US Army Corps of Engineers®
Walla Walla District

Boise Parks and Recreation Department Stewardship Plan For the Riparian Corridor from Barber Park to Glenwood Bridge

Submitted by:

US Army Corps of Engineers
Walla Walla District

Final
October 2002

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1.0 INTRODUCTION

1.1 Purpose and Location

This report provides a base inventory of vegetative cover type habitats, and recommends maintenance and restoration measures to facilitate management needs identified in the *Boise River Resource Management and Master Plan* (Boise Parks, 1999), dated December 14,1999. The study area includes Boise Parks and Recreation Department's greenbelt , as well as a 70-foot setback from the 6,500 cubic feet per second high water line of the Boise River in Boise, Idaho.

1.2 Riparian and Riverine Sustainability Plan

Riparian habitats are critical components of western United States landscapes. Practically all the aquatic resources are dependent on the health of riparian habitat and 80 to 90 percent of all terrestrial species are linked by life-cycle requirements to riparian areas.

The hydrogeomorphic approach to floodplain and riparian habitat assessment employs a collection of concepts and methods used to develop and apply functional parameters to the process (HGM, 2001). The approach was initially designed for use in the Clean Water Act Section 404 Regulatory Program, and includes permit review to consider alternatives, minimize impacts, assess unavoidable project impacts, determine mitigation requirements, and monitor the success of mitigation projects. However, a variety of other potential applications for the approach have been identified such as designing mitigation projects, managing wetlands, and long-term monitoring of wetlands. This functional approach will be used in this study for managing, restoring, and sustaining riparian habitats. A discussion of this approach is provided in Appendix B, and is recommended for a comprehensive understanding of management, restoration, and ecological processes.

Maintaining a characteristic plant community is defined as the capacity of the floodplain-wetland complex to sustain a native plant community that is appropriate for the Boise River, considering its regulated flow and narrowed floodplain. Vegetation is maintained by base conditions, especially water regime, nutrient cycling, soil development, and disturbance regimes. Maintaining a plant community characteristic to the floodplains of the region also requires vegetative properties such as the growth and development of propagates, seed dispersal, density, and growth rates that permit response to natural variations in climate and disturbances (*e.g.*, floods, fire, herbivores). A major change in the relative proportions of vegetative cover and/or invasion by non-native plants and uncharacteristic native species is an indication that this function has been diminished.

1.3 Scope

This plan provides a manual for managing and restoring riverine and riparian habitat in the park setting. The safety and welfare of the public has been considered with regard to producing a sustainable management plan.

2.0 COVER TYPE MAPPING OF BOISE PARKS RIPARIAN PLANT COMMUNITIES

2.1 Floodplain Cover Types

The Hydrogeomorphic Approach to Functional Assessment: A Regional Guidebook for Assessing the Functions of Riverine Floodplains in the Northern Rocky Mountains (HGM, 2001), dated March 2001, was used to develop riparian cover types in order to map and classify riparian areas along a 10-mile corridor of the Boise River, extending from Barber Park downstream to Glenwood Avenue in Boise, Idaho.

This system divides the Park into habitat vegetative plant communities. Each cover type has developed from the specific physical elements of its plant community. For example, an area with saturated soil conditions throughout the growing season would support wetland vegetation. If the area receives seasonal high water or groundwater, it most likely will support riparian habitat. By separating the riparian corridor into specific cover types supported by specific physical conditions, maintenance and restoration strategies can be more easily standardized.

The Hydrogeomorphic Approach to Functional Assessment: A Regional Guidebook for Assessing the Functions of Riverine Floodplains in the Northern Rocky Mountains (HGM, 2001) is a hydrogeomorphic approach to riverine functional assessment. The U.S. Army Corps of Engineers (Corps), other Federal agencies, and various academic entities are developing this approach. It was selected for its simple straightforward classifying methodology, and will be used as a tool for Boise Parks and Recreation Department when making future management decisions.

The floodplains of the Northern Rocky Mountains are complex, both structurally and ecologically. Table 1-1 is a summary of the most prevalent plant community cover types on the river floodplain. The ensuing paragraphs contain detailed descriptions on these cover types, which are the most common among floodplain-wetland complexes of alluvial gravel-bed rivers in the northwest. All but one of these cover types can be found along the Boise River study area, and two cover types have been modified to more specifically identify the riparian plant communities in the Boise River floodplain.

Table 1-1. List of Cover Types	
Cover Type	**Description**
1	Mature conifer dominating the canopy, with interspersed mature cottonwood. Soils generally developing an A-horizon (layer of top soil).
2	Mature cottonwood-dominated, greater than (>) 6 meters (m) in height and >25 centimeters (cm) diameter at breast height (dbh) May have early stages of conifers that have not reached the forest canopy or may be entirely devoid of conifers.
2a	Mature cottonwood river edge dominated >6 m in height and >25 cm dbh. This cover type separates park land from the river. Since it is an "edge" and narrow in width, it contains a denser understory due to the availability of sunlight and, in some situations, irrigation. These areas contain great plant diversity and non-native species.
3	Immature, pole cottonwood 2-6 m in height and <25 cm dbh. May also have interspersion of willow. Soils are generally cobble-dominated, with fine sediments accumulating over the surface.
4	Cottonwood or willow seedlings and early pioneer stages up to 2 m in height. Substrate, often with exposed cobble, but may also include deposited silts and sands, not dark in color or organic, indicating very early soil development.
5	Filled or partially-filled abandoned channel dominated by mix of willows, alders, shrubs, and interspersed herbaceous cover. Also, often the dominant cover type along edge of backwaters. Soils are generally composed of deeper fines (>10 cm), with developing top soil.
6	Herbaceous wetland vegetation dominated, but may have interspersion of an occasional shrub [less than (<) 10 percent of cover]. This cover type is often associated with an older, naturally-filled side channel or abandoned back channel, but may be on any surface type.
6a	Herbaceous vegetation dominated by dryland vegetation such as grasses, rabbit brush, and sagebrush.
7	Exposed cobble riverbed during base flows and inundated during most annual high flows. May have very sparse herbaceous vegetation or an occasional cottonwood or willow seedling composing <10 percent cover.
8	Main-channel surface during base flow; may be in a single channel or may be braided with islands.
9	Off main-channel water at the surface during base flow; includes spring brooks, oxbows, scour depressions and ponds, non-flow-through downstream connected side channels, and disconnect side channels.
10	Agricultural field – may be meadow or plowed, often planted and hayed; may have origin as a forested surface, but is now logged, or may have been a natural meadow.
11	Domestic or commercially developed land including homes, buildings, gravel pits, transportation corridors, *etc*.
11a	Old gravel pit filled with groundwater. This feature is functioning as a young manmade lake or pond.

2.2 Relationship of Cover Type to Boise Municipal Code

2.2.1 Section 11-16-03.2 – Class A Lands and Waters

Class A lands and waters are areas that provide extremely important habitats for fish and wildlife, as well as for flood control and protection. The objective for these lands is to preserve and protect them for their primary benefits to fish and wildlife in general, and to protect bald eagle, great blue heron, trout, and waterfowl habitats in particular. These areas include, but are not limited to floodways, diverse plant communities, riparian plant communities, wetlands, eagle winter habitat, islands in the river, and trout spawning areas. Cover types 1 through 9, with the exception of cover type 6a, are considered Class A Lands.

2.2.2 Section 11-16-03.4 – Class B Lands and Waters

Class B Lands and Waters are areas which provide a good potential for improvements to natural resource functions and values. The objective for these lands is to invite development plans which demonstrate improvement to natural resource functions and values, and mitigate negative impacts to existing natural resource functions and values. Class B Lands and Water include, but are not limited to agricultural lands, gravel pit ponds, and small lakes. Cover types 6a, and 10 through 11a are considered Class B Lands.

2.3 Description of Cover Types and Values

2.3.1 Cover Type 1

Mature conifers dominate the canopy of cover type 1 with interspersed mature cottonwood. Soils generally develop an A-horizon (top soil layer). This cover type does not exist in the study area. It is typical of mature unaltered floodplains located in more northern areas, or floodplains at higher elevations.

2.3.2 Cover Type 2

Cover type 2 consists of mature cottonwoods over 6 m in height, with a diameter at breast height (dbh) greater than 25 cm. There may be young conifers that have not reached the forest canopy, or they may be entirely devoid of conifers. Shade controls the understory, which generally consists of shade-tolerant species or remnant vegetation that is being outcompeted by the dominant overstory trees. Maples occupied as much as 10 percent of the canopy in the study area. Woody debris of all sizes was found on the ground, which helps develop soils. This cover type provides horizontal cover above from its canopy and vertical cover from trunks and stems. Large mammals, such as deer, use these areas. Songbirds use the ground and various levels of canopy; and heron, owls, and raptors use the area for nesting and perching sites. Larger, more secluded areas are used by wintering bald eagles. This cover type represents the most mature riparian community. Mature riparian habitat cycles nutrients, builds viable soils, and provides shade for the river that reduces water temperature and provides large woody debris to shape and create the river's unique habitat for fish and aquatic insects. Because it is the most mature stage of the riparian community, it is also the most difficult to reestablish. Mature cottonwoods serve as a measure of a systems health.

Photo 1: Cover Type 2, Background Bill MacDonald

2.3.3 Cover Type 2a

Cover type 2a has mature cottonwoods greater than 6 m in height, with a dbh over 25 cm. It separates the river from park lands and developed areas. Since it is an "edge" and narrow in width, it contains a denser understory due to the availability of sunlight and water. These areas contain great plant diversity and a high percentage of non-native species because of their proximity to developed areas. This cover type functions as a buffer between the river and developed upland areas. It provides many of the same functions as cover type 2 (see paragraph 2.3.2). It cycles nutrients and builds viable soils, shades the river and reduces temperature, and provides large woody debris to shape and create the river's unique habitat for fish and aquatic insects. It also functions as a corridor, allowing fauna to move upstream and downstream and between large areas of habitat that provide life-cycle requirements. Aesthetically and biologically, it is a critical habitat for the park.

Photo 2: Cover Type 2a Bill MacDonald

2.3.4 Cover Type 3

Cover type 3 provides immature pole cottonwood 2 to 6 m in height and less than 25 cm in dbh. It may also include a mixture of willow. Soils are generally cobble dominated, with fine sediments accumulating over the surface. This is an intermediate phase of floodplain development. Willow and cottonwood seedlings colonize newly eroded or deposited sediments. Herbaceous cover may occupy all or portions of the remaining exposed area. Willows are the first species to become established, and provide sediment traps to build soils. When conditions are favorable, cottonwoods gain control of the overstory and shade out competition. This cover type protects floodplain surfaces from erosion. Dense cottonwood stands with mixed shrubs and herbaceous cover provide excellent winter browse for big game (*i.e.*, deer and moose). Small mammals find refuge in the dense cover, and birds feed on seeds and insects.

Photo 3: Cover Type 3 Bill MacDonald

2.3.5 Cover Type 4

Cover type 4 consists of cottonwood or willow seedlings up to 2 m in height. Substrate soils often have exposed cobbles, but may also include deposited fines from flooding. Generally, soils are unstained by organics, thus indicating very early soil development. This cover type can develop within one growing season and be destroyed the next, but it will usually exist over several years with its growth dependent on moisture. Dry years will thin the stand, allowing other plants to grow larger. If protected from erosion, it may develop into cover type 3.

This habitat provides cover for fauna, but only limited food. It provides important escape cover for young birds (*e.g.*, ducks) and even mammals (*e.g.*, deer). Its most important function is trapping debris and sediments. This is the phase that separates herbaceous cover from woody riparian cover.

Photo 4: Cover Type 4 Bill MacDonald

2.3.6 Cover Type 5

This cover type consists of filled and partially-filled abandoned channels dominated by mixed willows, alders, and shrubs, and interspersed with herbaceous cover. Cover type 5 is often the dominant cover type along the edge of backwaters. Soils are generally composed of deeper fines and development of a top soil horizon. These areas provide the greatest diversity and very high productivity, and are commonly referred to as shrub scrub or emergent wetlands. Settling organic matter is deposited in a hydric, or season-moist, environment. Depositing sediments usually provide a good seed bank for species found upstream. These are the herbaceous plants that provide important sources of nutrients. Shrubs, like alder, are nitrogen fixing and free nutrients for other terrestrial and aquatic plants. Shrubs, like silverberry, provide valuable food sources. Many of the floodplains mammals and birds use these areas for feeding. These areas will eventually progress to form the richest woody riparian plants due to their deep organic silts and water supply.

Photo 5: Cover Type 5 Bill MacDonald

2.3.7 Cover Type 6

Herbaceous vegetation dominates cover type 6, but may have up to 10-percent shrub cover. This cover type is often associated with a naturally-filled side channel or abandoned back channel, but may also include non-depressional surfaces. It may be dominated by emergent vegetation, such as cattails or wet meadow-type grass and sedge. This cover type is very productive, and provides a wide range of wildlife value. If the area contains small pockets of open water, submergent and floating plants (*e.g.*, duck weed), which are necessary to sustain a wide diversity of waterfowl, may be present. Water quality is enhanced by nitrate and phosphate cycles.

