IDAHO POWER
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Integration of Terrestrial Resource Analyses and Impacts

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Technical Report
Appendix E.3.2-45

Hells Canyon Complex
FERC No. 1971

April 2002
Revised July 2003

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1. INTRODUCTION

Idaho Power Company (IPC) operates the Hells Canyon Hydroelectric Complex (HCC) under a license (License No. 1971) issued by the Federal Energy Regulatory Commission (FERC). Because this license will expire in 2005, IPC entered the formal FERC process for obtaining a new operating license (i.e., relicensing). The FERC relicensing process is composed of 7 major steps: 1) decision to file for a new license, 2) first-stage consultation, 3) study execution and draft application preparation, 4) second-stage consultation, 5) application filing with the FERC, 6) application processing and National Environmental Policy Act compliance actions, and 7) license issuance and monitoring of terms and conditions (FERC 1990).

Prior to filing a license application, potential applicants must conduct first stage-consultation with state and federal agencies, Native American tribes, non-governmental organizations, and the public. During first-stage consultation, an applicant and others achieve an understanding of the hydroelectric project and develop concerns and issues about potentially impacted natural resources (FERC 1990). IPC began first-stage consultation in 1996 through the Collaborative Process, which was developed to encourage participation with IPC in the FERC relicensing process. The Collaborative Process was operationalized as an assemblage of Resource Workgroups organized by major resource disciplines: Aquatic, Cultural, Economic, Recreation, and Terrestrial (IPC 1997).

Between 1996 and 2001, the Terrestrial Resource Workgroup (TRWG) 1) developed wildlife and botanical issues, 2) designed studies investigating issues and identifying impacts from the HCC, 3) developed desired future conditions (DFCs) and goals for terrestrial resources in Hells Canyon, and 4) suggested protection, mitigation, and enhancement (PM&E) measures (congruent with DFCs and goals) to offset potential impacts. TRWG members formulated concerns, related to issues about HCC operation and maintenance (O&M) activities, that addressed potential impacts to specific wildlife and botanical resources. O&M activities are associated with 1) reservoir water-levels, 2) downstream water-flows and water-levels, 3) hydroelectric facilities (e.g., power plants and access roads), 4) IPC properties, 5) recreational developments, and 6) the transmission system. Public scoping meetings were also conducted to further develop issues about the HCC. The TRWG combined similar issues into problem statements, and IPC initiated several resource studies to identify potential impacts (i.e., impact studies) from HCC O&M activities (IPC 1997).

IPC also identified natural resource issues by reviewing existing environmental literature from the Hells Canyon region (e.g., environmental impact statements, environmental assessments, land use plans, and resource management plans) and by consulting with resource specialists within natural resource management agencies. IPC initiated many descriptive studies that developed a baseline understanding of the Hells Canyon ecosystem. Many descriptive studies were conducted prior to the Collaborative Process to appraise resource values, support impact studies, and meet general FERC requirements for preparing a license application.

2. OBJECTIVES

Our goals were to identify and estimate magnitudes of HCC impacts on wildlife and botanical resources in Hells Canyon. Our objectives were to synthesize and integrate information from descriptive and impact studies into a comprehensive assessment of HCC impacts on terrestrial resources. Identifying impacts will guide development of IPC's proposed PM&E measures.

3. STUDY AREA

3.1. Hells Canyon Hydroelectric Complex

3.1.1. Location

The Hells Canyon Reach of the Snake River is situated in west-central Idaho and northeastern Oregon. The HCC generation facilities are located on the Snake River in the southern portion of Hells Canyon and are composed of 3 reservoirs: Brownlee, Oxbow, and Hells Canyon. The reach below Hells Canyon Dam is unimpounded, although the 3-dam complex seasonally influences river flows. The Hells Canyon Relicensing Study Area for evaluating terrestrial resources (IPC 1997) is located between the city of Weiser and the confluence of the Salmon and Snake rivers (from approximately river mile [RM] 351 to RM 188).

The Snake River, a major tributary to the Columbia River, is the focal point of Hells Canyon. Its generally northward flow forms part of the boundary between Idaho and Oregon. Federal agencies, including the Bureau of Land Management (BLM) and U.S. Forest Service (USFS), are responsible for managing the majority of public land in Hells Canyon. These areas fall within the jurisdictional boundaries of the Wallowa–Whitman National Forest, Oregon; Payette National Forest, Idaho; Nez Perce National Forest, Idaho; Four Rivers Field Office (FO) of the Lower Snake River District, BLM–Idaho; Cottonwood FO of the Upper Columbia-Salmon-Clearwater District, BLM–Idaho; and Baker FO and Malheur FO of the Vale District, BLM-Oregon. Other agencies with natural resource jurisdiction in the Hells Canyon area include the U.S. Department of the Interior (USDI) National Marine Fisheries Service, USDI Bureau of Indian Affairs, USDI Fish and Wildlife Service (USFWS), and state agencies from Idaho and Oregon.

The Terrestrial Relicensing Study Area in Hells Canyon was broadly divided longitudinally (i.e., north to south) into 5 reaches based on distinct geomorphic features, river characteristics, and legal HCC boundaries:

- Upstream of Brownlee Reservoir to the Weiser Bridge (approximately 12 mi; RM 351.2 to RM 339.2).

- Brownlee Reservoir including the Powder River Arm (approximately 55 mi; RM 339.2 to RM 284.6).

- Oxbow Reservoir (approximately 12 mi; RM 284.6 to RM 272.2).
- Hells Canyon Reservoir (approximately 25 mi; RM 272.2 to RM 247.0).
- Downstream of Hells Canyon Dam to the confluence of the Snake and Salmon rivers (approximately 59 mi, RM 247.0 to RM 188.2).

The lateral (i.e., east to west) extent of the reaches was also divided into 3 tiers: Intensive, Rim-to-Rim, and Extensive. The Intensive Tier includes all land within 0.5 mi of each shoreline for reaches above Hells Canyon Dam and all land within 0.25 mi of the shoreline below Hells Canyon Dam (Holmstead 2001a). Watershed and topographic features within Hells Canyon defined lateral boundaries for the Rim-to-Rim Tier (Christensen 2001), which include all land within 1-10 km (depending on topography) of shorelines of the 5 reaches. The Extensive Tier extends laterally approximately 48 km from the 5 Hells Canyon reaches and was designed to include jurisdictional boundaries associated with natural resource management authority in Hells Canyon. Other lateral extents of the Terrestrial Relicensing Study Area vary depending on specific objectives for resources being studied (IPC 1997).

In the upstream reach, the Snake River is characterized as a low-gradient (0.2 to 0.4 m/km) river, with several island complexes. Agriculture and rural development on flat to gentle topography surround this reach. Large amounts of irrigation returns cause high turbidities and increased nutrient loading. Brownlee Reservoir is a steep-sided reservoir with a maximum depth approaching 300 ft near the dam. Large rock outcrops occur throughout its entire length. Oxbow Reservoir is a relatively small and shallow re-regulating reservoir surrounded by moderate to steep topography (20% to 75% slopes). Shorelines are primarily basalt outcrops and talus, except for alluvial fans created by small tributaries. Hells Canyon Reservoir is a re-regulating reservoir with maximum depths approaching 200 ft. Reservoir shorelines are generally very steep, and substrates are primarily composed of basalt outcrops and talus slopes. The Snake River downstream of Hells Canyon Dam is a high-gradient river (1.8 m/km) bounded by nearly vertical cliff faces. The Snake River below Hells Canyon Dam supports a diversity of aquatic habitat, including numerous large rapids, shallow riffles, and deep pools. Shoreline substrates are also diverse, ranging from large basalt outcrops and boulders to cobble/sand bars.

3.1.2. Physiography

Hells Canyon is the deepest and one of the most rugged river gorges in the continental United States. It ranges between 2,000 and 3,000 ft deep from Weiser to Oxbow Dam. Below Oxbow Dam, the river enters a narrow, steep-sided chasm measuring up to 5,500 ft deep. From the confluence with the Grande Ronde River, the Snake River then flows into a lava-filled basin and through a much shallower canyon to Lewiston, Idaho (DOE 1985). The elevation of the Snake River near Weiser, Idaho, is about 2,090 ft above mean sea level (msl), descending to about 910 ft msl at the confluence of the Salmon River, about 59 mi below Hells Canyon Dam.

Throughout Hells Canyon, topography is generally steep and broken, with slopes often dominated by rock outcrops and talus slopes. At the deepest points, canyon walls rise almost vertically. Canyon walls are also deeply dissected by numerous side canyons with tributaries to the Snake River. The Seven Devils Mountains to the east and the Wallowa Mountains to the west

form the upper reaches of the canyon walls. These mountains form a series of jagged peaks reaching almost 10,000 ft, with subalpine and alpine conditions (USDA 1990).

3.1.3. Land Features and Geology

Hells Canyon consists of a series of folded and faulted metamorphosed sediments and volcanics overlain unconformably by nearly horizontal flows of Columbia River basalt. This basalt group covered much of eastern Washington, northern Oregon, and adjacent parts of Idaho (Bush and Seward 1992). The older rocks in the series are Permian to Jurassic in age and represent at least 2 episodes of island arc volcanism and adjacent marine sedimentation similar to those found today in the Aleutian Islands west of Alaska. These rock units represent old island arc chains that were sequentially "welded" to the west coast of North America during the late Paleozoic and early to mid-Mesozoic eras by subduction of a tectonic plate beneath the North American continental tectonic plate (Asherin and Claar 1976, USDA 1994).

In more recent geologic time, the Snake River formed Hells Canyon through erosion of the Blue Mountains in Oregon and Seven Devils Mountains in Idaho (DOE 1985). The Snake River has existed since the Pliocene and probably cut to its present level in Hells Canyon during the Pleistocene. During the Pleistocene, glacial meltwater provided abundant runoff for down-cutting, while regional uplifting created weak points in the 2,000- to 3,000-foot-thick basalt plateau that overlaid the Blue and Seven Devils mountains. Resulting erosion formed the currently observed drainage pattern that established the Snake River (DOE 1985). Northeast-trending, high-angle fault patterns characterize the extensive Snake River fault system running throughout Hells Canyon (Fitzgerald 1982).

Besides basalt, other rock types are also present within Hells Canyon. Extensive limestone outcrops are found in some tributary drainage areas, and local granitic outcrops also occur.

3.1.4. Soils

The soils throughout Hells Canyon are derived primarily from Columbia River basalt, covered in most areas with a thin mantle of residual soils from weathered native rock. Isolated areas contain deposits of windblown silt. Unconsolidated materials include ash-loess from the Mount Mazama eruption 6,900 years ago, river sands and gravel deposited during the Bonneville floods 15,000 years ago, and colluvium and talus deposited more recently. The amount of soil cover declines northward through Hells Canyon. Near Hells Canyon Dam (RM 247), most rock faces are nearly vertical with little soil cover (USDA 1994).

Most soil complexes are well drained and vary from very shallow to moderately deep. Loams are the dominant textural class and vary from very stony to silty, often with a clay subsoil component (NRCS 1995).

3.1.5. Climate

Climate in Hells Canyon, located in the High Desert region, is significantly influenced by the rain shadow of the Cascade Mountains to the west. From late fall to early spring, the climate of

west-central Idaho and eastern Oregon is typically influenced by cool and moist Pacific maritime air. Periodically this westerly flow is interrupted by outbreaks of cold, dry continental air from the north, which is normally blocked by mountain ranges to the east. During the summer, a Pacific high-pressure system dominates weather patterns, resulting in minimal precipitation and more continental climatic conditions overall (Ross and Savage 1967).

Climatological information is summarized for Weiser, Richland, Brownlee Dam, and Lewiston (Figure 1). Average annual precipitation is lowest at the southern end of Hells Canyon (Weiser, 286 mm), increases northward (Richland, 298 mm), peaks around Brownlee Dam (445 mm), and declines towards Lewiston (326 mm). The average annual precipitation ranges from about 380 to 500 mm (15 to 20 inches), depending on elevation. Nearly 45% of the average annual precipitation at Brownlee Dam (445 mm [17.8 inches]) falls from November through January, which strongly contrasts with the 9% average recorded for July through September. Thus, most precipitation occurs in spring and winter (Tisdale et al. 1969, Tisdale 1986, Johnson and Simon 1987), and little or no precipitation falls during the hottest months of summer. Average annual evapotranspiration is estimated to be about 1,300 mm (52 inches).

Mean annual temperatures are similar among the 4 weather stations. Generally, the climate tends to become drier and warmer downstream of Brownlee Dam. Climatological information from Brownlee Dam (RM 284.6) is probably characteristic of the central section of Hells Canyon. The canyon bottom area is dry with seasonal temperatures ranging from lows of about –5 ºC in January to highs of about 35 ºC in July (Figure 1). Temperatures below freezing are normally experienced from mid-November through mid-April. As a rule, winters in the canyons are mild, while summers on the canyon floor may be hot. Mean temperatures above 2,000 m (6,562 ft msl) range from –9 ºC in January to 13 ºC in July. By contrast, mean temperatures below 1,000 m (3281 ft msl) elevation range from 0 ºC in January to between 28 ºC and 33 ºC in July (Johnson and Simon 1987).

3.1.6. Vegetation

The types of vegetation growing along the canyon slopes of the Snake River are the result of 3 primary ecological factors: topography, soils, and climate. Climate exerts the strongest influence on the development of plant life. The relatively mild winters below the canyon rim have allowed the development of disjunct species such as hackberry (*Celtis reticulata*), which is most often found in the southwestern states, though it commonly occurs along middle and lower portions of the Snake River (Tisdale 1979, DeBolt 1992).

Within the context of regional climate, topography is a major influence on the development and distribution of vegetation (Tisdale et al. 1969, Tisdale 1979, Tisdale 1986). The topographical complexity of Hells Canyon has produced a mosaic of vegetation types (Tisdale 1979, BPA 1984, USDI 1987). Grassland, shrubland, riparian, and coniferous forest communities exist in close proximity. Interfingering of grassland and forest, for example, occurs at a number of sites throughout the canyon due to variations in aspect (Tisdale 1979).

Twenty-six cover types were identified along the Snake River in the Hells Canyon Study Area (Holmstead 2001a). The area that was classified covered up to approximately 1/2 mi on both sides of the Snake River or associated reservoirs and from above Brownlee Reservoir at the town

of Weiser, Idaho (RM 351.2), downstream to the confluence with the Salmon River (RM 188.2). The dominant cover types were *Grassland* (35.5%), *Shrub Savanna* (21.0%), *Lotic* (16.1%), *Shrubland* (6.6%), and *Cliff/Talus* (5.6%). All remaining cover types covered less than 5% of the area classified.

Wetland and Riparian-Dominated Vegetation Types—A narrow band of diverse riparian communities intermittently follows the course of the Snake River and its many tributaries. Although limited in geographic area, this riparian zone is vital because of its biological diversity. Emergent wetland communities are composed mostly of broad-leaved pepperweed (*Lepidium latifolium*), marsh grass (*Heleochloa alopecuroides*), purple loosestrife (*Lythrum salicaria*), common cocklebur (*Xanthium strumarium*), hemp dogbane (*Apocynum cannabinum*), alkali saltgrass (*Distichlis stricta*), and purslane (*Portulaca oleracea*). Predominant shrub species in riparian areas include netleaf hackberry, false indigo (*Amorpha fruticosa*), coyote willow (*Salix exigua*), common chokecherry (*Prunus virginian*a), poison ivy (*Toxicodendron radicans*), syringa (or mock orange, *Philadelphus lewisii*), Himalayan blackberry (*Rubus discolor*), and tamarisk (*Tamarix parviflora*).

Predominant tree species include water birch (*Betula occidentalis*), white alder (*Alnus rhombifolia*), black cottonwood (*Populus trichocarpa*), silver maple (*Acer saccharinum*), and peachleaf willow (*Salix amygdaloides*). Most weedy exotic species occur at and above the headwaters of Brownlee Reservoir (Holmstead 2001a).

Many shoreline sections have no riparian vegetation. Rather, upland vegetation on steep canyon slopes simply meets the rocky shoreline. Grassland and shrubland communities are common along the Snake River and its tributaries.

Herbaceous-Dominated Vegetation Types—The dry climate and typically stony, shallow soils of the canyon have favored the development of grassland steppe communities at the lower and middle elevations (Tisdale 1979, Tisdale 1986). Commonly occurring grass species in Hells Canyon include bunchgrasses such as bluebunch wheatgrass (*Pseudoroegneria spicata)* and Idaho fescue (*Festuca idahoensis*), and annual grasses such as cheatgrass (*Bromus tectorum*) and medusahead wildrye (*Taeniatherum caput-medusae*) (Holmstead 2001a). Other grasses such as Sand dropseed (*Sporobolus cryptandrus*) and red threeawn (*Aristida longiseta*) are locally common (BPA 1984, Tisdale 1986).

Shrub-Dominated Vegetation Types—Shrub species comprise a large segment of the canyon's overall vegetation composition. Shrub-steppe vegetation types occur at mid-elevations in Hells Canyon, especially in its southern region (BPA 1984). Commonly occurring shrubs include big sagebrush (*Artemisia tridentata*), bitterbrush (*Purshia tridentata*), hackberry, serviceberry (*Amelanchier alnifolia*), and bitter cherry (*Prunus emarginata*) (BPA 1984, Tisdale 1986, Holmstead 2001a). For the most part, sagebrush stands are limited to the area around Brownlee Reservoir. In these stands, the herbaceous layer is dominated by cheatgrass, with a variety of forbs also occurring.

Stands of hackberry can be found throughout Hells Canyon, either on lower slopes with rocky residual/colluvial soil or on alluvial terraces with sandy soil (Tisdale 1986). In these stands, hackberry is often mixed with a number of other shrub and tree species, including antelope

bitterbrush, blue elderberry (*Sambucus cerulea*), and ponderosa pine (*Pinus ponderosa*) (BPA 1984). Poison ivy is also abundant. The herbaceous layer is most often dominated by bluebunch wheatgrass, with cheatgrass dominant in those areas moderately to heavily disturbed by past livestock use.

Tree-Dominated Vegetation Types—Although generally restricted to the higher elevations of steep canyon slopes, coniferous forest communities do reach down as far as the river at certain locations. For example, stands of ponderosa pine or Douglas fir (*Psuedotsuga menziesii*), typically with a common snowberry (*Symphoricarpos albus*) understory, extend to the river on north-facing slopes at sites around Oxbow and Hells Canyon reservoirs, and downstream of Hells Canyon Dam (Holmstead 2001a).

3.1.7. Land Use

Hells Canyon and the vicinity is still dominated by the land-use patterns established in the early 1900s: irrigated and nonirrigated agriculture, livestock grazing, mining, large areas of open space, and scattered rural development. The bottomlands adjacent to the reservoirs are now generally used for grazing, some farming, and rapidly growing recreational activities.

3.2. Hells Canyon Complex Operations

3.2.1. Current Operations

Hells Canyon, on the Oregon–Idaho border, is the deepest canyon in North America and home to IPC's largest hydroelectric generating complex, the HCC. The HCC includes the Brownlee, Oxbow, and Hells Canyon dams, reservoirs, and power plants. Operations of the 3 projects of the complex are closely coordinated to generate electricity and to serve many other public purposes.

IPC operates the complex to comply with the FERC license, as well as to accommodate other concerns, such as recreational use, environmental conditions and voluntary arrangements. Among these arrangements are the 1980 *Hells Canyon Settlement Agreement*, the *Idaho Power Fall Chinook Interim Recovery Plan and Study* adopted in 1991, and, between 1995 and 2001, the cooperative arrangement that IPC had with federal interests in implementing portions of the Federal Columbia River Power System (FCRPS) biological opinion flow augmentation, which is intended to avoid jeopardy of the FCRPS operations below the HCC.

Brownlee Reservoir is the only 1 of the 3 HCC facilities—and IPC's only project—with significant storage. It has 101 vertical feet of active storage capacity, which equals approximately 1 million acre-feet of water. On the other hand, Oxbow and Hells Canyon reservoirs have significantly smaller active storage capacities—approximately 0.5 and 1.0% of Brownlee Reservoir's volume, respectively.

Brownlee Dam's hydraulic capacity is also the largest of the 3 projects. Its powerhouse capacity is approximately 35,000 cubic feet per second (cfs), while the Oxbow and Hells Canyon powerhouses have hydraulic capacities of 28,000 and 30,500 cfs, respectively.

Target elevations for Brownlee Reservoir define the flow through the HCC. However, when flows exceed powerhouse capacity for any of the projects, water is released over the spillways at those projects. When flows through the HCC are below hydraulic capacity, all 3 projects operate closely together to re-regulate flows through the Oxbow and Hells Canyon projects so that they remain within the 1-foot per hour ramp rate requirement (measured at Johnson Bar below Hells Canyon Dam) and meet daily peak load demands.

In addition to maintaining the ramp rate, IPC maintains minimum flow rates in the Snake River downstream of Hells Canyon Dam. These minimum flow rates are for navigation purposes and IPC's compliance with Article 43 of the existing license. Neither the Brownlee Project nor the Oxbow Project has a minimum flow requirement below its powerhouse. However, because of the Oxbow Project's unique configuration, a flow of 100 cfs is maintained through the bypassed reach of the Snake River below the dam (a segment called the Oxbow Bypass).

3.2.2. Brownlee Reservoir Seasonal Operations

Brownlee Reservoir is a multiple-use, year-round resource for the Northwest. Although its primary purpose is providing a stable power source, Brownlee Reservoir is also used for flood control, fish and wildlife mitigation, and recreation.

Brownlee Dam is one of several Northwest dams that cooperates to provide springtime flood control on the lower Columbia River and, between 1995 and 2001, to regulate flow in the lower Snake River. For flood control, IPC operates the reservoir cooperatively with the U.S. Army Corps of Engineers (COE) North Pacific Division, according to Article 42 of the existing license.

After flood-control requirements have been met in early summer, the reservoir is refilled to meet peak summer electricity demands and provide suitable habitat for spawning bass and crappie. The full reservoir also offers optimal recreational opportunities through the Fourth of July holiday.

As part of the flow augmentation reasonable and prudent alternative (RPA) implemented by the 1995 and 2000 FCRPS biological opinions, the Bureau of Reclamation (BOR) periodically releases water from BOR storage reservoirs in the upper Snake River to assist with the migration of anadromous fish past the lower Snake River FCRPS projects. From 1995 through the summer of 2001, IPC cooperated with the BOR and other federal interests in these flow augmentation efforts by shaping (or prereleasing) water from Brownlee Reservoir (and later refilling the drafted reservoir space with water released by the BOR from the upper Snake River reservoirs) and by occasionally contributing water to flow augmentation efforts. To facilitate IPC's cooperation with the flow augmentation RPA, in 1996 the Bonneville Power Administration (BPA) entered into an energy exchange agreement with IPC. The agreement reimbursed IPC for any energy losses it incurred as a result of the company's participation through an energy exchange mechanism. The agreement expired in April 2001 and has not been renewed by BPA.

Later in the fall, Brownlee Reservoir's releases are managed to maintain constant flows below Hells Canyon Dam. These flow requirements, which are based on the *Idaho Power Fall Chinook Interim Recovery Plan and Study* (1991), as well as the minimum flow required by Article 43, help ensure sufficient water levels to protect even the shallowest spawning nests, or redds.

After fall chinook spawn, IPC attempts to have a full reservoir by the first week of December to meet winter peak demands.

Winter—December through February

Electricity demands in IPC's service territory—and throughout the Northwest—are critical during the winter. To meet peak winter demands and maintain system reliability, the water level in Brownlee Reservoir is approximately 2,075 feet msl by the first week in December. If the reservoir is filled to that level, the system can provide stable, reliable energy through the winter and reduce operating costs by minimizing the need for purchasing outside power.

During these months, IPC maintains minimum flows below Hells Canyon Dam to ensure sufficient water levels for fall chinook spawning nests. By January or February, IPC begins to draft the reservoir to meet elevation targets for flood control.

Spring—March through May

The COE's North Pacific Division defines flood-control requirements and coordinates flood-control efforts with IPC. During the spring, IPC complies with Article 42 and responds to the COE request to lower the water level in Brownlee Reservoir. The lower water level provides space for excess spring runoff and helps prevent flooding, primarily on the lower Columbia and lower Snake rivers.

In IPC's license, FERC requires that the reservoir's elevation be at or below 2,034 feet by March 1, a level that provides approximately 500,000 acre-feet of storage space for flood control. The license also stipulates that the COE may request an additional 500,000 acre-feet of storage space, if necessary. However, in past years when the snow pack was less than normal, the COE reduced the storage space requirement.

In the mid-1980s, the COE examined the reservoir's flood-control operation and developed a rule curve table for Brownlee Reservoir's target elevations. These target elevations define the space in the reservoir needed for flood control and are based on forecasted runoff at both the Brownlee and The Dalles projects. More recently, the rule curve procedure was improved. This new rule curve now provides a more gradual change in reservoir elevations to reach required storage volumes by targeted dates.

IPC initiated the new rule curve for water year 2000 flood-control requirements. Depending on the water year and COE mandates, flood-control requirements for Brownlee Reservoir may continue through June. In order to meet mandated target elevations for flood control, IPC may need to spill water through the HCC. Although there are no official refill target elevations, the COE controls how quickly the reservoir can be refilled once flood-control requirements are met.

Summer—June through August

After IPC is released from flood-control responsibilities, the company begins refilling Brownlee Reservoir. The refill target is 2,069 feet msl (about 8 feet below the full reservoir capacity of 2,077 feet) toward the end of May and full by the end of June. Meeting these targets ensures that enough water is stored in Brownlee Reservoir to meet peak summer electricity

demands, provide suitable spawning habitat for bass and crappie, and offer optimal recreational opportunities.

In an effort to cooperate with federal efforts to meet flow objectives at Lower Granite Dam outlined in the 1995 and 2000 FCRPS flow augmentation RPA, since 1996 IPC has released water from Brownlee Reservoir to contribute to the federal flow augmentation program. If Brownlee Reservoir is full by the first of July and projections indicate that the space will refill on time, IPC has contributed up to 237,000 acre-feet of water from Brownlee Reservoir during the summer. IPC's cooperative contribution has been generally defined by reservoir space rather than a specific amount of storage water. To effectuate its contribution, IPC drafts Brownlee Reservoir to an elevation of 2,059 feet msl, which, if the reservoir is full, equals a contribution of approximately 237,000 acre-feet.

Also during these months, BOR projects upstream begin releasing 427,000 acre-feet of water to increase Snake River flows in an effort to meet the Lower Granite Dam flow objectives. Because BOR cannot release all of that water within the augmentation period, some of the federal water doesn't reach Lower Granite Dam during the flow augmentation period specified in the RPA. So, during July and August, IPC shapes (or prereleases) water from Brownlee Reservoir and later refills the drafted reservoir space with water released by the BOR from the upper Snake River reservoirs. In a typical year, Brownlee Reservoir shapes approximately 130,000 acre-feet of BOR water. The volume of water shaped fluctuates depending on the type of water year the Snake River Basin is experiencing.

As mentioned earlier, the BPA agreed to an energy exchange with IPC for IPC's cooperation with the flow augmentation RPA. Under this agreement, BPA reimbursed IPC for energy losses resulting from shaping BOR water and contributing water from Brownlee Reservoir. Again, that agreement was not renewed by BPA after it expired in April 2001.

Historically, there were some years when weather, stream flow, and power demands required further drafting of Brownlee Reservoir.

Fall—September through November

During the fall, Brownlee Reservoir is operated largely to benefit fall chinook below the HCC. After the delivery of flow augmentation water, Brownlee Reservoir releases are managed to maintain a constant flow below Hells Canyon Dam to provide stable conditions for spawning fall chinook. The spawning flow is based upon a minimum reservoir elevation of approximately 2,040 feet msl when the program starts in October, and forecasted inflows such that Brownlee Reservoir is full, around elevation 2,075 feet msl, by the first week in December. The minimum flow below Hells Canyon Dam is maintained through fry emergence in the spring and established by maintaining water over the shallow-most redd. Once this flow is set, it is considered the minimum flow necessary to keep embryos from desiccating until they emerge as fry in the spring. In other words, the spawning flow is maintained as a minimum flow until emergence is complete. It should also be pointed out that the lower the reservoir elevation in Brownlee Reservoir, the lower the power production capability of the plant. This situation, in turn, may require IPC to purchase power from other sources if the load demand cannot be met due to the loss in net head at the reservoir.

3.2.3. Operational Scenarios

Operational analyses use the proposed operation of the HCC as the base case scenario, which defines the operational parameters under which the complex would typically operate. *Proposed operations* for the HCC provide for flood control in the spring, water releases for fall chinook, and other constraints to operations, such as reservoir fluctuation limits (Parkinson 2002).

Varying hydrologic conditions and numerous other factors influence the way hydropower projects operate. Daily operations are influenced by many factors, which may include project inflow, energy demand, market conditions, or emergency situations and are difficult to predict on a long-term basis with any certainty. Therefore, for the purposes of the relicensing studies, *operations* is defined in general terms. In addition, IPC's definition of proposed project operations looks forward into the new license term and provides a general point of comparison for other potential operating scenarios. It is important to note that, if the output of IPC's operations model were compared with historical conditions, differences would be apparent. Therefore, the output should not be compared with past conditions.

In order to capture the types of hydrology entering the project, *proposed operations* scenarios have also been defined in terms of low-, medium-, and high-water years. These distinctions are made to reflect variations in operations based on inflowing water conditions.

Parameters of the proposed operating scenario for the HCC differ considerably from the operating parameters of the original license. The reason for these differences is that over time energy and environmental conditions have altered how the HCC is operated. For example, when fall chinook salmon were designated as *threatened* under the Endangered Species Act, IPC modified its operations. In the fall of 1991, IPC started a program to protect spawning adults and emerging fry. *Proposed operations* continue this special program.

Full pool run-of-river is the operational scenario IPC will compare with the base case scenario (*proposed operations*) to determine project impacts. *Run-of-river operations* establishes a scenario where inflows to the HCC, as well as tributary inflows, equal outflows from the HCC. This scenario does not necessarily reflect conditions that would be most beneficial to environmental resources. Rather, it reflects a condition in which IPC could analyze impacts with the project in place but without project operations influencing the outflow hydrograph. A complete description of input parameters for each scenario of the operations model is presented in Parkinson (2002).

3.3. Hells Canyon Complex Transmission System

IPC operates and maintains transmission lines on about 1,061 km (659 mi) of rights-of-way (ROW) associated with the HCC (Table 1) and 1,127 km (700 mi) of service roads. These ROWs extend from the HCC southeast across the Snake River Plain to American Falls, Idaho, and northwest over the Wallowa Mountains to Enterprise, Oregon. Important population centers located near the transmission-line ROW include Pocatello and Boise in Idaho and Ontario, Baker City, and Enterprise in Oregon. The transmission-line study area is limited to public lands

under the jurisdiction of state or federal authorities. About 568 km (353 mi) of the transmission lines are located on public lands in Idaho and Oregon.

For study purposes, a transmission-line corridor is considered a linear feature that buffers a transmission line ROW. The width of the transmission corridor may vary depending on the natural resources being evaluated. The principle corridor evaluated in these studies was 5 km on either side of the transmission line. Easements, grants, special-use permits, or FERC licenses define widths of ROWs. Such permits define the IPC's rights within the ROW.

4. RESULTS AND DISCUSSION

4.1. Impacts to Wildlife Resources

4.1.1. Vicinity of HCC

4.1.1.1. Reservoir Operations

The TRWG identified specific issues concerning operations of the HCC reservoirs and their potential impact on wildlife resources. These were that reservoirs: 1) accumulated contaminants potentially toxic to wildlife below the maximum operational drafting depth of Brownlee Reservoir (i.e., reservoir inundation zone), 2) precluded the establishment of perennial low-elevation wildlife habitat between the reservoirs' maximum operational drafting depths and full-pool shorelines (i.e., reservoir fluctuation zones), 3) prevented the establishment of perennial riparian habitat along full-pool reservoir shorelines (i.e., reservoir shoreline zones), 4) fragmented patches of riparian habitat patches in the reservoir shoreline zones, 5) limited waterfowl brooding habitat in the shoreline zones, 6) decreased habitat for *threatened*, *endangered*, *candidate*, and *special status* species in the shoreline zones, and 7) reduced the capability of winter range (i.e., winter range zone) for supporting mule deer (*Odocoileus hemionus*) (IPC 1997) (Figures 2a and 2b).

IPC initiated numerous studies that specifically investigated these issues. IPC evaluated and compared operational impacts to wildlife for 2 potential operational scenarios: 1) *proposed operations* for the HCC, and 2) *full pool run-of-river operations* (see Section 3.2.3). For addressing an individual wildlife issue, studies were designed to 1) describe current resource conditions, 2) identify potential impacts from *proposed operations* of the HCC relative to *run-of-river operations*, and 3) specifically estimate magnitudes of operational impacts. Often, several studies were coordinated to address individual aspects of an issue. For example, 5 separate studies were integrated when investigating impacts to mule deer. To evaluate operational impacts to an individual wildlife issue, we synthesized information from the relevant studies and then estimated the magnitude of the impact within a specific impact zone (i.e., inundation zone, fluctuation zone, shoreline zone, and winter range zone; Figures 2a and 2b).

4.1.1.1.1. Reservoir Contaminants in Brownlee Reservoir Inundation Zone

Dombrowsky et al. (2001) evaluated the risk to wildlife from organochlorine compounds (e.g., DDE and DDT) and trace metals in fish tissue from Brownlee Reservoir. Total DDE in white suckers (*Catostomus commersoni*) exceeded national background tissue-residue levels (Table 5 in Dombrowsky et al. 2001). In addition, total DDT concentrations in fish tissue samples significantly exceeded 2 comparable regionally measured levels (Table 5 in Dombrowsky et al. 2001). Finally, total DDT concentrations in carp (*Cyprinus carpio carpio*) exceeded all applicable ecologically based benchmark and media-specific/receptor-specific criteria values (CVs) (Table 6 in Dombrowsky et al. 2001). Dombrowsky et al. (2001, Tables 3 and 4) then modeled the biomagnification of analytes in the food web using 2 species: the otter (*Lutra canadensis*) and the great blue heron (*Ardea herodias*). Modeling results suggested that total DDT in the otter and great blue heron significantly exceeded benchmarks using conservative, non-species-specific values as the basis of comparison (Table 6 in Dombrowsky et al. 2001). All other analytes were either near or below all comparison values for both modeled species. These results suggest that the potential for impacts of contaminants to fish-eating wildlife in Brownlee Reservoir is low to non-existent for all chemicals of potential concern, with the exception of total DDT/DDE (Table 8 in Dombrowsky et al. 2001).

Dombrowsky et al. (2001) evaluated the feasibility and practicality of possible actions to mitigate for the potential adverse impacts from the presence of total DDT and other contaminants in sediments of Brownlee Reservoir. The potential for adverse ecological impacts to upper tropic level organisms appears to be minimal. Thus, the degree of risk reduction achievable through any active remediation efforts would be negligible. Moreover, any attempts to remove or isolate impacted sediment from the aquatic environment would be negated by the presence of upstream sources (e.g., non–point agricultural runoff and possibly historic mining runoff). Any sediment remediation program must be implemented in conjunction with upstream source reduction or removal to ensure long-term effectiveness. In the case of Brownlee Reservoir, source elimination on a regional scale is currently deemed infeasible and ineffective, particularly for pesticides and other persistent organochlorine compounds.

4.1.1.1.2. Habitat in Reservoir Fluctuation Zones

In Hells Canyon, low-elevation areas provide crucial habitat (e.g., riparian habitat and winter range) for many wildlife species and populations. Two integrated studies (Blair et al. 2001, Blair et al 2002) specifically investigated potential impacts to wildlife habitat within fluctuation zones. Blair et al. (2001) first identified historic conditions of wildlife habitat along the Snake River in Hells Canyon, and then Blair et al. (2002) specifically assessed potential impacts from *proposed operations* for the HCC reservoirs. We synthesized information from these 2 studies to quantify impacts to wildlife habitat that would result from operational fluctuation of the HCC reservoirs.

The HCC reservoirs inundated some of the lowest-elevation wildlife habitat in the region (Blair et al. 2001) and formed fluctuation zones where water levels were manipulated during *historical operations* (1958–1999) (Parkinson 2002). Blair et al. (2002) determined that *historical operations* of the HCC reservoirs, where water levels changed daily and seasonally (Table 2), precluded the establishment of low-elevation habitat in the reservoir fluctuation zones.

Although drafting of Brownlee Reservoir has historically varied within and among years, relatively large seasonal fluctuations were common for flood-control during years with a large spring run-off (Parkinson 2002). However, Brownlee Reservoir was rarely drafted to the maximum operational depth of 101 vertical ft below the full-pool elevation (2,077 ft above MSL) (Parkinson 2002). In contrast, Oxbow and Hells Canyon are re-regulating reservoirs that experienced relatively small and regular changes in water-surface elevations. Oxbow Reservoir typically fluctuated daily within 5.6 ft (maximum of 10 ft) of full pool (1,805 ft), and Hells Canyon Reservoir typically fluctuated within 3.8 ft (10 ft maximum) of full pool (1,688 ft) (Parkinson 2002). Therefore, the fluctuation zones of Oxbow and Hells Canyon reservoirs were relatively small. Nonetheless, seasonal and daily water-level changes inundated areas of each reservoir's fluctuation zone for various periods, which eliminated vegetation that historically provided riparian and upland wildlife habitats.

