Draft Monitoring and Evaluation Plan for the

Hangman Restoration Project

Prepared for the Coeur d'Alene Tribe
Fisheries and Wildlife Programs
P.O. Box 408 / 850 A Street
Plummer, ID 83851

Submitted by:

Bertie J. Weddell, Ph.D.
Draba Consulting
1415 NW State Street
Pullman, WA 99163

and

Gerald I. Green
Wildlife Mitigation Biologist
Coeur d'Alene Tribe
850 A Street, P.O. Box 408
Plummer, ID 83851

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INTRODUCTION

Lake Coeur d'Alene and its tributaries formed the center of the aboriginal Coeur d'Alene territory. The territory was spread over 5 million acres (2,024,291 hectares) of what is now portions of northeastern Washington, northern Idaho, and western Montana (Coeur d'Alene Tribe 2000). Resident fish, including bull trout (*Salvelinus confluentus*), westslope cutthroat trout (*Oncorhynchus clarki lewisi*), and mountain whitefish (*Prosopium williamsoni*), were a main staple above barrier falls that prevented access to anadromous fish (Graves et al. 1992). Anadromous fish, including chinook salmon (*Oncorhynchus tshawytscha*) and steelhead trout (*Oncorhynchus mykiss*), were harvested from the Spokane River and its tributaries below the barrier falls (Scholz et al. 1985; Seltice 1990). Because it was below the barrier falls, the Hangman Watershed provided a source of anadromous fish and redband rainbow, as well as camas (*Camassia quamash*), which the Coeur d'Alene People harvested from wet meadows near the salmon-producing streams (Seltice 1990). Principal anadromous fishing sites were located at the mouth of Hangman Creek and near the confluence of Hangman and Little Hangman Creeks in the upper Hangman Watershed (Scholz et al. 1985; Seltice 1990). The redband rainbow trout was the common resident fish in the Spokane River and its tributaries below the barrier falls (Behnke 1992). In addition to fish and root resources, the Hangman Watershed also provided an abundance of game, including the now extirpated Columbian sharp-tailed grouse (*Tympanuchus phasianellus*) (which was referred to as the prairie chicken) (Edelen and Allen 1998), to the Coeur d'Alene and neighboring tribes (Power 1997).

The Coeur d'Alene Tribe took up more permanent residence in the Hangman Watershed in the latter part of the 19th century, when pursuit of their semi-nomadic heritage became problematic due to changes in resource availability resulting from the influx of Euro-Americans (Dozier 1961; Seltice 1990; Palmer 2001). However, even as the Coeur d'Alene Tribe became adept at using the agricultural practices of Euro-Americans in the latter half of the 19th century (Palmer 2001), hunting and gathering remained an important component of their economy (Power 1997).

The development of hydropower facilities in the Columbia River Basin early in the 20th Century cut off the salmon runs to Hangman Creek. Simultaneously, rapid changes in land management practices further altered the fish species composition in Hangman Creek and the availability of native terrestrial wildlife habitat (Edelen and Allen 1998). As a result of the Dawes Severalty Act of 1887, the Coeur d'Alene Tribal members were allotted lands and the Reservation was opened to white settlement early in the 20th century. This completely disrupted the Tribe's traditional relationship with the land, and the Tribe itself underwent a period of disintegration (Ross and Dozier 1974). Early farming methods, which were used by the Coeur d'Alene Tribe, restricted tillage to small acreages, but as more mechanized methods became available the acreage of land under tillage increased (Jennings et al. 1990; Edelen and Allen 1998). From the World War II era to the present, efforts were expended to straighten and channelize the streams to provide more arable lands, with the greatest efforts occurring during the 1950s and 1960s. By 1996, the predominant use of the land within the Hangman Watershed on the

Coeur d'Alene Reservation was agriculture (60.4%), followed by forest (38.3%); grassland, development, and wetland each made up less than 1% of the landscape (Redmond and Prather 1996).

While the Hangman Watershed was once rich in resources that met the Coeur d'Alene Tribe's subsistence needs, little habitat remains in the agricultural landscape of the Hangman Watershed for either native fish or native wildlife. Populations of native fish and wildlife are largely restricted to the upper, forested elevations. The Hangman Watershed's reduced capability to support native fish and wildlife and its historical importance to the Coeur d'Alene Tribe prompted the Tribe to submit a proposal to the Northwest Power Planning Council to begin a coordinated effort to protect and restore fish and wildlife habitats along with the natural functions of wetlands, riparian areas, and streams within the Hangman Watershed Project Area. The proposal was intended as an anadromous fish substitution action to provide alternate subsistence resources for extirpated salmon. The *Hangman Restoration Project* (BPA Project #2001-033-00) was submitted in conjunction with the Coeur d'Alene Tribe Fisheries Program's *Implement Fisheries Enhancement on the Coeur d'Alene Indian Reservation: Hangman Creek* (BPA Project #2001-032-00). These proposals were submitted during the fall of 2000 for inclusion in the FY2001–FY2003 budget cycle for the Spokane River Subbasin of the Intermountain Province. The ultimate goal of these Projects is to prepare the Hangman Creek system for the return of anadromous fish and thus pave the way for future generations of Coeur d'Alenes to once again harvest anadromous fish from Hangman Creek. The proximate goal of the *Hangman Restoration Project* is to *protect and/or restore riparian, wetland, and upland habitats within the Upper Hangman Creek Watershed to promote healthy, self-sustaining wildlife populations capable of supporting traditional tribal uses*. The intent is to use wildlife habitat, particularly within riparian zones and wetlands, to moderate the current flashy hydrograph as well as to reduce sediment and temperature pollution of Hangman streams. These proposals were funded as part of the Bonneville Power Administration's commitment "to rebuilding healthy, naturally producing fish and wildlife populations by protecting and restoring habitats and biological systems within them" (Northwest Power Planning Council 2000). A Prioritization Plan was produced in September of 2002 that delineated parcels that could contribute substantively to sustaining native fish and wildlife populations within the Project Area. Restoration will take place within selected areas where management rights will be acquired to provide habitat for native fish and wildlife. The emphasis will be on acquiring management rights to high-priority parcels that were identified by the Priority Plan.

