitments should be included in the HCP: management guidelines consistent with the objectives for the watershed and measures to restore previously altered habitats.

Types of Watershed Management Mitigation and Conservation Measures

As described above, the Watershed Management Mitigation and Conservation Strategies are based on four types of mitigation and conservation measures:

(1) Protection of key areas of habitat by designating them for reserve status, for the purpose of maintaining undisturbed areas and recruiting more future, high-quality forest habitat in previously disturbed areas;

(2) <u>Restoration of aquatic, riparian, and upland forest habitats, and the natural processes that create and maintain them, through a program of active intervention;</u>

(3) <u>Protection of key habitats and areas by implementing management guidelines</u> that constrain certain activities within the watershed; and

(4) <u>Species conservation strategies</u>, targeted at species of greatest concern.

The City believes that the most important contributions it can make to conservation of species within the municipal watershed are protection of existing high-quality habitat of all key types needed by aquatic and terrestrial species addressed by the HCP and recruitment of more mature and late-successional forest habitat in upland and riparian areas. The City’s commitment not to harvest timber for commercial purposes will:

(1) Protect sensitive and important non-forested habitats, including all aquatic habitats;

(2) Result, over time, in “blocking up” and connecting older forest habitats as previously harvested stands mature;

(3) Provide connectivity among aquatic and other non-forested habitats, through a development of a more completely forested environment; and

(4) Through the removal of a large fraction of watershed roads, result in improved water quality and aquatic habitats as sediment loading to steams is reduced.

Botkin (1990) has also argued that “no action” is a form of management, which often is not the wisest course of action when an area has been disturbed by past human activities. Many scientists believe that restoration can also be important for a reserve system in which prior human-caused disturbance may have degraded or otherwise altered key habitats. For any reserve system, initial conditions must be considered in formulating management plans, which should be tailored both to management objectives and to the area (Franklin and Forman 1987; Franklin 1992).

Some forest stands in the watershed could greatly benefit by careful silvicultural intervention to accelerate development of ecological characteristics of late-successional and old-growth habitat or, in streamside forests, to develop structure characteristics of natural, mature riparian forests. The Watershed Management Mitigation and Conservation Strategies include two types of silvicultural intervention: (1) *thinning* to restore structural diversity in upland and riparian forests and to accelerate development of old-growth forest conditions, and (2) *planting* to restore natural diversity in upland forest communities and recruit desired species, such as western redcedar, in riparian forests. In addition to restoration of riparian forests, measures directed at restoring streams include instream habitat projects, projects to restore stream connectivity, and improvement and decommissioning (removal) of roads to reduce sediment loading that could affect aquatic habitat.

However, effective protection in a reserve system created by no commercial timber harvest also requires careful control of human activities so that those activities do not compromise the conservation objectives for the watershed. In recognition of this need, the City developed watershed management guidelines to constrain management activities in a manner that will protect the species addressed in the HCP. Many of the guidelines were based on a Watershed Assessment (Section 3.3) and several workshops with outside scientists (Section 3.4).

Habitat Associations of Species Addressed by the HCP

The primary habitat associations for all species addressed by this HCP are given in Table 4.2-3, which also lists the key habitats for those species that will be protected or improved by habitat restoration measures in the HCP. The species are grouped by the three major components of the Watershed Management Mitigation and Conservation Strategies: Aquatic and Riparian Ecosystem, Late-successional and Old-growth Forest Communities, and Special Habitats.

The literature indicates that wildlife species use riparian habitats disproportionately more than other types of habitat (O'Connell et al. 1993). Results from a study on the habitat use of 414 species of wildlife in western Washington and Oregon indicate that 87 percent of the species use riparian zones or wetlands during some season(s) or part(s) of their life cycles (Brown 1985a). In the Cedar River Municipal Watershed, aquatic or riparian habitat appears to be key habitat for about half of the species addressed by the HCP (Table 4.2-3), and is key habitat for many other species that are not on the list of species addressed by this HCP.

A wide variety of species in the Pacific Northwest are also dependent on mature, late-successional, and old-growth conifer forests (Brown 1985a; FEMAT 1993). Some species of nonvascular plants (and invertebrates) appear to be more closely adapted to the habitat conditions in old-growth forests than those in earlier seral stages, and some of these species may not occur at all absent such conditions (Ruggiero et al. 1991a; Henderson 1993). However, few species of vertebrates or vascular plants appear to be strictly dependent on old-growth forests (Rugierro et al. 1991a), and many seem to do well in earlier seral forests that have such characteristics of younger *unmanaged* stands as abundant logs, snags, and gaps in the canopy (Ruggiero et al. 1991a; Spies 1991). In the municipal watershed, late-successional and old-growth habitat appears to be key habitat for about 30 percent of species addressed by the HCP (Table 4.2-3) and is also key habitat for many other species in the watershed that are not on the list of species addressed by this HCP.

However, forest conditions over the entire landscape are also important for the dispersal and movement of many organisms that live in existing old-growth forest, and the forested parts of the landscape that are not old growth can provide habitat important to many of the species addressed in the HCP. For example, the home ranges of such characteristic old-growth species as the northern spotted owl and northern goshawk are in the thousands of acres (sections 3.5.2 and 3.5.4, respectively), so the forest conditions over large areas are important to these species. In addition, other species addressed by this HCP – such as brown creeper, olive-sided flycatcher, three-toed woodpecker, and some bat species – regularly use seral stages other than old growth (Harris 1984; Brown 1985a).

Thirteen species addressed in this HCP depend on one or more of the Special Habitat types, although many of these species also use other habitat types as well (Table 4.2-3). For example, peregrine falcons, black swifts, and golden eagles typically nest on cliffs, but forage widely over a variety of open habitats. Nine of the 11 bat species depend on late-successional and old-growth forests, but also use caves and rock crevices for roosting. Grizzly bears, gray wolves, wolverines, Larch Mountain salamanders, and Van Dyke's salamanders – although not known to be present in the municipal watershed – use such open habitats as natural meadows, persistent shrub communities, and talus slopes, and some of these species also use forests.

Close inspection of Table 4.2-3 reveals that many species rely on more than one of the major habitat groupings: Aquatic and Riparian Ecosystem, Late-successional and Old-growth Forest Communities, and the Special Habitats. Of the 83 species listed in Table 4.2-3, about one-fourth depend on more than one of the above three ecosystems, communities, or habitat groups, and about 10 percent of the species depend on all three. Over 80 percent of the species that depend primarily on Special Habitat types also depend on at least one of the two ecosystems and communities (Aquatic and Riparian Ecosystem, and Late-successional and Old-growth Forest Communities).

Table 4.2-3. Primary habitat associations (key habitat) for species addressed by the HCP, and habitat that will be protected or restored by the HCP. An asterisk (*) indicates species of greatest concern.

Species	Key Habitat	Potential Key Habitat Protected or Restored
Aquatic & Riparian Ecosystem		
Bald Eagle* *Haliaeetus leucocephalus*	Mature and old-growth forests near lakes, reservoirs, and rivers (Brown 1985b)	<u>Protection</u>: all lakes, rivers, and the reservoir complex; all streamside and riparian habitat; all forest, including old-growth. <u>Restoration</u>: significant recruitment of mature and late-successional forest at low to middle elevation.
Common Loon* *Gavia immer*	Large wooded lakes (Vermeer 1973)	<u>Protection</u>: all lake habitat, including reservoir complex; associated riparian areas. <u>Restoration</u>: riparian and other forest.
Great Blue Heron *Ardea herodias*	Tall deciduous or coniferous trees near wetlands (WDW 1991)	<u>Protection</u>: all river and stream habitat along the Cedar River and tributaries between Landsburg Dam and Cedar Falls; all streamside and riparian habitat; all wetland habitat. <u>Restoration</u>: significant recruitment of mature and late-successional forest at low to middle elevation.
Harlequin Duck *Histrionicus histrionicus*	Fast-flowing rivers and streams and associated bank vegetation; large woody debris (Cassirer and Groves 1989; Harlequin Duck Working Group 1993)	<u>Protection</u>: all potential streamside breeding habitat. <u>Restoration</u>: riparian and streamside forest.
Osprey *Pandion haliaetus*	Conifer/deciduous forest along lakes, streams, and rivers (Ehrlich et al. 1988)	<u>Protection</u>: all lake and riverine habitat; all streamside and riparian habitat. <u>Restoration</u>: riparian and streamside forest.
Willow Flycatcher *Empidonax traillii*	Swamps; thickets; riparian willows (Ehrlich et al. 1988)	<u>Protection</u>: all riparian and wetland habitat and meadow complexes. <u>Restoration</u>: riparian and streamside forest.
Bull Trout* *Salvelinus confluentus*	Cold, clear streams and lakes with an abundance of cover (LWD) and gravel for spawning; wetlands (WDFW 1994; Bond 1992)	<u>Protection</u>: all river and stream habitat associated with the reservoir and all wetlands used for rearing or spawning; all streamside and riparian habitat. <u>Restoration</u>: streams, riparian and streamside forest.

Species	Key Habitat	Potential Key Habitat Protected or Restored
Chinook Salmon* *Oncorhynchus tshawytscha*	Cool, clear rivers and larger streams; gravel and cobble for spawning (Groot and Margolis 1991)	Protection: all river and stream habitat along the Cedar River and tributaries between Landsburg Dam and Cedar Falls; all streamside and riparian habitat; improved water quality for river downstream of Landsburg Diversion Dam. Restoration: streams, riparian and streamside forest; habitat downstream of watershed; increased recruitment of large woody debris; improved water quality for river downstream of Landsburg Diversion Dam.
Coho Salmon* *Oncorhynchus kisutch*	Lakes, ponds, and associated wetlands; structurally complex streams with debris, pools, and gravel and cobble (Scrivener and Andersen 1982)	Protection: all river and stream habitat along the Cedar River and tributaries between Landsburg Dam and Cedar Falls; all accessible wetlands, lakes, and ponds; Walsh Lake wetland complex; all streamside and riparian habitat; improved water quality for river downstream of Landsburg Diversion Dam. Restoration: streams, riparian and streamside forest; habitat downstream of watershed; improved water quality for river downstream of Landsburg Diversion Dam.
Cutthroat Trout (sea run) *Oncorhynchus clarki*	Cool headwaters of tributaries; streams with gravel bottoms (Scott and Crossman 1973; Wydoski and Whitney 1979)	Protection: all streams in lower watershed; all wetlands associated with streams; all streamside and riparian habitat; improved water quality for river downstream of Landsburg Diversion Dam. Restoration: streams, riparian and streamside forest; habitat downstream of watershed; improved water quality for river downstream of Landsburg Diversion Dam.
Kokanee (resident sockeye) *Oncorhynchus nerka*	Lakes; streams with gravel for spawning (Scott and Crossman 1973)	Protection: Walsh Lake wetland complex; all streamside and riparian habitat; improved water quality for river downstream of Landsburg Diversion Dam. Restoration: streams, riparian and streamside forest; habitat downstream of watershed; improved water quality for river downstream of Landsburg Diversion Dam.

Species	Key Habitat	Potential Key Habitat Protected or Restored
Pacific Lamprey *Lampetra tridentatus*	Streams with gravel, rock, or sandy gravel substrates; pools with soft bottoms (Hart 1973)	Protection: all river and stream habitat below Cedar Falls, all streamside and riparian habitat. Restoration: streams, riparian and streamside forest; habitat downstream of watershed; improved water quality for river downstream of Landsburg Diversion Dam.
Pygmy Whitefish* *Prosopium coulteri*	Lakes with depth of >20 ft; stream reaches with swift current, cold water, and coarse gravel (Scott and Crossman 1973)	Protection: all river and stream habitat associated with the reservoir and all wetlands used for rearing or spawning; all streamside and riparian habitat. Restoration: streams, riparian and streamside forest.
River Lamprey *Lampetra ayresi*	Streams and rivers with mud or sand bottoms, and gravel bottoms for spawning (Scott and Crossman 1973)	Protection: all river and stream habitat below Cedar Falls, all streamside and riparian habitat; improved water quality for river downstream of Landsburg Diversion Dam. Restoration: streams, riparian and streamside forest; habitat downstream of watershed; improved water quality for river downstream of Landsburg Diversion Dam.
Sockeye Salmon* *Oncorhynchus nerka*	Cool, clear lakes and streams; gravel and cobble for spawning (Groot and Margolis 1991)	Protection: improved water quality for river downstream of Landsburg Diversion Dam, in part resulting from protection of all aquatic habitat above Landsburg. Restoration: habitat downstream of watershed.
Steelhead Trout* *Oncorhynchus mykiss*	Well oxygenated, cool streams; streams with gravel and cobble (Scott and Crossman 1973; Wydoski and Whitney 1979)	Protection: all river and stream habitat along the Cedar River and tributaries between Landsburg Dam and Cedar Falls; all streamside and riparian habitat. Restoration: streams, riparian and streamside forest; habitat downstream of watershed; improved water quality for river downstream of Landsburg Diversion Dam.
Masked Shrew *Sorex cinereus*	Alder and willow thickets; forested riparian areas (Johnson and Cassidy 1997)	Protection: all streamside and riparian habitat; all forest habitat; all naturally open habitats. Restoration: streamside and riparian habitat.
Northern Water Shrew *Sorex palustris*	Forested areas along small streams and ponds, and forested wetlands with abundant cover (Johnson and Cassidy 1997).	Protection: all wetlands; all river and stream habitat; all streamside and riparian habitats. Restoration: streams, streamside and riparian habitat.
Cascades Frog *Rana cascadae*	Pools adjacent to streams flowing through subalpine meadows (Leonard et al. 1996)	Protection: all ponds and wetlands; all river and stream habitat; all streamside and riparian habitats. Restoration: streams, streamside and riparian habitat.

Species	Key Habitat	Potential Key Habitat Protected or Restored
Cascade Torrent Salamander *Rhyacotriton cascadae*	Cold clear streams, seepages, and waterfalls (Leonard et al. 1996)	Protection: all wetlands; all river and stream habitat; all streamside and riparian habitats; all forest habitat. Restoration: streams, streamside and riparian habitat.
Long-toed Salamander *Ambystoma macrodactylum*	Lowland forests; pastures; high-elevation small lakes and ponds (Leonard et al. 1996)	Protection: all lowland forest; all wetlands, lakes, and ponds; all streamside and riparian habitat; naturally open habitats. Restoration: riparian habitat.
Northwestern Salamander *Ambystoma gracile*	Wetlands adjacent to lakes, ponds, and slow-moving streams; rotting logs (Leonard et al. 1996)	Protection: all wetlands, lakes, and ponds; all streamside and riparian habitat; all forest; recruitment of logs through silviculture. Restoration: streams, streamside and riparian habitat.
Oregon Spotted Frog *Rana pretiosa*	Marshes, ponds, or streams with little or no flow; associated with non-woody wetland plant communities (Leonard et al. 1996)	Protection: all rivers, streams, lakes, ponds, and wetlands; all streamside and riparian habitat; all natural meadows. Restoration: streams, streamside and riparian habitat.
Pacific Giant Salamander *Dicamptodon tenebrosus*	Cold streams; cool, moist, conifer forests near cold clear streams and mountain lakes (Leonard et al. 1996)	Protection: all rivers, streams, lakes, and ponds; all streamside and riparian habitat; all forest.
Red-legged Frog *Rana aurora*	Ponds, lakes, slow-moving streams, wetlands, and riparian areas in forested ecosystems (ODFW 1996; Leonard et al. 1996)	Protection: all rivers, streams, lakes, ponds, and wetlands; all streamside and riparian habitat; all forest. Restoration: streams, streamside and riparian habitat.
Rough-skinned Newt *Taricha granulosa*	Wetlands; slow-moving streams (Leonard et al. 1996)	Protection: all rivers, streams, lakes, ponds, and wetlands; all streamside and riparian habitat. Restoration: streams, streamside and riparian habitat.
Tailed Frog *Ascaphus truei*	Cold rocky rivers and streams (Leonard et al. 1996)	Protection: all rivers and streams; all streamside and riparian habitats. Restoration: streams, streamside and riparian habitat.
Van Dyke's Salamander *Plethodon vandykei*	Usually associated with seepages and streams, some near talus; woody debris near water (Leonard et al. 1996)	Protection: all aquatic habitats; all streamside and riparian habitats; vegetated talus. Restoration: streams, streamside and riparian habitat.
Western Pond Turtle *Clemmys marmorata*	Wetlands and riparian areas and forest edge habitat (WDW 1993); marshes; sloughs; moderately deep ponds; slow moving creeks (Nussbaum et al. 1983)	Protection: all streams, lakes, ponds, and wetlands; all streamside and riparian habitats; all forest. Restoration: streams, streamside and riparian habitat.
Western Toad *Bufo boreas*	Rivers, lakes, and ponds; riparian areas; wetlands; meadows; shrubby thickets; woodlands (Brown 1985b; Leonard et al. 1996)	Protection: all rivers, streams, lakes, ponds, and wetlands; all streamside and riparian habitats; all forest; all permanent shrub communities. Restoration: riparian and upland forest.

Species	Key Habitat	Potential Key Habitat Protected or Restored
Beller's Ground Beetle *Agonum belleri*	Lowland sphagnum bogs (below 1000 m elevation) (Johnson 1979)	Protection: all wetlands, bogs, aquatic and riparian habitats; all forest. Restoration: riparian forest.
Carabid beetle: *Bembidion gordoni*	Fast-running montane streams (Bergdahl 1995)	Protection: all streams; all streamside and riparian habitats.
Carabid beetle: *Bembidion stillaquamish*	Streams and riparian areas (Bergdahl 1995)	Protection: all streams; all streamside and riparian habitats. Restoration: streamside and riparian forest.
Carabid beetle: *Bembidion viator*	Swamps and forested marshes in lowlands (Bergdahl 1995)	Protection: all wetland habits; all riparian habitat; all forest. Restoration: riparian forest.
Carabid beetle: *Bradycellus fenderi*	Low-elevation swamps and forested marshes (Bergdahl 1995)	Protection: all wetland habits; all riparian habitat; all forest. Restoration: riparian forest.
Carabid beetle: *Nebria gebleri cascadensis*	Streams (Bergdahl 1995)	Protection: all streams; all streamside and riparian habitat. Restoration: streamside and riparian forest.
Carabid beetle: *Nebria kincaidi*	Montane streams (Bergdahl 1995)	Protection: all streams; all streamside and riparian habitat. Restoration: streamside and riparian forest.
Carabid beetle: *Nebria paradisi*	Montane streams (Bergdahl 1995)	Protection: all streams; all streamside and riparian habitat. Restoration: streamside and riparian forest.
Carabid beetle: *Omus dejeanii*	Low-elevation woodlands; forest glades (Bergdahl 1995)	Protection: all low-elevation forest; all wetlands; all riparian habitats. Restoration: upland and riparian forest.
Carabid beetle: *Pterostichus johnsoni*	Streams and groundwater-fed streams with unstable, sliding mud and scree; waterfall spray (Bergdahl 1995)	Protection: all streams; all streamside and riparian habitat. Restoration: streamside and riparian forest.
Fender's Soliperlan Stonefly *Soliperla fenderi*	Seeps, streams and creeks (WDFW 1991; Opler and Lattin 1998)	Protection: all streams; all streamside and riparian habitat. Restoration: streamside and riparian forest.
Hatch's Click Beetle *Eanus hatchi*	Lowland sphagnum bogs (below 1000 m elevation) (Johnson 1979)	Protection: all wetlands, including bogs; all riparian habitats. Restoration: streamside and riparian forest.
Long-horned Leaf Beetle *Donacia idola*	Lowland sphagnum bogs (below 1,000 m elevation); other wetland habitats (Johnson 1979; Bergdahl, J., Northwest Biodiversity Center, June 1998, personal communication)	Protection: all wetlands, including bogs, with surrounding forest; all riparian habitats; wetland complexes below 1,000 m elevation. Restoration: streamside and riparian forest.
Papillose Taildropper (slug) *Prophysaon dubium*	Moist coniferous forest, low to middle elevations (Frest and Johannes 1993)	Protection: all riparian habitats; all forest, including old-growth. Restoration: significant recruitment of mature and late-successional forest at low to middle elevation.

Species	Key Habitat	Potential Key Habitat Protected or Restored
Snail *Valvata mergella*	Lakes with mud bottom and well-oxygenated water (Richter, K., King Co. Environmental Division, Bellevue, Washington, October 1995, personal communication.)	Protection: all lakes, ponds, and other aquatic habitats; all riparian habitat. Restoration: riparian forest.
	Late-successional and Old-growth Forest Communities	
Brown Creeper *Certhia americana*	Deciduous, conifer, and mixed deciduous and conifer wetland forests (pole to late stages); mid- to later seral forests; conifer dominated wetlands (Brown 1985b; Smith et al. 1998)	Protection: all forest, including old growth; northern spotted owl CHU; forested wetlands. Restoration: significant recruitment of mature and late-successional forest at low to middle elevation.
Marbled Murrelet* *Brachyramphus marmoratus*	Mature to old-growth conifer forests (Ralph and Nelson 1992)	Protection: all forest, including old growth; northern spotted owl CHU. Restoration: significant recruitment of mature and late-successional forest.
Northern Goshawk* *Accipiter gentilis*	Mature to old-growth forests (Brown 1985b)	As above.
Northern Spotted Owl* *Strix occidentalis caurina*	Mature to old-growth forests (Thomas et al. 1990)	As above.
Olive-sided Flycatcher *Contopus borealis*	Conifer and mixed deciduous and conifer wetland forests (middle to late stages); forest edges near openings (Brown 1985b; Smith et al. 1998)	Protection: all forest, including old growth; northern spotted owl CHU; forested wetlands; meadows and persistent shrub. Restoration: riparian and upland forest, with significant recruitment of mature and late-successional forest.
Pileated Woodpecker *Dryocopus pileatus*	Mature and old-growth conifer forests (Mellen 1987)	Protection: all forest, including old growth; northern spotted owl CHU. Restoration: significant recruitment of mature and late-successional forest.
Three-toed Woodpecker *Picoides tridactylus*	Mountainous wet conifer forests (Wahl and Paulson 1991); high-elevation conifer forest (Smith et al. 1997)	Protection: all forest, including old growth; northern spotted owl CHU. Restoration: significant recruitment of mature and late-successional forest.
Vaux's Swift *Chaetura vauxi*	Conifer and mixed deciduous and conifer wetland forests (mature and late stages); snags (Brown 1985b)	Protection: all forest, including old growth; northern spotted owl CHU. Restoration: significant recruitment of mature and late-successional forest; snag recruitment through silviculture.

Species	Key Habitat	Potential Key Habitat Protected or Restored
Big Brown Bat *Eptesicus fuscus*	Conifer and mixed deciduous and wetland forests (mature and late stages); rivers and streams; cliffs and caves; snags (Brown 1985b)	Protection: all forest, including old growth; northern spotted owl CHU; all wetlands; all cliff and cave habitat; all naturally open habitat. Restoration: significant recruitment of mature and late-successional forest, and snags.
California Myotis *Myotis californicus*	Old-growth forest; various riparian, wetland and edge habitat; cliffs and caves; snags (Thomas 1988; Christy and West 1993)	As above.
Canada Lynx *Lynx canadensis*	High-elevation mature to old-growth forest near areas of high snowshoe hare density (WDW 1993c).	Protection: all forest, including old growth; northern spotted owl CHU; naturally open habitats. Restoration: significant recruitment of mature and late-successional forest.
Fisher *Martes pennanti*	Low-elevation mature and old-growth conifer forest; forested riparian areas; low levels of human activity (Aubry and Houston 1992; Powell 1993)	Protection: all forest, including old-growth and forested wetlands; all streamside and riparian forest; northern spotted owl CHU. Restoration: significant recruitment of mature and late-successional forest, upland and riparian.
Fringed Myotis *Myotis thysanodes*	Deciduous, conifer, and mixed deciduous and conifer wetland forests (mature and late stages); naturally open habitats; cliffs and caves (Brown 1985b; Christy and West 1993)	Protection: all forest, including old growth and forested wetlands; all streamside and riparian forest; northern spotted owl CHU; all cliffs and caves; all naturally open habitat. Restoration: significant recruitment of mature and late-successional forest, upland and riparian; snag recruitment through silviculture.
Hoary Bat *Lasiurus cinereus*	Forested areas: primarily conifer or mixed conifer and deciduous forest (Maser et al. 1984)	Protection: all forest, including old growth and deciduous forest; all streamside and riparian forest; northern spotted owl CHU. Restoration: significant recruitment of mature and late-successional forest, upland and riparian.
Keen's Myotis *Myotis keenii*	Riparian wetland areas; mixed conifer and deciduous forests; cliffs and caves; snags (Brown 1985b; Maser et al. 1984)	Protection: all forest, including old growth and forested wetlands; all streamside and riparian forest; northern spotted owl CHU; all cliffs and caves. Restoration: significant recruitment of mature and late-successional forest, upland and riparian; snag recruitment through silviculture.

Species	Key Habitat	Potential Key Habitat Protected or Restored
Little Brown Myotis *Myotis lucifugus*	Mature, late-successional, and old-growth forests; open wetlands, stream corridors, and open water bodies; cliffs and caves; snags (Thomas 1988; Brown 1985b)	As above.
Long-eared Myotis *Myotis evotis*	Riparian wetland areas; conifer forest; caves; snags (Maser et al. 1984)	As above.
Long-legged Myotis *Myotis volans*	Mature, late-successional, and old-growth conifer forests; open water; caves; snags (Maser et al. 1984; Thomas 1988)	Protection: all forest, including old-growth and forested wetlands; all streamside and riparian forest; northern spotted owl CHU; all persistent shrub and natural meadows; all cliffs and caves. Restoration: significant recruitment of mature and late-successional forest, upland and riparian; snag recruitment through silviculture.
Marten *Martes americana*	Conifer and mixed-conifer forests with snags; riparian areas (Koehler et al. 1975; Allen 1982; Strickland et al. 1987)	As above.
Silver-haired Bat *Lasionycteris noctivagans*	Mature, late-successional, and old-growth conifer forests; snags; open water for foraging (Thomas and West 1991; Christy and West 1993)	Protection: all forest, including old growth and forested wetlands; all streamside and riparian forest; northern spotted owl CHU. Restoration: significant recruitment of mature and late-successional forest, upland and riparian.
Townsend's Western Big-eared Bat *Corynorhinus townsendi*	Caves; wet meadows; riparian areas (Brown 1985b)	Protection: all cliffs, caves, rock outcrops; all wet meadows; all wetlands; all riparian habitat. Restoration: riparian forest.
Wolverine *Gulo gulo*	Remote montane forest areas; large areas with adequate prey levels and low level of human activity (Butts 1992; Banci 1994)	Protection: all forest, including old growth and forested wetlands; all streamside and riparian forest; northern spotted owl CHU; all wetlands and natural meadows. Restoration: significant recruitment of mature and late-successional forest, upland and riparian.
Yuma Myotis *Myotis yumanensis*	Deciduous, conifer, and mixed deciduous and conifer wetland forests (pole to late stages); rivers, streams, lakes, ponds, and swamps; caves; and cliffs; snags (Brown 1985b)	Protection: all forest, including old-growth and forested wetlands; all streamside and riparian forest; northern spotted owl CHU; all cliffs and caves; all rivers, streams, lakes, ponds, and wetlands. Restoration: significant recruitment of mature and late-successional forest, upland and riparian; snag recruitment through silviculture.

Species	Key Habitat	Potential Key Habitat Protected or Restored
Western Redback Salamander *Plethodon vehiculum*	Coniferous forests in mild climates; talus, boulders, and rock outcrops; logs and woody debris (Leonard et al. 1996)	Protection: all riparian habitats; all conifer forest; talus slopes and rock outcrops; significant areas of coniferous forest. Restoration: riparian and upland forest; recruitment of large woody debris through silviculture.
Blue-gray Taildropper (slug) *Prophysaon coeruleum*	Moist, coniferous forest (low to middle elevations) (Frest and Johannes 1993)	Protection: all forest, including old growth and forested wetlands; all streamside and riparian forest; northern spotted owl CHU. Restoration: significant recruitment of mature and late-successional forest at low to middle elevation, upland and riparian.
Johnson's (mistletoe) Hairstreak (butterfly) *Mitoura johnsoni*	Lowland coniferous forest containing dwarf mistletoe (Scott 1987)	Protection: all forest, including old growth and forested wetlands; all streamside and riparian forest. Restoration: significant recruitment of mature and late-successional forest at low elevation, upland and riparian.
Oregon Megomphix (snail) *Megomphix hemphilla*	Moist, low- to middle-elevation, undisturbed forest (Frest and Johannes 1993)	Protection: all forest, including old growth and forested wetlands; all streamside and riparian forest; northern spotted owl CHU. Restoration: significant recruitment of mature and late-successional forest at low elevation, upland and riparian.
Puget Oregonian (snail) *Cryptomastix devia*	Low- to middle-elevation riparian and old-growth forest (Frest and Johannes 1993)	Protection: all forest, including old growth and forested wetlands; all streamside and riparian forest; northern spotted owl CHU. Restoration: significant recruitment of mature and late-successional forest at low elevation, upland and riparian.
	Special Habitat Types	
Band-tailed Pigeon *Columba fasciata*	Mineral springs or other mineral sources; mixed coniferous and deciduous forests with openings (WDFW 1991)	Protection: all deciduous and mixed forest in riparian areas and floodplains. No mineral springs identified, but any will be protected. Restoration: development (through forest maturation and natural disturbances) of a landscape resembling that to which the band-tailed pigeon is adapted.
Black Swift *Cypseloides niger*	Moderate-elevation forests; steep cliffs, behind waterfalls (for nesting); many habitats for foraging (forages widely) (Smith et al. 1997)	Protection: all forest, including old-growth and forested wetlands; all streamside and riparian forest; northern spotted owl CHU; all cliffs; all naturally open habitats. Restoration: significant recruitment of mature and late-successional forest, upland and riparian.

Species	Key Habitat	Potential Key Habitat Protected or Restored
Golden Eagle *Aquila chrysaetos*	Open habitats, especially mountains and hills; edge habitat; cliffs and large trees (for nesting) (Brown 1985b; Ehrlich et al. 1988)	As above.
Merlin *Falco columbarius*	Open woodlands and meadows (Brown 1985b); mid- and late-seral conifer forest (Smith et al. 1997)	As above.
Peregrine Falcon* *Falco peregrinus*	Cliffs; wetlands; meadows (Pac. Coast Am. Per. Fal. Rec. Team 1982)	<u>Protection</u>: all cliffs; all naturally open habitats, including meadows; all wetlands.
Rufous Hummingbird *Selasphorus rufous*	Natural open habitat, open wetlands, open riparian habitats, and other areas where nectar-producing flowers are available (Zeiner et al. 1994)	<u>Protection</u>: all riparian habitat; all naturally open habitats, including meadows, persistent shrub, and talus. <u>Restoration</u>: development of shrub layer following silvicultural treatments.
Western Bluebird *Salia mexicana*	Mixed forest: grass/forb to sapling stage; meadows; emergent and scrub-shrub wetlands; snags (Brown 1985b)	<u>Protection</u>: all naturally open areas, including meadows, persistent shrub, and talus; all wetlands. <u>Restoration</u>: snag recruitment through silviculture.
Gray Wolf* *Canis lupus*	Any type of forest and natural opening; low level of human activity; adequate ungulate prey base (Laufer and Jenkins 1989)	<u>Protection</u>: all forest, including old-growth and forested wetlands; all streamside and riparian forest; all riparian habitat; northern spotted owl CHU; all naturally open habitats, including meadows, persistent shrub, and talus; continued limitations on public access into the Watershed. <u>Restoration</u>: significant recruitment of mature and late-successional forest, upland and riparian; removal of 38 percent of watershed roads.
Grizzly Bear* *Ursus arctos*	Upland meadows, talus, persistent shrub communities, emergent wetlands, riparian areas, and closed canopy forest, especially mature to old-growth forest stages; also, low level of human activity (USDI 1993)	As above.
Larch Mountain Salamander *Plethodon larselli*	Vegetated talus slopes; forested areas with rocky substrates; old-growth forest on steep slopes (Leonard et al. 1993; Olson 1996)	<u>Protection</u>: all vegetated talus slopes and adjacent forest.

Measures Applicable Primarily to Late-successional and Old-growth Forest Communities

Context and Issues

Forest Habitat Opportunities in the Cedar River Municipal Watershed

As noted in Section 4.2.1, virtually all of the old-growth forest at low elevations in the Puget Sound region has been logged. As a result of substantial loss and fragmentation of old-growth forest habitats, as well as urbanization and removal of forests in the lowlands, the wide variety of fish and wildlife species that depend on mature, late-successional, and old-growth conifer forests collectively represent one of the greatest at-risk groups in the region (Thomas et al. 1993).

The Cedar River Municipal Watershed extends from the lowlands to the Cascade crest, and from 543 ft to 5,414 ft elevation. Because of its geographic location and its range of elevations, the watershed represents an unusual opportunity to redevelop, over time, some old-growth forest at low- to middle-elevations, to protect and redevelop old-growth forest at higher elevations, and to provide important connectivity both within the watershed and with other late-successional and old-growth forest reserves in the region.

Because the municipal watershed has been managed as a water supply for nearly a century, the rate of timber harvest has been lower than the rate on much of the private land in the Puget Sound region. Even though timber has been harvested in the watershed since the 1880s, 13,889 acres of old-growth conifer forest remains. This old growth ranges from 190 to nearly 800 years of age, a range that means the older stands in the watershed are some of the oldest in the Cascade Mountains of Washington (Agee 1993).

As indicated on maps 5, 6, and 7, there are several large blocks and smaller, fragmented patches of existing old-growth forest in the municipal watershed. The large blocks are all in the northern spotted owl CHU in the eastern portion of the watershed, whereas the smaller patches are to the west of the CHU, but most are all still within the upper watershed. Protection of the remnant old-growth forest in the CHU, if combined with adjacent second-growth forest, could play a critical role in the protection and recovery of the northern spotted owl. Further, because the CHU is an element of the federal late-successional and old-growth reserve system, the designation of the municipal watershed as a forested reserve that includes the CHU could be critical in the protection and recovery of many additional species that depend on mature, late-successional, and old-growth forests. The marbled murrelet, for example, may benefit because the CHU is entirely within 50 miles of saltwater, the range that encompasses breeding habitat for the species (Section 3.5.3).

In addition, some species of nonvascular plants and invertebrates may also require conditions only present in ancient, old-growth forests (Ruggiero et al. 1991a; Henderson 1993). Thus, protecting existing old-growth habitats is key to protecting those species most dependent on those habitats. However, naturally regenerated mature forest (81-120 years old) and late-successional forest (121-190 years old) also can be important to species dependent on old-growth ecosystems (Brown 1985a; Ruggiero et al. 1991b; Spies 1991; FEMAT 1993).

Some scientists also now argue that many species that rely on late-successional and old-growth forests can experience considerable benefit from previously harvested forests if those forests have such characteristics of naturally regenerated stands as multiple canopy layers, large trees, gaps in the canopy, and abundant logs and snags (Ruggiero et al. 1991a). Over 20 percent (24,478 acres) of second-growth in the municipal watershed is between 61 and 80 years of age (Figure 1.2-1), but only about 1 percent (1,094 acres) of the second-growth is more than 80 years of age (Figure 1.2-1), the age at which the habitat characteristics of *mature* forest may appear (Carey and Curtis 1996). Some scientists believe that the age at which a developing forest stand develops mature or late-successional habitat characteristics can be accelerated through silviculture (Carey et al. 1995, 1996).

Use of Silviculture to Accelerate Development of Mature and Late-successional Forest Characteristics

Carey and Curtis (1996) have argued that, with appropriate silvicultural intervention, previously harvested forests from 80 to 120 years of age or older can have most of the functional value of old-growth forest in terms of conserving biodiversity. The Late-successional and Old-growth Communities component of the Watershed Management Mitigation and Conservation Strategies is based on the assumption that the species addressed in this HCP that depend on old-growth forest will benefit substantially by both (1) a commitment not to harvest timber for commercial purposes, which will result in recruitment of additional mature and late-successional forest, and (2) a program of silvicultural intervention designed to accelerate development of old-growth conditions in selected previously harvested stands. These commitments together should provide a landscape with large, essentially contiguous patches of mature, late-successional, and old-growth forest habitat, which would in turn provide maximum connectivity among patches of older forest habitat in the municipal watershed and with adjacent areas.

The silvicultural intervention will be designed to mimic, to some extent, the actions of natural disturbances that result in the complex habitat structure and biological diversity found in many unmanaged forests. In the absence of human activities related to timber harvest or forest clearing, fire has been the major agent of large-scale disturbance in western Washington forest (Agee 1993). A variety of agents such as wind, disease, and insects produce small- to mid-scale disturbances that create habitat structure in developing stands (Spies and Franklin 1991; McComb et al. 1993).

During many of these large-scale natural disturbances, the ecological functions of the forest are sustained because key elements of the previous forest that are carried over into the regenerating forest (Franklin 1989, 1992). These key elements, or *legacies*, include live trees, snags, down wood, and other ecologically important elements of the mature forest (Agee 1993; Cascade Center for Ecosystem Management 1995). These legacies carry over into the young regenerated stands, which often have higher levels of coarse woody debris than mature stands over 100 years in age (Spies and Franklin 1991). Some of the organisms associated with old trees and snags are literally "carried over" into the regenerating forest as well. Late-successional and old-growth forests, however, also owe their biological diversity to finer-scale disturbances, such as individual tree death, limited windthrow or wind damage, and pockets of insect, disease, fungal, and parasite infestations.

Examples of the results of such fine-scale disturbances include scattered small gaps (Lertzman and Krebs 1991, as cited in Bunnell 1995; Spies and Franklin 1989; Spies et al. 1990); variable light regimes; understory development; trees of different sizes, snags, logs, and broken tree tops; as well as damage in the canopy that supports complex invertebrate communities (Schowalter 1989). Small scale disturbances in the riparian zone, such as when a tree falls into a stream, serve to create habitat complexity and contribute to biological diversity.

Two findings of recent research in the Pacific Northwest must be considered if silvicultural intervention is be used successfully in accelerating development of forests that have the functional characteristics of mature and late-successional forests: (1) coarse woody debris, both standing and down, plays an important role in forest ecosystems (Maser and Trappe 1984: Maser et al. 1988; Brown 1985a) and (2) biological diversity is suppressed during the closed-canopy, competitive exclusion phase of forest development that occurs early in a stand's existence (Oliver and Larson 1990; Carey and Curtis 1996).