Blair et al. (2002) evaluated operational impacts in fluctuation zones from *proposed operations* relative to *run-of-river operations* (Parkinson 2002). *Proposed operations* include daily and seasonal water-level fluctuations similar to what occurred historically, whereas *run-of-river operations* maintain the 3 reservoirs at full-pool elevations yearlong. Blair et al. (2002) proposed that the current preclusion of wildlife habitat (i.e., low-elevation habitat) in the fluctuation zones would persist into the future regardless of operational scenario. That is, reservoir fluctuation zones would be at least seasonally inundated with either *proposed operations* or *run-of-river operations*. Consequently, we conclude that *proposed operations* would, for practical purposes, permanently eliminate the capability of the fluctuation zones to support quality wildlife habitat into the future (Blair et al. 2002).

With a Geographical Information System (GIS), Blair et al. (2002) determined the acreage of land in each reservoir's operational fluctuation zone. For Brownlee Reservoir, Blair et al. (2002) estimated the area of land that would be seasonally inundated between full pool and the maximum operational drafting depth of 101 vertical ft below full pool. Similarly, the area of land was estimated for fluctuation zones in Oxbow and Hells Canyon reservoirs having maximum operational drafting depths of 10 vertical ft below respective full pools. Estimated areas are 5,820 acres in the 101-ft fluctuation zone of Brownlee Reservoir, 89 acres in the 10-ft fluctuation zone of Oxbow Reservoir, and 240 acres in the 10-ft fluctuation zone of Hells Canyon Reservoir (Blair et al. 2002).

Blair et al. (2002) further evaluated impacts to wildlife in the reservoir fluctuation zones by reporting a theoretical amount of perennial riparian and upland habitats that *proposed operations* would preclude from establishing. For *proposed operations*, Blair et al. (2002) reported that the magnitude of seasonal and daily changes in reservoir water levels would prevent riparian vegetation from establishing and persisting on reservoir and tributary shorelines (formed at the lower extent of the fluctuation zones) and upland vegetation from establishing elsewhere in the fluctuation zones. Using a series of assumptions about the spatial characteristics of the reservoir fluctuation zones and botanical data from Holmstead (2001b), Blair et al. (2002) reported that *proposed operations* would prevent the fluctuation zone of 1) Brownlee Reservoir from supporting 372 acres of riparian and 5,448 acres of upland habitats, 2) Oxbow Reservoir from supporting 7 acres of riparian and 82 acres of upland habitats, and 3) Hells Canyon Reservoir from supporting 9 acres of riparian and 231 acres of upland habitats. Hence, we conclude that the HCC *proposed operations* would completely impact and eliminate 6,149 acres (388 riparian and

5,761 upland) of wildlife habitat within the fluctuation zones of the 3 reservoirs. The protection (e.g. through acquisition) and enhancement of riparian and upland wildlife habitat would constitute appropriate mitigation for operational impacts to the reservoir fluctuation zones.

4.1.1.1.3. Riparian Habitat in Reservoir Shoreline Zones

Habitat loss and fragmentation, especially in crucial habitats, are major factors contributing to the decline of many wildlife species (Harris 1984, Saunders et al. 1991). In the western U.S., riparian habitats comprise only 0.5% of the landscape (Ohmart and Anderson 1996), but the structural and vegetative complexity of these habitats supports a disproportionate diversity and abundance of wildlife (Thomas 1979, Szaro 1980, Brinson et al. 1981, Knopf et al. 1988, Saab et al. 1995). Much riparian habitat in the West has been impacted by hydroelectric developments where reservoir operations that include large seasonal water-level fluctuations often prevent the establishment of riparian vegetation along newly created reservoir shorelines (Lewke and Buss 1977). Consequently, reservoir operations often impact crucial riparian wildlife habitat.

Considering the value of riparian habitat for wildlife in the semi-arid environment of Hells Canyon, IPC conducted 2 studies (Blair et al. 2002, Rocklage and Edelmann 2002) that allow assessment of impacts to riparian wildlife habitat within the reservoir shoreline zones from *proposed operation* of the HCC reservoirs (Parkinson 2002). Reservoir shoreline zones are defined as an area within 50 planimetric meters upslope of full-pool shorelines. Rocklage and Edelmann (2002) described current levels of riparian fragmentation within shoreline zones. Blair et al. (2002) then assessed impacts from *proposed operations* on the establishment of riparian habitat in shoreline zones. We summarize information reported in Blair et al. (2002) and Rocklage and Edelmann (2002) and then estimate HCC impacts on riparian habitat in the shoreline zones (Figures 2a and 2b).

Riparian Establishment—Currently, large seasonal drafting of Brownlee Reservoir has limited the extent of riparian habitat in the shoreline zone of this reservoir (Holmstead 2001a). Most existing riparian habitat in the shoreline zone of Brownlee Reservoir occurs near the mouths of tributary streams or springs, where the shoreline soil moisture is not dependent on reservoir water-surface elevation. In some locations, a narrow linear band of facultative riparian species (i.e., adapted to benefit from temporary mesic conditions) also exists along full-pool shorelines (Braatne et al. 2002). Otherwise, upland vegetation comprises most of the shoreline zone, extending to the reservoir full-pool shoreline (Holmstead 2001a).

In contrast to Brownlee Reservoir, shoreline zones for both Oxbow and Hells Canyon reservoirs currently contain many riparian cover types (*Forested Wetland*, *Scrub-Shrub Wetland*, and *Shore & Bottomland Wetland*) (Holmstead 2001a). Historically, relatively stable water levels on both Oxbow and Hells Canyon reservoirs enhanced the establishment of riparian habitat in the shoreline zones (Blair et al. 2002, Braatne et al. 2002). Where suitable substrate and topography occurred, a relatively wide band of riparian habitat was promoted by small, daily and regular, water-surface fluctuations and by the lack of large seasonal fluctuations (Braatne et al. 2002, Blair et al. 2001).

Blair et al. (2002) estimated impacts to the establishment and extent of riparian habitat in reservoir shoreline zones by comparing the projected future extent and composition of cover

types between *proposed operations* and *run-of-river operations*. *Proposed operations* nearly mimic patterns of water-surface elevations that historically occurred during the vegetation-growing season. Under *proposed operations*, Brownlee Reservoir is projected to maintain large-scale seasonal drafting patterns, while Oxbow and Hells Canyon reservoirs would maintain small but regular water-surface elevation changes that return daily to full pool (Parkinson 2002). Therefore, Blair et al. (2002) estimated that over 30 years of *proposed operations* the relative composition of riparian and upland habitats within all reservoir shoreline zones would remain unchanged from current conditions.

For *run-of-river operations*, water-surface elevations would be similar to maximum daily levels that historically occurred on Oxbow and Hells Canyon reservoirs (Parkinson 2002). Therefore, Blair et al. (2002) assumed that, like *proposed operations*, *run-of-river operations* would not alter the relative composition of riparian and upland habitats from current conditions within shoreline zones of Oxbow and Hells Canyon reservoirs. However, under *run-of-river operations*, Blair et al. (2002) proposed that current habitat conditions within the shoreline zone of Brownlee Reservoir would change into the future with a water-surface elevation constantly at full pool. At the full-pool shoreline of Brownlee Reservoir, *run-of-river operations* would maintain greater soil moisture throughout the growing season than *proposed operations*. Thus, Blair et al. (2002) estimated that 343 of the 3,296-acre shoreline zone of Brownlee Reservoir would be converted from upland habitat to riparian habitat under *run-of-river operations* (Table 2).

Relative to *run-of-river operations*, we therefore conclude that *proposed operations* would prevent 343 acres of riparian habitat from establishing in areas of the Brownlee Reservoir shoreline zone that are currently occupied by upland habitat. Habitat management actions designed to protect (e.g., through acquisition) or develop 343 acres of riparian vegetation would constitute appropriate mitigation for operational impacts to riparian habitat in the shoreline zone of Brownlee Reservoir.

Riparian Fragmentation—Rocklage and Edelmann (2002) described the current landscape pattern of riparian habitat adjacent to the HCC reservoirs. They concluded that patches of riparian habitat were typically fragmented (i.e., small, narrow, and isolated) and that woody riparian vegetation was rare and most fragmented along the shoreline of Brownlee Reservoir (Rocklage and Edelmann 2002). Large seasonal water-level fluctuations (≤101 ft from full pool) from *historical operations* of Brownlee Reservoir (Parkinson 2002) contributed to the currently eroded shorelines (Holmstead 2001b), with sparse vegetation (Holmstead 2001a) often consisting of weedy herbaceous annuals (Krichbaum 2000). Moreover, most woody riparian habitat along Brownlee Reservoir is mainly in tributary drainages, and tributaries are typically isolated from one another by barren reservoir shoreline (Rocklage and Edelmann 2002). In contrast, relatively stable water-surface elevations have likely contributed to a historical increase in the extent and continuity of woody riparian habitat in the shoreline zones of Oxbow and Hells Canyon reservoirs (Blair et al. 2001, Holmstead 2001a, Parkinson 2002).

The current pattern of riparian vegetation and fragmentation in Hells Canyon is a result of many natural physiographic and anthropogenic processes (Blair et al. 2001, Holmstead 2001a, Rocklage and Edelmann 2002). For wildlife, impacts of riparian habitat fragmentation are complex and often species specific (McGarigal and Marks 1995, Donovan et al. 1997, Tewksbury et al. 1998). For example, an assessment of mountain quail winter habitat in

Hells Canyon identified numerous tributaries to Brownlee Reservoir with small patches of suitable but isolated habitat (Rocklage and Edelmann 2002). The likelihood of a viable mountain quail population occurring adjacent to the HCC reservoirs would potentially improve with suitable habitat in tributaries being interconnected by woody riparian vegetation along the shoreline of Brownlee Reservoir. Nonetheless, the overriding impact of riparian fragmentation on wildlife is the simple loss or unavailability of this important habitat (Skagen et al. 1998).

Because of the linear nature of riparian vegetation in the shoreline zones (Holmstead 2001a), we propose that fragmentation of riparian habitat will decrease with an increase in the spatial extent of riparian habitats. Rocklage and Edelmann (2002) suggested that seasonal drafting that causes an absence of riparian habitat in the shoreline zone of Brownlee Reservoir is a primary impact of HCC operations leading to fragmentation of riparian wildlife habitat. Furthermore, Blair et al. (2002) estimated that *proposed operations* would maintain the current extent of riparian habitat, whereas *run-of-river operations* would promote the establishment of 343 acres of riparian habitat along Brownlee Reservoir. Blair et al. (2002) also estimated that the extent of riparian habitat in shoreline zones of Oxbow and Hells Canyon reservoirs would remain unchanged from current conditions for both *proposed operations* and *run-of-river operations*.

Therefore, we conclude that *proposed operations* for the HCC, which includes drafting during the growing season (Parkinson 2002), would continue to prevent the establishment of woody riparian habitat (Blair et al. 2002). Thus, current levels of fragmentation would likely be maintained in the shoreline zone of Brownlee Reservoir under *proposed operations*, but likely be decreased under *run-of-river operations*. We also conclude that *proposed operations*, with minimal water fluctuations of Oxbow and Hells Canyon reservoirs (Parkinson 2002), would maintain the current extent of riparian habitat and thus maintain current levels of fragmentation along these reservoirs (Rocklage and Edelmann 2002). Habitat management actions designed to encourage the extent and interconnectedness of woody riparian vegetation (potentially associated with habitat protection through land acquisition) would generally constitute appropriate mitigation for fragmentation of riparian habitat in the shoreline zone of Brownlee Reservoir.

Impact Summary—The loss and fragmentation of riparian habitat are major factors contributing to the decline of many wildlife species in the West and are important wildlife issues for relicensing the HCC. IPC conducted 2 integrated studies (Blair 2002, Rocklage and Edelmann 2002) that assessed impacts to riparian habitat within reservoir shoreline zones (i.e., within 50 m upslope of the full-pool shorelines) from *proposed operations* of the HCC relative to *run-of-river operations*.

Based on Blair et al. (2002) and Rocklage and Edelmann (2002), we conclude that the extent and connectedness of riparian habitat in shorelines zones of Oxbow and Hells Canyon reservoirs would remain essentially unchanged regardless of *proposed operations* or *run-of-river operations*. Contrastingly, we conclude that *proposed operations* would prevent (i.e., impact) 343 acres of riparian habitat from establishing in areas of the Brownlee Reservoir shoreline zone that is currently occupied by upland habitat. *Proposed operations* would also maintain the highly fragmented distribution of riparian habitats along Brownlee Reservoir. Habitat management actions designed to protect (e.g., through acquisition) or develop 343 acres of interconnected riparian vegetation would constitute appropriate mitigation for operational impacts to the establishment and fragmentation of riparian wildlife habitat along Brownlee Reservoir.

4.1.1.1.4. Waterfowl Nesting in Reservoir Shoreline Zones

Waterfowl are an important international wildlife resource, with high public and ecological importance. Riparian and wetland habitats suitable for waterfowl reproduction (i.e., nesting and brood rearing) have been severely reduced across North America and are often locally limited (Smith et al. 1989). Because of the large potential for hydroelectric operations to impact brooding habitat in the reservoir shoreline zones (Lewke and Buss 1977, Tabor et al. 1980, Duebbert 1982), IPC conducted 2 studies (a field study and a modeling study) that allow evaluation of impacts to waterfowl from *proposed operations* of the HCC (IPC 1997). Rocklage et al. (2001a) described the relative distribution and abundance of waterfowl broods along shorelines of the HCC reservoirs, and Blair et al. (2002) evaluated effects of *proposed operations* and *run-of-river operations* on the mallard (*Anas platyrhynchos*).

Currently, important waterfowl nesting and brood-rearing areas are largely restricted to shoreline zones of the Powder River Pool and upstream sections of Brownlee Reservoir, including both the mainland and the islands (Rocklage et al. 2001a, Blair 2002). Although unaffected by reservoir operations, Rocklage et al. (2001a) also identified concentrations of waterfowl broods along the Snake River shorelines and islands between Brownlee Reservoir and Weiser, Idaho. The low river gradient and shoreline sediments of these areas support concentrations of riparian vegetation (Holmstead 2001a) that provide suitable habitat for waterfowl (Blair et al. 2002). Nonetheless, Blair et al. (2002) identified with a Habitat Suitability Model that habitat conditions in these areas are less than optimal for waterfowl and would benefit from the enhancement of riparian habitat.

Relative to *run-of-river operations*, Blair et al. (2002) projected that *proposed operations* would impact the establishment and extent of riparian habitats, which would in turn impact mallard breeding habitat. Moreover, drafting of Brownlee Reservoir during the waterfowl nesting and brooding period would cause riparian habitat in shoreline zones to become unavailable (Books 1985). Enhancement of riparian habitats in 1) upstream portions of Brownlee Reservoir, 2) the Powder River Pool, and 3) islands between Weiser, Idaho and Brownlee Reservoir would benefit waterfowl associated with the HCC.

4.1.1.1.5. Threatened, Endangered, Candidate, and Special Status Species in Shoreline Zones

One hundred six species with a *threatened*, *endangered*, *candidate*, or other *special status* (TECS) designation by federal or state agencies are potentially associated with the HCC reservoirs (Table 3). From this extensive set of species, the TRWG identified 37 species to be evaluated for potential impacts from HCC operations (4 amphibian species, 18 birds, 11 mammals, and 4 insects; Table 3). *Candidate* species are discussed in this document with species listed as *threatened* and *endangered* by the USFWS. Of the 106 species considered in this section, those species not federally classified as *threatened*, *endangered*, or *candidate* species were characterized as "*special status*" species. State and federal agencies use many designations for species that are rare, have questionable status, or have special conservation needs, but that are not listed by the USFWS as *threatened*, *endangered*, or *candidate* species.

Information on TECS species was collected in 16 studies. Beck et al. (2001) conducted studies on amphibians and reptiles. Isaacs et al. (1992), Akenson (1996), Holthuijzen (1999a and b), Pope and Holthuijzen (2000), Turley and Holthuijzen (2000), Rocklage and Edelmann (2001),

Rocklage et al. (2001a), SAIC (2001), and Turley and Edelmann (2001) studied birds including waterfowl, upland gamebirds, and raptors. Ratti and Lucia (1998), Edelmann and Copeland (1999), Anderson (2000), Turley et al. (2001), and Edelmann (2002) studied mammals including bats, carnivores, and big game. Specific studies were not conducted as part of the HCC relicensing for the 4 insect species, and impact assessment was based on available literature and information provided by the Entomological Laboratory of the University of Idaho. All information collected on TECS species was summarized to assess the status of each species in Hells Canyon (Turley and Holthuijzen 2002). The potential impacts of *proposed operations* and *run-of-river operations* were qualitatively evaluated based on wildlife habitat assessments (Blair et al. 2001, Blair et al. 2002) and the species' life history characteristics, distribution, and habitat relationships.

The following is separated into 2 sections. The first discusses species with a federal designation of *threatened* or *endangered* or is a *candidate* for listing under the Endangered Species Act. The second section includes species with various status designations from state agencies or from other federal agencies, such as the BLM and USFS (Table 3), which we designated as *special status* species.

4.1.1.1.5.1. Threatened, Endangered, and Candidate Species

Five species potentially occurring in Hells Canyon are protected as *threatened* or *endangered* under the Endangered Species Act. Four of these were observed in Hells Canyon: bald eagle (*Haliaeetus leucocephalus*), peregrine falcon (*Falco peregrinus*), gray wolf (*Canis lupus*) and northern Idaho ground squirrel (*Spermophilus brunneus brunneus*). Lynx (*Lynx canadensis*), the fifth species, has not been observed in Hells Canyon, but is present in the Seven Devils Mountains of Idaho and the Wallowa Mountains of Oregon. Thus, lynx could potentially be present at higher elevations within Hells Canyon. Three *candidate* species are also discussed in the following: the southern Idaho ground squirrel (*Spermophilus brunneus endemicus*), spotted frog (*Rana luteiventris*), and yellow-billed cuckoo (*Coccyzus americanus*).

Bald Eagle—In 1998, a bald eagle nest was discovered along the Idaho side of Hells Canyon Reservoir and in 1999 another nest was found on the Oregon side of Oxbow Reservoir (Pope and Holthuijzen 2000). Both nests were successful in all years surveyed (IPC, unpublished data). Lands adjacent to the HCC reservoirs, therefore, appear to provide adequate resources for breeding. Furthermore, the reservoirs themselves provide a stable food source (i.e., fish and carrion) for bald eagles. This situation is likely to remain similar for the 2 operational scenarios evaluated for the HCC. As the population continues to increase throughout the region, it is anticipated that the number of bald eagle breeding territories will also increase in Hells Canyon. The only identified limiting factor may be the availability of suitable nest trees.

Populations of wintering bald eagles in Oregon and Idaho have approximately doubled over the past 2 decades (USFWS 1986; Isaacs et al. 1992, 1993, 1996; Beals and Melquist 2001). Wintering bald eagles along the HCC reservoirs represent about 11% of the total wintering population in Idaho and Oregon combined (Isaacs et al. 1993). Bald eagles are opportunistic foragers and can quickly respond to changing and favorable conditions (Isaacs et al. 1992, Holthuijzen 1999a). The spatial distribution of wintering bald eagles in Hells Canyon appears to be driven by food abundance, particularly carrion (e.g., mule deer), fish, and waterfowl

(Holthuijzen 1999a). Key parameters influencing the concentration of wintering bald eagles are availability of food, perch sites, night roosts, and little human disturbance. These conditions are currently met in Hells Canyon and are unlikely to change under either HCC operational scenario evaluated. Therefore, we predict no impacts to nesting or wintering bald eagles for *proposed operations* compared to *run-of-river operations*.

***Peregrine Falcon*—**In 1995, Marzluff et al. (1995) documented a peregrine falcon breeding territory near Hells Canyon Dam. In 1996, an eyrie was located and 1 young fledged successfully. The eyrie was occupied during the following years, but breeding could not be confirmed. In 2001, a single bird was observed and the territory was classified as "unknown" (IPC, unpublished data). Operations of the HCC are not expected to impact peregrine falcons. The eyrie is located on a remote cliff face that is protected from disturbance by the steep topography. Peregrine foraging areas include upland habitat above the cliffs and riparian along tributaries to the Snake River. Neither of these habitats would be affected by either of the HCC operational scenarios evaluated. Therefore, no impacts to the peregrine falcon are identified for *proposed operations* or *run-of-river operations*.

Gray Wolf—The gray wolf was observed incidentally on the Idaho side of Hells Canyon Reservoir. Gray wolves are likely moving through Hells Canyon while dispersing into Oregon (Turley and Holthuijzen 2002). Potential habitat for the gray wolf likely exists within areas of Hells Canyon where low road densities are found. This habitat is not impacted by operation of the HCC. Dispersing wolves are unlikely to be impeded by the reservoirs, suggested by wolves radio-marked in Idaho reported in Oregon. Difference in width of the reservoirs would be similar between the 2 HCC operational scenarios and would not affect the animal's ability to cross these reservoirs. Therefore, no impacts to the gray wolf are identified for *proposed operations* as compared to *run-of-river operations*.

***Northern Idaho Ground Squirrel*—**The northern Idaho ground squirrel was found at Barber Flat (IPC property) at the upper elevations of Hells Canyon (Turley and Holthuijzen 2002). Factors potentially threatening northern Idaho ground squirrel are land-use changes, recreational shooting, poisoning, and naturally occurring events. However, no current threats were identified at Barber Flat. Neither *proposed operations* nor *run-of-river operations* of the HCC would affect the northern Idaho ground squirrel.

***Southern Idaho Ground Squirrel*—**In 1980, 3 southern Idaho ground squirrel sites were located in the vicinity of Cobb Rapids, at the upper end of Brownlee Reservoir (Turley and Holthuijzen 2002). In 2000, 2 of these still existed, while the status of the remaining site was unconfirmed. Two additional sites were discovered near Cobb Rapids in 1998 (Turley et al. 2001). This upland species is not affected by operations of the HCC. Dumas et al. (2002a) further describes the distribution and other potential impacts on southern Idaho ground squirrel.

***Lynx*—**Lynx may be present in the Seven Devils Mountains of Idaho and the Wallowa Mountains of Oregon. The species may only use Hells Canyon as a travel corridor between suitable habitat at higher elevations in Idaho and Oregon. Therefore, operations of the HCC are not expected to impact the lynx.

***Yellow-billed Cuckoo*—**The yellow-billed cuckoo has declined in the western U.S. since the 1930s and was not observed in Hells Canyon. The species was formerly a common breeding species along the Columbia River west of the Cascades and bred in southern Idaho, at least during historical times (Stephens and Sturts 1998). No current nest sites are known in Oregon (Marshall et al. 1996). The cuckoo requires large (>20 ha) patches of riparian habitat with a dense willow understory for nesting and a cottonwood overstory for foraging (Laymon and Halterman 1989). A total of 343 acres of riparian shoreline habitat (*Forested Wetland, Scrub-Shrub Wetland* and *Emergent Herbaceous Wetland*) are impacted by *proposed operations* compared to *run-of-river operations* (Blair et al. 2002). Therefore, the yellow-billed cuckoo may be impacted by *proposed operations*. However, under either scenario, the patches of shoreline riparian habitat are likely to be too small to meet nesting requirements of the yellow-billed cuckoo.

***Spotted Frog*—**The spotted frog was found at 1 location near the confluence of Eagle Creek and the Powder River during several consecutive years (Beck et al. 2001). In the spring, snowmelt floods much of the area and the creek consists of many channels through meadows and forested areas. Breeding habitat, however, is above the full pool elevation of Brownlee Reservoir. Therefore, HCC *proposed operations* are not expected to impact this species.

4.1.1.1.5.2. Special Status Species

***Amphibians*—**The predicted distribution of the northern leopard frog (*Rana pipiens)* includes the southern portion of Hells Canyon near Farewell Bend (Groves et al. 1997), but the species was not observed. This frog is known in Oregon mostly from older records, and recent surveys have failed to find it in the state (Csuti et al. 1997). The northern leopard frog prefers marshes and meadows, from which they may range into hay fields and grassy woodlands. *Emergent Herbaceous Wetlands,* habitat used by the northern leopard frog, would be impacted by *proposed operations* of the HCC compared to *run-of-river operations*.

The tailed frog (*Ascaphus truei*) is found in cold, fast-flowing permanent streams in forested areas. The tailed frog was observed in 5 tributaries to the Snake River in Hells Canyon and is likely to occur more commonly at higher elevations (Beck et al. 2001). Although tailed frog tadpoles were found along Brownlee Reservoir at the mouth of Dukes Creek and an adult was found on the shoreline of the Snake River at the mouth of Granite Creek, their presence in the lower reaches of these tributaries appears to be unusual. Because tailed frogs occur in small tributaries rather than the Snake River, HCC operations do not impact this species.

The western toad (*Bufo boreas)* was common throughout Hells Canyon (Beck et al. 2001). Although western toad breeding habitat adjacent to the former river channel was eliminated by the construction of the HCC reservoirs, Beck et al. (2001) observed the western toad at 27 wetlands not associated with the Snake River or HCC reservoirs. In addition, IPC personnel recorded 35 incidental observations. The species was also observed breeding in Grouse Creek (a tributary to Brownlee Reservoir) and in overflow ponds on the Wildhorse River (a tributary to Oxbow Reservoir) (Beck et al. 2001). Asherin and Claar (1976) found western toad eggs in Hells Canyon Reservoir. Due to lowering of the water level, they observed that eggs become stranded and desiccated. However, no evidence of breeding was found in the HCC reservoirs from 1995–2000 (Beck et al. 2001). *Proposed operations* apparently would create unsuitable

breeding habitat and thus negatively impact western toads along the shorelines of the 3 HCC reservoirs.

Grassland and Shrub-Steppe—A number of grassland and shrub-steppe species are found in Hells Canyon, such as the sage grouse (*Centrocercus urophasianus*), sharp-tailed grouse (*Tympanuchus phasianellus*), loggerhead shrike (*Lanius ludovicianus*), grasshopper sparrow (*Ammodramus savannarum*), and Brewer's sparrow (*Spizella breweri*). However, species associated with upland habitat (e.g., *Grassland* and *Shrubland* habitats) are outside the zone of hydropower influence and not impacted by HCC operations. Impacts to grassland and shrub-steppe species are generally associated with overgrazing, invasion of exotic vegetation, and fire.

Forested Upland—Several *special status* species found in Hells Canyon are most commonly observed in *Forested Upland* or mountain shrub habitat (e.g., Townsend's warbler [*Dendroica townsendi*] and plumbeous vireo [*Vireo plumbeus*]). Typically these habitats are found in small patches on north-facing slopes or at somewhat higher elevations in Hells Canyon. These habitats are generally not found along reservoir margins and are not impacted by HCC operations.

Open Water—Species associated with open water at least during part of the year, such as the trumpeter swan (*Cygnus buccinator*), harlequin duck (*Histrionicus histrionicus*), and black tern (*Chlidonias niger*), likely benefit from the HCC reservoirs. Therefore, no impacts to species associated with open water are identified for *proposed operations* compared to *run-of-river operations*.

Riparian Shoreline Vegetation—Riparian shoreline vegetation along the HCC reservoirs provide important habitat to a variety of birds, many of which are neotropical migrant birds. Riparian wildlife species include the mountain quail (*Oreortyx pictus*), willow flycatcher (*Empidonax traillii*), yellow warbler (*Dendroica petechia*), MacGillivray's warbler (*Oporornis tolmiei*), Wilson's warbler (*Wilsonia pusilla*), plumbeous vireo, yellow-headed blackbird (*Xanthocephalus xanthocephalus*), and river otter (*Lutra canadensis*). In general, no difference between *run-of-river operations* and *proposed operations* was found for the amount of riparian habitat available along Oxbow and Hells Canyon reservoirs (Blair et al. 2002). Compared to *run-of-river operations, proposed operations* were estimated to impact a total of 343 acres of riparian habitat (*Forested Wetland, Scrub-Shrub Wetland,* and *Emergent Herbaceous Wetland*) (Blair et al. 2002). Therefore, on Brownlee Reservoir, all species depending on riparian shoreline vegetation for their life requirements would be impacted by *proposed operations*.

Bats—Within the Columbia River Basin, the Snake River corridor in Hells Canyon and its surrounding terrains may contain the most pristine bat habitats available (Anderson 2000). The juxtaposition of high lithic complexity, plentiful water supplies with its associated macro-invertebrates, and relatively high security from major land alterations provide a high level of security for a bat community that may be at or near historic or pre-historic numbers and complexity (Anderson 2000). Bat species observed in Hells Canyon were Townsend's big-eared bat (*Corynorhinus townsendii*), spotted bat (*Euderma maculatum*), fringed myotis (*Myotis thysanodes*), and western pipistrelle (*Pipistrellus hesperus*). Operation of the HCC does not impact these species. Therefore, no impacts to bats are identified for *proposed operations* compared to *run-of-river operations*.

Ungulates— The California bighorn sheep (*Ovis canadensis californiana*) is found in desert canyons of southwestern Idaho and Oregon. In Oregon, bighorn sheep south of the Burnt River are considered to be California bighorn sheep, a *special status* species (Table 3). Bighorns north of the Burnt River are considered to be Rocky Mountain bighorn sheep, which is not a *special status* species. Fifteen California bighorn sheep were released along the Burnt River in 1987 on BLM lands. In 1997, this population had increased to at least 73 individuals (G. Keister, personal communication). Domestic sheep, and the parasites and diseases they carry, are the most serious threat to bighorn sheep populations. Bighorn sheep are typically not immune to these parasites and diseases, and in addition domestic sheep can directly compete with bighorns for forage (VanDyke et al. 1983). Riparian habitats are impacted along the reservoir reaches by *proposed operations* compared to *run-of-river operations* (Blair et al. 2002). No publications, however, were located that suggested riparian habitats were important to bighorn sheep (Ratti and Lucia 1998). California bighorn sheep are unlikely to occur within Hells Canyon or near the HCC, thus *proposed operations* are unlikely to affect this species.

Forest Carnivores—Fishers (*Martes pennanti)* potentially occur adjacent to Hells Canyon in the Wallowa Mountains of Oregon and Seven Devils Mountains of Idaho (Spahr et al. 1991, Marshall et al. 1996). No studies of fisher habitat have been conducted in Oregon (Marshall et al. 1996) or Idaho in the proximity of Hells Canyon. Fishers prefer forests dominated by conifers with extensive and continuous canopies (e.g., 70–80%). Dense lowland forests and mature to old-growth forests with high canopy closure often satisfy the habitat requirements of the fisher (Spahr et al. 1991). Because preferred habitat of the fisher occurs at higher elevations, HCC operations would not impact this species.

Wolverine sightings have been reported for Wallowa and Baker counties in Oregon and Adams (Schommer 1994) and Idaho counties in Idaho (Turley and Holthuijzen 2002). Low elevation areas such as big game winter range are important wolverine habitat during winter (Schommer 1994), as evidenced by a sighting at Eagle Bar (Turley and Holthuijzen 2002). However, their presence is likely very rare near the HCC reservoirs, and effects of operationally regulated flows on wolverine movement are unknown. Nonetheless, the wolverine ranges widely across large areas in northern latitudes that are intersected by large lakes and rivers (e.g., Alaska and Canada) (Edelmann and Copeland 1999). Therefore, the wolverine is likely adapted to navigating large water bodies, and we conclude that wolverines are unlikely to be impeded by the HCC reservoirs. Difference in width of the HCC reservoirs would be similar between the 2 operations scenarios. Thus, we expect that the wolverine would not be impacted by either *proposed operations* or *run-of-river operations*.

Insects— Limited insect inventories have been conducted in Hells Canyon. None of the *special status* butterfly species were detected in a butterfly survey of the Cecil D. Andrus Wildlife Management Area (Stephens 1998). Johnson's hairstreak (*Callophrys johnsoni*), silver-bordered fritillary (*Boloria selene tollandensis*), and Yuma skipper (*Ochlodes yuma*) are not known as canyon species and none have been found to occur within Hells Canyon (Frank Merickel, Idaho State University, personal communication). Therefore, HCC operations do not affect the Johnson's hairstreak, silver-bordered fritillary, and Yuma skipper.

Historic populations of the Columbia River tiger beetle (*Cicindela columbica*) were reported to be locally abundant on sandbars of the Columbia and Snake rivers, from The Dalles, Oregon,

eastward to just west of Lewiston, Idaho (Hatch 1938). Surveys were conducted by Shook (1981) along the Snake River from the confluence of the Salmon River to Heller Bar and the lower Salmon River. The closest known population of the Columbia River tiger beetle occurs along the Lower Salmon River between Slate Creek and Eagle Creek (Shook 1981). No Columbia River tiger beetles were found along the Snake River. Therefore, the Columbia River tiger beetle is not expected to occur in Hells Canyon.

Impact Summary—The loss and fragmentation of riparian habitat are major factors contributing to the decline of many wildlife species, including TECS species in the West, and are therefore important wildlife issues for relicensing the HCC. IPC conducted 2 studies (Blair et al. 2002, Turley and Holthuijzen 2002) that assessed impacts to riparian habitat and associated TECS species within reservoir shoreline zones from *proposed operations* of the HCC.

Six *threatened*, *endangered*, and *candidate* species (bald eagle, peregrine falcon, gray wolf, southern Idaho ground squirrel, northern Idaho ground squirrel, and lynx) were not considered to be impacted by *proposed operations* of the HCC compared to *run-of-river operations*, because important habitats used by these species were not affected. Habitat for 2 species, the yellow-billed cuckoo and spotted frog, may be impacted by *proposed operations*, but neither species has been observed in Hells Canyon. Furthermore, under either scenario, patches of shoreline riparian habitat are likely to be too small to meet nesting requirements of the yellow-billed cuckoo.

Special status species associated with upland habitats (*Grassland*, *Shrub-Steppe*, and *Forested Upland*), located above the reservoir shoreline, would not be impacted by operations of the HCC. This includes the California bighorn sheep, forest carnivores, bats, and several insect species. Species associated with open water (e.g., the trumpeter swan and other water birds) likely benefit from the HCC reservoirs.

Reservoir shoreline vegetation provides important habitat to a number of *special status* species, including the mountain quail, willow flycatcher, yellow warbler, MacGillivray's warbler, Wilson's warbler, plumbeus vireo, yellow-headed blackbird, and river otter. In general, no difference between *run-of-river operations* and *proposed operations* was found for the amount of riparian habitat available in the shoreline zones of Oxbow and Hells Canyon reservoirs. However, an estimated 343 acres of riparian habitat (*Forested Wetland, Scrub-Shrub Wetland* and *Emergent Herbaceous Wetland*) would be impacted by *proposed operations* compared to *run-of-river operations* (Blair et al. 2002), which may potentially affect these species (Turley and Holthuijzen 2002).

4.1.1.1.6. Mule Deer Winter Range Zone

Mule deer is a native game species that is highly valued by the public, and natural resource agencies strive to optimize mule deer habitat and populations (ODFW 1990, Scott 1991). Furthermore, the HCC bisects important mule deer winter range in eastern Oregon and western Idaho. Accordingly, IPC conducted 5 studies (2 information review, 1 modeling, and 2 field studies) that comprehensively investigated potential impacts to mule deer from the HCC. Studies were integrated and designed first to identify potential impacts to mule deer from operation of the HCC, and then specifically to investigate the potential impacts.

Several issues and potential impacts were identified during the 2 information review studies. Ratti and Lucia (1998) reviewed the status of big game populations in Hells Canyon and recommended that IPC investigate potential impacts to mule deer habitat and barriers to migration from hydroelectric operations. Christensen (2001) mapped big game winter range in Hells Canyon and identified, through expert-opinion surveys, that the HCC (especially Brownlee Reservoir) potentially impacts mule deer winter habitat, migration routes, and survival. Similar issues and concerns about potential impacts were also expressed during IPC relicensing consultation with state and federal resource agencies (IPC 1997). Ice formation on Brownlee Reservoir, as a cause of mule deer mortality, was an additional issue identified during consultation (IPC 1997).

Potential impacts to mule deer were investigated with a modeling study and 2 field studies. Because conditions causing significant reservoir ice are uncommon and unpredictable, Ryel et al. (2001) modeled reservoir-icing events and explored potential influences to mule deer wintering adjacent to Brownlee Reservoir. Edelmann et al. (2001) described relationships between mule deer and the HCC by estimating late-winter/early-spring population abundance and distribution on winter range adjacent to the HCC reservoirs (i.e., HCC Winter Range). Edelmann (2002) identified mule deer interactions with Brownlee and Oxbow reservoirs by investigating deer movements, habitat selection, and mortality.

We identified and quantified HCC impacts to mule deer within the winter range zone and fluctuation zone by synthesizing information and data in Edelmann et al. (2001), Ryel et al. (2001), and Edelmann (2002). We quantified 3 types of impacts associated with the HCC reservoirs (primarily Brownlee Reservoir): inhibited movements, limited winter habitat selection, and directly or indirectly caused mortality (i.e., reservoir-related mortality). We quantified impacts separately for each of the 3 impact types. We then estimated and standardized measures of impacts across impact types as habitat coefficients. We defined a habitat coefficient of an HCC impact as the decrease in the capability of the HCC Winter Range for supporting mule deer. Within the fluctuation zone of Brownlee Reservoir (i.e., 101-ft zone for operational water-level fluctuations, ranging between 2,077 ft and 1,976 ft; Parkinson 2002), a habitat coefficient was quantified as the projected proportional decrease in population abundance from habitat impacts of *proposed operations*. Within the winter range zone (i.e., habitat from full-pool shorelines to 4,700 ft msl; Figures 2a and 2b), a habitat coefficient was quantified as the proportional mortality from the HCC reservoirs.