Photo 6: Cover Type 6 Bill MacDonald

2.3.8 Cover Type 6a

Cover type 6a consists primarily of herbaceous vegetation (*e.g.*, grasses) with dryland shrubs (*i.e.*, rabbitbrush and sagebrush). This cover type is often associated with natural terraces which have not been altered by river flows. It is also associated with manmade fills that raise surface areas above the area influenced by river hydrology. This area receives moisture only from precipitation, not from surface or subsurface flows. This cover type adds species diversity and is extremely sensitive to surface impacts such as bicycles or foot traffic. Prairie grasses are critical for small mammals and seed-eating birds.

Photo 7: Cover Type 6a Bill MacDonald

2.3.9 Cover Type 7

Cover type 7 has exposed cobble riverbed during base flow, which is inundated during most annual high flows. There may be very sparse herbaceous vegetation or an occasional cottonwood or willow seedling, composing less than 10 percent of the cover. These areas are usually well armored, and cause directional changes in flow. Exposed cobble shoals are used by waterfowl for resting and molting, and provide a good view of approaching predators.

Photo 8: Cover Type 7 Bill MacDonald

2.3.10 Cover Type 8

Cover type 8 consists of a main-channel surface during base flow, and may be single channel or braided with islands. Healthy, natural channels, as displayed in photo 9, consist of pools and riffles, have diverse vegetated shoreline, and contain woody debris. They may have small or large secondary channels. The channel depicted in the photo is a natural channel located in the vicinity of Barber Park. Many channel sections below the Warm Springs Golf Course have been channelized and, therefore, do not provide the same fisheries values as natural sections.

Photo 9: Cover Type 8 Bill MacDonald

2.3.11 Cover Type 9

Cover type 9 provides off-channel water at the surface during base flow. This includes spring brooks, oxbows, scour depressions and ponds, and non-flowthrough downstream connected side channels and disconnected side channels. These are special habitats that provide a diversity of unique environments. Spring brooks or creeks are often spawning and rearing habitat for fish, such as cutthroat, brook, rainbow, and brown trout. Because these areas are fed by groundwater, they tend to maintain relatively constant temperatures. Quite often, they remain ice free, even in subfreezing temperatures. The constant high-quality water serves as a nursery area for many species of fish. Waterfowl seek out these areas when other waterways are frozen. The rich water provides many species of aquatic plants and benthic insects.

Photo 10: Cover Type 9 Bill MacDonald

2.3.12 Cover Type 10

Agricultural field, cover type 10, may be a meadow or plowed, and are often planted and hayed. These areas may have originally been forested areas that were logged, or they may have been a natural meadow.

Photo 11: Cover Type 10 Bill MacDonald

2.3.13 Cover Type 11

Cover type 11 has domestically or commercially developed land including homes, buildings, gravel pits, transportation corridors, *etc*.

Photo 12: Cover Type 11 Bill MacDonald

2.3.14 Cover Type 11a

An old gravel quarry filled with groundwater makes up cover type 11a. This feature may function as a young manmade lake or pond. Manmade depressions that intercept alluvial groundwater aquifers can be productive aquatic environments. If the quality of the groundwater is high, a productive freshwater lake can develop. Depressions that intercept groundwater usually become surface discharge areas. The quarry pond does not have a surface inlet, but a surface outlet can form from improved hydraulic passage of the water-down gradient. The water does not have to pass through the indices of the gravel deposits. Discharge streams can function as spring creeks, and may have spawning and rearing value. Because quarry ponds are a closed system, many management options exist. Groundwater-fed ponds can be managed as productive fisheries.

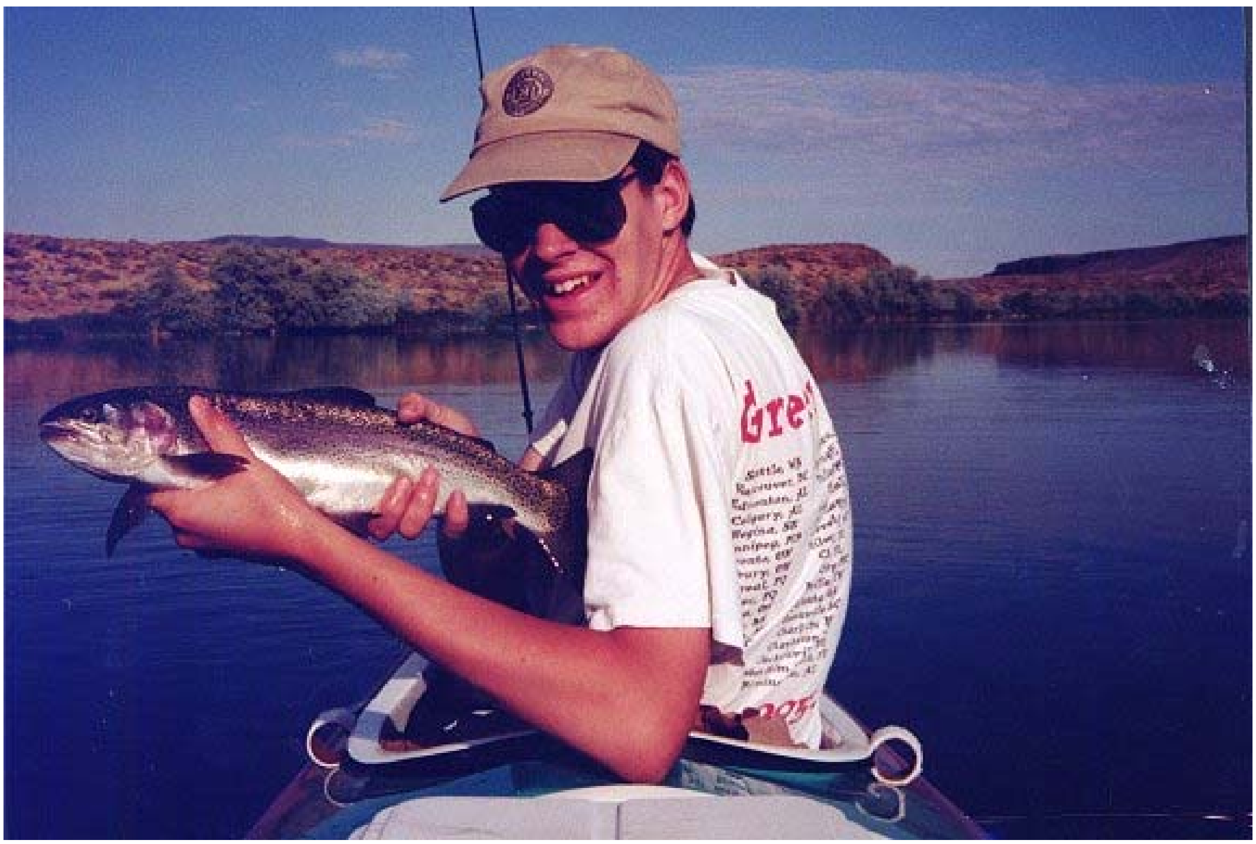


Photo 13: Cover Type 11a Bill MacDonald

3.0 MAINTENANCE AND RESTORATION PLAN FOR THE BOISE RIVER'S NATURAL VALUES

Maintenance and restoration measures are recommended for Boise Park. Measures are recommended by cover type so that the correct management practice can be made in the proper location. Cover type maps in appendix A provide locations for improvements, while Appendix C provides the best methods for achieving these improvements. These changes are recommended to improve the ecological function of the floodplain. Floodplain functions are described in Appendix B.

3.1 Cover Type 1

Because this cover type does not exist in the study area, no recommendations for maintenance and restoration are provided.

3.2 Cover Types 2 and 2a

3.2.1 Maintenance

Mature riparian habitats are maintained by surface and groundwater flows. Within the park, the river flow is altered by the flood control and irrigation operation of Lucky Peak Dam (see appendix B). Sections of the river below Warm Springs Golf Course have been channelized. Many sections from Barber Park downstream have been at least partially leveed. Although the river is not totally altered from its original state, the system does not function as an unaltered free-flowing system. To compensate, the following actions are recommended:

- All major riparian habitats should be fenced, and the number of volunteer trails should be limited. Trails that do not serve any useful purpose (such as fisherman access or other suitable recreational access) should be closed with brush and tree limbs. At the beginning of the trail and in open areas, wild rose hedges should be established. (See establishment technique in appendix C.)

- The park should seek the guidance of a fire ecologist, and conduct cool early spring controlled burns on a 5- to 10-year cycle. This allows dead and decaying debris to be removed and nutrients to be recycled into healthy plants. It also protects riparian areas from destructive accidental hot fire that could destroy plant diversity and floodplain soils.

3.2.2 Restoration

Mature riparian habitats should be restored in land-filled areas (areas where the surface layer of soil was placed artificially by man). Surface layers are to be lowered to an elevation consistent with the relative elevation of mature cottonwoods to channel elevation. For example, if a mature stand of healthy cottonwoods exist in the area and are 2 feet above the base river flow elevations, the area of planting should be lowered to agree with the natural condition. Plants should be established using technique 2 in appendix C.

3.3 Cover Type 3

3.3.1 Maintenance

Immature or early stages of riparian habitat are in a transitional phase. They may mature, be destroyed by high-energy flows, or die from periods of drought. Since these habitats are transitional, there is no maintenance recommended other than exotic weed control (see section 7.3). A hands-off policy will allow natural maintenance of this cover type.

3.3.2 Restoration

Immature riparian habitats are an immature phase of cottonwood riparian communities. Restoration is accomplished by following the cover type 2 techniques discussed in paragraph 3.2.

3.4 Cover Type 4

3.4.1 Maintenance

This cover type is found in the river's active channel area. It will be located at an elevation between the fall base flow and the summer sustained flow. No maintenance is recommended in areas below seasonal high water.

3.4.2 Restoration

No restoration efforts are recommended below annual high water. Natural river functions will establish this cover type.

3.5 Cover Type 5

3.5.1 Maintenance

Cover type 5 is a palustrine scrub shrub. Since natural process established the habitat, it is recommended that no intervention measures be taken. These areas should be monitored, because they provide a very important link in a healthy riparian corridor. The presence of cover type 5 is an indicator of interspersion and connectivity in the riverine system.

3.5.2 Restoration

Since this cover type is found below annual high water, no restoration actions are recommended.

3.6 Cover Type 6

3.6.1 Maintenance

This cover type is a palustrine emergent wetland. Since natural process established the habitat, it is recommended that no intervention occur. These areas should be monitored, because they provide a very important link in a healthy riparian corridor. Their presence is an indicator of interspersion and connectivity of the riverine system.

3.6.2 Restoration

Since this cover type is found below annual high water or in areas of groundwater discharge, no restoration actions are recommended.

3.7 Cover Type 6a

3.7.1 Maintenance

Cover type 6a consists primarily of herbaceous vegetation (*e.g.*, grasses) with dryland shrubs (*i.e.*, rabbitbrush and sagebrush). It is primarily associated with natural terraces or manmade fill. This cover type normally offers plant and fauna diversity, provides edge habitat for riparian areas, and also has a major effect on greenbelt aesthetics. However, the lack of native species and the repeated impacts caused by foot traffic and bicycles has severely affected the natural value of this particular area. Limiting access, especially during the growing season (March to July), and providing seasonal enhancement will best accomplish maintenance goals. These enhancements should include the planting of native wildflowers and the addition of other species of prairie grasses. Assigning a staff member sole responsibility for this upland cover, allowing "ownership," may provide the best means for accomplishing maintenance goals.

3.7.2 Restoration

Cover type 6a is very difficult to establish, and requires considerable expertise. The U.S. Army Corps of Engineers (Corps) has accepted this challenge many times at numerous sites along the Snake River. Because the staff for these areas have many diverse responsibilities, it has often been difficult to adequately prepare the site, seed at the appropriate time, and provide follow-up care for the site. During the growing season, staff members have additional workloads and conflicting responsibilities, and public activities are also greatly increased. As a result, the Corps has generally used professional contracts to establish and restore this cover type, and it is recommended that the Sponsor contract this restoration to local experts familiar with the establishment of native species in the local geographic area. To aid in this process, a copy of contract specifications used by the Corps is included as Appendix C.

3.8 Cover Type 7

3.8.1 Maintenance

This cover type is part of the riverine wetland system. Since natural processes established the habitat, it is recommended that no intervention occur, with one exception: if flows are causing undesirable bank erosion, the recommendations discussed in paragraph 3.9 may be implemented to correct the situation.

3.8.2 Restoration

Since this cover type is found below annual high water, no restoration actions are recommended. Restoration of main-channel diversity (cover type 8) may develop additional exposed cobble.