This Monitoring and Evaluation Plan was written to provide a strategy for gathering sound information on status and long-term trends of specific fish and wildlife species and habitats within the Project Area. The parameters and measuring protocols were selected to provide retrospective monitoring (Fancy 2002), which seeks to determine the effects of landscape changes on specific fish and wildlife populations, and predictive monitoring (Fancy 2002), which monitors potential specific stressors in order to determine degree of improvement in those stressors due to project implementation. Retrospective and predictive protocols are designed specifically to provide data on the effectiveness of project implementation (Hillman and Giorgi 2002). The evaluation of the effectiveness of project implementation will provide the feedback loop in an adaptive management strategy that seeks to maximize the efficiency of project implementation.

PROJECT AREA

The Project Area covers 156,591 acres (63,397 hectares) and consists of the portion of the Hangman Watershed that lies within the State of Idaho (Figure 1). The Project Area lies on the eastern edge of what Bailey (1995) referred to as the Dry Steppe portion of the Temperate Steppe Division. It is bounded by Universal Transverse Mercator Zone 11 coordinates 496-520 km east and 5209-5261 km north. The Washington-Idaho border, which corresponds to the western limit of the Coeur d'Alene Indian Reservation, marks the western boundary. The watershed divide between the Hangman Watershed and the Coeur d'Alene Basin runs southeast from the northwest corner of the Project Area. The divide between the Hangman Watershed and the Palouse River Watershed marks the southern boundary. Elevations range from 2,475 feet (785 m) in the northwest corner of the Project Area, where Rock Creek flows west into Washington, to 4,932 feet (1,504 m) at the peak of Moses Mountain, which is located in the southeastern portion of the Hangman/Coeur d'Alene Basin watershed boundary.

The climate in the Project Area is subhumid temperate with cool, wet winters and warm, dry summers. Average annual precipitation at Tensed, Idaho for the years 1963-1983 was 25.2 inches (64.0 cm) per year (www.wrcc.dri.edu). Approximately two-thirds of annual precipitation typically occurs between October or November and March. Temperatures in the watershed are mild. The average daily maximum for August, which was the hottest month of the year during the 1963-1983 recording period, was 82.2°F (27.9°C). The average daily minimum for January, the coldest month during the recording period, was 20.9°F (-6.2°C). Rain-on-snow events generated by moisture-laden Pacific air masses are common in the late winter months.

Forest habitat series in the Project Area include western hemlock (*Tsuga heterophylla*), western red cedar (*Thuja plicata*), grand fir (*Abies grandis*), Douglas-fir (*Pseudotsuga menziesii*), and ponderosa pine (*Pinus ponderosa*) (Cooper et al. 1991). These forest series are found along a gradient from moist forests in the higher elevations to dry, lower-elevation open woodlands. Western hemlock occurs in the highest elevations and is increasingly restricted to moist draws as elevation decreases. Western red cedar is confined to poorly drained soils in wetland and riparian areas. The grand fir series is intermediate and is the most widely dispersed series in the Project Area, with representation in both the moist and dry forest zones. The ponderosa pine series generally occurs below 4,000 feet (1,220 m) and occupies a narrow environmental strip between more mesic Douglas-fir forests and sites with the potential to support meadow steppe vegetation (Daubenmire and Daubenmire 1968; Daubenmire 1970). Many of the current ponderosa pine-dominated stands are actually seral to Douglas-fir. The dry forest types are increasingly restricted to south- and west-oriented, convex slopes as elevation increases. Since settlement of this region, the white pine (*Pinus monticola*) cover type has been eliminated by a combination of harvest and white pine blister rust (Neuenschwander