According to Brown (1985a), snags are used by nearly 100 species of wildlife in western Washington and Oregon; of these 100 species at least 53 species are cavity dependent. The absence of snags can be the major limiting factor for many snag-dependent species (Balda 1975, as cited in Brown 1985a). Other types of woody debris important ecologically include logs, stumps, and root wads in various stages of decay (Brown 1985a). Down woody material has tremendous ecological significance, both for supporting a diversity of organisms and for sustaining key ecosystem processes (Maser and Trappe 1984; Maser et al. 1988). Large snags and logs can be created in older stands through variable density thinning, which fosters growth of large trees, and by damaging trees in a variety of ways (Carey and Curtis 1996).

Research has shown that it is also possible to shorten the time in the competitive exclusion phase of forest development, which occurs when young stands are densely stocked, the canopy closes, competition among trees is intense, and little light reaches the forest floor (Oliver and Larson 1990; Oliver 1992; Carey and Curtis 1996). The stocking level in naturally and artificially regenerated stands is typically very high at *stand initiation* following an event, such as fire or regeneration harvest, which removes most of the overstory trees (Oliver and Larson 1990). Tree density declines over time through tree competition for light, water, and nutrients, and because of other processes that lead to tree mortality. During this phase, most of the understory vegetation is depressed or dies, and the stand has very little biological diversity (Oliver and Larson 1990; Carey and Curtis 1996).

Thinning in dense, young stands (called *restoration thinning* in this HCP) reduces the density of trees, thus reducing competition, opens the stand for better light penetration, stimulates tree growth, and brings on the next stage of forest development – *understory reinitiation* – sooner (Carey and Curtis 1996). During the understory reinitiation stage, biological diversification increases sharply. When the stocking level of a young stand is particularly high (called a dog-hair conditions), thinning can have a dramatic beneficial effect on biological diversification (see Figure 4.2-1 for a photo of a stand before and after thinning). Such dog-hair stands could also constitute a significant risk of fire, either through accumulation of dead woody material from competition mortality or, indirectly, through stress that fosters heavy disease or insect damage that produces significant tree mortality.

Figure 4.2-1. Examples of (a) a young stand with very high stocking density, and (b) a young stand after thinning.

a.

b.

The City only began thinning younger stands (typically less than 30 years old) in the Cedar River Municipal Watershed in 1995, and less than 2,000 acres of these young stands have been thinned to date. Surveys begun in 1994, and not yet completed, have identified over 8,000 acres of young, overstocked stands in the municipal watershed (SPU, unpublished observations). Stocking in these areas commonly exceeds 4,000 trees per acre with some as high as 10,000 per acre or more (SPU, unpublished observations), an order of magnitude or more higher than densities that would best accelerate forest development and provide beneficial habitat conditions for wildlife (Carey et al. 1995, 1996).

Thinning in stands older than 30 years, called *ecological thinning* in this HCP, can also accelerate development of mature and late-successional forest characteristics in previously harvested stands (Carey and Curtis 1996). Variable density thinning creates light gaps, encourages understory development, and promotes the growth of large trees (Carey et al. 1995, 1996). Short-term changes in forest structure typical of older forests can be effected by creation of snags, logs, and tree cavities by various means, and planting can be done to increase species diversity (Section 3.3.4).

Objectives for the Late-successional and Old-growth Forest Communities Component

The general objective of the Late-successional and Old-growth Communities component of the Watershed Management Mitigation and Conservation Strategies is to develop significantly more mature and late-successional forest habitat in the watershed that will support species addressed in this HCP that are dependent on late-successional or old-growth forests, as well as old-growth biological communities in general.

The more specific primary objectives of this component are to:

- Preserve all remaining old-growth forest in the municipal watershed;
- Recruit a significant amount of additional mature and late-successional forest, especially at lower elevation, providing an interconnected reserve of mature, late-successional, and old-growth forest habitat;
- Make a significant contribution to the federal late-successional reserve system, connecting north and south in the Cascade Mountains;
- Accelerate the development of old-growth conditions in a significant proportion of second-growth stands in the watershed through silvicultural intervention; and
- Significantly increase the long-term ability of the municipal watershed to support species addressed in the HCP that are dependent on, or use late-successional and old-growth forests.

Mitigation and Conservation Strategies for Late-successional and Old-growth Forest Communities

Protection of Late-successional and Old-growth Forest Communities Through Reserve Status

To accomplish the objectives described above, the City commits not to harvest timber for commercial purposes, effectively placing the following forested elements in reserve status (Table 4.2-2 and maps 5, 6, and 7):

- All old-growth forest in the watershed (13,889 acres);
- The entire spotted owl Critical Habitat Unit WA-33 (22,845 acres, including a wide variety of forest seral stages and non-forest habitats, most of the remaining old growth in the watershed, and all former federal land within the CHU); and
- All second-growth forest outside developed areas, including forested wetlands.

Placing all forest in reserve status not only confers protection on the forest ecosystem in the watershed but also confers protection on aquatic, riparian, and non-forested upland habitats, such as meadows, by providing natural forested margins to those habitats and by providing connectivity among them. Many species dependent on late-successional and old-growth forests use some of these other habitats (Table 4.2-3), and the commitment not to harvest timber for commercial purposes provides broad, ecosystem-level benefits for those species.

Restoration Measures for Late-successional and Old-growth Forest Communities

About 84 percent of the forest in the municipal watershed has been logged. Current stand conditions are variable, and many stands are on their way to structural and biological diversification (Section 3.2.2). However, some other stands could greatly benefit by careful silvicultural intervention to accelerate development of ecological conditions characteristic of late-successional and old-growth habitat (see discussion of old-growth restoration workshop in Section 3.3.4).

To accomplish the objectives of the Late-successional and Old-growth Communities component of the Watershed Management Mitigation and Conservation Strategies described above, the City will employ the following types of silvicultural intervention: restoration planting, restoration thinning (in stands typically under 30 years old), and ecological thinning (in stands typically from 30 to 60 years old, occasionally older).

Stands will be selected for these treatments by a City interdisciplinary team that includes watershed foresters, biologists, hydrologists, and other professionals, and outside experts will be consulted as needed. The team will use information from the forest inventory database, the Forest Projection System growth model, and the GIS database (Section 3.3.7), as well as field evaluations. All upland habitat restoration work (not associated with riparian areas) will be prioritized. The highest priority stands will be those with the most potential for accelerating the development of old-growth conditions and for reducing the risk of forest fires and subsequent catastrophic damage.

Restoration Planting

Restoration planting will be done in selected upland second-growth stands where needed to diversify the plant community. The planting program will be designed to develop a diversity of trees and shrubs characteristic of naturally regenerated stands on similar sites and that will support a diversity of native wildlife species. Techniques are likely to include planting native forbs, shrubs, and trees, and spraying lichen fragments in the canopy. Hardwood development will be enhanced by recruiting species such as big leaf maple (*Acer macrophyllum*) and black cottonwood (*Populus trichcocarpa*) to diversify stand structure at lower elevations. The stands that will receive highest priority for restoration planting will be those that have plant diversity much lower than expected, based on site characteristics, and those with the greatest potential for beneficial results.

Restoration planting is an experimental approach, and will be conducted within the adaptive management program described in Section 4.5.7. Projects will be monitored, and techniques will be changed in response to better understanding of how desired effects can be achieved. The program may be reduced or terminated if the City and Services determine that it is not effective in achieving its conservation objectives. If this program is terminated or cut back from that planned, funding for restoration planting will be used for other watershed conservation or mitigation activities (see sections 4.5.7 and 5.3.2)

Funding for restoration planting in upland areas will total $300,000. This includes $75,000 over the first 8 years, $75,000 over the second 8 years, and $150,000 over the remainder of the HCP term. The funding level is based on an estimated approximate average cost of $300 per acre for planting and maintenance. Based on that assumed cost per acre, the City expects that about 1,000 acres could be treated by restoration planting, about half of which would be treated in the first 16 years of the HCP term.

<u>Restoration thinning</u>

Restoration thinning will be done in upland areas where needed in densely stocked, young, second-growth stands (generally less than 30 years old) to move the stands more quickly out of the stem exclusion or competitive exclusion stage (Oliver and Larson 1990; Carey and Curtis 1996). In such over-stocked stands (often called dog-hair stands), understory is typically absent, habitat conditions for wildlife are poor, and competition for limited nutrients, water, and light results in slowed growth and greater risk of insect outbreaks, disease epidemics, and forest fires. Herbaceous and shrub layers valuable for wildlife are typically absent or poorly developed.

The restoration thinning program will be designed to accelerate development of late-successional and old-growth conditions, develop habitat structure that supports a diversity of native wildlife and reduce the chance of catastrophic damage to the forest. Risk of catastrophic damage can be elevated in such dense stands when competition among trees for water, light, and nutrients causes tree death directly or indirectly by creating stress, which may make the stand more susceptible to insect or disease infestations (Oliver and Larson 1990). Large-scale tree mortality can result in buildup of fuels that can increase the risk of fire ignition and the degree of spread of fires.

The stands that will receive highest priority for restoration thinning will be those that: (1) are most over-stocked, based on age, species, and site characteristics; (2) exhibit signs of severe competition and stress and are determined to be at greatest risk of causing catastrophic damage; and (3) have the greatest potential for beneficial results. The decision regarding the density of leave trees will be made on a site-specific basis. As noted above, during the early part of implementation of the HCP, the City will consult with the Services regarding how best to identify any short-term impacts of restoration thinning and develop approaches to minimize and mitigate for impacts and produce the greatest overall ecological benefit from this intervention strategy. In addition, the City will hold field trips with the public and interested groups during development of the criteria for restoration thinning, to solicit input and answer questions.

Restoration thinning is an experimental approach, and will be conducted within the adaptive management program described in Section 4.5.7. Prescriptions will vary by site and will focus on creating conditions that resemble naturally regenerated stands. However, the approach is based on the long-established practice of precommercial thinning, which has widely accepted, beneficial effects. Projects will be monitored, and techniques will be changed in response to better understanding of how desired effects can be achieved.

Funding for restoration thinning in upland areas will total $2,620,000. This includes $1,614,000 over the first 8 years and $1,006,000 over the next 7 years. The funding level is based on an estimated approximate average cost of $250 per acre for restoration thinning. Based on that assumed cost per acre, the City expects that about 10,480 acres would be treated by restoration thinning, all of which would be treated in the first 15 years of the HCP term. Nearly 90 percent of stands younger than 30 years old were at least 10 years old in 1997. The restoration thinning treatment has to be applied to stands early in the term of the HCP, before stands mature beyond the age at which such thinning treatments are effective. Conducting this thinning early in the HCP in areas where road removals are planned also will allow road deconstruction to proceed more rapidly.

Ecological thinning

Ecological thinning activities in older stands (typically between the ages of 30 and 60, occasionally older) will be done in some upland areas, where appropriate. The appropriateness of such intervention in older stand will be determined by an interdisciplinary team determines that intervention can improve habitat for wildlife and accelerate the development of late-successional and old-growth forest characteristics (see discussion of the old-growth restoration workshop in Section 3.3.4).

The ecological thinning program will include both thinning to promote long-term development of late-successional forest structure and killing and damaging trees to recruit coarse woody debris to provide short-term habitat benefits. It will be designed to encourage development of the habitat structure and heterogeneity typical of late-successional and old-growth stands by: (1) creating variable spacing among trees, a diversity of tree diameters, and several canopy layers; (2) creating small forest openings to recruit desired plant species and to stimulate growth of large trees and understory shrubs and trees; (3) increasing light levels to *release* intermediate-sized trees and advanced regeneration (small western hemlocks and western redcedars) for increased growth; and (4) favoring desired species and damaged trees. The stands that will receive highest priority for ecological thinning will be those that are the most overstocked based on size, age, and species and have the least biological and structural diversity and have the greatest potential for beneficial results.

The program may employ variable density thinning; creating small forest openings; creation of snags and cavities in trees using various methods, such as topping, damaging, or burning trees; injection of decay-producing fungi; creating logs by felling trees; uprooting trees to create logs, root masses, and holes; and related techniques. Care will be given to leave and protect existing features that generate and contribute to stand diversity, which may include root rot centers. Operations will be carefully planned to minimize impacts. The decision regarding the density and distribution of leave trees will be made on a site-specific basis. As noted above, during the early part of implementation of the HCP, the City will consult with the Services regarding how best to identify any short-term impacts of ecological thinning and develop approaches to minimize and mitigate for impacts and produce the greatest overall ecological benefit from this intervention strategy. In addition, the City will hold field trips with the public and interested groups during development of the criteria for ecological thinning, to solicit input and answer questions.

Ecological thinning is an experimental approach, and will be conducted within the adaptive management program described in Section 4.5.7. The program may be terminated if the City and Services determine that it is not effective in achieving its conservation objectives or that it is creating adverse impacts. Projects will be monitored, and techniques will be changed in response to better understanding of how desired effects can be achieved. If this program is terminated or cut back from that planned, funding for ecological thinning will be used for other watershed conservation or mitigation activities (see sections 4.5.7 and 5.3.2).

Funding for ecological thinning and related activities in upland areas will total $1,000,000. This includes $250,000 over the first 8 years, $250,000 over the second 8 years, and $500,000 over the remainder of the term of the HCP. The funding level is based on an estimated average cost of about $500 per acre for ecological thinning, including research and modeling analyses. Based on that assumed cost per acre, the City expects that about 2,000 acres could be treated by ecological thinning, about half of which would be treated in the first 16 years of the HCP term for greatest effect.

The purposes of ecological thinning are strictly ecological in nature. However, if consistent with the biological objectives of an ecological thinning project, logs may be removed from a site and sold, or put to use in other restoration projects. Sale of logs will only be done if tree density, tree spacing, and the amount and distribution of coarse woody debris (snags and logs) meet the biological objectives for the HCP and the thinning operation. So that these objectives will be clearly understood, during the early part of implementation of the HCP, the City will consult with the Services and will solicit public input regarding biological standards for ecological thinning that would be applied in deciding whether logs can be removed from a site and sold, or used for other restoration purposes. If such sales occur, the City will use resulting net revenues only for watershed restoration under the HCP. In some cases, thinning contracts may be arranged to trade the value of the logs for services to perform the restoration activities at the site or restoration activities in other areas.

Guidelines Related to Late-successional and Old-growth Forest Communities

Management guidelines applicable to Late-successional and Old-growth Forest Communities are described below under the section entitled "Administration of the Municipal Watershed and Applicable Management Guidelines." That section includes descriptions of City activities expected within the watershed and management guidelines developed to avoid, minimize, and mitigate impacts of those activities. It includes guidelines applicable to the watershed as a whole, to Late-successional and Old-growth Forest Communities, and to other habitats in the municipal watershed.

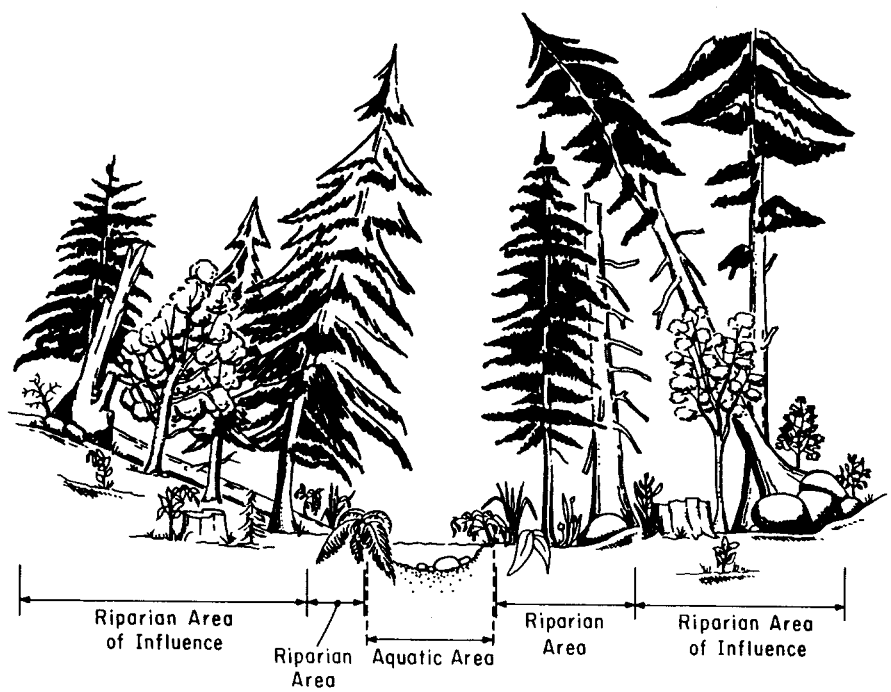
Measures Applicable Primarily to the Aquatic and Riparian Ecosystem Component

Context and Issues

Protection of drinking water quality goes hand in hand with protection of aquatic habitats in the municipal watershed, and both go hand in hand with protection of vegetation near water bodies and minimization of sediment delivery to streams from upland activities. The complex of water bodies that includes streams, lakes and ponds, and wetlands functions as an interrelated, and mostly interconnected, system that provides high quality water and aquatic habitat for a variety of animals addressed by this HCP. Protection of these aquatic habitats requires protection of associated riparian habitats.

The riparian zone is the area adjacent to surface waters and areas of high groundwater levels where the terrestrial system both influences, and is influenced by, the aquatic system (Bilby 1988; Swanson et al. 1992). Riparian ecosystem components include features such as the water's edge, subsurface water, active floodplains and overflow channels, trees that shade the water, vegetation that is frequently flooded, and associated fish and wildlife. Riparian zones can be associated with flowing water systems and with lakes, ponds, and wetlands. The size and structure of the riparian zone is closely related to the size and dynamics of the surface water and the topography that surrounds the body of water, as well as the groundwater at or near the surface. Riparian zones vary from narrow bands along streams in tightly confined channels to broad floodplains along large rivers in wide valleys (Figure 4.2-2).

Figure 4.2-2. The size and structure of the riparian zone reflects the dynamics of the water body and the surrounding topography. From Sedell et al. 1989.



The interactions between the riparian zone and open bodies of water affect both systems, and both systems are influenced by processes, such as soil erosion and water runoff, that originate in the surrounding uplands. Ecological processes significant to stream and riparian ecosystems can be defined by the interactions among vegetation, hydrology, and substrates (Kauffman et al. 1997). For example, soil conditions and available water influence the plant community. In turn, the physical presence and binding capabilities of streamside vegetation can redirect the forces of flowing water and influence bank stability. In a healthy watershed, these ecological processes occur within a natural pattern of disturbances, such as flooding and landslides, which vary in frequency, magnitude, and location. This natural disturbance regime maintains the sustainability, diversity, and vitality of stream and riparian ecosystems (Naiman et al. 1992).

A great variety of species are dependent on aquatic and riparian ecosystems in the Pacific Northwest (Brown 1985a; Raedeke 1988). Although stream and riparian habitats are formed by disturbances (Agee 1988), these habitats can be negatively impacted by disturbance regimes that are altered as a consequence of human activities. It is widely acknowledged that watershed management activities, if not properly planned, can have adverse impacts on the aquatic/riparian ecosystem (Naiman 1992; Raedeke 1988).

For example, in forested watersheds, timber harvesting and road building can affect structure, size, and maturity of the vegetation; reduce shade and increase water temperature; increase erosion and sediment loads; alter nutrient inputs; fragment stream and riparian connections; alter the hydrologic regime; and modify channel morphology (O'Connell et al. 1993). Timber harvest activities near streams, including removal of vegetation, can result in several kinds of adverse impacts. Erosion resulting from substantial vegetation removal and soil disturbance ultimately leads to increased delivery of sediment to streams and subsequent adverse impacts to water quality and aquatic habitat (Bisson and Sedell 1984; MacDonald et al. 1991). Removal of most streamside vegetation, particularly trees, also can increase stream temperatures, which can adversely impact habitat for many salmonid species, including bull trout (Sidle et al. 1985). Removal of vegetation near lakes, ponds, and wetlands can also reduce ecological function by disrupting the intricate interrelationship between the aquatic and riparian elements of the ecosystem (Kauffman 1988).

Landslides related to roads or timber harvest units in *upland* areas that deliver sediments to streams − especially fine sediments − can adversely impact both water quality and aquatic habitat (Appendix 15; Bisson and Sedell 1984; MacDonald et al. 1991). Suspended, fine sediments raise turbidity, a major indicator of drinking water quality that is regulated under the Safe Drinking Water Act (Section 2.2.9). Fine sediments, in suspension or deposited on stream substrates, can have direct and indirect deleterious effects on aquatic organisms. Where suspended material settles out, it can fill pools and the interstitial spaces in gravels, a process that can reduce the quality of spawning and other habitats used by fish, salamanders, and other animals.

Protection of water quality within the Cedar River Watershed is vitally significant both from the standpoint of the Cedar River's role as the major source of municipal water supply for the greater Seattle area, and because of the quality of habitat (aquatic and terrestrial) that is available to resident and anadromous fish and to wildlife species that depend on the river's riparian corridor. Historically, forest road construction and use have resulted in adverse impacts to some streams and water quality in specific areas of the municipal watershed.

In the Cedar River Municipal Watershed, there are approximately 400 miles of streams and associated riparian areas, as well as riparian areas that surround lakes and other aquatic systems (sections 3.2.2 and 3.2.4). Although the stream and riparian conditions have greatly benefited from the lack of urban development in the watershed, many of the watershed streams and riparian areas have been negatively affected by past timber harvest and road building activities and specific practices (Section 3.2.2). Some segments of the existing network of about 620 miles of roads likely is a major contributor of sediment to streams within parts of the municipal watershed.

Altered conditions on some stream reaches also include increased occurrence of, and conversion to, hardwood-dominated riparian forests, loss of shade, changes in stream temperature, lack of large in-channel wood, decreased potential for woody debris recruitment, reduced instream complexity, fish migration barriers, channel widening, and increased sediment inputs (Seattle Water Department 1995). Activities on unstable slopes have subjected some streams to a greater frequency and magnitude of sediment loading from hillslope failures.

Past logging and timber salvage in riparian areas and past stream-cleaning efforts have reduced the frequency and volume of large woody debris (LWD) input to some streams. The volume of LWD delivery to streams from hillslope failures may have been reduced because of the increased frequency of hillslope landslides occurring after timber removal. Additionally, road construction has fragmented fish habitat by creating barriers to upstream fish movement. Efforts to protect the drinking water supply and the water supply infrastructure have also historically affected the condition of a few streams and riparian areas as a result of manipulation of instream wood, conifer revegetation, and channel alteration (Marshall et al. 1954). These drinking water quality protection efforts primarily affected streams that are downstream of the reservoir.

Of particular concern within the municipal watershed are inner gorges and headwall basins, both of which typically have high or very high surface erosion hazard and are prone to slope failures, especially when root strength and soil retention capabilities are jeopardized by large scale tree removal (Sidle et al. 1985). Sensitive soils, especially soils with relatively high water tables or those derived from alluvial deposits found in floodplain and riparian zones, also typically have high or very high surface erosion potential.

The potential risks of surface erosion and landslides for lands within the watershed were specifically evaluated as part of the Watershed Assessment conducted by the City (Section 3.3.3 and Appendix 15). Watershed Prescriptions (Appendix 16) restricting forest harvest activities on high-risk sites were also developed as part of the assessment process. A more complete discussion of the assessment process, evaluations, and prescriptions is contained in the Watershed Assessment documents (Foster Wheeler Env. Corp. 1995b; Seattle Water Department 1995; Cupp and Metzler 1995), and these prescriptions are incorporated into the Watershed Management Mitigation and Conservation Strategies as appropriate.

In 1993, the Forest Ecosystem Management Assessment Team (FEMAT) concluded an analysis of forest management options on federal land in the Pacific Northwest that was initiated in response to concerns about the northern spotted owl and other species dependent on old-growth ecosystems (FEMAT 1993). The recommendations under FEMAT's Option 9 were subsequently incorporated into the Northwest Forest Plan (Tuchmann 1996). Based on Option 9, the Northwest Forest Plan includes the following components of an aquatic conservation strategy to restore the productivity and resilience of riparian and aquatic ecosystems:

- Establishment of a system of riparian reserves, including adequate buffers, to protect streamside areas, unstable upland areas, wetlands, and other water bodies;
- Protection of key watersheds as refugia crucial to at-risk fish stocks and water quality;

- Watershed analysis, performed to describe watershed conditions, provide the basis for designing needed management guidelines, and identify priorities for restoration; and

- A program of watershed restoration targeted at reestablishing natural, physical, and ecological processes that create and maintain habitats for riparian species and fish.

The federal scientists on the FEMAT reviewed the research on protection of riparian areas and streams, and developed recommendations for buffers that would address a variety of physical and ecological concerns related to the protection of aquatic ecosystems. In developing the recommendations, they considered the need to maintain streamside forest cover to:

- Retain sufficient conifer trees for shade to maintain cool water temperatures;

- Retain sufficient trees and other plants to provide litter fall as a source of nutrients for aquatic organisms;

- Keep tree root systems intact to maintain bank stability and minimize sediment delivery to streams from bank failure;

- Provide a source of large woody debris from mature streamside conifers;

- Provide adequate microclimate for plants and animals by having a sufficient band of vegetation; and

- Provide a safety factor, or increase, in buffer size to reduce the adverse effects of windthrow at the outer edges of the buffers (edge creep) near timber harvest units.

The recommended buffers are keyed to the size and potential ecological significance of a particular water body, and the FEMAT scientists recommended that all riparian habitat and floodplains be included in the riparian reserves, as well as inner gorges and other landslide-prone areas.

In addition, the federal team recommended that:

- Trees be cut in the riparian reserve only to restore ecological functions; and

- Programs be implemented to decommission and improve forest roads, restore riparian forests, and restore instream habitat.

FEMAT recommended that thinning be done in riparian areas only to meet ecological objectives and only if supported by a watershed analysis. The Watershed Assessment conducted by the City supported such silvicultural intervention in some previously harvested riparian areas, if site conditions warrant and if an interdisciplinary team decides that such intervention would provide overall beneficial results (Appendix 16).

It is clear from the FEMAT analysis that protection of the interrelated system of water bodies in the Cedar River Municipal Watershed can be accomplished by a combination of three actions: (1) restricting activities near streams, lakes and ponds, and wetlands; (2) maintaining and restoring the integrity of habitat near these aquatic features through management guidelines and restoration activities; and (3) restricting activities in upland areas with very steep slopes and erodible soils, where such activities could result in the delivery of sediment to streams, wetlands, and other water bodies.

Habitat continuity and connectivity also may affect the survival of some populations (Frissell 1993). Because of demographic risks to small populations, the long-term survival of a metapopulation of organisms depends on the ability of individuals to move from one habitat patch to another (Gilpin and Soule 1986; Morrison et al. 1992). The City made the following assumptions concerning establishing landscape connectivity among aquatic habitats and maintaining the functions of wetlands:

- For organisms that are strictly aquatic, connectivity within the river and stream network can best be achieved by a combination of removing barriers to movement and protecting and restoring instream habitat.

- For organisms that use both aquatic and riparian habitats, or only riparian habitats, connectivity among aquatic habitats can best be provided by a combination of protecting and restoring true riparian habitat, protecting and restoring other streamside forests, protecting complexes of aquatic elements, and managing upland forests to recruit mature and late-successional forest habitat.

- Sustaining and restoring all key ecological functions of wetlands, such as by protecting recharge areas.

While the City used the FEMAT recommendations in developing this HCP, because the City has committed not to harvest timber for commercial purposes and consequently will be able to remove a large portion of the existing road system, the commitments in this HCP clearly exceed the FEMAT recommendations for protecting aquatic and riparian habitats.

Development of Mitigation and Conservation Strategies for the Aquatic and Riparian Ecosystem

Intent and Analyses

The City's strategies for the Aquatic and Riparian Ecosystem are designed to protect the region's supply of high-quality drinking water, to preserve and enhance stream and riparian ecosystems within the municipal watershed, and to restore and rehabilitate stream and riparian functions. These strategies were developed after considering current ecological theory and the best available information on conditions in the municipal watershed. Site-specific information was gathered through various studies in the watershed including a watershed assessment (Section 3.3.3; Appendix 15), fishery research (Section 3.2.4; Appendix 23), and road and stream-crossing surveys. In addition, the City sponsored several workshops that focused on recent research in the region. The workshops were used as means to gather expert opinions on options available for restoring and rehabilitating stream and riparian systems in the watershed (Section 3.3.4; Appendix 14). In addition, the strategies incorporate and build upon the policy decision not to harvest timber for commercial purposes.

The City used Washington State's stream typing system (WAC 222-16-030), as it existed prior to the Forest and Fish Report, dated April 29, 1999, as the basis for assigning various protection guidelines that will be implemented through this HCP (final rules based on the Forest and Fish report had not been adopted as of finalization of this HCP). These protection guidelines include guidelines for activities near streams and provision for passage of fish where roads cross streams. As defined by the state, stream type classifications are dependent, in part, on the presence or absence of anadromous or resident fish.

The overall condition of stream and riparian habitat in the watershed was assessed through a Cedar River Watershed Assessment that was completed in 1995 (Foster Wheeler Env. Corp. 1995b; Cupp and Metzler 1995; Seattle Water Department 1995). This assessment provided a comprehensive analysis of the current watershed condition. The assessment closely followed the procedures described in the Washington State Watershed Analysis Manual, Version 2.0 (Washington Forest Practices Board 1993). The results of this analysis provide an overall description of the watershed's geology, geomorphology, landslide potential, hillslope erosion potential, peak flow regimes, riparian conditions, and fish habitat. The assessment also resulted in prescriptions for aquatic ecosystem protection and recommendations for rehabilitation efforts. The descriptions of basin conditions and the resultant prescriptions are integral components in the design of the strategies for the Aquatic and Riparian Ecosystem. A more complete discussion of the objectives, methods, and results from this assessment is provided in Section 3.3.3 and in Appendix 15. The Watershed Assessment Prescriptions are detailed in Appendix 16.

The strategies for the Aquatic and Riparian Ecosystem are designed to be closely integrated with the mitigation strategies for the anadromous fish barrier at Landsburg (Section 4.3). The strategies reflect the complex interactions that define stream and riparian ecological processes and the influences that basin conditions exert on the stream and riparian ecosystem.

Conservation, Restoration, Protection, and Rehabilitation

After several decades of restoration activities on western United States stream and riparian systems, assessments indicate that, although some projects achieve significant biological objectives, many of these efforts have not achieved their stated goals (Beschta et al. 1996). This realization contributed to a philosophical discussion within the scientific community regarding the ecological definition of restoration. In its purest sense, restoration can be defined as the reestablishment of predisturbance conditions where the disturbances are anthropogenic (Kauffman et al. 1997). Within an ecological framework, and because ecosystems are made up of complex interactions among organisms and their environment, some scientists believe the term restoration should not be used to describe activities that benefit only a single species or process. Rather, restoration is a holistic process that affects complex systems (National Research Council 1992). This view of restoration as something larger than the sum of its parts is echoed by Roper et al. (1997), who defined restoration as activities that reconnect fragmented habitats and reconstruct historical ecosystem processes.

The City will use the term restoration in a general sense with respect to the Aquatic and Riparian Ecosystem to characterize different types of active intervention that have the objective of increasing the quality of aquatic and riparian habitats that have been disturbed by past human activities or of returning aquatic and riparian habitats closer to more "natural" (predisturbance) conditions and ecological functioning. The strategies in this HCP for the Aquatic and Riparian Ecosystem use a holistic approach that incorporates aspects of restoration as well as efforts that could be better categorized as preservation, rehabilitation, enhancement, and/or mitigation, or some combination of these categories. According to Kaufmann et al. (1997), preservation is the maintenance of intact ecosystems, and rehabilitation implies making the system useful again, but it does not imply reestablishment of the original conditions. Enhancement is an improvement of a structural or functional attribute that may or may not restore the original linkages to other parts of the ecosystem. Mitigation is the alleviation of detrimental effects or environmental damage that results from anthropogenic actions, including the environmental improvements off site. There is overlap among these categories, as well as overlap between the categories and the definition of restoration.

The strategies for the Aquatic and Riparian Ecosystem are made up of several elements. Each element focuses on achieving a better condition for one or more processes (e.g., sediment loading, LWD recruitment, fish passage). These elements are coordinated to complement one another so that the overall conservation strategy is likely to achieve restoration of the aquatic and riparian ecosystems over the long term. This coordination of specific elements is an especially useful technique for watersheds in an early stage of recovery from disturbances where rehabilitation techniques can help accelerate restoration (Cederholm et al. 1996).

Some of the active interventions included in this HCP will be designed to bridge the gap between current, disturbed conditions under which key ecological functions are impaired and habitat quality is relatively poor and future conditions under which the aquatic/riparian ecosystem sustainably supports processes that create and maintain habitat over the long term without human intervention. For example, large woody debris may be physically added to a stream deficient in large woody debris to improve habitat, but the long-term goal will be to restore the riparian forest's capability to recruit sufficient quantities of large woody debris *without* human intervention.

The strategies for the Aquatic and Riparian Ecosystem in the municipal watershed were designed using the concept that the implementation of watershed-wide land stewardship is the most important part of any restoration effort (see Beschta et al. 1996; Naiman et al. 1992; Reeves et al. 1991; Harr and Nichols 1993; Bisson et al. 1992). As a result, the strategies will be implemented throughout the watershed and coordinated with other Watershed Management Mitigation and Conservation Strategies in an effort to achieve a holistic approach to watershed restoration. Protection and restoration of the municipal watershed will also provide a foundation upon which to build a comprehensive salmonid conservation program for the Lake Washington Basin as a whole (Section 4.3).

A monitoring and research program (Section 4.5) is another important component of the strategies for the Aquatic and Riparian Ecosystem, because ecological processes and interactions are not fully understood, and because it is impossible to predict with certainty the outcome of all management and restoration activities. Monitoring and research will be used to evaluate project success with respect to the conservation objectives discussed below. Information compiled during monitoring and research will be used in an adaptive management approach that incorporates new information as it becomes available.

If elements are determined to be unsuccessful, or no longer needed, they will be suspended based on the adaptive management strategies outlined in Section 4.5.7.

Measures will be abandoned only by agreement of the Services, which will include agreement on use of the funds for alternative mitigation (Section 5.3.2).

Prioritization

Stream reaches and riparian corridors in need of rehabilitation or restoration efforts through the strategies for the Aquatic and Riparian Ecosystem will be identified from the results of several investigations. These include a watershed assessment conducted for the Cedar River Watershed (Section 3.3.3; Appendix 15); continuing research on bull trout, other salmonids, and fish habitat (Section 4.5.5); additional fish distribution surveys (Section 4.5.5); road condition surveys; and a comprehensive field survey of stream-crossing structures in the watershed (Section 3.2.4).

All stream and riparian restoration projects will be prioritized based on their ability to protect the water supply, to enhance natural stream and riparian processes, to protect or enhance resources for species of concern, to have a high likelihood of success, and to produce a relatively high level of benefits for the cost. Projects will be scheduled so that efforts to reduce disturbances that originate in upslope or upstream areas will be addressed prior to initiating projects downslope or downstream of these same disturbances. A City interdisciplinary team will be used to prioritize and schedule projects.

Objectives for the Aquatic and Riparian Ecosystem Component

The specific objectives listed in this section were developed from the more comprehensive set of HCP objectives presented in Section 2.4. These objectives support the goal of avoiding, minimizing, and mitigating the impacts of any incidental take of species listed as threatened or endangered and additionally treat unlisted species of concern as if they were listed. They include a commitment to protect or improve the quality of the surface water in Cedar River Municipal Watershed, to provide a net benefit for species of concern that are dependent on riparian or aquatic habitats, and to contribute to the recovery of these species. The specific objectives established for Aquatic and Riparian Ecosystem will also help restore and rehabilitate stream and riparian functions and stream and riparian habitat, while preserving and protecting the municipal water supply.

The focus of the Aquatic and Riparian Ecosystem component of the Watershed Management Mitigation and Conservation Strategies is to protect water quality and aquatic and riparian habitats through the commitment not to harvest timber for commercial purposes (effectively placing all forests outside limited developed areas in reserve status), management guidelines, and restoration of streams and riparian forests. Of particular concern are the need to maintain intact plant communities and vegetative cover in riparian zones, the need to minimize delivery of sediment to streams from human activities, and the need to provide landscape connectivity.

The primary objectives for the Aquatic and Riparian Ecosystem include the following:

- Through a commitment not to harvest timber for commercial purposes and other measures, protect streamside habitats, both riparian and upland in nature, to maintain or improve stream temperature regimes, to recruit large woody debris, and to maintain bank stability through maintenance and recruitment of large-diameter conifers;

- Through a commitment not to harvest timber for commercial purposes and other measures, protect wetlands, lakes, and ponds and all true riparian habitats from degradation of function and ability to support species addressed in the HCP as a result of land management activities;
- Through a commitment not to harvest timber for commercial purposes and other measures, protect sensitive and highly erodible soils in floodplains and riparian zones from degradation and erosion caused by land management activities;
- Through engineered road improvements, decommissioning, and improved maintenance, reduce the higher rate of fine and coarse sediment loading to aquatic systems from sources influenced by past timber harvest, poor past road design or construction, and continued road maintenance;
- Through a commitment not to harvest timber for commercial purposes and other measures, avoid disturbance of sensitive and highly erodible soils on steep slopes within inner gorges and headwall basins, and in other areas, that can result in sediment delivery to streams, wetlands, and other water bodies;
- Implement management guidelines and prescriptions to provide protection for aquatic and riparian habitats additional to that afforded by a commitment not to harvest timber for commercial purposes;
- By silvicultural intervention, contribute to restoration of natural ecological and physical processes and functions that create and maintain aquatic and riparian habitats;
- Through a commitment not to harvest timber for commercial purposes and other measures, reduce the magnitude and frequency of human-influenced bank failures, landslides, mass wasting, and debris flows;
- Protect stream, wetland, and riparian habitats by following conservative management guidelines for road management activities that influence stream, wetland, and riparian habitats;
- Promote the restoration of natural aquatic and riparian ecological functions;
- Where technically feasible, improve fish access to significant upstream habitat where connections are interrupted by roads;
- Accelerate the reestablishment of diverse and structurally complex riparian forests where past harvest or human-caused alterations to channel dynamics have created early successional riparian forest stands or have replaced conifer stands with hardwoods;
- Protect, enhance, and restore stream and riparian habitat complexity; and
- Use the results of monitoring these and other conservation strategies to help realize the full measure of benefits offered by conservation efforts in the watershed and the Lake Washington Basin.