We assumed that an HCC impact on habitat capability increased proportionally with a habitat coefficient estimate, which ranged from 0.0 to 1.0. A habitat coefficient of 0 indicates no loss of habitat capability (i.e., no impact from the HCC) on a defined portion of the winter range, and 1.0 indicates a complete loss of habitat capability. We further standardized impact estimates by multiplying habitat coefficients by the acreage of the area over which the impact occurs (i.e., fluctuation and winter range zones). The estimated acreage resulting from multiplication (i.e., impact acreage = habitat coefficient x acreage of impacted area) conceptually represents the amount of habitat required to mitigate for an identified impact.

Movements—Uninhibited movements within and among seasonal ranges is essential for resource selection by mule deer (Wallmo 1981). Edelmann (2002) investigated mule deer movements across the HCC reservoirs during winter and spring migration. Edelmann (2002) reported

153 reservoir crossings by 54 radio-collared deer (i.e., 21% of the 255 radio-collared sample). The relatively large winter population on the HCC Winter Range (Edelmann et al. 2001) is primarily composed of migratory (74%) deer. Correspondingly, 62% of reservoir crossings were associated with migration. Most migration-related crossings were across the Powder River arm as deer in Oregon migrated from the southern portions of the winter range to summer range in the Wallowa Mountains (i.e., the Powder River-Summit Ridge migration corridor). Migration across the Powder River arm appeared to occur independently of Brownlee Reservoir's water-surface elevation (i.e., HCC operations) (Edelmann 2002). Deer in Idaho, however, rarely encountered the HCC reservoirs during migration, and few deer swam between Idaho and Oregon during migration. Edelmann (2002) identified only 6 of 117 (5%) migrants that swam Brownlee Reservoir when moving between seasonal ranges.

Short-term crossings, which were unrelated to migration, predominantly occurred across Brownlee and Oxbow reservoirs during winter. Although unable to detect a statistically significant relationship, Edelmann (2002) concluded that deer tended to cross Brownlee Reservoir more frequently at lower water-surface elevations. Nonetheless, Brownlee Reservoir, even when at full pool, did not appear to prevent deer from successfully swimming between Idaho and Oregon.

When considering findings of Edelmann (2002) and research elsewhere (Robinette 1966, Boroski 1998), we conclude that the HCC does not appear to significantly inhibit mule deer movements. Deer successfully swim HCC reservoirs during all seasons and at all water-surface elevations, which would include conditions of both *proposed operations* and *run-of-river operations*. Only 2 deer deaths were directly associated with swimming, which we assess in the section of this report titled "Reservoir-related Mortalities." We conclude that the HCC currently does not, nor would *proposed operations*, impact habitat capability (i.e., habitat coefficient of 0.0) of the HCC Winter Range by inhibiting mule deer movements (Table 4).

Habitat Selection—Winter range is a critical component of mule deer ecology (Wallmo 1981). Edelmann (2002) identified that mule deer wintering adjacent to the HCC selected habitats on southerly aspects, at relatively low elevation, and with a diversity of vegetation communities and forages. Furthermore, Edelmann et al. (2001) documented that deer concentrated at low elevations on winter range adjacent to Brownlee Reservoir during late winter. Although deer were distributed from the Brownlee Reservoir full-pool shoreline (i.e., 2,077 ft above msl rounded to 2,100 ft for analysis) to 4,700 ft, deer were disproportionately concentrated within 600 ft (i.e., 2,677 ft rounded to 2,700 ft) above full pool (i.e., crucial winter range zone; Figures 3 and 4) (Edelmann et al. 2001). Therefore, we vertically subdivided lands within the winter range zone into crucial winter range (i.e., full pool to 2,700 ft) and general winter range (i.e., 2,700 ft to 4,700 ft).

We conclude that the capability of winter habitat in Hells Canyon for supporting mule deer increases with decreasing elevation. We therefore conclude that the fluctuation zone of Brownlee Reservoir impacts the availability of low-elevation winter range beyond the simple amount of land within the zone. Water-level fluctuations preclude the establishment of vegetation providing deer forage, thus permanently reducing the capability of the fluctuation zone to support quality mule deer habitat. Blair et al. (2002) concluded that the reservoir fluctuation zones would be impacted into the future regardless of *proposed operations* or *run-of-river operations*. We

similarly conclude that the loss of habitat in the fluctuation zone of Brownlee Reservoir would impact mule deer habitat capability regardless of HCC operational scenario.

We used least-squares linear regression (Ott 1988) to estimate a habitat coefficient that quantifies the HCC impact on the capability of low-elevation habitat that is precluded from establishing in the fluctuation zone of Brownlee Reservoir (5,819 acres; Blair et al 2002). We stratified the winter range adjacent to Brownlee Reservoir into 26 100-ft elevation categories ranging from Brownlee Reservoir's full pool elevation to the upper elevation boundary of the winter range (i.e., 4,700 ft above msl). We then grouped numbers of deer observed in Edelmann et al. (2001) adjacent to Brownlee Reservoir and calculated proportions of the total population within elevation categories. We regressed elevation categories (i.e., predictor variable) and population proportions (i.e., response variable) (Figure 4). Extrapolating the resulting regression equation to the 101-ft fluctuation zone, we estimated a 0.10 habitat coefficient for the 5,819 acres of habitat in the fluctuation zone of Brownlee Reservoir.

Because population abundance increased with decreasing elevation above Brownlee Reservoir, we assumed that habitat capability of the winter range also increased with decreasing elevation. Therefore, low-elevation winter range that is unavailable in the fluctuation zone likely had a greater habitat capability and would potentially support 10% more deer than habitats at higher elevations. We estimated that 582 acres (582 impact acres = 0.10 x 5,819 acres) of winter habitat at higher elevations, in addition to the 5,819 acres identified in Blair et al. (2002), would be required to mitigate for impacts to low-elevation winter range that is unavailable in the fluctuation zone of Brownlee Reservoir (Tables 2 and 4).

Reservoir-related Mortality—A large component of the annual mortality of mule deer populations in the Intermountain West occurs while deer are concentrated on winter range (Wallmo 1981, Bartmann and Bowden 1984, White et al. 1996). To identify HCC impacts, we quantified 3 components of mortality on the HCC Winter Range: 1) mortality unrelated to the HCC reservoirs, 2) reservoir-related mortality during years with mild−moderate winter conditions, and 3) reservoir-related mortality during years with harsh winter conditions. Edelmann (2002) quantified levels and causes of mule deer mortality directly and indirectly related to the HCC during 3 years with relatively mild−moderate winter conditions (Edelmann et al. 2001). Additionally, Edelmann et al. (2001) reported weather parameters and corresponding changes in annual mule deer population numbers during years with harsh winter conditions. Ryel et al. (2001) also reported on the likelihood of significant ice formation on Brownlee Reservoir during harsh winters and implications for reservoir-related mortality.

Edelmann (2002) documented only 2 mortalities (1% of 139 mortalities) for which the HCC was directly responsible; 2 fawns drowned while swimming a reservoir. However, HCC reservoirs indirectly influenced another 33 (24% of 139 mortalities) predation mortalities that occurred on reservoir ice (1 mortality), during crossings (3 mortalities), and along shorelines (29 mortalities) of Brownlee Reservoir (Edelmann 2002). Hence, Edelmann (2002) proposed that HCC shorelines form an ecological trap (Donovan and Thompson 2001). Presumably because of benefits for winter survival, large proportions of the deer on the HCC Winter Range, concentrated adjacent to the reservoirs (Edelmann et al. 2001), and selected home ranges at the lowest elevations available where nutritious forage was more readily available (Edelmann 2002). However, time spent near shorelines of Brownlee Reservoir apparently predisposed deer to

potentially additive mortality from predators. Specifically, Brownlee Reservoir appeared to increase predator (primarily coyote [*Canis latrans*]) efficiency and decrease overall deer survival. Because *proposed operations* would result in reservoir conditions similar to those occurring during the study by Edelmann (2002), we conclude that reservoir-related mortality reported by Edelmann (2002) would similarly occur under *proposed operations*.

Assuming that mortalities from specific causes were additive, Edelmann (2002) estimated the annual rate of reservoir-related mortalities to be 0.099 (range = 0.086–0.123, n = 3 years). While on the HCC Winter Range, deer had an approximately 10% annual probability of succumbing to mortality that directly or indirectly involved an HCC reservoir (primarily Brownlee Reservoir). Therefore, we propose that reservoirs decrease the habitat capability (as measured by deer mortality) of the HCC Winter Range for supporting mule deer by a coefficient of 0.10 during years with mild−moderate winter conditions (Tables 4 and 5).

Using a GIS, we estimated that the crucial winter range adjacent to Brownlee Reservoir encompasses 86,408 acres. After applying the 0.10 habitat coefficient to the 86,408 acres of crucial winter range, we estimated that 8,641 acres (8,641 impacted acres = 0.10 x 86,408 acres) of winter habitat would be required to mitigate for impacts of *proposed operations* from reservoir-related mortality adjacent to Brownlee Reservoir that would occur during years with mild−moderate winter conditions (Tables 4 and 5).

However, during years with harsh winter conditions, more reservoir-related mortality might be expected, especially when deep snows force more deer to concentrate close to Brownlee Reservoir (Ryel et al. 2001, Edelmann 2002). From an examination of historical deer survey data, Edelmann et al. (2001) found that significant mule deer declines ($\bar{x}$ = –27%, range = −17 to –44% in Oregon between consecutive years) occurred on the HCC Winter Range during 5 winters: 1983–1984, 1984–1985, 1985–1986, 1988–1989, and 1992–1993. Weather conditions during these winters were typically characterized as having colder than average temperatures (0.5–12.3 °F) early in the winter (i.e., November and December) and heavy snowfalls (10.5−33.2 inches) often throughout the winter (i.e., November–February) (Edelmann et al. 2001). Below-average temperatures would also likely have caused relatively extensive and prolonged icing of Brownlee Reservoir (Ryel et al. 2001). Therefore, we anticipate that during a harsh winter deer would be more vulnerable to reservoir-related mortality, which would be additive to mortality typical of mild−moderate winters experienced from 1999 to 2001.

We then estimated a habitat coefficient that encompasses increased HCC impacts because of reduced habitat capability of crucial winter range during a harsh winter. Edelmann (2002) was unable to document reservoir-related mortality during a severe winter, and other data for empirically estimating reservoir-related mortality during a harsh winter are unavailable. Therefore, we made several assumptions and used historical Oregon Department of Fish and Wildlife population data (Edelmann et al. 2001) to estimate the expected magnitude of additional reservoir-related mortality during a harsh winter. We assumed that:

1) estimates reported in Edelmann (2002) are indicative of reservoir-related and total mortality adjacent to Brownlee Reservoir during years with mild−moderate winter conditions;

2) estimates of negative population change reported in Edelmann et al. (2001) are indicative of winter mortality adjacent to Brownlee Reservoir during years with harsh winter conditions;

3) mortality during seasons other than winter is similar between years with harsh winters and years with mild−moderate winters;

4) additional mortality during a harsh winter is caused by increased reservoir-related mortality (e.g., shoreline, crossing, drowning, and icing mortality) because deer are heavily concentrated adjacent to Brownlee Reservoir (the primary source of reservoir-related mortality) and that this mortality is additive to that experienced during a mild−moderate winter; and

5) reproduction is constant among years, and fawn mortality is constant in seasons other than winter.

With data from Edelmann (2002), we estimated mean seasonal and annual mule deer mortality from 1999 to 2001. We also estimated the average population change for the 5 years with harsh winter conditions reported in Edelmann et al. (2001). The mean winter mortality rate during a mild−moderate winter was 0.18, of which 0.06 was due to reservoir-related mortality causes (Table 5). This level of winter mortality will likely occur each winter independent of harsh conditions. The mean population change was –0.27 for the 5 years with harsh winters. Therefore, we estimated that an additional reservoir-related mortality rate of 0.09 (i.e., 0.09 = 0.27 – 0.18), which we considered to be the harsh-winter habitat coefficient, could be expected during a harsh winter. While on the HCC Winter Range, we estimate that deer will have an additional 9% probability of succumbing to reservoir-related mortality during a harsh winter.

We propose that the HCC would effectively decrease the capability of the HCC Winter Range for supporting mule deer by a coefficient of 0.09 during years with harsh winter conditions. We applied the 0.09 harsh-winter habitat coefficient to the 86,408 acres of crucial winter range and estimated that 7,777 acres (7,777 impacted acres = 0.09 x 86,408 acres) of winter habitat would be required to mitigate for impacts to the winter range resulting from additional reservoir-related mortality during harsh winters (Table 4 and 5). We assume that protecting and enhancing the habitat capability of crucial winter range can mitigate for reservoir-related mortality.

Impact Summary—We assessed 3 types of impacts to mule deer from *proposed operations* of the HCC: inhibited movements, limited habitat selection, and reservoir-related mortality. We concluded that *proposed operations* would not significantly impact deer movements. However, we identified that *proposed operations* would impact mule deer by precluding low-elevation winter habitat in the fluctuation zone of Brownlee Reservoir. We also estimated that *proposed operations* would influence reservoir-related mortality and thus would reduce the habitat capability of the winter range zone for supporting mule deer.

We determined that the capability of the HCC Winter Range for supporting mule deer increased with decreasing elevation. Hence, we concluded that low-elevation winter habitat that is precluded from establishing in the fluctuation zone of Brownlee Reservoir would potentially support 10% more deer than higher-elevation habitats. Applying a habitat coefficient of 0.10 to

the 5,819-acre fluctuation zone (Blair et al. 2002), we estimate that 582 acres (in addition to the 5,819 acres of the fluctuation zone), of habitat would be required to mitigate for winter range that is unavailable in the fluctuation zone of Brownlee Reservoir (Tables 2 and 4).

For assessing impacts to the winter range zone, (i.e., reservoir-related mortality directly from drowning, and indirectly from crossing, shorelines, and icing), we quantified reservoir-related mortality expected to occur during years with mild−moderate winter conditions and years with harsh winter conditions. Edelmann (2002) estimated that deer, while on the HCC Winter Range, had a 10% annual probability of succumbing to reservoir-related mortality during years with mild−moderate winter conditions. Using historic data reported in Edelmann et al. (2001), we estimated that deer would likely succumb to an additional 9% reservoir-related mortality during harsh winters (e.g., cold temperatures, deep snow, and extensive reservoir icing). Therefore, *proposed operations* of the HCC (primarily Brownlee Reservoir) would negatively impact the capability of the HCC Winter Range for supporting mule deer by the cumulative effects of 0.10 and 0.09 habitat coefficients. Applying the 0.10 and 0.09 habitat coefficients to the 86,408 acres of crucial winter range, we estimate that 8,641 acres (8,641 impacted acres = 0.10 x 89,408 acres) and 7,777 acres (7,777 impacted acres = 0.09 x 86,408 acres) of habitat would be required to mitigate for impacts to habitat capability as measured by reservoir-related mortality (Tables 2, 4, and 5).

4.1.1.2. Land Management

IPC owns about 3,450 acres (not flooded) of land in fee in Hells Canyon from which it operates the HCC within the federal Project Area (16,580 acres of flooded and nonflooded lands) (Johnson and Holmstead 2002). All of these lands occur upstream of Hells Canyon Dam. This constitutes approximately 20.8% of the federal Project area. IPC also owns approximately 1,850 acres of land outside the Project Area in Hells Canyon. Combined, these 5,300 acres constitute approximately 0.6% of the approximately 848,000 acres where Johnson and Holmstead (2002) studied IPC land management influences on terrestrial resources within the rims of Hells Canyon between Weiser, Idaho, and the confluence of the Snake and Salmon Rivers.

Potential impacts of IPC land management actions on wildlife habitat are addressed in Section 4.2.1.2 under botanical resources. In short, land management activities are not known to impact TECS wildlife species on IPC lands (Johnson and Holmstead 2002). Generally, we recommend that IPC conduct more frequent monitoring of project leases and other properties to identify corrective actions needed regarding potential impacts to wildlife resources. Johnson (2002) summarizes specific policy revisions and land management actions proposed for implementation.

4.1.1.3. Human Use Impacts to Wildlife Resources

IPC personnel conduct many activities that are required for operation and maintenance (O&M) of the HCC. Furthermore, developed parks, dispersed recreation sites, roads, and trails associated with the HCC facilitate numerous recreational activities in Hells Canyon. During relicensing consultation, state and federal agencies and non-governmental organizations expressed concern that these human use activities may impact highly valued wildlife resources. Accordingly, IPC

conducted numerous relicensing studies characterizing IPC O&M activities, recreational activities, and wildlife resources associated with the HCC. Dumas et al. (2002a) then integrated data from the studies and comprehensively investigated potential natural resource impacts from human use activities within 0.5 mi upslope of the HCC reservoir shorelines.

Dumas et al. (2002a) assessed potential impacts to wildlife from human use activities associated with 29 IPC facilities (116 acres: dams, residential areas, and small substations), 4 IPC developed parks (114 acres), 7 non-IPC developed parks (136 acres), and 167 dispersed recreation sites (77 acres) (Brown 2001). Dumas et al. (2002a) also evaluated 26 roads (140 mi) and numerous trails (e.g., hiking trails, ATV trails, and dispersed recreation trails) that are associated with IPC facilities or are used by recreationists. We report potential impacts to big game while on winter range and to selected TECS wildlife species that were identified by Dumas et al. (2002a).

4.1.1.3.1. Big Game Winter Range

Elk (*Cervus elaphus*), mule deer, mountain goat (*Oreamnos americanus*), and Rocky Mountain bighorn sheep are important big game species in Hells Canyon, and the winter range adjacent to the HCC is crucial for big game populations (Christenson 2001). Human activities on critical winter range that cause unacceptable levels of disturbance can decrease habitat suitability and impact big game populations (Ratti and Lucia 1998, Dumas et al. 2002a).

During winter, high levels of human activity are associated with the O&M of many IPC facilities (e.g., Hells Canyon Dam, Oxbow Dam, Brownlee Powerhouse, Brownlee Residential Area, and Brownlee Trailer Park) (Dumas et al. 2002a). Consequently, human activity could potentially displace big game from winter range adjacent to the facilities. However, most IPC activities are concentrated inside the facilities during winter. Relatively heavy road use also occurs among IPC facilities during winter. Although a high potential source of disturbance, IPC roads are concentrated near reservoir shorelines and are not distributed throughout the winter range (i.e., 40 mi of IPC-managed access roads versus approximately 200 mi of reservoir shorelines). However, severe winter weather may cause big game to become more concentrated at the lowest elevations of the winter range. Hence, facility- and road-related impacts might become locally significant during harsh winters. Nonetheless, we conclude that in most years wintering big game should not be significantly impacted by human activities at IPC facilities or by IPC road use.

Dumas et al. (2002a) also identified potential impacts to big game and winter range from recreational activities. Several areas of the winter range, primarily near developed parks (e.g., McCormick Park, Woodhead Park, and Hells Canyon Park), were predicted to have high potential for recreational disturbance. However, most of the winter range in Hells Canyon is relatively free of disturbance from recreation, because human activities associated with recreation are largely concentrated immediately within developed parks during winter. As with IPC facilities, the likelihood for disturbance from recreation probably increases during harsh winters when big game is concentrated at the lowest elevations and near parks. However, recreational use would likely be much reduced during harsh winters (Dumas et al. 2002a). We conclude that winter recreational activities would not significantly impact big game or winter range during most years. Regardless, IPC should develop a program for educating the public about minimizing disturbance to big game and winter range during critical periods.

4.1.1.3.2. Threatened, Endangered, Candidate, and Special Status Species

TECS species receive special protection under state and federal legislation. Numerous TECS species occur in Hells Canyon and are associated with the HCC during various periods of the year. TECS species are often especially sensitive to disturbance from human activities in critical habitats. Therefore, Dumas et al. (2002a) evaluated potential impacts from human use activities that disturb or degrade habitats of selected TECS species (Turley and Holthuijzen 2002): mountain quail, bald eagle, and neotropical migrant passerines.

Mountain quail were historically found in large numbers in west-central Idaho, but populations have declined significantly (Heekin and Reese 1995, Rocklage and Edelmann 2001). The declines prompted a petition for mountain quail protection under the Endangered Species Act (Vogel and Reese 2002). Small and isolated populations are believed to occur adjacent to the HCC. In Hells Canyon, the majority of suitable winter habitat for mountain quail is composed of low-elevation riparian areas (Rocklage and Edelmann 2001), which are especially prone to disturbance from human activities associated with recreation, roads, and IPC's O&M activities. Dumas et al. (2002a) concluded, however, that the species' rarity makes disturbance seem improbable. However, all IPC parks, the Brownlee and Oxbow residential areas, and 7 dispersed recreation sites intersect potential mountain quail habitat (Rocklage and Edelmann 2001). Therefore, we concluded that IPC and recreational human-use activities, especially those occurring in low-elevation riparian habitat, might reduce opportunities for mountain quail recovery. Mitigation efforts that cooperatively enhance low-elevation riparian habitat would facilitate mountain quail restoration efforts in Hells Canyon.

The bald eagle is currently listed as *threatened* under the Endangered Species Act. Substantial numbers of bald eagles winter in Hells Canyon and use several communal night roosts and many day perches (Isaacs et al. 1992, Holthuijzen 1999a). Two bald eagle nests were also discovered in 1998 and 1999 (Pope and Holthuijzen 2000). Although effects are varied, bald eagles can be prone to many forms of disturbance (McGarigal et al. 1991, Stalmaster and Kaiser 1998). Using established criteria (i.e., 400 m radius buffer; Anthony et al. 1995, Hamann et al. 1999, Knight and Knight 1984, McGarigal et al. 1991), Dumas et al. (2002a) evaluated potential impacts from disturbance around nests, roosts, and perches. Activities associated with IPC facilities posed major disturbance risks to only 2 perches and 1 roost (Dumas et al. 2002a). Roads had the highest disturbance potential (Dumas et al. 2002a) because both bald eagle nests were located within 125 m of IPC roads. Despite nearby road use, both nests produced fledglings each year. Eight perches and 6 roosts were also vulnerable to road disturbance (Dumas et al. 2002a). Recreation sites were of relatively little concern with only 1 roost affected by an IPC park (i.e., McCormick Park) (Dumas et al. 2002a). Despite high levels of human activity, wintering bald eagle numbers have been relatively stable in Hells Canyon (Holthuijzen 1999a). Therefore, we conclude that current levels of human use activities do not displace bald eagles in Hells Canyon. However, an adaptive strategy for managing bald eagles in Hells Canyon, which includes annual monitoring, would help negate future impacts from increased levels of human use activities relative to a changing bald eagle distribution.

Many passerine bird species that nest in riparian habitats associated with the HCC are classified by state and federal agencies as neotropical migrants with *special status*: yellow warbler, Townsend's warbler, MacGillivray's warbler, Wilson's warbler, willow flycatcher, and plumbeus vireo (Pitocchelli 1995, Curson and Goguen 1998, Wright et al. 1998, Ammon and

Gilbert 1999, Lowther et al. 1999, Turley and Holthuijzen 2000). Because riparian habitat is limited in Hells Canyon (Holmstead 2001a), human activities within these habitats can especially impact *special status* passerine birds. Therefore, Dumas et al. (2002a) evaluated potential impacts to passerine birds that nest in riparian habitats having human use activities. IPC residential facilities (e.g., Oxbow Village) are often associated with riparian habitat, and human activities in residential areas potentially displace passerine species that do not habituate well to continual disturbance (Dumas et al. 2002a). Most potential impacts to *special status* passerines, though, are in riparian habitat associated with parks and dispersed recreation sites. Parks can provide suitable nesting habitat for many species (e.g., yellow warbler; Lowther et al. 1999), but only those tolerant of concentrated human activity are likely to be present. Therefore, we conclude that passerines with *special status* are likely impacted by human use of riparian habitats associated with IPC facilities and recreation sites (Dumas et al. 2002a). Sensitive passerines would benefit from management programs that enhance riparian habitat relative to sources of human activity.

4.1.2. Downstream of HCC

4.1.2.1. River Operations

The TRWG identified specific issues concerning daily flow fluctuations downstream of Hells Canyon Dam that result from HCC operations. These flow fluctuations may fragment and limit the establishment of riparian habitat along the Snake River shoreline (i.e., river shoreline zone) (IPC 2000).

IPC conducted 3 integrated studies (Blair et al. 2001, Blair 2002 et al., Rocklage and Edelmann 2002) that permit assessment of impacts to riparian wildlife habitat from *proposed operations* of the HCC relative to *run-of-river operations*. These studies were designed and integrated to 1) identify historic conditions of wildlife habitat along the Snake River downstream of Hells Canyon Dam (Blair et al. 2001), 2) describe current conditions of riparian wildlife habitat (Rocklage and Edelmann 2002), and 3) estimate influences of *proposed operations* and *run-of-river operations* to riparian habitat in shoreline zones (Blair et al. 2002). Using a description and map of shoreline vegetation (Holmstead 2001a, Braatne et al. 2002), Blair et al. (2002) and Rocklage and Edelmann (2002) described the current extent of riparian habitat and level of habitat fragmentation in the river shoreline zone (i.e., within 11 vertical m upslope of the average annual river stage; Braatne et al. 2002) between Hells Canyon Dam and the Snake and Salmon river confluence (i.e., 59 RM). Furthermore, Blair et al. (2002) evaluated *proposed operations* relative to *run-of-river operations* and estimated impacts to the extent of riparian wildlife habitat. We synthesized information from these 3 studies to estimate and quantify impacts from *proposed operations* to riparian wildlife habitat within the river shoreline zone.

4.1.2.1.1. Riparian Habitat in the River Shoreline Zone

Shorelines of the Snake River downstream of Hells Canyon Dam are steep, confined by bedrock, and typically covered by talus, rock-debris flows, and alluvial terraces (Miller et al. 2002). This geomorphology severely limits the extent of riparian vegetation both along the river shoreline and in tributaries. The confined canyon and static riverbed does not support extensive recruitment and survival of woody riparian vegetation (Holmstead 2001b, Braatne et al. 2002,

Rocklage and Edelmann 2002). The timing and magnitude of peak runoff flows and summer base flows further determine the extent and floristic characteristics of riparian habitat along river shorelines in Hells Canyon.

Prior to extensive development of the Snake River Basin for flood control, irrigation, and hydroelectricity, the extent of perennial riparian habitat along the Snake River shoreline was determined by scouring during large annual spring runoff flows and by the rapid recession of water levels during summer (Blair et al. 2001, Braatne et al. 2002). Hence, only sparse and fragmented (i.e., small, narrow, and isolated) riparian vegetation, typically confined to tributary mouths, existed along Snake River shorelines in Hells Canyon prior to the HCC (Blair et al. 2001).

Riparian Establishment— *Historical operations* of the HCC had little affect on the duration and timing of peak runoff flows in the Snake River (Parkinson 2002, Parkinson et al. 2002). However, historical HCC operations during summer did affect Snake River flows downstream of Hells Canyon Dam (Blair et al. 2002, Parkinson 2002). Daily fluctuations in flow volumes—and thereby river stage—from hydroelectric load-following operations out of Hells Canyon Dam have occurred during the past 41 years (1958–1999) (Parkinson 2002). The daily and seasonal storage capabilities of the HCC have permitted short-term deviations between flows entering and exiting the HCC (i.e., flow/stage fluctuations for load following). Although water levels only fluctuated where shorelines were scoured by spring runoff flows (Braatne et al. 2002, Parkinson 2002), historical load-following operations during summer have been described as an irrigation effect and hypothesized to benefit riparian vegetation (Blair et al. 2001, Braatne et al. 2002).

Blair et al. (2002) described the irrigation effect as a short-term (i.e., typically daily) elevation of summer base flows in the Snake River, which likely increased the extent of soil moisture up the shoreline slope. From historical photographs taken during the early part of the 1900s and recent photos, Blair et al. (2001) demonstrated an increase in size and extent of riparian habitat in the shoreline zone. Correspondingly, the irrigation effect from historical load-following operations (in addition to changes in land use practices) most likely contributed to the increased upslope extent and robustness of the riparian vegetation (especially hackberry) that currently fringes the river downstream of Hells Canyon Dam (Blair et al. 2001, Braatne et al. 2002). Furthermore, the development of storage reservoirs in the Snake River Basin upstream of the HCC has caused a decline in the intensity and duration of large scouring flows in Hells Canyon during runoff periods. Reduced scouring has encouraged the downslope extension of hackberry via root suckering (Blair et al. 2001). Nonetheless, periodically large scouring flows likely limit the lower extent of permanent vegetation on the shoreline slope (Holmstead 2001a, Braatne et al. 2002).

Modeling flow-stage-inundation relationships and characteristic flows for *historical operations*, *proposed operations*, and *run-of-river operations*, Blair et al. (2002) projected the extent of riparian habitat that would be expected in the river shoreline zone. *Historical operations* were characterized on average by relatively large daily changes in water-surface elevation and stage during summer (Parkinson 2002). *Proposed operations* also specifies load following, but projected daily-maximum flows were constrained to be lower than *historical operations*. *Run-of-river operations* had no load following, so projected daily flows from Hells Canyon Dam reflect projected daily inflows to the HCC. Blair et al. (2002) estimated that the shoreline zone (i.e., 3,435 total acres) is currently composed of 7.6% riparian habitat (i.e., 262 acres of

perennially vegetated riparian polygons). However, *proposed operations* are defined to have lower average-maximum daily summer flows, thus less shoreline irrigation effect (i.e., restricted load-following operations) than *historical operations*. Therefore, Blair et al. (2002) projected that riparian habitat would occupy slightly less area (7.4%, 255 acres) of the shoreline zone under *proposed operations*. Because no irrigation effect would occur, riparian habitat was projected to occupy even less of the shoreline zone (7.2%, 246 acres) with *run-of-river operations* (Blair et al. 2002). When compared to *run-of-river operation*, we conclude that *proposed operations* for the HCC would provide slightly more riparian wildlife habitat in the river shoreline zone downstream of Hells Canyon Dam.

Fragmentation—Rocklage and Edelmann (2001) described the landscape pattern of riparian habitat in the shoreline zone of the Snake River downstream of the HCC. Although the extent of riparian habitat historically has been and currently is limited downstream of Hells Canyon Dam, shoreline vegetation has nonetheless been influenced by *historical operations* of the HCC (Holmstead 2001b, Braatne et al. 2002). Shoreline vegetation below Hells Canyon Dam has likely benefited from daily water-level fluctuations (i.e., irrigation effect) for load following during the growing season, and declines in the intensity and duration of scouring flows during spring runoff (Blair et al. 2001, Parkinson 2002).

Blair et al. (2002) quantified the extent of riparian cover-types expected under *proposed operations* and *run-of-river operations*. They projected a slight decrease in the current extent of riparian habitat for *proposed operations* and a little larger decrease for *run-of-river operations*. Therefore, we conclude that reduced summer water-level fluctuations of *proposed operations* and decreased summer base flows of *run-of-river operations* (Parkinson 2002) would, over time, potentially increase the current level of riparian fragmentation by decreasing the extent of woody riparian vegetation (Blair et al. 2002). We propose that *run-of-river operations* would likely increase riparian fragmentation relatively more than *proposed operations*.

Impact Summary—Shoreline geomorphology of the Snake River downstream of Hells Canyon Dam is characterized as steep and rocky (Miller et al. 2002), which severely limits the extent of riparian habitat (Blair et al. 2001) and contributes to its fragmentation (Rocklage and Edelmann 2002). Prior to construction of the HCC, the extent of perennial riparian habitat along the Snake River shoreline was sparse because of scouring during large annual spring runoff flows and the rapid recession of water levels during summer (Blair et al. 2001, Braatne et al. 2002).

Following construction of the HCC, *historical operations* had little affect on the duration and timing of peak runoff flows in the Snake River downstream of Hells Canyon Dam (Parkinson et al. 2002, Parkinson 2002). However, *historical operations* during summer significantly affected Snake River flows (Blair et al. 2002, Parkinson 2002). Daily flow fluctuations from hydroelectric load-following operations (Parkinson 2002) during summer created an irrigation effect, which has been hypothesized to benefit riparian habitat (Blair et al. 2001, Braatne et al. 2002). *Proposed operations* for the HCC also specifies load following, but simulated daily-maximum flows were constrained to be lower than *historical operations* (Parkinson 2002). *Run-of-river operations* has no load following, so simulated daily flows from Hells Canyon Dam reflect projected daily inflows to the HCC.

Reduced summer water-level fluctuations of *proposed operations* and decreased summer base flows of *run-of-river operations* would therefore, over time, decrease the current extent of riparian habitat, while increasing fragmentation (Blair et al. 2002, Rocklage and Edelmann 2002). Blair et al. (2002) estimated that the shoreline zone (i.e., 3,435 total acres) is currently comprised of 7.6% riparian habitat (i.e., 262 acres of perennial riparian habitat). However, *proposed operations* would result in riparian habitat occupying slightly less area (7.4%, 255 acres) of the shoreline zone, because of the reduced irrigation effect (Blair et al. 2002). Riparian habitat would occupy even less of the shoreline zone (7.2%, 246 acres) with *run-of-river operations* (Blair et al. 2002) because no irrigation effect would occur. When compared to *run-of-river operation*, we conclude that *proposed operations* for the HCC would enhance riparian wildlife habitat in the river shoreline zone downstream of Hells Canyon. Nonetheless, habitat management actions designed to encourage the extent of woody riparian vegetation would decrease fragmentation and improve wildlife habitat downstream of Hells Canyon Dam.

4.1.2.1.2. Threatened, Endangered, Candidate, and Special Status Species in the River Shoreline Zone

Information collected on the 37 TECS species was summarized to assess status of the species downstream of Hells Canyon Dam (Turley and Holthuijzen 2002). The potential impacts of *proposed operations* for the HCC were qualitatively assessed based on wildlife habitat assessments reported by Blair et al. (2001–2002) and the species' life history characteristics, distributions, and habitat relationships. Furthermore, information on cover types and vegetation composition was useful in making qualitative assessments regarding species-habitat relationships (Holmstead 2001a, Braatne et al. 2002).

4.1.2.1.2.1. Threatened, Endangered, and Candidate Species

Two *threatened* and *endangered* species—the bald eagle and peregrine falcon— were observed downstream of Hells Canyon Dam. Lynx might be present in the Seven Devils Mountains of Idaho and the Wallowa Mountains of Oregon. The gray wolf has likely passed through Hells Canyon, because several wolves radio-collared in Idaho have been reported in Oregon. The distributions of the northern and southern Idaho ground squirrel do not extend into Hells Canyon downstream of Hells Canyon Dam. Therefore, the northern and southern Idaho ground squirrels are not further discussed in this section. Of the 2 remaining *candidate* species, the yellow-billed cuckoo and the spotted frog, only the yellow-billed cuckoo would potentially be present downstream of Hells Canyon Dam.

***Bald Eagle*—**Bald eagles currently do not nest downstream of Hells Canyon Dam, and no information is available about historical nest sites. Bald eagles winter in small numbers downstream of Hells Canyon Dam (0.4 bald eagles/RM) (Holthuijzen 1999a). Bald eagles are opportunistic foragers and can quickly respond to changing and favorable conditions (Isaacs et al. 1992, Holthuijzen 1999a). For example, bald eagles quickly responded to fish that were stranded below Hells Canyon Dam after the 1997 flood (Holthuijzen 1999a). Key parameters influencing the concentration of wintering bald eagles are availability of food, perch sites, night roosts, and low human disturbance. At this time, these conditions are met in Hells Canyon, and are unlikely to change under the 2 HCC operational scenarios. Therefore, no impacts to

wintering bald eagles are identified for *proposed operations* compared to *run-of-river operations*.

***Peregrine Falcon*—**In 1996, an eyrie was located near Hells Canyon Dam and 1 young fledged successfully (Pope and Holthuijzen 2000). In the following years the eyrie was occupied but breeding could not be confirmed. In 2001, a single bird was observed and the territory was classified as "unknown." Operations of the HCC are not expected to impact peregrine falcons in Hells Canyon. Eyries are generally located on remote cliff faces and are protected from disturbance by the steep topography. Foraging areas for the peregrine include uplands above the cliffs as well as riparian habitat along tributaries to the Snake River. Neither of these habitats would be affected by *proposed operations* or *run-of-river operations*.

***Gray Wolf*—**The gray wolf has not been observed downstream of Hells Canyon Dam. However, gray wolves may travel through Hells Canyon when moving into Oregon, as evidenced by a number of wolf sightings in Oregon of gray wolves that were radio-collared in Idaho (Turley and Holthuijzen 2002). Potential habitat for the gray wolf likely exists in Hells Canyon. This habitat is not impacted by operation of the HCC. Gray wolves passing through Hells Canyon would encounter crossing conditions downstream of Hells Canyon Dam similar to those occurring prior to the construction of the HCC (Parkinson 2002). Nonetheless, effects on gray wolves attempting to cross the Snake River downstream of Hells Canyon Dam are unknown for either *proposed operations* or *run-of-river operations*.

***Lynx*—** Lynx are present in the Seven Devils Mountains of Idaho and the Wallowa Mountains of Oregon. The species may use Hells Canyon as a travel corridor between suitable habitat at higher elevations in Idaho and Oregon. Therefore, operations of the HCC are not expected to impact lynx habitat.