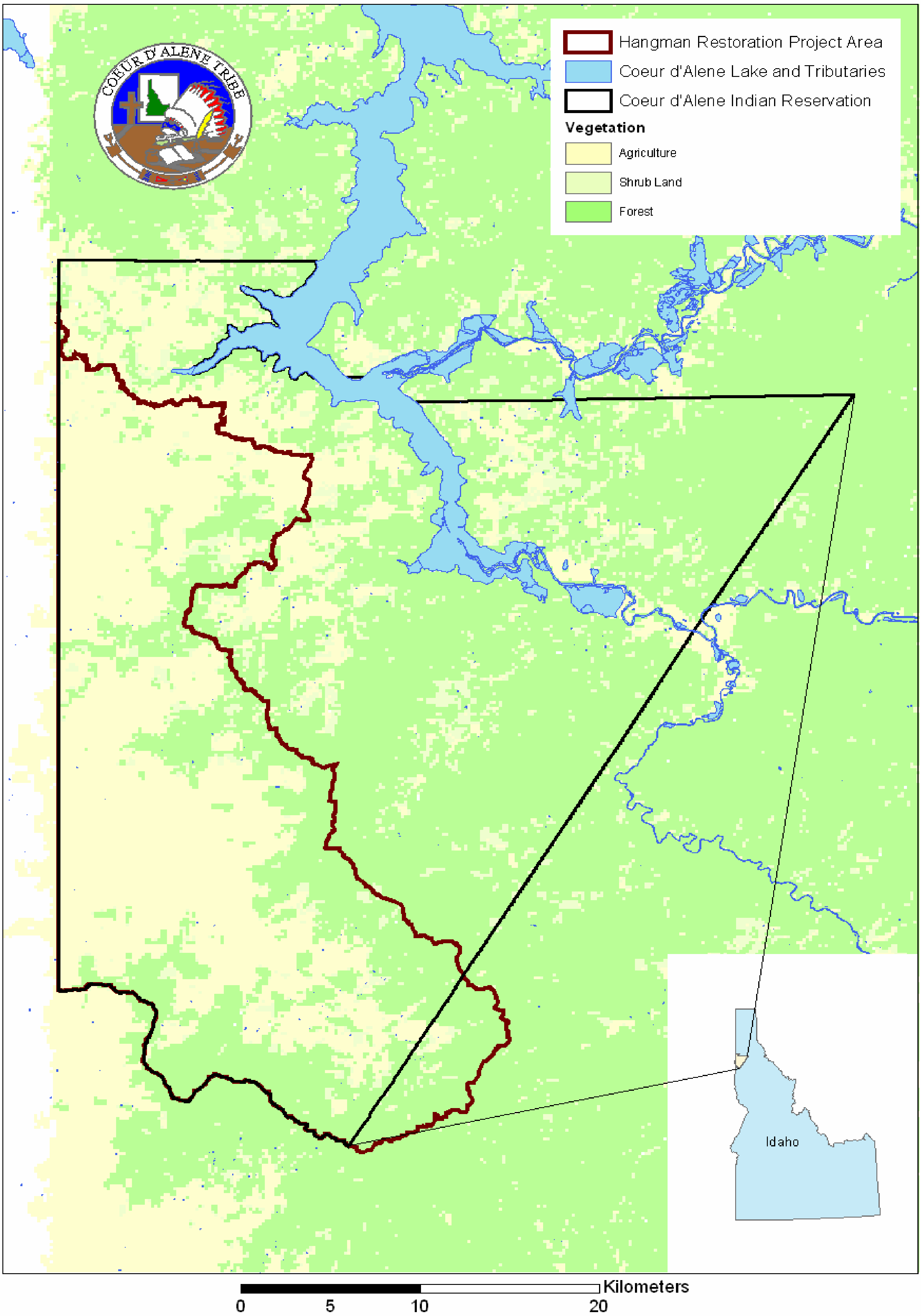

Figure 1. The Hangman Restoration Project Area consists of that portion of the Hangman Watershed within the State of Idaho.

et al. 1999), and the ponderosa pine and Douglas-fir cover types have been greatly reduced, while grand fir, cedar, and hemlock cover types have greatly increased (O'Laughlin 2002).

OBJECTIVES OF MONITORING

The objectives of the monitoring component of the Hangman Creek Project are:

- To assess the effectiveness of the project in restoring terrestrial and wetland plant communities similar to those that existed prior to 1870, and

- To assess the effectiveness of the project in creating habitats that are used by selected species and groups of wildlife.

Five wildlife species–Columbian sharp-tailed grouse, white-tailed deer (*Odocoileus virginianus*), elk (*Cervus elaphus*), beaver (*Castor canadensis*), and black bear (*Ursus americanus*)–have been selected as target species for monitoring because of their historical importance to the Coeur d'Alene people. In addition to the target species, two species assemblages–land birds and herpetofauna–will be monitored. Except for the sharp-tailed grouse, which declined precipitously as native vegetation was converted to cropland (Dziedzic 1951; Buss and Dziedzic 1955) and is now extirpated from northern Idaho, the target species are currently present on the Reservation. Sharp-tailed grouse will be reintroduced when suitable habitat has been restored.

METHODS

Duration and frequency of monitoring

Monitoring involves the measurement of selected variables over time in order to detect change. The frequency of measurements, the duration of monitoring, and the intensity of data analysis depend upon a project's goals and stage (MacDonald et al. 1991; Hillman and Giorgi 2002). To monitor the progress of the Hangman Restoration Project we will undertake baseline and effectiveness monitoring using a pulsed monitoring strategy similar to that described by Bryant (1995). For the first 4 to 6 years of the project, baseline monitoring will take place annually. This is similar to Tier 1 monitoring (Independent Scientific Review Panel 2001). These data will be analyzed and used to formulate hypotheses about relationships between specific habitat parameters and population trends. During this phase of the project, pilot studies will also be undertaken. These will (1) test key assumptions of the proposed methods, (2) evaluate the feasibility of the proposed techniques, and (3) determine minimum sample sizes and transect lengths (Table 1).

In the second phase of monitoring, selected hypotheses will be tested. This will involve effectiveness monitoring with sampling that will be less frequent but longer in duration, and data analysis that will be more intensive (Tier 2 monitoring). Tier 2 monitoring will be done in any cases where target populations decline by more than 10% for three or more years in a row and in other cases where data analysis suggests that follow-up studies would be appropriate.

Type of monitoring		**Duration**	**Frequency**	**Intensity of data analysis**
MacDonald et al. 1991	ISRP[1] 2001			
Baseline	Tier I	first 4-6 years of project	annual	moderate
Effectiveness	Tier II	at least 10 years	every 2-5 years	high

[1] Independent Scientific Review Panel.

Table 1. Summary of types of monitoring for Hangman Creek Restoration Project.

Indicators and models used as a basis for monitoring

Models

In adaptive management, a management action is considered a hypothesis to be tested, and monitoring is a means of gathering data to be used in testing that hypothesis (Holling 1978; Walters 1986). In most cases, several variables affect the abundance of a species or the condition of a habitat. Furthermore, these variables are likely to interact, in ways that may be quite complex. Management actions are always grounded in some understanding of how the managed system works, but often this understanding is not clearly stated at the outset of monitoring. Models that summarize the initial understanding of a system allow managers to identify their assumptions and hypotheses as well as variables that need to be measured (MacDonald and Smart 1993; Elzinga et al. 1998). Through long-term monitoring, managers can continually refine and improve their conceptual models by means of an iterative process that identifies the most relevant variables (Bryant 1995).

The key hypothesis underlying the Hangman Creek Restoration Project is that returning plant communities in the management rights areas (MRAs) to conditions which approximate historical communities in structure and composition will improve habitat quality for fish and wildlife. If this is true then restoration will result in increases in the abundance of these resources. The abundance of fish and wildlife within the Project Area is undoubtedly affected by many variables that interact in complex ways. To summarize our understanding of this complexity, we developed two types of models (Appendix 1). The habitat model summarizes our understanding of how the structures and functions of riparian, wetland, meadow steppe, and forest communities changed after settlement and the mechanisms that brought about those changes. The wildlife models summarize our understanding of the most important variables that control the abundance of the target species and the richness of the land avifauna and herpetofauna in the Project Area.