Additional objectives of this component are to:

- Through natural maturation and silvicultural intervention in riparian and other streamside forests, contribute habitat of value to species dependent on mature, late-successional, and old-growth forest habitats; and

- Provide connectivity among aquatic and riparian habitats through inclusion of upland forests in a reserve status to facilitate the dispersal and movement of organisms dependent on riparian and aquatic habitats.

Mitigation and Conservation Strategies for the Aquatic and Riparian Ecosystem

Protection of Elements of the Aquatic and Riparian Ecosystem in Reserve Status

Several types of open water habitat occur in the municipal watershed, including:

- Lakes, defined in this HCP as bodies of open water that are greater than 20 acres in area and at least 6.6 ft deep at low water;

- Ponds, defined as bodies of open water that are from 0.5 to 20 acres in area and at least 6.6 ft deep at low water;

- Rivers and streams; and

- The reservoir complex, defined to include Chester Morse Lake and the Masonry Pool, as well as the channel connecting the two.

Several types of wetland habitat occur in the municipal watershed. *Palustrine wetlands* are wetlands that are not directly associated with salt water (Tiner 1984). In the watershed, these include:

- *Palustrine emergent wetlands,* which are dominated by herbaceous vegetation that extends above the water surface (often called marshes, wet meadows, bogs, or fens);

- *Palustrine scrub-shrub wetlands,* which are dominated by woody vegetation less than 20 ft tall; and

- *Palustrine forested wetlands,* which are dominated by trees taller than 20 ft.

There are 110 mapped palustrine scrub-shrub wetlands, 236 mapped palustrine emergent wetlands, and 150 mapped forested wetlands in the watershed. Large wetland complexes occur in the Walsh Lake area and the Rex and Cedar river subbasins. The complex in the Walsh Lake area encompasses a number of large and small palustrine emergent, scrub-shrub, and forested wetlands, as well as Walsh Lake itself and other ponds and streams in this area. The complex in the Rex River and Cedar River encompasses a variety of components: (1) the recharge areas of the extensive palustrine, floating-mat wetlands south of Little Mountain; (2) areas near reaches of the Rex and Cedar rivers in which bull trout are known to spawn (as adults) or rear (as juveniles); and (3) a complex of wet meadows, wetlands, and remnant old-growth stands in the upper Rex River drainage.

All forests in undeveloped areas that are associated with aquatic and riparian habitats are included in reserve status, thus protecting all of the above types of aquatic habitats. In addition, reserve status for forests serves to protect all:

- True riparian habitat as identified by vegetation type (Watershed Assessment Prescription SORZ&W-4) and other streamside habitat;
- Inner gorges (Prescription IG-1), which serves to reduce the risk of slope failures in these unstable areas along streams;
- Headwall basins, which include very steep, usually wet and unstable, concave portions of the headwaters of streams; and
- Sensitive soils, including soils with moderate or high flood hazard potential or very slow drainage rates, soils that were formed in place, and alluvial soils.

The protection, through reserve status, of the interconnecting forest within the wetland complexes described above will also serve to interconnect the aquatic habitats by facilitating dispersal for such animals as salamanders, frogs, and riparian mammals.

Restoration of the Aquatic and Riparian Ecosystem: Road Management

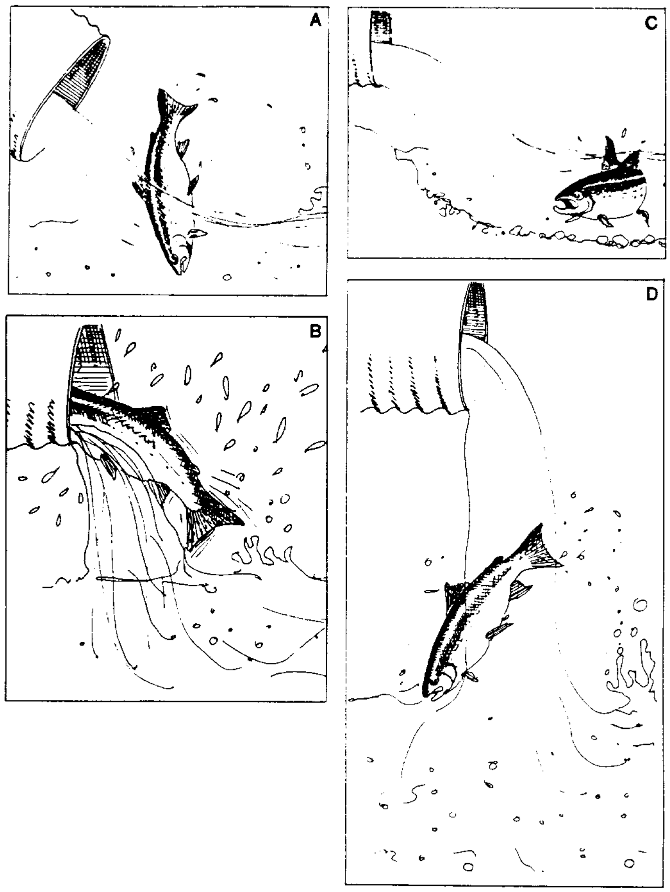
Road-related Problems in the Pacific Northwest

Hillslope and stream erosion are natural and continual processes. In managed watersheds human activities typically accelerate the rate of surface erosion and mass wasting and alter the natural frequency and magnitude of disturbances. In forested watersheds in the Pacific Northwest, roads are the major contributor to accelerated rates of erosion and resulting sediment delivery to streams (Sidle et al. 1985).

Forest roads in the Pacific Northwest have a long history of contributing to stream damage and sedimentation. Many of these roads have been constructed in an environment of relatively steep slopes, erodible soils, steep weathered bedrock, and high precipitation. Road design, construction, and maintenance problems have included poor location, undersized stream crossings, poorly designed ditches, infrequent cross-drains, unstable sidecast and fill material, and inadequate maintenance. Poorly designed and maintained roads in this environment can result in road drainage system failures that allow water to flow over or through the road prism, causing erosion, and delivering sediment to stream channels.

Inadequately sized and poorly installed stream-crossing structures, such as culverts, can negatively influence water quality and aquatic ecosystems by increasing sediment loading and transport, altering channel morphology, and fragmenting stream habitat. If a stream-crossing structure cannot pass peak flows and debris, it can cause water to flow over or through the road. This failure can deliver surface materials or entire road fills into the channel. Plugged culverts can also deliver large quantities of sediment into streams when water is diverted out of the channel and along or over the road bed. Crossing structures that restrict stream flows can cause changes in stream bank and bed configuration upstream and downstream of the structure. In addition to increasing sediment loading and transport, these conditions can cause alterations in stream velocity and flow depth, and can impact water quality and impede or prevent fish passage (Figure 4.2-3).

Figure 4.2-3. Culvert conditions that block fish passage: (A) water velocity too great; (B) water depth in culvert too shallow; (C) no resting pool below culvert; (D) jump too high (from Furniss et al. 1991, after Evans and Johnston 1980).



Hillslope drainage patterns can be altered by roads that intercept groundwater and surface flows, divert the water into road ditches, and concentrate the release of water at specific points. In addition, where cross-drains are infrequently spaced, accumulations of flowing water can cause erosion in the ditch or the area where it is directed away from the road onto the forest floor. This sediment-laden water is sometimes directed into a stream instead of through a ditch-out or cross-drain and onto the forest floor. If ditches are inadequately sized or are plugged, the water can flow across the road and erode the surfacing material. If this water runs into a channel, it typically carries the road sediment into the stream.

During some past road construction in the Pacific Northwest, including the municipal watershed, sidecast and road fill material were sometimes placed in unstable positions on steep slopes. Sometimes this road material contained stumps, logs, and other organic debris that reduce soil strength as they decompose. Landings were often left with large amounts of organic debris mixed with mineral soil in steep locations. Failures can occur where water runs over or through this material. These failures can deliver sediment to streams if there is no deposition zone to intercept the material.

An additional source of sediment to streams can be from road surfacing rock that breaks down under heavy truck traffic and incorrect road maintenance activities. This fine sediment can be washed into ditches and can be carried into streams if ditch water is not diverted into ditch-outs or cross-drains before it enters a stream.

Forest roads in the Pacific Northwest can also contribute to stream and riparian habitat damage in two ways that are not relevant to conditions in the Cedar River Municipal Watershed. Roads outside the boundaries of the municipal watershed often provide public access that can result in increased human disturbance to sensitive areas including streams and riparian zones. Because there is currently no unsupervised public access to the vast majority of the Cedar River Municipal Watershed, this effect is minimized (see section below entitled "Administration of the Municipal Watershed and Applicable Guidelines"). Additionally, on many forest roads, vegetation is controlled with herbicides. City policy prohibits the use of chemicals for vegetation control in the Cedar River Watershed (see section below entitled "Administration of the Municipal Watershed and Applicable Guidelines").

Cedar River Municipal Watershed Roads

The City will commit to a program of road deconstruction, improvement, and management targeted at reducing sediment loading to streams from landslides (mass wasting) and surface erosion related to the kinds of problems discussed in the preceding section. This program is important for improvement of water quality and aquatic habitat.

The Cedar River Municipal Watershed has a current inventory, based on the best available information, of approximately 620 miles of roads (Appendix 17). These road miles include all known active and infrequently used roads (about 520 miles) and overgrown and deconstructed roads. The roads in the municipal watershed were constructed during the course of watershed management by various landowners and to a variety of standards to support management activities. These management activities have included:

- Managing forests;
- Removing timber;
- Hauling rock and construction materials;
- Accessing the water storage dams, water systems, and utility lines;
- Maintaining security and fire protection; and
- Water quality, water quantity, and biological monitoring and research.

The current road density over the entire municipal watershed averages approximately 4.3 miles of road per square mile (Appendix 17). Road densities by specific subbasin (maps 1 and 13) range from approximately 1.6 to 6.6 road miles per square mile. For comparison, one study indicates from extrapolated data that in the Clearwater River drainage on the Olympic Peninsula, salmon spawning habitats have increased fine sediment loading where road density exceeds 2.5 miles per square mile (Cederholm et al.

1981). However, it is important to remember that geology, topography, and precipitation vary greatly between the Olympic Peninsula and the Cedar River Watershed. Also, roads that are poorly designed, constructed, and maintained contribute more sediment through mass-wasting and surface-erosion processes than those that are properly designed, constructed, and maintained.

It should also be noted that the level and type of vehicle traffic on roads can have a major impact on the amounts of sediment entering streams. Heavy truck hauling on roads, such as for commercial timber harvest operations, generates a significantly larger volume of sediment than administrative use of roads, such as by unloaded pickup trucks. Likewise, multiple trips over day over a road generate more sediment than single or a few trips.

Although no timber harvest for commercial purposes, and thus no heavy timber hauling, will occur under the HCP, many of the problems highlighted in the preceding discussion occur on roads in the municipal watershed. Construction and maintenance standards in the Transportation Plan are designed to prevent and correct these problems (Appendix 17). Although implementation of these standards is included as an element of this HCP's strategies for the Aquatic and Riparian Ecosystem, the City has already adopted these standards for the watershed and is following the guidelines in this plan.

Roads in the municipal watershed with the potential to significantly impact aquatic habitat will be either repaired or deconstructed, depending on the use of the road, following the guidelines in the Transportation Plan. In general, roads that provide desirable access are being and will be repaired under the HCP, but many of these roads that have potential to cause serious habitat damage will be deconstructed. Roads that are considered necessary but have severe problems will require reconstruction, which can be expensive. The difficult decisions of whether it is best to repair or deconstruct these roads will be made by an interdisciplinary team. Road projects will be prioritized and scheduled by the interdisciplinary team, with guidance from the results of the Watershed Assessment (Appendix 15). In addition, roads will be deconstructed over time that will no longer be needed under a program of no timber harvest for commercial purposes or for other management activities.

All new road construction supports localized management activities and follows construction standards in the Transportation Plan (Appendix 17). Some new road segments may be constructed as an alternative to existing roads that are in sensitive or unstable locations and need to be removed. New roads may be constructed if needed to provide access to facilities or project locations, or to provide necessary access lost by deconstruction of problem roads. All proposed new roads will undergo an extensive review by an interdisciplinary team. The City will not construct new roads into roadless areas of the Cedar River Watershed, unless unforeseen catastrophic events require access for emergency response or to accomplish repairs. Such roadless areas have had no previous entry or management activities.

The City follows all regulatory laws and will acquire all required permits associated with forest road construction and maintenance activities that will not be exempted by this HCP from state agency regulation. Construction and maintenance of forest roads are regulated by WDNR. Stream-related road activities are regulated by WDFW, WDNR, and WDOE.

Objectives for Road Management

The objectives for the road network (Appendix 17) relevant to the strategies for the Aquatic and Riparian Ecosystem are to improve and protect stream and riparian ecosystems. The program is designed to:

- Reduce the road network to what is needed for watershed management under conditions of no timber harvest for commercial purposes;
- Minimize sediment delivery to streams from roads;
- Improve drainage patterns that have been altered by roads; and
- Reestablish fish passage, where economically and technically feasible, between significant amounts of upstream and downstream aquatic habitats, where these connections are interrupted by roads.

The following strategies were developed to achieve the intent of the above objectives. The strategies are organized by the major activities of road deconstruction (removal), repair of existing roads, road construction, and road maintenance. Standards and guidelines for these activities are included in Appendix 17.

Mitigation and Conservation Measures for Roads

Road Deconstruction

- To reduce the road network to what would be needed under conditions of no timber harvest for commercial purposes and to reduce sediment loading to streams from roads that are not needed, the City will reduce the road network to a long-term *core* road system of approximately 384 miles. This reduction entails removing (deconstructing) approximately 236 miles of roads (about 38 percent of the current total) over the life of the HCP. The City will commit up to $5,000,000 to help pay for road deconstruction, and expects to average about 10 miles of roads per year for the first 20 years of the HCP.
- To minimize sediment delivery to streams and to improve drainage patterns, culverts and fill material at stream crossings will be removed as directed by a hydrologist and an engineer. Each stream crossing will be evaluated for methods to best restore natural drainage and to achieve channel stability at that particular site. Restored streambeds and streambanks will be graded and stabilized if necessary. Some fill material may be retained and stabilized where total removal would cause greater erosion or environmental damage.
- To reestablish fish passage in locations that would provide connectivity between significant amounts of resident or anadromous fish habitat, where technically and economically feasible. Stream channels will be reconstructed to help ensure fish passage and channel stability.
- To minimize sediment delivery to streams and to improve hillslope drainage patterns, roads will be deconstructed with an attempt to increase the frequency of cross-road drainage, using such methods as closely spaced waterbars across road beds. Drainage will be directed away from unstable areas and erodible soils.

- To minimize sediment delivery to streams, unsupported sidecast and fill material will be removed and placed against the cutbank or in a stable location. Priority will be given to removing material that is likely to enter stream channels or to travel for a long distance. Unstable landings will be dismantled and the organic and mineral material will be placed in stable locations. Drainage will be directed away from landing sites. Exposed soils will be protected from erosion and revegetated.

- Road deconstruction activities will be conducted in a manner that complies with agency regulations that are current at the time of the activity, unless the HCP expressly exempts the City from such regulations.

Improvement and Repair of Existing Roads

- To reduce sediment loading to streams and other water bodies over time, the City will commit up to $7,250,000 for repair and improvements of roads, some of which funding could be used for deconstruction, if more appropriate (see above).

- To minimize sediment delivery to streams and to improve drainage patterns, priority stream crossings will be upgraded to provide passage of 100-year flows. Road fills at problem stream crossings will be armored to reduce erosion.

- To minimize sediment delivery to streams and to improve drainage patterns, ditches will be sized to control hillslope surface and groundwater flows and to protect the road from surface erosion. Cross-drains will be installed at frequent intervals to move hillslope surface and groundwater across the road in a pattern that approximates the drainage pattern upslope of the road. Ditches will discharge to the forest floor or other areas, instead of entering stream channels.

- To minimize sediment delivery to streams, unstable sidecast and fill material will be moved to a stable location. If the resulting road is too narrow, it may be stabilized by constructing a supported fill keyed into native material, or by reconstructing the cutslope. Organic debris will be removed and placed in a stable location. Unstable landings will be dismantled and the material moved to a stable location. Vegetation will be encouraged to grow on cutbanks and fill slopes, but not where it will interfere with maintenance.

- To reestablish fish passage, fish-passable structures will be constructed in locations where road crossings interrupt connectivity between significant habitat for resident or anadromous fish, where it is technically and economically feasible, and where the stream channels are not currently carrying excessive amounts of sediment that would threaten the stability of the structures. These projects will be designed by an interdisciplinary team, comprised typically of a fish biologist, hydrologist, and engineer.

- To reestablish fish passage where a stream channel is carrying excessive amounts of sediment, placement of the permanent crossing structure may be delayed until the sediment volumes being transported decrease to a point where placement of an in-channel structure does not pose a threat to channel or road structures or cause additional channel instability.

- Road improvement and repair activities will be conducted in a manner that complies with agency regulations that are current at the time of the activity, unless the HCP expressly exempts the City from such regulations.

Road Construction

- New roads may be constructed for emergency response to unforeseen events, to access new facilities or project locations in the watershed, to reestablish necessary access lost as a result of removing roads for environmental reasons, or for other reasons related to management of the municipal watershed. The City expects that approximately five miles of road may be constructed during the term of the HCP, but that total could be larger or smaller under different circumstances.

- To minimize sediment delivery to streams, to improve drainage patterns, and to provide fish passage, any roads in the municipal watershed will be constructed according to the Construction Standards in the Transportation Plan. These standards are designed to establish roads that are stable and do not contribute fill, sidecast, or debris to streams, and that include well designed and constructed drainage structures.

- Road construction standards will be improved as new technology, materials, and equipment become available.

- Road construction activities will be conducted in a manner that complies with agency regulations that are current at the time of the activity, unless the HCP expressly exempts the City from such regulations.

Road Maintenance

- To minimize sediment delivery to streams, to improve drainage patterns, and to provide fish passage, road maintenance activities will be conducted as specified in the Road Maintenance Standards (Appendix 17). These standards are designed to maintain a stable, functional road system that minimizes adverse impacts on stream and riparian habitat.

- Road maintenance standards will be improved as new technology, materials, and equipment become available.

- Road maintenance activities will be conducted in a manner that complies with agency regulations that are current at the time of the activity, unless the HCP expressly exempts the City from such regulations.

Funding and Schedule for Road Management Measures

Road Improvement, Deconstruction, and Construction Projects

Road improvement, deconstruction, and construction projects will be designed to minimize sediment delivery to streams and to improve drainage patterns that have been altered by roads. Road deconstruction and minimization of new road construction should reduce net active road miles in the Cedar River Watershed by approximately 236 miles (38 percent) over the term of the HCP, with an average of about 10 miles deconstructed per year for the first 20 years of the HCP. Unforeseen events could require construction of additional road miles for emergency response, or new roads may be constructed to access new facilities or project locations, or to reestablish necessary access lost be removal of roads for environmental reasons.

Funding for road improvement and deconstruction projects will total $12,250,000, which includes $7,250,00 for road improvements and $5,000,00 for road deconstruction. Some of the funds for road improvements may be used for deconstruction, if appropriate. For road improvements, the total of $7,250,000 includes $1,750,000 over the first 5 years, $1,000,000 over the second 5 years, and $4,500,000 over the remainder of the HCP term. For deconstruction, the total of $5,000,000 includes $250,000 per year for the first 20 years. Funding levels are based on an approximate cost of roughly $25,000 per mile for complete deconstruction; $2,000 per mile for stabilization and repair; and $600 for each additional installed cross-drain.

As described above, the decision whether to repair or deconstruct a road with erosion problems will be made by an interdisciplinary team based on management activities served by the road, with costs required to repair and maintain the road also considered. The majority of road deconstruction will be phased over 20 years, and will be coordinated with restoration activities, including restoration and ecological thinning, restoration planting, research and monitoring, and stream restoration. Phasing and coordination is necessary to ensure that restoration activities can be accomplished and that restoration projects are stable before road access is eliminated.

Road Maintenance Activities

Road maintenance activities are designed to reduce sediment delivery to streams and to improve drainage patterns that have been altered by roads. Funding for increased maintenance activities will total $3,268,000. This includes $468,000 over the first 5 years, $400,000 over the second 5 years, and $2,400,000 over the remainder of the HCP term. The funding level is based on estimates that approximately 20-30 percent of total road maintenance costs will be related to correcting and avoiding direct impacts on streams, and that road maintenance costs will decline as total road miles are reduced and road conditions are improved. The funding commitments are for increases in levels of maintenance over current levels, and cover maintenance activities specifically targeted at reducing sediment loading to streams. Road maintenance activities will follow the standards included in the Transportation Plan (Appendix 17). These standards will be updated as new equipment, materials, and methods become available.

Stream Crossing Projects to Improve Flow Patterns

Stream crossing projects are designed to improve drainage patterns that have been altered by roads. Funding for drainage system improvements will total $850,000. This includes $125,000 over the first 8 years, $125,000 over the second 8 years, and $600,000 over the remainder of the HCP term. The funding level is based on the estimated approximate average cost of $1,250 per culvert, and the assumption that culverts may last 20-40 years depending on site conditions such as sediment transport and water pH.

There are approximately 1,300 stream crossing structures on non-fish-bearing streams in the Cedar River Watershed. Many need to be upgraded with regard to size or alignment, except where the road including the culverts is deconstructed. A few will need more expensive repairs. The first repairs will be directed at crossings that are known to have problems, as prioritized by an interdisciplinary team.

Stream Crossing Improvements to Reestablish Fish Passage

Stream crossing improvements are designed, where it is economically and technically feasible, to reestablish fish passage in locations where road crossings interrupt connectivity between significant habitat for resident or anadromous fish. Restoration of access to habitat by upgrading, replacing, and removing inadequate culverts on fish-bearing streams can be one of the most cost effective strategies for fish habitat restoration (Conroy 1997). Removing artificial migration barriers can also restore biological connections between upstream and downstream reaches that are an important part of natural stream functions (Ward 1989). Restored fish access can also result in increased fish production as a result of increased availability of habitat for rearing and spawning (Beechie et al. 1994).

Funding for projects to reestablish fish passage will total $1,220,000. This includes $960,000 over the first 8 years, $130,000 over the second 8 years, and $130,000 over the remainder of the HCP term. The funding level is based on estimated approximate costs of $20,000 to $36,000 per culvert or structural improvements for fish passage; $10,000 for channel reconfiguration; and the assumption that culverts may last 30-50 years.

A total of approximately 20 culverts in the municipal watershed have been identified as potentially non-fish-passable (Seattle Public Utilities 1998). The actual number of fish barrier culverts is likely different, because of limits to sampling methodology or because the culverts are potentially located above natural fish barriers (Section 3.2.4).

Restoration of the Aquatic and Riparian Ecosystem: Streambank Stabilization

Hillslope and streambank erosion are natural and continual ecosystem processes. Streambank erosion can be caused by natural channel migration, for example, which can replenish spawning gravels and create rearing habitat such as scour pools and undercut banks. Material from continually eroding streambanks is transported downstream to maintain spawning habitat throughout the lower portions of the basin. However, excessive localized streambank failures and altered stream channel configurations can be caused by road and land management activities. Inadequately sized stream crossings can constrict and redirect flows that can destabilize downstream streambanks. Flow constriction may also prevent the downstream movement of sediment by reducing flow velocities upstream of the constriction. The accumulated sediment can result in the loss of pool habitat upstream of the road crossing and cause streambank scour below the crossing.

Landslides are also an important natural process. Material transported into streams from landslides is a natural habitat-forming feature, and landslides are a common process for delivering wood to the lower portions of the basin (Maser et al. 1988; Murphy and Koski 1989). However, road failures and hillslope management activities can alter the frequency of landslides in a watershed and result in destabilized streambanks.

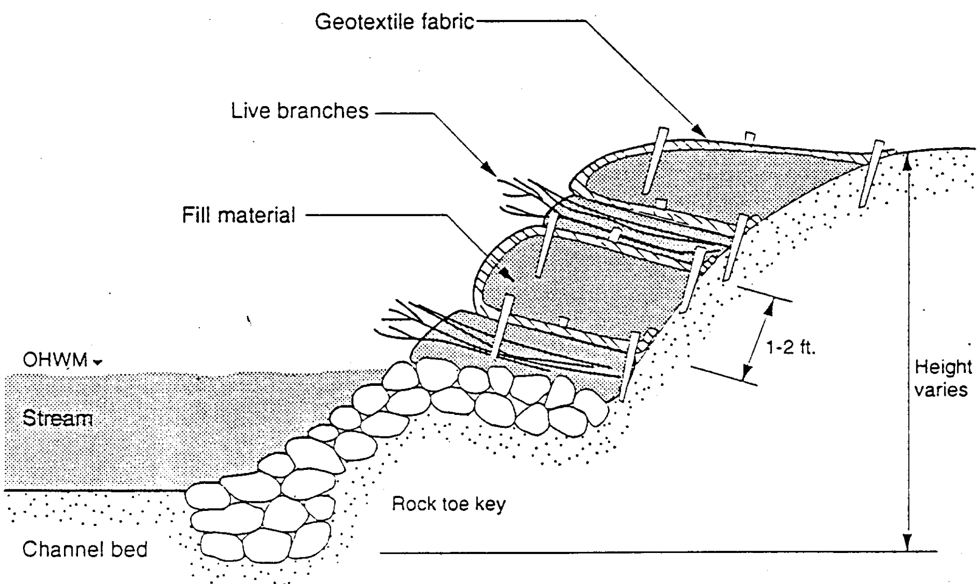
Objectives for Streambank Stabilization

The objective of the strategy for the streambank stabilization element is to minimize excessive rates of streambank erosion caused by roads and land management activities.

This element is closely linked with other elements of the strategies for the Aquatic and Riparian Ecosystem, including the road management program described above and in Appendix 17. The ecological benefits of the streambank stabilization effort will be improved storm-water quality and reduced magnitude and frequency of disturbance to fish habitat from sediment inputs and bedload movement.

Areas of localized streambank erosion that have been caused by management activities will be prioritized for stabilization by a multidisciplinary identification team. Projects will be prioritized based on a variety of factors including the presence of a channel migration zone, potential benefits from minimizing erosion, ability to successfully reduce erosion, and ease of access for construction and maintenance. Streambank stabilization projects will use materials appropriate to the site conditions, and both conventional and bio-stabilization techniques will be used. Conventional methods typically use the placement of large rocks to protect eroding banks, whereas bio-stabilization methods (Figure 4.2-4) will use a combination of logs, live plants, erosion control fabrics, and other materials to protect eroding banks (Sedell and Beschta 1991; Johnson and Stypula 1993).

Figure 4.2-4. An example of a streambank stabilization project using both conventional and bio-stabilization techniques (from Johnson and Stypula 1993).



Funding and Schedule for Streambank Stabilization

Funding for bank stabilization will total $756,000. This includes $158,000 over the first 8 years, $158,000 over the second 8 years, and $440,000 over the remainder of the HCP term. The funding level is based on an estimated approximate cost of $10,000 per 100 ft of stream bank.

Restoration of the Aquatic and Riparian Ecosystem: Stream and Riparian Complexity

Stream and associated riparian habitats within the Pacific Northwest region are characterized by variable disturbance regimes. Past forest management in the Pacific Northwest has typically affected riparian vegetation by a more chronic change: returning streamside forests to an earlier successional stage. Where mature conifers were harvested and not replanted, pioneer plants such as red alder (*Alnus rubra*), black cottonwood (*Populus trichocarpa*), and big leaf maple (*Acer macrophyllum*) often were established at much higher abundance and wider distribution than would occur after natural disturbances. Conifers that naturally reseed underneath these mixed hardwood stands are typically suppressed by limited light and competition for several decades. In some areas, conifer reestablishment is also hindered by a lack of seed trees and altered soil conditions.

Riparian vegetation has four direct effects on stream structure and function (O'Connell 1993). First, the roots of riparian vegetation can help stabilize streambanks, influence channel morphology, and reduce sedimentation. Second, large-diameter riparian trees are an important source of large woody debris that influences sediment movement, channel complexity, and nutrient cycling. Third, riparian vegetation influences nutrient input, assimilation, and transformation. Fourth, riparian vegetation can shade stream water that influences water temperature and primary production. All of these influences have effects on aquatic habitat and water quality (Juelson 1980; Sedell and Beschta 1991; Beschta 1991).

Streamside vegetation in previously harvested areas of the municipal watershed reflects the historical pattern of timber harvest within the watershed. The lower elevations were logged early in the twentieth century and the streamside vegetation has generally had a longer time to become reestablished than vegetation along streams in the higher elevations that was harvested more recently (Appendix 15). This past harvesting pattern is especially evident along the mainstem Cedar River between Cedar Falls and the Landsburg Dam and the Taylor Creek mainstem. Much of this lower-elevation forest was harvested more than 60-80 years ago, and the riparian forest today has many large conifers and a diverse canopy structure (Section 3.2.2).

Along some streams, naturally seeded trees have resulted in densely overstocked stands. These stands vary in species mix. Some stands are predominantly composed of a single species while others represent a broad species composition. Along other streams, vegetation may have been altered by an increased frequency of landslide material moving down the system and other scouring events. These disturbances can remove streamside trees, widen the unvegetated portion of the stream channels, and bury riparian vegetation under a layer of sediments from upslope.

The City will commit to conservation measures to enhance and restore stream habitats, increasing the structural complexity of riparian and instream habitat, by accelerating the reestablishment of diverse and structurally complex riparian forests and associated ecological functions. These elements are discussed below.

Streamside Revegetation

Objectives for Streamside Revegetation

The streamside revegetation element is a program to revegetate streambanks where past upstream or upslope activities have altered the riparian vegetation to a point where excessive streambank erosion is occurring and channel stability has been reduced. The objective of this element is to help restore the ecological functions associated with streambank stability by accelerating the recovery of vegetation characteristics appropriate to the site conditions. This may include encouraging the development of streamside forbs and shrubs, as well as the development of functional riparian forests. The channel migration zone will also be considered in design of streambank revegetation projects.

Selected streambanks that require revegetation efforts to improve bank stability will be planted with native plants. Scheduling and project prioritization will be closely linked with other elements in the strategies for the Aquatic and Riparian Ecosystem. The major effort for this program will occur within the first 16 years of the HCP. The program will use an experimental approach to revegetation, in which monitoring will be an important component. To help ensure success, projects will occur after excessive upslope or upstream sediment sources have been reduced. Plantings will be repeated and alternative applications will be implemented as needed and appropriate. The revegetation effort may include reconfiguring of streambanks and the use of erosion control materials, where appropriate.

Funding and Schedule for Streamside Revegetation

Funding for streamside revegetation will total $212,000. This includes $53,000 over the first 8 years, $53,000 over second 8 years, and $106,000 over the remainder of the HCP term. The funding level is based on estimated approximate average cost of $2,000 per 100 linear ft of streambank.

Conifer Under-planting and Long-term Maintenance

Conifer under-planting is a revegetation technique in which conifers are planted within an existing vegetation community. There are various methods of conifer under-planting, such as planting small trees with minimal site preparation, planting small trees in conjunction with thinning of the existing stand, and the use of animal browse deterrents. The initial methods used for this restoration effort will be based on the results of research on various techniques to accelerate the recovery of riparian conifer forests in coastal Oregon (Maas 1996; Emmingham 1996; Emmingham and Hibbs 1997).

This program will, where appropriate, promote biodiversity and the restoration of the native conifers in streamside areas that were disturbed by early timber harvest activities. Large conifers are important to developing and maintaining natural instream habitats (Cederholm et al. 1996). In addition, restoration planting will be done in forested areas around wetlands, ponds, and other nonforested aquatic habitats.

Objectives for Conifer Under-planting

The benefits and objectives of the conifer under-planting element are similar to those stated above for the streambank revegetation element. The primary objective of the conifer under-planting element is to reestablish conifers in riparian and streamside areas in order to help accelerate the restoration of diverse and structurally complex riparian stands within the watershed.

The highest priority project sites elected for conifer under-planting will be those in recently disturbed riparian zones that are currently vegetated but have a species composition that is not typical of such sites and that does not contribute to healthy, natural riparian function. The species to be planted are native conifers, which may include western redcedar (*Thuja plicata*), grand fir (*Abies grandis)*, and Sitka spruce (*Picea sitchensis*). The major emphasis of this effort will be in the first 16 years of the HCP. The program will use an experimental approach to revegetation, in which monitoring will be an important component. To increase the likelihood of success, projects will usually occur after excessive upslope or upstream sediment sources have been reduced. Planting techniques will be based on the results from similar programs in Oregon (Maas 1996; Emmingham 1996; Emmingham and Hibbs 1997). Plantings will be repeated and alternative applications will be implemented if needed and appropriate. The channel migration zone will also be considered in the design of overstory thinning projects, in order to avoid reducing bank stability.

Funding and Schedule for Conifer Under-planting

Funding for conifer under-planting and long-term maintenance will total $212,000. This includes $50,000 over the first 8 years, $50,000 over the second 8 years, and $112,000 over the remainder of the HCP term. The funding level is based on estimated approximate average cost of $300 per acre planted, and an approximate average cost of $200 per acre for maintenance.

Ecological and Restoration Thinning in Riparian Areas

Past logging in the watershed typically entailed removal of trees near streams, open water bodies, and wetlands (Section 3.2.2). The disturbance to both the adjacent vegetation and soils resulted in the conversion of many areas originally dominated by conifers to deciduous forest dominated by red alder or black cottonwood at abundances and with wider distributions than would occur as a result of natural disturbances (Section 3.2.2). Many of these disturbed areas could greatly benefit by careful silvicultural intervention to develop forest structure and composition characteristics of the natural, mature riparian conifer forest originally on the site. The City commits to a program of restoration thinning and ecological thinning within the riparian zone of streams, open water bodies, and wetlands.

Restoration and ecological thinning in upland areas are described above under Late-successional and Old-growth Forest Communities. With respect to areas near water bodies, restoration thinning of dense riparian stands younger than 30 years old can accelerate recovery of riparian functions by releasing neighboring trees from competitive constraints on growth (Oliver and Larson 1990; Carey and Curtis 1996) and by favoring multiple species (see Glossary figure G-1.a and G-1.b). Restoration thinning therefore can lead to the development of trees with a range of diameters along streams that can deliver large woody debris to the stream channel over time, as well as provide opportunities for the development of structural and community diversity.

This silvicultural strategy will protect water quality by reducing the risk of large-scale catastrophic damage to the watershed (primarily through development of windfirmness and increased resistance to insect attack, which is exacerbated by the stress caused by intense competition among trees). Techniques for restoration thinning include cutting, girdling, or otherwise killing some trees in variable density thinning patterns, retaining a mix of species that is characteristic of natural site conditions, and leaving small gaps or openings characteristic of naturally regenerated forests that result from small natural disturbances such as wind, disturbance from the stream channel, small fires, or disease.

Ecological thinning of second-growth riparian forests that are at least 30 years old, but typically less than 60 years old, can accelerate the development of diverse and structurally complex stands along municipal watershed streams. Ecological thinning will be done in selected previously harvested stands for which an interdisciplinary team determines that intervention can accelerate the development of natural riparian functions (see discussion of the old-growth restoration workshop in Section 3.3.4). Ecological thinning entails cutting, damaging, or otherwise killing some trees from some areas of older, overstocked, second-growth forest. Ecological thinning methods can be combined with other methods and may include variable-density thinning, retention of a variety of species, retention of sufficient standing and felled trees to provide coarse woody debris, under-planting, and cavity and snag creation (Carey et al. 1995).

As noted above, during the early part of implementation of the HCP, the City will consult with the Services regarding how best to identify any short-term adverse impacts of restoration and ecological thinning. By doing so, the City and Services can develop approaches to minimize and mitigate for impacts and thus produce the greatest overall ecological benefit from these intervention strategies.

As explained above under the section on Late-successional and Old-growth Forest Communities, some logs may be sold during ecological thinning operations, but only if the biological objectives of the thinning project are met.

Objectives for Restoration and Ecological Thinning in Riparian Areas

The objective of restoration and ecological thinning in streamside and riparian areas is to accelerate the growth and structural development of trees in riparian stands, thereby providing greater stream protection, and eventual reestablishment of older riparian stands with a high structural and habitat diversity to help restore natural stream and riparian ecosystem functions.

The major emphasis of this thinning effort will be within the first 16 years of the HCP. As part of site prioritization, evaluations will be conducted to ensure that thinning activities will not degrade habitat for key species. The program will use a conservative approach to thinning, an approach that includes the protection of fragile streambanks, monitoring, and necessary follow-up treatments. The channel migration zone will also be considered in the design of overstory thinning projects, in order to avoid reducing bank stability.

Site-specific prescriptions will be developed and monitored over time to determine anticipated versus actual response (Section 4.5). Adaptive management will be used to ensure project objectives are met (Section 4.5.7).

Funding and Schedule for Restoration and Ecological Thinning in Riparian Areas

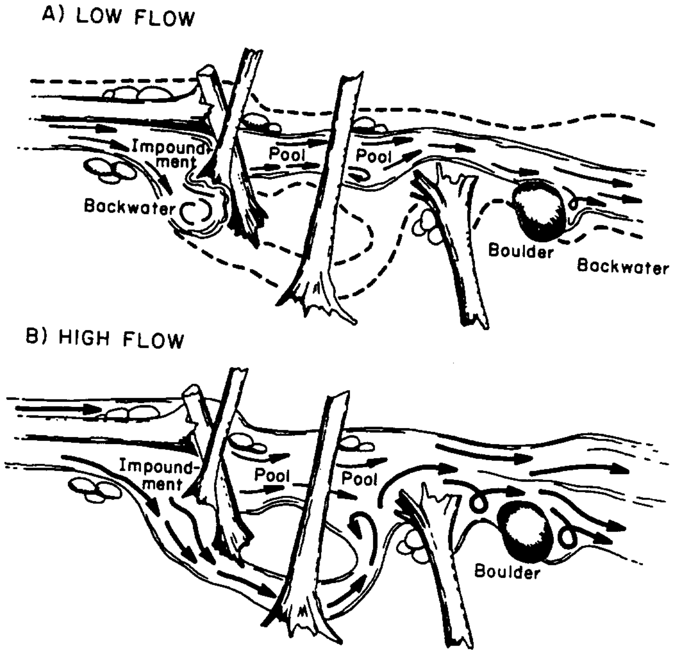
Funding for restoration and ecological thinning in riparian areas will total $180,000. This includes $45,000 over the first 8 years, $45,000 over the second 8 years, and $90,000 over the remainder of the HCP term. The funding level is based on an estimated approximate overall average cost of $316 per acre for thinning, with an assumed cost of $250/acre for restoration thinning and $500/acres for ecological thinning. Based on these assumed costs per acre, the City expects that about 150 acres will be treated by ecological thinning, and that about 420 acres will be treated by restoration thinning. About half of the area will be treated within the first 16 years of the HCP term.