***Yellow-Billed Cuckoo*—**The yellow-billed cuckoo has declined in the western U.S. since the 1930s. No current nest sites are known in either Oregon (Marshall et al. 1996) or Idaho (Stephens and Sturts 1998). The cuckoo requires a dense willow understory for nesting, a cottonwood overstory for foraging, and large patches of habitat in excess of 20 ha (Laymon and Halterman 1989). Current operations of the HCC have elevated summer base flows and induced an irrigation effect that has resulted in an increase in the vigor of riparian hackberry stands. Hackberry canopies are currently larger and more robust than shown in historic photos (Blair et al. 2001). Coyote willow, however, has decreased along with decreased sediment loads below Hells Canyon Dam (Blair et al. 2001, Parkinson et al. 2002). Thus, although the quantity of riparian habitat has increased the quality (i.e., species composition) has changed. The Snake River downstream of Hells Canyon Dam historically had a fragmented riparian zone with very few cottonwoods, which will not change under either *proposed operations* or *run-of-river operations* (Braatne et al. 2002, Blair et al. 2001). Therefore, no impacts to the yellow-billed cuckoo are identified for *proposed operations* as compared to *run-of-river operations*.

4.1.2.1.2.2. Special Status Species

***Amphibians*—**The predicted distribution of the northern leopard frog does not extend downstream of Hells Canyon Dam (Groves et al. 1997). Also, habitat preferred by the northern

leopard frog (marshes and meadows from the species may range into hay fields and grassy woodlands) is also lacking. Therefore, the northern leopard is not affected by the HCC.

The tailed frog is found in cold, fast-flowing permanent streams in forested areas, conditions that are more common at the higher elevations of Hells Canyon. The tailed frog was observed in 3 tributaries to the Snake River downstream of Hells Canyon Dam (Beck et al. 2001). Their presence in the lower portions of these tributaries appears to be unusual. Because tailed frogs typically occur only in the upper reaches of small tributaries, rather that the Snake River itself, HCC operations do not impact this species.

Downstream of Hells Canyon Dam, backwater ponds along the Snake River provide important breeding sites for the western toad (Beck et al. 2001). The common occurrence of western toad tadpoles in backwater ponds surveyed indicated that western toads breed effectively in relatively permanent backwater ponds. Based on an examination of aerial photographs, the size and shape of backwater ponds were fairly similar between 1955 and 1997, but vegetation had encroached at some sites while other sites had eroded (Beck et al. 2001). High spring runoff typically fills the backwater ponds. Because the HCC does not regulate spring runoff (Parkinson 2002), we do not expect that HCC *proposed operations* would affect the availability of breeding ponds downstream of Hells Canyon Dam.

Grassland and Shrub-Steppe—Species associated with *Grassland* and *Shrubland* habitats are outside the zone of hydropower influence and are not impacted by HCC operations. Furthermore, none of the *special status* grassland and shrubland species were observed downstream of Hells Canyon Dam.

Forested Upland—*Forested Upland* or mountain shrub habitat is typically found in pockets on north-facing slopes or at somewhat higher elevations. This habitat is generally not found along the river shoreline and is not impacted by HCC operations. Therefore, no impacts are identified to *Forested Upland* associated species (e.g., Townsend's warbler) under *proposed operations* compared to *run-of-river operations*.

Open Water—Lacustrine conditions are not present in the unimpounded portion of the Snake River downstream of Hells Canyon Dam. Therefore, species associated with open water are only rarely found downstream of Hells Canyon Dam, and likely are not impacted by HCC operations.

Riparian Shoreline Vegetation—Riparian shoreline vegetation provides important habitat to a variety of *special status* birds, many of which are neotropical migrant birds. Riparian wildlife species present downstream of Hells Canyon Dam include the mountain quail, willow flycatcher, yellow warbler, MacGillivray's warbler, Wilson's warbler, solitary vireo, yellow-headed blackbird, and river otter. Riparian habitat has expanded under *historical operations*, which are similar to *proposed operations* (Braatne et al. 2002, Blair et al. 2002, Blair et al. 2001). The composition of the riparian shoreline, however, has changed. Coyote willow has declined, while hackberry has increased (Braatne et al. 2002). *Proposed operations* favor riparian habitat, mainly through the irrigation effect and the elevated summer base flow, compared to *run-of-river operations* (Blair et al. 2002, Braatne et al. 2002), although the difference is small (about 1 acre of *Forested Wetland* and 8 acres of *Scrub-Shrub Wetland*). Therefore, we conclude that species

depending on riparian shoreline vegetation for their life requirements are marginally benefited by *proposed operations* compared to *run-of-river operations*.

***Bats*—**Within the Columbia River Basin, the Snake River corridor in Hells Canyon and its surrounding terrains may be among the most pristine bat habitats available (Anderson 2000). Operations of the HCC do not impact bat species present in Hells Canyon (e.g., Townsend's big-eared bat, spotted bat, fringed myotis, and western pipistrelle).

***Ungulates*—**The California bighorn sheep is not present downstream of Hells Canyon Dam. Therefore, HCC operations do not impact California bighorn sheep.

***Forest Carnivores*—**Fishers potentially occur adjacent to Hells Canyon in the Wallowa Mountains of Oregon and Seven Devils Mountains of Idaho (Spahr et al. 1991, Marshall et al. 1996). No studies of fisher habitat have been conducted in Oregon (Marshall et al. 1996) or Idaho in the proximity of Hells Canyon. Fishers prefer forests dominated by conifers with extensive and continuous canopies (e.g., 70–80%). Dense lowland forests and mature to old-growth forests with high canopy closure often satisfy the habitat requirements of the fisher (Spahr et al. 1991). Because preferred habitat of the fisher occurs at higher elevations, HCC operations would not impact this species.

Wolverine sightings have been reported for Wallowa and Baker counties in Oregon and Adams and Idaho counties in Idaho (Edelmann and Copeland 1999). Track intercept surveys by the Forest Service showed that wolverines were found in a variety of habitats, successional stages, and elevations, except in winter (Schommer 1994). Low elevation areas (<4,800 ft) such as big game winter range are important wolverine habitat at least during winter months (Schommer 1994). The wolverine may use Hells Canyon during winter, as evidenced by a sighting at Eagle Bar. However, their presence in areas adjacent to the Snake River is likely very rare. Wolverine might occur in Hells Canyon when traveling between suitable habitat in the Seven Devils Mountains and the Wallowa Mountains. Wolverines crossing Hells Canyon would encounter river conditions similar to those occurring prior to the construction of the HCC. However, during fall and winter months, river flows are artificially higher than the long-term average. The effect of somewhat higher flows is unknown. Nevertheless, crossing the unimpounded Snake River would probably not differ for the wolverine between *proposed operations* and *run-of-river operations*.

***Insects*—**Limited insect inventories have been conducted in Hells Canyon. Johnson's hairstreak, silver-bordered fritillary, and Yuma skipper are not known as canyon species and none have been found to occur in Hells Canyon (Frank Merickel, Idaho State University, personal communication).

Historic populations of the Columbia River tiger beetle were reported to be locally abundant on sandbars of the Columbia and Snake rivers from The Dalles, Oregon eastward to just west of Lewiston, Idaho (Hatch 1938). Surveys were conducted by Shook (1981) along the Snake River from the confluence of the Salmon River to Heller Bar and the lower Salmon River. The closest known population of the Columbia River tiger beetle occurs along the Lower Salmon River between Slate Creek and Eagle Creek (Shook 1981). Columbia River tiger beetles were not

found along the Snake River. Therefore, the Columbia River tiger beetle is not expected to occur in the reach downstream of Hells Canyon Dam and, therefore, is not affected by HCC operations.

Impact Summary—We concluded that no TECS species downstream of Hells Canyon Dam would be impacted by *proposed operations* of the HCC compared to *run-of-river operations*. Blair et al. (2002) concluded that both operational scenarios would cause a slight decrease in riparian habitat compared to current conditions: 262 current acres of riparian vegetation, 255 acres under *proposed operations*, and 246 acres under *run-of-river operations*. Therefore, the higher amount of riparian habitat under *proposed operations* may benefit some riparian-dependent species, such as neotropical migrant birds and mountain quail.

4.1.2.2. Human Use

Integrating data collected in numerous Hells Canyon relicensing studies, Dumas et al. (2002a) comprehensively studied the interaction of human use activities and natural resources in Hells Canyon downstream of Hells Canyon Dam (see Section 4.1.1.4. for more details). Although they identified wildlife-human activity interactions, these potential impacts are not IPC's jurisdiction or responsibility associated with the HCC. Therefore, there are no identified impacts associated with IPC's activities.

4.1.3. Transmission Lines and Service Roads

The HCC includes 1,061 km of transmission line rights-of-way (ROW) and associated service roads. ROWs are 15–46 m wide and extend from southeastern Idaho northwest to Enterprise, Oregon. IPC conducts numerous O&M activities (e.g., line patrolling, vegetation clearing, structure repair, and road maintenance) that potentially disturb wildlife and degrade habitat. Furthermore, transmission lines and structures potentially displace and kill wildlife. Hence, state and federal agencies and non-governmental organizations expressed concern that O&M activities may impact highly valued wildlife resources.

In response to concerns, Dumas and Carpenter (2002) assessed impacts to wildlife from HCC transmission lines, service roads, and O&M activities. They evaluated 32 TECS species and 28 species with high societal value (e.g., big game). The 60 species encompassed 4 amphibian species, 40 bird species, and 16 mammal species. Potential impacts were identified for 4 big game species and 7 TECS species (see Table 6 for species status), which are discussed below.

Big Game—Big game species occurring in HCC transmission line ROWs are elk, mule deer, mountain goat, and bighorn sheep. These transmission lines and associated service roads intersect several areas of big game winter range (Dumas and Carpenter 2002). Primary concerns are that transmission lines, service roads, and O&M activities may degrade big game habitat and disturb animals (Thompson 1977). IPC O&M activities potentially degrade habitat by facilitating noxious weeds through vegetation, road, and structure maintenance that causes ground disturbance. Typically, however, little ground disturbance occurs during routine road and structure maintenance (Dumas and Carpenter 2002). Most of IPC's vegetation management consists of clearing overstory trees along 17 km of HCC transmission lines that transect big game habitat in forested areas. The clearing maintains vegetation in early successional stages

(i.e., low shrub, grass, forb) (Dumas et al. 2002a), which contain big game forage plants (Goodwin 1975, Dumas and Carpenter 2002, Manitoba Hydro 2002).

Individual habitat impacts, therefore, are likely rare, small, and localized. However, we conclude that effects of habitat disturbance likely accumulate over time especially if noxious weeds become established and expand in ROWs. Hence, IPC should incorporate provisions into a management program for controlling weeds and rehabilitating habitat affected by O&M activities (Dumas and Carpenter 2002).

HCC transmission lines and O&M activities may also disturb big game (Rost and Bailey 1979, Unsworth et al. 1998, Rowland et al. 2000). However, big game species habituate well to transmission structures and conductor noises (Goodwin 1975, Thompson 1977). Furthermore, annual O&M activities typically last < ½ day at a location, and activities scheduled at 5–10 year intervals usually last only 1 day (Dumas and Carpenter 2002). Scheduled O&M activities likely cause only temporary and localized displacement of big game.

Service roads provide access to several winter ranges, where O&M and public-recreational activities may disturb big game during the critical winter period (Christensen 2001). Dumas and Carpenter (2002) concluded that detrimental disturbance from IPC's use of service roads is unlikely, because few O&M activities occur during the critical wintering period. IPC service roads also provide recreational (e.g., hunting; Goodwin 1975) access to winter range on public lands. Although numerous, IPC service roads are typically short, narrow, undeveloped, and used infrequently (Dumas and Carpenter 2002). Therefore, we conclude that IPC and public access on service roads likely cause little disturbance to wintering big game. Nonetheless, IPC should consider adjusting the timing of O&M activities to avoid crucial areas during winter months and cooperate with appropriate agencies to initiate necessary road closures if disturbances begin to negatively affect big game (Dumas and Carpenter 2002).

***Western Sage Grouse and Columbian Sharp-Tailed Grouse*—**Sage and sharp-tailed grouse have historically experienced significant population declines, and they are considered *special status* species by state and federal resource agencies (SAIC 2001). Therefore, IPC conducted 3 integrated studies that assessed potential influences of HCC transmission lines on sage and sharp-tailed grouse habitat and leks (SAIC 2001, Rocklage et al. 2001b, Dumas and Carpenter 2002). In particular, Dumas and Carpenter (2002) assessed how the HCC transmission lines and O&M activities may 1) disturb leks, 2) degrade habitat, and 3) facilitate avian predation on grouse.

SAIC (2001) identified sage grouse leks (29 active, 22 inactive, and 25 with unknown status) occurring within 3 km of the transmission lines; these were concentrated near Baker, Oregon, Weiser, Idaho, and Mountain Home, Idaho. Only 2 sharp-tailed grouse leks occurred within 3 km of transmission lines. During spring, O&M activities (e.g., line patrols and structure maintenance) might disturb breeding grouse occupying these leks. O&M activities that alter shrub-steppe communities or facilitate the infestation and expansion of noxious weeds might also impact grouse habitat (SAIC 2001). To eliminate disturbance to leks, Dumas and Carpenter (2002) recommended that O&M activities within 500 m of active leks should be scheduled outside the sage and sharp-tailed grouse breeding season. Furthermore, we recommend that IPC rehabilitate grouse habitat that is degraded by O&M activities.

Transmission lines can facilitate nesting and perching by raptors and common raven (*Corvus corax*) (Connelly et al. 1998, Schroeder et al. 1999). Golden eagles are particularly known to cause disturbances at leks (Hartzler 1974; Wallestad 1975; Jenni and Hartzler 1978; Ellis 1984, 1987), and ravens are significant predators of grouse eggs and chicks (Batterson and Morse 1948, Hanf et al. 1994). Therefore, Connelly et al. (2000) recommended that tall structures with suitable perches not be built within 3 km of sage grouse breeding habitat. In 1998, 15 raptor and raven nests on transmission line structures were identified within 3 km of 28 grouse leks (Dumas and Carpenter 2002). We conclude that HCC transmission structures that provide substrate for perching and nesting raptors and ravens could locally impact sage and sharp-tailed grouse. Therefore, we recommend that IPC develop and implement a management plan for discouraging raptor and raven nesting within 3 km of active leks (Dumas and Carpenter 2002).

Southern Idaho Ground Squirrel—The southern Idaho ground squirrel is a *candidate* for protection under the Endangered Species Act. Turley et al. (2001) surveyed southern Idaho ground squirrels along suitable habitat within ROWs of the HCC Transmission lines. Out of 26.5 km surveyed, burrows were observed at only 1 site. Dumas and Carpenter (2002) concluded that ground-disturbing O&M activities could potentially impact vegetation and soils near these burrows. Prolonged O&M activities, although rarely occurring, may also prevent foraging by the ground squirrels (Dumas and Carpenter 2002). Although impacts to the southern Idaho ground squirrel are likely minimal, we conclude that an O&M management plan should be developed that 1) avoids scheduling IPC activities near known colonies when active (January–July), 2) rehabilitates squirrel habitat impacted by O&M activities, and 3) monitors squirrel populations along the Brownlee-Boise Bench transmission lines and service roads.

Bald Eagle—The bald eagle is a federally protected species classified as *threatened* under the Endangered Species Act (Dumas and Carpenter 2002). Bald eagles are most often associated with HCC transmission lines along 3 HCC reservoirs during winter (Isaacs et al.1992, SAIC 2000a). In addition, 2 bald eagle nests occur along Oxbow and Hells Canyon reservoirs (Pope and Holthuijzen 2000). Although effects are variable, bald eagles can be prone to disturbance during roosting and nesting (Harmata and Oakleaf 1992, Anthony et al. 1995). Dumas and Carpenter (2002) evaluated potential disturbance to bald eagles from O&M activities of the HCC transmission lines.

Five night roosts occur within 400 m and another 3 occur within 1,200 m of HCC transmission lines (Isaacs et al.1992). However, eagles are away from roosts while foraging most daylight hours. Except for late in the afternoon or before dawn, O&M activities are unlikely to disturb roosting bald eagles. Hence Dumas and Carpenter (2002) recommended that November–March O&M activities, other than patrols, within 400 m of roosts be conducted from late morning to early afternoon.

In addition to transmission lines, both bald eagle nests occur near major roads and recreation areas (Dumas et al. 2002b). One nest is 790 m from the Brownlee-Oxbow line (no. 905) and the other is 135 m from the Oxbow-Hells Canyon line (no. 945) (Dumas and Carpenter 2002). Despite nearby activity, both pairs of nesting eagles are tolerant of human activity and have produced fledglings each year. Nonetheless, Dumas et al. (2002b) recommended that major road maintenance should not occur within a 400 m radius around each nest during the March to July

nesting period. Dumas and Carpenter (2002) further recommended that potentially threatening transmission line O&M activities not occur during the nesting period.

Northern Goshawk and Ferruginous Hawk—The northern goshawk (*Accipiter gentilis*) and ferruginous hawk (*Buteo regalis*) are considered to be *special status* species by state and federal resource agencies. Dumas and Carpenter (2002) reported that goshawks were sighted within 1,000 m of 3 transmission lines that pass through forested habitat, and that 2 pairs of ferruginous hawks occurred on the Boise-Midpoint lines. Because of their sensitivity to disturbance during nesting, seasonal O&M activities near nests would likely cause impacts (Dumas and Carpenter 2002). Therefore, Dumas and Carpenter (2002) recommended that a management program be developed with provisions for avoiding April to July O&M activities (except patrols) within 700 m of an occupied goshawk nest (Squires and Reynolds 1997) and within 800 m of an occupied ferruginous hawk nest (White and Thurow 1985, Richardson and Miller 1997).

Yellow Warbler—The yellow warbler is a neotropical migrant bird that typically nests in riparian habitat (Turley and Holthuijzen 2000). The yellow warbler is considered to be a *special status* species because of population declines resulting from the loss or degradation of riparian nesting habitat. However, Turley and Holthuijzen (2000) considered yellow warblers common in Hells Canyon during the breeding season. Although, removal or trimming of riparian vegetation typically 1) occurs in small, isolated patches, 2) affects a small fraction of available nesting habitat, and 3) impacts few yellow warbler nests in a local area, Dumas and Carpenter (2002) assumed that any O&M activities (i.e., vegetation management) in or near riparian habitat during the summer months might potentially impact yellow warblers. To essentially eliminate direct disturbance to nesting passerines, O&M activities on lines in riparian and forest habitats should only be permitted during August to March. Therefore, Dumas and Carpenter (2002) recommend that IPC develop a management program with O&M provisions that minimize removal of riparian habitat during the April to June breeding season for yellow warblers.

4.1.3.2. Avian Electrocution and Collision

Transmission lines can cause avian mortality by electrocuting perching birds, typically raptors, and by creating hazards where birds collide with wires (APLIC 1996). During relicensing consultation, state and federal agencies, and non-governmental organizations expressed concern that transmission lines impact birds, including TECS species, through electrocution and collision. Two studies were conducted that identified potential risks and impacts to avian species from electrocution (SAIC 2000a) and collision (SAIC 2000b) at HCC transmission lines.

4.1.3.2.1. Avian Electrocution

Electrocution occurs when a bird simultaneously touches 2 body parts (e.g., each wing) to a conductor and a groundwire (APLIC 1996). SAIC (2000a) identified that only 1 HCC transmission line—the Oxbow-Hells Canyon line (no. 945)—presents a potential risk for electrocuting perching raptors, particularly bald eagles. Other avian species that occur in the vicinity of the Oxbow-Hells Canyon line are small (e.g., passerines) and therefore unlikely to become electrocuted (APLIC 1996). Locations of raptor nests and bald eagle winter roosts indicate that up to 26% of the line is considered at risk to perching raptors (SAIC 2000a). However, we considered the line to be of low risk because of 1) limited use of structures by

perching raptors, 2) the abundance of alternate perching substrate, and 3) the paucity of reported electrocutions from this line (Holthuijzen 1999a). Therefore, we conclude that electrocution risk for bald eagles and other raptors is low on the Oxbow-Hells Canyon line.

However, bald eagles nesting pairs in Hells Canyon has increased in recent years from 0 pairs to 2 pairs (Pope and Holthuijzen 2000) and additional pairs may nest here in the future. As a precautionary measure for protecting raptors that nest and roost nearby, pole modifications were made in 1999 to the Oxbow-Hells Canyon line (SAIC 2000a). Therefore, we propose that additional modifications or mitigation measures would be warranted only if new bald eagle nests occur near the Oxbow-Hells Canyon line and are at risk. We propose to continue monitoring nesting activities of bald eagles to identify new risks that may occur in the future along the Oxbow-Hells Canyon line.

4.1.3.2.2. Avian Collision

SAIC (2000b) evaluated potential risks of avian collision at HCC transmission lines. In the literature, avian collision mortality has been documented for 16% (56 of 349) of species that occur at least seasonally near the HCC transmission lines (Csuti et al. 1997, Stephens and Sturts 1998). Moreover, 8 species were specifically identified as sustaining collision mortality from the HCC transmission lines (i.e., white-faced ibis [*Plagadis chihi*], American white pelican [*Pelecanus erythrorhynchos*], common merganser [*Mergus merganser*], double-crested cormorant [*Phalacrocorax auritus*], great blue heron, Franklin's gull [*Larus pipixcan*], marbled godwit [*Limosa fedoa*], and Baird's sandpiper [*Calidris bairdii*]. Nineteen of 56 sites (i.e., 2 km of the lines) where transmission lines intersect aquatic habitat were considered to have high avian use and therefore high collision potential. Avian collisions were confirmed at 2 of these sites (SAIC 2000b).

One collision site is located downstream of American Falls Dam where the Borah-Brady line (no. 923) spans the Snake River (Figure 7 in SAIC 2000b). During 31 days (85.5 h) of observation, IPC personnel observed 5 collisions at this site (IPC, unpublished data). In an attempt to minimize bird collisions, 258 Bird Flight Diverters were attached to the static wires of the Borah-Brady line and an additional transmission line on 21 January 2001. Subsequent monitoring between January and September 2001 revealed no additional collisions. The second collision site occurs along the Midpoint-Adelaide-Borah line (no. 951) where it crosses wastewater ponds for a food-processing factory. Between December 1999 and September 2001, IPC personnel surveyed the wastewater ponds. Thirty-one bird carcasses were found under this line and others that cross the ponds, although confirmation of collision could only be determined for 10 carcasses. Eighteen carcasses were of the white-faced ibis, a *special status* species in Idaho (Table 6).

To identify appropriate mitigation needs, we conclude that additional information is required at the 2 confirmed collision sites and other potential collision sites. We propose that monitoring at the wastewater-pond site and American Falls Dam site should continue for 1−2 years (i.e., 2002 and 2003). We also propose that monitoring should occur at sites where transmission lines cross aquatic habitats and have high potential for avian collision.

4.2. Impacts to Botanical Resources

Identifying impacts to botanical resources is a specific concern for relicensing the Hells Canyon Complex (FERC 1990, IPC 1997). During IPC's relicensing consultation, state and federal resource agencies identified several issues and expressed concerns about potential impacts to botanical resources (IPC 1997). Primary issues were that operations of the HCC 1) prevent perennial habitats from becoming established between reservoir maximum operational drafting depths and full-pool shorelines (referred to as reservoir fluctuation zones); 2) prevent the establishment of perennial riparian habitat along full-pool reservoir shorelines (reservoir shoreline zones); 3) negatively affect botanical resources downstream of Hells Canyon Dam (river shoreline zone), 4) decrease habitat for threatened, endangered or other special status plant species; 5) contribute to the spread of listed noxious weeds and other undesirable plants; and 6) accelerate erosion of shoreline banks and botanical habitats.

IPC conducted several studies to investigate issues about potential impacts to botanical resources. IPC evaluated and compared operational impacts to botanical resources for two potential operational scenarios; 1) proposed operations for the complex and 2) full pool run-of-river operations wherein hydroelectric operations would not influence reservoir water-surface elevations or outflows from Hells Canyon Dam (See Parkinson 2002 for a description of operational scenarios). For individual botanical issues, studies were designed to 1) describe current resource conditions, 2) identify potential impacts from proposed operations of the complex, and 3) estimate magnitudes of operational impacts.

4.2.1. Vicinity of HCC

4.2.1.1. Reservoir Operation

4.2.1.1.1. General Riparian and Upland Habitats in Fluctuation Zones

The Hells Canyon Complex reservoirs formed fluctuation zones when water levels were manipulated during historical operations (Parkinson 2002). Although drafting of Brownlee Reservoir has historically varied within and among years, relatively large seasonal fluctuations were common. But during years with a large spring runoff, fluctuations rarely extended to the 101-ft level (2,077 ft msl) allowed in the license for flood control (Parkinson 2002). The fluctuation zones of Oxbow and Hells Canyon reservoirs were relatively small (typically less than 5 ft rather than the 10-ft maximum allowed) (Parkinson 2002).

Large annual fluctuations on Brownlee Reservoir expose a barren zone and, where fine sediments are available, can be annually colonized by species such as *Xanthium strumarium* (common cocklebur), *Portulaca oleracea* (purslane), *Amaranthus* species (pigweed), and *Echinochloa crus-galli* (barnyard grass) before being inundated when Brownlee Reservoir is refilled (Holmstead 2001a, Braatne et al. 2002). In this fluctuation zone, these species are able to germinate, grow, and set seed during periods of drawdown, whereas most native and exotic perennial species cannot survive to propagate. In contrast, the smaller fluctuations of Oxbow and Hells Canyon Reservoirs largely prevent the establishment of annual species in the fluctuation zones, and shoreline habitats predominantly consist of perennial herbaceous and woody species (Braatne et al. 2002, Section 2.3.2.2).

Blair et al. 2002 conclude that the current lack of vegetation in the fluctuation zones would persist into the future, regardless of the operational scenario used. That is, under either proposed operations or full pool run-of-river operations, the reservoir fluctuation zones would be at least seasonally inundated. Therefore, proposed operations would permanently and completely eliminate the capability of the fluctuation zones to support perennial vegetation habitats (Blair et al. 2002).

Blair et al. (2002) estimated that 5,820 acres in the 101-ft fluctuation zone of Brownlee Reservoir, 89 acres in the 10-ft fluctuation zone of Oxbow Reservoir, and 240 acres in the 10-ft fluctuation zone of Hells Canyon Reservoir are affected by operations and therefore impact botanical habitat. To further evaluate impacts to botanical habitats (wildlife habitats), Blair et al. (2002) estimated theoretical amounts of perennial riparian and upland habitats that proposed operations would prevent from establishing in the fluctuation zones. It was estimated that proposed operations would prevent 1) Brownlee Reservoir from supporting 372 acres of riparian and 5,448 acres of upland habitats, 2) Oxbow Reservoir from supporting 7 acres of riparian and 82 acres of upland habitats, and 3) Hells Canyon Reservoir from supporting 9 acres of riparian and 231 acres of upland habitats (Blair et al. 2002).

We conclude that proposed operations would impact 6,148 acres (388 acres riparian habitat and 5,761 acres upland habitat) of botanical habitat within the fluctuation zones of the three Hells Canyon Complex reservoirs. Protecting (for example, through acquisition) and enhancing riparian and upland wildlife habitat would constitute appropriate mitigation for operational impacts to the reservoir fluctuation zones. This acreage is not additive to that stated in Section 4.1.1.1.2.

4.2.1.1.2. General Riparian and Upland Habitats in Shoreline Zones

Reservoir operations often affect riparian habitats, particularly where large seasonal water-level fluctuations occur. Such fluctuation, while creating new full-pool reservoir shorelines, inhibits riparian vegetation from establishing (Lewke and Buss 1977).

Comparing reservoir and lake ecology provides a reference point for understanding the environmental impacts associated with reservoir operation. Lakes are relatively stable ecological systems. Decades if not centuries are often required for lake shorelines to achieve equilibrium. Easily erodable shoreline substrates have been leveled creating shallow, low-gradient landscapes while more durable substrates such as rock outcrops remain as cliffs or steep-gradient shorelines.

The degree to which reservoirs function as natural lakes depends largely on the magnitude of water-level fluctuations. Reservoirs that closely mimic the water-level fluctuations of natural lakes tend to have richer shoreline communities, although generally not as rich as natural lakes. Reservoir shorelines are not as stable or complex as lake shorelines (Ganda 1996).

Large seasonal drafting of Brownlee Reservoir has historically limited the extent of riparian habitat in the shoreline zone of this reservoir (Holmstead 2001a and Braatne et al. 2002). Most existing riparian habitat in the shoreline zone of Brownlee Reservoir occurs near the mouths of tributary streams or springs, where the shoreline soil moisture is not dependent on reservoir water-surface elevation. In some locations, a narrow linear band of facultative perennial riparian species (i.e., adapted to benefit from temporary mesic conditions) exists along the full-pool

shoreline (Holmstead 2001a and Braatne et al. 2002). During periods of drawdown, where fine sediments occur, expansive areas can be colonized by ruderal annual species, such as *Xanthium strumarium*, *Portulaca oleracea*, *Amaranthus* species (pigweed), and *Echinochloa crus-galli* (barnyard grass). Otherwise, upland vegetation comprises most of the shoreline zone, extending to the reservoir full-pool shoreline (Holmstead 2001a).

In contrast to Brownlee Reservoir, trees, shrubs, and other perennial riparian species, are relatively abundant along Oxbow and Hells Canyon Reservoirs (Holmstead 2001a, Section 4.4; and Braatne et al. 2002, Section 2.3.2.2). Historic, relatively stable pool levels at both Oxbow and Hells Canyon reservoirs likely enhanced establishment of riparian habitats compared with what would exist if the reservoirs were not held relatively stable (Blair et al. 2001). Where suitable substrate and topography occur, a relatively wide band of perennial riparian habitat is promoted by the combination of small daily water fluctuations that "irrigate" riparian vegetation during the growing season and no large seasonal drafting (Braatne et al. 2002, Section 2.3.2.2; and Blair et al. 2001).

An 'irrigation effect' refers to the promotion of vegetation growth and vigor through supplemental water. Applicant considers that the phrase may be somewhat new relative to discussion of riparian hydraulics, but the recognition that an increase in summer stream flow (stage) can promote riparian vegetation is fully consistent with numerous reports (Nilsson and Keddy 1988, Hill et al. 1998, Springer et al. 1999, Jansson et al. 2000). Along Oxbow and Hells Canyon reservoirs, the obvious proliferation of trees and shrubs above the full-pool elevation provides further demonstration of an 'irrigation effect.'

Soil resources along Oxbow and Hells Canyon reservoirs are favorable for riparian vegetation establishment. Soil and substrate affinities for riparian vegetation occurrence on these reservoirs ranged from fine to coarse substrates, similar to patterns observed for Brownlee Reservoir (Braatne et al. 2002, Section 2.3.2.2). Using GIS cover type data from mapping efforts reported in Holmstead (2001a), existing riparian habitat (*Forested Wetland*, *Scrub-Shrub Wetland* and *Emergent Herbaceous Wetland* cover types) within a 20-m planimetric band above the high water mark constitute 21.5% and 20.0% of the total area along Oxbow and Hells Canyon Reservoirs, respectively. This compares to 9.8% along Brownlee Reservoir, 39.8% in the Weiser reach and 17.7% in the reach below Hells Canyon Dam.

To estimate impacts of potential future operation of the Hells Canyon Complex on the shoreline botanical resources, Braatne et al. (2002) modeled the effects of two hypothetical scenarios: proposed operations and run-of-river operations. Investigators predicted modest differences along shoreline riparian habitats between the 2 scenarios for Oxbow and Hells Canyon reservoirs, indicating that there is no real advantage from a general vegetation perspective of either scenario over the other because of the lack of dramatic or significant differences in timing and magnitude of water level variations between the scenarios (Braatne et al. 2002, Section 3.6.2.2 and Table 6.1). For Brownlee Reservoir, the riparian corridor would likely migrate upslope, and would be expected to be denser (i.e., more plant cover and plant density) under run-of-river operations than proposed operations (Braatne et al. 2002, Section 3.6.2.1). A distinct difference between the 2 scenarios was in relation to the dispersal and proliferation of noxious weed species, which is discussed later in Section 4.2.1.1.3

On Oxbow and Hells Canyon reservoirs, investigators predicted a slight reduction in the extent of perennial riparian vegetation with proposed operations compared to run-of-river operations (Braatne et al. 2002, Table 6.1). With proposed operations, riparian perennials would extend further downwards along the elevational profile, but those at the upper end of the riparian zone would be less favored. With run-of-river operations, the riparian zone would be expected to become more densely vegetated and migrate slightly upslope.

Generally, because perennial vegetation persists in the riparian zone of Oxbow and Hells Canyon reservoirs, opportunities for recruitment of annuals, which are ecological pioneers and often shade-intolerant, would be diminished. Modeling efforts predicted a slight downward extension of ruderal annuals with the proposed scenario but decreased occurrence from full pool up to about 2.5 m (Braatne et al. 2002, Figure 3.14). The ruderal annuals would likely not complete their life cycles under the daily/hourly fluctuation zone influence, and would not effectively compete with the perennial vegetation in the dense vegetation zone near full pool (Braatne et al. 2002, Section 3.6.2.2). Evidence for this predicted lack of annual species is demonstrated by the current composition of riparian plant assemblages along Oxbow and Hells Canyon reservoirs in which annual species are an insignificant component of the assemblages (Appendix 3 in Holmstead 2001a, and Section 2.3.2.2 in Braatne et al. 2002).

Overall, investigators predicted rather modest differences between the 2 scenarios along these reservoirs, indicating that there is no real advantage from a general vegetation perspective of either scenario over the other (Braatne et al. 2002, Section 3.6.2 and Table 6.1).

In attempts to quantify impacts to botanical habitats in the shoreline zones, Applicant's contractors estimated impacts to the establishment and extent of riparian habitat (Blair et al. 2002). They compared the projected future composition and extent of cover types in the reservoir shoreline zones for proposed and full pool run-of-river operational scenarios.

They determined that neither scenario would change the relative composition and extent of riparian and upland cover types from current conditions within shoreline zones of Oxbow and Hells Canyon reservoirs. Proposed operations nearly mimic patterns of water-surface elevations that historically occurred during the vegetation growing season (Parkinson 2002). It was concluded that if proposed operations occurred for 30 years or more, the relative composition of riparian and upland cover types within all three reservoir shoreline zones would remain unchanged from current conditions (Blair et al. 2002). Similarly, full pool run-of-river operations would not alter the relative composition of riparian and upland cover types from current conditions within shoreline zones of Oxbow and Hells Canyon reservoirs (Blair et al. 2002). Therefore, the extent and composition of riparian cover types in the shoreline zones of Oxbow and Hells Canyon reservoirs would remain essentially unchanged regardless of operation scenario. However, some negative influences of increase noxious weed dispersal from full pool run-of-river operations may decrease the quality of riparian cover types on these reservoirs, as discussed in Section 4.2.1.1.3.

Current riparian and upland cover type conditions within the shoreline zone of Brownlee Reservoir would change under full pool run-of-river operations. Under these operations, reservoir water-surface elevations would be held constantly at full pool, a level that would promote establishment of an estimated 343 additional acres of riparian cover types (Blair et al.

2002). Investigators indicate however, that newly established riparian plant communities along Brownlee Reservoir's shorelines would more closely resemble the characteristics (e.g., species cover, composition, density) of the abundant weed-dominated communities found upstream in the Weiser reach (Blair et al. 2002, Holmstead 2001a, Braatne et al. 2002). This invasion of weedy introduced riparian species would be expected to negatively influence native riparian communities located downstream of Brownlee Reservoir (Braatne et al. 2002, Chapter 4).

We conclude that proposed operations would prevent 343 acres of riparian habitat from establishing along the Brownlee Reservoir shoreline zone that is currently occupied by upland habitat, and that neither scenario would significantly alter vegetation cover types along Oxbow and Hells Canyon Reservoirs. Habitat management actions designed to protect (for example, through acquisition) and enhance 343 acres of riparian habitat would constitute appropriate mitigation for operational impacts to the establishment of riparian habitat along the reservoir shoreline zones. This acreage is not additive to that stated in Section 4.1.1.1.3.

4.2.1.1.3. Reservoir Operations and Noxious Weeds

Riparian zones are generally vulnerable to invasion by exotic species because riverine environments are dynamic and have recurrent disturbances (e.g., flooding, scour, and sediment movement and deposition), water is available year-round, and rivers form a natural network for propagule dispersal (Planty-Tabacchi et al. 1995). Weed invasions can be pronounced where natural communities are further disturbed by river regulation (Nilsson and Berggren 2000).

Prior to and since construction of the Hells Canyon Complex, residential, industrial, recreational, and agricultural influences both upstream and within Hells Canyon likely introduced many weedy species to the Hells Canyon ecosystem. Most of the weedy species identified in Krichbaum (2000) appear to have been present within the study corridor prior to the HCC (Blair et al. 2001). With these weed introductions and the capacity of these species to proliferate, the current abundance of weeds in Hells Canyon is not surprising. Weedy exotic species would occur along the Snake River in Hells Canyon without the influence of HCC operations. Nonetheless, historic operation of the HCC reservoirs has likely contributed to the spread of noxious weeds.

Although regulated water levels from hydroelectric operations can contribute to exotic weed invasion in riparian habitats, the large water-level fluctuations during historical operations on Brownlee Reservoir may have provided a barrier to impede downstream infestation of many perennial weedy species (Holmstead 2001a, Section 4.4; Braatne et al. 2002, Chapter 4). The capacity of reservoirs to hinder 'hydrochory', water-based plant propagation, is well established and underlies the concept of 'fragmentation' that is prominent in the current literature (Nilsson et al. 1991, Dynesius and Nilsson 1994, Nilsson and Jansson 1995, Johnson 2002). Essentially, floristic dissimilarities result between upstream, reservoir, and downstream reaches (Jansson et al. 2000). Most riparian plant species, both native and exotic, are unable to establish and survive the successive drying and flooding in reservoir fluctuation zones that experience large, seasonal water-level changes (Nilsson and Keddy 1988).