Indicators

Efficient and effective monitoring depends on the selection of appropriate indicator variables to be measured. In order to gain insight into the processes affecting the Hangman Creek Watershed, we will monitor at three levels of organization: species, communities, and landscapes (Noss 1990; Noss and Cooperrider 1994). Species and community level monitoring will be applied to areas where management rights are acquired, and landscape level monitoring will take place throughout the Project Area. Indicators for these different levels of organization are summarized in Tables 2-5.

At the community and landscape levels we have selected indicators of ecological integrity (Tables 4 and 5). In general, we expect scores to increase for positive indicators and decrease for negative indicators as the project proceeds and historical species compositions, functions, and structures are restored.

Study design

Landscape level sampling will take place throughout the Project Area. Within subwatersheds, samples will be stratified by soil type, and the number of samples per stratum will be in proportion to area. Within strata, sampling will be systematic along transects with randomly selected starting points. Within the MRAs, sampling will be more intensive, but agricultural lands that are not undergoing restoration efforts will be sampled less intensively than areas being restored, because cultivated land is relatively homogeneous.

Transects for sampling vegetation will be oriented across environmental gradients (i.e. usually perpendicular to slope contour) to maximize variability within transects (Elzinga et al. 1998). Point intercept sampling, with the transect as the sampling unit, will be used. With this technique field workers will record hits or misses for the indicators listed in Table 4.

Indicators of wildlife abundance (Tables 2 and 3) will be estimated in quadrats in the vicinity of the vegetation transects. Where appropriate, pilot studies will be carried out to test the assumptions of the census techniques; to assess the feasibility of using of those techniques in the Project Area; and to determine the optimum size, shape, number, and arrangement of quadrats (Elzinga et al. 1998).

Selected sites that are not undergoing restoration will be used as controls. They will serve as standards against which the effects of management actions will be measured. Unmodified reference sites are not available, since all parts of the Project Area have been impacted to some extent by exotic species, changes in disturbance regimes, and hydrological modifications. Therefore, we will base our conception of reference conditions on other sources of information, including: (1) original land survey notes from 1901-1907, (2) descriptions by botanists who visited the region prior to the 1920s (Geyer 1845; Piper 1906; Weaver 1917), (3) research on herbarium specimens of plants collected in wet meadows in the Palouse Region prior to 1917 (Weddell 2002)

	Assessing indicators of species abundance		**Assessing indicators of population structure**				
Taxon	*Technique/ variable measured*	*Parameters estimated*	*Technique/ variable measured*	*Parameters or ratios estimated*	*Assumptions*	*Strategies to minimize sampling error*	*References*
Elk	Pellet counts/ number of pellet groups; sign surveys/number of browsed stems, beds, tracks	Relative abundance in different years; relative abundance in different habitats if justified by pilot study	Survey of kills brought to local meat lockers/number of individuals in sex and age groups	Sex and age ratios	Relationship between relative abundance and number of pellet groups observed is constant for different activity levels and habitats	Conduct pilot study to verify assumption; standardize observer training	Nichols and Conroy 1996
White-tailed deer	Pellet counts/ number of pellet groups; sign surveys/number of browsed stems, beds, tracks	Relative abundance in different years; relative abundance in different habitats if justified by pilot study	Survey of kills brought to local meat lockers/number of individuals in sex and age groups	Sex and age ratios	Relationship between abundance and number of pellet groups observed is constant for different activity levels and habitats	Conduct pilot study to verify assumption; standardize observer training	Nichols and Conroy 1996
Beaver	Structure surveys/number of colonies, length and width of caches	Relative abundance in different years	Length and width of caches	Colony size	Colony size is proportional to cache size	Conduct pilot study to verify assumption	Easter-Pilcher 1990

Table 2. Indicators for assessing species abundance and population structure within MRAs.

Taxon	**Assessing indicators of species abundance**		**Assessing indicators of population structure**		*Assumptions*	*Strategies to minimize sampling error*	*References*
	Technique/ variable measured	*Parameters estimated*	*Technique/ variable measured*	*Parameters or ratios estimated*			
Black bear	Scent station use/number of visits	Relative abundance in different years and habitats			Relationship between station visits and relative abundance is constant across years and habitats	Conduct pilot study to verify feasibility of technique	Lindzey et al. 1977
Sharp-tailed grouse	Area searches, lek surveys/ number of groups of birds, number of individuals	Relative abundance in grassland habitats in different years	Observation of lek displays/number and breeding status of individuals	Number of breeding males	Relationship between abundance and detection is constant across years and habitats	Standardize observer training	Weddell 1992

Table 2 continued. Indicators for assessing species abundance and population structure within MRAs.

	Assessing indicators of species abundance		Assessing indicators of assemblage structure				
Taxon	*Technique/ variable measured*	*Parameters estimated*	*Technique/ variable measured*	*Parameters or ratios estimated*	*Assumptions*	*Strategies to minimize sampling error*	*References*
Amphibians	Auditory surveys/ species and number of individual male frogs	Species composition of breeding frog fauna by habitat; relative abundance of different species and in different years	Audio strip transects/ breeding status of frogs of different species	Number and species of breeding male frogs	Relationship between abundance and detection is constant across years	Standardize observer training, methods, and conditions (time of day, area, weather conditions, and duration of searches)	Zimmerman 1994
Amphibians and reptiles	Visual encounter surveys/ species and number of individual amphibians and reptiles	Species richness and composition of herpetofauna; relative abundance in different years[1]			Relationship between abundance and detection is constant across years	Standardize observer training, methods, and conditions (time of day, area, weather conditions, and duration of searches)	Crump and Scott 1994
Land birds	Area searches/ species and number, of individual birds	Species richness and composition of avifauna; relative abundance in different years[1]	Area searches/ age, sex, and breeding status of individual birds of different species	Sex and age ratios	Relationship between abundance and detection is constant across years	Standardize observer training, methods, and conditions (time of day, weather conditions, and duration of searches)	Ralph et al. 1993

[1] Cannot be used to compare abundances in different habitats because detectability differs by habitat.