Large Woody Debris Replacement

Large woody debris is a natural component of stream systems in the Pacific Northwest (Murphy and Koski 1989; Bisson et al. 1987; Hatten 1996). LWD interacts with the force of flowing water in several ways to affect biological and channel processes (Andrus et al. 1988; Bilby and Ward 1991; Robison and Beschta 1990). These processes include increased channel stability as a result of decreased stream energy, sediment storage upstream of woody debris, and reduced channel incision as a result of gradient controls (Figure 4.2-5). LWD also benefits fish habitat and fish production by providing areas of fast and slow water for fish to feed and rest, by creating areas of clean gravel for fish to spawn, by providing cover for prey and predators, by enhancing the base of the food web by trapping leaves and other nutritional materials, and by creating complexity that partitions habitat and provides refuge (Sedell et al. 1984; Fausch and Northcote 1992; Lonzarich and Quinn 1994; Cederholm et al. 1996).

In the Cedar River Watershed, many streams have a reduced volume of LWD (Cupp and Metzler 1995) as a result of timber harvest and stream cleaning. Some streams have been depleted of LWD as a result of early railroad logging practices that used streams as corridors for yarding logs to a road (Appendix 15). Other streams lack LWD as a result of reduced input from early successional riparian stands. Additionally, the past harvest of trees from inner gorges and steep slopes has reduced the amount of LWD associated with landslides that would have naturally entered the streams (Maser et al. 1988).

Figure 4.2-5. Diagram illustrating how the interactions between large woody debris and the flow of water influences channel shape and habitat features (from Reeves et al. 1991).



Objectives for Large Woody Debris Replacement

The objective of the LWD replacement element is to enhance stream habitat by placing LWD in selected streams that lack wood as a result of past disturbances. This program will be closely integrated with the three elements designed to restore streamside vegetation (streambank revegetation, conifer under-planting, and ecological thinning).

The placement of LWD in channels will be phased in generally after upstream and upslope influences on channel stability and fish habitat are addressed. Efforts will be emphasized in the second 8 years of HCP, after other integrated measures for the Aquatic and Riparian Ecosystem have been initiated.

A specific plan to manage large woody debris in the mainstem of the Cedar River between Cedar Falls and Landsburg is discussed below. A separate plan was developed for this reach of the river in order to incorporate specific water supply infrastructure, water quality, and personnel safety concerns.

Funding and Schedule for Large Woody Debris Replacement

Funding for large woody debris replacement will total $975,000. This includes $100,000 over the first 8 years, $375,000 over the second 8 years, and $500,000 over the remainder of the HCP term. The funding level is based on an estimated approximate cost of $20,000 per project.

Large Woody Debris Management Plan for the Mainstem Cedar River between the Cedar Falls Powerhouse and the Landsburg Diversion Dam

The Stream and Riparian Conservation Strategy in this HCP includes a specific management plan for the mainstem Cedar River between the Cedar Falls Powerhouse and the Landsburg Dam. A separate LWD plan was developed for this section of the river because downstream movement of fallen trees and large pieces of wood could threaten the integrity of the drinking water intake structure at the Landsburg diversion, as well as several bridges that span the river. This scenario happened during the 1990 flood, when large volumes of wood stacked up against the Landsburg Dam, creating a crisis situation.

The riparian stands along the Cedar River below Cedar Falls were last logged over 60 years ago. The relatively long period of subsequent regrowth has led to a high LWD recruitment potential of predominantly coniferous trees (see Maser et al. 1988). The amount of large coniferous woody debris entering the Cedar River over the 50-year term of the HCP is expected to gradually increase as riparian trees mature, and some larger trees fall into the stream channel (Seattle Water Department 1995).

Studies report no short- or long-term LWD recruitment deficiencies for the mainstem Cedar River between the powerhouse at Cedar Falls and the Landsburg Diversion Dam (Seattle Water Department 1995). Additional LWD inputs to this reach would enhance rearing habitat and refuge cover along the margins of the river, but would not be expected to significantly change the pool to riffle ratio of this section of river (Seattle Water Department 1995; Cupp and Metzler 1995). The City has no specific plans for bringing additional LWD into this reach. If necessary, however, LWD could be brought in from a different source in the future as part of the overall LWD program described above. LWD would only be brought in from an outside source if needed and if the process could be accomplished without risk to downstream facilities.

The City’s current policy has been to remove large woody debris (LWD) at Landsburg to prevent damage to the diversion structure and water intake facility. In addition, LWD removal was believed to reduce navigational hazards to boaters and reduce shoreline erosion on the lower river (downstream of Landsburg). Future improvements planned for the Landsburg Diversion include the addition of a floodway on the left side of the diversion structure to pass high flows around the structure. This new structure could facilitate passage of some LWD downstream. In view of the contribution LWD would make toward improving fish habitat in the lower Cedar River, the City will evaluate the floodway as a means of passing some woody debris downstream of the Landsburg Diversion, should this new floodway be constructed. Logs removed from the dam may also be made available for use in habitat restoration projects in the municipal watershed or downstream of Landsburg.

Interactions between large woody debris and sediment movement can also cause increases in turbidity (Bilby 1981; Beschta 1979; Bilby and Ward 1989) and can cause exceedance of drinking water quality standards at the Landsburg intake structure. The separate LWD plan for this section of the river is discussed here. The HCP provides goals and guidelines for managing LWD for structural safety, water quality, stream function, and fish habitat.

Objectives for Large Woody Debris Replacement above Landsburg

The objectives of the Large Woody Debris Management Plan for the Cedar River between Cedar Falls and the Landsburg Dam are to maintain drinking water quality, personal safety, and the integrity of river crossings and the Landsburg structures while optimizing the amount of large wood in the Cedar River to improve fish habitat and stream functions.

The large woody debris management plan for the mainstem Cedar River between Cedar Falls and the Landsburg Dam will be initiated in HCP year 1. This plan includes the following major elements:

- *Monitoring*. Periodic monitoring of the river and banks will be conducted at least once a year for the presence of newly fallen trees, trees about to enter the channel, and log jams in the channel.
- *Assessing Stability of Pieces*. Large woody debris along the river margins will be assessed for stability during high flow events. An interdisciplinary team comprised of a City biologist and/or hydrologist and an operations staff person will assess large woody debris pieces to determine how they can best benefit riparian or fish habitat while minimizing potential damage downstream.
- *Repositioning and Securing Pieces*. In general, any large wood that appears unstable will be repositioned or removed to a more hydraulically stable location or will be secured in place. Wood that cannot be secured and that threatens drinking water quality or structural safety of facilities will be removed and, if possible, used for fish habitat enhancement projects at other locations.
- *Assessing Log Jams*. An interdisciplinary team comprised of a City biologist and/or hydrologist and an operations staff person will assess logjams for potential controlled breaching.
- *Breaching Log Jams*. If a river-spanning logjam occurs that could cause unacceptably significant bank scour or channel migration, the jam may be partially breached or removed to reduce the risk of increased turbidity and compromised drinking water quality.
- *Removal of Wood from Structures*. Wood that becomes lodged against bridges and other structures may be removed by the City for structural integrity or safety reasons, either by removal from the channel or by release downstream.

Implementation Guidelines

General implementation guidelines specific to the Large Woody Debris Management Plan for the Mainstem Cedar River between the Cedar Falls Powerhouse and the Landsburg Dam are outlined below. Stabilization of large woody debris in the Cedar River will be accomplished according to these general guidelines unless the City determines that its safety and water quality goals cannot be met, or unless the guidelines prove impractical to implement in particular cases.

- Wood that is naturally secured in place (such as partially buried logs or trees with the roots still connected to the bank) will generally not be anchored by artificial means or moved from its present location to a different location.

- If wood is to be anchored and it is not in a position that can resist peak flows, it will be repositioned in a more stable place. Disturbance to the riverbed, banks, and vegetation will be minimized.

- Wood will be anchored in a position that can resist the extreme forces of peak flows. In the Cedar River between Cedar Falls and the Landsburg Dam, the most stable positions for logs are usually along the channel margins, associated with a boulder or another anchored log, or where the log is partially on the bank.

- In general, only coniferous trees (such as Douglas-fir, Sitka spruce, western redcedar, and western hemlock) of 12 inch or greater diameter and a minimum of 12 ft long will be anchored. Smaller conifers and deciduous trees (such as red alder, cottonwood, and big leaf maple), which tend to break apart after only a few years, will be allowed to move downstream and lodge behind larger, coniferous wood. In this way, the stabilized large wood will trap smaller logs and tree tops.

- Cutting, shortening, or trimming fallen wood will be avoided, if possible, because longer wood is more stable during high flow events, and attached branches and roots help to naturally anchor large wood in the river.

- Cables or other fastening devices will be anchored to stumps or boulders. If a live tree is used as an anchor, protective bumpers will be used so the tree will not be girdled.

- Cabling or other anchoring devices will be installed to allow the wood to move up and down with rising and falling water, where appropriate.

- Large coniferous wood that is removed at the Landsburg Dam or the bridges will generally not be trimmed or cut, unless necessary for operational or safety purposes. This wood will be reserved for riparian or fish habitat enhancement projects, if possible.

- In particular locations where risks outweigh the benefits of stabilized wood (such as immediately upstream of the Landsburg Dam and the bridges), the wood will be removed for use in rehabilitation projects elsewhere.

- During emergency flood conditions, practices to ensure structural and personal safety and water quality will take precedence over all other implementation guidelines.

- Operational guidelines will consider personal safety constraints that may exist or be exacerbated by flood conditions.

- The City will obtain all applicable permits to remove, reposition, or stabilize large wood. State and federal agencies agree to cooperate with the City and to provide assistance in obtaining any approvals or permits that may be required, and to write permit conditions consistent with this "Large Woody Debris Management Plan for the Mainstem Cedar between Cedar Falls and the Landsburg Dam."

Funding for Large Woody Debris Replacement above Landsburg

Funding for the Large Woody Debris Management Plan for the Mainstem Cedar between Cedar Falls and the Landsburg Dam is incorporated into the funding for the large woody debris replacement program described above.

Guidelines Related to the Aquatic and Riparian Ecosystem

Guidelines applicable to the Aquatic and Riparian Ecosystem are described below under the section entitled “Administration of the Municipal Watershed and Applicable Management Guidelines.” That section includes descriptions of City activities expected within the watershed and management guidelines developed to avoid, minimize, and mitigate impacts of those activities. It includes guidelines applicable to the watershed as a whole, to the Aquatic and Riparian Ecosystem, and to other habitats in the municipal watershed.

Measures Applicable Primarily to Special Habitats

Most wildlife species require a combination of habitat types or features within a certain spatial proximity in order to meet their biological requirements for food, cover, and reproduction over their life cycles (Brown 1985a; Morrison et al. 1992). Depending generally upon differences in size, mobility, and behavior, habitat requirements for different species can range from a micro-site or single habitat feature, such as a snag or a cave, to a landscape pattern of habitats or habitat features. In addition, habitat needs typically vary for most species on a seasonal, and often on a daily basis.

Special Habitats and Associated Species

Support of the natural biodiversity of the Late-successional and Old-growth Forest Communities in the municipal watershed requires protection of a variety of *special habitat types* that are embedded in the forested landscape, including talus and felsenmeer slopes; rock outcrops, cliffs, and caves; upland grass-forb meadows; and persistent shrub communities. These special habitat types are minor in terms of total area (Table 4.2-2) and occur primarily as small, scattered units (maps 6 and 7). However, some of the special habitat types are highly important to a number of the species addressed by this HCP (Table 4.2-3).

For example, several species use cliffs, rock outcrops, and caves. Peregrine falcons, black swifts, and golden eagles typically nest on cliffs. Although most bat species depend on late-successional and old-growth forests, nine species use caves and rock crevices for roosting (Table 4.2-3). Natural meadows, persistent shrub communities, and other open habitats are important as foraging areas for a number of species. Grizzly bears, gray wolves, and wolverines are not known to be present in the municipal watershed, but could use these open habitat types if they eventually invade, or are introduced into, the area. In addition, golden eagles and western bluebirds use one or more of these open habitat types for foraging. Existing open habitats created by logging (early seral forest) will diminish over the term of the HCP as these young stands mature.

Both the Larch Mountain salamander and the Van Dyke’s salamander regularly use talus slopes. While neither of these salamanders is known to occur in the municipal watershed, which is north of the reported range of both species in the Cascade Mountains (Leonard et al. 1993), both of these species are poorly known and could occur here.

Mapped, non-vegetated rock formations (talus and felsenmeer, cliffs, and rock outcrops) total 1,244 acres. Mapped vegetated talus and felsenmeer formations in the municipal watershed total 329 acres.

Except for prairie communities, which are not present in the municipal watershed, natural meadow communities typically occur in the Puget Sound region largely in alpine areas or areas of alpine parkland, to a lesser extent in the Mountain Hemlock Zone, and even more rarely in the Pacific Silver Fir Zone (Franklin and Dyrness 1973). The primary type of persistent shrub community in the region is dominated by Sitka alder (*Alnus sinuata*) and is found in unstable areas of deep snow accumulation at higher elevations, often in avalanche chutes (Franklin and Dyrness 1973).

Natural grass-forb meadows are defined for this HCP as naturally maintained, persistent, plant communities dominated by grasses and forbs; such meadows may have some shrubs and a few scattered trees. Persistent shrub communities are defined for this HCP as naturally maintained, persistent plant communities dominated by shrubs. Many of the mapped natural meadow and persistent shrub communities are less than 1 acre. Mapped natural, upland grass-forb meadow communities total 110 acres, and mapped, persistent shrub communities total 93 acres. Examples of either of these community types often occur on wet sites (Franklin and Dyrness 1973) and could also qualify as wetlands.

Two other cover types within the municipal watershed that could be described as a miscellaneous category were added to the Special Habitats component for reasons other than the objectives of this HCP. These include the former town site of Taylor (98 acres), a culturally significant site that is now covered largely by deciduous forest, and 33 acres of unclassified, nonforested habitats, which occur in very small and scattered patches.

Objectives for the Special Habitats Component

The objectives of the Special Habitats component of the Watershed Management Mitigation and Conservation Strategies are to:

- Protect the key habitats, communities, and landscape features – separate from those included in Late-successional and Old-growth Forest Communities and the Aquatic and Riparian Ecosystem – that are important to species addressed by this HCP; and
- Contribute to the long-term maintenance of biodiversity in the municipal watershed and the region.

Protection of Special Habitats Through Reserve Status

All forests in undeveloped areas are protected through reserve status, including those that are associated with Special Habitats. Reserve status for forests thus serves to protect all special habitat types in the municipal watershed (maps 6 and 7), including:

- All mapped vegetated talus and felsenmeer slopes (329 acres);
- All rock formations (total of 1,244 acres), which include non-vegetated talus and felsenmeer (1,188 acres), rock outcrops (50 acres), cliffs (4 acres), and other areas (landslides, 2 acres);

- All natural upland grass-forb meadows (110 acres) and persistent shrub communities (93 acres); and
- The former town site of Taylor (98 acres of largely deciduous forest) and 33 acres of unclassified nonforested habitats.

The above elements, which do not overlap spatially, total 1,907 acres.

Guidelines Related to Special Habitats

Guidelines applicable to Special Habitats are described below under the section entitled "Administration of the Municipal Watershed and Applicable Management Guidelines." That section includes descriptions of City activities expected within the watershed and management guidelines developed to avoid, minimize, and mitigate impacts of those activities. It includes guidelines applicable to the watershed as a whole, to Special Habitats, and to other habitats within the municipal watershed.

Administration of the Municipal Watershed and Applicable Management Guidelines

Administration of the watershed requires provisions for City operations and facilities within the municipal watershed. This section includes descriptions of many of the City activities and operations that will be covered by the incidental take permit (see Section 1.3). The City has also established the guidelines and provisions discussed below for covered operations and activities, including guidelines applicable to the watershed as a whole and to Late-successional and Old-growth Forest Communities, to the Aquatic and Riparian Ecosystem, and to Special Habitats. These guidelines are described below, following the description of City operations and activities.

City Operations and Activities within the Municipal Watershed

A general description of Covered Activities under the HCP is given in Section 1.3, and additional details are given below for those activities that are within the municipal watershed. Current City facilities and operations in the municipal watershed occur on many sites. Provisions are made in this HCP for the operation, maintenance, improvement, and/or modification of these facilities, and for City operations and other activities within the watershed in general. In addition, provisions are made for any mitigation or conservation activity in this HCP that would involve activities within the watershed, such as construction of fish ladders. Covered Activities that are outside the municipal watershed are described in Section 1.3 and in the Implementation Agreement (Appendix 1). Operation of pipelines and other water system facilities that are outside the municipal watershed are not Covered Activities under this HCP. Such facilities include the segment of the transmission pipeline to Lake Youngs west of the municipal watershed, Lake Youngs, and other distribution and operating facilities outside the municipal watershed.

The primary activities within the municipal watershed that are Covered Activities under this HCP are described below, along with any limitations that apply to such activities. Covered Activities within the municipal watershed generally include the following categories of activities:

- Activities associated with general management and administration of the municipal watershed, including all activities and facilities in and around the Cedar Falls administrative complex, Landsburg facilities, and Seattle City Light power plant; maintenance, removal (deconstruction), and improvement of roads; use of existing and new gravel pits and rock sources; and watershed security operations, including trail and fence maintenance, surveillance, and environmental sampling.

- Maintenance of rights-of-way for power lines, pipelines, roads, and trails, including removal and control of trees, non-native vegetation, and other vegetation for safety reasons (such as visibility), to maintain the integrity of road surfaces, or to maintain or gain access.

- Activities associated with operation of the municipal water supply and hydroelectric power supply, including the operation, maintenance, improvement, reconstruction, and replacement of attendant facilities at Landsburg, Cedar Falls, the Masonry Dam, the Overflow Dike, the hydroelectric penstocks to Cedar Falls, and the hydroelectric plant at Cedar Falls.

- Activities associated with public education, including the management and use of sites on Chester Morse Lake, at Cedar Falls (the waterfalls), the Cedar Falls administrative complex, and Rattlesnake Lake; the construction, maintenance, and operation of the new watershed educational center at Rattlesnake Lake; and the maintenance of trails in old growth and other forested areas or areas near wetlands or streams, and certain established vistas and observation points.

- Activities associated with watershed surveillance and protection, including maintenance of weather measurement facilities, performance of environmental observations and data collection, collection of hydrological data, and other surveillance activities;

- Activities associated with scientific research, including facilities and operations at Findley Lake and the Thompson Research Center, City monitoring and field studies not associated with the HCP, and monitoring and field studies by WDFW and other state or federal agencies.

- Habitat restoration, enhancement, or rehabilitation projects not associated with the HCP.

- Activities associated with public recreation, including construction, maintenance, improvement, and use of the recreational areas at Rattlesnake Lake and Landsburg; construction, maintenance, improvement, and use of recreational trails on the watershed periphery and near Rattlesnake Lake; and the construction, maintenance, improvement, and use of trailheads by Washington State Parks near Rattlesnake Lake.

- Activities associated with management of cultural resources, including protection and management of cultural resource sites, operation of new facilities within the planned education center at Rattlesnake Lake, and management and protection of the former town sites of Taylor and Barneston and sites of prior Native American use.

- Activities associated with mitigation and conservation measures for this HCP, including, but not limited to:
  - + The operation, maintenance, improvement, and/or dismantling of the interim sockeye salmon hatchery south of the Landsburg Diversion Dam (Section 4.3);
  - + The potential construction, maintenance, improvement, and/or dismantling of a replacement sockeye salmon hatchery at or near Landsburg (Section 4.3);
  - + The construction, maintenance, improvement, and/or dismantling of fish passage and protection facilities at Landsburg Diversion Dam and the pipeline crossing (see Section 4.3);
  - + The construction, maintenance, improvement, and/or dismantling of bull trout passage facilities in Chester Morse Lake (see Section 4.5);
  - + The installation maintenance, improvement, and/or dismantling of gages or other measuring devices related to monitoring of instream flows, water quality, or aquatic habitats, and sampling and other activities to support the HCP aquatic monitoring and research program;
  - + The installation maintenance, improvement, and/or dismantling of equipment or other measuring devices related to research and monitoring for terrestrial habitats or species, and sampling and other activities to support the HCP terrestrial monitoring and research program;
  - + Silvicultural activities to restore watershed habitats, including planting, thinning and other types of intervention;
  - + Improvement, reengineering, repair, decommissioning, and maintenance of forest roads, including modification, replacement, or removal of stream crossing structures and use of gravel pits and rock sources;
  - + Projects to restore streams, riparian habitats, and other aquatic habitats; and
  - + Research and monitoring activities.

Any of the activities as listed above could entail construction, reconstruction, maintenance, operation, improvement, modification, and/or dismantling of facilities within the watershed and other human activities needed to implement the various programs and functions of watershed and water supply management and the HCP. Any and all such activities, or other normal City operations and activities within the watershed, are permissible as long as they do not materially increase levels of incidental take from those assumed for the incidental take permit as issued for this HCP.

As described in Section 1.3, during the term of the HCP, the City may make significant modifications to, or may reconstruct or construct facilities within the municipal watershed for reasons that do not relate to the conservation and mitigation measures in the HCP. The City will notify and consult with the Services prior to such currently undescribed construction activities if there is a potential for take of Covered Species

(Section 1.4). The City agrees to notify the Services prior to such construction activities related to the Masonry Dam, hydroelectric facilities, and the water intake at Landsburg, and prior to construction of any new bridges over the Cedar River between lower Cedar Falls and Landsburg.

The primary impacts of water supply operation, hydroelectric power generation, and forest management are discussed elsewhere in Chapter 4, and the measures included in the mitigation and conservation strategies presented in this chapter are intended to minimize and mitigate for any impacts of taking related to these activities. For example, use of roads will be mitigated by improved maintenance, engineering improvements, substantial decommissioning (reduction of the road system), and the lack of log hauling to support a commercial timber harvest program. Use and development of gravel pits will be needed to provide a level of road maintenance that will keep sediment loading from road erosion to a minimum, and larger rocks will be needed for stream restoration and other activities. When constructing new gravel pits within the municipal watershed, the City will develop and implement measures to minimize and mitigate any potential take of Covered Species.

The City does not expect that normal operations around its facilities in the municipal watershed will represent any significant impacts on species addressed in the HCP, or result in any material level of take. The habitats in these areas are largely highly disturbed, and the activities in such areas pose little or no risk to species addressed in the HCP, most of which rely primarily on relatively natural habitats. Nor does the City expect that maintenance of rights-of-way, which are also disturbed habitats, will result in any significant impacts to species addressed in the HCP, unless an individual with poor mobility is inadvertently affected by heavy equipment, an event that should be relatively uncommon. No chemicals are used in the watershed for control of vegetation (see below).

The planned education center near Cedar Falls and Rattlesnake Lake will be built in a highly disturbed area also unlikely to support large numbers of any of the species addressed in the HCP, or any species listed at the time of permit issuance. Thus, impacts of construction and operation of that facility should not produce significant impacts to the species addressed in the HCP, nor should such activities as recreational use of the two parks in the watershed, conduct of the City's public education program, maintenance of trails, scientific research, and management of cultural resources. *Construction* of the education center is not a covered activity under this HCP.

Habitat restoration, enhancement, or rehabilitation projects are designed to improve habitat, and thus inherently include mitigation. Construction or reconstruction of facilities would have to be done with appropriate environmental review and permits, which typically entail mitigation for site-specific impacts.

Management Guidelines Applicable to the Entire Municipal Watershed

Controlled Public Access to the Watershed

The Cedar River Municipal Watershed is currently closed to unsupervised public access, and access is by permit or with supervision (see sections 2.2.2 and 2.3.10). Gates at road entry points to the interior of the watershed are closed and locked at all times, and the watershed is patrolled to find and exclude any trespassers. Access for hunting or fishing is not allowed, with the exception of fishing in the Rattlesnake Lake area for stocked trout. The City intends to continue this policy of watershed closure to protect water quality and minimize treatment costs, although this policy could be modified by the Seattle City Council in the future if treatment methods and/or regulatory requirements change, or for other reasons.

The watershed closure policy has distinct benefits for species addressed in this HCP. Human disturbance is known to adversely affect many species. For example, a major cause of nesting failure in common loons is disturbance along shorelines and boating activity (Section 3.5.5). Such activities in the municipal watershed are restricted to watershed staff, authorized consultants, agency biologists, scientific researchers, and permitted visitors, with the specific intent to minimize this kind of disturbance to fish and wildlife, especially during the breeding season. In addition, the watershed closure policy provides benefits to those species, such as grizzly bear (e.g., McLellan and Shackleton 1988), gray wolf (USFWS 1984, as cited in WDNR 1997), and bald eagle, that are particularly sensitive to the impact of human activities in their habitat.

Another major concern for many species is poaching. For example, poaching is believed to be a major threat to bull trout in Montana (Long, undated). Poaching of covered fish and wildlife can be expected to be much lower in the closed watershed than in areas open and accessible to the public. Furthermore, because the watershed is closed to unsupervised public access for fishing or other such activities, fishing mortality in general should be very low within the municipal watershed.

Prevention and Suppression of Forest Fires

A large-scale forest fire would jeopardize the drinking water supply and habitats of covered species. A heavily burned area can experience higher peak flows and increases in the rates of erosion and landslide activity as vegetative cover and soil litter is lost (Agee 1993). According to Agee (1993), in a Douglas-fir forest, sediment loading can increase five-fold in a burned area immediately following a severe fire, and may take 25 years to recover to base conditions. Increased sediment loading of this magnitude and duration would also have significant impacts on aquatic habitats. In addition, a severe wildfire in the municipal watershed would jeopardize remaining old-growth forest habitats, which are already scarce in the region.

Forest fires in this region are relatively rare and typically severe (Agee 1993; Henderson 1993; Bunnell 1995). Federal scientists have recommended that “Until we have fire management plans, all fires in west-side Late-Successional Reserves should be suppressed,” and that “matrix management should reduce risk of fire and other large-scale disturbances that would jeopardize the reserves” (FEMAT 1993).

Based on the above considerations, the City’s policy is to aggressively suppress all forest fires in the municipal watershed. The commitment not to harvest timber for commercial purposes should also reduce the risk of fire initiation overall relative to nearby areas by removing the risk associated with logging operations. Aerial application of retardants pre-approved (as safe for use) by the Director of SPU may be used to suppress fires within the municipal watershed, but, under current SPU regulations, no water may be drafted from the Chester Morse Reservoir. The risk of forest fires caused by human activity is also relatively less as a result of the watershed access policies described in sections 2.3.10 and above (see also Pasin et al. 1983). One of the reasons for maintaining a core road system is to allow access for suppression of forest fires.

Watershed Assessment Prescriptions

All Watershed Assessment Prescriptions (Appendix 16) will be followed, except those that apply only to timber harvest for commercial purposes, which will not occur under the HCP. References to stream and wetland buffers in specific prescriptions are no longer applicable as a result of the City's commitment in the HCP not to harvest timber for commercial purposes.

Forest Management

The following definitions will apply to forest management activities within the municipal watershed:

- Restoration thinning: Thinning of trees in over-stocked, younger stands (typically less than 30 years old), to create better habitat conditions by fostering development of understory vegetation and natural species diversity, increasing growth rate of trees, and reducing the risk of catastrophic events, including forest fires.

- Ecological thinning: Thinning of trees in older stands (typically over 30 years old but less than 60 years old) to foster development of understory vegetation and forest structure beneficial to species of concern, and to protect or help restore key ecological functions.

- Restoration planting: Planting vegetation for restoration of upland and riparian forests, and to stabilize soils.

- Catastrophic event: A large-scale, high-intensity natural or human-caused disturbance that occurs infrequently, such as insect or disease outbreaks, extraordinary flooding, or severe fire, that would require a prudent municipal watershed manager to take action to protect drinking water quality, protect public safety, prevent significant damage to natural resources, avoid significant failure to meet the habitat objectives of the HCP, or otherwise practice responsible environmental stewardship.

The following guidelines will be followed for salvage of trees:

- Incidental salvage: Removal of trees, down or standing, will be allowed along existing or new rights-of-way, including roads, to protect public safety and facilities and to allow access. Trees removed for such reasons may be sold by the City, as long as any net revenues are used to offset costs of the HCP or watershed management.

- Catastrophic salvage: Removal of down trees after a catastrophic event will be allowed, provided that the City consults with the Services and appropriate professionals to ensure that the salvage operation is needed to protect drinking water quality, protect public safety, prevent significant damage to natural resources, or avoid significant failure to meet habitat objectives of the HCP. Prior to such salvage operation, a salvage plan will be developed and subjected to appropriate review, and measures will be developed and implemented to protect water quality and aquatic habitats, and to minimize and mitigate the impacts of the salvage on the species addressed in the HCP. The commitment to develop a plan for catastrophic salvage shall not prevent the City from clearing road access and taking whatever emergency actions it deems necessary to protect public health, the drinking water supply, the safety of the public and City workforce, City facilities, or the watershed's natural or cultural resources. Logs will be removed from sites only if all biological objectives are met, including appropriate standards for coarse woody debris.

Any salvage plan developed for catastrophic salvage will include prescriptions for leaving coarse woody debris (snags and logs) for wildlife species, consistent with the need to control further risk of fire, the need to protect water quality, and objectives for the HCP. The impacts of such an event on the species addressed in the HCP cannot be determined in advance, but, during any salvage operation, efforts will be made to minimize and mitigate the impacts of the salvage on the species addressed in the HCP.

The following general guidelines will be followed for forest management:

- Restoration and ecological thinning: Restoration and ecological thinning will be conducted as mitigation under the HCP, as described above.
- Tree species diversity: Native tree species diversity will be promoted in the reforestation and restoration planting program by retaining and planting a variety of species appropriate to specific sites, and by planting for species diversity.
- Use of revenues: Any net revenues associated with selling logs from ecological thinning, incidental salvage, or catastrophic salvage may be used by the City only to offset the cost of the HCP or for watershed management and restoration.

Guidelines for forest management near streams and other aquatic habitats are described below under the section entitled "Additional Guidelines for the Aquatic and Riparian Ecosystem."

Smartwood Certification

When the HCP is approved, the City intends to apply for certification of forest management under the SmartWood program, founded by the Rainforest Alliance in 1989. The SmartWood certification program promotes an ecosystem-based approach to forest management for a variety of reasons, including sustainable forest management and watershed restoration (Jones, L., Northwest Natural Resource Group, 1999, personal communication).

SmartWood independently evaluates and audits forestry operations and certifies those that meet a strict set of environmental standards. Under the certification program, watershed forest management plans and activities are assessed and audited annually by an independent, multi-disciplinary team of scientists and professionals that evaluate environmental, economic, and social impacts.

The SmartWood Program operates in all forest types (tropical, temperate, and boreal) through the SmartWood Network, a cooperative effort among regional nonprofit forestry organizations around the world. The Quabbin Watershed, which provides drinking water to the city of Boston, was certified during the summer of 1997 by the Northeast Natural Resources Center, which is the Northeast chapter of the National Wildlife Federation and serves as the Northeast affiliate of the SmartWood Network.

Use of chemicals

Herbicides will not be used in the municipal watershed.

Revegetation of Disturbed Soils

Natural revegetation of disturbed soils will be augmented with native seed and/or plant species consistent with conservation goals and objectives of the HCP and other pertinent watershed management policies.

Additional Management Guidelines for Late-successional and Old-growth Forest Communities

All guidelines for Late-successional and Old-growth Forest Communities are encompassed by the guidelines described above for the municipal watershed as a whole, and the guidelines described below for the Aquatic and Riparian Ecosystem.

Additional Management Guidelines for the Aquatic and Riparian Ecosystem

The City commits to restrictions on activities within the Aquatic and Riparian Ecosystem component of the municipal watershed as described below.

Forest Management

The following general guidelines will be followed for areas near streams and other aquatic habitats:

- Tree removal will be limited to restoration thinning and ecological thinning to restore riparian ecosystem function, maintain or improve bank stability, accelerate development of late successional/old-growth stand conditions, or to maintain rights-of-way, including roads, or conduct salvage after catastrophic events.
- During restoration thinning or ecological thinning, no ground-based equipment will be allowed within 50 ft of streams or other aquatic habitats.
- No trees will be cut near streams in a manner that would reduce bank stability.
- Within wetlands, no cutting of trees will be allowed, except in limited circumstances where needed for restoration of natural wetland functions, and no ground-based equipment will be allowed within wetlands.

All silvicultural interventions near streams, lakes, ponds, or wetlands will be to provide long-term ecological benefits for species addressed in the HCP. While the City recognizes that cutting trees near streams must be done with care to minimize the risk of reducing bank stability, the City intentionally allowed flexibility to cut some trees near streams for restoration purposes. This flexibility may be needed to restore riparian forest function in some areas and will almost certainly be needed to accommodate or implement some instream restoration projects that entail placement of large woody debris (LWD). For example, restoration thinning of dense young stands (such as so called “dog hair” stands) near a stream may be needed to encourage tree growth and increase bank stability over the long term, and some trees near a stream may need to be felled to recruit LWD to the stream.

However, the City recognizes that such interventions near streams and other aquatic habitats could cause short-term, site-specific impacts, and the restrictions on such activities listed above were intended expressly to minimize such impacts. In addition, any silvicultural activities conducted for restoration purposes near streams and other aquatic habitats will be designed by an interdisciplinary team to minimize and mitigate any impacts on species addressed in the HCP. During the early part of implementation of the HCP, the City will consult with the Services regarding how best to identify such short-term adverse impacts and develop strategies to minimize and mitigate for such impacts and produce the greatest overall ecological benefits from intervention.

Roads

- New road construction will be minimized. Proposed new road construction will be evaluated on a site-specific basis by an interdisciplinary team, which typically will include a watershed hydrologist, engineer, and biologist. New roads will be designed to minimize impacts to stream and riparian functioning.

- To minimize the risk of human-caused mass-wasting failure (landslides) that may deliver excessive sediment or other debris to streams or other surface waters, prior to construction of any new road, a geotechnical slope stability analysis may be conducted in accordance with Watershed Assessment Prescription HLP-1, based on an initial assessment by a City interdisciplinary team on sites with slopes averaging greater than 30 percent mapped as having moderate or high landslide potential and on sites with an average slope greater than 30 percent mapped as having high landslide potential or a moderate or high delivery potential, or for other areas later identified as having such potential. Site-specific prescriptions for road construction or timber harvest will be developed in accordance with Watershed Assessment Prescriptions HLP-2 through HLP-5 for areas having shallow-rapid mass wasting, or deep-seated landslide potential.

As noted above, construction of new roads will be minimized. Because the road system is now extensive and will be substantially reduced, the City expects to construct no more than about 5 miles of roads (less than 1 percent of the current total road miles) during the 50-year term of the HCP, with a net overall loss of total road miles estimated to be about 236 miles. Some new road construction could be required to access new facilities or project areas, or to reestablish access lost as a result of decommissioning roads causing severe environmental problems by constructing alternative routes in areas with lower risks.

When the City has plans to construct a new road, an interdisciplinary team will make a site evaluation, and the City will consult with the Services regarding measures to minimize and mitigate the impacts. If 5 miles of new road were to be constructed over the term of the HCP, then only about 18 acres (0.02 percent) of the total of 85,477 acres of forested habitat in the watershed would be removed. For perspective, the deconstruction of 236 miles of roads planned under the HCP would result in a net increase of about 858 acres of forest as the roadbeds are reforested.

The City commits to a variety of additional prescriptions that will collectively minimize or avoid impacts to streams through protection of streamside vegetation and reduction of sediment delivery to streams. These prescriptions are presented in detail in Appendix 16. Collectively these prescriptions accomplish the following:

- Restrict road construction in inner gorges and on steep slopes;
- Provide strict standards for construction and maintenance of roads; and
- Reduce sediment delivery through engineering improvements to roads, decommissioning of problem roads, and a substantial net reduction of road miles in the municipal watershed (approximately 38 percent reduction).

The Watershed Assessment Prescriptions (Appendix 16) that are most directly related to the Aquatic and Riparian Ecosystem include those that guide and constrain road construction and maintenance so that impacts to stream and riparian areas are minimized. These include prescriptions related to road erosion (RE-1), high landslide potential (HLP-5), high surface erosion hazard (HSEH-9), and blockages on streams, open water bodies, riparian zones, and wetlands (SORZ&W-7 and SORZ&W-8).

RE-1 Road Decommissioning and Stabilization

To minimize sediment delivery from the exposed surfaces of roads, drainage facilities, and associated cut and fill slopes in the Cedar River Watershed, this prescription states that, "All proposed road decommissioning and road stabilization projects will follow accepted Road Construction and Maintenance standards (Chapter 222-24 WAC) and will be implemented according to the timeline identified in the comprehensive 'Transportation Plan' [Appendix 17] developed for the Cedar River Watershed and discussed as site-specific recommendations in the 'Cedar River Watershed Assessment – Basin Condition Reports, Prescriptions, and Restoration Opportunities'" (Seattle Water Department 1995). It also states that accepted Road Construction and Maintenance Standards will be used.

HLP-5 Road Decommissioning and Stabilization

To avoid and minimize landslides caused by management activities, including timber harvest and road construction and maintenance, this prescription states that, "All proposed road decommissioning and road stabilization projects will be implemented as part of the comprehensive 'Transportation Plan' [Appendix 17] developed for the Cedar River Watershed and discussed as site-specific recommendations in the 'Cedar River Watershed Assessment – Basin Condition Reports, Prescriptions, and Restoration Opportunities'" (Seattle Water Department 1995).

HSEH-9 Road Decommissioning and Stabilization

To minimize surface erosion, soil compaction, and sediment delivery to streams caused by management activities, including timber harvest and road construction and maintenance, in the Cedar River Watershed, this prescription states that, "All proposed road decommissioning and road stabilization projects will be implemented as part of the comprehensive 'Transportation Plan" [Appendix 17] developed for the Cedar River Watershed and discussed as site specific recommendations in the 'Cedar River Watershed Assessment – Basin Condition Reports, Prescriptions, and Restoration Opportunities'" (Seattle Water Department 1995).