3.9 Cover Type 8

3.9.1 Maintenance

Two tools to establish stabilization for eroded banks are recommended: barbs and the placement of large boulder revetments.

Barbs may be used in areas experiencing heavy erosion. A standard design has been selected for the Boise River. This design provides sufficient performance for a large range of site conditions, and also provides for fisheries habitat enhancement. The positioning of this structure does not follow standard placement criteria. It is randomly placed and positioned at a density that is greater than is needed, from an engineering standpoint. The position should primarily be designed for aesthetic and fish value (see appendix C).

Boulder revetments are recommended in areas that are heavily used by the public and experience heavy erosion. These are areas which are commonly riprapped. Boulder placement allows the park to establish an aesthetically pleasing shoreline which is “stepped” or “tiered.” Boulders, 4 to 6 feet in length, are individually placed. Voids between the boulders are filled with soil and planted with shrubs and grasses. The size of the boulders ensures bank stability and allows public access (see Appendix C).

3.9.2 Restoration

The restoration of instream habitat involves the placement of large boulders in the channel. They are recommended to enhance low-value channel reaches. Large woody debris would normally be used, but safety concerns regarding floaters and tubers is an issue. Large boulders are to be placed during base flow conditions (<100 cfs) in random locations, and at random densities. Random placement provides a natural, aesthetically-pleasing channel appearance.

Boulders should be placed in “pods,” as illustrated in Appendix D. Each “pod” will provide fisheries cover for 5 to 20 trout, as well as for other native species (*e.g.*, whitefish). Since cover is a limiting factor in simple channel configurations, this tool is expected to provide cover for larger fish. Boulder placement is strongly recommended.

3.10 Cover Type 9

3.10.1 Maintenance

Loggers Creek provides rearing and spawning habitat for salmonids. Off-channel waters provide various habitat functions, which change over time. These channels are usually established in old river channels or channel braids. A new freshly eroded channel provides only limited habit until plants, macrophytes, and insects become established. Once the channel matures and has a viable food chain, it may become spawning habitat if water quality is adequate. When salmonids spawn, they physically displace gravel as they form their spawning beds. Over time, the gravel is moved downstream out of the spawning site. Some gravel is moved to the sides of the channel, and is no longer available for spawning. Wyoming Game and Fish determined this behavior to be a “limiting factor” in fish population on the upper Snake River. They developed a gravel maintenance program to renew spawning gravels. This technique is described in appendix D. It is recommended that Boise Parks and Recreation Department, in cooperation with Idaho Fish and Game and Trout Unlimited, develop a maintenance program to renew spawning gravels. Appendix D provides a description of the Wyoming Game and Fish technique.

3.10.2 Restoration

The physical restoration of off-channel spring creeks is difficult, and well beyond the scope of this plan. Restoration involves considerable manpower and the removal of debris. Reshaping activities require skilled and knowledgeable machine operators. High flow flushing to mimic natural advents, while very desirable, requires a major planning effort. In addition, detailed coordination between public agencies, property owners, and government agencies is required. If maintenance procedures described in paragraph 3.10.1 are followed, some values will be restored. However, restoration measures beyond gravel renewal are not recommended at this time.

3.11 Cover Type 10

Specific areas of this cover type are suitable for purchase and restoration to riparian habitats.

3.12 Cover Type 11

Specific areas of this cover type are suitable for purchase and restoration to riparian habitats. If these areas are targeted for restoration, they should be returned to cover type 2 (see paragraph 3.2, above, and Appendix A, maps 3, 4, and 5).

3.13 Cover Type 11a

3.13.1 Maintenance

Maintenance measures for cover type 11a are described in paragraph 3.13.2.

3.13.2 Restoration

Depressions that intercept groundwater usually become surface discharge areas. Quarry ponds do not have surface inlets, but a surface outlet can form from improved hydraulic passage of the water-down gradient. The water does not have to pass through the indices of the gravel deposits. Discharge streams can function as spring creeks, and may have spawning and rearing value. Because quarry ponds are a closed system, many management options exist. Groundwater-fed ponds can be managed as productive and valuable fisheries.

Several quarry ponds exist on or adjacent to park lands. Aesthetic and natural values are limited because of the very nature of such excavated depressions. Quarry ponds require bathometric surveys to determine their depth and configurations. A limnologist should conduct invertebrate inventory and water quality studies to determine the biological potential of these resources.

Water should be tested for pH, alkalinity and hardness, phosphorus, orthophosphate, total nitrogen, ammonia, and nitrates. Oxygen and water temperature should be monitored in the summer months to evaluate maximum temperature and minimum dissolved oxygen levels. A chlorophyll test should be used to test phytoplankton abundance and provide an idea of primary productivity. Zooplankton testing can be done with a plankton net, while an ekman dredge can be used to qualitatively sample benthic invertebrates (Philip Fishella, Corps of Engineers, personal communication, March 2002). A quantitative analysis should be used to determine the best restoration and management options.

If there are sufficient shallow water areas to allow substrate removal, more naturally-configured shorelines and littoral zones can be constructed. A crane-mounted barge could very precisely excavate material and reposition it to enhance biological and aesthetic values. If the quarry is deep with limited littoral area, it may be necessary to bring in clean material to naturally configure the ponds. Cobble to sand-size material should be used for all subsurface and shoreline areas up to +1 foot above mean water elevation. Above this level, soils containing finer, richer material must be used. Shorelines should be sloped to provide a substrate to establish and support vegetation that will provide natural functions to the ponds.

A restoration plan for individual quarry ponds could be developed once existing conditions are studied and understood. Restoration is beyond the scope of this study, but could be developed with the Corps and community interest groups.

4.0 WILDLIFE HABITAT ENHANCEMENT PLAN

4.1 Introduction

Although a wide diversity of wildlife exists within the park system, songbirds and small mammals seem to be unusually scarce. The Boise River Master Plan (1999) also cites a lack of songbirds and ground squirrels. This study examined the riparian vegetation from aerial photography, as well as from ground observations. A total of 5 days were spent examining riparian habitats from Barber Park to Glenwood Street. The following observations were made: 1) many riparian habitats were diverse and, from a vegetative cover standpoint, appeared to provide for a wide diversity of wildlife; 2) the mixture or interspersion of cover types also appeared to be adequate; 3) connectivity of habitats appeared adequate for small mammals and birds (cover type 2a provides strips of cover for wildlife movement between different habitats located along the park corridor); and 4) waterfowl and heron appeared to be present in good numbers, and kingfishers were also observed.

Mourning doves and magpies were found in large numbers. The mourning doves may have been migrating birds in flocks or large family groups. Magpies, however, are predacious and omnivorous; and may be impacting songbirds.

4.2 Habitat Improvements

Trees, shrubs, and herbs that produce fruits or seeds appear to be limited. Since this food source is important to both small mammals and songbirds, additional plantings are recommended. There may also be an opportunity to enhance habitat for “keystone” species, such as sapsuckers.

Sapsuckers not only support themselves and their offspring, but a myriad of other species as well. Rednaped sapsuckers create at least 10 times as many nest holes as any of the less common woodpeckers. Sapsuckers drill a series of holes in willow and aspen trees. The holes do not damage the tree but provide a source of high-energy sap. The holes fill with sap and become a feeder for all kinds of insects, other birds, and even small mammals (Wyoming Wildlife, March 2002). One strategy is to plant willows (native species) in suitable sites. Willows attract sapsuckers, which will then provide nesting and feeding sites for many other species. Buffer areas, such as cover type 2a, are excellent locations for willows. All openings in cover type 2a, in Appendix A, are excellent sites for willow plantings.

Planting techniques are formulated to be relatively easy to accomplish, and are an effective way to improve food supply. They have been designed for park staff or volunteer groups (*i.e.*, boy and girl scouts) to effectively handle. Table 4-1 contains a list of preferred wildlife shrub plants that would enhance wildlife habitat. Planting instructions are included in appendix C.

Table 4-1 **Preferred Shrub Plants**	
Black Hawthorn	*Crataegus douglasii*
Golden Currant	*Ribes aureum*
Tatarian Honeysuckle	*Lonicera tatarica L.*
Wood's Rose	*Rosa woodsii*
Saskatoon Serviceberry	*Amelanchier alnifolia*
Red Twig Dogwood	*Cornus sericea (stolonifera)*
Silverberry	*Eleagnus commutata*
Black Chokecherry	*Prunus virginiana melanocarpa*
Blackberry	*Rubus fruticosus*
Elderberry	*Sambucus canadensis*
Sumac	*Rhus glabra*

5.0 TOOLS TO ASSIST IN THE PEOPLE MANAGEMENT PLAN

5.1 Introduction

Riparian and upland habitats are being adversely impacted by foot traffic and wheeled vehicles. Dryland or xeric vegetation included in cover type 6a cannot withstand trampling. Dryland herbaceous shrub and grasslands are in the most critical need of restoration and protection.

5.2 Dryland Grasses and Herbaceous Cover

The parks system provides recreation for a large and diverse user group. It is not reasonable to believe that posting or signing can control foot traffic. Fencing is recommended for all cover type 6a upland areas (see Appendix A). A western style fence, such as the “Whitman” or “buck rail fence” is recommended. Appendix E provides drawings and specification for either style of fence. Neither design will completely block pedestrian access, but will serve as a guide for traffic.

5.3 Wooded Park Areas

Public safety is an issue in areas where visibility is limited. Two possible actions are recommended that can be implemented individually or in combination with one another. All secondary footpaths (non-essential or of limited importance) should be closed with debris such as tree branch and other nature material available in the area. The opening should be planted with wild rose to provide a long-term deterrent to passage. Wild rose are to be planted in “pods” or “runs” to ensure success. See Appendix C for planting techniques.

6.0 NOXIOUS WEEDS CONTROL PLAN

6.1 Introduction

A field investigation conducted in October 2001 discovered very few noxious weed infestations from Barber Park downstream to Glenwood Street. The upstream right bank in the vicinity of Harris Ranch had the most weeds, but they were not widespread nor found in dense pockets. The one exception to this was the presents of false indigo, which is discussed in detail in the following paragraphs.

6.2 Background

False indigo (*Amorpha fruticosa*) is the dominant streamside cover for many waterways that have experienced human impact. This species provides wildlife cover and protects shorelines from erosion. It is not, however, a native species, and probably does not provide the ecological value of native species, but there is little evidence that it is displacing healthy native shrub vegetation. Because it primarily occupies disturbed shorelines and has outcompeted stressed native species, it would be extremely difficult to eradicate.

False indigo is a dominant streamside shrub in the project area. False indigo has become established on a majority of the lower Snake and Columbia Rivers. On the Snake River, many areas have been vegetated in the last 10 to 20 years, and false indigo is now found in arid areas where shrubs did not previously exist. In most areas, it occupies a site that formerly contained non-shrub or non-vegetated shorelines that have been impacted by grazing, water level manipulation, or other manmade disturbances.

The eradication of false indigo species within the park system would be very costly and may not provide improved wildlife habitat in the future. At this time, no recommendations are made to control or eliminate this species.

Silver maple (*Acer saccgarerrum*) is also a dominant species in the study area, and coexists with black cottonwood and various willows. In comparing aerial photographs taken in 1998 and 1951, it is clear that the denser riparian vegetation in the 1998 photograph contains a significant percent of maples in the canopy, while the 1951 photograph shows a sparser, more mosaic riparian canopy with no characteristic “fingerprint” of silver maple.

A review of literature and discussions with the staff biologist did not uncover any known adverse impacts resulting from silver maple in riparian habitat. Until more research on the ecological role of silver maple in riparian western habitat is completed, no action to encourage, control, or eliminate this species is recommended.

6.3 Recommended Weed Control Plan

Weed control specialists within the local area are usually the best source of information on weed control. They deal with the problem on a daily basis, and are aware of special geographic situations. Simplot Partners was contacted regarding recommendations for weed control. They conducted a survey of the park and identified the following problem species: Scotch thistle, purple loosestrife, Canada thistle, poison hemlock, puncture vine, and Russian knapweed.

Four programs that could be used to control problem species are identified in appendix F. Corps review of the programs identified Program #1 to be the most environmentally acceptable with a mid summer follow-up with program #3 for Puncturvine and knapweed. The most environmental acceptable treatment for Purple Loosestrife is a 1 % solution of Rodeo® applied during the flowering stage.

7.0 PEST CONTROL PLAN

The *Boise River Master Plan* (1999) identified beaver and Canada geese as problem species. Most of the park corridor was visited in October 2001, and surveyed for evidence of damage caused by beavers and Canada geese. The downstream section of the park (from the park headquarters building to Glenwood Street) was visited by vehicle and/or foot, while the upstream section of the park (from the headquarters building to Barber Park) was viewed by foot only.