Table 12 in Holmstead (2001a) identifies common and abundant exotic weedy riparian species found almost exclusively upstream and in the headwaters of Brownlee Reservoir that may have

been impeded in their downstream spread. These species have appropriate life history traits for potentially increasing in abundance and distribution downstream under natural or regulated river flow conditions. However, these species occur relatively infrequently, if at all, downstream of the headwaters of Brownlee Reservoir (Krichbaum 2000, Holmstead 2001a, Braatne et al. 2002). Life history traits for several riparian species including exotic weedy riparian species are discussed by Braatne et al. (2002) in Appendix 3.2 of that report.

Specific evidence suggests that seasonal drafting of Brownlee Reservoir has impeded *Tamarix* species from invading riparian habitats downstream of Brownlee Reservoir. *Tamarix* is an aggressive, woody species that produces massive quantities of small seeds and can propagate from buried or submerged stems or branch fragments. It often forms dense monotypic stands that out-compete other riparian species (de Gouvenain 1996) and replaces native trees (Ellis 1995, Cleverly et al. 1997). *Tamarix* is listed in other western states as a noxious weed, although not in Idaho. It was speculated to be a relatively recent (10–15 years) invader to the headwaters of Brownlee Reservoir (Holmstead 2001a), and the average age of a few cored plants in the study area was 9 years old (Braatne et al. 2002). However, the first record of *Tamarix* in the vicinity is in 1938 (54 years ago), occurring in an abandoned field northwest of Weiser, Idaho, Washington County (Rice, 2002). Salt cedar is quite prolific in the headwaters of Brownlee Reservoir and upstream along the Snake River, but was found nowhere else along the Snake River in Hells Canyon (Holmstead 2001a, Appendix 3, see distribution maps of *Tamarix*-dominated assemblages in the *Forested Wetland* and *Scrub-Shrub Wetland* cover types; and Krichbaum 2000, Figure 16). Suitable habitat for *Tamarix* occurs all along the Snake River in Hells Canyon (Braatne et al. 2002). Furthermore, *Tamarix* also occurs downstream of Hells Canyon on the Snake and Columbia rivers where it has negatively impacted native flora and fauna.

On the upper reaches of Brownlee Reservoir, young seedlings (or clonal fragments) of *Tamarix* annually establish in the fluctuation zone but are subsequently killed by refilling of the reservoir (Holmstead 2001a). *Tamarix* cannot survive more than 3 months of flooding (Stevens 1990). The young plants that establish in the reservoir shoreline zone are subsequently killed by long periods of drafting. Although not totally depended on permanent ground water (Turner 1974), mature *Tamarix* usually occurs in areas where its roots can reach the water table (depth to ground water does not exceed 3 to 5 m), such as flood plains, along irrigation ditches and on lakeshores. Given the invasive capacity of this species, if water levels were held relatively stable on Brownlee Reservoir (e.g., full pool run-of-river operations), *Tamarix* could spread rapidly downstream to quickly dominate shoreline riparian habitats (Holmstead 2001a, Braatne et al. 2002). After investigating potential impacts of proposed and full pool run-of-river operations on riparian habitats, investigators concluded, *"Of all of the probable impacts addressed in the present report, the prevention of encroachment of salt cedar into the natural riparian zone along the Snake River downstream from the Hells Canyon Dam may be the most ecologically significant"* (Braatne et al. 2002).

Although historical operations on Brownlee Reservoir may have been effective in controlling downstream infestation of many weedy riparian species, especially in the 41.5-mile long main pool subreach of Brownlee Reservoir, several other weedy species occur along Oxbow and Hells Canyon reservoirs. These have probably been introduced by other vectors (e.g., recreation activities, vehicles, livestock, homesteading) coincident with, and prior to, construction and operation of the HCC (Holmstead 2001a, Braatne et al. 2002). The Oxbow and Hells Canyon

reservoir reaches historically, and today, are readily accessible by vehicle traffic. However, in contrast to the headwaters of Brownlee and the Weiser reach, the most abundant and common riparian plant assemblages along Oxbow and Hells Canyon reservoirs are dominated by native woody species such as *Betula occidentalis*, *Alnus rhombifolia*, *Philadelphus lewisii*, *Toxicodendron radicans*, and *Populus trichocarpa*. Relatively few riparian plant assemblages along Oxbow and Hells Canyon reservoirs are dominated by non-native vegetation (Holmstead 2001a, Braatne et al. 2002).

Applicant conducted three integrated studies (Krichbaum 2000, Holmstead 2001a, Braatne et al. 2002) to assess the influence of proposed and full pool run-of-river operations on the spread of noxious weeds. The first two studies (Krichbaum 2000 and Holmstead 2001a) were designed to provide descriptive and predictive data on the occurrence of target weed species.

Results of Holmstead (2001a) helped to identify and quantify the relative distribution and abundance of noxious weed dominated plant assemblages throughout the study area using systematic random sampling protocols. Two important findings were identified regarding noxious weed occurrence; 1) distribution gradients exist for the occurrence of noxious weed dominated upland and riparian plant communities, and 2) that historic operations of the HCC may have imposed a dispersal barrier to the downstream spread of noxious riparian weeds by the draw-down pattern of Brownlee Reservoir (Holmstead 2001a, Section 4.4). Riparian noxious weed-dominated plant assemblages were more abundant and widespread in the upstream reaches (headwaters of Brownlee Reservoir and the Weiser Reach) compared to along Oxbow and Hells Canyon reservoirs and along the downstream reach.

Results of Krichbaum (2000) further identified and quantified the relative distribution and abundance of riparian and upland noxious weed populations and provided predictive data on the occurrence of weed populations. Investigators confirmed that riparian noxious weed populations were more abundant and widespread in the upstream reaches (headwaters of Brownlee Reservoir and the Weiser Reach) compared to the abundance of upland weed populations as one progresses downstream. Using data from Table 2 in Krichbaum (2000), each species was classified as a riparian or upland weed and the number of occurrences were summed by reach (tabulated below). Species considered to be riparian weeds included *Amorpha fruticosa, Lepidium latifolium, Phalaris arundinacea, Conium maculatum, Cirsium arvense, Tamarix, Elaeagnus angustifolia, Lythrum salicaria, Equisetum arvense, Cyperus esculentus*, and *Euphorbia esula*. Results indicate that the downstream reach had relatively few riparian weed populations (10% of the total sites). This compares to about 30% on Hells Canyon and Oxbow Reservoirs, about 45% on Brownlee Reservoir, and about 70% in the upstream Weiser reach. Most of the riparian weed populations on Brownlee Reservoir occurred along the headwaters of the reservoir (see weed distribution maps, Figures 3−21 of Krichbaum 2000).

	No. of weed populations and relative percent of reach (in parenthesis)					
Noxious weed type	Down-Stream	Hells Canyon Res.	Oxbow Res.	Brownlee Res.	Weiser	All Reaches
Riparian	32 (10.0)	109 (30.6)	63 (30.1)	356 (45.4)	164 (70.1)	724 (38.0)
Upland	289 (90.0)	247 (69.4)	146 (69.9)	429 (54.6)	70 (29.9)	1,181 (62.0)
Total	321	356	209	785	234	1,905
Total River Miles	59.3	22.0	14.2	55.5	12.0	163
Ac Riparian/RM[1]	3.0	3.7	3.6	2.0	15.9	3.8

[1] Acres of riparian vegetation in a 20-m planimetric band along the shoreline per river mile (RM).

Often, several factors influenced the occurrence of each noxious weed population. The types of disturbance present at each population and the level of disturbance (e.g., 'extreme,' 'high,' 'moderate,' or 'slight'; defined in Section 3.1.3 of Krichbaum 2000) at each population are summarized by species in Appendix 6 of Krichbaum (2000). Generally, each disturbance factor (alluvial, flow zone [water level fluctuations], livestock grazing, mining, fire, road maintenance, recreation [camping, boating facilities], trail use, industry, agriculture and off road vehicle use) was significantly ($p<0.001$) correlated with populations of one or more noxious weed species. In the reservoir reaches, 2,664 disturbance types were recorded at 1,350 weed populations. The most frequent disturbance factors were flow zone, recreation, road maintenance and livestock grazing (Krichbaum 2000, Appendix 5).

Investigators identified two noxious weed species (*Lepidium latifolium* and *Phalaris arundinacea*) and one special interest weed (*Amorpha fruticosa*) to be significantly and positively associated with water fluctuations (Krichbaum 2000, Table 5). These species benefit from recurrent water-level fluctuations that create sites for weeds to establish and persist in riparian habitats. Other species, specifically *Cyperus esculentus*, *Equisetum arvense*, *Euphorbia esula*, *Lythrum salicaria*, and *Tamarix* were also positively associated with water-level fluctuations (Krichbaum 2000, Table 5).

To specifically assess the potential effects of future operations, a modeling study was conducted (Braatne et al. 2002). Investigator's results, based on a combination of the modeling analysis and life history consideration, predicted that fifteen weedy species would be similarly affected across the two operational scenarios. One ruderal annual species, *Tribulus terrestris*, was predicted to increase in abundance with the proposed versus full pool run-of-river scenario. Four perennial species, including *Cardaria draba*, *Euphorbia esula*, *Tamarix* species and possibly *Elaeagnus angustifolia*, would be substantially reduced with the proposed scenario because the draw-down of Brownlee Reservoir would continue to impede their downstream expansion. Investigators also recognized the occurrence of a dispersal barrier imposed by the draw-down pattern of Brownlee Reservoir, and anticipated a substantial ecological benefit of the proposed scenario relative to the

full pool run-of-river scenario (Braatne et al. 2002, Section 4.3) by retarding the downstream spread of undesirable plant species.

In summary, we conclude that proposed operations would contribute to the spread of noxious weeds along the reservoir reaches in Hells Canyon, but to a much lesser extent than with full pool run-of-river operations. We cannot quantitatively identify the extent (e.g., acreage or number of populations) of operational impacts of either future scenario on the potential spread of noxious weeds along the reservoir reaches. Under proposed operations, the combination of drought stress and inundation stress on Brownlee Reservoir would eliminate the vast majority of many weedy species encroaching from upstream sources (reduction of seeds and plant propagules), controlling downstream infestation especially in the 41.5-mile long main pool subreach of Brownlee Reservoir.

Braatne et al. (2002) acknowledges that it may be just a matter of time before botanical resources along the reservoir reaches are negatively influenced by upstream weed sources regardless of the dispersal barrier imposed by drawdown operations on Brownlee Reservoir. Occasionally, individuals of these invasive weeds would become established at locations such as near tributary inflows, that would be survivable, and although impeded, eventually these plants would probably extend downstream beyond Brownlee Reservoir. Additionally, there are alternate propagule sources beyond the inputs from the Weiser reach and the Powder River, and these would also enable expansion of invasive plants. On Oxbow and Hells Canyon reservoirs, both proposed and full pool run-of-river operations would contribute similarly to the spread of existing levels of noxious weeds.

Other factors that influence the spread of noxious weeds along the Snake River corridor through Hells Canyon include management actions of federal and state agencies and other private landowners. Because of the high percentage of federally owned lands in the reservoir reaches, which are largely under BLM ownership, actions of the BLM and USFS likely play a significant role in the spread of noxious weeds. Federal and state land managers oversee grazing allotments, road maintenance activities, recreation facilities and other public uses in the study area, all of which can contribute to the spread of noxious weeds. These influences can affect the spread of weeds 1) directly through spreading of weed seed and plant parts, and 2) indirectly by creating disturbance to soil and vegetation which create conditions more conducive to weed invasion. Recreationists, livestock operators, subcontractors, federal personnel, and the public that visit this area can unknowingly spread weeds when passing through areas of noxious weeds. Weed propagules are picked up on equipment, clothing and animals and can be spread along roadways or travel corridors, including water-based recreation sites (Loney and Hobbs 1991). Weeds can be transported within the canyon, or brought in from outside sources from visitors. Once present, these weeds can invade adjacent native habitats (MacLellan and Stewart 1986). Actions by natural resource agencies, state and county governments, non-governmental organizations, private landowners and the public contribute to disturbance of upland and riparian habitats and make weed control necessary.

Because many factors influence the spread of noxious weeds along the reservoir reaches, we recommend that IPC take the lead role in developing and participating in cooperative agreements with federal land management agencies and other private landowners to control establishment and spread of noxious weeds in the project area. All landowners would be expected to contribute

one or more of the following items: 1) funding, 2) management, 3) technical expertise, 4) logistical involvement, 5) in-kind support, and 6) materials, to assist in weed control activities. Specifically, we recommend participating with local organizations called Cooperative Weed Management Areas (CWMAs), or with similar organizations, that are involved with areas bordering the Snake River in Hells Canyon and with increasing focus on the control of *Tamarix* species. CWMAs build cooperative relationships among agencies, landowners, land managers, and other interested individuals and organizations—relationships that are needed to effectively manage noxious weeds (ISDA 1999).

4.2.1.1.4. Reservoir Operations and Rare Plant Species

Many factors negatively impact rare plant populations along the Snake River corridor through Hells Canyon (Krichbaum 2000). This can include disturbance from off-road vehicle use, camping, hiking, boating, livestock grazing, agriculture, residential activities, industrial activities, fire, road maintenance, and water level fluctuations (both natural and river regulation). Actions by natural resource agencies, state and county governments, non-governmental organizations, private land owners and the public contribute to disturbance of upland and riparian habitats and make protection of rare plant populations necessary.

Applicant conducted two integrated studies (Krichbaum 2000 and Braatne et al. 2002) to assess the influence of proposed and full pool run-of-river operations on rare plants. In the first study, populations of four species of special status plants were found in the reservoir reaches. These included: *Mimulus patulus*, *Leptodactylon pungens* ssp. *hazeliae*, *Bolandra oregana*, and *Carex hystricina* (Krichbaum 2000). *Mimulus patulus* occurred only in the reservoir reaches, while the latter three species also occurred in the reach below Hells Canyon Dam.

No federally listed endangered or threatened species are known to occur in the shoreline zones of the HCC reservoir reaches. Therefore, no negative impacts to federally listed species are expected to occur from either proposed or full pool run-of-river operations.

In the second study, investigators predicted the potential influence of proposed and full pool run-of-river operations based on knowledge of life history traits and distributional patterns of the species (Braatne et al. 2002, Chapter 5). It was originally intended to conduct a modeling study to predict the potential influence of future scenarios, but due to lack of sampling data (too few observations), a modeling approach was deemed infeasible. For most species considered to be rare, there is a lack of clear documentation of their geographic distribution and ecological properties. Braatne et al. (2002) did not observe rare plants along reservoir shorelines during vegetation sampling (185 transects; 1.15 transects/RM), but did encounter several populations of *Cyperus schweinitzii* (Schweinitz flatsedge), within the riparian zone of the Hells Canyon reach of the Snake River (see Section 4.2.2.1.3). Investigator's used results of rare plant observations from Krichbaum (2000) and professional judgment to assess potential influences to populations of these special status species from proposed or full pool run-of-river operations on the reservoirs as identified below.

One population of *Mimulus patulus* was found along Oxbow Reservoir. The population was found growing on gently sloping, damp, rocky ground in a road cut adjacent to State Route 71. Status of this species is reviewed by Krichbaum (2000) (Section 3.2.2 of that report). The site is

located well above the full pool shoreline and approximately 20 m laterally from Oxbow Reservoir. Disturbance from the road corridor was recorded as 'extreme' for this site (although a retaining wall does separate the population from the road) (for definitions of ratings such as 'extreme,' 'high,' 'moderate,' or 'slight' used in rare plant surveys, see Section 3.1.3 of Krichbaum 2000). Disturbance from recreation, livestock, and alluvial erosion and/or deposition was recorded as slight. The site is not affected by water level fluctuations of either proposed operations or run-of-river operations (Krichbaum 2000, Braatne et al. 2002).

Six populations of *Leptodactylon pungens* ssp. *hazeliae* were found: one downstream of Hells Canyon Dam, and five along Hells Canyon Reservoir. There are 7 previously known populations in the vicinity of the HCC. Status of this species is reviewed by Krichbaum (2000) (Section 3.2.2 of that report). The 5 newly located populations were found growing on dry, steep to vertical cliffs above the reservoir's full pool shoreline. Neither proposed operations or run-of-river operations would negatively affect the populations as they are outside the influence of water level fluctuations (Krichbaum 2000, Braatne et al. 2002). No other disturbance factors were noted, such as disturbance from recreation activities, road maintenance, livestock grazing, fire, or off-road vehicle use.

Four populations of *Bolandra oregana* were found: 1 along Hells Canyon Reservoir and 3 on Oxbow Reservoir. There are also 2 previously known populations of this species on the Oregon side of the Snake River, just north of Brownlee Dam. These 2 populations were outside the 50-m-wide survey area. Status of this species is reviewed by Krichbaum (2000) (Section 3.2.2 of that report). All populations were found growing near seeps or streams in cliffs, surrounded mostly by bare rock. The 4 sites on Hells Canyon and Oxbow reservoirs were subject to a variety of disturbances including alluvial action, recreation, road corridor disturbance, livestock grazing, fire, and off-road vehicle use. The sites are not affected by water level fluctuations of either proposed operations or run-of-river operations (Krichbaum 2000, Braatne et al. 2002).

Seven populations of *Carex hystricina* were found along Oxbow Reservoir. There are two previously known occurrences of this species in the vicinity of the HCC; one along Hells Canyon Reservoir and one along Oxbow Reservoir. These two sites are located outside the 50 m survey corridor of the reservoir shorelines. Status of this species is reviewed by Krichbaum (2000) (Section 3.2.2 of that report). Populations were found growing in either relatively bare shoreline areas, or relatively lush riparian communities. Disturbance from many sources was evident at most of the sites. Because proposed conditions nearly mimic patterns of water-surface elevations that historically occurred during the vegetation growing season, proposed operations should not negatively affected these populations. However, full pool run-of-river operations may further benefit populations by providing more stable hydrologic conditions on the reservoirs for this obligate riparian species (Braatne et al. 2002).

We conclude that compared to full pool run-of-river operations, proposed operations may limit expansion of some hydrophytic rare plant populations, specifically *Carex hystricina*, along Hells Canyon and Oxbow reservoir reaches.

Because many factors negatively impact rare plant populations along the reservoirs, and because much of the area surrounding the reservoir reaches is under BLM and USFS jurisdiction, we recommend working cooperatively with federal land management agencies and other

conservation groups to protect rare plant sites impacted by disturbance activities (activities both related and unrelated to HCC operations). Cooperative efforts could include protection (e.g., land acquisition or management actions) and site enhancement activities (including reintroduction projects when determined to be viable and consistent with agency management plans).

4.2.1.1.5. Reservoir Operations and Shoreline Erosion of Terrestrial Habitat

The comparison between reservoir and lake ecology again provides a useful reference point for understanding environmental impacts associated with reservoir operation, specifically regarding shoreline bank erosion. Lakes are relatively stable ecological systems. The state of equilibrium that lakes have achieved with their shorelines is generally the result of decades if not centuries of interaction. Easily erodable shoreline substrates have been leveled creating shallow, low-gradient landscapes while more durable substrates such as rock outcrops remain as cliffs or steep-gradient shorelines. Generally, reservoir shorelines are young, still moving toward a more stable state. As a result, many reservoirs are beset by shoreline erosion problems (Allen and Wade 1991). Erosion problems are particularly severe along reservoir shorelines that are steep and friable. Shoreline erosion can be the most severe in reservoirs with large fluctuations (O'Neil and McDonnell 1995).

Historic operations of the Hells Canyon Complex have contributed to the current extent of shoreline erosion along the reservoir reaches. The total area of shoreline erosion sites in the study area (from Weiser to the confluence of the Salmon River) was estimated to be 100.7 acres (Holmstead 2001b). Detailed information on the location, extent, and other inventory data for each site are provided in Figure 3 and Appendix 2 of Holmstead 2001b). Excluding sites in the Weiser reach (10.6 acres), 90.1 acres of erosion sites occurred along reaches potentially influenced by historic HCC operations; of these, about 83.8 acres were in the reservoir reaches, and 6.3 acres were below Hells Canyon Dam.

The Brownlee Reservoir reach had the highest rate of bank erosion: 261 sites (69% of all sites) occurring along about 27.2% of the available shoreline (49.6 mi out of 182.3 total shoreline miles). Total area of erosion was estimated as 79.07 acres on Brownlee Reservoir. The Oxbow Reservoir reach had relatively little bank erosion: 9 sites along 2.0% of the available shoreline (0.51 mi out of 25.0 total miles). Total area of erosion was estimated at 1.34 acres. Similarly, the Hells Canyon Reservoir reach had relatively little bank erosion: 39 sites along 2.7% of the available shoreline (1.45 mi out of 53.9 total miles). Total area of erosion was estimated at 3.45 acres.

Shorelines along the reservoirs are susceptible to many natural and human influences, including wind-driven waves, boat-generated waves, water level fluctuations, groundwater seepage, grazing, roads, alluvial flooding, channel flow, and recreation (for example, bank fishing and camping in undeveloped sites, sometimes called dispersed or impromptu camping). Usually, several factors influence erosion at each site. The types and severity of influences (e.g., 'extreme,' 'high,' 'moderate,' or 'slight') affecting each erosion site are identified in Appendix 2 of Holmstead (2001b). On Brownlee Reservoir, 1,263 disturbance types were recorded at 261 erosion sites. This compares to 41 factors at 9 sites on Oxbow Reservoir, and 162 factors at 39 sites on Hells Canyon Reservoir. Generally, the most frequent disturbance factors in the reservoir reaches were water level fluctuations, wind-generated waves, excessive slope, boat-

generated waves, highly erosive soil, and recreation (Holmstead 2001b, Table 3). Because many of these influences are interrelated, attributing the cause of erosion at each site to any single factor is difficult. Because the reservoirs in the HCC are relatively recent features, some level of erosion is expected to occur under any operational scenario until the new shorelines reach equilibrium with the ecological and human influences.

Predicting quantitative differences between the effects of the proposed and the full pool run-of-river scenarios on shoreline erosion is difficult (e.g., acreage or number of sites). We believe that full pool run-of-river operations on Brownlee Reservoir would reduce shoreline erosion. This reduction would be due to an absence of large drawdowns and therefore decreased potential for slumping during periods of drawdown, when slopes are often susceptible to failure because of rapid soil moisture movements. Stable water levels on Brownlee Reservoir would also be expected to result in an additional 343 acres of riparian vegetation (Section 4.2.1.1.2), which would afford some degree of protection to shorelines from erosional influences. However, under full pool run-of-river operations, slopes along the full-pool shoreline would be more susceptible to erosion from wind-driven waves, especially in areas that face into prevailing winds and in areas where wind and waves travel over large distances. During periods of drawdown, the erosional force of wind-driven waves would not be directed at the full-pool shoreline. Other erosional influences (e.g., recreation traffic, livestock grazing) would also be more concentrated at the full-pool elevation under run-of-river conditions, rather than focused on areas in the drawdown zone during periods of lower pool levels.

On Oxbow and Hells Canyon reservoirs, few differences would be expected between the two proposed scenarios. Because proposed operations nearly mimic patterns of water-surface elevations that occurred historically, and because relatively little erosion has occurred on these reservoirs, little erosion would be expected in the future. Shorelines along these reservoirs appear to be more in equilibrium with past ecological and human influences on these reservoirs. Because of the minimal differences in water-surface elevations between proposed and full pool run-of-river operations, little difference in the occurrence and extent of future shoreline erosion would be expected.

Other factors that influence the erosion of shoreline banks along the reservoir reaches include management actions of federal, state, and county agencies, public interest groups, and other private landowners. Federal and state land managers oversee grazing allotments, road maintenance activities, recreation facilities and other public uses in the study area. County agencies likewise oversee road maintenance activities and recreation facilities. These activities can contribute to factors such as ‘livestock grazing,’ ‘boat-generated waves,’ ‘roads,’ ‘recreation,’ and ‘industrial’ disturbance types, which were documented to influence erosion of shoreline banks along the reservoirs (Table 3 and Appendix 2 in Holmstead 2001b).

We conclude that, compared to full pool run-of-river operations, proposed operations would result in a greater amount of shoreline bank erosion on Brownlee Reservoir. Because we cannot predict a quantitative difference in shoreline erosion between scenarios on the reservoirs (e.g., acreage or number of sites), we assume that the amount of bank erosion under proposed operations would not be greater than the current amount of bank erosion. Therefore, we recommend that habitat management actions designed to protect 84 acres of terrestrial habitat

(the total extent of shoreline erosion in all reservoir reaches) would constitute appropriate mitigation for proposed operational impacts to shoreline erosion along reservoir reaches.

By proposing to mitigate for the total extent of shoreline bank erosion along the reservoir reaches, IPC would not limit its actions solely to it's contribution to shoreline bank erosion. Other influences outside of IPC control also impact shoreline bank erosion. Such factors include recreation activities (boat-driven waves, camping, trails and dispersed recreation), livestock grazing, and road or other construction or maintenance activities under the management actions of federal, state, or county agencies, public interest groups, or other private land owners. These factors would continue to influence shoreline bank erosion under either proposed or full pool run-of-river operations.

Mitigation for 84 acres of existing shoreline erosion could be accomplished through acquisition and enhancement actions (e.g., additive to other acquisition/enhancement measures), by specific management actions to eliminate causes of erosion, and where feasible, by limited site stabilization/revegetation actions.

Management actions could be implemented to control human-caused factors that negatively affect shoreline banks. These actions should focus on controlling recreation influences (for example, boat-driven waves, camping, trails, and vehicle use), minimizing effects of roads and construction or maintenance activities, and reducing the livestock grazing that has negative effects (Holmstead 2001b). Because these management actions largely fall under the control of state and federal land managers in the reservoir reaches, the IPC has little management authority. Because water fluctuations are necessary if the HCC is used for flood control, anadromous fish spawning and protection, downstream navigation, and hydroelectric generation, eliminating all negative impacts from human activity is not possible.

Stabilizing and revegetating most of the shoreline erosion sites in the study area may not be practical, feasible, or even desirable (Holmstead 2001b). The subsoil remaining at these sites would likely be hard, rocky, infertile, and droughty, making it difficult to reestablish vegetation cover. Without soil amendments, the remaining soil probably could not support adequate growth and, therefore, would not adequately stabilize the banks. The steep topography and remoteness of the canyon makes access it difficult to access and work on most sites. However, proper stabilization and revegetation techniques possibly could be employed at specific sites if analysis indicated that such techniques were appropriate.

4.2.1.2. Land Management Impacts to Botanical Resources

IPC owns about 3,450 acres (not flooded) of land in fee in Hells Canyon from which it operates its HCC within the federal Project Area (16,580 acres of flooded and nonflooded lands) (Johnson & Holmstead 2002). All of these lands occur upstream of Hells Canyon Dam. This constitutes approximately 20.8% of the federal Project Area. IPC also owns approximately 1,850 acres of land outside the Project Area in Hells Canyon. Combined, these 5,300 acres constitute approximately 0.6% of the approximately 848,000 acres studied by Johnson & Holmstead (2002) (canyon rim to canyon rim, from just downstream of Weiser, Idaho, to the confluence of the Snake and Salmon Rivers) regarding IPC land management influences on terrestrial resources.

In addition to the activities associated with the operation of the HCC, IPC allows residents of its lands (primarily employees) to conduct other activities such as livestock grazing. IPC also allows public access to most of its undeveloped lands for recreation (dispersed recreation), issues various permits for private recreational use (e.g., cabins and docks), and provides leases for a variety of activities including grazing, agricultural cultivation, communications, and utilities. IPC lands are also subject to trespass uses.

The small amount of accessory use grazing that occurs on parcels of residential land, totaling less than 12 acres, has no appreciable impact where lands are irrigated (most of these lands) (Johnson 2002). However, pastures can at times be overgrazed which can promote weed invasion and soil erosion. Where irrigation does not occur, vegetation and soil resources can be negatively impacted by grazing. In this climate, grazing in upland, non-irrigated areas often results in poor condition of vegetation and soils. This is particularly true in smaller areas constrained by fencing, and overstocked with livestock. A few fenced upland areas were observed to be in poor condition, notably the caretaker pasture near Hells Canyon Park (Johnson & Holmstead 2002).

Leases and permits issued by IPC for such activities as grazing, agriculture, and communications are quite limited, affecting only about 118 acres. Leases are monitored irregularly. Generally current leases have been found to have little impact on terrestrial resources (Johnson & Holmstead 2002), primarily because they have specific authorization and conditions relevant to their use, they are monitored, and IPC controls noxious weeds occurring on the properties.

Dispersed recreation activities result in damage to vegetation and soils, primarily due to indiscriminate use of motor vehicles on these lands, and some trash and sanitation problems. Individually these recreational activities result in limited impacts, but cumulatively they can have substantial effect. Hall and Bird (2002) identified 169 dispersed recreation sites (i.e., with no developed recreational facilities) within the Project area. The average density of these impromptu sites is about 2 sites per river mile. Of the 169 sites in the Project Area, 55 were fully or partially on IPC land and had areas showing definite signs of past use. Together, the 55 sites total slightly less than 50 acres, or about 0.2% of the land within the federal Project boundary; the obviously used portion of these sites (i.e., usually where vegetation has been wholly or mostly destroyed) totals about 37 acres. These lands have been trampled by vehicles and human traffic, and are therefore subject to increased soil erosion and invasion by weeds.

Some unauthorized uses occur on IPC lands; specifically, trespass grazing, private residential structures, and special events (e.g., parties, community events). Unauthorized uses of IPC lands occur for several reasons: users may be unaware of property boundaries, users are simply uncaring about the property rights of others, or property rights may be disputed. No estimate is available as to how many parcels or acres are affected by unauthorized uses.

Cattle grazing is the primary unauthorized use and is the most difficult to eliminate because of its transitory nature and the widespread and remote property boundaries (Johnson and Holmstead 2002). Idaho and Oregon state law establish open range (i.e., one person's livestock may legally graze on another's land if no constraints to the animals have been constructed). Even when lands are otherwise fenced, drafting of Brownlee Reservoir often enables easy passage of animals among ownership when water levels recede. Most encroachments from grazing occur where IPC land abuts extensive private holdings that are grazed. To manage unauthorized grazing,

either the land must be fenced or a use agreement must be reached with the livestock owner setting conditions on use.

Structural encroachments can occur as a result of the lack of landmarks (e.g., fences or other structures) by which to judge extent of ownership. Enforcement on a regular basis is difficult because of the remoteness of much of IPC's land and lack of access. Temporary short-term uses such as parties or parking of trailers occur occasionally, some without seeking permission, some after permission has been denied. Such uses are difficult to monitor and are usually gone before action can be taken.

No negative impacts to listed *threatened* or *endangered* plant species, or other plant species of special concern are known to occur on IPC lands from land management activities (Johnson & Holmstead 2002). Generally, we recommend that IPC conduct more frequent monitoring of project leases and other properties to identify corrective actions needed regarding negative impacts to botanical resources. Specific policy revisions and land management actions proposed for implementation are summarized by Johnson (2002). Ongoing actions to control noxious weeds and enhance native plant communities should be continued.

4.2.1.3. Human Use Activities and Botanical Resources

Dumas et al. (2002a) evaluated the potential impacts of human activities and use on riparian vegetation and rare plants in Hells Canyon. For an introduction and background information pertinent to this study, refer to Section 4.1.1.3.

Impacts to vegetation from human activities can be both direct and indirect. Human activities can affect vegetation directly by trampling, removal of stems in the shrub and sapling layer, and mutilation or vandalism of larger or mature trees (Manning 2000). Trampling can cause direct injury or mortality to vegetation, which reduces species cover, biomass, and diversity. Indirectly, human activities can also affect plants by compacting soil and causing other consequential changes in the physical environment (Hammit and Cole 1998).

These factors result in reduced site potential and decreased reproduction, which prolongs the time it takes vegetation to recover, even when use is removed. The relatively wetter soils associated with riparian areas are especially susceptible to compaction from trampling. Impacts to riparian areas also diminish or eliminate its filtering function, which could degrade water quality. Ground cover species often show signs of reduced abundance, height, vigor, resilience, and reproductive capacity at recreation sites and along trails. Additionally, native vegetation at recreation sites and along trails is often replaced by more resistant and aggressive exotic and invader species (Cole 1998, Hammit and Cole 1998).

4.2.1.3.1. Rare Plants

No federally listed plant species were associated with the HCC (Krichbaum 2000). However, Dumas et al. (2002a) evaluated element occurrences for 23 species of rare plants in Hells Canyon. Twelve rare plant species were found at 67 human use sites (Dumas et al. 2002a). Their spatial modeling identified 22 element occurrences with moderate or higher risk of disturbance. Of those, 3 element occurrences occurred at locations where IPC has management responsibility or authority. These 3 occurrences were located in riparian areas along the reservoir

margins near dispersed recreation sites. Two occurrences of porcupine sedge occurred along Oxbow Reservoir and, 1 occurrence of shining flatsedge (*Cyperus rivularis*) occurred along Brownlee Reservoir. IPC, in coordination with appropriate state or federal agencies, should further evaluate the occurrences at risk along the reservoirs and determine if protective measures are warranted (Dumas et al. 2002a).

4.2.1.3.2. Riparian Habitat

Riparian areas are a critical resource in Hells Canyon that provide important habitat for many botanical and wildlife species (Dumas et al. 2002a). During summer, however, Hells Canyon is hot and dry, and people are attracted to riparian areas for many reasons, including the presence of water, shade, wildlife, and appealing scenery. Therefore, the potential exists for various human uses to degrade riparian areas.

Dumas et al. (2002a) determined that 32.1 acres (13 ha) of riparian habitat directly overlap human use areas. This represents 1.3% of the riparian habitat in the area studied. They evaluated the risk of human disturbance to riparian resources on a habitat patch basis. Patches were composed of 3 cover types—*Forested Wetland, Scrub-Shrub Wetland,* and *Emergent Herbaceous Wetland*—mapped by Holmstead (2001a). Thirty-five riparian patches, totaling 16 acres (6.5 ha), had either a very high or high Risk Index (Dumas et al. 2002a). Roads (7.2 acres), parks (5.7 acres), and dispersed recreation sites (3 acres) accounted for most of the risk. The distribution of very high and high risk patches correspond with areas where riparian habitat is most abundant; i.e., on Oxbow and Hells Canyon reservoirs and the headwaters of Brownlee Reservoir (Dumas et al. 2002a)

The full influence of human use on riparian areas is likely much higher than indicated from the direct overlap. Dumas et al. (2002a) suggested that the footprint of existing roads may be large, but is relatively static through time. To a lesser degree, parks are similar in that they have established boundaries. Overlap with roads and parks has probably stabilized. Unless use levels increase or spatial patterns of use change in parks, impacts would not be expected to increase. In some cases, tree plantings in parks have actually increased the amount of riparian habitat available. Conversely, dispersed recreation sites are often not contained, and thus impacts are able to expand, especially if human use increases. Dispersed camping, for example, has an effect because of the amount of time people spend in riparian areas and their movement within the immediate area.

Dumas et al. (2002a) recommended that IPC identify locations where opportunities exist to improve the management of riparian and human use interactions. They cited several areas where such opportunities might exist. In addition, they suggested that areas of high quality, undisturbed or only marginally disturbed riparian habitat be enhanced and protected to provide a diversity of riparian habitat types and conditions in Hells Canyon.

4.2.2. Downstream of HCC

4.2.2.1. River Operations

4.2.2.1.1. General Riparian and Upland Habitats in the River Shoreline Zone

In the reach below Hells Canyon Dam, the riparian zone is limited by the prevalence of steep canyon walls, rocky shorelines, and a high gradient river slope. Nevertheless, there is a relatively substantial amount of riparian habitat in this reach. Using GIS cover type data from mapping efforts reported in Holmstead (2001a), existing riparian habitat (*Forested Wetland*, *Scrub-Shrub Wetland* and *Emergent Herbaceous Wetland* cover types) within a 20-m planimetric band above the high water mark constitute 17.6% of the total area (178.4 of 1,015.3 acres) along this reach. This compares to 21.1% riparian habitat (82.0 of 388.2 acres) along Hells Canyon Reservoir, 21.2% riparian habitat (51.3 of 242.3 acres) along Oxbow Reservoir, 8.4% riparian habitat (111.5 of 1,332.6 acres) along Brownlee Reservoir, and 62.3% riparian habitat (190.9 of 306.7 acres) in the Weiser reach. For the downstream reach, this converts to approximately 3.0 ac/RM in the 20-m band. This compares to 3.7 ac/RM on Hells Canyon Reservoir, 3.6 ac/RM on Oxbow Reservoir, 2.0 ac/RM on Brownlee Reservoir, and 15.9 ac/RM in the upstream Weiser reach.

Riparian cover types are primarily dominated by native perennial species. Dominant tree and shrub species include *Celtis reticulata*, *Betula occidentalis*, *Alnus rhombifolia*, *Philadelphus lewisii*, *Salix exigua*, and *Toxicodendron radicans*. Common herbaceous riparian species include *Glycyrrhiza lepidota*, *Physalis longifolia*, *Artemisia ludoviciana*, *A. lindleyana*, *Anthriscus scandicina*, *Galium aparine*, and *Solidago canadensis* (Holmstead 2001a, Appendix 3; and Braatne et al. 2002, Chapter 2).

Historical photographs taken during the early part of the 1900s and retaken recently clearly show an increase in size and extent of riparian communities both above and below the river's high water mark (Blair et al. 2001, Section 5.4, Photos SR-1 to SR-12, and Table 20). Following damming and flow regulation, the band of perennial riparian vegetation became more dense and continuous along the reach (Braatne et al. 2002, Section 3.6.3). This expansion is likely related to both historic HCC operations and changes in land use practices.