SORZ&W-7 Culvert Blockages to Fish Passage

To protect and restore aquatic and riparian ecosystems in the Cedar River Watershed by avoiding potential adverse impacts to streams, lakes, ponds, other open water bodies, riparian zones, and wetlands from cumulative effects caused by management activities, this prescription states that, "All potential blockages to fish passage identified as part of the '1994 Cedar River Watershed Survey of Culverts Draining Stream Types I - IV' (see Seattle Public Utilities 1998) will be evaluated to determine whether or not a blockage actually exists. If the investigation determines that a blockage exists, then the culvert or culverts responsible for the barrier will be repaired or replaced as necessary so that upstream and downstream passage of fish is provided."

SORZ&W-8 Road Decommissioning and Stabilization

To protect and restore aquatic and riparian ecosystems in the Cedar River Watershed by avoiding potential adverse impacts to streams, lakes, ponds, other open water bodies, riparian zones, and wetlands from cumulative effects caused by management activities, this prescription states that, "All proposed road decommissioning and road stabilization projects, including the replacement of inadequately sized culverts and failing stream crossings, will be implemented to control potential sediment delivery problems as part of the comprehensive 'Transportation Plan' [Appendix 17] developed for the Cedar River Watershed and discussed as site specific recommendations in the 'Cedar River Watershed Assessment – Basin Condition Reports, Prescriptions, and Restoration Opportunities'" (Seattle Water Department 1995).

HLP-3 and 4 Geotechnical Analyses for Road Construction

If the ID Team determines that a geotechnical analysis is needed, then site investigations will be conducted by a qualified soil scientist, geomorphologist, engineering geologist, geotechnical engineer, and/or forest engineer to identify potential landslide types, analyze risks, and develop site-specific prescriptions for road construction. If site investigations determine that the site is stable and has a low potential for shallow-rapid mass-wasting, road design would be based on a slope stability analysis, and prescriptions could vary from road construction using standard best management practices in areas of low risk, to either no road construction or a fully engineered road on areas of high risk.

HSEH-7 and 8 Road Construction and Maintenance

The contribution of sediment delivery to streams from all new roads will be minimized through road design and placement consistent with accepted Road

Construction and Maintenance Standards (Chapter 222-24 WAC). No new roads will be constructed on sites designated as high and very high surface erosion hazard areas unless: A) the roads can be engineered to minimize the delivery of sediment to streams; and B) best management practices for road construction can be implemented to minimize delivery of sediment to streams.

Additional Management Guidelines for Special Habitats

During watershed operations near any natural grass-forb meadow, persistent shrub, talus and felsenmeer slopes (both vegetated and non-vegetated), cliffs, caves, or other rock formations, operations will be regulated within 200 ft of the habitat element. Restoration and ecological thinning, as well as restoration planting, will be allowed within this 200-ft zone to improve the protection of the Special Habitat, thus providing a benefit to species using this habitat. During the early part of implementation of the HCP, the City will consult with the Services regarding how best to identify any short-term impacts of thinning near Special Habitats and develop approaches to minimize and mitigate for impacts in order to produce the greatest overall ecological benefit from this intervention strategy.

New road construction will be minimized within 200 ft of Special Habitats, and proposed new road construction will be evaluated on a site-specific basis by an interdisciplinary team that typically will include an engineer and a biologist. Roads will be designed to minimize impacts on the adjacent forest and thus on the protected habitats. When the City has plans to construct a road that could pass within 200 ft of a Special Habitat, an interdisciplinary team will make a site evaluation, and the City will consult with the Services regarding measures to minimize and mitigate the impacts. In addition, operations near breeding individuals of the species of greatest concern, including all listed species, will be restricted as described below.

Species Conservation Strategies

Introduction

To identify species of regional concern that occur or could occur in the municipal watershed, the City solicited input from over 30 taxonomic experts, 22 of whom responded (Section 3.4; Appendix 18). From the comments of these experts, and additional consultation with the Services, the City developed the list of 83 species addressed in this HCP (Section 3.4). The primary habitat associations of each of these 83 species are given in Table 4.2-3.

Also, based on the comments from the taxonomic experts and consultation with the Services, the City identified 14 of the 83 species as those of greatest concern, including the 10 species considered by the taxonomic experts to be at greatest risk (Species of Greatest Concern, Section 3.5) and 4 additional species that are currently listed as threatened or endangered by the USFWS under the ESA. The 10 species considered at greatest risk are: bull trout, chinook salmon, coho salmon, common loon, marbled murrelet, northern goshawk, northern spotted owl, pygmy whitefish, sockeye salmon, and steelhead trout. The four additional listed species include three species − gray wolf, grizzly bear, and peregrine falcon − that are not known to occur in the municipal watershed at this time, but that could occur in the future. Also included is the bald eagle, which, along with the peregrine falcon, is now under consideration for delisting as a result of its substantial recovery in many areas.

Developing specific strategies for all of the 83 species addressed in this HCP is not feasible, but the City has developed strategies for the 14 species of greatest concern (termed "Species Conservation Strategies"). Furthermore, as discussed above in this section, the City believes that a community- or ecosystem-based approach is the most effective way for the City to contribute to sustaining populations of most of the species addressed in the HCP over the long term. However, the City also recognizes the need for specific measures targeted at some of the species of greatest concern. For example, specific measures are obviously needed to protect the four species of anadromous fish that now occur outside the municipal watershed. These species depend on water released into the Cedar River downstream of the Landsburg Diversion Dam, and the Landsburg Dam itself currently blocks the passage of these species upstream into the municipal watershed.

Measures are also needed to protect, especially during the sensitive reproductive period, some of the most "at-risk" wildlife species that now occur or could occur in the municipal watershed. To respond to this concern, the City developed some of the species strategies to add protection for reproductive adults and their offspring during the breeding season. For other species, the City believed it appropriate to add measures that would provide habitat and habitat elements specifically needed by the individual target species or that would increase the level of habitat protection greater than that included in the community-based strategies described above in this section.

Although most of the Species Conservation Strategies have unique measures targeted to the individual species, the strategies for all of the 14 species are based primarily upon other conservation and mitigation strategies and measures. The community-based conservation strategies described above apply to all 14 species. All of these species either occur or could occur in the Cedar River Basin. All of these species, except sockeye salmon, either occur within the municipal watershed, could occur within the watershed, or will occur within the watershed after HCP fish passage facilities are completed at the Landsburg Diversion Dam (allowing chinook, coho, and steelhead, and other native species into the municipal watershed) (Section 4.3). The community-based conservation strategies apply to sockeye salmon largely by their expected effect in improving, over time, the quality of surface water that is passed downstream over the Landsburg Diversion Dam. In addition, the mitigation strategies for the anadromous fish barrier at Landsburg (Section 4.3) and the Instream Flow Management Strategy (Section 4.4) apply to all species of anadromous fish.

For the purpose of presenting the Species Conservation Strategies, the 14 species of greatest concern have been categorized by their primary habitat associations (Table 4.2-3) as follows:

- *Species dependent on Late-successional and Old-growth Forest Communities:*
  Marbled murrelet, northern goshawk, and northern spotted owl
- *Species dependent on the Aquatic and Riparian Ecosystem:*
  Resident fish: bull trout and pygmy whitefish
  Anadromous fish: chinook, coho, and sockeye salmon, and steelhead trout

Birds: bald eagle and common loon

- *Species dependent primarily on Special Habitats:*
  Gray wolf, grizzly bear, and peregrine falcon.

As described above in this section, the Special Habitats include cliffs, rock outcrops, caves, vegetated and non-vegetated talus and felsenmeer slopes, natural grass-forb meadows, and persistent shrub communities.

The Species Conservation Strategies incorporate the other conservation and mitigation strategies shown in Table 4.2-4 below. The following parts of this section describe the specific Species Conservation Strategies that will be implemented for each of these 14 species, briefly summarize measures presented elsewhere in Chapter 4 that benefit the individual species or above three groups of species, and describe any additional measures developed for any of the species. The species strategies may be updated if any threatened or endangered species are delisted or if any new species are listed, or change status in a significant way, during the term of the HCP.

For the 69 other species of concern, the conservation strategies are based entirely on the community-based conservation strategies described above in this section. The biological goals and measurable objectives for those other species of concern are described below in the section entitled “Biological Goals and Objectives for Other Species of Concern.”

Development of Species Conservation Strategies

The development of the Species Conservation Strategies was based on the habitat needs of the 14 species of greatest concern, federal programs for species listed under the ESA (see Chapter 3), and the need for additional protection during sensitive periods of the annual life cycle of some of the species. The status of each of these species is discussed in detail in Chapter 3 and is summarized only briefly below to provide context.

As indicated in Table 4.2-4, the Species Conservation Strategies for species that now occur or may occur in the municipal watershed − with the exception of the four anadromous fish species − depend largely on the Community-based Conservation Strategies described above, as well as parts of the Monitoring and Research Program for the watershed (Section 4.5). The strategies for anadromous fish species are composed of elements of the Anadromous Fish Conservation Strategy (Section 4.3), Instream Flow Conservation Strategy (Section 4.4), Monitoring and Research Program related to instream flows and anadromous fish mitigation (sections 4.5.2 and 4.5.3), and the community-based parts of the Watershed Management Mitigation and Conservation Strategies described above in this section that affect water quality and aquatic and riparian habitat in areas that are or will be accessible to anadromous fish when fish passage facilities are built at Landsburg (see Section 4.3).

Table 4.2-4. Community-based conservation and mitigation strategies that are incorporated into the 14 Species Conservation Strategies, with species grouped by habitat association[1]. Shaded areas indicate those strategies that benefit particular species.

<table>
<tr><th>Ecosystem or Habitat
Species</th><th>Aquatic & Riparian Ecosystem</th><th>Late-Successional & Old-growth Forest Communities</th><th>Special Habitats</th><th>Watershed Management Guidelines</th><th>Mitigation Strategies for Anadromous Fish Barrier at Landsburg</th><th>Instream Flow Management Strategy</th></tr>
<tr><td>Section:</td><td>4.2.2</td><td>4.2.2</td><td>4.2.2</td><td>4.2.2</td><td>4.3.2</td><td>4.4.2</td></tr>
<tr><td>Late-successional & Old-growth Ecosystem</td><td colspan="6"></td></tr>
<tr><td>Marbled murrelet</td><td></td><td bgcolor="#d9d9d9"></td><td></td><td bgcolor="#d9d9d9"></td><td></td><td></td></tr>
<tr><td>Northern goshawk</td><td></td><td bgcolor="#d9d9d9"></td><td></td><td bgcolor="#d9d9d9"></td><td></td><td></td></tr>
<tr><td>Northern spotted owl</td><td></td><td bgcolor="#d9d9d9"></td><td></td><td bgcolor="#d9d9d9"></td><td></td><td></td></tr>
<tr><td>Aquatic & Riparian Ecosystem</td><td colspan="6"></td></tr>
<tr><td>Resident fish</td><td colspan="6"></td></tr>
<tr><td>Bull trout</td><td bgcolor="#d9d9d9"></td><td></td><td></td><td bgcolor="#d9d9d9"></td><td></td><td></td></tr>
<tr><td>Pygmy whitefish</td><td bgcolor="#d9d9d9"></td><td></td><td></td><td bgcolor="#d9d9d9"></td><td></td><td></td></tr>
<tr><td>Anadromous fish</td><td colspan="6"></td></tr>
<tr><td>Chinook salmon</td><td bgcolor="#d9d9d9"></td><td></td><td></td><td bgcolor="#d9d9d9"></td><td bgcolor="#d9d9d9"></td><td bgcolor="#d9d9d9"></td></tr>
<tr><td>Coho salmon</td><td bgcolor="#d9d9d9"></td><td></td><td></td><td bgcolor="#d9d9d9"></td><td bgcolor="#d9d9d9"></td><td bgcolor="#d9d9d9"></td></tr>
<tr><td>Sockeye salmon</td><td>Water quality</td><td></td><td></td><td></td><td bgcolor="#d9d9d9"></td><td bgcolor="#d9d9d9"></td></tr>
<tr><td>Steelhead trout</td><td bgcolor="#d9d9d9"></td><td></td><td></td><td bgcolor="#d9d9d9"></td><td bgcolor="#d9d9d9"></td><td bgcolor="#d9d9d9"></td></tr>
<tr><td>Birds</td><td colspan="6"></td></tr>
<tr><td>Bald eagle</td><td bgcolor="#d9d9d9"></td><td></td><td></td><td bgcolor="#d9d9d9"></td><td bgcolor="#d9d9d9"></td><td bgcolor="#d9d9d9"></td></tr>
<tr><td>Common loon</td><td bgcolor="#d9d9d9"></td><td></td><td></td><td bgcolor="#d9d9d9"></td><td></td><td></td></tr>
<tr><td>Special Habitats</td><td colspan="6"></td></tr>
<tr><td>Gray wolf [2]</td><td bgcolor="#d9d9d9"></td><td bgcolor="#d9d9d9"></td><td bgcolor="#d9d9d9"></td><td bgcolor="#d9d9d9"></td><td></td><td></td></tr>
<tr><td>Grizzly bear[2]</td><td></td><td bgcolor="#d9d9d9"></td><td bgcolor="#d9d9d9"></td><td bgcolor="#d9d9d9"></td><td></td><td></td></tr>
<tr><td>Peregrine falcon[2]</td><td bgcolor="#d9d9d9"></td><td></td><td bgcolor="#d9d9d9"></td><td bgcolor="#d9d9d9"></td><td></td><td></td></tr>
</table>

1 Excludes Monitoring and Research (Section 4.5), which applies to all 14 species.

2 If present.

The community-based conservation strategies described above in this section were designed to preserve, protect, and enhance key habitat in the Cedar River Watershed that is used by species addressed by the HCP for reproduction; roosting, denning, and holding; foraging; rearing; and dispersal. The strategies for anadromous fish were developed cooperatively with state and federal agencies, with input from the Muckleshoot Indian Tribe, during negotiations, studies, and analyses conducted over the last 13 years. The strategies for the remaining 10 species were developed cooperatively with the agencies, with input from the Muckleshoot Tribe, during preparation of this HCP.

Conservation Objectives for Species Conservation Strategies

The objectives of the Species Conservation Strategies derive from the more comprehensive set of HCP objectives presented in Section 2.4. The objectives of the Species Conservation Strategies generally are to avoid, minimize, or mitigate for impacts of any incidental take of the species addressed in the HCP, including potential take of species listed under the ESA and the equivalent of take for the unlisted species, and to provide additional protection during sensitive periods of the annual life cycles of some of the species. Each strategy is intended to produce a net benefit for the species addressed, over the term of the HCP, compared to current conditions, and to contribute to recovery of any of the species that are or may be listed.

Strategies for Species Dependent on Late-successional and Old-growth Forest Communities

Species Addressed

Strategies are provided for three species dependent on Late-successional and Old-growth Communities: the northern spotted owl, marbled murrelet, and northern goshawk.

Summary of Status for Species Dependent on Late-successional and Old-growth Forest Communities

<u>Northern Spotted Owl</u>

The northern spotted owl (*Strix occidentalis caurina*) in western Washington depends on late-successional and old-growth forests (USDI 1992b; Thomas et al. 1993). The species is listed as threatened by the federal government (Fed. Reg. Vol. 55, Pp. 26114-26194), and it is listed as endangered by Washington State (WAC 232-12-014). The most significant factor contributing to the overall decline of the northern spotted owl is the loss of nesting, roosting, and foraging habitat (Thomas et al. 1990) as a result of a reduction in late-successional and old-growth forests (Section 3.5.2).

Within the municipal watershed only two northern spotted owl reproductive site centers have been found. Only one of the reproductive site centers is currently active; the second has not been active since 1981. Similarly, two single-resident site centers have been found, but only one center is currently active. The other site center has not been active since 1987. One single-resident northern spotted owl site center also has been reported within the municipal watershed (WDFW 1997d), but its current status is unknown. In addition, two reproductive site centers located outside of the watershed boundary have owl circles (of 1.8 mile radius: see Section 3.5.2) that partially overlap the municipal watershed (WDFW 1997d). All reported site centers have been within old-growth forest.

The boundaries of all known reproductive site centers of the northern spotted owl, both inside and outside the municipal watershed, are within the designated boundaries of CHU WA-33, which includes 22,845 acres of City land in the eastern portion of the watershed. All areas of known reproductive site centers for the spotted owl that are within the municipal watershed are protected by the City's commitment not to harvest timber for commercial purposes, placing all forest outside limited developed areas in reserve status. The state has also designated a Spotted Owl Special Emphasis Area (SOSEA) (the I-90 West SOSEA) that incorporates 48,877 acres of the municipal watershed and overlaps all of the CHU (Figure 3.5-2). The state designated the SOSEA land in the municipal watershed for either *demographic support* or *dispersal support*.

Demographic support lands offer appropriate habitat for nesting, roosting, and foraging ("NRF" habitat), while dispersal support lands offer minimum necessary habitat for young to cross from the natal stand to a new territory. There is 25,501 acres of demographic support land in the municipal watershed, 22,167 acres of which overlap the CHU. An additional 23,367 acres of the municipal watershed within the SOSEA is designated for dispersal support, 668 acres of which are in the CHU.

Marbled Murrelet

The marbled murrelet (*Brachyramphus marmoratus*) is a marine bird that occurs inland only during the breeding season. Mated pairs typically nest in old-growth trees, specifically on large branches and usually more than 100 ft above ground. They nest on naturally formed platforms that are usually composed of large, wide limbs with thick moss or duff, mistletoe brooms, or other structural deformities that provide a surface of sufficient size to rear a chick. Adult marbled murrelets approach and leave the nest at high speed primarily at dusk and dawn (WDW 1993d) and appear to favor forest with the irregular canopies typical of old growth, which likely provide openings in the canopy through which birds can enter and emerge.

"Suitable marbled murrelet habitat" (for nesting) is generally considered to be contiguous forest at least 7 acres in area, within 50 miles of marine waters, that contains trees capable of providing nesting opportunities (WAC 222-16-010). These opportunities are considered to be present in stands in which at least 40 percent of the dominant and codominant trees are Douglas-fir, western hemlock, western redcedar, or Sitka spruce, and there are two or more potential nesting platforms per acre. Adequate nesting platforms are considered to be branches at least 7 inches in diameter and at least 50 ft above ground, on trees at least 32 inches dbh.

The marbled murrelet is federally listed as threatened in Washington, Oregon, and California (Fed. Reg. Vol. 57, No. 191). The species is also listed as threatened by Washington State (WAC 232-12-011). Listing was a result of population declines resulting primarily from loss of old-growth nesting habitat, and secondarily because of mortality caused by ocean fishing with gill nets (USDI 1992a). Critical Habitat for marbled murrelets was designated on former USFS lands within the municipal watershed (USDI 1996); all the Critical Habitat falls within the spotted owl CHU. A final Recovery Plan for marbled murrelets was published in 1997 (USDI 1997a).

Currently, insufficient information exists on abundance and regional distribution to definitively determine population trends in the western Cascade region. However, the recent estimate of 5,500 marbled murrelets in Washington (Speich and Wahl 1995; Varoujean and Williams 1995) reflects a possible region-wide decline in the population. This regional decline is thought to be caused by a combination of many factors, including a reduction in old-growth forests, oil spills in marine waters, and entanglement in gill nets (Marshall 1988; Leschner and Cummins 1992).

In 1991, City staff consulted with WDNR personnel who were actively studying marbled murrelet ecology in other areas of the western slope of the Cascades. Existing habitat conditions within the municipal watershed were reviewed based on topography, relative forest age, and existing knowledge of forest stand structural development. One area was identified as having the greatest potential for providing nesting habitat for murrelets. The area was surveyed late in the nesting season, and no murrelets were detected. However, in 1992, WDFW surveyed the same area during the nesting season and detected murrelet calls on two occasions (WDFW 1994b). No nest site was located, and no additional surveys have been conducted to date (Section 3.5.3).

Northern Goshawk

In the Pacific Northwest, the northern goshawk (*Accipiter gentilis*) is most abundant in old-growth habitat and is also associated with late-successional coniferous forests (Thomas et al. 1993). Nesting habitat selected by northern goshawks is similar to that selected by northern spotted owls (Marshall 1992; Buchanan 1992).

The northern goshawk is a federal species of concern and a state candidate for listing as a threatened species (WAC 232-12-297). On September 29, 1997, the USFWS published a 90-day finding on a petition to list the northern goshawk in the Western United States under the ESA (Fed. Reg. Vol. 62, No. 188, Pp. 50892-50896), which announced that listing of the northern goshawk was not warranted. Another finding was published in June of 1998 (Fed Reg. Vol. 63, No 124, Pp. 35183-35184) after a one-year finding on another listing petition, announcing also that listing was not warranted. The principal reason for the decline of the species that led to the concern of regulatory agencies is considered to be habitat loss resulting from intensive timber harvest.

No comprehensive studies of northern goshawk numbers or distribution have been conducted within the Cedar River Municipal Watershed, and specific knowledge concerning the species' use of existing habitat is limited. Presently, only one northern goshawk nesting territory has been documented within the municipal watershed. The site was identified during surveys by WDW personnel in the summer of 1992, in unharvested native forest included within the spotted owl CHU in the eastern section of the watershed. The site was also occupied during 1996, but no offspring were observed (Spencer, R., WDW, 1997, personal communication). This northern goshawk nesting territory is located within a defined 1.8-mile northern spotted owl circle near the spotted owl reproductive site center (Section 3.5.4).

Conservation Objectives for Species Dependent on Late-successional and Old-growth Forest Communities

Northern Spotted Owl

The objectives of the northern spotted owl conservation strategy are to avoid, minimize, or mitigate for the impacts of any incidental take of spotted owls, to provide a net benefit for the owl, and to contribute to its recovery. These objectives will be pursued by protecting existing old-growth habitat; by enhancing and recruiting significantly more of its nesting, roosting, foraging, and dispersal habitat; and by protecting nest sites and reproductive pairs and their offspring.

Marbled Murrelet

The objectives of the marbled murrelet conservation strategy are to avoid, minimize, or mitigate for impacts of any incidental take of marbled murrelets; to provide a net benefit for the murrelet; and to contribute to its recovery. These objectives will be pursued by protecting existing old-growth habitat, by enhancing and recruiting more of its potential nesting habitat, and by protecting nest sites and reproductive pairs and their offspring.

Northern Goshawk

The objectives of the northern goshawk conservation strategies are to avoid, minimize, or mitigate for impacts of any incidental take of northern goshawks; to provide a net benefit for the species; and to contribute to its recovery, if it is listed. These objectives will be pursued by protecting existing old-growth habitat; by enhancing, and recruiting significantly more of its potential nesting, roosting, foraging and dispersal habitat; and by protecting nest sites and reproductive pairs and their offspring during the breeding season.

Common Elements of Conservation Strategies for Species Dependent on Late-successional and Old-growth Forest Communities

Conservation strategies for the northern spotted owl, marbled murrelet, and northern goshawk are based largely on the component of the Community-based Conservation Strategies that focuses on Late-successional and Old-growth Communities. The commitment not to harvest timber for commercial purposes and the designation of all forest outside developed areas for reserve status should provide substantial protection for the habitat of these species and recruit substantially more habitat over the 50-year term of the HCP.

The total mature, late-successional, and old-growth forest projected at year 2050 for the watershed is 72,739 acres; compared to 15,054 acres of these seral stages in 1997, this represents nearly a fivefold increase. Approximately 15,000 acres of forest is expected to receive silvicultural treatments that will accelerate the development of natural biodiversity and structural characteristics of late-successional and old-growth forests.

These silvicultural methods will encourage the development of multi-layered stands that have vertical and horizontal structural complexity, large trees, large snags and logs, and understory development. These characteristics will provide perching and roosting sites for owls, and will promote the creation of nest platforms for owls as older trees mature and the tops break off. They will also promote development of large branches of the type that are used by murrelets for nesting.

As a consequence of the City's commitment not to harvest timber for commercial purposes, early seral forest (less than 30 years old) will not be created by commercial harvest under the HCP, and the current early seral forest habitat will have matured into later seral stages by year 2027. Some early seral forest habitat, however, can be expected to be created by natural disturbances such as windstorms, disease, or fire. This reduction in early seral forest should facilitate dispersal of spotted owls and goshawks and reduce mortality during dispersal. Designation of the entire spotted owl CHU for reserve status will allow forest in this area to mature, increasing the CHU's effectiveness within the federal late-successional reserve system and providing regional connectivity for spotted owls and goshawks. The thirteen-fold increase in mature, late-successional, and old-growth forest below 3,000 feet and the substantial increase in this habitat in the western portion of the watershed should also provide increased nesting habitat for marbled murrelets over the long term. The reduction in forest fragmentation should benefit all three species, as it should reduce the numbers of potential predators that use forest edges, and it should ameliorate environmental effects of recent clearcuts on forest interior conditions.

The above measures, and the effects of those measures collectively, should contribute significantly to demographic support for all three species and to dispersal support for the spotted owl and goshawk. In addition, the current closure of the municipal watershed to unsupervised public access and the substantial reduction in the watershed road system will reduce disturbance to individuals and pairs of all three species.

Additional Mitigation and Conservation Measures for Species Dependent on Late-successional and Old-growth Forest Communities

<u>Measures Benefiting the Northern Spotted Owl</u>

The City will implement the following measures for the northern spotted owl:

(1) The City will protect all documented spotted owl nest sites and suitable habitat within the watershed, documenting such sites either by survey or incidental observation.

(2) The City will conduct a baseline survey of northern spotted owl presence in old-growth forest within the watershed, if those areas are not actively being monitored by other agencies or interested parties, such as adjacent landowners.

(3) The City will conduct an annual survey of reproductive site centers within the watershed, or coordinate with other agencies or interested parties to conduct an annual survey, for a period of 5 years after the last documented activity of spotted owls within such sites.

(4) Unless affected owls are not actively nesting, the City will avoid road construction activities, operation of heavy equipment, slash burning, blasting, and helicopter operations that could disrupt successful nesting within 0.25 miles of any active reproductive site center between March 1 and August 31 (the nesting season, as defined in WAC 222).

Funding for the conservation and mitigation measures for the northern spotted owl is covered under other mitigation and conservation strategies. Funding for monitoring related to the spotted owl is covered in Section 4.5.5.

The monitoring and research program outlined in Section 4.5.5 will be used to determine if the conservation strategy for the northern spotted owl achieves its conservation objectives, and to support the adaptive management program (Section 4.5.7), which is designed to provide a means with which mitigation strategies can be altered to better meet conservation objectives. Elements of the monitoring and research program important for all species dependent on Late-successional and Old-growth Forest Communities, including the northern spotted owl, include the following:

- a project to improve the forest habitat inventory and database;
- a project to track changes in forest habitat characteristics;
- a study to classify old-growth forest types in the watershed; and
- projects to monitor forest restoration projects.

Additional monitoring and research pertinent to spotted owls include a baseline survey of the watershed and surveys of reproductive site centers following their last use.

Measures Benefiting the Marbled Murrelet

The City will implement the following measures for the marbled murrelet:

(1) The City will protect all documented marbled murrelet nest sites and suitable habitat, documenting such sites either by survey or incidental observation.

(2) A habitat assessment program will be conducted to identify potential suitable marbled murrelet habitat (as defined above) in second growth along with site-occupancy surveys, as described in Section 4.5.5, to provide information for choosing sites for habitat restoration and for monitoring changes in murrelet habitat use over time.

(3) The City will avoid cutting any trees during ecological thinning that meet requirements for murrelet nesting trees (as described above).

(4) The City will avoid road construction and operation of heavy equipment, which could disrupt successful nesting, within 0.25 miles of an occupied marbled murrelet site during the daily peak activity periods within the critical nesting period and will avoid blasting within 0.25 miles of an occupied marbled murrelet site during the critical nesting period.

(5) If the USFWS agrees to cooperate in the project, the City will conduct an experimental project to develop nesting habitat for murrelets within selected second-growth forest within the watershed. The timing and details of this project are discussed in Section 4.5.5.

Funding for the conservation and mitigation measures for the marbled murrelet is covered under other mitigation and conservation strategies. Funding for monitoring related to the marbled murrelet is covered in Section 4.5.5.

The monitoring and research program outlined in Section 4.5.5 will be used to determine if the conservation strategy for the marbled murrelet achieves its conservation objectives, and to support the adaptive management program (Section 4.5.7), which is designed to provide a means with which mitigation strategies can be altered to better meet conservation objectives. Elements of the monitoring and research program important for all species dependent on Late-successional and Old-growth Forest Communities, including the marbled murrelet, are as described above for the northern spotted owl. Additional monitoring and research pertinent to marbled murrelets includes:

- Baseline surveys;
- Determination of potential suitable murrelet habitat in second-growth forest;
- Occupancy surveys in potential suitable habitat in second growth;
- Long-term occupancy surveys; and
- Monitoring of experimental projects to develop nesting habitat.

Measures Benefiting the Northern Goshawk

The City will implement the following measures for the northern goshawk:

(1) The City will protect all documented northern goshawk nest sites and suitable habitat, documenting such sites either by survey or incidental observation.

(2) The City will avoid road construction, operation of heavy equipment, and blasting, which could disrupt successful nesting, within 0.50 miles any known active northern goshawk nest site from April 1 to August 31.

While no surveys for goshawks are planned as part of this HCP, some of the $150,000 in contingency funds for additional wildlife species surveys included in the monitoring and research program (Section 4.5.5) may be used for such surveys if the Services agree, or surveys may be conducted by another agency. However, the major protections afforded goshawks under the HCP are the commitment not to harvest timber for commercial purposes and the designation of all forest outside developed areas for reserve status. This is projected to result in an overall five-fold increase in mature, late-successional, and old-growth forest over the term of the HCP.

The monitoring and research program outlined in Section 4.5.5 regarding development of habitat with late-successional and old-growth characteristics will be used to determine if the conservation strategy for the northern goshawk achieves its conservation objectives, and to support the adaptive management program (Section 4.5.7), which is designed to provide a means with which mitigation strategies can be altered to better meet conservation objectives. Elements of the monitoring and research program important for all species dependent on Late-successional and Old-growth Forest Communities, including the northern goshawk, are as described above for the northern spotted owl.

Strategies for Species Dependent on the Aquatic and Riparian Ecosystem

Species Addressed

Strategies are provided for eight species dependent on the Aquatic and Riparian Ecosystem:

- Resident fish: bull trout and pygmy whitefish
- Anadromous fish: chinook, coho, and sockeye salmon, and steelhead trout
- Birds: bald eagle and common loon.

Summary of Status of Species Dependent on the Aquatic and Riparian Ecosystem

Status of Bull Trout

The USFWS listed the Puget Sound Distinct Population Segment as threatened on November 1, 1999 (Fed. Reg. Vol. 64, No. 210). The U.S. Fish and Wildlife Service has also recently listed the Columbia River Basin populations as threatened (Fed. Reg. Vol. 64, No. 210, page 58909). Currently, Washington State does not give bull trout a listing status, but does classify bull trout as a priority species because it is considered to be vulnerable to significant population declines (WDFW 1996a).

The Cedar River Municipal Watershed supports a reproductively isolated stock of bull trout in the reservoir complex and its tributaries. In a 1998 study, WDFW assessed the status of individual populations of bull trout and Dolly Varden (*Salvelinus malma*) in Washington State and found that of the 80 identified stocks placed into five rating categories (healthy, depressed, critical, unknown, or extinct), the status of 72.5 percent are unknown, and 17.5 percent are categorized as healthy. The status of the Chester Morse Lake stock is classified as unknown. However, the assessment states "there are no data suggesting a chronically low condition, or short-term severe decline" in the population (WDFW 1998). A detailed discussion of the Chester Morse Lake bull trout population is provided in Section 3.5.6. Bull trout are rare in the Cedar River Basin downstream of Chester Morse Lake, and any individuals found in this area could be from the reservoir.

Status of Pygmy Whitefish

The pygmy whitefish (*Prosopium coulteri*) was listed as a Washington State sensitive species on October 27, 1998 (WDFW 1998c). The listing became effective in December 1998. The pygmy whitefish is found in only nine lakes in Washington State (Hallock and Mongillo 1998), and its populations are especially vulnerable to local extinction, because recruitment of new individuals is usually impossible in isolated systems. Introductions of non-native fishes are believed to have extinguished pygmy whitefish populations in other systems (Section 3.5.7).

The Chester Morse Lake system supports a relatively large population of pygmy whitefish. The fish are the most abundant salmonid in the lake, and they are one of the major prey items for the Chester Morse Lake bull trout population (R2 Resource Consultants, in preparation). A detailed discussion of the pygmy whitefish in the Cedar River Watershed is provided in Section 3.5.7. The pygmy whitefish is not known to occur in the Cedar River Basin below Chester Morse Lake.

Status of Chinook Salmon

The Washington Department of Fisheries et al. (1993) identified 26 stocks of chinook salmon (*Oncorhynchus tshawytscha*) in Puget Sound. At the time of their report, the authors classified the population status of approximately half of the stocks as depressed.

Since that time, there has been a sharp decline in the abundance of Puget Sound chinook, resulting from poor ocean survivals, habitat alterations, and harvest pressures (Johnson et al. 1997). The continued downward trend has led the State of Washington to reclassify the status of Puget Sound chinook as depressed. Following a status review by NMFS, chinook salmon in Puget Sound were proposed for listing as threatened under the federal ESA in 1998 (Fed. Reg. Vol. 63, No. 45, March 9, 1998) and were listed by NMFS as threatened on March 24, 1999 (Fed. Reg. Vol. 64, No. 56, page 14307). No final regulations regarding chinook under Section 4(d) of the ESA have been published by NMFS to date.

Washington Department of Fisheries et al. (1993) classified the status of Lake Washington chinook salmon as unresolved because of differing viewpoints of state and Tribal resource managers. Since this analysis, chinook abundance has declined sharply, and the State of Washington now classifies the demographic status of Lake Washington chinook as depressed (Smith, C., WDFW, 1998, personal communication). Since the completion of the Landsburg Dam, chinook salmon have been unable to migrate past the dam and into the waters between Landsburg and the natural barrier at lower Cedar Falls. A detailed discussion of chinook salmon is provided in Section 3.5.10.

Status of Coho Salmon

In 1995, NMFS completed a comprehensive status review of coho salmon (*Oncorhynchus kisutch*) along the west coast of the United States. The status review identified six populations of coho within this range. Because coho from Puget Sound and the Strait of Georgia formed a coherent genetic cluster, it was determined that this population was unique. The population includes coho from Lake Washington and the Cedar River. In comparison to other populations along the California and Oregon coasts, NMFS determined that coho salmon in Puget Sound and the Strait of Georgia were generally stable and a listing was not warranted. However, because of limited information regarding the health of this population and definitive information on the risks to naturally reproducing fish, NMFS decided to add the Puget Sound/Strait of Georgia population to the federal list of candidates for threatened and endangered species. Upon reevaluation at any time, NMFS may reconsider the present candidate listing and propose to list the Puget Sound/Strait of Georgia population as threatened or endangered.

Coho populations in the Lake Washington Basin have undergone significant declines in recent years. Coho escapement peaked at over 30,000 fish in 1970, but declined to less than 2,000 fish in 1992 (Fresh 1994). The desired escapement for Lake Washington is 15,000 fish, an escapement level that has not been achieved since 1979. Although the status of Cedar River coho salmon was determined to be healthy in 1992 (WDFW et al. 1993), this assessment acknowledged that the stock would fall into the depressed classification if future returns similar to those in 1991 were observed. Because of the continuation of the downward population trend, coho salmon are now considered depressed in the Cedar River and elsewhere in the Lake Washington Basin. Since the completion of the Landsburg Dam, coho salmon have been unable to migrate past the dam and into the waters between Landsburg and the natural barrier at lower Cedar Falls. A detailed discussion of coho salmon is provided in Section 3.5.9.

Status of Sockeye Salmon

NMFS completed a comprehensive status review of west coast sockeye salmon (*Oncorhynchus nerka*) populations in Washington, Oregon, and California in 1998 (Fed. Reg. Vol. 63, No. 46, March 10, 1998). NMFS concluded that only the Ozette Lake sockeye is likely to become endangered in the foreseeable future, and proposed them for listing. NMFS also added Baker River sockeye to the candidate species list. NMFS considered the sockeye salmon stock from the Cedar River to be apparently introduced from outside the Lake Washington Basin and did not recognize this stock as an Evolutionarily Significant Unit (ESU).

Washington Department of Fisheries et al. (1993) identified four populations of sockeye salmon (*Oncorhynchus nerka*) in Puget Sound: three populations in the Lake Washington Basin and one population in Baker River. In the Lake Washington Basin, the sockeye salmon is the most numerous reproducing salmonid. In years of high abundance, sockeye salmon support a significant Tribal treaty harvest and one of the largest sport fisheries in the state (Fresh 1994). The summer migration of adult sockeye salmon through the fish ladder at the Ballard Locks attracts thousands of visitors each year and the observation of spawning sockeye in the Cedar River, Bear Creek, and Issaquah Creek has become a popular outdoor recreation activity.

After building to relative robust levels in the 1960s and 1970s, the Lake Washington Sockeye population has experienced a period of significant decline. Since 1967, the escapement goal for Lake Washington of 350,000 adult fish has been met or exceeded only four times. Because the escapement goal was last achieved in 1988, WDF et al. (1993) classified the Lake Washington sockeye population as depressed in the Cedar River and elsewhere in the Lake Washington Basin.

Sockeye harvest opportunities have recently declined in frequency. In 8 of the 22 years between 1967 and 1988, Tribal and sport harvest included substantial numbers of sockeye in Lake Washington. Since 1988, Tribal and sport harvests have been conducted in Lake Washington only in 1996 (WDFW, unpublished data). Although the 1996 return of approximately 450,000 adult fish indicates that the system has retained some potential to produce significant numbers of fish, the general trend in the sockeye population remains one of relatively steep decline. A detailed discussion of sockeye salmon is provided in Section 3.5.8.

Status of Steelhead Trout

There are 60 wild steelhead (*Oncorhynchus mykiss*) stocks inhabiting the Puget Sound drainage (WDF et al. 1993). Of these stocks, 16 are considered healthy, 14 are classified as depressed, and 1 stock is considered to be in critical condition. The remaining 29 stocks in the Puget Sound drainage are designated "status unknown." A regional status review of steelhead stocks by NMFS in 1994 determined that steelhead in Puget Sound, which includes the Lake Washington stock, did not warrant listing under the federal ESA.

The Lake Washington Basin is considered to have only one stock of native/wild steelhead trout. This steelhead stock is considered to be depressed, and there is no longer significant natural production from any stream in the basin other than the Cedar River (Foley, S., WDFW, 1997, personal communication). Between 1983 and 1997, escapement estimates for the Lake Washington Basin ranged from 2,575 fish in 1983 to

70 fish in 1994. Low returns in the early 1990s resulted in closing of all recreational fisheries until steelhead numbers returned to healthy levels. Since the record low return in 1994, steelhead escapement has generally increased, with escapement ranging from 126 to 616 fish per year.