7.1 Beaver

Barber Park, the City of Boise, and Ada County have an ongoing beaver degradation program. Barber Park and volunteers wrap trees located along the river and in the recreational areas of the park to discourage the destruction of trees by beaver. In addition, beaver are captured, and nurtured or relocated to prevent damage. During the October 2001 survey, cuttings were viewed in the river and downed trees were discovered along the banks, but excessive damage was not noted. It appeared that the current programs have been working. Discussions with park staff also indicated that “wrapping parties” were also social events, which served to educate volunteers regarding the importance of a healthy riparian river corridor.

Based on the apparent success and benefits of the current park program, no changes are recommended.

7.2 Canada Geese

Canada geese are migratory waterfowl protected by the National Migratory Protection Act. At one point, their population was severely reduced by unregulated and market hunting, and they were close to extinction. There are several different species of Canada geese, but one species, *Branta canadensis*, is increasingly becoming a pest in the study area. *Branta canadensis* is a magnificent bird that mates for life, and can live for as long as 20 years. The sound of its call and majestic sight of the bird in flight brings a feeling of awe and delight to people.

Urbanized Canada geese have posed a management dilemma for wildlife biologists since the early 1990’s. Control of the geese is necessary because fecal contamination on park lawns creates an unsightly appearance. This management challenge has taken many twists and turns, but ultimate control of the problem lies in a combination of several management tools for reducing goose numbers, including liberal hunting seasons and bag limits, shoreline barriers, chemical and trained dog usage, and egg addling. These techniques are discussed in Appendix G.

Photo 14: Canada Geese Bill MacDonald

8.0 REFERENCES

Boise Parks, 1999. *Boise River Resource Management and Master Plan*. Provided for Boise Parks and Recreation Department by Spatial Dynamics, Mary McGown, and Agua Tierra Environmental Consulting, Inc., December 14, 1999.

Butler, Mike, 2002. Personal Communication. U.S. Army Corps of Engineers, Clarkston Resource Office, Clarkston, Washington.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe, 1979. *Classification of Wetlands and Deepwater Habitats of the United States.* FWS/OBS-79/31. U.S. Fish and Wildlife Service, Washington, D.C.

HGM, 2001. Hauer, F. Richard, Bradley J. Cook, Michael C. Gilbert, Ellis C. Clairain, and R. Daniel Smith, *The Hydrogeomorphic Approach to Functional Assessment: A Regional Guidebook for Assessing the Functions of Riverine Floodplains in the Northern Rock Mountains*, March 2001.

Peliesser, Mike, 2002. Personal Communication. National Resource Conservation Service, Walla Walla County, Washington.

Wyoming Wildlife, 2002. Wyoming Game and Fish Commission. *Wyoming Wildlife*, Volume LXVI, No. 3, March 2002.

Appendix A

Cover Type Maps of Riparian and Floodplain Community

Appendix B

Methodologies for Development of A Sustainability Plan for Riparian Habitat

[Excerpted from *The Hydrogeomorphic Approach to Functional Assessment: A Regional Guidebook for Assessing the Functions of Riverine Floodplains In the Northern Rocky Mountains*
by
R. Richard Hauer, Bradley J. Cook, Michael C. Gilbert,
Ellis C. Clairain, and R. Daniel Smith
March 2001]

The hydrogeomorphic approach to floodplain and riparian habitat assessment employs a collection of concepts and methods used to develop and apply functional indices to the assessment process. The approach was initially designed for use in the Clean Water Act Section 404 Regulatory Program, and includes permit review to consider alternatives, minimize impacts, assess unavoidable project impacts, determine mitigation requirements, and monitor the success of mitigation projects. However, a variety of other potential applications for the approach have been identified such as designing mitigation projects, managing wetlands, and long-term monitoring of wetlands. This functional approach will be used in this study for managing, restoring, and sustaining riparian habitats. The following paragraphs provide descriptions and methodologies to use in the formulation of a forest sustainability plan for riparian habitat.

3.1 Function 1: Surface-Groundwater Storage and Flow

3.1.1 Definition

The surface-groundwater storage and flow function is defined as the capacity of river, floodplain, and associated wetlands to dynamically store and route water primarily under the influence of surface and subsurface flows. The usually occurs dynamically in the Northern Rocky Mountains when spring snowmelt from the watershed increases river discharge and, thus, river stage height (HGM, 2001). The aggraded floodplains of the Northern Rockies are generally characterized by braided conditions within aggraded channel networks, as well as a highly developed system of side channels and surface and subsurface paleochannels (HGM, 2001).

3.1.2 Characteristics and Processes That Influence the Function

The characteristics and processes that influence the capacity of the floodplain to exchange and store floodwater are related to the following: 1) the hydrographic regime of the river affecting both surface flooding and subsurface flooding; 2) the geomorphology of the floodplain; and 3) the interconnectivity between the main channel, side channels, and surface and subsurface paleochannels. These characteristics are affected by hydrologic factors subject to climate, watershed characteristics, and conditions in the stream channel.

3.2 Function 2: Nutrient Cycling

3.2.1 Definition

Nutrient cycling is defined as acquiring inorganic forms of essential nutrients, converting them to organic forms (general resulting plant growth), and converting them back into inorganic forms through various microbial-mediated metabolic and biogeochemical processes. The two nutrients of general interest, as well as of concern as sources of eutrophication (dissolved oxygen reduction) and nutrient enrichment, are phosphorus and nitrogen. Phosphorus comes from a variety of sources, including parent geologic material (as dissolved or particulate forms in wet and dry precipitation) and anthropogenic sources of pollution. Nitrogen comes to the floodplain from a variety of sources as well but, unlike phosphorus, nitrogen is present in the atmosphere as a gas that can be fixed by microbes. Nitrogen is most readily used and cycled in a reduced condition, but is also absorbed and used as nitrate. The vast majority of the world's ecosystems cycle nutrients (HGM, 2001). However, unique to riverine systems are unidirectional flow and the process by which nutrient cycling becomes nutrient spiraling (HGM, 2001). Floodplains and their associated riverine wetlands apparently cycle nutrients in a way that increases the efficiency with which these limiting elements are utilized; and results in high productivity, a reduction in dissolved nutrients, and maintenance/improvement of water quality.

3.2.2 Characteristics and Processes That Influence the Function

River floodplains and their associated wetlands in the Northern Rocky Mountains are extremely diverse and complex. Floodplain surfaces have a variety of plants that may or may not be hydrophytes (plants uniquely adapted to living in water or wet soil environments). Hydrophytes do, however, dominate the vegetative community. Physiological adaptations in leaves, stems, and roots allow for greater gas exchange, and permit respiration to take place, thus allowing the plant to harvest stored chemical energy it has produced through photosynthesis. Although there is no clear starting or ending points for nutrient cycling, it can be argued that the interrelationship between fluvial geomorphology, river power, and the temporal presence of water on the floodplain-wetland complex determines the characteristic plant community. In turn, the maintenance of the characteristic primary productivity of the plant community sets the stage for all subsequent transformation of energy and materials at each trophic level on the floodplain surface. Likewise, the growth and metabolic activities of plant communities on the floodplain surfaces have a significant influence on subsurface processes, which affect the productivity of both the river and the floodplain. Alterations to hydrologic inputs, outputs, or storage; and/or changes to the characteristic plant community, will directly affect the way in which the floodplain-wetland complex performs the function of nutrient cycling.

3.3 Function 3: Retention of Organic and Inorganic Particles

3.3.1 Definition

Retention of organic and inorganic particles is defined as the ability of the riverine floodplain-riparian-wetland mosaic to capture and temporarily (*e.g.*, years, decades, and centuries) train both organic and inorganic particles. These particles range in size from cobble to colloidal inorganic, and from trees to very fine seston organics (organic materials suspended in the water). These materials are either imported to the floodplain from other sources in the watershed or may originate on the floodplain.

3.3.2 Characteristics and Processes That Influence the Function

This function is primarily influenced by characteristics and processes of the river and its floodplain wetlands to transport water, bed sediments, and organic particles; and then to retain those materials in the aggraded section of the river (*i.e.*, floodplains). River morphology reflects the concentration and size of the sediments moving down the channel. When river sediments are predominately fine-grained (*i.e.*, silts and sands), materials are largely carried in suspension and much of the sediment load is deposited in depositional zones on floodplains, during floods. This leads to the building of relatively high, fine-grained, and cohesive banks; and a relatively narrow, single-threaded channel that meanders across the floodplain. However, when river sediments are composed primarily of coarse materials (*i.e.*, gravel and cobble), these materials are transported on or near the bed surface and deposited in bars, which fill the channel and deflect the river in irregular patterns (HGM, 2001). Depending on the supply of sediments, coarse-grained river systems are characteristically wide and shallow with irregular, braided channels and non-cohesive banks formed from the coarse materials. The dynamic deposition and reworking of these porous bed sediments by fluvial processes are viewed within the context of contemporary river ecology as a dynamic mosaic of fully- or partially-saturated habitats. These habitats exist in a three-dimensional state where interconnected patches exchange materials both horizontally and vertically (HGM, 2001). In the reference standard condition, flooding occurs annually within the channel, as well as through side channels and subsurface paleochannels. During higher stage floods, with recurrence intervals of more than 10 years, higher surfaces are also incorporated in the flooding event.

3.4 Function 4: Generation and Export of Organic Carbon

3.4.1 Definition

The generation and export of organic carbon is defined as the capacity of a riverine floodplain-wetland complex to generate organic carbon (both dissolved and particulate) through primary production, and to export that carbon downstream to other riverine or floodplain habitats and systems. Mechanisms of export include leaching of litter, flushing, displacement, and erosion.

3.4.2 Characteristics and Processes That Influence the Function

Floodplains, and their associated wetlands of alluvial gravel-bed rivers, can best be viewed as open ecosystems with significant flux of water and materials. A major component of the material flux occurs within the organic fraction, both as dissolved carbon and as particulate. Because of the high porosity of the alluvium distributed across the floodplain surface (which has been worked and reworked by fluvial processes), the floodplain surface and subsurface is a complex mosaic of hydrologic affinities. Characteristic riparian vegetation is often highly productive, due to its vertical proximity to a water table maintained by the continuous supply of water from the river and the routing of water throughout the complex mosaic of surface and subsurface flow pathways. Thus, river-floodplains function as open systems structured by their hydrographic regimes and the fluvial geomorphology that facilities the flow of materials. Watersheds with large river floodplain-wetland complexes have generally been found to export organic carbon at higher rates than watersheds with fewer wetlands (HGM, 2001). This is attributable to several factors: 1) the large amount of organic matter in the litter and soil layers that comes into contact with surface water during inundation by flooding; 2) relatively long periods of inundation and, consequently, contact between surface water and organic matter allowing for significant leaching of dissolved organic matter; 3) the ability of the labile (likely to undergo chemical change) carbon faction to be rapidly leached from organic matter when exposed to water (HGM, 2001); and 4) the ability of floodwater to transport dissolved and particulate organic carbon from the floodplain to the stream channel.

3.5 Function 5: Characteristic Plant Community

3.5.1 Definition

Maintaining a characteristic plant community is defined as the capacity of the floodplain-wetland complex to sustain a native plant community that is appropriate for the Boise River, considering its regulated flow and narrowed floodplain. Vegetation is maintained by base conditions, especially water regime, nutrient cycling, soil development, and disturbance regimes. Maintaining a plant community characteristic to the floodplains of the region also requires vegetative properties such as the growth and development of propagates, seed dispersal, density, and growth rates that permit response to natural variations in climate and disturbances (*e.g.*, floods, fire, herbivores). A major change in the relative proportions of vegetative cover and/or invasion by non-native plants and uncharacteristic native species is an indication that this function has been diminished.

3.5.2 Characteristics and Processes That Influence the Function

A characteristic plant community is maintained by a variety of biophysical variables. Several gradients influence the distribution and abundance of plant species. Not surprisingly, numerous studies have found that depth of water strongly influences vegetation patterns (HGM, 2001). Likewise, the chemistry of water has a marked effect on nutrient availability and, thus, on plant species composition. Vegetation growing on the floodplain accounts for the vast majority of the organic matter supply to the floodplain-wetland complex that supports higher trophic levels. The higher trophic levels, in turn, influence the structure of the vegetative community through herbivores and decomposition of detritus biomass. Thus, vegetation is also the primary source of organic matter to fuel the detrital-microbial decomposition process.

3.6 Function 6: Characteristic Aquatic Invertebrate Food Webs

3.6.1 Definition

The function of maintaining characteristic aquatic invertebrate food webs is defined as the capacity of the river floodplain to maintain a characteristic diversity and abundance of aquatic invertebrates. Invertebrates are subject to considerable variation over the annual climatic cycle, thus leading to inaccuracies in functional assessments if the assessment period occurs at a time of the year when densities or diversity are naturally low. Invertebrates may also be difficult to collect, identify, and enumerate without extensive training. Therefore, within the framework of the *Hydrogeomorphic Approach to Functional Assessment of the Northern Rock Mountain Alluvial Floodplains* (2001), this function is based on the evaluation of habitat, vegetation structure, hydrographic regime, and the complexity of the floodplain mosaic rather than direct measures of the invertebrates. This characteristic implies that the complexity of the Boise River floodplain mosaic determines the diversity and abundance of aquatic insects.