Most of the increase in riparian extent and cover occurred in native *Celtis reticulata* communities. Botanical characteristics of the dominant *Celtis* plant assemblage in this reach are described on pages 286−287 of Appendix 3 in Holmstead (2001a). In some instances today, the margin of the river is entirely bordered by riparian *Celtis* communities, while scattered individuals were found there 60 to 80 years ago (Blair et al. 2001).

There are three main hydrologic reasons for the observed increase in riparian habitat. First, base flows from the HCC were higher during summer, and more stable, than they were before the HCC was constructed (Parkinson 2002). Second, the load-following flows in late spring and summer (following spring runoff), below 30,000 cfs stage levels, repeatedly irrigated portions of the riverbed. Daily water levels often fluctuated several feet in the riverbed zone that was previously annually scoured and then left dry as river stage decreased after spring runoff. Analyses of historic HCC operations indicate that between June 1 and September 30, daily

fluctuations below Hells Canyon were 10,000 cfs or below, 80% of the time (Parkinson 2002). Third, scouring of the roots of *Celtis reticulata* growing near the high-water mark stimulated the growth and suckering of the root systems, which benefited from higher base flows and repeated 'irrigation' events (Blair et al. 2001 and Braatne et al. 2002). All combined, these conditions enabled *Celtis reticulata* communities to occupy a broader zone that was previously not available.

An 'irrigation' effect refers to the promotion of vegetation growth and vigor through supplemental water. This phrase may be somewhat new relative to discussions of riparian hydraulics, but the recognition that an increase in summer stream flow (stage) can promote riparian vegetation is fully consistent with numerous reports (Nilsson and Keddy 1988, Hill et al. 1998, Springer et al. 1999, Jansson et al. 2000). In the Hells Canyon corridor, the obvious proliferation of trees and shrubs above the full-pool elevation along Oxbow and Hells Canyon reservoirs provides further demonstration of an 'irrigation' effect.

Data on new *Celtis* plants regenerating or establishing along the river are provided in various technical reports (e.g., Blair et al. 2002, Holmstead 2001a and Braatne et al. 2002). Specifically, Holmstead (2001a) (Appendix 3, pages 286−287) identifies vegetation characteristics for the *Celtis reticulata-Toxicodentron radicans* plant assemblage, the dominant *Celtis* community in this reach. These data indicate an average density of 6,044 seedlings/ha (plants less than 0.5 m-tall) of *Celtis reticulata* growing in this community along the river. No distinction is made between plants establishing from seed versus those establishing from root suckers.

Another reason for the observed increase in riparian habitat may also be from changes in land use: cessation of grazing, particularly of domestic sheep and reduction in homesteading, ranching, and mining in the canyon. Reduction in these activities could have positively affected the survival and growth of *Celtis reticulata*. Coring *Celtis reticulata* to determine age indicated that most hackberry stands established during the past 60 to 80 years (Braatne et al. 2002). A similar increase in the *Forested Wetlands* cover type in the reach between Swan Falls Dam and Farewell Bend was reported by Dixon and Johnson (1999), hypothesizing a similar mechanism (reduced consumptive use of riparian areas) for the increase of the acreage and cover of these *Forested Wetlands*.

Some plant communities may have declined in abundance due to historic operations. HCC operations likely contributed to the decline of some obligate riparian plants especially *Salix exigua* because the dams trap incoming sediment of the sizes useful for building rooting substrate (Parkinson et al. 2002). Although quantification is difficult due to the lack of pre-dam riparian inventories, it is probable that the loss of sand and sandbars has produced a proportional loss of *Salix* as well as the loss of some other obligate riparian species that similarly require fine sediments for colonization.

While sands and other fine sediments have been depleted from the surfaces of the riparian zones through Hells Canyon, fine sediments still persist in the interstitial spaces between the coarser materials as well as in subsurface substrates. Applicant found that substrate affinities of riparian vegetation in this reach ranged from fine soils to coarser cobbles with interstitial fines (Braatne et al. 2002, Section 2.3.5.2.). Although shoreline substrates are typically comprised of large basalt outcrops (bedrock) or large boulders and cobbles, this does not preclude fine substrates

from occurring in the interstitial spaces or underneath an "armored" layer; a sediment layer covered with boulders or cobbles (Braatne et al. 2002; Miller et al. 2002, Appendix C). The existing fine sediment provides some of the substrate that support the current riparian vegetation and will be expected to continue to support vegetation in the future (Braatne et al. 2002, Section 6.2). All sediments, even coarse materials, influence the processes of water infiltration, retention, and drainage, and capillarity is substantial with many sediments coarser than silt (Mahoney and Rood 1991, 1992, 1998; Richter and Richter 2000).

Outside of land uses (e.g., grazing, homesteading, mining, and agricultural activities), the extent and characteristics of riparian communities downstream of Hells Canyon Dam have been historically, and under HCC operations, largely determined by the timing and magnitude of peak flows and summer base flows. In this reach, a deep, narrow valley that is confined by bedrock walls, talus slopes, debris flows, landslides, and alluvial terraces characterizes the river environment (e.g., Bonneville Flood deposits, landslide backwater deposits, relict alluvial fans, or relict bars) (Miller et al. 2002). This confinement has precluded the development of an alluvial floodplain that is typical of other rivers of comparable discharge, area, and gradient (10.5 to 3.7 feet per mile) (Miller et al. 2002). Historically, annual runoff events scoured the canyon walls and created a barren shoreline between the high water mark and summer base flows. Riparian vegetation, therefore, was sparse in this reach as evidenced by photographs and General Land Office records from 1900 to the late 1950s (Blair et al. 2001). Current conditions are even less suitable for establishment and growth of *Salix* species in the Hells Canyon reach.

To estimate impacts of potential future operation of the Hells Canyon Complex on shoreline botanical resources, Applicant conducted two integrated studies (Braatne et al. 2002 and Blair et al. 2002) to model the effects of two hypothetical scenarios: proposed operations and run-of-river operations. Braatne et al. (2002) provided more qualitative comparisons of plant species response to the two scenarios, while Blair et al. (2002) predicted quantitative differences in extent of riparian habitats.

Braatne et al. (2002) predicted that overall differences across the two operational scenarios for the Snake River reach below Hells Canyon Dam would be intermediate in magnitude between the substantial changes along the Brownlee Reservoir reach and the slight differences along Oxbow and Hells Canyon reservoir reaches (Braatne et al. 2002, Chapter 3) (see Chapter 6 and Table 6.1 in the same report for numerical values represented by comparative terms such as 'slight,' 'intermediate,' 'minor,' etc). Both current and projected riparian vegetation zones along the Snake River are somewhat different than the riparian zones along the reservoir shorelines. In terms of spatial pattern, the greatest difference involves the elevational extent of riparian vegetation. Obligate riparian vegetation extends up to about 10m above the mean annual water level along the Snake River but is limited to about 4 m above full pool along the reservoirs (Braatne et al. 2002). This reflects the elevational dynamics of water surface as the river stage varies substantially within and across years. In contrast, the reservoir elevations have a defined lower limit imposed by the full pool elevation.

To predict differences in species response across the scenarios, plant responses were modeled by life form and species' hydrologic indicator status. Species were classified into six groups; ruderal annuals, facultative riparian annuals and perennials, obligate riparian annuals and perennials, and hydrophytes (Braatne et al. 2002, Section 3.3). Overall, ruderal annuals would not substantially

change under the two operations scenarios, while a slight increase would occur in the facultative riparian annuals and perennials (0.4% and 2.2%, respectively) under the proposed scenario (Braatne et al. 2002, Table 6.1). A slight increase in the obligate riparian annuals and perennials (2.2% and 9.0%, respectively), particularly in the zone immediately above the mean annual water level, was also predicted with the proposed scenario. Additionally, an increase of 24.7% in hydrophytes was predicted with the proposed scenario, although the magnitude of this increase was questioned. Currently, hydrophytes have a limited distribution at higher elevations due to localized water retention from fine sediment lenses. Investigators anticipated their distribution to remain sparse under the proposed scenario, with some moderate increases in abundance and distribution under the run-of-river scenario. Species classified into each of the six groups are listed in Table 3.1.E of Braatne et al. (2002). A summary of the predicted vegetation responses for each reach and under both operational scenarios is presented in Table 6.1 of Braatne et al. (2002).

Blair et al. (2002) modeled flow-stage-inundation relationships and characteristic flows for historical operations, proposed operations, and run-of-river operations, to project the extent of riparian habitat that would be expected along the river shorelines. Historical operations were characterized on average by relatively large daily changes in water-surface elevation and stage during summer (Miller et al. 2002). Proposed operations also specifies load following, but projected daily-maximum flows were constrained to be lower than historical operations. However, proposed operations were defined to have lower average-maximum daily summer flows, thus less shoreline irrigation effect (i.e., restricted load-following operations) than historical operations. Run-of-river operations had no load following, so projected daily flows from Hells Canyon Dam reflect projected daily inflows to the HCC. It was estimated that 7.6% of the shoreline zone (262 of 3,435 acres) was composed of riparian habitat (perennially vegetated riparian polygons). The shoreline zone included all lands within 11 m vertically above the 20,595 cfs water-surface elevation (Blair et al. 2002). Investigators projected that riparian habitat would occupy slightly less area (7.4%, 255 acres) of the shoreline zone under proposed operations (Blair et al. 2002). Because no irrigation effect would occur, riparian habitat was projected to occupy even less of the shoreline zone (7.2%, 246 acres) with run-of-river operations (Blair et al. 2002).

We conclude that slightly less riparian habitat would occur along the shorelines under both of the modeled scenarios; about 7 acres less with proposed operations and 16 acres less with full pool run-of-river operations. Proposed operations for the HCC would provide slightly more (about 9 acres) riparian habitat in the river shoreline zone downstream of Hells Canyon Dam than would occur with full pool run-of-river operations.

4.2.2.1.2. Downstream Operations and Noxious Weeds

Riparian zones are generally vulnerable to invasion by exotic species because riverine environments are dynamic and have recurrent disturbances (e.g., flooding, scour, and sediment movement and deposition), water is available year-round, and rivers form a natural network for propagule dispersal (Planty-Tabacchi et al. 1995). Weed invasions can be pronounced where natural communities are further disturbed by river regulation (Nilsson and Berggren 2000). Historic operation of the HCC reservoirs has likely contributed to the spread of noxious weeds.

Yet, relatively few occurrences of riparian noxious weeds occur below Hells Canyon Dam. Botanists located three occurrences of *Phalaris arundinacea* (reed canarygrass), eight of *Equisetum arvense* (common horsetail), and six of *Cyperus esculentus* (yellow nut sedge) that could have been spread by historic water level fluctuations (Krichbaum 2000). A few occurrences of other riparian noxious weeds were found in the riparian zone (within 50 m of the shoreline) (*Amorpha fruticosa* [11 sites] and *Conium maculatum* [1 site]), but these species were not found to have positive association with water fluctuations (Krichbaum 2000); they were just as likely to occur in upland settings and to be associated with other forms of disturbance. Ninety percent all noxious weeds populations below Hells Canyon Dam (289 of 321 sites) are upland species (see Section 4.2.1.1.3) that appeared to have been influenced by factors other than historic flow fluctuations (Krichbaum 2000).

Results of USFS noxious weed surveys along the Snake River in the Hells Canyon National Recreation area also provide insight on weed occurrence below Hells Canyon Dam. Reports identified and described occurrences of 10 species of noxious plants (Burton 1993a, 1993b). Three of these species are considered to be riparian noxious weeds (*Lythrum salicaria, Euphorbia esula* and *Cirsium arvense*) and the rest upland weed species (*Chondrilla juncea, Linaria genistifolia, Centaurea diffusa, Centaurea maculosa, Cardaria draba, Onopordum acanthium* and *Tribulus terrestris*). Burton (1993a) reports that most of the occurrences were associated with recreation sites (e.g., campgrounds, trails) and reports being surprised that some of the weed species such as *Centaurea diffusa, Euphorbia esula, Lythrum salicaria,* and *Cardaria draba* were not more widespread than found. The investigators suspected that the one site of *Euphorbia esula* came in by boat or trailer from Pittsburg Landing. It was believed that *"the drawdown of the river levels during the summer months when seed from up river sources is available limits establishment"* (Burton 1993a). He further reported, *"...we were also amazed purple loosestrife was established on only spring sources away from the river itself. It is almost like the seeds came in with birds dependant of cattail sites"* (Burton 1993a).

Applicant conducted three integrated studies (Krichbaum 2000, Holmstead 2001a, and Braatne et al. 2002) to assess the influence of proposed and full pool run-of-river operations on the spread of noxious weeds. The first two studies (Krichbaum 2000 and Holmstead 2001a) were designed to provide descriptive and predictive data on the occurrence of target weed species.

Holmstead (2001a) identified the relative distribution and abundance of noxious weed dominated plant assemblages throughout the study area using systematic random sampling protocols. Two important findings were identified regarding noxious weed occurrence; 1) distribution gradients exist for the occurrence of noxious weed dominated upland and riparian plant communities, and 2) that historic operations of the HCC may have imposed a dispersal barrier to the downstream spread of noxious riparian weeds by the draw-down pattern of Brownlee Reservoir (Holmstead 2001a, Section 4.4). Riparian noxious weed dominated plant assemblages were more abundant and widespread in the upstream reaches (headwaters of Brownlee Reservoir and the Weiser Reach) compared to along Oxbow and Hells Canyon reservoirs and the downstream reach.

Krichbaum (2000) further identified the relative distribution and abundance of riparian and upland noxious weed populations and provided predictive data on the occurrence of weed populations. Krichbaum (2000) confirmed that riparian noxious weed populations were more abundant and widespread in the upstream reaches (headwaters of Brownlee Reservoir and the

Weiser Reach) compared to the abundance of upland weed populations as one progresses downstream (see Section 4.2.1.1.3). About 10% of the weed populations were riparian species in the reach below Hells Canyon Dam (32 of 321 sites). This compares to about 30% on Hells Canyon Reservoir (109 of 356 sites), about 30% on Oxbow Reservoir (63 of 209 sites), about 45% on Brownlee Reservoir (356 of 785 sites), and 70% in the Weiser reach (164 of 234 sites).

Often, several factors influenced the occurrence of each noxious weed population. The types of disturbance present at each population and the level of disturbance (e.g., 'extreme,' 'high,' 'moderate,' or 'slight'; defined in Section 3.1.3 of Krichbaum 2000) at each population are summarized by species in Appendix 6 of Krichbaum (2000). Generally, at least one disturbance factor (alluvial, flow zone [water level fluctuations], livestock grazing, mining, fire, road maintenance, recreation [camping, boating facilities], trail use, industry, agriculture and off road vehicle use) was significantly ($p<0.001$) correlated with populations of one or more noxious weed species. In the downstream river reach, 488 disturbance types were recorded at 321 weed populations. The most frequent disturbance factors were recreation (40%; 129 sites), livestock (38%; 121 sites), flow zone (21%; 67 sites), alluvial (15%; 47 sites) and trail use (14%; 46 sites) (Krichbaum 2000, Appendix 5).

Krichbaum (2000) identified two noxious weed species (*Lepidium latifolium* and *Phalaris arundinacea*) and 1 special interest weed (*Amorpha fruticosa*) to be significantly and positively associated with water fluctuations. These species benefit from recurrent water-level fluctuations that create sites for weeds to establish and persist in riparian habitats. Other species, specifically *Cyperus esculentus*, *Equisetum arvense*, *Euphorbia esula*, *Lythrum salicaria*, and *Tamarix* were also positively associated with water-level fluctuations (Krichbaum 2000, Table 5).

To specifically assess the potential effects of future operations, a modeling study was conducted (Braatne et al. 2002). Investigator's results, based on a combination of the modeling analysis and life history consideration, predicted that fifteen weedy species would be similarly affected across the two operational scenarios. One ruderal annual species, *Tribulus terrestris*, was predicted to increase in abundance with the proposed versus full pool run-of-river scenario. Four perennial species, including *Cardaria draba*, *Euphorbia esula*, *Tamarix* and possibly *Elaeagnus angustifolia*, would be substantially reduced with the proposed scenario because the draw-down of Brownlee Reservoir would continue to impede their downstream expansion. Investigators also recognized the occurrence of a dispersal barrier imposed by the draw-down pattern of Brownlee Reservoir, and anticipated a substantial ecological benefit of the proposed scenario relative to the full pool run-of-river scenario (Braatne et al. 2002, Section 4.3) by retarding the downstream spread of undesirable plant species (see Section 4.2.1.1.3).

The capacity of reservoirs to hinder 'hydrochory', water-based plant propagation, is well established and underlies the concept of 'fragmentation' that is prominent in the current literature (Nilsson et al. 1991, Dynesius and Nilsson 1994, Nilsson and Jansson 1995, Johnson 2002). Essentially, floristic dissimilarities result between upstream, reservoir, and downstream reaches (Jansson et al. 2000). Most riparian plant species, both native and exotic, are unable to establish and survive the successive drying and flooding in reservoir fluctuation zones that experience large, seasonal water-level changes (Nilsson and Keddy 1988). Potential inputs of weed seed and

propagules from upstream sources must be considered in comparing conditions for weed spread under future operational scenarios in the downstream reach.

After investigating potential impacts of proposed and full pool run-of-river operations on riparian habitats, Braatne et al. (2002) concluded, *"Of all of the probable impacts addressed in the present report, the prevention of encroachment of salt cedar into the natural riparian zone along the Snake River downstream from the Hells Canyon Dam may be the most ecologically significant."* With respect to populations of native *Salix* in the downstream reach, observations of Dudley and Collins (1995) are noteworthy. They state that *Tamarix* has been able to out-compete willow and other riparian plants in many locations, greatly diminishing the quantity and quality of riparian habitat for migrant songbirds and vegetation dependent birds. Additionally, results of Stohlgren et al, (2003) and others (Levine and D-Antonio 1999, Stohlgren et al. 1999, Levine 2000) indicate that highly invasive plant species such as *Tamarix, Elaeagnus angustifolia*, and *Lythrum salicaria*, can become widely established in native species-rich riparian zones compared to habitats of low plant diversity which were thought to be more vulnerable to plant invasions through the process of competitive exclusion (Grime 1973). Applicant considers the native downstream communities to be particularly at risk to invasion of *Tamarix* under full pool run-of-river operations.

Compared to full pool run-of-river operations, the downstream reach would experience limited increases in distribution and abundance of riparian noxious weeds under proposed operations. On the upstream reservoirs, proposed operations nearly mimic patterns of water-surface elevations that historically occurred in the reservoir reaches. If these conditions occurred for another 30 years or more, the abundant weed sources in the upstream reach would be impeded in their downstream movement. The spread of weeds in the downstream reach would be restricted to 1) the capacity of limited existing populations to spread, and 2) the capacity of populations on Oxbow and Hells Canyon Reservoirs to spread into the reach. Differences in downstream flows between the two future scenarios are expected to have minimal difference on the spread of noxious weeds.

Under full pool run-of-river operations, new sources of noxious weeds delivered to the canyon from above the HCC would 1) introduce previously unknown species to this reach (e.g., *Tamarix*), 2) significantly augment populations in the Oxbow and Hells Canyon reservoirs (which would increase their capacity to influence the downstream reach), and 3) add to existing populations of weedy species in the downstream reach. Combined, these influences would result in comparatively greater negative impacts to existing native perennial communities than under proposed operations (Holmstead 2001a, Braatne et al. 2002).

In summary, we conclude that proposed operations would contribute to the spread of noxious weeds along the river reach below Hells Canyon Dam, but to a much lesser extent than with full pool run-of-river operations. We cannot quantitatively identify the extent (e.g., acreage or number of populations) of operational impacts of either future scenario on the potential spread of noxious weeds in the downstream reach. Under proposed operations, the combination of drought stress and inundation stress on Brownlee Reservoir would eliminate the vast majority of many weedy species encroaching from upstream sources (reduction of seeds and plant propagules), controlling downstream infestation especially in the 41.5-mile long main pool subreach of Brownlee Reservoir. Proposed operations may also deter the invasion of some species currently

not found below Hells Canyon Dam, especially *Tamarix* species (Holmstead 2001a, Braatne et al. 2002).

Braatne et al. (2002) notes that it may be just a matter of time before downstream botanical resources are negatively influenced by upstream weed sources regardless of the dispersal barrier imposed by drawdown operations on Brownlee Reservoir. Occasionally, individuals of these invasive weeds would become established at locations such as near tributary inflows, that would be survivable, and although impeded, eventually these plants would probably extend downstream beyond Brownlee Reservoir. Additionally, there are alternate propagule sources beyond the inputs from the Weiser reach and the Powder River, and these would also enable expansion of invasive plants (Braatne et al. 2002, Section 4.3).

Other factors that influence the spread of noxious weeds along the Snake River corridor through Hells Canyon include management actions of federal and state agencies and other private landowners. Because of the high percentage of federally owned lands in the downstream reach, largely under USFS ownership, actions of the USFS likely play a significant role in the spread of noxious weeds. Federal land managers oversee grazing allotments, road maintenance activities, camping and boating recreation facilities, and other public uses in the study area, all of which can contribute to the spread of noxious weeds. These influences can affect the spread of weeds 1) directly through spreading of weed seed and plant parts, and 2) indirectly by creating disturbance to soil and vegetation which create conditions more conducive to weed invasion. Recreationists, livestock operators, subcontractors, federal personnel, and the public that visit this area can unknowingly spread weeds when passing through areas of noxious weeds. Weed propagules are picked up on equipment, clothing and animals and can be spread along roadways or travel corridors, including water-based recreation sites (Loney and Hobbs 1991). Weeds can be transported within the canyon, or brought in from outside sources from visitors. Once present, these weeds can invade adjacent native habitats (MacLellan and Stewart 1986). Actions by natural resource agencies, state and county governments, non-governmental organizations, private landowners and the public contribute to disturbance of upland and riparian habitats and make weed control necessary.

Because many factors influence the spread of noxious weeds along the downstream reach, and because this reach is largely under the management jurisdiction of the USFS, we recommend that IPC that the lead role in developing and participating in cooperative agreements with the USFS and other interested agencies and groups to control establishment and spread of noxious weeds. All landowners and participants would be expected to contribute personnel and funds to assist in weed control activities. Specifically, we recommend participating with local organizations called Cooperative Weed Management Areas (CWMAs), or with similar organizations, that are involved with areas bordering the Snake River in Hells Canyon and with increasing focus on the control of *Tamarix* species. CWMAs build cooperative relationships among agencies, landowners, land managers, and other interested individuals and organizations—relationships that are needed to effectively manage noxious weeds (ISDA 1999).

4.2.2.1.3. Downstream Operations and Rare Plant Species

Many factors negatively impact rare plant populations along the Snake River corridor through Hells Canyon (Krichbaum 2000). This can include disturbance from off-road vehicle use,

camping, hiking, boating, livestock grazing, agriculture, residential activities, industrial activities, fire, road maintenance and water level fluctuations (both natural and river regulation). Actions by natural resource agencies, state and county governments, non-governmental organizations, private land owners and the public contribute to disturbance of upland and riparian habitats and make protection of rare plant populations necessary.

Applicant conducted two integrated studies (Krichbaum 2000 and Braatne et al. 2002) to assess the influence of proposed and full pool run-of-river operations on rare plants. In the first study, populations of five species of special status plants were found to be potentially impacted by historic operations in the reach below Hells Canyon Dam. These included: *Cyperus schweinitzii*, *Teucrium canadense* var. *occidentale*, *Bolandra oregana*, *Carex hystricina*, and *Leptodactylon pungens* ssp. *hazeliae* (Krichbaum 2000, Section 3). The first two species were found only in the downstream reach, while the latter three species were found in the downstream reach and in Oxbow or Hells Canyon reservoirs.

No federally listed endangered or threatened species are known to occur in the 50 m survey areas along shorelines in the downstream reach. However, three populations of the federally threatened *Mirabilis macfarlanei* occur upslope of the river corridor near Pittsburg Landing. No negative impacts to listed species are expected to occur from either proposed or full pool run-of-river operations.

In the second study, investigators predicted the potential influence of proposed and full pool run-of-river operations based on knowledge of life history traits and distributional patterns of the species (Braatne et al. 2002, Chapter 5). It was originally intended to conduct a modeling study to predict the potential influence of future scenarios, but due to lack of sampling data (too few observations), a modeling approach was deemed infeasible. Braatne et al. (2002) did not observe rare plants along reservoir shorelines, but did encounter several populations of *Cyperus schweinitzii*, within the riparian zone in the downstream reach. Braatne et al. (2002) used results of rare plant observations from Krichbaum (2000) and professional judgment to assess potential influences to populations of these special status species from operational scenarios. In addition, based on their relative distribution and abundance in the downstream reach, six populations of *Cyperus schweinitzii* were randomly selected out of the 21 populations recorded in Krichbaum (2000) for more intensive study (Braatne et al. 2002, Section 5.3). Potential influences to populations of the five special status species from proposed or full pool run-of-river operations in the downstream reach are identified below.

Twenty-one populations of *Cyperus schweinitzii* were found downstream of Hells Canyon Dam. All the populations were situated near the Snake River on dry, coarse, sandy loam soils of gentle to moderate slope. Status of this species is reviewed in Krichbaum (2000) (Section 3.2.2. of that report). The majority of the sites (17 out of 21, or 81%) did not extend downslope of the mean high-water mark. Recreation, fire, and livestock were the major disturbance types reported for the Schweinitz flatsedge populations. Because proposed operations are defined to have daily summer flow of lower average maximums than under historic operations, riparian habitat would occupy slightly less area (7 acres less, Blair et al. 2001). This may negatively affect the populations. Because no permanent water would available to the upper riparian zone during the growing season with full pool run-of-river operations, riparian habitat would occupy even less of

the shoreline zone (16 acres less, Blair et al. 2001). This may negatively affect the populations (Braatne et al. 2002).

More intensive study of six randomly selected populations of *Cyperus schweinitzii* identified additional conclusions. Investigators found that the elevational distribution ranged from 2.57 m to 6.6 m above the mean annual water level (Braatne et al. 2002, Table 5.2 and Figure 5.2). These populations occurred well above mean annual peak flows (2.10 m above), yet were subject to inundation during relatively infrequent historic peakflow events. Their relative abundance was low to moderate, ranging from 1 to 27% cover per sample plot (mean = 9.8% cover). This pattern of distribution indicates that populations of *Cyperus schweinitzii* were located toward the upper end of the facultative riparian zone; an area only rarely inundated by scouring peak flows. Situated at these high elevations, these plants would be minimally influenced by the differences in flow patterns across the two scenarios (Braatne et al. 2002, Section 3).

One population of *Teucrium canadense* var. *occidentale* was found, and 2 other populations were previously known to occur downstream of Hells Canyon Dam. Only 1 of the 3 populations was within 50 m of the Snake River. Status of this species is reviewed by Krichbaum (2000) (Section 3.2.2 of that report). The population found during this survey was growing on gently sloping, moist, rocky ground along the shoreline of the Snake River. Plants spanned about 15 cm above to 75 cm below the mean high water mark. Horizontal distance ranged from 10 cm above to 2 m below the mean high water mark. Recreational activity was noted to provide slight disturbance to the site. Because proposed operations are defined to have daily summer flow of lower average maximums than under historic operations, riparian habitat would occupy slightly less area (7 acres less, see Blair et al. 2002). This may negatively affect the population. Because no permanent water would available to the upper riparian zone during the growing season with full pool run-of-river operations, riparian habitat would occupy even less of the shoreline zone (16 acres less, see Blair et al. 2002). This may negatively affect the population (Braatne et al. 2002).

Four populations of *Bolandra oregana* were found downstream of Hells Canyon Dam. In addition, there are 2 previously known populations of this species downstream of Hells Canyon Dam; 1 is near Hells Canyon Dam and the other is near the confluence of Cow Creek and the Imnaha River. However, neither was within the 50-m-wide survey area. Status of this species is reviewed by Krichbaum (2000) (Section 3.2.2 of that report). All populations were growing near seeps or streams in cliffs, surrounded mostly by bare rock. No observable disturbances were recorded for the four new populations. Because populations occur outside the influence of water level fluctuations, no negative impacts are expected from either proposed or full pool run-of-river operations (Krichbaum 2000, Braatne et al. 2002).

Three populations of *Carex hystricina* were found downstream of Hells Canyon Dam. Status of this species is reviewed by Krichbaum (2000) (Section 3.2.2 of that report). Populations were found growing in either relatively bare flow zone areas, or relatively lush riparian communities. Disturbance from many sources was evident at most of the sites. Hydrologic disturbance was heavy at 1 site, and extreme at 4 sites. Because proposed operations are defined to have daily summer flow of lower average maximums than under historic operations, riparian habitat would occupy slightly less area (7 acres less, see Blair et al. 2002). This may negatively affect the populations. Because no permanent water would available to the upper riparian zone during the

growing season with full pool run-of-river operations, riparian habitat would occupy even less of the shoreline zone (16 acres less, see Blair et al. 2002). This may negatively affect the populations (Braatne et al. 2002).

Six populations of *Leptodactylon pungens* ssp. *hazeliae* were found: one downstream of Hells Canyon Dam, and five along Hells Canyon Reservoir. There are 7 previously known populations in the vicinity of the HCC. Status of this species is reviewed by Krichbaum (2000) (Section 3.2.2 of that report). The 5 newly located populations were found growing on dry, steep to vertical cliffs above the shoreline. Neither proposed operations or run-of-river operations would negatively affect the populations as they are outside the influence of water level fluctuations (Krichbaum 2000, Braatne et al. 2002). No other disturbance factors were noted, such as disturbance from recreation activities, road maintenance, livestock grazing, fire, or off-road vehicle use.

We conclude that both operational scenarios may negatively affect populations of three of the five special status plant species located in the downstream reach: *Cyperus schweinitzii*, *Teucrium canadense* var. *occidentale*, and *Carex hystricina*. This is due to an expected decrease in 7 acres of riparian habitat under proposed operations and a decrease of 19 acres of riparian habitat under full pool run-of-river operations from existing levels. Populations of *Leptodactylon pungens* ssp. *hazeliae* were found growing outside of riparian areas on dry, steep to vertical cliffs above the shoreline outside the influence of water level fluctuations. Populations of *Bolandra oregana* were found near seeps or streams in cliffs, outside the influence of water level fluctuations.

Because many factors negatively impact rare plant populations along the downstream reach, and because this reach is largely under the management jurisdiction of the USFS, we recommend working cooperatively with USFS and other interested agencies and groups to protect rare plant sites that are threatened by flow levels and other disturbance activities below Hells Canyon Dam.

4.2.2.1.4. Downstream Operations and Shoreline Erosion of Terrestrial Habitat

Riverbanks in the reach below Hells Canyon Dam are very stable except at a few locations. This downstream river reach was one of the most stable of the reaches studied (from Weiser above the HCC to the Salmon River). Shoreline bank erosion occurred at 60 sites (6.3 acres) along 2.0% of the available shoreline (2.44 mi out of 125 total miles) (Holmstead 2001b). This compares to 9 sites (10.6 acres) along the Weiser reach along 7.5% of the available shoreline (3.45 mi of 45.8 mi), 261 sites (79.07 acres) along the Brownlee Reservoir reach along 27.2% of the available shoreline (49.58 mi of 182.3 mi), 9 sites (1.34 acres) along the Oxbow Reservoir reach along 2.0% of the available shoreline (0.51 mi of 25.0 mi), and 39 sites (3.45 acres) occurring along the Hells Canyon Reservoir reach along 2.7% of the available shoreline (1.45 mi of 53.9 mi). Slopes are extremely steep in the upper portions of the downstream reach, often greater than 60 degrees, and soils are usually shallow, when present. Mass movements can be expected at any time along the main canyon and in side canyons (Vallier 1998). Many of the canyon walls are precipitous, and rocks are crumbly and severely weathered (Vallier 1998). Shoreline substrates are diverse, but are composed almost entirely of large basalt outcrops (bedrock) and large boulders and cobbles, with few sands or gravels. However, fine sediments still persist in the interstitial spaces between the coarser materials as well as in subsurface substrates (Braatne et al. 2002,

Section 2.3.5.2). The coarseness of the shoreline substrates reduces the potential for shoreline erosion.

Miller et al. (2002) (Appendix C of that report) provides details on the geomorphic characteristics of the shorelines below Hells Canyon Dam. Geomorphologists focused on areas affected by recent historic flows (*recent* defined in this study as the historic record of the past 90 years) and areas that could be affected by future flow scenarios. These areas essentially encompassed a narrow riparian zone, including riparian vegetation and excluding upland habitats. Total length of shorelines were classified by substrate class (bedrock, boulder, cobble, gravel, sand), geomorphic feature (e.g., hillslope, terrace, fan, island, bar), and material source (e.g., alluvium, colluvium). Location data were collected using a sub-meter global positioning system (GPS) unit coupled with a laser range finder. The table below indicates the percent of total available shoreline (miles) in each substrate class from Hells Canyon Dam to the confluence of the Salmon River. The most prevalent class is dominated by boulders which occurs along about 62% of the available shoreline, while the least frequent are the sand and cobble substrate classes that each occur along little more than 1% of the available shoreline.

Overlaying these data with the GPS locations obtained for the shoreline bank erosion sites (Holmstead 2001b) indicates most of the erosion (80%, 5.08 acres of the 6.34 acres) occurred in the boulder substrate class (see table below). This compares to about 7% (0.47 acres) occurring in the sand class, 5% (0.35 acres) in the bedrock class, 5% (0.32 acres) in the cobble class, and 2% (0.13 acres) in the gravel class. For comparative purposes, there are about 1,015 acres in a 20-m corridor along both shoreline below Hells Canyon Dam to the Confluence of the Salmon River.

Substrate Class	Shoreline Bank Erosion (acres)	% Available (total shoreline miles)
BEDROCK	0.35	28.2
BOULDER	5.08	61.9
COBBLE	0.32	7.2
GRAVEL	0.13	1.5
SAND	0.47	1.2
Total	6.34	100.0

Combined, the above data indicate the relative amount of shoreline bank erosion occurring along each substrate class compared to the amount of the substrate class available in the reach. For example, approximately 80% of the bank erosion sites (5.08 of 6.34 acres) occurred in the boulder substrate class which is available along about 62% of the reach. Likewise, about 7% of the bank erosion (0.47 of 6.34 acres) occurred in the sand substrate class which is available along about 1% of the reach.

Factors that probably influenced past bank erosion include hydroelectric operations, boat-generated waves, disturbance from recreation (for example, camping and hiking), channel flow,

flooding of tributary drainages, shoreline substrate and topography, vegetation cover, livestock grazing, and homesteading activities (Holmstead 2001b). Usually, several factors influenced erosion at each site. The types and severity of influences (e.g., 'extreme,' 'high,' 'moderate,' or 'slight') affecting each erosion site are identified in Appendix 2 of Holmstead (2001b). In the downstream reach, 207 disturbance types were recorded at 60 erosion sites. The most common factors were highly erosive soil (60 sites), excessive slope (59 sites), boat-generated waves (58 sites), recreation (12 sites) and water level fluctuations (8 sites) (Holmstead 2001b, Table 3). From a hydrologic perspective, most bank erosion sites (52 of 60) are located upslope of the 30,000 cfs stage level; above the typical zone influenced by water fluctuations and summer base flows from past HCC operations. These sites are believed to be primarily impacted during periods of high flows (Holmstead 2001b). Because many of these influences are interrelated, attributing the cause of erosion at each site to any single factor is difficult.

Predicting quantitative differences between the effects of the proposed and the full pool run-of-river scenarios on shoreline erosion is difficult (e.g., acreage or number of sites). Although proposed operations are defined to have daily summer flow of lower average maximums than under historic operations, other operational influences (e.g., daily ramping rates) and natural flow events (e.g., spring runoff flows greater that 30,000 cfs; the capacity of Hells Canyon Dam) are expected to be similar to historic conditions. Therefore, a similar amount of shoreline bank erosion may be expected over the next 30 years as has occurred during historic operations. Full pool run-of-river operations would eliminate large daily fluctuations from HCC operations and result in smoother stage decline rates and lower summer base flows (Parkinson 2002). This may reduce bank erosion below the 30,000 cfs stage compared to proposed operations. However, a similar rate of bank erosion would be expected on shoreline substrates at and above the 30,000 cfs stage. Other erosional influences (e.g., recreation traffic, boat-generated waves) would continue to exert influence on shoreline bank erosion under both scenarios.

Other factors that influence the erosion of shoreline banks along the downstream reach include management actions of federal and private landowners. In this reach, which is almost entirely under USFS ownership, USFS oversees grazing allotments, road and recreation facility maintenance, river boating activities, and other public uses. These activities can contribute to factors such as 'livestock grazing,' 'boat-generated waves,' 'roads,' and 'recreation' disturbance types, which were documented to influence erosion of shoreline banks along this reach (Table 3 and Appendix 2 in Holmstead 2001b).

We conclude that, compared to full pool run-of-river operations, proposed operations would result in a greater amount of shoreline bank erosion on the downstream reach, especially those sites impacted below the 30,000 cfs stage level. Because we cannot predict a quantitative difference in shoreline erosion between scenarios on the river reach (e.g., acreage or number of sites), it assumes that the amount of bank erosion under proposed operations would not be greater than the amount of current bank erosion.

By proposing to mitigate for the total extent of shoreline bank erosion in this reach, IPC would not limit it's actions solely to it's contribution to shoreline bank erosion. Other influences outside of IPC control also impact shoreline bank erosion. Such factors include recreation activities (boat-driven waves, camping, trails and dispersed recreation), livestock grazing, and road or other construction or maintenance activities under the actions of federal agencies, public interest

groups, or other private land owners. These factors would continue to influence shoreline bank erosion under either proposed or full pool run-of-river operations.