Table 3. Indicators for assessing species richness and structure of species assemblages within MRAs.

Community level monitoring		
Type of community/Reference	**Indicators measured**	*Metrics calculated*
Meadow steppe and steppe/forest transition (Weaver 1917; Daubenmire 1942, 1970; Daubenmire and Daubenmire 1968)	Positive indicators Native perennial graminoid cover Native perennial forb cover Cryptogam cover Presence of rare plant taxa Negative indicators Annual graminoid cover Non-native perennial graminoid cover Annual forb cover Non-native perennial forb cover Noxious weed cover Neutral indicators Shrub cover Species and height of trees ≤2 m Species and diameter at breast height of trees >2 m	Modified Floristic Quality Assessment Index (*I*) (Andreas and Lichvar 1995)
Riparian (Weaver 1917; Platts et al. 1987)	Positive indicators Native tree cover Native shrub cover Cover of native herbaceous species other than reed canarygrass (*Phalaris arundinacea*) Presence of rare plant or amphibian taxa Number of vegetative strata Height in comparison to vegetation in exclosure cages Vegetative overhang Stream bank stability Streamside cover Negative indicators Cover of exotic species Cover of reed canarygrass Neutral indicators Vegetative use by animals	Modified Floristic Quality Assessment Index (*I*) (Andreas and Lichvar 1995)

Table 4. Indicator variables for assessing ecological integrity at the community level in MRAs. Neutral indicators are useful in a qualitative way for characterizing community composition and processes such as succession, but they are not unambiguously associated with either ecological health or degradation.

Community level monitoring		
Type of community/Reference	*Indicators measured*	*Metrics calculated*
Wetland (Weaver 1917; Victor 1935; Keddy et al. 1993)	Positive indicators Cover of native herbaceous species Species of special interest (e.g. camas in seasonally wet meadows) Presence of rare plant or amphibian taxa Cover of species with wetland indicator status of "obligate" or "facultative wetland" Negative indicators Cover of exotic species Cover of reed canarygrass Neutral indicators Cover of native trees and shrubs	Modified Floristic Quality Assessment Index (*I*) (Andreas and Lichvar 1995)
Forests (Weaver 1943, 1947; Belsky and Blumenthal 1997; United States Department of Agriculture 2002)	Positive indicators Native perennial grass cover Tree diameter at breast height Negative indicators Cover of exotic species Sapling density Woody debris Density of dead trees Density of damaged trees Neutral indicators Tree species composition Lichen biomass	Modified Floristic Quality Assessment Index (*I*) (Andreas and Lichvar 1995)
Amphibian and reptile communities	Species abundances	Shannon-Weaver information function (*H'*) Equitability index (*J'*)
Bird communities	Species abundances	Shannon-Weaver information function (*H'*) Equitability index (*J'*)

Table 4-continued. Indicator variables for assessing ecological integrity at the community level in MRAs.

Indicator	Definition of variable	Source of data	Reference
Positive indicators			
Area of interior habitat	Forests: percentage of closed-canopy forest more than 328 feet (100 m) from the edge of an open-canopy patch	GIS database	Wallin et al. 1996
	Grasslands: percentage of patch more than 328 feet (100 m) from edge of cropland or developed land	GIS database	
Amount of habitat containing interspersed deer and elk requirements	Zones that extend 600 ft (183 m) on both sides of intersections of cover (forested) areas and forage (grassland, agricultural land, herbaceous wetland) areas	GIS database	Thomas et al. 1979
Similarity to historical proportions of vegetation types	Historical coverage of vegetation types Current coverage of vegetation types	Historical cover: solar radiance and land surveyor notes Current cover: GIS database	Johnson 1999
Negative indicator			
Road density	Miles of road per square km	GIS database	Perry and Overly 1976
Neutral indicator			
Changes in community type	Historical community type at NRI locations Current community type at same locations	Historical photographs Repeat photography at permanent photomonitoring points	Skovlin and Thomas 1995

Table 5. Indicator variables for assessing ecological integrity at the landscape level throughout the Project Area. Neutral indicators are useful in a qualitative way for characterizing community composition and processes such as succession, but they are not unambiguously associated with either ecological health or degradation.

After the first two years of pilot studies, the number of sampling units necessary to detect a specified difference between Year 1 and Year 2 will be calculated using the following formula for calculating an adequate sample size when using paired or permanent sampling units (Elzinga et al. 1998):

$$n = \frac{(s^2)(Z_\alpha + Z_\beta)^2}{(MDC)^2}$$

Where:

s = standard deviation of the differences between paired samples (Year 1 and Year 2);
Z_α = Z coefficient for false-change (Type I) error rate;
Z_β = Z coefficient for missed-change (Type II) error rate; and
MDC = minimum detectable change size.

This approach uses information about the desired precision level and about the variance between paired samples to calculate sample size. In situations where variability is high, greater sampling intensity will be required to detect a difference. Likewise, if the objective is to detect a very small change between years, a large sample size will be necessary.

Techniques for assessing wildlife abundance

We will use data from counts of animal signs or individuals as indices of animal abundance for the five target species and two species assemblages of interest. Tables 2 and 3 summarize the methods that will be used to census wildlife populations.

Deer and elk will be censused by means of pellet group counts. This method is simple and inexpensive to implement. If deposition rate is known, pellet counts can be used to estimate population size (Eberhardt and Van Etten 1956), but since rates of pellet deposition in our study area are not known, we will use pellet counts only as an index to relative abundance.

In warm, moist environments, rapid decomposition of pellets compromises the effectiveness of pellet group counts as a census technique. However, Lehmkuhl at al. (1994) found that in forests of the Olympic Peninsula more than 90% of Roosevelt elk (*C. e. roosevelti*) pellets were detected up to 1 year after deposition. Since the climate of our Project Area is similar to that of coastal Washington (temperate with wet winters and dry summers) but drier and colder, we assume that decomposition rates in our study will be even lower than those measured on the Olympic Peninsula.