3.6.2 Characteristics and Processes That Influence the Function

An extraordinary body of research has been directed toward understanding aquatic invertebrate populations and their dynamics in stream and river systems (HGM, 2001). However, much less is specifically known about the distribution and abundance of aquatic invertebrates distributed across the complex aquatic habitats that characterize the riverine floodplains.

Aquatic invertebrates, particularly insects, crustaceans, and mollusks are often diverse and abundant in floodplain spring brook and marsh habitats. Hundreds of species commonly occupy a variety of benthic, epiphytic, lentic, and lotic habitats. Although macroinvertebrates have many characteristics that make them ideal for freshwater biomonitoring programs, the ecology of floodplain macroinvertebrates is not as well understood. Yet, it is known that macroinvertebrates may serve as sentinel organisms for the early warning of water pollution or losses of continuity of particular habitats. Likewise, the presence of particular habitats result in a characteristic fauna. Macroinvertebrates have proven sensitive to a variety of environmental changes and contaminants, such as toxic metals and organic pollution, acidification, salinization, sedimentation, and habitat fragmentation and disturbance (HGM, 2001).

3.7 Function 7: Characteristic Vertebrate Habitats

3.7.1 Definition

The function of maintaining characteristic vertebrate habitats is defined as the capacity of the river floodplain-wetland complex to maintain the habitats necessary for characteristic diversity and abundance of fish, herptiles (*i.e.*, amphibians and reptiles), birds, and mammals. Many of the representatives of these vertebrate groups are extremely mobile, with high variability in spatial and/or temporal use of floodplain wetlands. For example, migratory waterfowl and neotropical birds are extremely temporal in their use of floodplains. In contrast, frogs, toads, and salamanders are far less mobile than birds, and generally will remain on the floodplain throughout their lifetime. Likewise, very small mammals (*e.g.*, voles, shrews, *etc.*) have relatively small ranges, while large mammals that commonly use riverine floodplains and their associated wetlands (*e.g.*, elk, deer, bear, *etc.*) may range over several kilometers in a single day. The consequence of high spatial and temporal variability among mammals is that direct measurement of the presence of or absence of a species is often impractical or misleading. Therefore, functional assessment protocols for this function are based on indicators of high quality habitat for the various vertebrate species.

3.7.2 Characteristics and Processes That Influence the Function

There are many factors that affect the quality and quantity of vertebrate habitat across habitats that characterize riverine floodplains. The fundamental drivers of floodplain structure and function (*i.e.*, hydrology and geomorphology) greatly affect vertebrate response. For example, a temporarily flooded floodplain marsh that holds water throughout the spring and summer will possess not only significantly different vegetation from that of a spring brook or a temporarily flooded side channel, but will also be significantly different in support of aquatic habitats for various species (*e.g.*, amphibian immature life stages). Thus, duration of flooding is an important variable that directly influences the characteristics and processes of this function. Likewise, the connectivity of water surfaces, particularly as influenced by the depth and duration of flooding, has a significant effect on fish access to floodplain habitats as well as the quality of those habitats for life-cycle support. For example, small immature fish require permanent waters of sufficient depth and temperature to avoid predators and sustain appropriate metabolic rates.

Alterations of hydrographic regimes or geomorphic configuration affect the primary response variables expressed by the vegetation. The geomorphic alteration of the floodplain via levees, dikes, or other structures to either protect structures or land has been a significant source of river and river floodplain degradation. Land use across the floodplain surface, particularly transportation corridors, construction of homes, and farming (*e.g.*, cultivation, grazing by cattle, and haying) all have an effect on vertebrate habitat. Alterations of vegetation affect trophic structure, as well as nutrient and energy flux, which is integral to the trophic support of vertebrates.

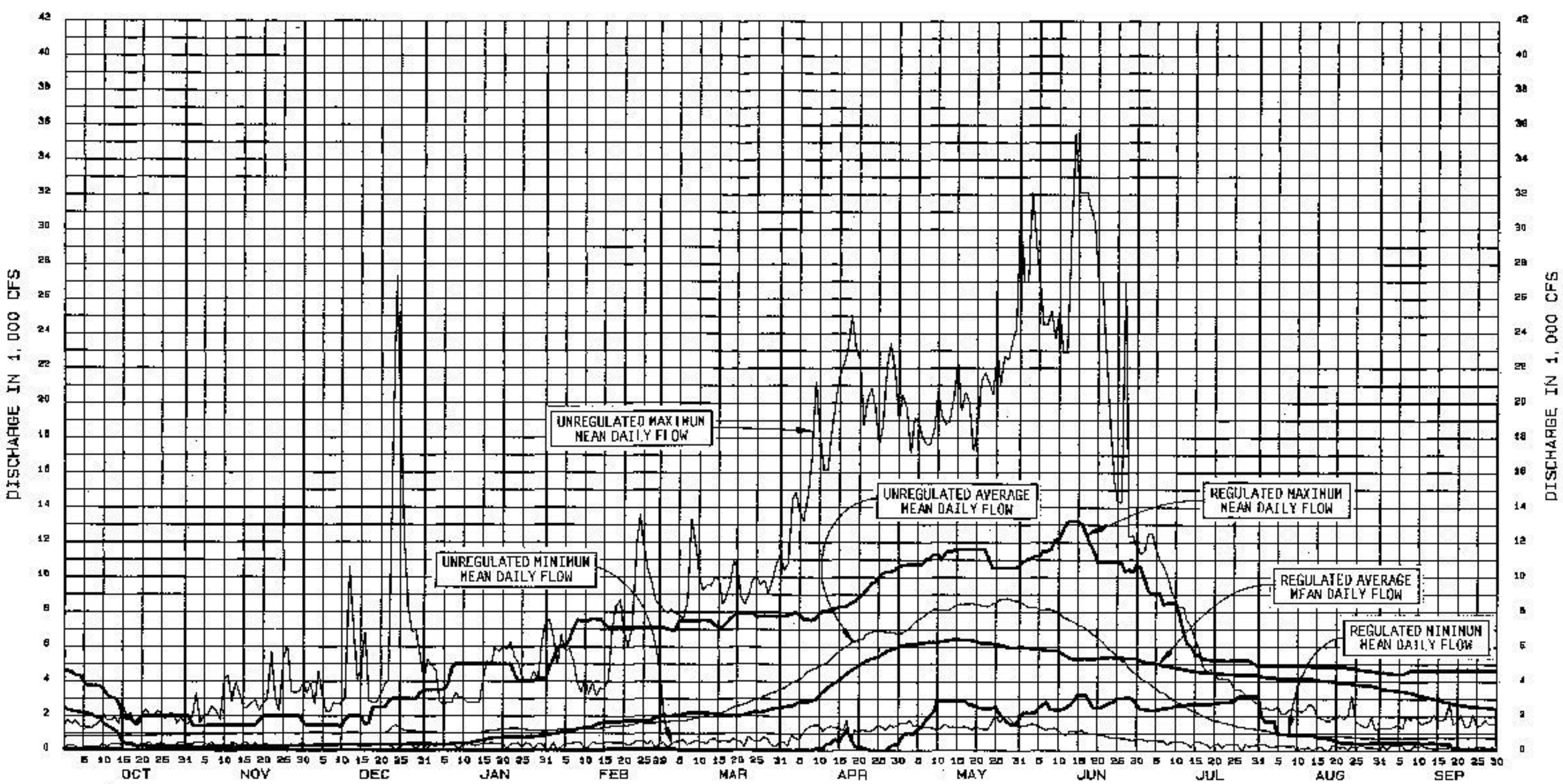
3.8 Function 8: Floodplain Interspersion and Connectivity

3.8.1 Definition

The function of maintaining characteristic floodplain interspersion and connectivity is defined as the maintenance of landscape features of habitat interspersion and connectivity between the river, its floodplain wetlands, and the surrounding floodplain habitats composed of lentic and lotic environments. Relatively high-energy rivers that course through cobble substrata dominate large river floodplains of the Northern rocky Mountains. A mosaic of surfaces that include strongly interspersed and interconnected wetland habitats characterizes these floodplains. The floodplain surfaces are underlain by subsurface variability in substratum material that has been sorted into zones of high and low hydrologic conductivity.

3.8.2 Characteristics and Processes That Influence the Function

This function is largely founded on the premise that the patterning of landscape elements (*i.e.*, riverine floodplains and their associated wetlands) strongly influences ecological relationships. The focus of this function is the relative role of land use in and around the wetland; and landscape features, particularly habitat connectivity and the proportionality of floodplain surfaces and habitats across the landscape mosaic. Most vertebrates not only require food resources to sustain populations, but also require structural habitat and cover associated with predator avoidance, nesting, resting, *etc.* To maintain these vital associations, vertebrate populations that use river floodplains to complete some portion of their lifecycle requirements need to be able to move between neighboring habitats. Whereas function 7 (paragraph 3.7) focused on the quality of habitats, the function focuses on the connectivity and interspersion (*e.g.*, distribution) of these landscape patches. For example, a floodplain terrace that is a cultivated field or intensively grazed pasture may lack the habitat structure necessary for wildlife to move freely between adjacent habitats. Likewise, birds may lack the cover necessary to raise broods or move easily with their young. In particular, geomorphic modification of the floodplain has a significant effect that alters surface flooding and, eventually, subsurface flooding. Losses of this nature result in a disconnection between the river and its floodplain which affect both the river and floodplain habitats in deleterious ways that soon equate to losses in production, species complexity, and diversity.



NOTES:

1. REGULATED VALUES ARE DATA FOR USGS GAGE NO. 13202000, BOISE RIVER NEAR BOISE, IDAHO.
2. UNREGULATED VALUES WERE COMPUTED FROM DAILY CHANGES IN STORAGE AT ANDERSON RANCH, ARROWROCK, AND LUCKY PEAK RESERVOIRS AND WERE ADDED TO LUCKY PEAK'S OUTFLOW. TRAVEL TIMES AND OTHER ROUTING EFFECTS WERE NEGLECTED
3. THE PLOT REPRESENTS A COMPARISON OF REGULATED MAXIMUM, AVERAGE, AND MINIMUM MEAN DAILY FLOWS TO UNREGULATED MAXIMUM, AVERAGE, AND MINIMUM MEAN DAILY FLOWS.
4. PERIOD OF RECORD - 1955 THROUGH 1994.
5. DRAINAGE AREA = 2,680 SQUARE MILES.
6. UNREGULATED VALUES WERE COMPUTED BY THE BUREAU OF RECLAMATION IN BOISE, IDAHO.

BOISE RIVER, IDAHO
LUCKY PEAK DAM AND RESERVOIR
SUMMARY HYDROGRAPHS
U.S. ARMY ENGINEER DISTRICT
WALLA WALLA - HYDROLOGY BRANCH
SPANGRUDE/SCHUSTER MARCH, 1995

APPENDIX B PLATE 3

Appendix C

Forest Sustainability Plan for Cottonwood Regeneration

1. Planting Trees and Shrubs

Planting with landscape fabric has greatly improved the success of low maintenance wildlife plantings in the west. Arid conditions and high winds have been major obstacles in the success of wildlife plantings in arid areas. Ten years ago, it was not uncommon to lose over 90 percent of the wildlife plants during their first year of establishment. Today, with the use of landscape material, it is quite common to have a 90-percent success rate with phenomenal growth. It is not uncommon for trees and shrubs to grow over 6 feet in a single year.

The photos below show plantings of Rocky Mountain juniper, as well as other trees and shrubs, using a landscaped fabric technique. This technique involves the following steps:

- **Planting Season:** All plantings should occur between October 15 and the end of April.

- **Pre-Planting Preparation:** The site is tilled during the period from October 15 to March 15. The entire planting area should be tilled to a depth of 8 inches. Tilling should completely break up and turn over all grass sod. The ground should have a maximum of 10 percent coverage of any plant material, and no sod or grass clumps bigger than 1 inch in length. The area should be ”cultipacked” after complete tilling. The ground should be racked relatively smooth so that fabric will lay flat, without air pockets, which will make the stacking of plants more difficult.

- **Fabric Mulch:** Fabric should be laid before the trees and shrubs are planted and watered. A tractor-drawn fabric mulch layer should be used for large sites. On small sites, the mulch can be placed by hand. The fabric should be anchored securely at the ends and sides by placing soil on the fabric to weight it down. A 6-inch cut parallel with the fabric, and another perpendicular cut, should be made to allow planting of the tree or shrub. The fabric should be pulled away from the stem, and a 1-foot-square piece of fabric with a single cut to the center should be positioned around the stem. The four corners are then laid flat around the stem so no fabric can rub the stem. Each corner of the 6-inch cut is folded back, and four stables (8 by 2 inches) will secure the corners. The purpose of the underlayment and secured corners is to ensure that the material is securely placed around the stem. If there is an open space (gap), grasses or herbaceous weeds will sprout and compete with the planting, which could cause a weed pulling maintenance problem. The material should not be so tight that it damages the stem.