Since the completion of the Landsburg Dam, steelhead trout have been unable to migrate past the dam and into the waters between Landsburg and the natural barrier at lower Cedar Falls. A detailed discussion of steelhead trout is provided in Section 3.5.11.

Status of Bald Eagle

A subspecies of the bald eagle (*Haliaeetus leucocephalus*) was federally listed as endangered (Fed. Reg. Vol. 32, Pg. 4001, March 11, 1967) under the Endangered Species Protection Act of 1966 (16 U.S.C. 668aa-668cc). In 1978, the legal status of the bald eagle in North America was clarified by listing the bald eagle population as endangered for the entire lower 48 States, without referring to subspecies (Fed. Reg. Vol. 43, Pg. 6233, February 14, 1978). In a special rule, the U.S. Fish and Wildlife Service reclassified the bald eagle from endangered to threatened in the lower 48 States (Fed. Reg. Vol. 60, No. 133, July 12, 1995). The bald eagle also occurs in Alaska and Canada, where it is not at risk and is not protected under the ESA. Washington State lists the bald eagle as threatened (WAC 232-12-011). Because of significant recovery in large parts of its range, the bald eagle is now under consideration for delisting under ESA.

Bald eagles are present year-round throughout Washington. Most nesting in the state occurs on the San Juan Islands and along the Olympic Peninsula coastline. Nesting territories are also found along Hood Canal, on Kitsap Peninsula, along the Columbia River in southwestern Washington, in the Cascade Mountains, and in eastern Washington (USFWS 1986), as well as on Lake Washington. Primary wintering areas include the Olympic Peninsula, the San Juan Islands, Puget Sound and its tributaries, Hood Canal, the Cowlitz and Columbia rivers (Taylor 1989), and rivers of the western Cascade slopes such as the Skagit River.

Bald eagles are common visitors to the watershed during spring and fall migrations, but are not known to nest within the boundaries of the municipal watershed. During the fall and spring, bald eagles are regularly seen in trees around the lakes of the watershed.

Status of Common Loon

The common loon (*Gavia immer*) is a Washington State candidate species under WDFW Policy POL-M6001. The candidate status of the loon is a result of a suspected decline in breeding population size and the increase in human activities near loon breeding and nesting habitat. Nest sites have been confirmed on at least five lakes in King County during the last decade. Nest sites have also been confirmed in four other counties in the state, three of which are in eastern Washington (Richardson and Spencer 1999). Only 5-11 common loon breeding sites are known to have been active at any time during the last decade in Washington State (Richardson and Spencer 1999).

Three mated pairs of common loons have been present on Chester Morse Lake and Masonry Pool during each pair-bonding and nesting season for the years 1989-1997. Two of the nesting territories have been occupied by reproductive pairs in each of the 9 years of the City study described in Section 3.5.5. A pair of loons has been present in a third territory in each of the 9 years of the study, but the pair failed to establish a nest during 3 of those years. Low water levels or other factors may have prevented successful reproduction during these 3 years.

Since 1990, the City has conducted an experimental project designed to ameliorate the effects of reservoir fluctuations on common loon nesting success (Section 3.5.5) and has been conducting research on the breeding biology of loons in the municipal watershed. The experimental project entails deployment of artificial nest platforms, which have been made available within each of the three loon nesting territories on the reservoir complex each year since 1990. The floating platforms provide nesting loons with an alternative, more stable, nest site that can more effectively adjust for most rising water conditions, but only to some degree for falling lake levels. Platforms have been used in at least one, and typically in two, of the three nesting territories in each of the 8 years during which platforms have been deployed.

Of the 21 common loon nests established during the 8-year period 1990-1997, 7 have been on natural nest sites and 14 have been on experimental platforms. A total of 24 chicks have hatched: 6 on natural nests (5 of which survived to fledging) and 18 on platforms (16 of which survived to fledging). Four chicks hatched and survived to fledging from three natural nests in 1989, before any experimental platforms were deployed. A detailed discussion of common loons is provided in Section 3.5.5.

Conservation Objectives for Species Dependent on the Aquatic and Riparian Ecosystem

Objectives for Bull Trout

The objectives of the bull trout conservation strategy are to avoid, minimize, or mitigate for impacts of any incidental take of bull trout, to provide a net benefit for the bull trout, to contribute to its recovery, if it is listed, and to maintain the health and viability of the Cedar River Watershed bull trout population. These objectives will be pursued by protecting and enhancing bull trout habitat in tributaries to the reservoir complex, by monitoring population trends, and by controlling risks to the population that could result from water supply and watershed management activities.

Objectives for Pygmy Whitefish

The objectives of the pygmy whitefish conservation strategy are to avoid, minimize, or mitigate for impacts of any incidental take of pygmy whitefish, to maintain the health and viability of the Cedar River Watershed pygmy whitefish population, to provide a net benefit for the pygmy whitefish, and to contribute to its recovery, if it is listed. These objectives will be pursued by protecting and enhancing pygmy whitefish habitat in tributaries to the reservoir complex, by gaining a better understanding of its life history, and by controlling risks to the population that could result from water supply and watershed management activities.

Objectives for Chinook Salmon, Coho Salmon, Steelhead Trout, and Sockeye Salmon

The conservation objectives of the strategies for chinook, coho, and sockeye salmon, and steelhead trout are to avoid, minimize, or mitigate for impacts of any incidental take of any of these species, to provide a net benefit for each species, and to contribute to the recovery of any of these species that becomes listed under the ESA. As described in

Section 4.3, additional objectives with respect to mitigation for the blockage to passage at the Landsburg Diversion Dam are to:

(1) Implement biologically sound, short- and long-term solutions that help provide for the recovery and persistence of well-adapted, genetically diverse, healthy, harvestable populations of these species in the Cedar River;

(2) Provide fish passage over the Landsburg Diversion Dam, consistent with water quality protection, and in a manner that is coordinated with run recovery, biological need, water supply operations, and facility maintenance requirements;

(3) Implement solutions that have a high likelihood of success and that provide substantial value for target resources and the ecosystems upon which they depend; and

(4) Coordinate with and support other compatible rehabilitation activities to help realize the full benefits offered by aquatic resource conservation efforts in the Lake Washington Basin.

For chinook, coho, and steelhead, the objective is to restore access to the municipal watershed for spawning and rearing by construction of passage facilities at the Landsburg Diversion Dam. As explained in Section 4.3, sockeye cannot be passed above the Diversion Dam without jeopardizing the quality and safety of the drinking water supply. The objective for sockeye is to otherwise mitigate for the lost spawning and incubation capacity for sockeye upstream of Landsburg Dam.

As described in Section 4.4, additional objectives with respect to instream flows are to:

(1) Implement a beneficial instream flow regime, based on the best current scientific information, that will help provide high quality fish habitat throughout the potential range of anadromous fish in the Cedar River from Lake Washington to the natural migration barrier formed by lower Cedar Falls;

(2) Reduce the risks of stranding juvenile salmonids and dewatering salmonid redds to levels that will help promote the full recovery and persistence of anadromous salmonid populations in the Cedar River;

(3) Provide an instream flow regime that significantly improves existing habitat conditions for all four species of anadromous salmonids in the Cedar River over existing conditions;

(4) Maintain the supply capacity from the municipal water system, including the Cedar River, as measured by average annual firm yield, protect drinking water quality and public health, and preserve the operational flexibility necessary to water supply operations;

(5) Help support measures that will contribute to improving downstream migration conditions for juvenile salmonids at the Hiram Chittenden (Ballard) Locks; and

(6) Preserve flexibility to meet water needs for people and fish that may be identified in the future.

Objectives for Bald Eagle

The objectives of the bald eagle conservation strategy are to avoid, minimize, or mitigate for impacts of any incidental take of bald eagles, to provide a net benefit for the eagle, and to contribute to its recovery by protecting potential nesting, roosting, perching, and foraging habitat within the watershed, and by recruiting additional nesting, roosting, and perching habitat.

Objectives for Common Loon

The objectives of the common loon conservation strategies are to avoid, minimize, or mitigate for impacts of any incidental take of common loons, to provide a net benefit for the loon and contribute to its recovery, if it is listed, by protecting and improving nesting conditions and nesting success. An additional objective is to collect biological information that will help identify and design effective and biologically sound, short- and long-term conservation measures.

Common Elements of Conservation Strategies for Species Dependent on the Aquatic and Riparian Ecosystem

Conservation strategies for the bull trout, pygmy whitefish, bald eagle, and common loon are based on the components of the Community-based Conservation Strategies described above that focus on the Aquatic and Riparian Ecosystem. The conservation strategies for the four species of anadromous fish – chinook salmon, coho salmon, sockeye salmon, and steelhead trout – are dependent largely on the mitigation and conservation measures for the anadromous fish barrier at Landsburg (Section 4.3) and the Instream Flow Management Strategy (Section 4.4), but these species will benefit from Watershed Management Mitigation and Conservation Strategies for the Aquatic and Riparian Ecosystem also.

The strategy for the Aquatic and Riparian Ecosystem within the municipal watershed (Table 4.2-4) is designed to contribute to sustaining populations of species dependent on aquatic and riparian habitats by: (1) protecting all aquatic habitats in the watershed, consistent with operation of the water supply; (2) improving aquatic and riparian habitats and water quality through restoration projects; (3) sustaining natural processes and functions that create and maintain habitats, and restoring to a more natural range of variation those processes that have been disturbed by past human activities; and (4) providing landscape connectivity within stream systems and among significant wetlands and associated riparian areas. Protection of aquatic and riparian habitats will be accomplished through a combination of the commitment not to harvest timber for commercial purposes, protection of all forest outside developed areas through reserve status, and implementation of the management guidelines.

In addition to protection of nearly all aquatic and riparian habitats through reserve status, the Aquatic and Riparian Ecosystem is protected through a variety of guidelines. These management guidelines are designed to reduce anthropogenic sediment loading to aquatic habitats and improve water quality over the long term by improved construction and maintenance standards for forest roads, a commitment to remove a large portion of the watershed road system, and a commitment to reengineer other roads to reduce sediment loading to streams. Aquatic and riparian habitats will also be improved by restoration projects for stream and riparian habitats, and stream habitat accessibility will be restored by a program to upgrade stream-crossing structures that block passage.

All four species of anadromous fish will benefit by the Instream Flow Management Strategy (Section 4.4). Instream flow is a major factor determining habitat quality in the Cedar River, as habitat quality depends on the total available area of habitat that meets species requirements for water depth and velocity, and for substrate type and cover (Section 3.3.2). The flow regime in the HCP was developed over an 11-year period through cooperative studies by a group that included state and federal resource agencies with input from the Muckleshoot Indian Tribe (Section 3.3.2), and subsequent negotiations and modeling based on those studies (Section 4.4). The flow regime provides flows for spawning, incubation, rearing (of juveniles), holding of adults, and outmigration of fry, as well as standards for downramping (rate of reduction of flows) designed to minimize stranding of juvenile fish as river water levels drop. The four species and the life stages of those four species have different flow needs by season, and the interagency group selected a species and life stage that should receive primary emphasis for each period of the year (Section 3.3.2).

Because hydrologic conditions can vary substantially by year, many operational decisions need to be made to best allocate available water for the various species and life stages of fish in any given year. The Instream Flow Management Strategy incorporates provisions to capitalize on better hydrologic conditions by enhancing instream flows. To manage decisions on flow augmentation adaptively, implementation of the instream flow regime will be overseen by a multi-agency commission (Appendix 27). Data collected in the cooperative study indicate that the improved flows, particularly when combined with adaptive management of flows through the commission, should create better conditions for all four species than currently exist in the Cedar River (Section 4.4). In response to citizen comment seeking to have the City ensure that some of the water which it may be entitled to withdraw under its 300 mgd water right claim should instead be left in the river for the benefit of fish over the term of the HCP, the also is committing to seek a means to dedicate a large portion (one-third, or 100 mgd) of its water right claim to fish, or 150 mgd if and to manage its water supply to more closely mimic natural patterns of river flows in response to new understanding should allow considerable flexibility to provide additional benefits for the riverine ecosystem and the individual species in the future (Section 4.4.2). It is also the City's intent to reserve an additional one-sixth or 50 mgd of its water right claim (on an annual average basis), subject to the additional condition that the City resolves some outstanding issues with the Muckleshoot Indian Tribe.

The Ballard Locks is a bottleneck for all anadromous fish entering and leaving the Lake Washington Basin because the Lake Washington Ship Canal is the sole access route to the basin. Mortality and injury of smolts leaving the lake occurs at the Locks. The instream flow component of the HCP includes funding by the City for improvements at the Ballard Locks that will be designed to increase survival of smolts of all four anadromous salmonids (Section 4.4.2). In addition, the City will commit as additional mitigation approximately $3.3 million for habitat protection and restoration downstream of the Landsburg Diversion Dam and in the Walsh Lake system for the benefit of anadromous fish species.

All four species of anadromous fish will also benefit by the Mitigation Strategies for the Anadromous Fish Barrier at Landsburg (Section 4.3). A major feature of this strategy includes construction of upstream and downstream fish passage and protection facilities at the Landsburg Diversion Dam and the City's water supply line crossing the Cedar

River near the dam. The passage facilities will allow passage of chinook, coho, and steelhead into about 17 miles of mainstem and tributary "refuge" habitat within the highly protected municipal watershed for the first time in a century and will increase the total miles of mainstem habitat available by 55 percent. For the period prior to construction of fish passage facilities, the strategy also includes interim mitigation in the form of funding for much needed studies or, potentially, for emergency supplementation. Once fish passage is effected at Landsburg, the benefits of mitigation and conservation measures for the Aquatic and Riparian Ecosystem will also accrue to these species. In addition, the City will commit as additional mitigation more than $1.6 million for habitat protection and restoration downstream of the Landsburg Diversion Dam and in the Walsh Lake system for the benefit of anadromous fish species (this $1.6 million adds to the $3.3 million described above to total approximately $5 million).

In addition, the current closure of the municipal watershed to unsupervised public access will protect all species that are now or will be within the municipal watershed from many sources of human disturbance and mortality, including poaching. Because passing the mass-spawning sockeye salmon above the raw water intake at Landsburg would jeopardize the safety of the drinking water supply, alternative mitigation was developed for sockeye, as described below.

Additional Mitigation and Conservation Measures for Species Dependent on the Aquatic and Riparian Ecosystem

Measures Benefiting Bull Trout

Several measures are of particular importance to bull trout: (1) the commitment not to harvest timber for commercial purposes, (2) the designation of all forest outside developed areas in reserve status, (3) commitments to restoration of stream and riparian habitats, (4) replacement of stream crossing structures that block fish passage, and (5) removal (deconstruction) of about 38 percent of watershed roads. Through these commitments, all known or potential spawning and rearing areas will be protected, access to these areas will be improved, and some areas will be rehabilitated. The restriction of public access into the watershed will also protect the bull population from the impacts of possible poaching, which has adversely affected populations in other areas.

Integral to the bull trout conservation strategy is a comprehensive program of monitoring and research (sections 4.5.4 and 4.5.6). Elements within this program are designed to provide a better understanding of the life history, habitat needs, and population status of the Chester Morse Lake bull trout, to assess the success of habitat restoration projects, to determine the impacts of reservoir management on reproductive success, to mitigate for potential adverse impacts on the bull trout population from reservoir management, and to provide information needed for adaptive management.

Funding for the conservation and mitigation measures for the bull trout is covered under other mitigation and conservation strategies. Funding for monitoring related to the bull trout is covered in sections 4.5.4 and 4.5.6.

The monitoring and research program outlined in sections 4.5.4 and 4.5.6 will be used to determine if the conservation strategy for bull trout achieves its conservation objectives. The monitoring and research program will also be used to support the adaptive management program (Section 4.5.7), which is designed to provide a means by which mitigation strategies can be altered to better meet conservation objectives. Elements of the monitoring and research program important for all species dependent on the Aquatic and Riparian Ecosystem, including bull trout, include the long-term stream monitoring program, designed to evaluate trends in aquatic habitat and water quality, and the monitoring of individual stream and riparian restoration projects. Additional monitoring and research pertinent to bull trout include:

- Population monitoring; spawning surveys;
- Juvenile and fry surveys; telemetry studies of adult movement;
- Stream distribution surveys; and
- A redd inundation study to determine the extent of the suspected egg and fry mortality as a result of spring reservoir refill.

As part of the evaluation of the Cedar Permanent Dead Storage Project (contained in Section 4.5.6), additional studies will focus on:

- The potential project impacts of reservoir elevation changes on the fall spawning migration of bull trout;
- Development of a passage assistance plan for bull trout in the fall should passage be impeded by increased reservoir drawdown in the summer and fall;
- Studies of pygmy whitefish life history (pygmy whitefish are a major prey species for adult bull trout in the reservoir); and
- Monitoring of wetland plant communities in the Cedar and Rex river deltas.

Measures Benefiting Pygmy Whitefish

Several measures are of particular importance to pygmy whitefish: (1) the commitment not to harvest timber for commercial purposes, (2) the designation of all forest outside developed areas in reserve status, (3) commitments to restoration of stream and riparian habitats, (4) replacement of stream crossing structures that could block fish passage, and (5) removal (deconstruction) of about 38 percent of watershed roads. Through these commitments, all known or potential spawning and rearing areas will be protected, access to these areas will be improved, and some areas will be rehabilitated. The restriction of public access into the watershed will also protect the pygmy whitefish population from the impacts of possible unregulated introductions of non-native fishes, which have adversely affected populations in other areas.

Integral to the pygmy whitefish conservation strategy is a program of monitoring and research (section 4.5.4 and 4.5.6). Elements within this program are designed to provide a better understanding of the life history and habitat needs of the Chester Morse Lake pygmy whitefish population, to assess the success of habitat restoration projects, to determine the impacts of reservoir management on reproductive success, to mitigate for potential adverse impacts on the pygmy whitefish population from reservoir management, and to provide information needed for adaptive management.

Funding for the conservation and mitigation measures for the pygmy whitefish is covered under other mitigation and conservation strategies. Funding for monitoring related to the pygmy whitefish is covered in sections 4.5.4 and 4.5.6.

The monitoring and research program outlined in sections 4.5.4 and 4.5.6 will be used to determine if the conservation strategy for pygmy whitefish achieves its conservation objectives. The monitoring and research program will also be used to support the adaptive management program (Section 4.5.7), which is designed to provide a means with which mitigation strategies can be altered to better meet conservation objectives. Elements of the monitoring and research program important for all species dependent on the Aquatic and Riparian Ecosystem, including pygmy whitefish, are as described above for bull trout. As part of the evaluation of the Cedar Permanent Dead Storage Project (Section 4.5.6), additional studies will focus on the life history of pygmy whitefish, including distribution and reproductive strategies; potential impacts of lowered reservoir levels on pygmy whitefish; and monitoring of wetland plant communities in the Cedar and Rex river deltas.

Measures Benefiting Chinook Salmon, Coho Salmon, and Steelhead Trout

The conservation strategies for chinook salmon, coho salmon, and steelhead trout are based primarily on the Mitigation Strategies for the Anadromous Fish Barrier at Landsburg (Section 4.3) and the Instream Flow Management Strategy (Section 4.4), but these species will also benefit by the mitigation and conservation measures for the Aquatic and Riparian Ecosystem. Of particular importance for these three species are the following:

- The construction of fish passage and protection facilities at the Landsburg Diversion Dam, which now blocks passage into the municipal watershed;
- Funding for interim mitigation before passage is effected—funding that may cover much needed studies or emergency supplementation;
- Instream flows to protect habitat for spawning adults and juveniles, and to protect redds from dewatering;
- Flow downramping standards to protect young fish from stranding;
- Funding for projects at the Ballard Locks designed to increase survival of outmigrating smolts; and
- Management to more closely mimic natural flow patterns important to the riverine ecosystem and its species.

Passage above the Landsburg Diversion Dam will provide access to about 17 miles of mainstem and tributary stream habitat that is highly protected and that could be considered refuge habitat, and will increase the miles of mainstem habitat by 55 percent.

Once these three species are passed above the Landsburg Diversion Dam, they will benefit by strategies for the Aquatic and Riparian Ecosystem as described above. Of particular importance are: (1) the commitment not to harvest timber for commercial purposes, (2) the designation of all forest outside developed areas in reserve status, (3) commitments to restoration of stream and riparian habitats, (4) replacement of stream crossing structures that block fish passage, and (5) removal (deconstruction) of about 38 percent of watershed roads. Coho will also receive additional benefit from the protection of wetlands in the Walsh Lake area, which is accessible through the Walsh Lake Diversion Ditch (Section 3.2.4), from the protection of the Rock Creek subbasin, and from the commitment to restoration measures in the Walsh Lake and Rock Creek subbasins (Section 4.4.2).

Funding for the conservation and mitigation measures for chinook, coho, and steelhead is covered under other mitigation and conservation strategies. Funding for monitoring related to these species is covered in sections 4.5.2 and 4.5.3.

The monitoring and research program outlined in sections 4.5.2 and 4.5.3 will be used to determine if the conservation strategies for these three species achieve their conservation objectives and to support the adaptive management program (Section 4.5.7), which is designed to provide a means with which mitigation strategies can be altered to better meet conservation objectives. Elements of the monitoring and research program important for all these include:

- Instream flow compliance;
- Downramping compliance;
- A study of the accretion inflow assumptions used to establish instream flows, which deals with inflows to the Cedar River from infiltration and tributaries;
- A study to improve flow-switching criteria, which deals with decisions to reduce flows under poorer hydrologic conditions;
- Fish ladder counts at Landsburg; and
- Evaluation and monitoring of the protective screens to be installed on the raw water intake at Landsburg.

In addition, steelhead will benefit by the continued redd incubation monitoring study (Section 4.5.2), in which redds are located and evaluated with respect to vulnerability to reduced flows. This monitoring study will be used to support decisions regarding instream flows in order to reduce impacts to steelhead eggs and fry during summer. Chinook will benefit by the commitment of $1 million for studies related to early life history and other issues in the Cedar River and Lake Washington (Section 4.5.2). All three species will benefit by the monitoring related to the Aquatic and Riparian Ecosystem, as described above for bull trout.

Measures Benefiting Sockeye Salmon

The conservation strategy for sockeye salmon is based primarily on the Mitigation Strategies for the Anadromous Fish Barrier at Landsburg (Section 4.3) and the Instream Flow Management Strategy (Section 4.4), but sockeye will also benefit by long-term improvements in water quality and restoration of natural ecological processes that should result from the strategy for the Aquatic and Riparian Ecosystem described above. Of particular importance for sockeye are the continued operation of the interim hatchery at Landsburg (Section 4.3.2); funding for habitat protection and restoration in the Cedar River below Landsburg (Section 4.4.2); and construction of a replacement hatchery for long-term artificial production of sockeye fry (Section 4.3.2). Because sockeye redds are vulnerable to scour at high river flows, the interim and replacement hatchery will effectively provide *incubation refuges* to help protect incubating eggs and alevins from damage during peak flow events and to increase egg-to-fry survival. The return of additional adult sockeye salmon through supplementation will increase the likelihood that natural spawning areas in the river are fully seeded, and the interim and replacement hatcheries should help reverse the decline of the sockeye population in Lake Washington and provide more opportunities for sport and Tribal fishers. Sockeye will also receive additional benefit from the commitment to restoration measures in the Walsh Lake subbasin (Section 4.4.2).

In response to concerns related to potential impacts of artificial production of sockeye fry on wild sockeye and other salmonids in the Lake Washington Basin, an extensive monitoring and research program will be conducted (sections 4.5.2 and 4.5.3) within an adaptive management paradigm (Section 4.5.7; Appendix 28). Monitoring, research, and adaptive management will be based upon the four primary objectives of the sockeye production program:

(1) The replacement hatchery should be designed to produce up to 34 million fry;

(2) The production program should be designed to produce fry equivalent in quality to those produced naturally;

(3) The program should avoid or minimize detrimental impacts on the reproductive fitness and genetic diversity of naturally reproducing sockeye salmon populations in the Cedar River and Bear Creek subbasins; and

(4) The program should avoid or minimize detrimental ecological impacts on native salmonids throughout the Lake Washington Basin.

Guidelines will be developed to govern the design, construction, operation, and monitoring phases of the sockeye fry production program. These guidelines will include procedures for developing and modifying annual production targets. If the monitoring indicates that the program is not meeting program objectives, the program can be altered. If the sockeye fry production program is discontinued, the City will commit remaining funds for sockeye to alternative mitigation as agreed by the parties to the Landsburg Mitigation Agreement (Appendix 28), including the City, the Services, and the WDFW.

Funding for the conservation and mitigation measures for sockeye is covered under other mitigation and conservation strategies. Funding for monitoring related to sockeye is covered in sections 4.5.2 and 4.5.3.

The monitoring and research program outlined in sections 4.5.2 and 4.5.3 will be used to determine if the conservation strategy for sockeye salmon achieves its conservation objectives, and to support the adaptive management program (sections 4.3.3 and 4.5.7; Appendix 28), which is designed to provide a means with which mitigation strategies can be altered to better meet conservation objectives. The monitoring related to instream flows described above for chinook, coho, and steelhead is also relevant to sockeye. Additional monitoring and research specific to sockeye includes:

- Marking and evaluation of condition of hatchery fry;
- Trapping and counting both hatchery and wild fry to provide a basis for estimating recruitment into Lake Washington and for evaluating relative survival;
- Fish health monitoring at hatchery;
- Studies of zooplankton in Lake Washington, which is the major food supply for young sockeye;

- Studies of adult sockeye designed to detect phenotypic and genetic changes; and
- Studies of adult sockeye to determined relative survival of hatchery-produced versus wild fish, and potential impacts of straying of hatchery fish into Bear Creek.

Measures Benefiting Bald Eagle

Eagles prefer structurally heterogeneous forest stands for nesting and roosting habitat (Grubb 1976, as cited in Brown 1985a). Snags and large trees are important to the eagle as perches and are an important feature of old-growth and riparian forests that will be protected within the watershed. While nest sites are usually located near water, bald eagle winter-roost site selection is thought to depend more on protective landforms and availability of coniferous forests than on proximity to water (Brown 1995a). Therefore, riparian protection and enhancement, protection of old-growth forest, and development of second-growth stands into mature and late-successional uneven-aged stands are all important conservation strategies for the bald eagle. Furthermore, eagles feed on fish that depend on high-quality stream and riparian habitat.

Of particular importance for the bald eagle are the designation of all forest to reserve status and silvicultural activities to accelerate the development of late-successional forest characteristics, both of which will result in maintenance and recruitment of a substantial amount of mature and late-successional forest in the future. Both the designation of forest to reserve status and the silvicultural activities will provide for the maintenance and recruitment of suitable nesting and perching trees. In its objective of improving fish habitat and restoring mature riparian forests, the strategy for the Aquatic and Riparian Ecosystem should also improve foraging conditions for bald eagles over time. Foraging opportunities should also be increased after fish passage is effected at the Landsburg Diversion Dam (Section 4.3). Finally, because disturbance during foraging can adversely affect bald eagles, the restriction of public access into the watershed will also provide distinct benefits for foraging and nesting eagles, should eagles eventually nest within the municipal watershed.

In order to protect eagles that may nest within the municipal watershed or groups of eagles that may use the watershed for foraging, the City will not cut trees or construct roads within 0.5 mile of a known active bald eagle nest site between the dates of January 1 and August 15 or within 0.25 mile of a known active bald eagle nest site at other times of the year, or within 0.25 mile of an active communal roosting site.

Funding for the conservation and mitigation measures for the bald eagle is covered under other mitigation and conservation strategies. The monitoring and research program outlined in sections 4.5.2, 4.5.3, and 4.5.4, and the program outlined in Section 4.5.5 will be used to determine if the conservation strategy for the bald eagle achieves its conservation objectives. The monitoring and research program will also be used to support the adaptive management program (Section 4.5.7), which is designed to provide a means with which mitigation strategies can be altered to better meet conservation objectives. The monitoring and research program described above for anadromous fish (sections 4.5.2 and 4.5.3) will have direct relevance for bald eagles, which feed on these species. Forest habitat monitoring described above for the northern spotted will also be relevant as a means to track changes in habitat that could be used for perching and roosting and, potentially, for nesting. In addition, the aquatic monitoring program described in Section 4.5.4 will provide information on trends in the overall quality of stream habitats in the municipal watershed.

Measures Benefiting Common Loon

The incremental effects of changed reservoir management to support the instream flow regime in the HCP (Section 4.4) are reviewed in Section 4.5.6. As indicated in that review, these effects are expected to be very minor with regard to loons and several of the fish species on which they may feed. However, there are still concerns and uncertainties with regard to the effects of current operations on nesting loons. For example, recent changes in vegetation around the reservoir complex may have reduced nesting cover for loons, and thus may affect their choices of nest sites and their nesting success (Section 3.5.5).

Because common loons typically nest at or near the waterline or on emergent surfaces such as logs, relatively small water level changes can make their eggs and nests vulnerable to inundation, stranding, or disturbance from overhanging vegetation. Adverse effects of changed operations thus may occur as a result of manipulation of reservoir levels during the nesting stage, or from adverse effects on the reservoir fish population. As discussed in Section 3.5.5, loons are also sensitive to human disturbance during nest-site selection and nesting and when rearing chicks.

Through the Community-based Conservation Strategies described above, the riparian vegetation (above the normal high waterline) surrounding the reservoir complex – on which common loons nest within the municipal watershed – will be protected and restored over the long term, as will wetlands and riparian areas associated with other water bodies in the watershed. Recovery and maturation of the forest above the normal high water line around the reservoir complex and along tributaries to the reservoir are expected to provide additional nesting surfaces in the form of large logs in the reservoir as this material is routed through some stream channels. As mentioned above, however, the changes in coniferous and deciduous vegetation in the zone of inundation around the reservoir have occurred recently and may continue for some time, which may delay recovery of parts of the riparian vegetation around the reservoir.

The City's policies of controlling access to the municipal watershed will continue to provide a substantial level of protection for nesting loons against human disturbance. Although some use of boats on the reservoir complex will be needed for fisheries research, for water quality sampling, and for watershed protection, the City's policy of carefully controlling the use of boats on the reservoir complex, especially during the loon's nesting and rearing season (April through August), will minimize disturbance and provide added protection for loons during the sensitive reproductive period.

In addition, the City intends to continue the experimental nest platform project for loons described above, although the City may discontinue or change this program as appropriate, depending on the results of monitoring. One or more nest platforms are typically deployed annually within each of the territories of the three current nesting pairs on the reservoir complex, but deployment may not be needed or appropriate in some years or for particular territories within a given year. For example, if reservoir elevations are very low, platforms would have to be deployed in open water, away from cover, which could result in detrimental effects on reproductive success if the platforms were used by loons. Under such suboptimal conditions, vulnerability of nests to predation and exposure would be increased. The City will consult with the Services prior to terminating the platform project.

Funding for the conservation and mitigation measures for the common loon is covered under other mitigation and conservation strategies. Funding for monitoring related to the common loon is covered in section 4.5.4 and 4.5.5.

The monitoring and research program outlined in Section 4.5.5 will be used to determine if the conservation strategy for the common loon achieves its conservation objectives, and to provide information necessary for adaptive management, and to support the adaptive management program (Section 4.5.7), which is designed to provide a means with which mitigation strategies can be altered to better meet conservation objectives. Elements of the monitoring and research program important for all species dependent on the Aquatic and Riparian Ecosystem, including the common loon, are as described above for bull trout. Additional monitoring and research pertinent to common loons includes: (1) annual surveys in Chester Morse Lake and Masonry Pool to document the reproductive status of common loons using the reservoir system, including the use of nesting platforms; and (2) studies of new reservoir operating regimes to evaluate potential impacts to common loon nesting habitat and food resources resulting from fluctuating lake levels.

Strategies for Species Dependent Primarily on Special Habitats

Strategies are provided for three species dependent primarily on Special Habitats: the gray wolf, grizzly bear, and peregrine falcon. All three of these species also depend, to some extent, on Late-successional and Old-growth Forest Communities and the Aquatic and Riparian Ecosystem within the municipal watershed.

Summary of Status for Species Dependent Primarily on Special Habitats

Status of Gray Wolf

In 1967, a subspecies of gray wolf, the timber wolf (*Canis lupus lycaon*), was listed as endangered (Fed. Reg. Vol. 32, Pg. 4001). In 1973, the northern Rocky Mountain subspecies (*C. l. irremotus*), as then understood, was also listed as endangered, as was the Texas subspecies (*C. l. monstrabilis*) (Fed. Reg. Vol. 38, Pg. 14678). In 1978, the legal status of the gray wolf in North America was clarified by listing the Minnesota wolf population as threatened and other members of the species south of Canada were listed as endangered, without referring to subspecies (Fed. Reg. 43, Pg. 9607). The gray wolf is listed as endangered by Washington State (WAC 232-12-014). The gray wolf is now under consideration for delisting under ESA.

There have been two confirmed sightings of wolf family groups in Washington in the past 10 years, in Ross Lake National Recreation Area of the North Cascades National Park Complex and in Okanogan County. Three other reported sightings appear to be reliable but are unconfirmed (Almack, J., WDFW, November 18, 1997, personal communication).

Gray wolves use a variety of habitat types including open areas, forests, and brush lands, and in British Columbia they have been observed in high areas above timberline and in forests along the coast (Cowan and Guiguet 1965). Wolves in British Columbia feed mainly on large ungulates such as deer, but also prey on smaller mammals and birds. Like all species in the family Canidae, wolves use dens for reproduction.

No gray wolf sightings in the municipal watershed have been verified, and gray wolves are not known to inhabit the municipal watershed currently. The watershed is within the potential range of the gray wolf, however, and contains elements of suitable habitat, including a substantial ungulate prey base and an environment relatively secure from most human intrusion and disturbance.

Status of Grizzly Bear

The grizzly bear (*Ursus arctos*) is listed as a federal threatened species in the lower 48 States (Fed. Reg. Vol. 40, No.145, Part IV, Pp. 3173-3174), and it is listed by Washington State as endangered (WAC 232-12-014).

The grizzly bear is a wide-ranging species that typically uses many vegetation types to fulfill its life requisites. Areas with low human activity are considered to be more suitable for this species (IGBC 1994). Grizzly bears occurred historically throughout most of central and western North America (FWS 1982). In 1997, approximately 5-10 grizzly bears were believed to reside in the North Cascades (Almack, J., WDFW, November 18, 1997, personal communication), with most of the sightings occurring north of the Skykomish Ranger District of the Mt. Baker-Snoqualmie National Forest.

The Cedar River Watershed is within the potential range of the grizzly bear and contains elements of suitable habitat, including an environment that is relatively secure from human disturbance. However, no grizzly bears have been observed or are known to exist in the watershed.

Status of Peregrine Falcon

Because of population declines of American peregrine falcons (*Falco peregrinus anatum*), the USFWS, in 1970, listed this subspecies as endangered under the Endangered Species Conservation Act of 1969 (P.L. 91-135, 83 Stat. 275). American peregrine falcons were included in the list of threatened and endangered foreign species on June 2, 1970 (Fed. Reg. Vol. 35, Pg. 8495), and were included in the United States list of endangered and threatened species on October 13, 1970 (Fed. Reg. Vol. 35, Pg. 16047). The subspecies was subsequently listed under the ESA of 1973, as amended (16 U.S.C. 1531 et seq.). The peregrine falcon was also listed as an endangered species by Washington State (WAC 232-12-014). Because of significant recovery in large parts of its range, the peregrine falcon was formally delisted under ESA on August 25, 1999 (Fed. Reg., Vol. 64, No. 164, page 46541).

Peregrine falcons occur year-round in Washington as either nesting or migratory individuals. Of the three subspecies that occur in the state (Allen 1991), *F. p. anatum* is the only one known to nest in Washington (Peregrine Falcon Recovery Team 1982; Johnsgard 1990). The other two subspecies are migrants and winter visitors that would be unlikely to utilize the Cedar River Watershed, as they depend on large concentrations of waterfowl and shorebirds in that season.

No comprehensive studies of peregrine falcon numbers or distribution have been conducted within the Cedar River Watershed. No peregrine falcons have been observed or are known to inhabit the Cedar River Watershed. However, the municipal watershed is within its potential range, and it contains some suitable nesting habitat, including rock outcrops and cliffs. Nesting of a pair of peregrines was documented in 1998 on nearby Mt. Si, to the north of the municipal watershed.

Conservation Objectives for Species Dependent Primarily on Special Habitats

Objectives for Gray Wolf

The objectives of the gray wolf conservation strategy are to avoid, minimize, or mitigate for impacts of any incidental take of gray wolves, to provide a net benefit for the wolf, and to contribute to its recovery. These objectives will be pursued within the municipal watershed by protecting potential gray wolf breeding, denning, and foraging habitat.

Objectives for Grizzly Bear

The objectives of the grizzly bear conservation strategy are to avoid, minimize, or mitigate for impacts of any incidental take of grizzly bears, to provide a net benefit for the grizzly bear, and to contribute to its recovery. These objectives will be pursued within the municipal watershed by protecting potential grizzly bear denning and foraging habitat.

Objectives for Peregrine Falcon

The objectives of the peregrine falcon conservation strategy are to avoid, minimize, or mitigate for impacts of any incidental take of peregrine falcons, to provide a net benefit for the peregrine falcon, and to contribute to its recovery. These objectives will be pursued for the peregrine falcon within the municipal watershed by protecting their nesting, foraging, and roosting habitat within the watershed.

Common Elements of Species Conservation Strategies for Species Dependent Primarily on Special Habitats

All of the Community-based Conservation Strategies have potential benefits for the gray wolf, grizzly bear, and peregrine falcon, should any of these species occur in the municipal watershed. These three species all use Special Habitats (Table 4.2-3), and all three forage widely in various open habitat types that are protected by the reserve status of watershed forests. Efforts to protect and restore wetland areas, natural meadows, and persistent shrub communities should contribute foraging habitat. Protection of old-growth forest and recruitment of additional mature and late-successional forest may also provide benefits for gray wolves and grizzly bears, to the extent these species may use such areas for foraging and denning. Although no forest openings will be created by commercial timber harvest under the HCP, natural disturbances such as fires and windstorms can be expected to create forest openings used by ungulates and other wildlife species that are prey for the three species.