Pellet counts are only reliable if (1) the amount of time animals spend in a habitat is correlated with the number of pellet groups they deposit in that habitat, (2) the period of time over which pellets are deposited can be accurately determined, and (3) observers detect all pellet groups. These conditions are often not met because of animal mobility and differences in observer expertise in detecting and aging pellet groups. Thus, although pellet counts are a widely used method of assessing ungulate abundance, this technique has not been shown to unambiguously reflect abundance (Fuller 1991, 1992).

Because of the limitations of pellet counts, we will supplement this technique with data from other types of deer and elk sign, such as tracks, beds, and browsed vegetation. The disadvantages of this method are that tracks are not equally evident in all habitats and weather conditions, and evidence of ungulate browsing is not always species-specific (Skovlin 1982). Qualitative information from sign surveys will, however, be helpful in interpreting pellet group counts.

In addition, we will use data on sex and age from local meat lockers to calculate sex and age ratios of hunted deer and elk.

Surveys of sign have long be used to estimate beaver populations (Novak 1987). At beaver colonies in northwestern Montana, however, there were no significant relationships between beaver abundance and numbers of tracks, dams, or cut stems, but cache area accounted for significant variation in colony size (Easter-Pilcher 1990). For this reason, we will use the number and area of caches as an indicator of beaver abundance in this project. Colony sites will be located by ground reconnaissance, and the length and width of all caches will be measured.

Tracks at scent stations will be used as an index to black bear populations in the Project Area. Scent station visits are a non-invasive means of indexing bear populations (Lindzey et al. 1977). If sufficient funds are available, we will also document visits by means of automatic cameras connected to pressure plates (Moruzzi et al. 2002).

Trends in sharp-tailed grouse abundance will be monitored through a combination of lek counts and area searches. Grouse are commonly censused by counting males during breeding displays. This method is relatively easy and inexpensive to carry out, but the results of lek surveys can be misleading because the number of birds per lek is not necessarily correlated with regional population, and because grouse may abandon a traditional display site and begin displaying elsewhere (Cannon and Knopf 1981; Weddell 1992; Schroeder et al. 2000). For this reason, observations at known lek sites will be combined with thorough searches to make sure that all leks are located and that changes in lek location are detected.

Grouse released in the Project Area will be marked with individually color-coded bands prior to their release, and if sufficient funding is available, some released birds will also be fitted with radio-transmitters. Radiotelemetry can provide valuable information on the locations of individual birds; however, some studies have reported high mortality in instrumented sharp-tailed grouse, perhaps because of increased vulnerability to predation (Gratson 1982; Marks and Marks 1987). For this reason, care will be taken to ensure that the lightest transmitter packages available are used, and telemetry studies will be discontinued if there is any indication that the transmitters are detrimental.

Visual encounter surveys will be used to census herpetofauna (Crump and Scott 1994). In this method observers spend a fixed amount of time searching quadrats for reptiles and amphibians. Visual encounter surveys are similar to the time-constrained surveys described by Corn and Bury (1990), except that their surveys were plotless and they collected the individuals they encountered. Visual encounter surveys can be used to determine the species richness and species composition of an assemblage and to estimate relative species abundances at a site; however, this technique cannot be used to estimate absolute abundance, because it does not provide information on the proportion of the population that is encountered. Furthermore, visual encounter surveys should not be used to compare relative abundances in different habitats, because habitats differ in the ease with which species are detected.

Because many species of frogs use species-specific calls to advertise their position during the breeding season, we will use auditory surveys of streams and pond margins to supplement visual encounter surveys of amphibians. These auditory surveys will provide information about the species composition of the breeding frog fauna in different habitats and about the relative abundance of calling males of different species in different years, but they will not allow the densities of calling species to be estimated. Because we will use auditory surveys along linear streambanks and shorelines, individuals will be counted directly and quadrats will not be used (Zimmerman 1994).

Bird communities will be censused by means of time-constrained area surveys. This method is similar to the time-constrained visual encounter survey that we will use to census herpetofauna, but both visual and auditory encounters with birds will be recorded. Field personnel will search specified quadrats during a series of 20-minute periods. Unlike point count surveys, where the position of the observer is fixed and detectability varies with the amount of obstructive vegetation in the habitat, observers will be able to move through the area in order to search it thoroughly. This method mimics the method used by birders and allows observers to locate birds giving unfamiliar calls as well as silent birds (Ralph et al. 1993).

All of the methods of censusing wildlife described above are based on the assumption that observers do not differ in their ability to detect and identify animals and animal sign. This is unlikely to be the case, but steps will be taken to minimize errors resulting from differences between observers. To reduce experimental error, all members of the field crews will receive standardized training in recognizing relevant taxa or signs, finding the boundaries of the areas to be searched, and recording data. Where different observers will be censusing the same species or species assemblage, they will practice surveying the same test area and results will be compared. These comparisons will point up potential problems and biases, which will be addressed by additional training if necessary. For each species or species assemblage, surveys will be conducted under specified conditions of weather, season, and time of day. For time-constrained searches, search time will be strictly controlled.

Data analysis

Data on wildlife populations, species assemblages, and habitat indicators will be analyzed within vegetation types. For each indicator, we will compare values for different years. For the first two years, we will use paired *t* tests; subsequently, when we have more than two years of data we will use analysis of variance (ANOVA) with repeated measures to compare different years. In addition, in some cases, we will calculate metrics that synthesize information from several variables (Table 4). At the landscape level, the current and historical percentages of the vegetation types will be transformed with an arc sine square root transformation and compared with ANOVA.

All data collected in the field will be entered into a computerized database within two months of the completion of the field season. Data will be summarized in tables and charts and examined subjectively. This procedure will not substitute for statistical analysis of the data, but the insights gained from this evaluation will help managers to identify potential problems that need to be addressed or new hypotheses that would be appropriate. In particular, it is likely that the results of the Tier I sampling will suggest additional hypotheses about relationships between specific habitat parameters and population trends. This will allow a subset of these hypotheses to be tested in the second phase of monitoring.