Mitigation for 6 acres of existing shoreline erosion could be accomplished through acquisition and enhancement actions (e.g., additive to other acquisition/enhancement measures), by specific management actions to eliminate anthropogenic causes of erosion, and where feasible, by limited site stabilization/revegetation actions.

Management actions could be implemented to control human-caused factors that negatively affect shoreline banks. These actions should focus on controlling recreation influences (for example, boat-driven waves, camping, trails, and vehicle use), minimizing effects of roads and construction or maintenance activities, and reducing the livestock grazing that has negative effects (Holmstead 2001b). Because these management actions fall under the jurisdiction of the USFS in this downstream reach, the Applicant has little management authority. Because water fluctuations are necessary if the HCC is used for flood control, anadromous fish spawning and protection, downstream navigation, and hydroelectric generation, eliminating all negative impacts from human activity is not possible.

Stabilizing and revegetating most of the shoreline erosion sites in the study area may not be practical, feasible, or even desirable (Holmstead 2001b). The subsoil remaining at these sites would likely be hard, rocky, infertile, and droughty, making it difficult to reestablish vegetation cover. Without soil amendments, the remaining soil probably could not support adequate growth and, therefore, would not adequately stabilize the banks. The steep topography and remoteness of the canyon makes access it difficult to access and work on most sites. Improper design or implementation often results in problems more severe than those that were to be avoided. However, because natural resources below Hells Canyon Dam are highly valued by many people for recreation, cultural, and aesthetic resources, cooperative efforts to stabilize and enhance priority sites that have shoreline erosion may be appropriate to benefit these values.

4.2.2.2. Human Use Activities on Botanical Resources

IPC does not manage or have responsibilities for human use activities downstream of Hells Canyon Dam. Nonetheless, Dumas et al. (2002a) estimated 19.8 acres (8 ha) of riparian habitat directly overlaps human use sites along the Snake River downstream of Hells Canyon Dam. Although human use levels are relatively low (Brown 2002), Dumas et al. (2002a) recommended that the USFS (the primary resource management agency) monitor riparian area-human use interactions and determine a threshold impact level at which changes in human use management should occur.

4.2.3. Transmission Lines and Service Roads

4.2.3.1. General Vegetation

There is little evidence that the transmission line ROWs and service roads are affecting vegetation composition or pattern along most of the HCC transmissions (Dumas et al. 2002b). O&M activities, including ROW vegetation clearing, generally have limited site-specific impacts in the region. The greatest potential for impacts of IPC O&M activities occurs on the Wallowa-

Whitman National Forest (WWNF) of Oregon where clearing occurs in forests and in riparian habitats of the Imnaha River.

Currently, most of the shrub-steppe ecosystems associated with the HCC transmission lines have departed significantly from historical vegetation composition and patterns. Landscape changes have resulted from continued large-scale disturbances, principally by livestock grazing, fire, and land use conversion (Quigley and Arbelbide 1997). These changes in vegetation composition and pattern are clearly causing fragmented ecosystems (Knick and Rotenberry 1995). IPC's O&M activities for the HCC transmission lines are negligible for fragmenting these ecosystems. Dumas et al. (2002b) compared vegetation patches intersecting the ROWs with similar corridors 1 km away from either side of the ROWs. They found no appreciable differences in landscape structure between ROWs and the comparison corridors in the shrub-steppe regions studied.

In the forested region intersected by the HCC transmission lines (i.e., the WWNF), however, clearing of tall vegetation in the ROWs has effected vegetation composition and pattern. Vegetation clearing occurs on about 23 km of ROWs (Dumas et al. 2002b). About 17 km of ROW appear to have changed from a tree cover type to a shrub or grass cover type and about 7 km have changed from one non-forested cover type to a different non-forested type. Some of this latter change may be due to natural succession and some is likely due to suppression of tall vegetation by IPC. The most common conversion of forested to non-forested cover type has been to montane shrub (12.6 km). The remaining conversion is almost all dry meadow (2.6 km) or alpine shrub (1.6 km). Some of these shrub types were likely present in the forest understory prior to tree removal.

The overall impacts of vegetation clearing in the forested region are confined, except for snag densities, to the ROWs and do not extend to adjacent plant communities (Dumas et al. 2002b). The ROWs occur within an environment of naturally fragmented patches of denser forest canopy mixed with open forest savannahs, shrublands, or grasslands. Historically, fire heavily influenced the ecology of these forests, resulting in less dense, smaller patches of early successional species (Quigley and Arbelbide 1997, Heyerdahl et al. 2001). The potential for IPC vegetation clearing to result in forest fragmentation is minimized by the localized nature of the impacts and the natural patchiness of the forest environment (Dumas et al. 2002b).

Throughout the forested region, snag and large-tree resources are lacking where ROW are cleared. It is necessary to keep ROWs cleared of vegetation that represents a hazard to the safety and reliability of the transmission lines. Therefore, these conditions will persist in the future. In addition, trees and snags that may interfere with the transmission lines are routinely cleared from a hazard area adjacent to a ROW. This hazard area buffers both sides of a ROW for about 30 m. Other than hazard tree removal, vegetation in this zone is not disturbed when line clearing occurs, and downed vegetation is left in place. Dumas et al. (2002b) found no difference in large-tree and downed-wood resources, and about a 50% decrease in snag resources in the hazard zone when compared to adjacent comparison areas. Even with the reduction, the density of snags (3.5 snags/ha) in the hazard zone was sufficient to meet management recommendations for many primary excavators (Thomas 1979, Bull and Holthausen 1993, Bull et al. 1997).

Dumas et al. (2002b) estimated that 1.5 km of the 9.7 km (15%) of riparian vegetation in the ROWs require vegetation management in the form of periodic trimming or removal. Over half of

this vegetation management occurs on the Oxbow to Lolo line (no. 907). The Imnaha River corridor on the WWNF has the most substantial and contiguous riparian habitat associated with the HCC transmission lines. The Oxbow to Lolo line (nos. 907 and 908) parallels and crosses the Imnaha River on public land (WWNF) for approximately 39 km. Within this area, vegetation clearing is required on about 1.3 km of ROW, all of which occurs on the Oxbow to Lolo line (no. 907) (Dumas et al. 2002b). Of that length, vegetation clearing occurs on approximately 10.6 acres (4.3 ha), of which 1.5 acres (0.6 ha) is riparian vegetation. These riparian patches are small and numerous—24 different patches are managed for tall-growing vegetation. In addition to ROW clearing, areas of the Oxbow to Lolo line (nos. 907 and 908) receive heavy grazing, recreational use, and are influenced by land use activities where private property intermingles with federal land. The location of the Oxbow to Lolo line (no. 907) along the Imnaha River coincides with the south to north transition from closed canopy, forested riparian communities to more open, savannah like riparian communities. This transition results in less ROW clearing, and thus less impact to the riparian plant communities. The northern section of the Oxbow to Lolo line (no. 908), in contrast, mainly passes through upland cover types where it intercepts federal land (WWNF).

4.2.3.2. Noxious Weeds

Dumas et al. (2002b) surveyed a sample of service roads and tower sites for the presence of noxious weeds. They recorded 1,118 occurrences of 17 listed noxious weed species. At least 1 noxious weed was located on 607 (i.e., 77%) of the 785 survey units comprising the 14 HCC transmission lines (Table 1) (Dumas et al. 2002b). O&M activities do play a role in the spread of noxious weeds along transmission line service roads and at tower locations. However, because most disturbance factors (i.e., fire, grazing) are interrelated, it is difficult if not impossible to attribute the potential cause of noxious weed occurrence and spread to any single influence.

Dumas et al. (2000b) assigned a Risk Index to individual survey units along each transmission line. The Risk Index is based on the potential for O&M activities to negatively impact botanical resources. Noxious weeds were found in all Risk Index classes. However, Dumas et al. (2002b) only considered noxious weed occurrences on survey units with a “moderate” or “high” Risk Index to be impacted by O&M activities.

Dumas et al. (2000b) detected a positive correlation between the number of weed occurrences on a survey unit and Risk Index class, i.e., the average number of weed occurrences per survey unit increased with increasing Risk Index class. The “low” risk survey units had a mean of 0.6 weed occurrences per survey unit. Survey units categorized as “moderately low” had a mean of 1.2 occurrences per survey unit. “Moderate” risk survey units had a mean of 2.0 weed occurrences per survey unit, while “high” risk survey units had a mean of 3.6 weed occurrences per survey unit (Dumas et al. 2002b). Specific information regarding potential O&M impacts to each of the 17 species of noxious weeds found during IPC surveys are detailed below.

Whitetop (also called hoary cress) is found throughout most of the U.S. and is extensive in both Idaho and Oregon. It is a perennial species that reproduces by both seed and root segments. It increases with drought and disturbance and is extremely competitive once established. Deep and extensively branching root systems make control difficult. Hoary cress is listed as noxious in both Idaho and Oregon. Hoary cress was located on 146 of 785 units surveyed (19%). It

averaged locally frequent in the roadway on 121 units, locally frequent in the 50-m buffer zone on 128 units, and frequent outside of the buffer zone on 30 units. Occurrences were highly concentrated in Hells Canyon, with 61 occurrences on the Brownlee-Quartz Jct. line (no. 903), 57 on the Brownlee-Boise Bench #1&2 line (no. 904), 10 on the Oxbow-Brownlee line (no. 905), and 11 on the Brownlee-Boise Bench #3&4 line (no. 911). Livestock disturbance and disturbance from service road construction each averaged moderate on over 90% of units containing hoary cress, while big game disturbance averaged slight to moderate on 73% of units containing the species. Other disturbances present on units containing this species included water erosion (moderate on 52 units), road use (moderate on 34 units), non-project roads (slight to moderate on 36 units), fire (slight to moderate on 18 units), and off-highway vehicles (slight on 28 units) (Dumas et al. 2002b).

Diffuse knapweed (*Centaurea diffusa*) is widespread in the western half of both the U.S. and Canada, and is extensive in Idaho and Oregon. It is an annual, biennial, or short-lived perennial species that reproduces by seed. The species is common along roadsides, in waste areas, and dry rangeland, but can survive in a wide variety of environmental conditions. It increases with drought and disturbance and spreads rapidly. It is an extremely competitive plant that often replaces desirable forage species, posing a threat to pastures and rangelands. Diffuse knapweed is noxious in both Idaho and Oregon. It was located on 29 of 785 units surveyed (4%). It averaged occasional in the roadway on 21 units, occasional in the 50-m buffer zone on 15 units, and rare outside of the buffer zone on 3 units. Ten occurrences were on the Oxbow-Pallette Jct. line (no. 907), and 4 were on the Pallette Jct.-Imnaha line (no. 908). Livestock disturbance and disturbance from service road construction each averaged moderate on 86% of units containing diffuse knapweed, while road use and water erosion each averaged moderate to high on approximately half of units containing the species. Other disturbances present on units containing diffuse knapweed included non-project roads (moderate on 12 units), big game (slight on 12 units), corridor clearing (moderate to high on 8 units), off-highway vehicles (slight on 7 units), and fire (moderate to high on 5 units) (Dumas et al. 2002b).

Rush skeletonweed (*Chondrilla juncea*) is widespread in the western U.S. and is extensive in both Idaho and Oregon. It is a perennial species that reproduces primarily by seed, but is also spread by tillage. It commonly inhabits roadsides, ditches, rangelands, grain fields, and pastures. Deep, extensively branching root systems make control difficult. Rush skeletonweed is noxious in both Idaho and Oregon. It was located on 212 of 785 units surveyed (27%). It averaged occasional in the roadway on 116 units, occasional in the 50-m buffer zone on 194 units, and occasional to locally frequent outside of the buffer zone on 79 units. Occurrences were concentrated on lines between Brownlee and Midpoint, with 53 occurrences on the Brownlee-Boise Bench #1&2 line (no. 904), 31 on the Boise Bench-Midpoint #2 line (no. 906), 70 on the Brownlee-Boise Bench #3&4 line (no. 911), and 58 on the Boise Bench-Midpoint # 3 line (no. 912). Rush skeletonweed was not located on the 7 remaining lines. On units containing this species, livestock disturbance and disturbance from service road construction averaged moderate on 94% and 86%, respectively, while fire and road use averaged moderate on 70% and 66%, respectively. Other disturbances present on units containing this species included big game (slight to moderate on 160 units), off-highway vehicles (slight on 117 units), non-project roads (slight to moderate on 94 units), and water erosion (moderate on 109 units) (Dumas et al. 2002b).

Canada thistle is widespread throughout most of the U.S. and Canada and is extensive in both Idaho and Oregon. It is a perennial species that reproduces by seed and extensive, colony-forming rhizomes that are readily spread by tillage. It grows in a wide range of soils and environmental conditions, posing threats to cropland, rangeland, pastures, and wetlands. Extensive rhizomes make control difficult. Canada thistle is noxious in both Idaho and Oregon. It was located on 101 of 785 units surveyed (13%). It averaged occasional in the roadway on 55 units, occasional to locally frequent in the 50-m buffer zone on 79 units, and frequent outside of the buffer zone on 4 units. Occurrences were distributed throughout transmission line and service road ROWs with the highest concentrations occurring between Oxbow and Enterprise. Forty-one occurrences were located along the Oxbow-Pallette Jct. line (no. 907) and 34 occurrences were located along the Pallette Jct.-Enterprise line (no. 913). Disturbance from service road construction averaged moderate on 88% of units containing Canada thistle, while livestock disturbance and corridor clearing averaged moderate, and moderate to high, respectively, on nearly two-thirds of units containing the species (Dumas et al. 2002b).

Poison hemlock grows throughout most of the U.S., with extensive occurrences in Idaho. It is found throughout most of western Oregon and in Umatilla and Wallowa counties in northeastern Oregon. It is a biennial species that reproduces by seed, and inhabits poorly drained soils near stream shorelines, ditches, and other surface water. It often borders pastures and cropland, threatening perennial crops such as alfalfa. The species contains poisonous alkaloids that are toxic to humans and all classes of livestock. Poison hemlock is noxious in both Idaho and Oregon. It was located on 10 of 785 units surveyed (1%). It averaged locally occasional in the roadway on 5 units, locally occasional to occasional in the 50-m buffer zone on 8 units, and was not located outside of the buffer zone. Occurrences were concentrated near Brownlee with 5 occurrences on the Brownlee-Boise Bench #1&2 line (no. 904), 1 occurrence on the Oxbow-Brownlee line (no. 905), and 4 occurrences on the Brownlee-Boise Bench #3&4 line (no. 911). Poison hemlock was not located on the 11 remaining transmission lines (Table 1). Livestock disturbance averaged moderate and disturbance from service road construction averaged moderate to high on all units containing poison hemlock. Other disturbances present on units containing poison hemlock included big game (moderate on 6 units), fire (high on 3 units), non-project roads (moderate on 5 units), and water erosion (moderate to high on 7 units) (Dumas et al. 2002b).

Field bindweed is widespread in the U.S., except for the southeastern states, and is extensive in both Idaho and Oregon. It is a perennial species that reproduces by seed and creeping roots and often inhabits cultivated fields, waste places, roadbeds, and lawns. Twisting, prostrate stems can form dense mats and often climb other vegetation. With seeds that remain viable for up to 50 years and roots that can penetrate soil up to 20 feet, field bindweed is extremely difficult to eradicate. Field bindweed is noxious in both Idaho and Oregon. It was located on 75 of 785 units surveyed (10%). It averaged locally frequent in the roadway on 69 units, locally frequent to frequent in the 50-m buffer zone on 53 units, and frequent outside of the buffer zone on 7 units. Eighteen occurrences were on the Brownlee-Quartz Jct. line (no. 903), 22 occurrences on the Brownlee-Boise Bench #1&2 line (no. 904), and 10 occurrences each on the Oxbow-Pallette Jct. line (no. 907) and the Brownlee-Boise Bench #3&4 line (no. 911). Livestock disturbance averaged moderate to high and disturbance from service road construction averaged moderate on 96% of units containing field bindweed, while water erosion averaged moderate on 70% of units containing the species. Other disturbances present on units containing field bindweed included

big game (slight to moderate on 52 units), fire (slight to moderate on 18 units), off-highway vehicles (slight on 24 units), non-project roads (slight to moderate on 37 units), and road use (moderate on 24 units) (Dumas et al. 2002b).

Houndstongue has been reported in all of the U.S. except for Alabama, Florida, Louisiana, Oklahoma, South Carolina, and Texas. Infestations are common but scattered in Idaho and Oregon. It is a biennial species that reproduces by seed and often inhabits rangeland, pasture, roadsides, and other disturbed habitat. The species contains toxic alkaloids that can cause liver damage in some mammals. Houndstongue is noxious in Oregon, but not in Idaho. It was located on 160 of 299 units surveyed in Oregon (54%). It averaged locally occasional to occasional in the roadway on 120 units, occasional in the 50-m buffer zone on 132 units, and locally occasional outside of the buffer zone on 9 units. Occurrences were concentrated along the northwestern most transmission lines with 74 occurrences on the Oxbow-Pallette Jct. line (no. 907), 44 on the Pallette Jct.-Enterprise line (no. 913), 19 on the Pallette Jct.-Imnaha line (no. 908), 14 on the Pallette Jct.-Hells Canyon line (no. 910), and 8 on the Brownlee-Quartz Jct. line (no. 903). Disturbance from service road construction averaged moderate on 91% of units containing houndstongue, while livestock averaged moderate on 66% of units containing the species. Other disturbances present on units containing houndstongue included big game (slight on 57 units), corridor clearing (moderate to high on 89 units), non-project roads (moderate on 74 units), road use (moderate on 47 units), and water erosion (moderate on 64 units) (Dumas et al. 2002b).

Common teasel (*Dipsacus sylvestris*) is widespread in North America and is spreading rapidly in the Northwest. Infestations are common but scattered in Idaho and Oregon. It is a biennial species that spreads by seed and commonly inhabits moist sites such as along irrigation ditches, canals, and disturbed stream banks. Common teasel is noxious in Oregon but not Idaho. It was located on 39 of 299 units surveyed in Oregon (13%). It averaged frequent in the roadway on 23 units, frequent in the 50-m buffer zone on 36 units, and frequent outside of the buffer zone on 5 units. Occurrences were concentrated along the northern transmission lines with 18 occurrences on the Pallette Jct.-Imnaha line (no. 908), 15 on the Brownlee-Quartz Jct. line (no. 903), 4 on the Oxbow-Pallette Jct. line (no. 907), and 2 on the Pallette Jct.-Enterprise line (no. 913). Common teasel was not located on the 8 remaining lines. Disturbance from service road construction averaged moderate on all units containing common teasel, while livestock disturbance averaged moderate to high on 90% of units containing the species. Other disturbances present on units containing common teasel included big game (slight to moderate on 21 units), non-project roads (slight to moderate on 16 units), and water erosion (moderate on 31 units) (Dumas et al. 2002b).

Leafy spurge is common in the western and north-central U.S. and southern Canada. It is extensive in both Idaho and Oregon. It is a perennial species that reproduces by seed and vigorous rootstalks, and commonly inhabits unplanted pasture or rangeland along stream shorelines. The species contains milky latex that can cause irritation of the mouth and digestive tract in cattle and horses. Leafy spurge is noxious in both Idaho and Oregon. It was located on 7 of 785 units surveyed (<1%). It averaged occasional in the roadway on 3 units, frequent in the 50-m buffer zone on 6 units, and frequent outside of the buffer zone on 3 units. Occurrences were located on units associated with the Brownlee-Boise Bench #1&2 (no. 904) and the Brownlee-Boise Bench #3&4 (no. 911) lines. Livestock and big game disturbance averaged

slight on all units containing leafy spurge, while road use and disturbance from service road construction each averaged moderate on 6 of 7 units containing the species. Other disturbances present on units containing leafy spurge included: water erosion (moderate on 5 units) and off-road vehicles (slight on 5 units) (Dumas et al. 2002b).

St. John's wort is widespread in the western U.S. and portions of Canada. It is common in both Idaho and Oregon. It is a perennial species that reproduces by seed and by underground runners. It commonly inhabits sandy or gravelly soils, but can survive in a variety of environmental conditions, often invading pasture and rangeland. The species contains toxins that can be cumulatively poisonous to livestock, especially to light-pigmented animals. St. John's wort is noxious in Oregon but not in Idaho. It was located on 69 of 299 units surveyed in Oregon (23%). It averaged occasional in the roadway on 41 units, occasional in the 50-m buffer zone on 57 units, and occasional to locally frequent outside of the buffer zone on 11 units. Occurrences were concentrated along the northern transmission lines with 33 occurrences on the Oxbow-Pallette Jct. line (no. 907), 18 on the Pallette Jct.-Imnaha line (no. 908), 9 on the Brownlee-Quartz Jct. line (no. 903), and 5 on the Pallette Jct.-Hells Canyon line (no. 910). Disturbance from service road construction averaged moderate on 91% of units containing St. John's wort, while livestock disturbance averaged moderate to high, and water erosion averaged moderate on 59% of units containing the species. Other disturbance types present on units containing St. John's wort varied greatly (Dumas et al. 2002b).

Scotch thistle is widespread over much of North America and is common throughout Idaho and eastern Oregon. It is a biennial species that spreads primarily by seed. It commonly inhabits waste areas, moist areas, and drainages in dry locations. The species is very aggressive and often forms dense, impenetrable stands. Scotch thistle is noxious in both Idaho and Oregon. It was located on 157 of 785 units surveyed (20%). It averaged locally occasional to occasional in the roadway on 99 units, occasional in the 50-m buffer zone on 127 units, and occasional outside of the buffer zone on 11 units. Occurrences were widespread, but concentrated along the northern transmission lines with 40 occurrences on the Brownlee-Quartz Jct. line (no. 903), 33 on the Brownlee-Boise Bench #1&2 line (no. 904), 43 on the Oxbow-Brownlee line (no. 905), 13 on the Oxbow-Pallette Jct.-Hells Canyon line (no. 907), and 16 on the Brownlee-Boise Bench #3&4 line (no.911). Livestock disturbance and disturbance from service road construction averaged moderate on >90% of units containing Scotch thistle, while big game disturbance averaged moderate on 73% of units containing the species. Other common disturbance types present on units containing Scotch thistle include water erosion (moderate on 76 units), road use (moderate on 43 units), off-highway vehicles (slight on 38 units), and non-project roads (slight to moderate on 38 units) (Dumas et al. 2002b).

Curly dock (*Rumex crispus*) is found throughout North America and is common in both Idaho and Oregon. It is a tap-rooted perennial that reproduces by seed and commonly inhabits wet meadows, ditch banks, and waste areas. Curly dock is noxious in Oregon, but not in Idaho. It was located on 41 of 299 units surveyed in Oregon (14%). It averaged locally occasional to occasional in the roadway on 17 units, locally occasional in the 50-m buffer zone on 35 units, and rare outside of the buffer zone on 1 unit. Occurrences were concentrated along the northern transmission lines with 19 occurrences on the Brownlee-Quartz Jct. line (no. 903), 7 on the Oxbow-Pallette Jct. line (no. 907), 11 on the Pallette Jct.-Imnaha line (no. 908), and 4 on the Pallette Jct.-Enterprise line (no. 913). Disturbance from service road construction averaged

moderate on 93% of units containing curly dock, while livestock disturbance averaged moderate to high on 88%, and water erosion averaged slight to moderate on 76% of units containing the species. Other disturbance types present on units containing curly dock varied greatly (Dumas et al. 2002b).

Medusahead wildrye is common in the western U.S. and is scattered throughout much of Oregon and south-central Idaho. It is an extremely competitive winter annual that is capable of out-competing many species, including other aggressive species such as cheatgrass. The species is unpalatable at all growth stages to livestock and has spread enough to render rangelands useless for grazing. Medusahead wildrye is noxious in Oregon, but not in Idaho. It was located on 64 of 299 units surveyed in Oregon (21%). It averaged frequent in the roadway on 42 units, frequent in the 50-m buffer zone on 63 units, and locally abundant outside of the buffer zone on 18 units. Occurrences were concentrated along the Brownlee-Quartz Jct. line (no. 903), occurring on 55 units. Livestock disturbance averaged moderate to high on 97% of units containing medusahead wildrye, while disturbance from service road construction averaged moderate on 94%, and big game disturbance averaged slight to moderate on 75% of units. Other disturbances present on units containing medusahead wildrye included water erosion (moderate on 38 units), non-project roads (slight to moderate on 30 units), road use (moderate on 22 units) off-highway vehicles (slight on 22 units), and fire (slight on 13 units) (Dumas et al. 2002b).

Jointed goatgrass (*Aegilops cylindrica*) is common in most winter wheat growing areas in North America, including much of Idaho and Benton and Baker counties in Oregon. It is a winter annual that spreads by seed. It most commonly inhabits cultivated fields, waste areas and roadsides, but can also invade grasslands. Jointed goatgrass is noxious in both Idaho and Oregon. It was located on units associated with towers 29 and 32 of the Brownlee-Boise Bench #1&2 line (no. 904). It was locally rare in the roadway of 1 unit, and frequent in the roadway of the other unit. No occurrences were located outside of the roadway. Disturbance from service road construction was moderate to high, livestock disturbance was moderate, and big game disturbance was slight in both units, while disturbance from non-project roads was moderate on 1 unit (Dumas et al. 2002b).

Spotted knapweed (*Centaurea maculosa*) is widespread in North America and is found throughout Idaho and most of Oregon. It is a biennial or short-lived perennial that reproduces by seed and readily inhabits any disturbed soil. Seed production is prolific and seeds can remain viable in the soil for 8 years. Early spring growth makes the species highly competitive for soil moisture and nutrients. Spotted knapweed is noxious in both Idaho and Oregon. One occurrence was located on the Brownlee-Boise Bench #3&4 line (no. 911). It was locally abundant in both the roadway and the 50-m buffer zone, but was not observed outside the buffer zone. Livestock disturbance was moderate, while agriculture, big game, and water erosion were each slight on the unit (Dumas et al. 2002b).

Russian knapweed (*Centaurea repens*) is widespread in western North America and is found throughout Idaho and much of Oregon. It is a perennial species that reproduces by seed and adventitious roots and commonly inhabits cultivated fields, orchards, pastures, and roadsides. Extensive and deep root systems with prolific root shoot production make the species difficult to control. Russian knapweed is noxious in both Idaho and Oregon. Three occurrences were located with 2 occurrences on the Pallette Jct.-Enterprise line (no. 913) and 1 on the Oxbow-Pallette Jct.

line (no. 907). It was locally frequent in the roadway on the first unit, locally frequent in the 50-m buffer zone in the second unit, and locally rare in the roadway of the third unit. It was not observed outside of the buffer zone. Disturbance from service road construction was slight on all units, whereas corridor clearing was high, and livestock and disturbance from non-project roads were each slight on 2 units. Water erosion was moderate and big game disturbance was slight on 1 unit (Dumas et al. 2002b).

Puncturevine (*Tribulus terrestris*) is widespread over much of North America and is common throughout most of Idaho and parts of Oregon. It is an annual species that reproduces by seed and commonly inhabits sandy, dry, or gravelly sites in cultivated fields, pastures, waste areas, and roadsides. Hard spines on fruit segments can puncture bicycle tires, therefore reducing the recreational value of some sites. The spines also damage wool, contaminate hay, and can injure livestock. Puncturevine is noxious in both Idaho and Oregon. Two occurrences were located, with 1 occurrence each on the Brownlee-Quartz Jct. line (no. 903) and Oxbow-Brownlee line (no. 905). It was locally frequent in the roadway on both units and locally occasional in the 50-m buffer zone in 1 unit. It was not observed outside of the buffer zone. Disturbance from service road construction was moderate to high in both units, whereas big game, livestock, and water erosion were slight to moderate on both units. Road use was high in 1 unit and off-highway vehicle disturbance was slight on 1 unit (Dumas et al. 2002b).

We recommend that IPC take the lead role in developing cooperative agreements with federal land management agencies and other private landowners to control establishment and spread of noxious weeds. Specifically, we recommended participating with local Cooperative Weed Management Areas (CWMAs) traversed by the transmission line ROWs. These groups build cooperative relationships between agencies, landowners, land managers, and other interested individuals and organizations that are needed for effective management of noxious weeds.

4.2.3.3. Threatened, Endangered, and Rare Plant Species

IPC surveys located 62 occurrences of 9 rare plant species along service roads or at tower sites associated with HCC transmission lines (Dumas et al. 2002b). No federally listed as *threatened* or *endangered* plant species were found. Specific information regarding potential O&M impacts to each of the 9 species of rare plants found during IPC surveys are detailed below.

Three occurrences of Aase's onion (*Allium aaseae*) were found in the Boise Foothills, along the Brownlee-Boise Bench #1&2 line (no. 904). Two occurrences were located within the 50-m road buffer zone, and 1 occurrence lies within the service road right-of-way. As of August 2001, 69 occurrences of Aase's onion were on file at the ICDC. The 3 new occurrences found during IPC surveys were located in the eastern half of the species' distribution, where occurrences are vulnerable to urban development and private land management (Mancuso 1995). They occurred within the known range and expected habitat of the species, therefore supporting the current range description for Idaho. Dumas et al. (2002b) cited livestock grazing, recreational trail use, urbanization, and exotic species invasion as the most likely threats to the occurrences. These occurrences are considered to have little risk from O&M activities (Dumas et al. 2002b).

Nineteen occurrences of morning milkvetch (*Astragalus atratus* var. *inseptus*) were located along the Boise Bench-Midpoint #2 and Boise Bench-Midpoint #3 lines (Dumas et al. 2002b).

As of August 2001, 60 occurrences of morning milkvetch were on file at the ICDC. The 19 new occurrences located during IPC surveys were within the known range and expected habitat of the species, therefore supporting the current range description for Idaho. Dumas et al. (2002b) cite livestock grazing and service road maintenance as the most likely threats to the occurrences. Five of the occurrences were in units with a "moderate" Risk Index rating for potential O&M impacts (Dumas et al. 2002b).

Two possible (not yet confirmed) occurrences of Snake River milkvetch (*Astragalus purshii* var. *ophiogenes*) were located along the Boise Bench-Midpoint #3 line (Dumas et al. 2002b). The accuracy of location and plant identification is currently under investigation. Both occurrences were outside of the expected range and at a higher elevation than the endemic occurrence. In the event of positive verification, the occurrences will likely be regarded as disjunct occurrences of the endemic population, and the federal and local status ranks for the species would remain unchanged. As of August 2001, 51 occurrences of Snake River milkvetch were on file at the ICDC, and 26 occurrences were on file at the ONHP. One of the 2 new occurrences located during IPC surveys was located within the service road and within the 50-m buffer, while the other occurrence was just in the 50-m buffer area. These occurrences are considered to have little risk of potential O&M impacts (Dumas et al. 2002b).

Four occurrences of Owyhee milkvetch (*Astragalus atratus* var. *owyheensis*) were located along the Brownlee-Quartz Jct. line in Oregon (Dumas et al. 2002b). As of August 2001, 9 occurrences of Owyhee milkvetch were on file at the ONHP. These 4 new occurrences were located within the known range and expected habitat of the species, therefore supporting the current range description for Oregon. One of the 4 occurrences was in a survey unit with a "moderate" O&M Risk Index category (Dumas et al. 2002b). It was rare in the 50-m buffer zone and absent in both the roadway and the area beyond the buffer zone.

One occurrence of Oregon bolandra was located along Pallette Jct.-Imnaha line in Oregon (Dumas et al. 2002b). As of August 2001, 50 occurrences of Oregon bolandra were on file at the ONHP. The new occurrence was located within the known range and expected habitat of the species, therefore supporting the current range description for Oregon. It was in a unit with a "high" O&M Risk Index (Dumas et al. 2002b). It occurred in the 50-m buffer zone, and was absent in both the roadway and the area beyond the buffer zone. However, because it was found growing in the cracks of exposed basalt under a small waterfall, service road O&M activities are not a likely threat (Dumas et al. 2002b). In addition, the occurrence occupies such a narrow niche that impacts from invasion by other species or grazing by livestock are unlikely.

Ten occurrences of Back's sedge (*Carex backii*) were located in Oregon; with 2 occurrences on Pallette Jct.-Imnaha line, 7 occurrences on the Oxbow-Pallette Jct. line, and 1 occurrence on the Pallette Jct.-Hells Canyon line (Dumas et al. 2002b). Four of these occurrences were found within the service road area. Others occurred in the 50-m buffer zone or outside of the buffer zone. Although there were 26 previously known occurrences of Back's sedge in Oregon, most occurrences have less than 10 plants (i.e., clumps or ramets), and intensive grazing and timber harvest reportedly threaten nearly all occurrences. Livestock disturbance was an imminent threat to all of the 10 new occurrences found during IPC surveys. Six of the 10 occurrences were in units with a "moderate" or "high" O&M Risk Index (Dumas et al. 2002b).

One occurrence of bank monkeyflower (*Mimulus clivicola*) was located on the Oxbow-Pallette Jct. line in Oregon (Dumas et al. 2002b). As of August 2001, 140 occurrences of bank monkeyflower were on file at the ICDC, and 30 were on file at the ONHP. This new occurrence was within the known range and expected habitat of the species, therefore supporting the current range descriptions for both Idaho and Oregon. It was found growing in saturated sphagnum soil, along the banks of a small perennial stream within the 50-m buffer area. Because of this location, it is considered to have little risk from potential O&M impacts (Dumas et al. 2002b).

Ten occurrences of bartonberry (*Rubus bartonianus*) were located in the Payette National Forest, along the Oxbow-Hells Canyon line (Dumas et al. 2002b). As of August 2001, 9 occurrences of bartonberry were on file at the ICDC, and 9 were on file at the ONHP. The 10 new occurrences were located within the known range and expected habitat of the species, therefore supporting the current range descriptions for both Idaho and Oregon. All disturbance factors associated with bartonberry occurrences were relatively minimal and they are considered to have little risk of potential O&M impacts (Dumas et al. 2002b).

Thirteen occurrences of hooked stylocline (*Stylocline filaginea*) were located in Idaho along Brownlee-Boise Bench #1&2, Boise Bench-Midpoint #2, Brownlee-Boise Bench #3&4, and Boise Bench-Midpoint #3 (Dumas et al. 2002b). As of August 2001, 13 occurrences of *Stylocline filaginea* were on file at the ICDC. Although only doubling the known Idaho occurrences, the 13 new occurrences located by IPC were so large and widespread that the findings will likely downlist the ranking of the species in Idaho. In addition, IPC botanists observed numerous unreported occurrences between survey units associated with lines 906 and 912 in portions of south-central Idaho. Dumas et al. (2002b) cite big game, livestock, road use, and service road disturbances as the most likely threats to the occurrences. Five of the 13 new occurrences were in units with a "moderate" O&M Risk Index (Dumas et al. 2002b).

In general, we recommend working cooperatively with federal land management agencies to protect rare plant sites impacted by disturbance activities. Specific actions to reduce disturbance from O&M activities should be implemented. O&M activities can promote the spread of noxious weeds, which may negatively impact the 38 rare plant occurrences that lie within service road ROWs (Table 6 in Dumas et al. 2002b). Rare plant occurrences that lie within survey units with O&M Risk Index categories of "moderate" or "high" are considered to have potential impacts from O&M activities. Sixteen rare plant occurrences were located in survey units with a "moderate" Risk Index and 2 occurrences were located on survey units with the "high" Risk Index (Table 73 in Dumas et al. 2002b). Specific protection activities should be adopted to minimize negative impacts from O&M activities to rare plants and specifically to these 18 occurrences.

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Table 1. Transmission lines associated with the Hells Canyon Complex.

FERC Name	IPC Name	Line No.
Boise-Brownlee-Baker	Brownlee-Boise Bench #1&2	904
	Brownlee-Quartz Jct.	903
Boise-Brady #2	Boise Bench-Midpoint #2	906
	Midpoint-Adelaide-Borah	951
	Borah-Brady	923
Brownlee-Boise Bench #3&4	Brownlee-Boise Bench #3&4	911
Boise Bench-Midpoint	Boise Bench-Midpoint #3	912
Adelaide Tap 345kV	Adelaide Tap	952
Oxbow-Brownlee	Oxbow-Brownlee	905
Oxbow-Pallette Jct.-Hells Canyon	Oxbow-Pallette Jct.	907
	Pallette Jct.-Hells Canyon	910
Pallette Jct.-Divide Creek	Pallette Jct.-Imnaha	908
Pallette Jct.-Enterprise	Pallette Jct.-Enterprise	913
Oxbow-Hells Canyon	Oxbow-Hells Canyon	945

Table 2. Summary of estimated acres impacted by proposed operations of the HCC.

Impact Zone	Area of Impact Zone (acres)	Proportion of Zone Impacted	Impact Acres
	Vicinity of HCC		
Brownlee Reservoir Inundation Zone	4,072	0.0%	0
Reservoir Fluctuation Zones			
Wildlife Habitat Impacts	6,149	100.0%	6,149
Brownlee Reservoir Low-elevation Winter Range Impacts	5,820	10.0%	582
Reservoir Shoreline Zones			
Brownlee Riparian Habitat	3,296	10.4%	343
Oxbow and Hells Canyon Riparian Habitat	1,570	0.0%	0
Soil Erosion	4,866	1.7%	84
Crucial Winter Range	86,408	19.0%	16,418
	Downstream of Hells Canyon Dam		
River Shoreline Zones			
Riparian Habitat	3,435	0.0%	0
Soil Erosion	3,435	0.2%	6
Total			**23,582**

Table 3. Threatened, endangered, candidate, and special status species known or suspected to occur in Hells Canyon.