In addition, the current closure of the municipal watershed to unsupervised public access, including watershed roads, should be of particular importance for gray wolves and grizzly bears, which are both sensitive to human disturbance (e.g., see USDI 1993). While some forest roads are reported in the scientific literature to create adverse conditions for wolves and grizzlies, the major problem is illegal hunting and other human disturbance, both of which should be greatly curtailed by the locked gates on the watershed and surveillance by watershed inspectors (Section 2.3.10). The planned removal (deconstruction) of about 38 percent of forest roads and the commitment not to harvest timber for commercial purposes will also reduce the potential for disturbance related to roads.

Additional Mitigation and Conservation Measures for Species Dependent Primarily on Special Habitats

Measures Benefiting the Gray Wolf

Protection of rock outcrops, meadows, and persistent shrub communities (Special Habitats) through designation of all forests outside developed areas, including forest adjacent to Special Habitats, for reserve status, and protection and restoration of riparian areas will protect and provide foraging habitat for the wolf. Potential den sites may also be available, particularly in the protected rocky areas and areas of old-growth forest, which include large hollow trees and logs. All of these habitat types are protected through the HCP. An increase in the area of mature and late-successional forest cover within the municipal watershed may also benefit the wolf to the extent that late seral forests provide adequate foraging opportunities or denning sites.

The commitment not to harvest timber for commercial purposes, meaning there will also be no log haul for a commercial program, will greatly limit the amount of potential disturbance to the wolf and its habitat. Minimal human contact is believed to be the second most important factor for the recovery of wolves (USFWS 1984, as cited in WDNR 1997). Potential disturbance to wolves during reproduction should be low as a result of restrictions on public entry into the watershed. Restriction of access on watershed roads will reduce potential mortality or injury from motor vehicle collisions and reduce the ability of poachers and trespassers to harass or harm wolves.

To protect wolves during denning, the City will avoid silvicultural activities, road construction, blasting, and helicopter operations within 1 mile of active gray wolf dens from March 1 to July 31 and within 0.25 mile during the rest of the year. Disturbance will also be limited near any rendezvous sites that are located within the municipal watershed. If wolves are documented in the municipal watershed, the City will consult with the Services concerning the most effective and feasible measures to minimize and mitigate impacts of watershed operations, and the City will develop a plan for such measures.

Funding for the gray wolf conservation strategy is incorporated into the funding established for other mitigation and conservation strategies.

The monitoring and research program outlined in Section 4.5.5 will be used to determine if the conservation strategy for the gray wolf achieves its conservation objectives and to support the adaptive management program (Section 4.5.7), which is designed to provide a means with which mitigation strategies can be altered to better meet conservation objectives. Should wolves den within the watershed, wolf dens may be monitored, consistent with minimizing disturbance, in order to better understand the behavior of the animals so that strategies for future protection can be developed.

Measures Benefiting the Grizzly Bear

Protection of the grizzly bear will be accomplished by preserving and protecting non-forested habitats the bear uses such as wet meadows, ponds, and marshes. Denning habitat for the grizzly bear will be protected through the enhancement and protection of riparian areas and the logs and down wood associated with old-growth forests. The protection and absence of commercial harvest within the Northern Spotted Owl CHU, which provides habitat and connectivity to adjacent forest lands, will provide further benefits for the grizzly bear, should this species ever occur within the municipal watershed.

Potential disturbance to grizzly bears during reproduction should be low as a result of restrictions on public entry into the watershed. Restriction of access on watershed roads will reduce potential mortality or injury from motor vehicle collisions and reduce the ability of poachers and trespassers to harass or otherwise harm bears.

To protect grizzly bears during denning, the City will avoid harvest and road construction within 1 mile of active grizzly bear dens from October 1 to May 30 and within 0.25 mile during the rest of the year. If grizzly bears are documented in the municipal watershed, the City will consult with the Services concerning the most effective and feasible measures to minimize and mitigate impacts of watershed operations, and the City will develop a plan for such measures.

Funding for the grizzly bear conservation strategy is incorporated into the funding established for other mitigation and conservation strategies.

The monitoring and research program outlined in Section 4.5.5 will be used to determine if the conservation strategy for the grizzly bear achieves its conservation objectives, and to support the adaptive management program (Section 4.5.7), which is designed to provide a means with which mitigation strategies can be altered to better meet conservation objectives. Should grizzly bears den within the watershed, bear dens may be monitored, consistent with minimizing disturbance, in order to better understand the behavior of the animals so that strategies for future protection can be developed.

Measures Benefiting the Peregrine Falcon

Peregrine falcons will be protected primarily through the protection of open habitats by giving reserve status to all watershed forests outside developed areas, including forest adjacent to Special Habitats. All identified cliff habitat will be protected in this manner, thus protecting possible nesting habitat. Additionally, the forested reserve will protect wetlands, meadows, and riparian areas that could provide foraging opportunities for peregrine falcons in the municipal watershed.

To protect peregrine falcons during the nesting season, the City will avoid or minimize silvicultural activities or construct roads within 0.5 mile of a known active nest site between the dates of March 1 and July 31, or within 0.25 mile of a nest site at other times of the year.

Funding for the peregrine falcon conservation strategy is incorporated into the funding established for other mitigation and conservation strategies.

The monitoring and research program outlined in Section 4.5.5 will be used to determine if the conservation strategy for the peregrine falcon achieves its conservation objectives, and to support the adaptive management program (Section 4.5.7), which is designed to provide a means with which mitigation strategies can be altered to better meet conservation objectives. Should peregrines nest within the watershed, nests may be monitored, consistent with minimizing disturbance, in order to better understand the behavior of the animals so that strategies for future protection can be developed.

Biological Goals and Objectives for Other Species of Concern

Overall Objectives

Only seven species addressed in the HCP are currently listed under the federal ESA. All seven species were included in the group of 14 species of greatest concern, for which individual species conservation strategies are presented above. The 69 species addressed in the HCP that are not included in the group of 14 species of greatest concern are termed the *other species of concern* (Section 3.6).

Many of the general planning objectives for the HCP that are described in Section 2.4 apply to the other species of concern. The mitigation and conservation strategies for the 69 other species of concern are designed to avoid, minimize, or mitigate for the impacts of the equivalent of any taking during the term of the HCP. These strategies are also designed to provide a net benefit for the 69 species and contribute to their recovery, should any become listed under the ESA.

The mitigation and conservation strategies for the other species of concern are habitat-based and are primarily covered by the Community-based Conservation Strategies presented above, which are targeted at species dependent on Late-successional and Old-growth Forest Communities, the Aquatic and Riparian Ecosystem, and Special Habitats. The objectives of the Community-based Conservation Strategies relate to the *overall functioning* of the combination of all conservation and mitigation measures on a landscape level, as they can potentially affect the species addressed in this HCP.

Because of the commitment in the HCP not to harvest timber for commercial purposes, those species that depend primarily on the earliest seral forest habitats, such as the grass-forb-shrub stage of succession, will receive relatively less benefit from the HCP (see effects analyses in Section 4.6 for more complete discussion). These community-based strategies and related habitat-based objectives are described above. The biological goals and measurable objectives applicable to the 69 other species of concern are briefly described below.

Several of the other species of concern, all aquatic, now occur, or would be likely to occur if present in the Cedar River, primarily downstream of the Landsburg Diversion Dam. These species include the Pacific lamprey, river lamprey, and sea-run cutthroat trout. All of these species will be able to pass over the Landsburg Diversion Dam after the fish passage facilities are constructed (Section 4.3.2; Section 4.6.4) and will benefit by elements of the Community-based Conservation Strategies targeted at protection and restoration of aquatic and riparian habitats in the municipal watershed. They will also benefit by the downstream habitat protection and restoration that is part of the mitigation for instream flows and other elements of the Instream Flow Management strategy (Section 4.4.2) that will provide habitat, reduce the risk of stranding, and improve survival through the Ballard Locks. In short, these species will benefit by many of the conservation and mitigation measures included in the Species Conservation Strategies described above for the anadromous fish species that are included in the species of greatest concern, as well as in the Community-based Conservation Strategies.

Objectives for Habitat and Community Types

The primary objectives of the community-based conservation strategies are, over the term of the HCP, to protect or improve the quality and/or quantity of key habitats within the municipal watershed for all of the species addressed in the HCP (Table 4.2-3), and to preserve the biological communities that include those species. The specific biological objectives for the Community-based Conservation Strategies that are applicable to the 69 other species of concern are to:

- Contribute to sustaining populations of species dependent on *late-successional and old-growth forests* by:

  (1) Protecting all existing old growth in the municipal watershed;

  (2) Recruiting a significant amount of additional mature and late-successional forest over time from previously harvested second growth;

  (3) Improving forest structure and habitat quality through silviculture in areas of second-growth forest to accelerate development of characteristics similar to those of late-successional forests;

  (4) Restoring natural forest processes that create and maintain habitat for species dependent on late-successional and old-growth forests; and

  (5) Developing an overall spatial pattern of mature, late-successional, and old-growth forest in the municipal watershed that is capable of supporting the species addressed in the HCP and that provides landscape connectivity both within the watershed and with key areas outside the watershed in a manner that is an improvement over current conditions.

- Contribute to sustaining populations of species dependent on *aquatic and riparian habitats* by:

  (1) Protecting all aquatic habitats in the watershed;

  (2) Improving aquatic and riparian habitats and water quality through restoration projects;

  (3) Sustaining natural processes and functions that create and maintain habitats, and restoring to a more natural range of variation those processes that have been disturbed by past human activities; and

  (4) Providing landscape connectivity within stream systems and among significant wetlands and associated riparian areas.

- Contribute to sustaining populations of species dependent on *Special Habitats* in the municipal watershed by:

  (1) Protecting Special Habitats from degradation;

  (2) Protecting other habitats needed by species dependent on Special Habitats for such uses as foraging and dispersal; and

  (3) Providing landscape connectivity through increases in proportion of older seral forest in intervening areas.

- Maintain natural biological diversity of species and communities within the municipal watershed, recognizing the important functional linkages among the major ecosystems, biological communities, and habitats present.

Some additional general, but relevant, conservation objectives pertinent to the other species of concern were also described in Section 4.2.1. These objectives are less measurable, but nonetheless important. They include:

- Develop an integrated, landscape approach that addresses the spatial relationship of habitats within the watershed and with regard to nearby areas to improve the ability of the watershed, over time, to support the species addressed by the HCP;

- Develop strategies to restore and sustain the natural processes that create and maintain key habitats for species addressed by the HCP and that foster natural biological diversity of native species and their communities;

- Pursue land management approaches that, as practicable, help avoid catastrophic events such as forest fires that would jeopardize drinking water or habitats for species addressed by the HCP; and

- Develop a forest management program that would sustain the forest ecosystem as a whole in the municipal watershed to better support the species addressed by the HCP over time.

Monitoring and Research Program Related to Other Species of Concern

The Monitoring and Research program for the HCP includes many elements that pertain to measuring progress with respect to achieving the above objectives for other species of concern. Performance of the HCP related to the objectives for species dependent on late-successional and old-growth forests in the municipal watershed will be monitored by:

- An inventory of terrestrial habitats, which includes an assessment of the forest inventory data, augmentation of inventory data by additional sampling, ecological classification of old-growth forest to better characterize habitat quality, field verification of the database, and a long-term habitat inventory program that will allow changes in forest habitat attributes to be tracked.

- Monitoring of forest restoration projects, including projects to redevelop forest structure and diversity in second growth, to allow tracking the success of individual projects in achieving their objectives.

- Surveys for spotted owls and marbled murrelets.

- Funding for optional surveys and studies targeted at individual species or sensitive habitats. These surveys can be prioritized as most appropriate to provide new information or track changes in populations or key habitats.

- Monitoring to evaluate the effectiveness of habitat restoration projects in aquatic, riparian, and upland habitats.

- Use of the Geographical Information System for tracking and mapping habitat changes over time.

- Development of a predictive model of forest growth, succession, and habitat development, and a basic model of species and habitat relationships, in both cases to facilitate adaptive management of restoration and forest management activities.

Performance of the HCP related to the objectives for species dependent on the Aquatic and Riparian Ecosystem will be monitored by:

- Instream flow and downramping compliance monitoring for those species dependent on regulated streamflows, with additional monitoring targeted at chinook and steelhead.
- Long-term stream and riparian monitoring and research in the municipal watershed, which includes monitoring based upon an index of biological integrity, or an alternative approach, for streams and water quality indicators that will allow tracking of changes in the quality of stream environments.
- Monitoring of stream and riparian restoration projects in the municipal watershed, which will allow tracking the success of individual projects in achieving their objectives.
- Evaluation of the permanent use of dead storage in Chester Morse Lake (Permanent Cedar Dead Storage Project), including an evaluation of impacts on vegetation on the deltas of the Rex and Cedar rivers. This evaluation will provide useful information for future decisions related to this project and in subsequent monitoring if the project is implemented, which would require a plan amendment.

Performance of the HCP related to the objectives for species dependent on Special Habitats in the municipal watershed will be monitored by:

- Tracking of habitat changes described above that will provide information on Special Habitats, including upland grass-forb meadows, upland persistent shrub communities, and vegetated talus and felsenmeer slopes.
- Elements of the above monitoring programs that provide information on habitats *adjacent to* Special Habitats, such as forests, and on other habitats that are used by any of the species dependent on Special Habitats, such as aquatic habitats and forests.
- Compliance monitoring of HCP activities related to Special Habitats.

Importance of Adaptive Management for Other Species of Concern

Information that will be collected in the above monitoring programs, as well as information on species addressed in the HCP that will be collected by federal and state agencies, will be used in the adaptive management program of the HCP (Section 4.5.7). The adaptive management program provides flexibility to alter mitigation *adaptively* in response to new information or understanding, including any change in status of the species addressed in the HCP, in order to most effectively meet the conservation objectives of the HCP. This flexibility includes the ability to shift and reprioritize funds for mitigation and conservation measures (Section 5.3.2).

The adaptive management program also provides for response to *changed circumstances* related to environmental events that can be reasonably anticipated and that could either impact species and habitats addressed by the HCP or undermine the effectiveness of particular conservation and mitigation measures. Such events include forest fires, windstorms, floods, and droughts.

Rational for Watershed Management Mitigation and Conservation Strategies

Introduction

The Watershed Management Conservation and Mitigation Strategies described in the preceding parts of this section are intended to minimize and mitigate for the impacts of any take of species addressed in the HCP as a result of City activities covered by this HCP (Section 1.3; Appendix 1). The strategies do so by guiding and constraining watershed management activities to protect and rehabilitate key habitat in the municipal watershed for fish and wildlife species addressed in the HCP, and by providing additional measures for the conservation of the species of greatest concern. The plan is based on the assumption that *ecosystem management*, in a broad and practical sense, must be integrated with any human uses of natural resources that are occurring (Grumbine 1994). In the case of the Watershed Management Mitigation and Conservation Strategies, the resource uses are the withdrawal of water for human use and the generation of electricity through operation of a hydroelectric plant. The City intends that such resource use be *sustainable* over the long term.

Within this overall context, the rationale for the Watershed Management Mitigation and Conservation Strategies has four components:

(1) A conservative approach to landscape management;

(2) Incorporation of both community-based and species-specific conservation strategies;

(3) Measures to sustain and restore those natural processes that create and maintain habitats; and

(4) Biological targets that should foster biodiversity and produce a net benefit for species addressed in the HCP.

Conservative Approach to Landscape Management

As discussed in Section 3.3.4, scientists at the two watershed conservation biology workshops did not agree on one single approach to watershed forest management. Some favored applying a long-rotation timber harvest approach to the entire watershed, arguing that late-seral forest could be developed that would have most of the functional value of late-successional and old-growth forests. Others scientists felt that this approach is as yet too experimental and needed to be combined with a commitment to ecological reserves, particularly to protect aquatic and riparian habitats. There was also a difference of opinion as to whether tree retention at harvest or silvicultural intervention during stand development would be the best way to produce late-seral forest that could have the structural and biological attributes of late-successional and old-growth forests of high-quality (Carey and Curtis 1996). As described above, the Seattle City Council made a policy decision to take the most conservative, low-risk approach and eliminate timber harvest for commercial purposes within the municipal watershed.

This conservative landscape approach is projected to result in an increase by nearly a factor of five in the acreage of mature, late-successional, and old-growth forest in the municipal watershed over the 50-year term of the HCP. Water quality and aquatic habitats are also projected to improve over time.

Incorporation of both Community-based and Species-specific Strategies

Introduction

The Watershed Management Mitigation and Conservation Strategies combine a "coarse-filtered" approach that focuses on whole biological communities (Community-based Conservation Strategies) with a "fine-filtered" approach that provides additional measures for a few target species (Species Conservation Strategies for the 14 species of greatest concern) (Marcot et al. 1994).

Community-based Conservation Strategies

The plan is also based on the premise that protection of species, and the ecosystems on which they depend, can best be accomplished by focusing on entire biological communities through a combination of: (1) *preserving relatively undisturbed habitats*, (2) *protecting other key habitats*, (3) actively *intervening to rehabilitate and restore degraded habitats* that are important to overall landscape function, and (4) *providing landscape connectivity* (Franklin and Forman 1987; Frissell 1993; Franklin 1992).

Scientists are in broad agreement that *protection of relatively undisturbed "refuge" habitat* is key to any long-term strategies to protect species (Franklin 1990; Sedell et al. 1990; FEMAT 1993; Moyle and Yoshiyama 1994; Frissell and Bayles 1996). Key undisturbed, or relatively undisturbed, habitats in the watershed include existing old-growth forest, many wetlands and streams, and other Special Habitats (e.g. natural meadows and rock formations) needed by some species. All these habitats are protected by placing all watershed forests outside developed areas in reserve status. Inclusion of all second-growth forest in a watershed reserve will provide much better landscape distribution of later seral forest across the watershed in the future than exists now. Additional protection of key habitats is provided by the management guidelines for the watershed.

The HCP includes *active intervention to restore or rehabilitate streams and riparian forests* and *upland forests*, as well as commitments to improve and remove roads to reduce sediment loading to streams. These measures will collectively improve the quality of habitats over time and restore natural functionality of upland forests, riparian forests, and aquatic habitats.

Connectivity will be greatly improved for aquatic habitats by upgrading, replacement, or improvement of culverts that block fish passage (described above) and construction of the fish ladders and other passage facilities at Landsburg (Section 4.3). *Connectivity of riparian habitat will be improved* by the inclusion in reserve status of all riparian habitats and all other forest, interconnecting all these habitats both along the stream system and across the landscape. *Habitat connectivity will be greatly improved in upland habitats* for species dependent on mature, late-successional, and old-growth forest by the designation of all forest, including all old growth, as reserve, thereby recruiting over time a relatively large amount of mature and late-successional forest. Mature, late-successional, and old-growth forests, overall, will increase in acreage by a factor of nearly five over the term of the HCP, and the older forest will be much better distributed over the watershed than it is today. As second growth in the CHU matures, there will be better linkage with the federal late-successional reserves system in the Cascades.

Species-specific Conservation Strategies

Because the biology of the species addressed in the HCP differs among those species, and because the regional status of the species varies, the strategies for the 14 individual species also vary. Strategies for a number of species – the marbled murrelet, northern goshawk, northern spotted owl, bald eagle, common loon, gray wolf, grizzly bear, and peregrine falcon – include seasonal protection during sensitive periods, primarily breeding. For several species – the marbled murrelet, common loon, and bull trout – the strategies also include additional measures to protect habitat or provide other benefits beyond what is included in the Community-based Conservation Strategies. A significant monitoring and research effort is directed at bull trout, pygmy whitefish, and marbled murrelets, and monitoring directed at other species is included as well (see Section 4.5).

The Species Conservation Strategies for the four anadromous fish that are species of greatest concern are addressed in sections 4.3 and 4.4. Three of the four species will be allowed within the municipal watershed, for the first time in a century, when the fish ladders are constructed at Landsburg (Section 4.3). Emergency population supplementation may be used for any of these species, if needed, and a hatchery will be constructed to enhance the sockeye population (Section 4.3). A substantial commitment is made to monitoring and research for all four species. This monitoring and research will provide the basis for effective adaptive management and new, key information for fisheries managers that will contribute to better management of these stocks to sustain healthy, harvestable runs.

Sustaining and Restoring Natural Processes that Create and Maintain Habitats

The City believes it is appropriate to consider both *natural processes that create and maintain habitats* and *desired future conditions* in designing a landscape management plan (Franklin 1992; Oliver 1992; Grumbine 1994). There is emerging scientific agreement that habitats and communities, and the species that depend on them, can only be sustained over the long term if the natural processes that create and maintain those habitats and habitat elements are sustained or, if applied to disturbed systems, brought back within a relatively normal range of variation (Franklin 1992; Frissell and Bayles 1996).

The City's approach incorporates two elements:

(1) Short-term measures to *replace, by human intervention, key elements* of a natural system, such as adding large woody debris to stream and creating snags in forests, where such elements are lacking because natural ecological processes have been disturbed; and

(2) Long-term measures to *restore an ecological system's ability to provide key elements itself*, without human subsidy, through natural processes.

The desired future conditions are, in general, conditions characteristic of relatively undisturbed aquatic habitats and naturally maintained late-successional and old-growth forests. For streams used by salmonids, amphibians, and invertebrates, these conditions include riparian forests with large conifers to provide bank stability, shade, a source of nutrients for the stream community, and large woody debris so important to stream habitat quality, complexity, and function (discussed above). When riparian forests are completely removed during logging, this functionality is lost. While healthy streams need the sediment delivered by natural landslides and erosion, the intensified delivery rates from such anthropogenic sources as poorly constructed forest roads overload streams with sediment and degrade habitats. In older forests, complex forest structure, and associated biological diversity, is produced by such natural processes as disease, wind damage, and competition. These processes create the snags and logs, and the multiple canopy layers so important to many species, yet lacking in many intensively managed tree plantations.

In the *short term*, human intervention will be used to replace missing elements in aquatic and forest ecosystems (for example, placing logs in streams to recreate habitat complexity, revegetating banks to increase bank stability, topping or damaging trees to produce snags, and cutting trees to produce logs). In the short term, it is also important to *minimize impacts of further anthropogenic perturbations*. Avoidance, minimization, or mitigation of impacts is accomplished in this HCP by the commitment not to harvest timber for commercial purposes, by a variety of standards and guidelines for protecting habitats and species during watershed operations, and by improvements and substantial decommissioning (removal) of forest roads to reduce sediment loading to streams. The functional elements and protection provided by intervention in the short term will serve to *bridge the period of transition* to the time when the ecological systems have recovered and are self-sustaining.

In the *long term*, the goal is to have LWD recruited into a steam in normal amounts from a healthy, naturally functioning riparian forest, and snags and logs recruited into older forest by natural processes of tree mortality. To that end, silviculture will be used to accelerate development of the kind of forest structure and composition in watershed forests that generates those critical processes in riparian and upland areas, with patterns of growth, competition, and mortality typical of high quality, naturally regenerated stands.

The commitment not to harvest timber for commercial purposes, normal forest growth and maturation, and the commitments regarding silvicultural intervention will combine with natural processes such as windthrow, disease, and fire to develop, over time, the structure and diversity of naturally regenerated, older forests. These processes will result in development of large live trees, a multi-layered forest, and a diversity of plants, and the recruitment of such biological legacies as large snags and logs. The resulting landscape in the watershed will be characterized by a proportion of mature, late-successional, and old-growth forest more characteristic of the region prior to European settlement (Henderson 1990, 1993; Bolsinger and Waddell 1993).

In short, the Watershed Management Mitigation and Conservation Strategies were designed to restore the natural processes of forest development, riparian function, sediment loading to streams, and peak stream flows to within a more normal envelope of variability. The intent of the landscape interventions is to accelerate, to the extent possible, the development of mature habitat conditions and functionality, and redevelopment of the natural processes that create and maintain key habitat elements.

Biological Targets that Foster Biodiversity and Produce a Net Benefit

The HCP incorporates a number of general, and some specific, biological targets (desired conditions and outcomes) that will contribute to maintaining natural biological diversity and supporting the species addressed in the HCP. These include:

- Conditions characteristic of relatively undisturbed aquatic habitats, and naturally maintained late-successional and old-growth forests;
- Measures to provide for habitat patterns and connectivity across the watershed landscape that will support the full natural diversity of communities and species;
- Rates of disturbance (e.g., sediment production, forest removal, peak storm flows) that are within or close to within natural bounds of variation;
- A proportion of late seral forest more typical of landscapes prior to logging;
- Maintenance of the full range of habitats needed to support the species addressed in the HCP; and
- Measures that produce a net benefit for the species addressed in the HCP and that will contribute to their recovery, thus improving habitat conditions overall.

4.2.3 Monitoring and Research

The City will commit to a program of monitoring and research to accomplish the following:

- Determine whether HCP programs and elements are implemented as written (compliance monitoring);
- Track the results of efforts to protect and restore habitats for species of concern (effectiveness monitoring);
- Obtain more information on species of concern, to test critical assumptions in the plan and reduce uncertainty; and
- Gain understanding needed to refine management decisions to better meet plan objectives.

The program is described in detail in Section 4.5, Monitoring and Research.

Monitoring and research elements include short and long-term programs, cooperative research, habitat and species inventories, data management, and modeling. Each element will be developed after gathering information from agency biologists and other experts. Periodic reports detailing all activities and data will be submitted to the appropriate oversight subcommittee as detailed in Section 4.5, Monitoring and Research. Elements of the monitoring and research program directly related to the Watershed Management Mitigation and Conservation Strategies include:

- Experimental 2-year watershed stream monitoring and research program;
- Long-term watershed stream monitoring and research program;
- Aquatic habitat restoration monitoring;
- Species monitoring and research for several fish species;
- Terrestrial habitat inventories;
- Habitat restoration research and monitoring;
- Terrestrial species monitoring and research for several avian species;
- Optional species survey(s) in experimental and sensitive habitats;
- Data formats and geographic information system (GIS) compatibility;
- Forest growth/habitat development modeling program;
- Habitat/species relationship basic modeling program; and
- Studies related to the Cedar Permanent Dead Storage Project.

4.2.4 Summary of Effects of Watershed Management Mitigation and Conservation Strategies

Introduction

The objectives and the potential effects of the various watershed management mitigation and conservation measures were discussed in detail in preceding sections in conjunction with the discussion of the measures themselves. Monitoring to determine the effectiveness of the measures in meeting the stated conservation objectives is described briefly in Section 4.2.2 above and in detail in Section 4.5 below, along with additional studies and research to provide important information. This section (4.2.4) gives an overall summary of the effects of the Watershed Management Mitigation and Conservation Strategies, taken as a whole, on the species addressed in the HCP. The funding commitments for the measures included in Section 4.2 are summarized in Table 4.2-10, at the end of this section. Details of funding and costs are given above. Note that this section provides primarily a landscape-level discussion of the ecological effects of the Watershed Management Mitigation and Conservation Strategies; Section 4.6 provides an in-depth evaluation of the effects of the HCP on all species addressed in the HCP from the standpoint of potential take.

The watershed mitigation and conservation measures collectively entail:

- Changes in operations and activities within the municipal watershed that will alter the nature and intensity of ongoing impacts in the future;
- Impacts of past activities;
- Increase protection of habitats that should result in recovery from conditions of prior disturbance;

- Employ direct intervention to improve, rehabilitate, or restore habitats affected by past activities; and
- Provide additional protection specifically targeted at the species of greatest concern.

The major types of City land management operations in the municipal watershed that could adversely affect the species addressed in the HCP are related to silviculture (restoration thinning and ecological thinning), use and management of forest roads, and related activities. The potential impacts from these kinds of activities are discussed in detail above in the context of both regional practices and practices within the municipal watershed. Research in the Pacific Northwest has identified a number of general impacts from activities related to timber harvest and forest roads (Sidle et al. 1985; Franklin 1992; Curtis 1993). These types of potential impacts generally include:

- Impacts to water quality and aquatic habitat caused by increased delivery of sediment from slope failures or accelerated erosion associated with forest roads or clearcuts;
- Degradation of riparian and aquatic habitats associated with removal of riparian vegetation, and anthropogenic sediment and debris loading in streams;
- Forest fragmentation and loss of older seral forest habitat through clearcutting;
- Impacts to soils and vegetation from timber harvest activities; and
- Cumulative effects of timber harvest and forest roads on streams through increased peak runoff.

In addition to measures to avoid, minimize, or mitigate these kinds of impacts, the HCP includes measures to improve aquatic, riparian, and forest habitats through direct intervention. The City believes that these measures will, on the whole, produce significant improvements in habitat over time. However, the City acknowledges that current approaches and techniques for habitat improvement, rehabilitation, and restoration are experimental in nature. To respond to this uncertainty, the City will:

(1) Apply these measures conservatively;

(2) Monitor experimental projects for effectiveness and adequacy, and monitor overall trends in habitat quality (Section 4.5); and

(3) Operate under a paradigm of adaptive management, with provisions to abandon or alter restoration techniques that are unsuccessful or ineffective in favor of other forms of mitigation (section 4.5.7, 5.3, and 5.5).

This summary of effects includes a discussion of effects organized by (1) the ecosystems, communities, and habitats addressed, (2) the Species Conservation Strategies for the 14 species of greatest concern, and (3) a set of five overall objectives and four benchmarks for the measures to avoid, minimize, and mitigate impacts of potential take on the species addressed in the HCP.

Effects of Conservation and Mitigation Strategies

Expected Effects of Community-based Measures for Late-successional and Old-growth Forest Communities

The forest habitat projections presented below were modeled using the Forest Projection System (Section 3.3.7). Table 4.2-5 and Figure 4.2-6 show the expected change in forest seral stages within the municipal watershed over the term of the HCP, and Table 4.2-6 and Figure 4.2-7 show expected change in forest age classes. Table 4.2-7 gives the distribution of forest seral stages by 1,000-ft elevation zones for the same years.

Table 4.2-5. Acres and percent of the forested land in different seral stages within the watershed as existed in 1997 and as projected to occur in 2020 and 2050 under the HCP.

Forest Seral Stage (age)	1997	2020	2050
Early (0-29)	15,610 (18.3%)	1,165 (1.4%)	0 (0.0%)
Mid (30-79)	54,591 (63.9%)	34,008 (39.8%)	12,332 (14.4%)
Mature (80-119 years)	1,074 (1.3%)	35,819 (41.9%)	34,931 (40.9%)
Late-successional (120-189 years)	91 (0.1%)	190 (0.2%)	23,919 (28.0%)
Old-growth (190 – 850 years)	13,889 (16.2%)	13,889 (16.2%)	13,889 (16.2%)
No age or not modeled	222	406	406
Total	85,477	85,477	85,477

Figure 4.2-6. Forest seral stages in the municipal watershed, by acres, as existed in the year 1997 and as projected for years 2020 and 2050 under the HCP.

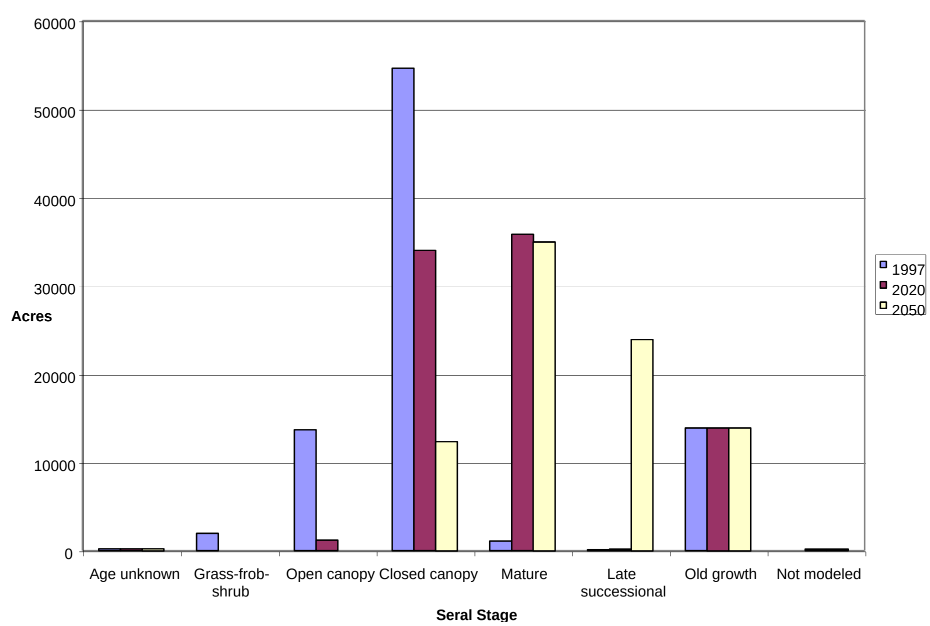


Table 4.2-6. Stand age distribution in the municipal watershed, by acres, as existed in 1997 and as projected to occur in 2020 and 2050 under the HCP.

		Projected	
Stand Age	**1997**	**2020**	**2050**
Age unknown	222	222	222
0-9	1,937	0	0
10-19	6,035	0	0
20-29	7,638	1,165	0
30-39	7,605	5,352	0
40-49	10,767	5,815	0
50-59	6,470	8,814	1,164
60-69	17,878	8,369	5,352
70-79	11,871	5,658	5,815
80-89	950	12,091	8,814
90-99	112	15,613	8,370
100-119	12	8,115	17,747
120-189	91	190	23,919
> 189	13,889	13,889	13,889
Not modeled	0	184	184
Total	85,477	85,477	85,477

Figure 4.2-7. Stand age distribution in the municipal watershed, by acres, as existed in year 1997 and as projected for years 2020 and 2050 under the HCP.

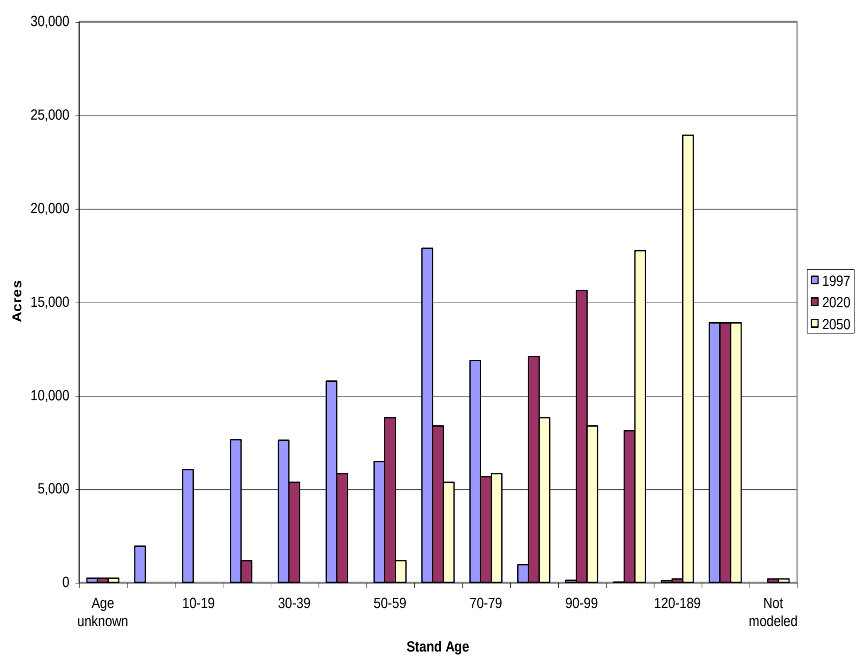


Table 4.2-7. Stand age distribution, by acres and by elevation zone, in the municipal watershed for year 1997 and projected for years 2020 and 2050 under the HCP.

			Projected	
Elevation (ft)	**Seral Stage**	**1997**	**2020**	**2050**
0-999	Early Seral: Grass-forb-shrub (0-9)	7	0	0
	Early Seral: Open canopy (10-29)	541	0	0
	Mid-seral: Closed canopy (30-79)	8,982	979	495
	Mature (80-119)	437	8,882	2,180
	Late-successional (120-189)	91	190	7,376
	Old-growth (190-850)	0	0	0
	Age unknown	0	0	0
	Not modeled	0	7	7
0-999 Total		**10,058**	**10,058**	**10,058**
1000-1999	Early Seral: Grass-forb-shrub (0-9)	793	0	0
	Early Seral: Open canopy (10-29)	221	749	0
	Mid-seral: Closed canopy (30-79)	18,118	1,730	919
	Mature (80-119)	456	17,064	7,164
	Late-successional (120-189)	0	0	11,460
	Old-growth (190-850)	150	150	150
	Age unknown	21	21	21
	Not modeled	0	45	45
1000-1999 Total		**19759**	**19759**	**19759**
2000-2999	Early Seral: Grass-forb-shrub (0-9)	516	0	0
	Early Seral: Open canopy (10-29)	3,322	299	0
	Mid-seral: Closed canopy (30-79)	18,555	12,553	2,743
	Mature (80-119)	181	9,708	14,764
	Late-successional (120-189)	0	0	5,053
	Old-growth (190-850)	2,415	2,415	2,415
	Age unknown	129	129	129
	Not modeled	0	14	14
2000-2999 Total		**25,118**	**25,118**	**25,118**
3000-3999	Early Seral: Grass-forb-shrub (0-9)	568	0	0
	Early Seral: Open canopy (10-29)	8,015	117	0
	Mid-seral: Closed canopy (30-79)	8,634	16,843	6,779
	Mature (80-119)	0	165	10,316
	Late-successional (120-189)	0	0	30
	Old-growth (190-850)	7,123	7,123	7,123
	Age unknown	47	47	47
	Not modeled	0	92	92
3000-3999 Total		**24387**	**24,387**	**24,387**
4000-4999	Early Seral: Grass-forb-shrub (0-9)	53	0	0
	Early Seral: Open canopy (10-29)	1,574	0	0
	Mid-seral: Closed canopy (30-79)	302	1,903	1,396
	Mature (80-119)	0	0	507
	Late-successional (120-189)	0	0	0
	Old-growth (190-850)	4,188	4,188	4,188
	Age unknown	25	25	25
	Not modeled	0	26	26
4000-4999 Total		**6,142**	**6,142**	**6,142**

5000+	Early Seral: grass-forb-shrub	0	0	0
	Old-growth (190-850)	13	13	13
	Age unknown	0	0	0
	Not modeled	0	0	0
5000+ Total		**13**	**13**	**13**
Grand Total		**85,477**	**85,477**	**85,477**

Barring a severe natural or anthropogenic disturbance such as a forest fire, all existing old-growth forest (13,889 acres) would be retained, and by the year 2050, a total of 72,739 acres (70 percent) of the known age forest would be between 80 and 850 years old, compared to about 15,054 acres (18 percent) of the forest in these older seral stages in 1997 (Table 4.2-5; Figure 4.2-6). This represents a nearly fivefold increase in older forest seral stages. All conifer forest within the watershed will be at least 50 years of age at year 2050. These changes should make a significant future contribution of habitat on a regional basis for species dependent on late-successional and old-growth forests, such as the northern spotted owl, marbled murrelet, northern goshawk, and forest bats (Table 4.2-3).