- **Trees and Shrubs:** Trees and shrubs should be planted in a tilled planting area according to the specifications. Mechanical tree planting for large sites, or hand planting, can be used to plant trees in desired locations at small sites. All trees and shrubs should be planted so soil around the stem is within 2 inches of the surrounding ground.

- **Watering:** Once the plants are in the ground, they must be watered with a minimum of 2 gallons per plant within a maximum time period of 2 hours. If it is a warm spring day, they should be watered immediately after planting.

- **Natural Cover:** The landscape fabric should be covered with leaves, branches, and debris. If possible, a “chipper” should be used to cover the fabric with chips and mulch. The goal is to cover the fabric so that it appears natural. The fabric is designed to decompose in 3 to 5 years, allowing the trees and shrubs to become well established without competition from other plants.

- The work should be conducted in a manner that prevents unnecessary damage or disturbance to existing trees, shrubs, and herbaceous cover.

2. Rose Plantings

Wild rose, *Rosa woodsi*, can be used as a very effective “trail block” to discourage the use of volunteer paths and, at the same time, provide excellent cover for wildlife. Rose hips are important wildlife food sources during late winter, when food is critical. Both “pods” and linear “runs” are recommended planting strategies.

- **Pods** are planted in open areas of a trail or at the entrance point where the trail departs the maintained greenbelt area. A pod is four to six plants in a circular area, with 3 feet between plants. The planting should be made using the artificial turf technique described above.

- **Runs** follow linear open areas (*e.g.*, a path). The ground is tilled and prepared, as described above, following the opening or trail. Roots from adjacent trees may need to be cut. Very large roots (greater than 2 to 3 inches in diameter) may remain. Rose bushes in the 3- to 5-gallon container size are planted along the material, with 3 feet between plants.

Site 1. Passive approach

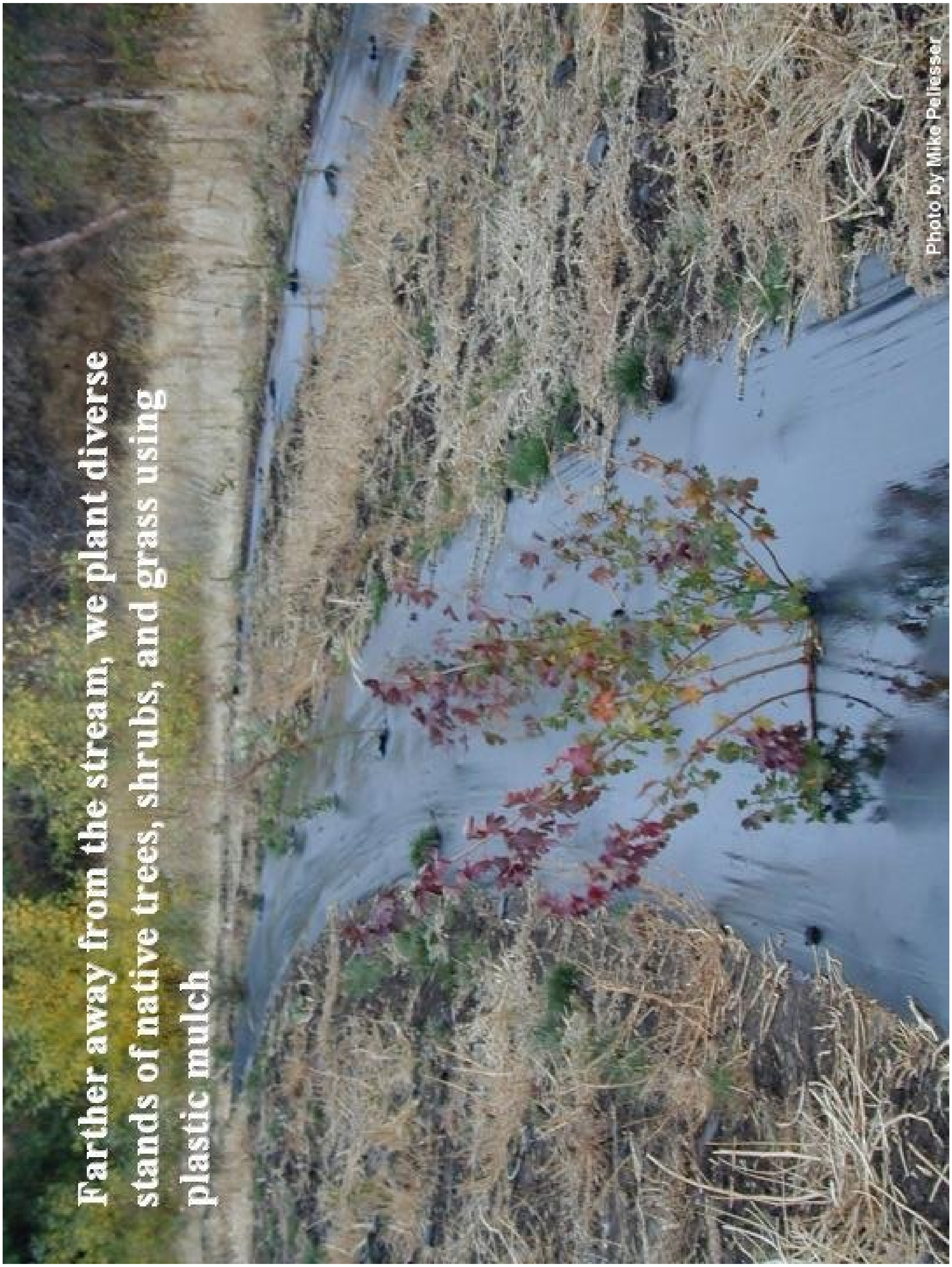
- Irrigation: none (12" rainfall zone)
- Date planted: 1990
- Date photo taken: 1999
- Survival rate : <10%
- Tree height: 2-4 feet
- Species shown: Rocky Mountain Juniper

Site 2. Active approach

- Irrigation: none (12" rainfall zone)
- Date planted: 1993
- Date photo taken: 1999
- Survival rate : 95%
- Tree height: 10 feet+
- Species shown: Rocky Mountain Juniper

Sites planted by Steve Henry, WDFW

Photos by Mike Peliesser


Farther away from the stream, we plant diverse stands of native trees, shrubs, and grass using plastic mulch
Photo by Mike Pellesser


The key is to create the most random, natural buffer you can, but still get good survival and growth.
Tarps (these are the most effective technique in lower rainfall areas)
Photo by Mike Pellesser


One year growth
of snowberry. No irrigation
Photo by Mike Peliesser

3. Dryland Prairie Grasses

The Corps has generally used professional contractors to establish and restore field plantings, and it is recommended that the Sponsor contract this restoration to local experts familiar with the establishment of native species in the local geographic area. To aid in this process, a copy of contract specifications used by the Corps is included in the following paragraphs.

3.1 Work Description

- **General.** The CONTRACTOR shall be responsible for the preparation of a seedbed and the establishment or re-establishment of fields, as directed by the Park. The CONTRACTOR shall be responsible for obtaining seed, fertilizer, pesticides, and equipment for the field (cover type 6a) re-establishment. A Brillion seeder or equivalent shall be required. The CONTRACTOR shall provide the appropriate Parks official with a receipt showing the varieties of seed mixtures and pure live seed (PLS) prior to planting. Work for either seedbed preparation and/or seeding shall be performed after execution of an indefinite delivery order for each work item.

- **Seedbed Preparation.** The CONTRACTOR shall begin seedbed preparation July 1st. All areas shall be sprayed with glyphosate. After 14 days, the area shall be moldboard plowed once, then disced to a depth of not less than 6 inches. If, after completing this requirement, more than 30 percent of the soil surface is covered with sod, weed, and/or crop residue, a second discing shall be required prior to tillage activities. Mowing shall be performed between July 1 and July 15. All mowing residue shall be removed prior to application of glyphosate. Once this operation has been performed, tillage activities can commence. The area shall then be irrigated where possible. Following irrigation, the area shall be disced again to a depth of 6 inches followed by one pass with a cultipacker roller. Ninety percent of the soil surface shall have dirt clods less than 3 inches across. If not, discing and packing shall be performed again. Once seedbed preparation is complete, no irrigation shall be applied until seeding is to occur.

  On dryland sites, seedbed preparation shall be the same except no irrigation shall be available. The CONTRACTOR can set up temporary irrigation, if they choose, at their own expense. After the first discing and glyphosphate application, the second discing shall not occur till after September 1.

- **Seeding.** Cover type 6a is a perennial development. Field mixtures are listed in Table C-1. Locations and acreages shall be negotiated with the respective Parks official. Prior to planting, or concurrent with planting, the CONTRACTOR shall apply fertilizer at the rate determined necessary for the site. Seeding will normally occur from 1 October through 1 December. However, the Park Official shall retain the right to adjust seeding dates based on environmental conditions or budgetary constraints. Seeding depth shall be ½ inch to ¾ inch for all grass seeding.

- **Payment.** Payment for seedbed preparation and seeding shall be made when each work task is completed to the satisfaction of the respective Park Official.

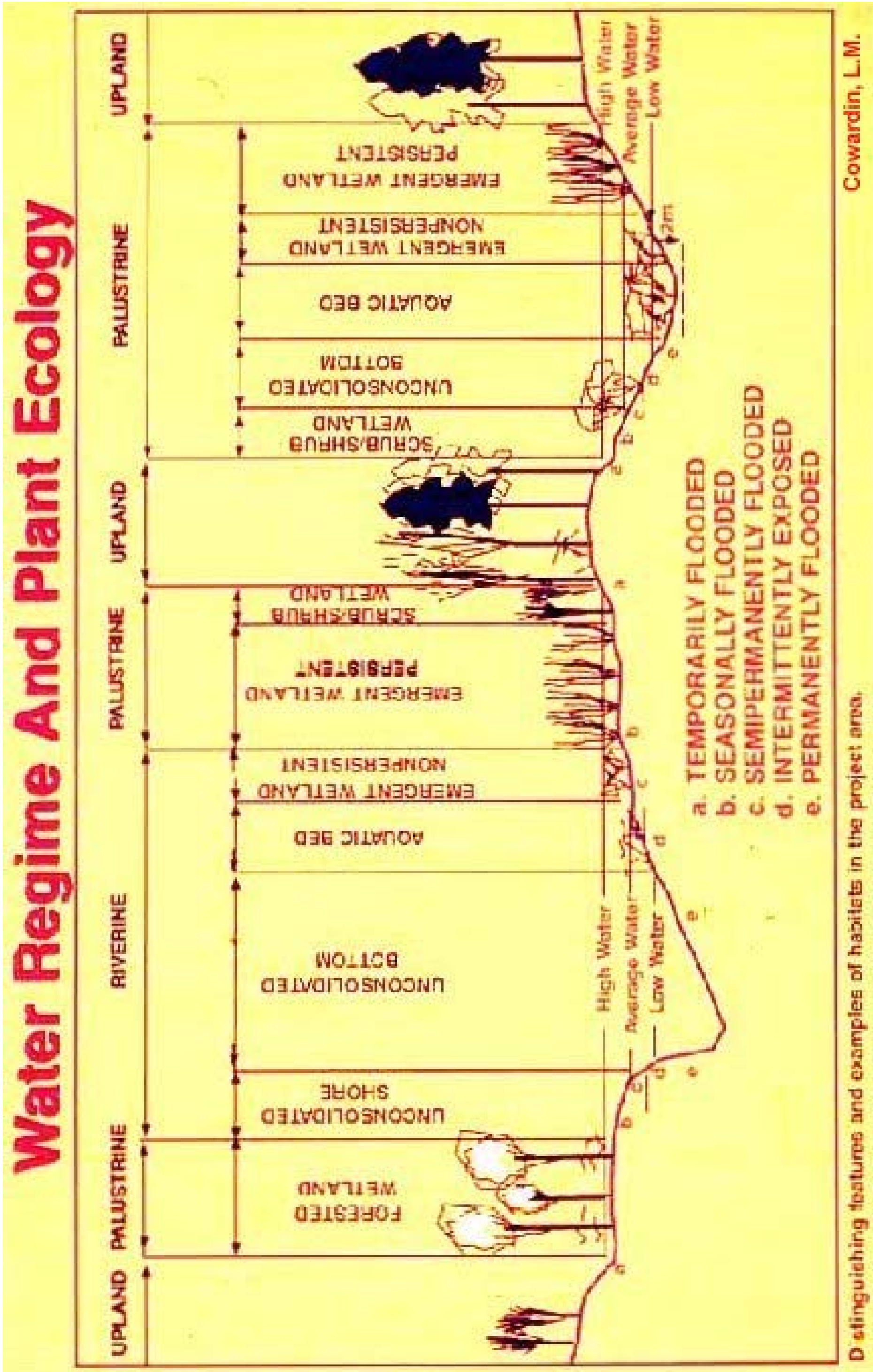
Table C-1
Field (Cover Type 6a) Planting Mixtures
For Re-Establishment

Mixture	Pounds Per Acre	Common Name (Variety)
FIELD (F-1)	10	Idaho Fescue (Joseph or Nezpurs)
	10	Great Basin Wildrye (Magnar)
	10	Sandberg's Bluegrass
	20	Bluebunch Wheatgrass (Secar)

4. Land Contouring: Throughout the Rocky Mountains of Montana, Wyoming, Idaho, and northeastern Washington, the rivers are largely characterized by a series of attributes that greatly affect their ecological structure and function. The Boise River is no exception, with a river floodplain consisting of alluvial gravel. Alluvial floodplains are a mosaic of intermittently flooded low riparian terraces and groundwater-driven spring creeks, seeps, scour pools, and backwaters. The physical geologic character of the river determines and maintains the floodplains functions described in Appendix B of this report.