Careful attention to the results of the first phase of the project will also allow investigators to identify trends that are likely to be a source of concern. Tier 2 monitoring should be done in any cases where target populations decline by more than 10% for three or more consecutive years, unless data are available suggesting that this much variability fits a typical pattern of population fluctuations for the species in question.

DATA STORAGE

Data will be archived and catalogued for long-term storage. In addition, detailed records will be kept of all procedures used and any problems or unusual circumstances that occurred. This will aid future investigators in interpreting and evaluating the results of this monitoring project.

Appendix 1: Habitat and Species Models for Hangman restoration project

Habitat model

Basic hypothesis

The underlying hypothesis driving the Hangman Restoration Project is that *restoration of the plant communities in the Hangman Watershed to conditions that are closer to pre-settlement conditions will lead to a decrease in the amount of sediment entering streams in the Project Area*. Figure A-1 illustrates the conceptual model upon which this hypothesis is based.

Water quality, including sediment loads, will be monitored by the Coeur d'Alene Tribe Fisheries Program. This monitoring will provide information that can be used to test the above hypothesis as restoration proceeds.

Subsidiary hypotheses

In order to return habitats to conditions that approach pre-settlement conditions, a series of management actions will be undertaken in MRAs with the goal of restoring pre-settlement conditions. The subsidiary hypotheses in this phase of the project are that the management actions will be effective in bringing structures, functions, and community composition closer to pre-settlement conditions. These hypotheses will be tested by gathering information on the variables listed in Table 4.

Wildlife models

Basic hypothesis

We developed models to summarize our expectations about the effect of the Hangman Restoration Project on wildlife. These are all grounded in the hypothesis that *restoration of the plant communities in MRAs within the Hangman Watershed to conditions that are closer to pre-settlement conditions will lead to improvements in the quality and quantity of habitat features required by the target species and assemblages*. If this is the case, then we would expect populations of the target species to increase and species richness of the avifauna and herpetofauna to increase.

We anticipate that habitat restoration will create communities and landscapes that are more heterogeneous, with greater structural diversity. Consequently, there will be more microhabitats, each of which will provide unique resources and environmental conditions. This is likely to support more species of birds, reptiles, and amphibians than the existing landscape, much of which is currently dominated by croplands or by homogenous stands of exotic species. Thus, we expect the species richness of avian, reptilian, and amphibian communities to increase as a result of the Hangman Restoration Project, and our monitoring program is designed to test this prediction.

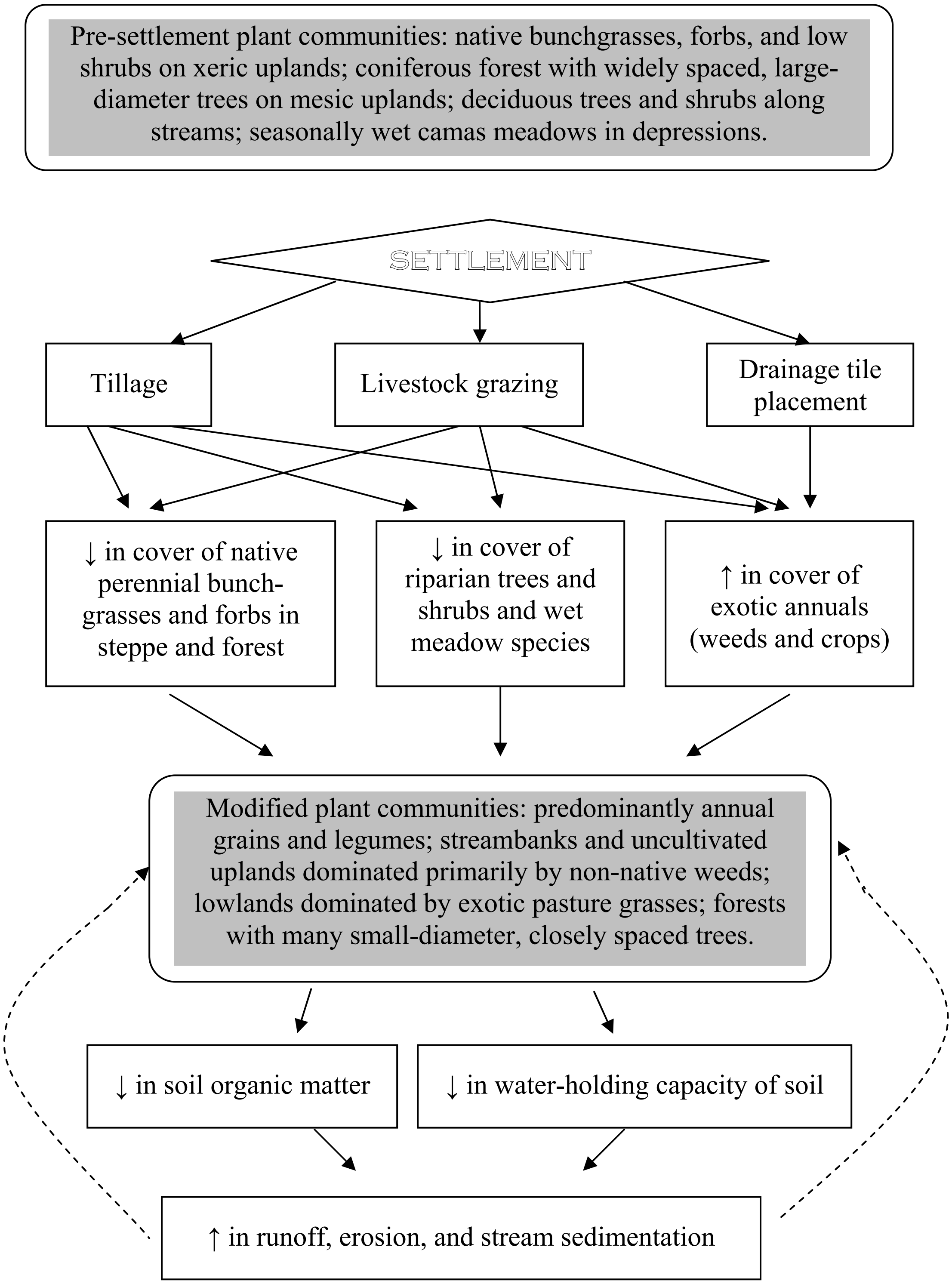

Figure A-1. Flow chart summarizing model of how post-settlement changes in vegetation in the Project Area led to increased runoff, erosion, and stream sedimentation. (Based on Weaver 1917; Daubenmire 1942, 1970; United States Department of Agriculture 1978; Platts et al. 1987; Steiner 1987; Jennings et al. 1990; and Belsky and Blumenthal 1997).