Taxon	IDCDC[a] Rank	IDFG[b] Status	USFS[c] Region4	USFS[c] Region6	USBLM[c] Status	USFWS[d] Status	ORNHP[a] Rank	ORFW[e] Status
Amphibians								
Tiger salamander *Ambystoma tigrinum*							S4	SU
Columbia spotted frog[f] *Rana luteiventris*	G5/S2S3	SC	S	S	S	CE	S2?	SU
Tailed frog[f] *Ascaphus truei*						W	S3	SV
Woodhouse toad *Bufo woodhousii*	G5/S3					W	S2	SP
Northern leopard frog[f] *Rana pipiens*	G4/S3	SC			S	SC	S2?	SC
Western toad[f] *Bufo boreas*	G4/S4	SC			S	W/SC	S4	SV
Reptiles								
Western ground snake *Sonora semiannulata*	G5/S3	SC			S	W	S2	SP
Ringneck snake *Diadophis punctatus*	G5/S1?	SC			S	W		
Mojave black-collared lizard *Crotaphytus bicinctores*	G5/S2	SC			S	W	S2	SV
Longnose snake *Rhinocheilus lecontei*	G5/S3	SC			S	W		
Desert horned lizard *Phrynosoma platyrhinos*							S3	SV
Northern sagebrush lizard *Sceloporus graciosus*						W	S5?	SV

Taxon	IDCDC[a] Rank	IDFG[b] Status	USFS[c] Region4	USFS[c] Region6	USBLM[c] Status	USFWS[d] Status	ORNHP[a] Rank	ORFW[e] Status
Birds								
Common loon	G5/S1	SC	S	S		W		
Gavia immer								
Horned grebe	G5/S1?	P					S2	SP
Podiceps auritus								
Trumpeter swan[f]	G4/S1B	SC	S		S	SC		
Cygnus buccinator								
Harlequin duck[f]	G5/S1	SC	S	S	S	W	S2	SU
Histrionicus histrionicus								
American white pelican	G3/S1	SC		S			S1	SV
Pelecanus erythrorhynchos								
Franklin's gull	G4/S2	P					S1	SP
Larus pipixcan								
Black tern[f]	G4/S2	SC					S3	
Chlidonias niger								
Great egret	G5/S1	SC					S3	
Casmerodius albus								
Snowy egret	G5/S2	P					S2	SV
Egretta thula								
White-faced ibis	G5/S2	P			SC		S3	
Plegadis chihi								
Greater sandhill crane				S			S3	SV
Grus canadensis tabida								
Upland sandpiper	G5/S1	SC		S	S	W		
Bartramia longicauda								
Long-billed curlew	G5/S3	P		S	S	SC		
Numenius americanus								
Greater sage-grouse[f]				S	S	SC	S3	SV
Centrocercus urophasianus								

Taxon	IDCDC[a] Rank	IDFG[b] Status	USFS[c] Region4	USFS[c] Region6	USBLM[c] Status	USFWS[d] Status	ORNHP[a] Rank	ORFW[e] Status
Columbian sharp-tailed grouse[f] *Tympanuchus phasianellus*	G4/S3	GSC	S		S	SC	S1	
Spruce grouse *Dendragapus canadensis*							S3	SU
Mountain quail[f] *Oreortyx pictus*	G5/S2	SC	S		S	SC	S4?	SU
Northern harrier *Circus cyaneus*					S			
Northern goshawk *Accipiter gentilis*	G5/S4	SC	S		S	W	S3	SC
Ferruginous hawk *Buteo regalis*	G4/S3	P		S	S	W	S3	SC
Swainson's hawk *Buteo swainsoni*	G4/S4				S		S3	SV
Merlin *Falco columbarius*	G4/S1	P			S	W	S1	
Prairie falcon *Falco mexicanus*					S			
Peregrine falcon[f] *Falco peregrinus*	G4/S1	E	S	S		DM	S1	LE
Bald eagle[f] *Haliaeetus leucocephalus*	G3/S3	E	T	T		LT	S3	LT
Boreal owl *Aegolius funereus*	G5/S2	SC	S		S	W	S3?	SU
Burrowing owl *Athene cunicularia*	G4/S3	P			S	SC	S2?	SC
Northern pygmy owl *Glaucidium gnoma*	G5/S4	SC			W	W	S4	SC
Flammulated owl *Otus flammeolus*	G4/S3	SC	S		S	W	S4B	SC

Taxon	IDCDC[a] Rank	IDFG[b] Status	USFS[c] Region4	USFS[c] Region6	USBLM[c] Status	USFWS[d] Status	ORNHP[a] Rank	ORFW[e] Status
Great gray owl	G5/S2	SC	S		S	W	S3	SV
Strix nebulosa								
Yellow-billed cuckoo[f]	G5/S1	SC			S	CE	S1	SC
Coccyzus americanus								
Pileated woodpecker							S4?	SV
Dryocopus pileatus								
Lewis' woodpecker					S		S3	SC
Melanerpes lewis								
White-headed woodpecker	G4/S2	SC	S		S	W	S3	SC
Picoides albolarvatus								
Black-backed woodpecker	G5/S3	SC			S	W	S3	SC
Picoides arcticus								
Three-toed woodpecker	G5/S3	SC	S		S	W	S3	SC
Picoides tridactylus								
Red-naped sapsucker					S			
Sphyrapicus nuchalis								
Williamson's sapsucker					S		S4	SU
Sphyrapicus thyroideus								
Bank swallow							S4	SU
Riparia riparia								
Pygmy nuthatch	G5/S2S3	SC			S	W	S4?	SC
Sitta pygmaea								
Loggerhead shrike[f]	G4/S3	SC			S	SC	S4	SV
Lanius ludovicianus								
Vaux's swift					S			
Chaetura vauxi								
Olive-sided flycatcher					S	SC	S4	SV
Contopus borealis								
Dusky flycatcher					S			
Empidonax oberholseri								

Taxon	IDCDC[a] Rank	IDFG[b] Status	USFS[c] Region4	USFS[c] Region6	USBLM[c] Status	USFWS[d] Status	ORNHP[a] Rank	ORFW[e] Status
Cordilleran flycatcher					S			
Empidonax occidentalis								
Hammond's flycatcher					S			
Empidonax hammondii								
Willow flycatcher[f]					S		SU	SU
Empidonax traillii								
Townsend's warbler[f]					S			
Dendroica townsendi								
Yellow warbler[f]					S			
Dendroica petechia								
MacGillivray's warbler[f]					S			
Oporornis tolmiei								
Wilson's warbler[f]					S			
Wilsonia pusilla								
Plumbeous vireo[f]					S			
Vireo plumbeus								
Swainson's thrush					S			
Catharus ustulatus								
Veery					S			
Catharus fuscescens								
Calliope hummingbird					S			
Stella calliope								
Rufous hummingbird					S			
Selaphorus rufus								
Yellow-headed blackbird[f]					S			
Xanthocephalus xanthocephalus								
Grasshopper sparrow					S		S2?	SV/SP
Ammodramus savannarum								
Brewer's sparrow[f]					S			
Spizella breweri								
Sage sparrow[f]					S		S4	SC
Amphispiza belli								
Black-throated sparrow							S2?	SP
Amphispiza bilineata								

Taxon	IDCDC[a] Rank	IDFG[b] Status	USFS[c] Region4	USFS[c] Region6	USBLM[c] Status	USFWS[d] Status	ORNHP[a] Rank	ORFW[e] Status
Green-tailed towhee					S			
Pipilo chlorurus								
Black rosy finch				S			S2	SP
Leucosticte arctoa atrata								
Wallowa rosy finch							S2	
Leucosticte arctoa tephrocotis								
Bobolink					S		S2	SV
Dolichonyx oryzivorus								
Mammals								
Preble's shrew				S	S		S3	
Sorex preblei								
Coast mole	G5/S1?	SC				W		
Scapanus orarius								
Pallid bat	G5/S1?						S3	SV
Antrozous pallidus								
Townsend's big-eared bat[f]	G4/S2?	SC	S	S		SC	S2?	SC
Corynorhinus townsendii								
Spotted bat[f]	G4/S4	SC	S		S	W	S1	
Euderma maculatum								
Yuma myotis	G5/S3?				S	W	S3	
Myotis yumanensis								
Long-eared myotis	G5/S3?				S	W	S3	SU
Myotis evotis								
Fringed myotis[f]	G5/S1?	SC			S	W		
Myotis thysanodes								
Long-legged myotis	G5/S3?				S	W	S3	SU
Myotis volans								
California myotis	G5/S1?	SC				W		
Myotis Californius								
Small-footed myotis	G5/S4?				S	W	S3	SU
Myotis ciliolabrum								
Western pipistrelle[f]	G5/S1?	SC				W		
Pipistrellus hesperus								

Taxon	IDCDC[a] Rank	IDFG[b] Status	USFS[c] Region4	USFS[c] Region6	USBLM[c] Status	USFWS[d] Status	ORNHP[a] Rank	ORFW[e] Status
Northern Idaho ground squirrel[f]	G2/S2	SC	T		S	LT		
Spermophilus brunneus brunneus								
Southern Idaho ground squirrel[f]	G2/S2	SC	S		S	CE		
Spermophilus brunneus endemicus								
Northern flying squirrel	G3/S3				W			
Glaucomys sabrinus								
Pygmy rabbit	G4/S3	GSC		S	S	W	S2?	SV
Brachylagus idahoensis								
White-tailed jackrabbit							S4?	SU
Lepus townsendii								
Gray wolf[f]	G4/S1	E	E	E		LE/XN	SH	LE
Canis lupus								
American marten							S3	SV
Martes americana								
Fisher[f]	G5/S1	SC	S		S	W	S2	SC
Martes pennanti								
Kit fox	G4/S1	SC			S	W	S1	LT
Vulpes macrotis								
River otter[f]	G5/S4				W			
Lutra canadensis								
California wolverine[f]	G4/S2	SC	S	S	S	W	S2	LT
Gulo gulo luteus								
Lynx[f]	G4/S1	GSC	T	T	S	LT	S1	
Lynx canadensis								
California bighorn sheep[f]	G4/S3	G		S	S	SC	S2?	
Ovis canadensis californiana								
Invertebrates								
Columbia River tiger beetle[f]	G2/SH						SH	
Cicindela columbica								
Silver-bordered fritillary[f]	G5/S1						S2	
Boloria selene								
Johnson's hairstreak[f]	G2G3/						S2?	
Mitoura johnsoni								

Taxon	IDCDC[a] Rank	IDFG[b] Status	USFS[c] Region4	USFS[c] Region6	USBLM[c] Status	USFWS[d] Status	ORNHP[a] Rank	ORFW[e] Status
Yuma skipper[f]	G5/S1						S1?	
Ochlodes yuma								

[a] Natural Heritage Network ranks: G = global rank indicator, T = trinomial rank indicator, and S = state rank indicator; 1 = critically imperiled, 2 = imperiled because of rarity, 3 = very rare and local throughout its range or found locally, 4 = apparently secure, and 5 = demonstrably secure, H = Historical occurrence

[b] IDFG ranks: T = listed threatened; E = listed endangered, SC = species of special concern, P = protected nongame, G = game species

[c] USFS and BLM ranks: S = sensitive

[d] USFWS (Federal) status: LE = listed endangered, LT = listed threatened, XN = Experimental nonessential population, CE = candidate endangered, CT = candidate threatened; Snake River Field Office: SC = species of concern, W = watch species, and DM = delisted monitoring

[e] ODFW status (all sensitive): LT = listed threatened; LE = listed endangered, SC = critical, SV=vulnerable, SP=peripheral (or naturally rare), and SU=undetermined status

[f] Threatened, endangered, candidate, and special status species to be evaluated for impacts related to the Hells Canyon Complex and associated transmission line corridors as recommended by the TRWG

Table 4. Summary of estimated HCC impacts (primarily from Brownlee Reservoir) on the capability of the HCC Winter Range for supporting mule deer.

Impact Category	Estimated Habitat Coefficient	Impacted Area (acres)	Impact Acres
Movements	0.00	0	0
Habitat Selection of Low-elevation Winter Range	0.10	5,819	582
Reservoir-related Mortality during years with Mild−moderate Winter Conditions	0.10	86,408	8,641
Reservoir-related Mortality during years with Harsh Winter Conditions	0.09	86,408	7,777
Total			17,000

Table 5. Mule deer mortality rates used for estimating habitat coefficients and HCC impacts (primarily from Brownlee Reservoir) on the capability of the HCC Winter Range for supporting mule deer.

	Estimated Mortality for a Year with Mild−moderate Winter Conditions[a]			Estimated Mortality for a Year with Harsh Winter Conditions[b]		
	Mortality Related to the HCC[c] (%)	Mortality Not Related to the HCC (%)	Total Mortality (%)	Mortality Related to the HCC[c] (%)	Mortality Not Related to the HCC (%)	Total Mortality (%)
Winter	6	12	18	15[d]	12	27
Green-up	1	4	5	1	4	5
Spring Migration	1	2	3	1	2	3
Summer	0	5	5	0	5	5
Fall Migration	2	3	5	2	3	5
Annual	10	27	37	19	27	46

[a] Analyzed with data reported in Edelmann (2002).

[b] Analyzed with data reported in Edelmann et al. (2001) and Edelmann (2002).

[c] Includes direct (i.e., drowning) and indirect (i.e., icing, crossing, and shoreline) reservoir-related mortality.

[d] Sum of 6% reservoir-related mortality estimated for a mild−moderate winter and 9% reservoir-related mortality estimated for a harsh winter. Additional reservoir-related mortality during a harsh winter is assumed to include an unknown combination of direct and indirect mortality that is additive to the reservoir-related mortality that occurs during a mild−moderate winter.

Table 6. State and federal designations for species of special concern known or suspected to occur along the Hells Canyon Complex transmission lines. Species shown in bold were identified as medium to high risk for line collision by SAIC (2000a).

			IDAHO			OREGON		
Taxon	**USFWS[a]**	**USBLM[b]**	**IDFG[b]**	**INHP[c]**	**USFS[b] Region 4**	**ORFW[b]**	**ONHP[c]**	**USFS[b] Region 6**
Amphibians								
Columbia Spotted frog *Rana luteiventris*	CE	S	SSC	3	S	SC	2	
Tailed frog *Ascaphus truei*	W					SV	3	
N. Leopard frog *Rana pipiens*	SC	S	SSC	3		SC	2	
Western toad *Bufo boreas*	W/SC	S	SSC	4		SV	3	
Birds								
Horned grebe *Podiceps auritus*			P	1		SP	4	
Trumpeter swan *Cygnus buccinator*	W	S	SSC	1	S			
Harlequin duck *Histrionicus histrionicus*	W	S	SSC	1	S	SU	2	S
American white pelican *Pelecanus erythrorhynchos*			SSC	1		SV	2	S
Franklin's gull *Larus pipixcan*			P			SP	2	
Black tern Chlidonias niger			SSC	2		SC	3	
Great egret *Casmerodius albus*			SSC	1			3	
Snowy egret *Egretta thula*						SV	4	
White-faced ibis *Plegadis chihi*		SSC	P	2			4	
Greater sandhill crane *Grus canadensis tabida*						SV	4	S
Upland Sandpiper *Bartramia longicauda*	W	S	SSC	1				S

Taxon	USFWS[a]	USBLM[b]	IDAHO			OREGON		
			IDFG[b]	INHP[c]	USFS[b] Region 4	ORFW[b]	ONHP[c]	USFS[b] Region 6
Western sage grouse	SC	S				SV	2	S
Centrocercus urophasianus phaios								
Columbian sharp-tailed grouse	SC	S	GSC	3	S		1	S
Tympanuchus phasianellus columbianus								
Spruce grouse						SU	3	
Dendragapus canadensis								
Mountain quail	SC	S	SSC	2	S	SU	4	
Oreortyx pictus								
Northern goshawk	W	S	SSC	4	S	SC	3	
Accipiter gentilis								
Ferruginous hawk	W	S	SSC	3		SC	3	S
Buteo regalis								
Swainson's hawk		S		4		SV	3	
Buteo swainsoni								
Peregrine falcon	DM		E	1	S	E	1	S
Falco peregrinus								
Bald eagle	LT		T	3	T	T	1	T
Haliaeetus leucocephalus								
Burrowing owl	SC	S	P	3		SC	3	
Athene cunicularia								
Great gray owl	W	S	SSC	2	S	SV	4	S
Strix nebulosa								
Yellow-billed cuckoo	CE	S	SSC	3		SC	2	
Coccyzus americanus								
Pileated woodpecker						SV	4	
Dryocopus pileatus								
Lewis' woodpecker		S				SC	3	
Melanerpes lewis								
White-headed woodpecker	W	S	SSC	2	S	SC	3	
Picoides albolarvatus								

Taxon	USFWS[a]	USBLM[b]	IDAHO			OREGON		
			IDFG[b]	INHP[c]	USFS[b] Region 4	ORFW[b]	ONHP[c]	USFS[b] Region 6
Black-backed woodpecker	W	S	SSC	3		SC	4	
Picoides arcticus								
Three-toed woodpecker	W	S	SSC	3	S	SC	4	
Picoides tridactylus								
Pygmy nuthatch	W	S	SSC	3		SC	4	
Sitta pygmaea								
Loggerhead shrike	SC	S	SSC	3			4	
Lanius ludovicianus								
Vaux's swift		S						
Chaetura vauxi								
Willow flycatcher		S						
Empidonax traillii								
Townsend's warbler		S						
Dendroica townsendi								
Yellow warbler		S						
Dendroica petechia								
MacGillivray's warbler		S						
Oporornis tolmiei								
Wilson's warbler		S						
Wilsonia pusilla								
Plumbeus vireo		S						
Vireo plumbeus								
Yellow-headed blackbird		S						
Xanthocephalus xanthocephalus								
Brewer's sparrow		S						
Spizella breweri								
Sage sparrow		S						
Amphispiza belli								
Mammals								
Townsend's big-eared bat			SSC	2	S	SC	2	S
Corynorhinus townsendii								
Spotted bat	W	S	SSC	4	S	SC	2	S
Euderma maculatum								
Fringed myotis	W	S	SSC	1				
Myotis thysanodes								

			IDAHO			OREGON		
Taxon	**USFWS[a]**	**USBLM[b]**	**IDFG[b]**	**INHP[c]**	**USFS[b] Region 4**	**ORFW[b]**	**ONHP[c]**	**USFS[b] Region 6**
Western pipistrelle	W		SSC	1				
Pipistrelus hesperus								
S. Idaho ground squirrel	CE	S	SSC	2	S			
Spermophilus brunneus endemicus								
Pygmy rabbit	W	W	GSC	3		SV	2	S
Brachylagus idahoensis								
Kit fox	W	S	SSC	1		T	2	
Vulpes macrotis								
Gray wolf	LE		E	1	E	E	2	E
Canis lupus								
Fisher	W	S	SSC	1	S	SC	2	
Martes pennanti								
Wolverine	W	S	SSC	2	S	T	2	S
Gulo gulo								
River otter		W		4				
Lutra canadensis								
Canada Lynx	LT	S	GSC	1	T		2	T
Lynx canadensis								
Elk								
Cervis canadensis								
Mule Deer								
Odocoileus hemionus								
Rocky Mountain bighorn sheep								
Ovis canadensis								
Mountain goat								
Oreamnos americanus								

[a] USFWS (Federal) status: CE = candidate endangered, DM = delisted with monitoring, LE = listed endangered, LT=listed threatened, SC = species of concern, W= watch species

[b] IDFG, ORFW, USFS, and BLM ranks: E = endangered, GSC = game species of special concern, P = protected, S = sensitive, SC = critical, SP = peripheral or naturally rare, SSC = species of special concern, SU = undetermined status, SV = vulnerable, T = threatened, W = watch species

[c] INHP and ONHP ranks: 1 = critically imperiled, 2 = imperiled because of rarity, 3 = very rare and local throughout its range or found locally, 4 = apparently secure

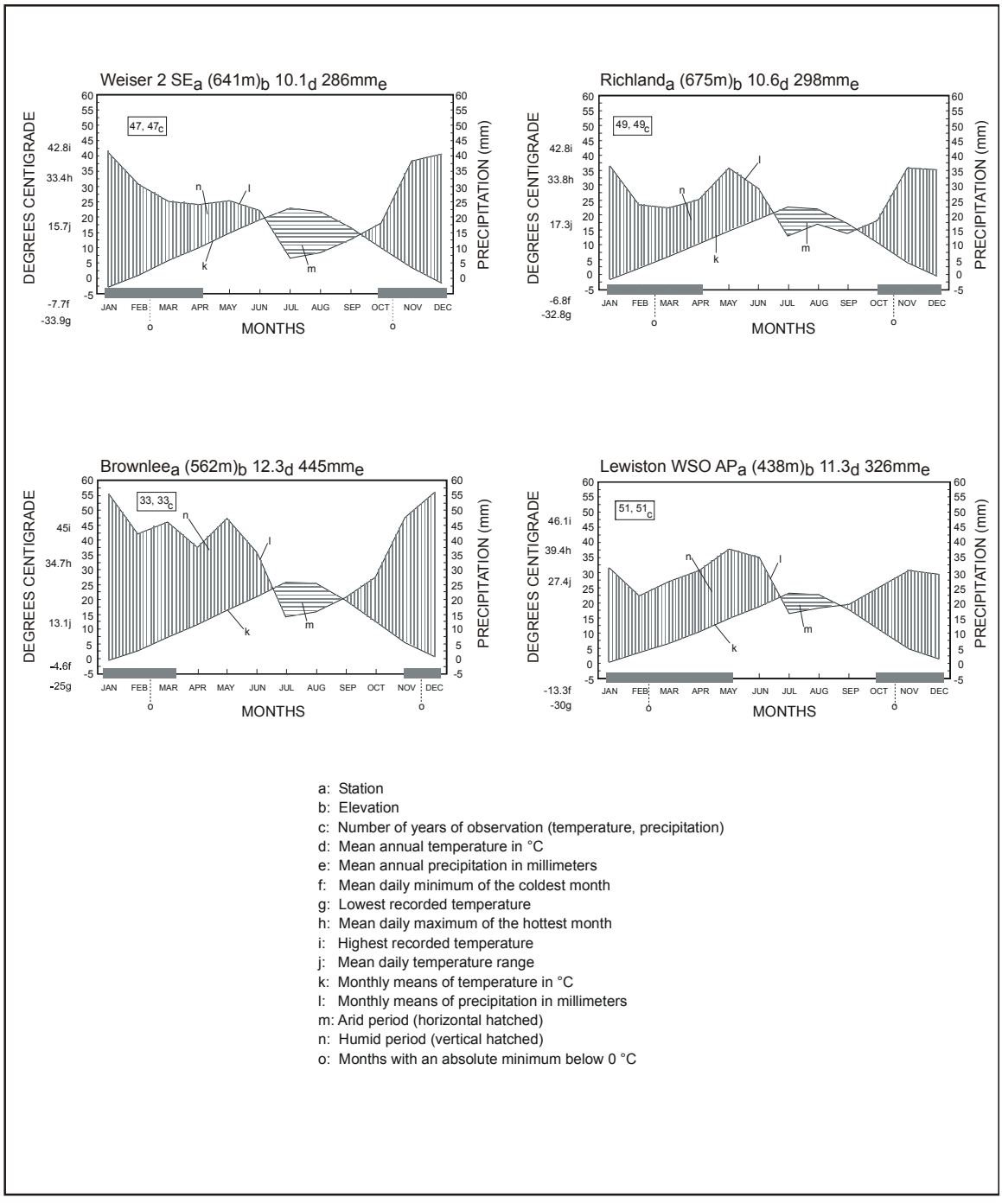

Figure 1. Köppen climate diagrams for the Weiser, Richland, Brownlee, and Lewiston weather stations, Hells Canyon Study Area, Idaho–Oregon border.

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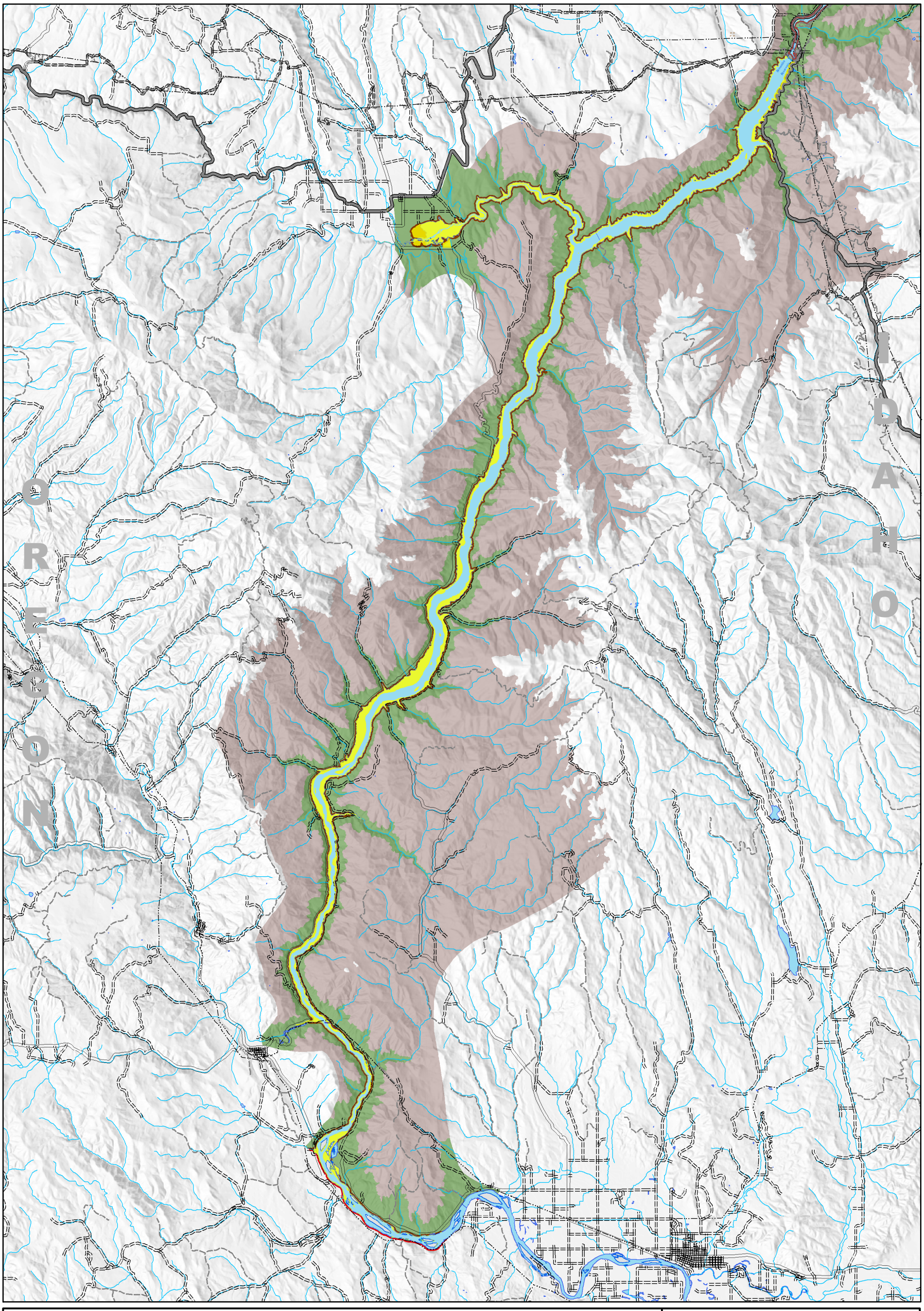

Vicinity Map

Legend

- Highway
- Light Duty Road
- Unimproved Road
- 4WD Trail
- Transmission Line
- Inundation Zone
- Fluctuation Zone
- Shoreline Zone (50m)
- Crucial Winter Range (Fullpool - 2700')
- Winter Range Zone (2700' - 4700')

Hells Canyon Complex
Tech. Report E.3.2 - 45 Figure 2a

Terrestrial Resources: Reservoir Impact Zones

Idaho Power Company
Boise, Idaho

0 0.5 1 2 3 4 5 Miles

N W E S

IDAHO POWER
An IDACORP Company

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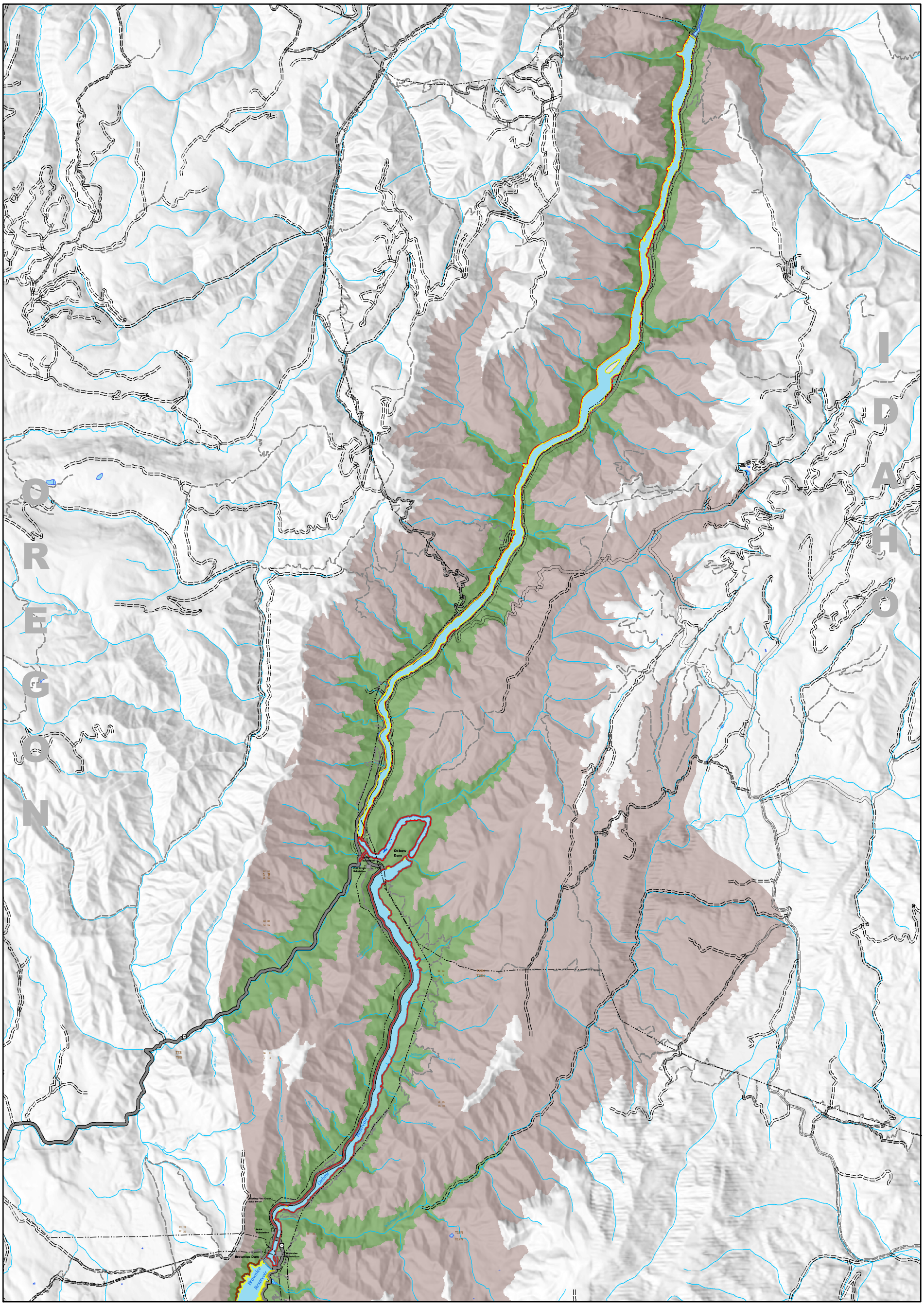

Vicinity Map

Legend

- Highway
- Light Duty Road
- Unimproved Road
- 4WD Trail
- Transmission Line
- Inundation Zone
- Fluctuation Zone
- Shoreline Zone (50m)
- Crucial Winter Range (Fullpool - 2700')
- Winter Range Zone (2700' - 4700')

Hells Canyon Complex
Tech. Report E.3.2 - 45 Figure 2b

Terrestrial Resources: Reservoir Impact Zones

Idaho Power Company
Boise, Idaho

N W E S

0 0.5 1 2 3 Miles

IDAHO POWER
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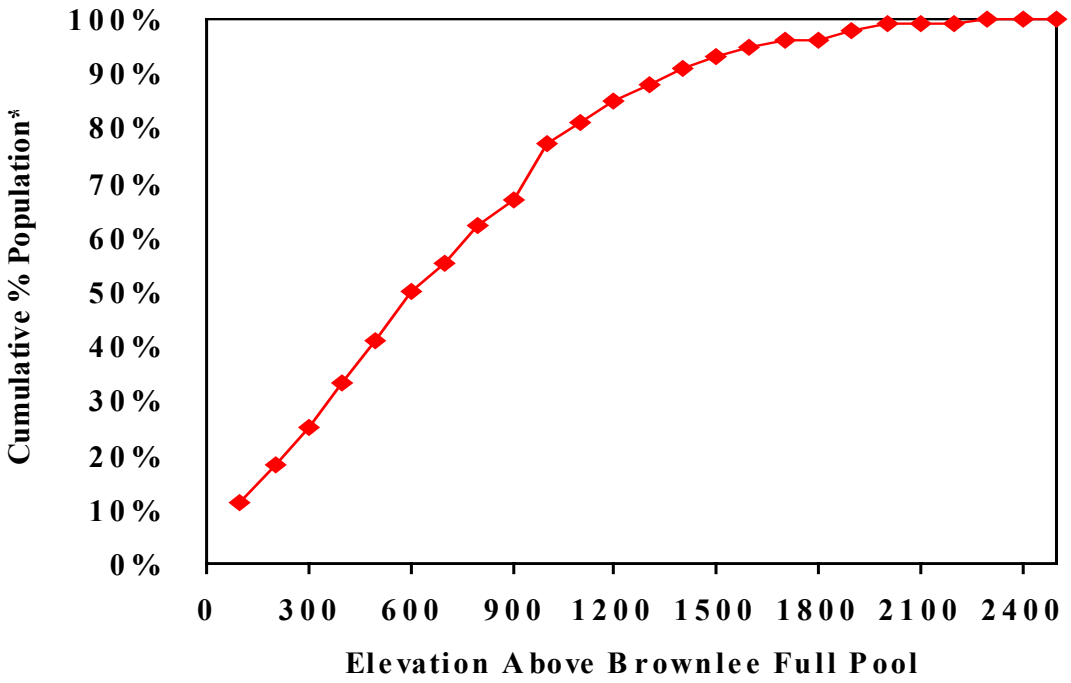
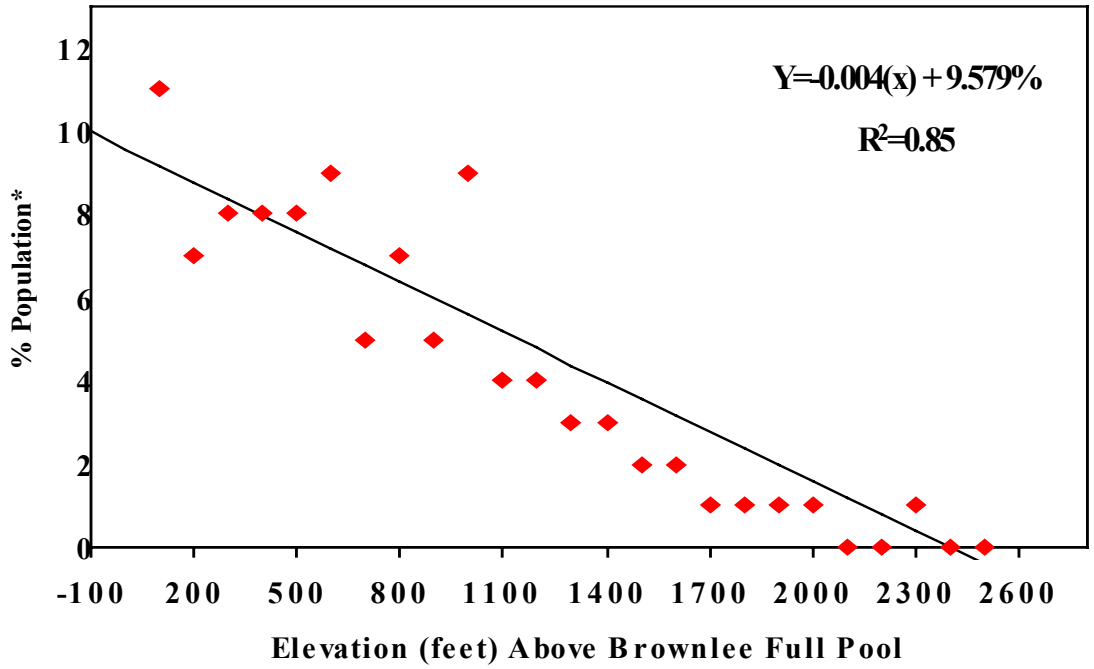


*** Population estimated from March mule deer population surveys, HCC Winter Range, 2000-2001.**

Figure 3. Winter elevation distribution of the mule deer population on the HCC Winter Range.



*** Population estimated from March mule deer population surveys, HCC Winter Range, 2000-2001.**

Figure 4. Regression of elevation and proportion of the mule deer population on the HCC Winter Range.