Within the park system, the Boise River is located below Lucky Peak Dam. The dam alters the natural flow regime, and blocks sediments. A summary hydrograph of Lucky Peak Dam, located in Appendix B, provides a detailed diagram of the alteration of flows both with and without the dam in place. Some sections of the river contain flood control levees, and other sections are channelized. To maintain and regain the natural functions that drive the river ecosystem, features described in the various cover types must be reshaped and built. As landscaping is done, the location of surface and sub-surface water surfaces, in relation to excavation, must be considered. By considering this interspersion and connectivity, plant communities that will produce and cycle nutrients to support mammals and birds can be established.

The following diagram illustrates various plant cover types and the corresponding water levels.



Appendix D

Riverine Habitat Development

Considerable thought has gone into the opportunities for fisheries enhancement within the Park boundary. From Barber Park to Park Center Bridge, the river has a slot limit to encourage wild stocks. The quality of the water is excellent and suitable to promote a natural fishery. Habitat (cover and structure) is limited in many areas due to manmade improvements—primarily for flood control purposes. From Barber Park downstream there are several reaches of low channel diversity. Historic gravel removal shaped the channel from Julia Davis Park downstream. Although much of this area is managed as a “put-and-take” fishery, it has potential as a natural self-sustaining fishery. It is recommended that Boise Parks and Recreation Department and Idaho Department of . From Barber Park downstream there are several reaches of low channel diversity. Fish and Game undertake in-stream structure improvements to further promote a wild and sustainable fishery.

Plate 2 in Appendix A includes channel sections with good in-stream structures. Boulder placement in the slower sections would provide enhancement. This is especially true in sections displayed in Plates 4 and 5, downstream of B. Quinn Riverside Park. The section shown on Plate 6, adjacent to Ann Morrison Park, is a channelized section that could use extensive boulder placement. Areas mapped on Plates 7 and 8 could use boulder placement in specific sites to further enhance the fishery. The area shown on Plate 9, which is within the 2 fish over 14 inches section, could be upgraded considerably with both boulder and barb placement. Barbs are required to protect the bank where it directly impacts Warm Springs Golf Course (identified as cover type 7). Selected boulder placement should occur in the reach mapped on Plate 10. The reach mapped on Plates 11 and 12 could also be significantly enhanced by boulder placement and barbs.

The Boise River has a large, diverse user base. Recreationists wade, fish, raft, and go boating on the river. Large wood debris (*i.e.*, tree trunks and root wades) could cause serious user conflicts and safety issues. The present management of wood debris and snags provides for a balance of safety, flood passage, and habitat. The Boise Corps of Engineers’ Regulatory Office can assist in providing guidance for authorization for the discharge of fill material into “Waters of the United States.” The Park is responsible to ensure that all permits and authorizations are obtained prior to any construction. The following structures are designed to provide a definite structural habitat increase and, at the same time, do not affect safety issues. These structures are designed to provide environmental enhancement, and would be in the public interest. There are also designed to meet Corps’ nationwide authorization, and do not require any individual Corps permits.

- **Barbs:** The “basic 45°” is illustrated in Figure D-1. This structure has several unique features. All boulders are oversized and exceed the engineering requirements of the site. No underlayment of fabric cloth is used. Boulder size and associated voids are expected to fill in with natural sediments, and will provide a viable substrate for native plants. Although the primary intent of this structure is to provide streambank stabilization, it is also designed to provide maximum value as fish and wildlife habitat. Fish use is illustrated in Figure D-1. Generally, there are one to three fish per linear foot of vertical intrusion into the river current. As flow becomes larger and impedes on the structure, habitat value is increases. Large rock also eliminates the need for angular material, which can become unstable to walk on. The large stones are more aesthetically pleasing, and provide larger and more secure footing for river users. Examples of this style barb can be found on the left bank, downstream of Glenwood Street.

The “basic 45” meets the authorization requirements of Corps’ nationwide permit Number 27. The Park Department should coordinate with the Corps prior to construction to ensure compliance with permit Number 27.

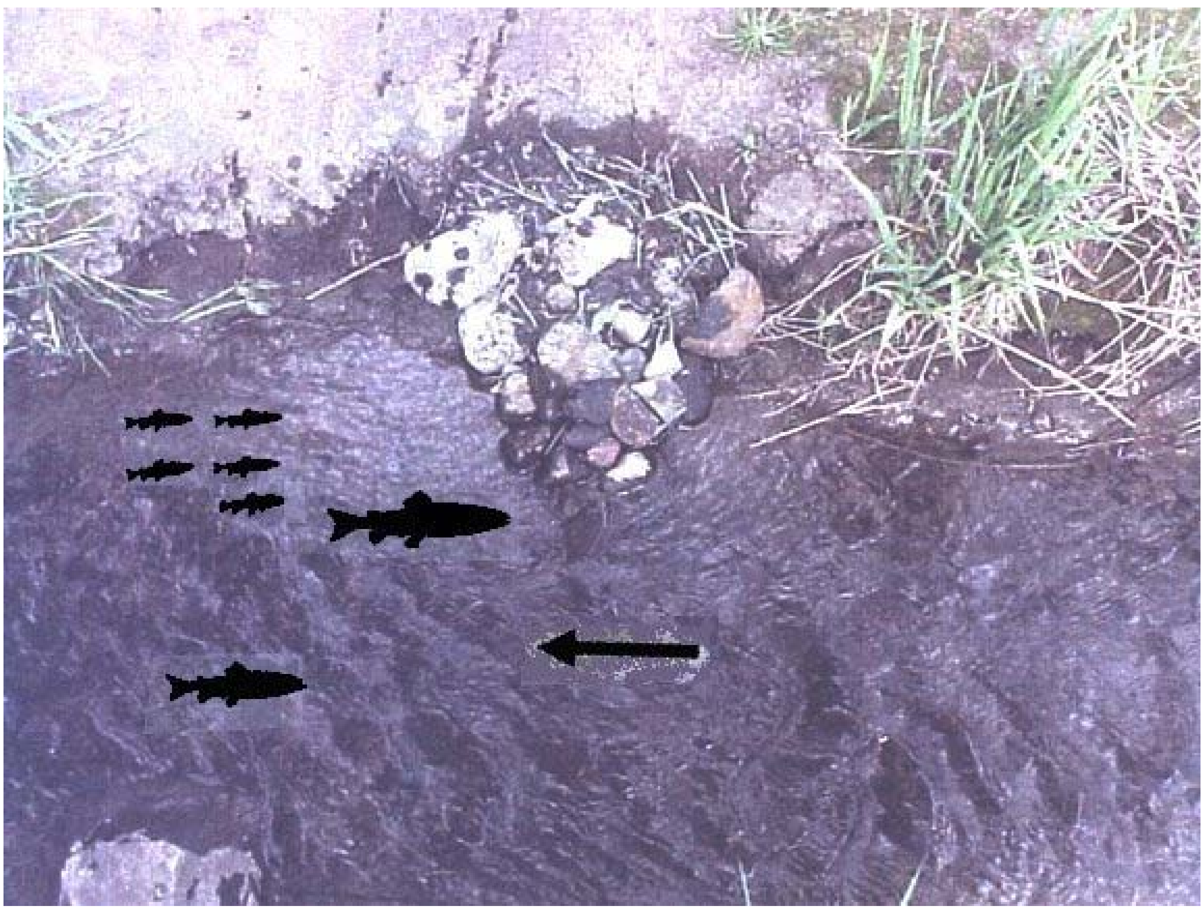


Figure D-1. “Basic 45 Degree Barb” MacDonald/Kelly

Excellent cover and resting areas, large feeding lane (current).
Protects backwater and bank. 5 to 15 boulders: 1 to 5 tons each,
placed close together at 45 degrees horizontally and vertically.

- **Large Boulder Placement:** The placement of large boulders is recommended in specific river reaches, as specified in preceding paragraphs. Boulders would provide fisheries values in other more natural river reaches as well, but priority should be given to the most impacted areas. Existing conditions are shown in figure D-2, while five arrangements of boulders are illustrated in figures D-3 through D-6. Designs are intended to provide maximum fisheries values and appear natural and aesthetically pleasing, in keeping with the beauty of the greenbelt. The true test of these arrangements is to be undetectable as man-placed structures.

  To facilitate their natural value, the boulder structures should be placed in random locations and in random configurations. This can best be achieved by selecting a random number from 50 to 150. This determines the distance upstream to the next structure. A second random number, from –15 to +15 is then selected. This second number determines the side-to-side location from the center of the river. Facing upstream, negative numbers are placed to the left of center, while positive numbers are placed right of center.

  The third random number, selected from D-3 to D-6, determines the structure design. Figures D-3 through D-6 display these various structures, which are named and numbered to facilitate placement and design.

  Boulder enhancement structures may be authorized by Nationwide Permit Number 4, *Fisheries Enhancement.* The Park Department should coordinate with the Corps prior to construction to ensure concurrence with this permit.

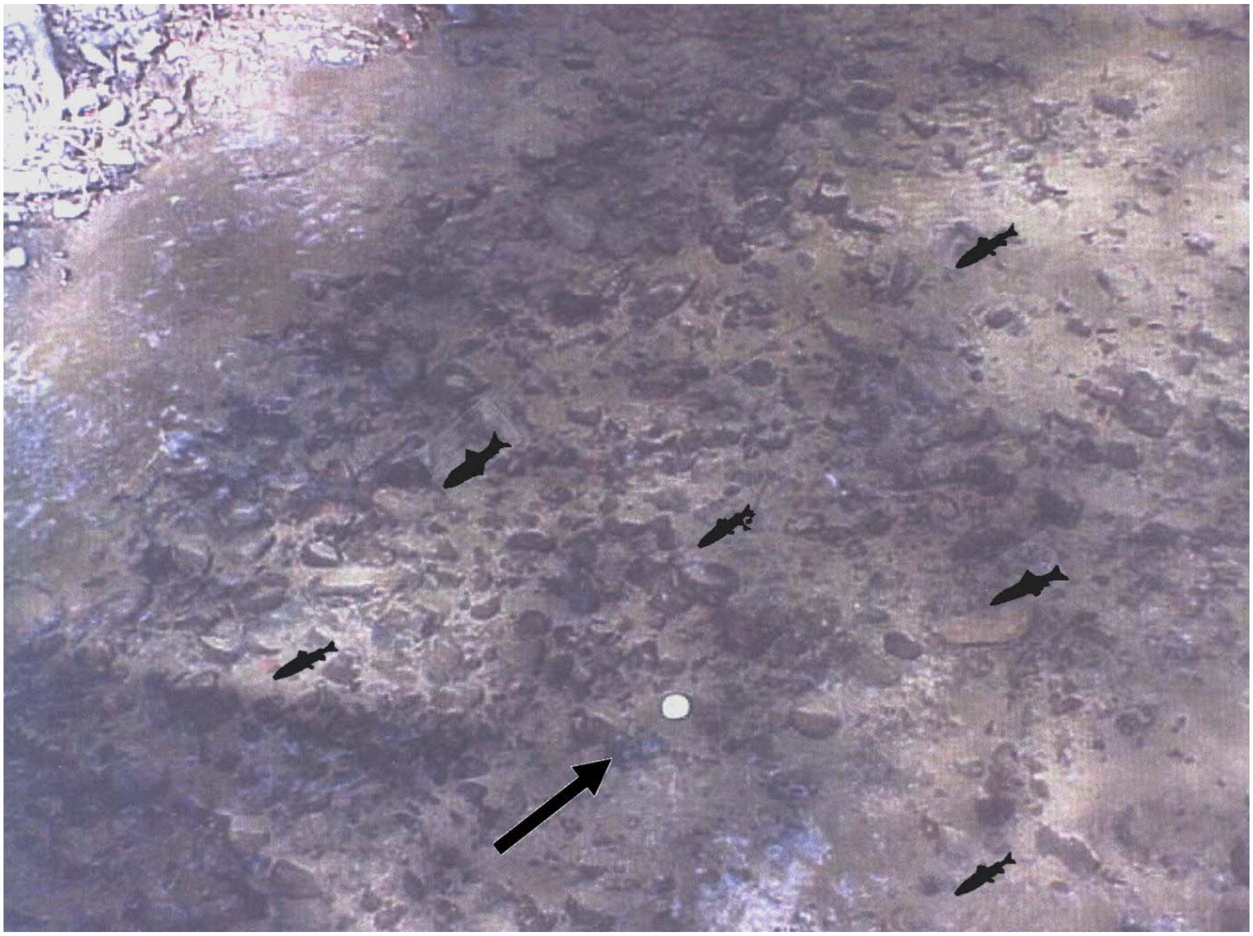


Figure D-2. Existing Conditions. MacDonald/Kelly
Uniform flow and minimal cover. Small fish with a lack of physical diversity.