Protection of old growth and recruitment of mature forest in the CHU and the remainder of the watershed will establish a key link in the federal late-successional reserve system. The recruitment of older forest habitat under the HCP will serve to connect habitats for old-growth dependent species on either side of the I-90 corridor, make a valuable contribution to maintaining populations of those species in the long term, and generally increase the effectiveness of the federal late-successional and old-growth reserve system in an area of critical importance.

The inclusion in reserve status of forested lands that are currently in early seral stages will, as the forest matures, serve to make habitat types less fragmented and more contiguous, widen travel and dispersal corridors for most wildlife species, reduce edge effects, and more effectively connect forest elements within the watershed with similar key and sensitive habitats on lands in other ownerships adjacent to watershed boundaries.

As can be seen from Table 4.2-7, 50,562 acres (70 percent) of the 72,739 acres of the mature, late-successional, and old-growth forest in the year 2050 will be below 3,000 ft elevation, a thirteen-fold increase at this elevation from the acreage in 1997 (3,730 acres). Given both the current scarcity of older forest below 3,000 ft and the continued human development of forestlands in the Puget Sound region, these projected increases in older seral habitats below 3,000 ft elevation should make a significant future contribution of habitat for species dependent on late-successional and old-growth forests at lower elevations, such as the fisher.

This older forest habitat west of Cedar Falls will also provide an important link from the federal reserve system at higher elevations to the forests in Tiger Mountain State Park (managed by WDNR) to the northwest of the municipal watershed. The forest in the Rattlesnake Lake Recreational Area will similarly link to the Rattlesnake Ridge Natural Area (also managed by WDNR). The CHU and other forest land in the upper watershed will link to the federal late-successional reserve system and the Adaptive Management Areas managed by the USFS in the I-90 corridor, and hence to the nearby Alpine Lakes Wilderness.

Under a program of no timber harvest for commercial purposes, early forest seral stages (less than 30 years old) created by past commercial timber harvest will disappear through natural maturation by year 2027 under the HCP, but some early seral forest habitat likely will be created by natural events such as windstorms and fire. The expected pattern of forest seral stages likely would approach the pattern present before commercial timber harvest began in the watershed, and thus should be favorable for species dependent on late seral forests. This pattern of forest seral stages should greatly facilitate dispersal of forest species.

To the extent that any species addressed by the HCP use recently harvested areas for foraging, the elimination of early seral forest habitat created by commercial timber harvest will reduce the amount of such habitats compared to current, more extensively disturbed, conditions. However, future early seral forest habitats will be created by natural processes such as fires and windstorms, and thus provide a more natural pattern and quality of such habitats than what would be created by commercial timber harvest.

The projected combined total of 54 percent of the landscape in late-successional and old-growth forest (all at least 120 years old) in 2050, assuming no significant removal by fires, begins to compare reasonably to the average of 50 percent forest over 200 years old in landscapes in the Olympic and Mt. Baker-Snoqualmie national forests during the last millennium (Henderson 1990). However, Henderson (1993) reported an average rate of disturbance of 0.33 percent of forest per year from historic forest fires in the Mt. Baker-Snoqualmie National Forest, which would equate to about 282 acres per year in the municipal watershed.

Because of the episodic, rather than periodic, nature of forest fires in this region (Agee 1993), the above-mentioned average rate of disturbance is not useful in predicting the amount of early seral forest at any particular time, but it can be expected that some areas of early seral forest will be created during the term of the HCP by fire or windstorm, or possibly by disease or defoliating insects. The actual rate and magnitude of forest disturbances will be affected by regional climate change, chance events, changing environmental conditions, risk of fires caused by humans or lightning, and the City's policy of suppressing forest fires to prevent catastrophic damage and to protect water quality (described above).

Some penetration of light and wind at the edges of old-growth stands (edge effects) will occur, reducing the quality of interior habitat, and there is a risk of blowdown and edge creep (unraveling at forest edges exposed to winds from nearby cleared areas). However, both edge effects and edge creep should decrease over time as adjacent forest matures and both should become of minor concern. Removal of about 38 percent of forest roads will further serve to reduce forest fragmentation and reduce edge effects on interior forest habitats (see section above entitled "Measures Applicable Primarily to the Aquatic and Riparian Ecosystem Component").

Planned silvicultural interventions should also improve the quality of the developing forest for species dependent on late-successional and old-growth forests. Restoration and ecological thinning and restoration planting will be designed to accelerate development of characteristics of late-successional and old-growth forest, or to restore riparian function in streamside forests. As indicated in Table 4.2-8, the City expects to treat about 15,000 acres of forest in a manner that should improve forest structure and composition for species dependent on late-successional and old-growth forests. Thus, treatments will be applied over 20 percent of the total of more than 71,000 acres of second-growth forest in the watershed.

Table 4.2-8. Estimated acres expected to receive silvicultural treatments that should improve habitat conditions for species dependent on late-successional and old-growth forests.

Area of watershed	Restoration planting	Restoration thinning in young stands	Ecological thinning in older stands	Total
Upland Forest	1,000	10,480	2,000	13,500
Riparian Forest[1]	700	420	150	1,270
TOTAL	1,700	10,900	2,150	14,770

[1] Acreage breakdown only approximate for restoration and ecological thinning.

However, the City acknowledges that the restoration and rehabilitation measures and projects that will be employed in the upland, riparian, and aquatic habitats are experimental in nature. Consequently, the City will carefully monitor these projects and manage them within an adaptive management paradigm to improve their effectiveness over time (Section 4.5.7). Overall trends in habitat change will also be monitored, and techniques will be developed to better characterize habitat quality for both upland and aquatic habitats (Section 4.5).

Short-term, site-specific impacts from restoration and ecological thinning operations can be expected, but the long-term improvement in habitat development should more than offset those impacts, producing a net benefit to species addressed in the HCP (see Section 4.6). In addition, the City will develop and implement measures to avoid, minimize, or mitigate such short-term impacts.

Expected Effects of Effects of Community-based Measures for the Aquatic and Riparian Ecosystem

Virtually all elements of the Aquatic and Riparian Ecosystem are protected by the inclusion of all watershed forest in reserve status. The City expects that the combination described above of protection of habitats through reserve status, aquatic and riparian restoration activities over the term of the HCP, and management guidelines will result in significant improvement in water quality and the condition and quality of aquatic habitats (particularly stream habitats) and riparian habitats (particularly forested habitats near streams). All riparian forest and other forest near water bodies will be at least 50 years old at HCP year 50, and the majority of this forest will be much older.

In order to estimate how the relative amount of older forest age classes will change in “riparian” forest over the 50-year term of HCP, “riparian” zones of 300 ft (on Type I-III waters), 150 ft (on Type IV waters), and 100 ft (on Type V waters) were established using GIS data and acreage for forest age classes under current and future predicted conditions were calculated. Currently, only 16 percent of the 15,160 acres of forest within this riparian zone is over 80 years old (mature, late-successional, or old growth), while at the end of the HCP term (year 2050) 85 percent will be more than 80 years old, a near fivefold increase.

Additional measures included in the HCP to improve or help restore riparian and aquatic habitats include placement of large woody debris in streams, bank stabilization and revegetation, conifer underplanting to restore native conifers, and replacement of stream crossing structures that impede or block fish passage, which will restore access to currently inaccessible stream habitats.

Over the term of the HCP, the City expects that the Community-based Strategies described above will achieve the stated conservation objectives and will:

- Improve the quality of stream and riparian habitats substantially;
- Protect other aquatic habitats;
- Restore accessibility to stream habitats where now blocked or impeded;
- Improve surface water quality; and
- Provide improved connectivity among aquatic habitats over the watershed landscape.

Expected Effects of Community-based Measures on Special Habitats

The City expects that the measures described above will serve to protect and maintain the long-term viability of the special habitats in the municipal watershed, and improve connectivity among these habitats through creation of a forest reserve. As long as the regional populations of the species dependent on these habitats remain viable, the combination of these measures with other measures included in the Watershed Management Mitigation and Conservation Strategies should serve to maintain these species in the municipal watershed.

Intensity of Activity and Associated Mitigation

With a commitment not to harvest timber for commercial purposes, general watershed management, silvicultural interventions, and restoration and management of roads are the primary land management activities that could produce impacts on the species addressed in the HCP or their habitats. The City intends that the watershed management mitigation and conservation measures as a whole, including the various management guidelines specified, serve as mitigation for the watershed management activities described above. These mitigation and conservation measures include:

(1) The commitment not to harvest timber for commercial purposes;

(2) Restoration activities included for roads, forests, and streams–activities that will reduce anthropogenic impacts over time and produce long-term habitat improvements;

(3) Management guidelines designed to avoid, minimize, and mitigate impacts of those activities;

(4) Additional measures for the 14 species of greatest concern; and

(5) Additional measures to be developed in the early stages of the HCP, in consultation with the Services, to minimize and mitigate those activities.

Estimates of the totals and rates for *silvicultural activities* over the term of the HCP are summarized below.

- <u>Restoration thinning in young stands</u> (typically less than 30 years old):

  Upland forest: about 10,500 acres (average 700 acres/year over the first 15 years)

  Riparian forest: 420 acres (average 28 acres/year over the first 15 years)

- <u>Ecological thinning in older stands</u> (typically between 30 and 60 years old):

  Upland forest: 2,000 acres (average 40 acres/year)

  Riparian forest: 150 acres (average 3 acres/year)

- <u>Restoration planting</u>:

  Upland forest: 1,000 acres (average 20 acres/year)

  Riparian areas: about 700 acres (average 14 acres/year)

Estimates of the totals and rates for *road management activities* over the term of the HCP are summarized below.

- <u>Road maintenance</u> (required on all active roads each year, varying by year and including inspection, grading, cleaning ditches, cleaning culverts, brushing, and minor repairs)

  Approximately 520 miles/year in HCP year 1, diminishing as roads are removed to about 384 miles/year at HCP year 20 and beyond

- <u>Road construction</u>:

  Approximately 5 miles total over 50 years

- <u>Road improvements</u> (reengineering and major repairs):

  Approximately 4-10 miles/year, potentially more in some years

- <u>Road removal or deconstruction</u>:

  Approximately 38 percent of road system (236 miles) (average about 10 miles/year over first 20 years, with possibly more roads removed after HCP year 20)

- <u>Culvert upgrades for passage of peak flows at stream crossings</u>:

  Approximately 700 culverts, possibly more or fewer, depending on need

- <u>Road use</u> (watershed administration and management):

  Normal watershed management and administrative operations

  Facility construction, upgrades, or repair

  Occasionally, to support sale of logs from ecological thinning or salvage, or to move logs to restoration sites

Estimates of the totals or rates for *stream restoration* over the term of the HCP are summarized below.

- Bank stabilization (armoring):

  Approximately 7,500 ft of bank, possibly more or less, depending on need

- Bank revegetation:

  Approximately 10,000 ft of bank, possibly more or less, depending on need

- Large woody debris placement:

  Approximately 50 projects, possibly more or fewer, depending on need and cost

- Culvert upgrades for fish passage at stream crossings:

  Approximately 30-60 culverts, possibly more or fewer, depending on need.

Restoration thinning, ecological thinning can be expected to produce some short-term impacts to the forest and harvest site, but these activities will be mitigated by the following measures, developed in consultation with the Services, to minimize and mitigate site-specific impacts:

- Guidelines to protect soils and vegetation during these activities;
- Improvements in forest structure and diversity produced by these activities; and
- Additional measures to be developed early in the HCP.

As discussed above, hauling timber is the major use of forest roads that can result in sediment loading to streams. Elimination of timber harvest for commercial purposes under the HCP thus eliminates the major source of sediment production from road use. Forest roads will be used for watershed administration and management, for watershed surveillance and access, for research and monitoring, for habitat restoration activities, and for other uses, such as educational programs, scientific research, and facility construction.

Construction work related to roads can also produce short-term impacts, but these impacts will be minimized and mitigated through construction guidelines (Appendix 17). In the long run, sediment loading to water bodies will be substantially *reduced* by removal (deconstruction) of roads, road improvements, replacement or modification of stream crossing structures not properly designed to pass peak flood flows, improved road maintenance and repair standards, and programs designed to reduce surface erosion and road-related landslides that deliver sediment to streams. The result should be an improvement, over time, in both water quality and aquatic habitats.

Construction and operational activities related to mitigation for the blockage to anadromous fish at Landsburg are discussed in Section 4.3. Construction and operational activities related to management of instream flows within the municipal watershed are discussed in Section 4.4.

Summary of Expected Effects for Species of Concern

Habitat should be maintained or improved for all species addressed over the term of the HCP either through improvements in the amount, quality, or level of protection of habitat (e.g., for aquatic, riparian, and mature and late-successional forest habitats) *or* through the reestablishment of more natural patterns of habitat distribution. To the extent that any species uses recently harvested areas for foraging, the elimination of early seral forest habitat created by past commercial timber harvest will reduce the amount of such habitats compared to current, more extensively disturbed, conditions. However, future early seral forest habitats will be created by natural processes such and fires and windstorms, and thus provide a *more natural pattern and quality of such habitats* than what would be created by commercial timber harvest or what exists today.

The City expects that the Species Conservation Strategies described above for the 14 species of greatest concern will meet the stated conservation objectives, providing benefits and protections in addition to the benefits and protections associated with the Community-based Conservation Strategies. Habitat should be maintained or improved for all 14 species over the term of the HCP, and additional protection will be provided during sensitive periods of the life cycle of many of the species. Unless external factors intervene, the City expects that the population status of each of the species in the municipal watershed will be at least maintained, and, in most cases, improved under the Species Conservation Strategies described above.

The City also expects that the Community-based Conservation Strategies that apply to the 69 other species of concern will meet the conservation objectives described above for those species. Key habitat should be maintained or improved for all 69 species over the term of the HCP. Unless external factors intervene, the City expects that the population status of each of the species in the municipal watershed will be at least maintained, and in most cases improved, during the term of the HCP.

While several species that use early seral forest habitat are expected to experience a decrease in that habitat over the term of the HCP, the watershed landscape will, over time, approach a condition more similar to the natural pattern to which the species are adapted. Furthermore, the generally reduced level of human disturbance in the watershed under the HCP and the expected availability of clearcuts in areas adjacent to the municipal watershed should both serve to offset the effects of reduced early seral forest habitat within the municipal watershed. Finally, the 50-year commitment by the City to protect and restore the municipal watershed may be very important to many species in a region now experiencing and projected to experience high levels of population growth and development. This commitment may be especially important for species that occur primarily at elevations in the Puget Sound Region.

An evaluation of effects of the HCP to support a determination of allowable take and an ESA Section 7 determination of jeopardy by the Services is included in Section 4.6. This section includes more detailed discussion of effect by species or groups of species.

Evaluation of Effectiveness in Meeting Objectives

Along with the various specific conservation objectives presented in the preceding subsections of Section 4.2, the City has stated five overall objectives that can be directly related to a determination of the effects and effectiveness of the watershed management mitigation and conservation measures for species addressed in the HCP. These five objectives applicable to land management in the municipal watershed are to:

(1) Avoid, minimize, or mitigate the impacts of incidental taking of species listed under the ESA as threatened or endangered, to the maximum extent practicable, and the impacts of the equivalent of taking for unlisted species;

(2) Maintain, and restore to more natural ranges of variation, those natural processes that create and maintain habitats and important habitat elements in the municipal watershed;

(3) Provide habitat connectivity within the municipal watershed and with other significant areas of habitat in the region;

(4) Provide a net benefit to all the species and contribute to their recovery; and

(5) Manage the watershed in a manner that can sustain the forest ecosystem and the Aquatic and Riparian Ecosystem over the long term in a manner that can support native species and that fosters natural biodiversity.

The objectives related to anadromous fish are given in the Mitigation Strategies for the Anadromous Fish Barrier at Landsburg (Section 4.3) and the Instream Flow Management Strategy (Section 4.4). These two sets of mitigation and conservation strategies address the impacts of the water supply diversion and regulation of instream flows by the City, and the effects of the Landsburg Diversion Dam in blocking passage of anadromous fish. The Watershed Management Mitigation and Conservation Strategies complement these two sets of mitigation and conservation strategies, particularly for the three species (chinook and coho salmon, and steelhead trout) that will be passed over the Landsburg Diversion Dam when fish ladders and other fish passage and protection facilities are constructed (Section 4.3).

The evaluation of the Watershed Management Mitigation and Conservation Strategies with respect to meeting the objectives listed above are discussed below in the context of four types of *benchmarks*:

(1) Current habitat conditions;

(2) Current population status, largely as a function of current habitat capability;

(3) Current level of commitments for watershed land management; and

(4) Impacts of current and past operations and activities.

Based on the foregoing discussion of the expected effects of the combined mitigation and conservation measures, the City believes that the Watershed Management Mitigation and Conservation Strategies will meet the five overall objectives stated above, as well as the various conservation objectives presented in the preceding subsections of Section 4.2. The primary measures and effects of the HCP that contribute to that conclusion are summarized in Table 4.2-9 with respect to each of the five overall objectives. The following subsection briefly indicates the major criteria used for evaluating effectiveness in meeting each objective.

Predicted Effectiveness in Meeting Objectives

Objective: Avoid, Minimize, or Mitigate Impacts of Taking to Extent Practicable

In determining whether or not the Watershed Management Mitigation and Conservation Strategies can be expected to effectively avoid, minimize, or mitigate the impacts of the expected taking to the maximum extent practicable, the City considered the direction and magnitude of incremental impacts of changes in operations or facilities under the HCP, and the measures that would mitigate for those impacts. The following factors were considered to contribute to meeting this objective:

- Incremental impacts of operations or facilities that can be expected to be either small and effectively mitigated, if adverse, or positive in nature;
- Effectiveness of species-specific mitigation and conservation measures; and
- Additional programs that would create a benefit to counter any predicted negative impact.

Although road use and some tree-cutting will occur, the level of road use and tree-cutting will be relatively minor under the commitment not to harvest timber for commercial purposes, and these activities will be mitigated with the variety of measures described above. The City believes that it will achieve the standard of avoiding, minimizing, and mitigating the impacts of potential taking to the maximum extent practicable for four reasons: (1) the expected level of potential impacts of expected land management activities within the municipal watershed is relatively low; (2) conservative management guidelines designed to minimize and mitigate impacts will be implemented; (3) take of most species addressed in the HCP is expected to be very limited over the term of the HCP; (4) the HCP includes a substantial commitment to habitat restoration; and (5) the broad commitments to habitat protection, especially for forests, will lower the potential for take over large areas of the watershed.

With respect to the four benchmarks listed above:

(1) Habitat conditions for species addressed in the HCP will improve over time, even for species that use early seral forest habitats if the conclusion is made that a more natural pattern and quality of forest habitats, including early seral habitat produced by natural disturbances, will be more beneficial for those species than the quantity of such early seral habitat produced by timber harvest.

(2) Populations of nearly all species should be maintained or should increase, to the extent that habitat and conditions in the municipal watershed influence those populations and if external factors do not intervene. The only populations of species that might decrease as a result of the HCP are those populations for which the availability of early seral forest habitat in the watershed is limiting, which may not apply to any of the species addressed in the HCP.

(3) Commitments for watershed land management and restoration are legally binding under the HCP, and are thus stronger. Watershed management under the HCP is considerably more conservative than past commitments, particularly because the City is forgoing the opportunity to harvest timber for commercial purposes, and the commitment to watershed restoration is substantially greater than the present level of commitment.

(4) Compared to impacts of past levels of activity, impacts of ongoing operations and activities will be substantially reduced and/or mitigated by the measures included in the HCP, particularly because the City is eliminating harvest of timber for commercial purposes. Impacts of past activities that adversely affected habitats will be addressed by a substantial commitment to restoration and rehabilitation under the HCP.

Objective: Maintain and Restore Natural Processes

The Watershed Management Mitigation and Conservation Strategies include several programs and measures designed to sustain relatively undisturbed natural processes and to restore natural processes disrupted by past or current human activities to within more natural limits. These programs and measures include:

- Programs to reduce anthropogenic sediment loading to streams and other aquatic habitats by removal of a large part of the watershed road system, improved maintenance of roads, engineering improvements to roads and stream crossings, stabilization of streambanks, and minimization of impacts by elimination of timber harvest for commercial purposes;
- Projects to restore instream habitat functionality and complexity with placement of large woody debris, providing habitat complexity during the transition between current conditions and future conditions under which the riparian forests provide an adequate supply of large woody debris, on a sustained basis, without human intervention;
- Programs to accelerate restoration of the natural functions and complexity of riparian forest through protection and silvicultural intervention;
- Programs to accelerate the development of old-growth conditions in the previously harvested forest within the watershed through silvicultural intervention, with the ultimate objective of self-sustaining, natural recruitment of coarse woody debris and other features of late seral forests; and
- Development, over time, of a pattern of forest cover more similar to that which existed prior to commercial timber harvest in the watershed, with forest openings primarily created by natural processes.

Objective: Provide Local and Regional Habitat Connectivity

The Watershed Management Mitigation and Conservation Strategies include several measures and programs designed to restore disrupted connectivity among habitats within the watershed and with outside areas:

- For stream habitats:
    + Replacement, modification, or removal of structures that block or impede passage of fish at stream crossings, restoring within-watershed connectivity for stream systems; and
    + Construction of fish passage facilities at the Landsburg Diversion Dam (Section 4.3), improving regional connectivity in the Cedar River for all native species.

- For riparian habitats:

    + Establishment of a continuous riparian corridor within the watershed, which connects all streams and associated water bodies and wetlands.

- For wetlands:

    + Connectivity for dispersal among wetlands and other aquatic habitats through protection of all forest outside developed areas.

- For mature, late-successional, and old-growth forests:

    + Development, over the 50-year term of the HCP, of an overall landscape within the municipal watershed that will have about 50 times the acreage of mature and late-successional forest than exists today, and early seral forest created primarily by natural processes, providing substantially improved conditions for breeding, wintering, and dispersal within the watershed;

    + Improved linkages between high elevation forests near the Cascade Crest and low-elevation forests in the western portion of the municipal watershed; and

    + As the second-growth forest matures in the municipal watershed over time, improved linkages between the spotted owl CHU and other elements of the federal late-successional reserve system and between the watershed and other key forest habitat in the region.

- For Special Habitats:

    + Development of substantially more mature and late-successional forest between Special Habitats, facilitating dispersal among habitat patches.

Objective: Provide a Net Benefit to the Species and Contribute to Their Recovery

In determining whether the Watershed Management Mitigation and Conservation Strategies can be expected to provide a net benefit for species addressed in the HCP, and thus contribute to the recovery of any that are listed, the following factors were considered to contribute to a net benefit:

- Incremental impacts of changes in operations or facilities under the HCP that are expected to be either small and effectively mitigated, if adverse, or positive in nature;

- An increase in quantity of usable habitat for the species addressed;

- An increase in quality of habitat for the species addressed;

- Improved landscape connectivity among patches of similar habitat;

- An increased level of protection over prior levels; and

- Species-specific measures that provide any additional benefits to a species compared to current conditions.

As indicated in Table 4.2-9, the City believes that the Watershed Management Mitigation and Conservation Strategies should provide a net benefit to all species addressed in the HCP. However, discussion of benefits for a number of species is warranted.

Bull trout and pygmy whitefish are predicted to experience incremental impacts of changes in reservoir operations (with the new instream flow regime) that are negative. However, when compared to current operations, these impacts are expected to be extremely minor for bull trout and even less for pygmy whitefish (sections 4.5.6 and 4.6). Other programs, such as stream protection and restoration, will provide positive benefits for these species that should more than offset the minor negative effects of changed reservoir operation, particularly if rearing habitat is limiting rather than spawning habitat (see discussion of bull trout workshop in Section 3.3.4). Restoration activities begin in HCP year 1, and most road and streams restoration projects will be completed within the first decade of the HCP.

Because of recent changes in vegetation around the reservoir, impacts of recent reservoir operations on common loons are uncertain (sections 3.35 and 4.5.6). However, these impacts are not a consequence of changes in reservoir operations under the HCP's instream flow regime, which is not projected to differ measurably from the current regime with respect to impacts on loons (Section 4.5.6). Rather, these impacts are a consequence of changes in reservoir operations that began more than a decade ago, but for which effects on vegetation have lagged behind the changes in operations. However, the reproductive success of loons on the reservoir will be monitored to identify any problems and to develop solutions, if needed, through adaptive management (Section 4.5.7).

The Cedar Permanent Dead Storage Project would benefit anadromous fish but could have adverse impacts on bull trout, pygmy whitefish, and/or loons. However, construction of this project itself is not a Covered Activity under the HCP (Section 1.3), and implementation of the project will require a plan amendment. Before this project is implemented, impacts will be carefully evaluated over a period of 5 years, and mitigation will be developed (Section 4.5.6).

All anadromous species should receive a net benefit under the HCP immediately after implementation, because the proposed instream flow regime has significant benefits compared to the current regime. Not only are the instream flows superior in terms of providing habitat, but the risk of stranding will be reduced for all species by downramping constraints, better protection will be provided for redds, increased flows for outmigrating sockeye fry should increase fry survival compared to conditions under current flows, and the City will manage flows to more closely mimic those natural patterns that help sustain the riverine ecosystem (Section 4.4.2). Other measures will provide even greater benefits during the early part of the HCP, including construction of fish passage facilities at Landsburg, funding for improvements at the Ballard Locks to increase survival of smolts, and a contribution of about $5 million for habitat protection and restoration downstream of the Landsburg Diversion and in the Walsh Lake system (Section 4.4.2).

Habitat for the band-tailed pigeon may not improve, as the proportion of mixed coniferous and deciduous should not change much, and forest openings will decrease. Mineral springs, important to this species, will be protected if found, but none are known to exist in the municipal watershed currently. Nesting habitat for golden eagles will be protected. To the extent that this species uses recently harvested areas for foraging, foraging habitat will decrease over time, but the habitat should better represent more natural conditions than what exists today, in terms of both the acreage of forest openings and the quality of naturally open habitat.

Effects on species not known to be present in the watershed are speculative and would depend on their future presence in the municipal watershed as well as the habitats that they may use. The known naturally open-habitat types for grizzly bear, gray wolf, and wolverine will be protected, and habitat connectivity among habitat patches will be improved as the proportion of later seral forest increases over time. To the extent these species use only Special Habitats for foraging, the available habitat will not be increased in amount, but some should improve in quality as a result of the maturation and development of forest adjacent to them and better connectivity among them. If any of these species also use later seral forest, then habitat will be increased. In addition, dens of gray wolves and grizzly bears, if found, will be protected.

Objective: Manage for Sustainable Ecosystems

While the evaluation of the four overall objectives discussed above is relatively straightforward, the City acknowledges the difficulty of evaluating whether the proposed watershed management mitigation and conservation measures will result in *sustainable* forest, riparian, and aquatic ecosystems within the municipal watershed. Some potential future effects on the ecosystems, communities, and habitats − such as global climatic change (Franklin et al. 1991) or a drastic regional decline of many species that occur or could occur within the municipal watershed − are obviously outside the control of the City. Whether or not *any* approach to watershed management is sustainable may well depend on factors over which few in the region have any control. While acknowledging the difficulty of defining sustainability, as well as the difficulty of demonstrating its achievement or non-achievement over the term of the HCP, the City believes that sustainable management is an important goal that should be pursued.

One widely accepted requisite of sustainability is the maintenance of biological diversity and ecological integrity (Karr 1991; Covington and DeBano 1993). Studies have shown that biological diversity can buffer an ecosystem against extreme events (Tilman 1994), and Aldo Leopold has cautioned that the first step in intelligent tinkering is to keep all the "cogs and wheels" (Leopold 1949). Franklin et al. (1991) have argued that maintaining forest ecosystem diversity will require attention to not only reserves but also "commodity lands," and that whole landscapes must be managed in an integrated manner to maintain diversity and to provide for movement and dispersal of organisms.

Marcot et al. (1994) argue that sustainable ecosystem management entails maintenance or restoration of biodiversity, maintenance of long-term site productivity, and sustainable natural resource production, and that objectives must be defined and pursued at several scales of space and time. Amaranthus et al. (1989) conclude that maintaining site productivity entails avoidance of severe disturbances to timber harvest sites, such as extensive soil compaction, broadcast burning, and erosion; preservation of organic matter; protection of natural soil communities; and rapid recolonization with indigenous plants and soil organisms. Franklin et al. (1989) add that maintaining long-term productivity goes beyond site management and requires maintaining natural diversity across the landscape.

Carey and Curtis (1996) have argued that much of the “ecological functionality” of late-successional forests can be achieved through proper silviculture and long harvest rotations. On the other hand, Franklin (1990) has argued that such new approaches to forest management, because they are still experimental, do not preclude the need for reserved areas.

A wide variety of natural processes and disturbances both create and maintain habitat important for species in any ecosystem. Broad agreement is developing that degradation of ecosystems occurs when such natural process or disturbance regimes are altered by anthropogenic factors so that these processes and disturbance regimes move outside of normal limits of behavior (FEMAT 1993). For example, increased sediment loading into streams from the increased rates of landslides and erosion associated with forest roads and clearcuts has long been recognized to have adverse impacts to fish habitats (Bisson and Sedell 1984). Controlling anthropogenic influences can bring a process or disturbance regime back within a normal range of variation, and serve to restore biological diversity. Because most modern landscapes − including the municipal watershed − have been disturbed or degraded by past human activities, ecosystem restoration should have a place in any program that aspires to be sustainable (Primack 1993).

To respond to the goal of achieving sustainable management of the watershed ecosystems, the City developed Watershed Management Mitigation and Conservation Strategies that:

- Take the highly conservative approach of eliminating the harvest of timber for commercial purposes, placing all watershed forest outside developed areas in reserve status and resulting in an expected fifty-fold increase in the amount of mature and late-successional forest by HCP year 50;
- Preserve long-term *site productivity* by limiting most activities that disturb soils and vegetation to restoration activities and by implementing various protective measures to protect soils and vegetation;
- Include measures to both *protect* riparian and aquatic habitats with measures to *restore or rehabilitate* previously disturbed areas; and
- Allow *rates of forest disturbance to be governed largely by natural factors*, with the exception of City efforts to control the risks and adverse impacts of forest fires.

Absent major external factors that may have severe impacts on the watershed, the City believes the combination of measures described above has a high likelihood of resulting in sustainable aquatic, riparian, and forest ecosystems in the watershed.

Funding Commitments for Watershed Management Mitigation and Conservation Strategies

Funding commitments for Watershed Management Mitigation and Conservation Strategies are described in preceding subsections of Section 4.2 and are summarized in Table 4.2-10 below and in Table 5.3-2 in Chapter 5.

Table 4.2-9. Summary of effects of Watershed Management Mitigation and Conservation Strategies in terms of meeting five overall conservation objectives over the 50-year term of the HCP.

Species Group[1] / Objective[2]	Species dependent on: Riparian & Aquatic Ecosystem	Species dependent on: Late-successional & Old-growth Forest Communities	Species dependent on: Special Habitats
1. Avoid, minimize, & mitigate take to maximum extent practicable	• All wetlands, streams, lakes, & ponds protected in reserve • Delivery of sediment to streams from roads reduced substantially from historic levels • Elimination of delivery of sediment from timber harvest • Strict constraints on road construction & management • Protection of nest sites in the breeding season (or longer) for two species of greatest concern • Improved passage for all native fish within the watershed & at Landsburg (Section 4.3) • Instream flows that provide improved anadromous fish habitat & downramping flow restrictions to reduce stranding of young fish (Section 4.4) ***Take avoided, minimized, or mitigated to maximum extent practicable***	• Elimination of timber harvest for commercial purposes, resulting in a fifty-fold increase in mature & late-successional forest • All old growth & entire CHU protected • Silvicultural intervention to accelerate development of late-successional forest characteristics • Protection of nesting sites in the breeding season (or longer) for all three species of greatest concern ***Take avoided, minimized, or mitigated to maximum extent practicable***	• All Special Habitats protected within forested reserve • Guidelines to minimize impacts of activities near Special Habitats • Protection of nests sites or dens for all three species of greatest concern ***Take avoided, minimized, or mitigated to maximum extent practicable***

Species Group[1] / Objective[2]	Species dependent on: Riparian & Aquatic Ecosystem	Species dependent on: Late-successional & Old-growth Forest Communities	Species dependent on: Special Habitats
2. Maintain & restore natural processes	• Natural riparian forest functions restored, including LWD recruitment to streams & bank stabilization • Anthropogenic sediment delivery rate reduced significantly through road removal, road improvements, better road maintenance, and elimination of timber harvest for commercial purposes • Stream continuity restored • More natural patterns of river flows than current (Section 4.4) ***Stream & riparian processes sustained & restored***	• Development of old-growth characteristics & processes, including recruitment of coarse woody debris through reserve status • Silvicultural intervention to accelerate development of late-successional forest characteristics and provide habitat during transition to development of natural processes that create and maintain habitat • Natural diversity of forest tree species increased through planting • Forest continuity restored ***Natural processes of forest development sustained & restored***	• Natural relationship with surrounding forest restored • Protection from impacts • Restore natural connectivity through older seral forest ***Natural relationships with other habitats protected & restored***

Species Group[1] / Objective[2]	Species dependent on: Riparian & Aquatic Ecosystem	Species dependent on: Late-successional & Old-growth Forest Communities	Species dependent on: Special Habitats
3. Provide habitat connectivity	• Restoration of access to inaccessible habitat for resident fish[3] • Protection of forest adjacent to all streams, ponds, lakes, & wetlands through reserve status • Protection of all riparian areas in reserve status • Protection of included forests in wetland complexes ***Connectivity provided & restored for wetlands, streams, & riparian areas***	• Development of continuous mature forest corridors in watershed • Development of larger and interconnected areas of older seral-stage forest • All forest in CHU protected through reserve status, linking to federal late-successional forest reserve • More natural spatial pattern of forest seral stages ***Significantly improved connectivity within watershed & regionally***	• Improved connectivity provided by commitment not to harvest timber for commercial purposes, protecting forest among Special Habitats • Increased connectivity with overall increase in late seral forests, & decrease in early seral forests ***Improved connectivity among Special Habitats & with other habitats needed by species that use Special Habitats***
4. Provide net benefit	• Increased protection over time as riparian forest matures • Recovery of degraded stream habitats over time through protection & restoration • Accessibility restored to habitat • Hatchery facility, downstream habitat restoration, and improved instream flows (sections 4.3 & 4.4) ***Net benefit for all species***[4]	• All old growth protected • Fifty-fold increase in mature & late-successional forest • Elimination of early seral forest created by timber harvest ***Net benefit for all species***	• Increased protection over time as adjacent forest matures • Increased connectivity with increase in older forest ***Net benefit for all species***[5]

Species Group[1] / Objective[2]	Species dependent on: Riparian & Aquatic Ecosystem	Species dependent on: Late-successional & Old-growth Forest Communities	Species dependent on: Special Habitats
5. Manage sustainably	• Protection of riparian & aquatic habitats from impacts • Recovery of aquatic habitat from past damage, and reestablishment of more natural levels of sediment loading • Reestablishment of stream continuity at road crossings • Reestablishment of forest connectivity in wetland complexes & with riparian corridors on streams ***Aquatic/riparian ecosystem should be sustained***	• Very conservative approach with elimination of timber harvest for commercial purposes • Amount of older seral-stage forest recovering to proportion similar to pre-logging conditions in region • Forest openings created primarily by natural disturbances • Improved landscape connectivity ***Forest ecosystem should be sustained***	• Protection of Special Habitats from impacts • Protection of adjacent forests through reserve status • Restoration of adjacent forest through silvicultural intervention • Improved connectivity among Special Habitats through commitment not to harvest timber for commercial purposes ***Special Habitats should be sustained***

[1] See Table 4.2-3 for species groupings.

[2] See description above.

[3] Passage for anadromous chinook, steelhead, and coho, and other native species will be restored at Landsburg Diversion Dam as well (Section 4.3). In addition, the HCP includes funding to increase survival of smolts of all four species passing through the Ballard Locks (Section 4.4).

[4] The effects on bull trout, pygmy whitefish, and common loons from reservoir operations related to the new instream flow regime (Section 4.4) are discussed in Section 4.5.6. The incremental effects of the change in reservoir management are expected to be minor.

5 See discussion in text above.

Table 4.2-10. Summary of funding commitments and schedule[1,2] for Watershed Management Mitigation and Conservation Strategies.

Projects	Average Cost per Year[3] During Phase 1 of Implementation	Average Cost per Year[3] During Phase 2 of Implementation	Average Cost Per Year[3] Throughout Rest of HCP	Total (for entire HCP)
Habitat Restoration	HCP years 1-8	HCP years 9-16	HCP years 17-50	Total
Culvert upgrades & replacement for fish passage	$120,000	$16,250	$3,824	$1,220,000
Culvert upgrades & replacements for sediment reduction	$15,625	$15,625	$17,647	$ 850,000
LWD placement	$12,500	$46,875	$14,706	$ 975,000
Bank armoring	$19,750	$19,750	$12,941	$ 756,000
Bank revegetation	$6,625	$6,625	$3,118	$ 212,000
Conifer under-planting & long-term maintenance	$6,250	$6,250	$3,294	$ 212,000
Restoration and ecological thinning in riparian areas	$5,625	$5,625	$2,647	$ 180,000
Restoration thinning in uplands [4]	$201,750	$125,750	$0	$2,620,000
Ecological thinning in uplands [4]	$31,250	$31,250	$14,706	$1,000,000
Restoration planting in uplands	$9,375	$9,375	$4,412	$ 300,000
Road Management & Improvement	HCP years 1-5	HCP years 6-10	HCP years 11-50	Total
Road stabilization [5]	$350,000	$200,000	$112,500	$7,250,000
Road decommissioning	$250,000	$250,000	$2,500 [6]	$5,000,000
Road Maintenance Program	$93,600	$80,000	$60,000	$3,268,000
Total for 50 years				**$15,518,000**

1 All budget estimates are made in 1996 dollars and will be adjusted for inflation and deflation.
2 Watershed management costs associated with the monitoring and research activities discussed in Section 4.5 are not reflected in this table. For more detail on these additional funding commitments for monitoring and research see Section 4.5.
3 Actual costs per year will depend on the projects implemented during any period of the HCP, and will vary over time.
4 Accelerates development of late-successional forest conditions.
5 Some funds for stabilization may be used for deconstruction (decommissioning).
6 For HCP years 11-20.