Species hypotheses

Models of the effects of restoration on the target wildlife species are summarized below.

White-tailed deer and elk

Hypothesis: *The abundance of white-tailed deer and elk in the Project Area is limited by the availability of plants that provide forage, thermal cover, and hiding cover in close proximity to each other; the Hangman Restoration Project will improve the availability and interspersion of these requirements.*

Optimum habitat for elk and deer in the Intermountain West contains an interspersion of water, forage, thermal cover, and hiding cover (Thomas et al. 1979). Hiding cover and thermal cover, which are provided by trees, saplings, and shrubs, are important because they reduce the energy that ungulates must spend fleeing from predators or hunters and regulating their body temperature. Forage areas occur where grasses, forbs, and shrubs are abundant. Riparian zones, steppe vegetation, and cropland all provide forage, but the value of large fields as feeding areas is limited when their interiors are more than 600 feet (183 m) from cover. The degree of canopy cover also influences forage value because closed canopy forests have less herbaceous biomass than forests with open canopies (Thomas et al. 1979). Nutrition influences recruitment in members of the deer family that are capable of producing litters of more than a single fawn (Bunnell 1982), as is the case with white-tailed deer. Furthermore, high-quality cover/forage complexes support high densities of breeding female whitetails and high rates of recruitment (Dusek et al. 1989). Currently deer and elk populations are limited by the high proportion of the watershed that is in cropland. We expect that restoration of native vegetation and the conversion to a less homogeneous landscape–including wooded riparian corridors, bunchgrass-forb communities, and open, parklike coniferous forests–will benefit deer and elk on the Project Area by improving the quality and interspersion of available forage and cover.

Black bear

Hypothesis: *Black bear populations are controlled by food quality; therefore, black bears in the Project Area will benefit from the restoration of habitats that provide abundant bear foods such as riparian and upland shrubs.*

Reproduction in black bears is limited by food supply. Because the milk of lactating black bears is more concentrated than that of most other terrestrial carnivores (Farley and Robbins 1995), obtaining an adequate supply of high-energy foods is critical for reproductive females. Pregnant females do not give birth unless they receive adequate nutrition prior to denning. Furthermore, females may abandon their young if they do not receive adequate food to support lactation, and the growth and development of cubs is strongly influenced by food supply (Rogers 1976; Rogers and Allen 1987; Elowe and Dodge 1989; Farley and Robbins 1995). In our region, the fruits of shrubs such as chokecherries (*Prunus virginiana*), bittercherry (*P. emarginata*), hawthorn (*Crataegus* spp.), and huckleberries (*Vaccinium* spp.) are important black bear foods (Amstrup and Beecham 1976; Unsworth et al. 1989). Thus we predict that restored riparian and forest habitats in the Project Area will provide high-quality food for black bears and will support a viable population of this species.

Beaver

Hypothesis: *In semiarid habitats where there are few lakes or ponds, beaver require low-gradient streams in the proximity of deciduous trees or shrubs; therefore beaver populations will increase following the restoration of riparian vegetation within the Project Area.*

Beaver are highly specialized for life in streams, ponds, or the margins of large lakes. They feed primarily on deciduous trees found near water, especially aspen (*Populus tremuloides*), willows (*Salix* spp.), cottonwood (*Populus* spp.), and alder (*Alnus* spp.) (Slough and Sadleir 1977; Allen 1983). Habitat quality influences beaver reproduction in several ways. Litter size varies with food availability; and there is evidence that aspens, willows, and cottonwoods are positively associated with beaver fecundity. Furthermore, beaver kits in high-quality habitats delay dispersal, thereby postponing dispersal-related mortality (Novak 1987). Woody riparian vegetation has declined in the Hangman Watershed as a result of livestock grazing and agricultural practices such as draining fields and cultivating all the way to the edges of stream banks. We suggest, therefore, that the restoration of riparian habitat in the Project Area will benefit beaver. The activities of beaver may, in turn, restore some aspects of natural hydrological functioning to the watershed.

Sharp-tailed grouse

Hypothesis: *The abundance of Columbian sharp-tailed grouse in the Inland Northwest is limited by the availability of deciduous trees and shrubs (winter habitat) and native bunchgrass/forb communities (spring/summer habitat); consequently, sharp-tailed grouse introductions will be most successful where winter habitat and spring/summer habitat are interspersed.*

Historically, Columbian sharp-tailed grouse in northern Idaho utilized native meadow steppe associations for displaying, nesting, and brood rearing. As the amount of land under cultivation increased, populations of this subspecies declined (Dziedzic 1951; Buss and Dziedzic 1955). Native meadow steppe plant communities provide high-quality nesting and brooding habitat for Columbian sharp-tailed grouse. Nest success is higher in native grass/forb communities than in communities with substantial non-native grass cover (Apa 1998). The structural heterogeneity of bunchgrasses conceals grouse from predators and may also allow nesting females to detect approaching predators (Bergerud 1988; see Weddell 1992 for review). These effects result in increased survival during the breeding season and increased recruitment. In fall and winter, Columbian sharp-tailed grouse move to deciduous trees and shrubs, which provide food (Marks and Marks 1988), concealment from predators (Bergerud 1988), and shelter (Evans and Moen 1975) until spring. Thus we anticipate that the restoration of deciduous trees and shrubs along stream courses and perennial bunchgrasses and forbs in uplands will create conditions in which reintroduced Columbian sharp-tailed grouse will be able to establish a viable population in the Project Area.

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