Figure D-3. "Max's Run" MacDonald/Kelly

Four or more resting and feeding pockets. Good cover.
Three boulders, 2 to 5 tons each, placed in a line 6 to 8 feet apart.

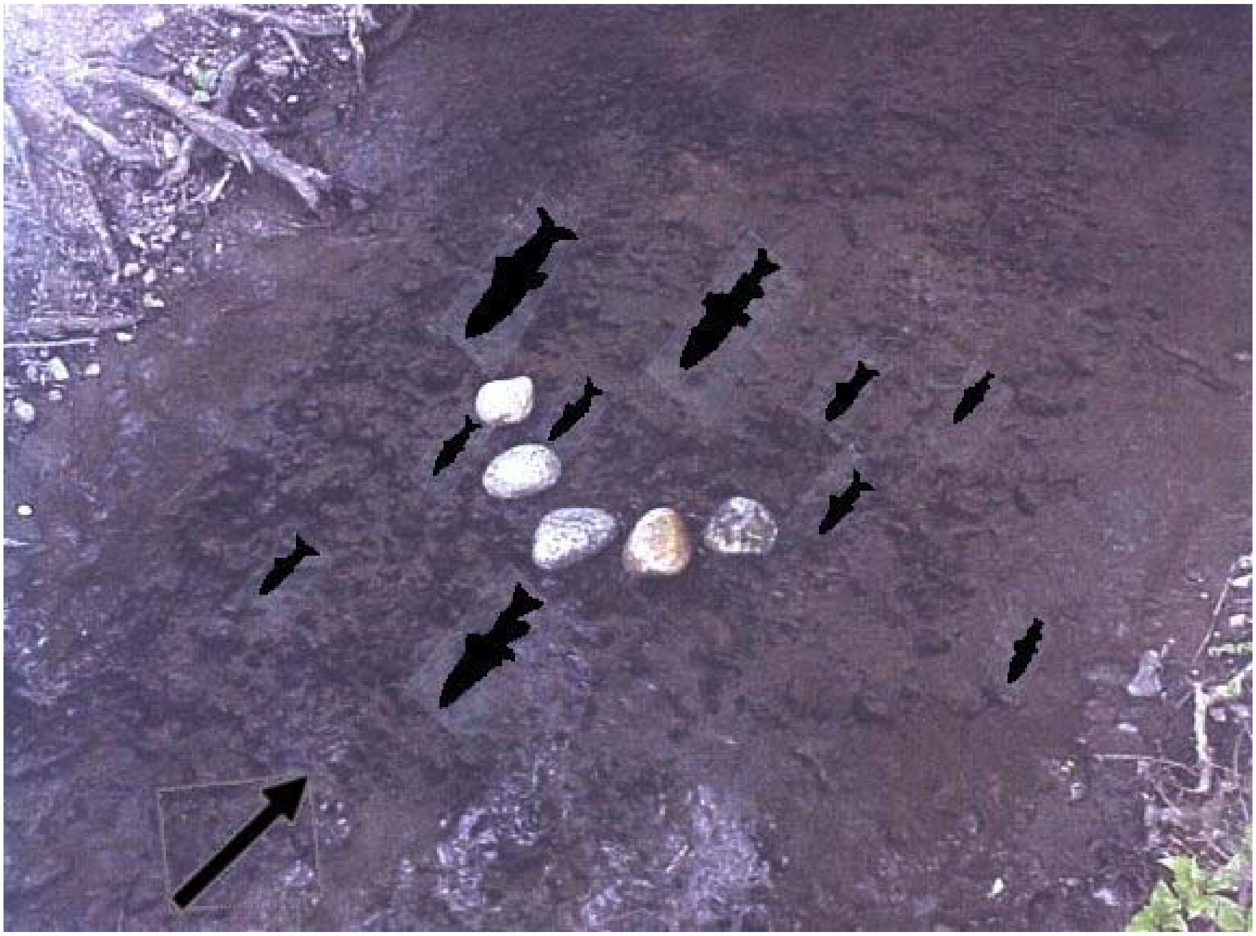


Figure D-4. "The Pocket" MacDonald/Kelly
Excellent cover, resting habitat, and feeding seams (currents).
Five boulders, 2 to 5 tons each, placed close together.

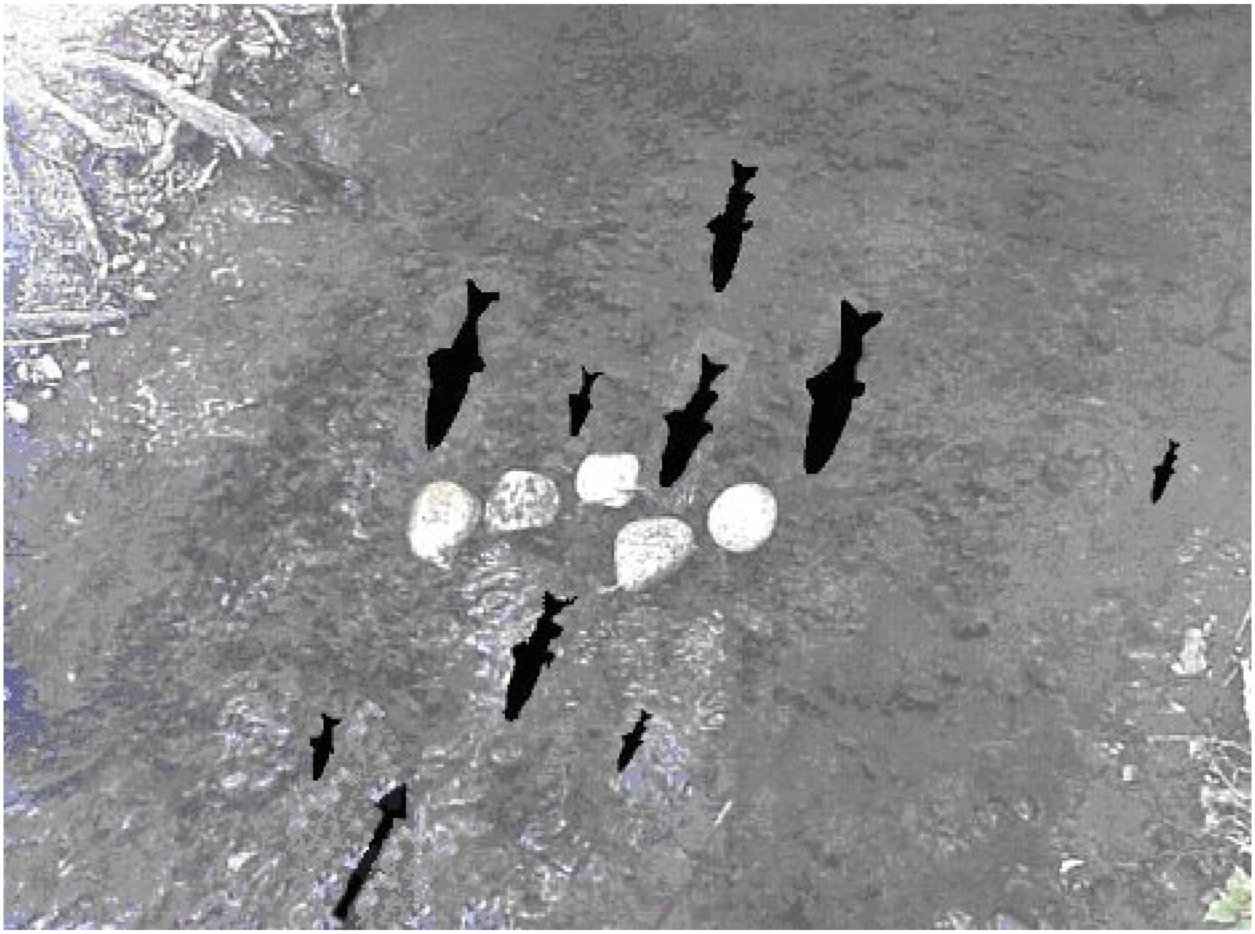


Figure D-5. “Old Mossback” MacDonald/Kelly
Excellent cover and resting areas, and multiple feeding currents.
Five boulders, 2 to 5 tons each, placed close together.

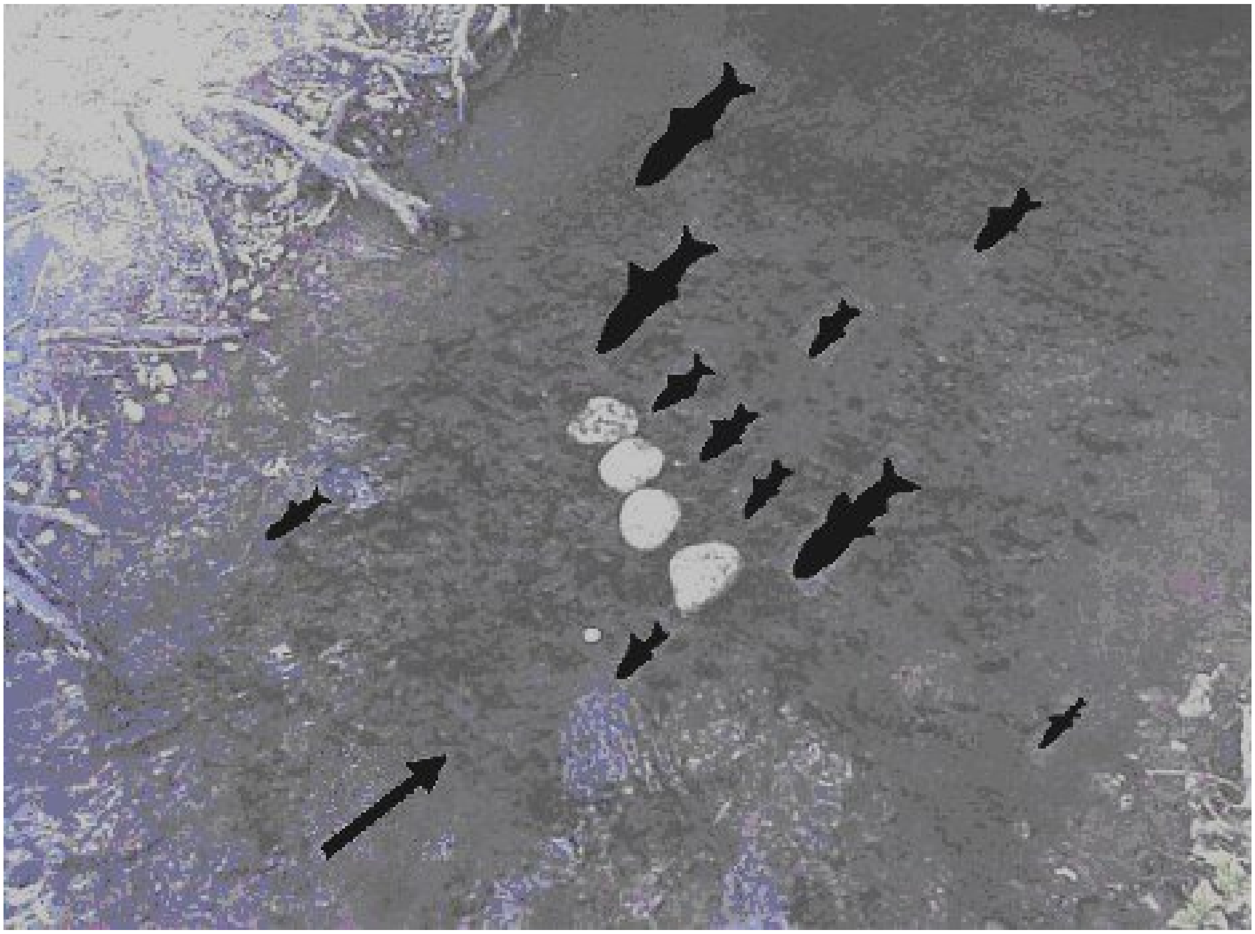


Figure D-6. “The Seam” MacDonald/Kelly

Good cover in front and behind boulders.
One major feeding seam (current) and one minor seam.
Five boulders, 2 to 5 tons each, placed close together.

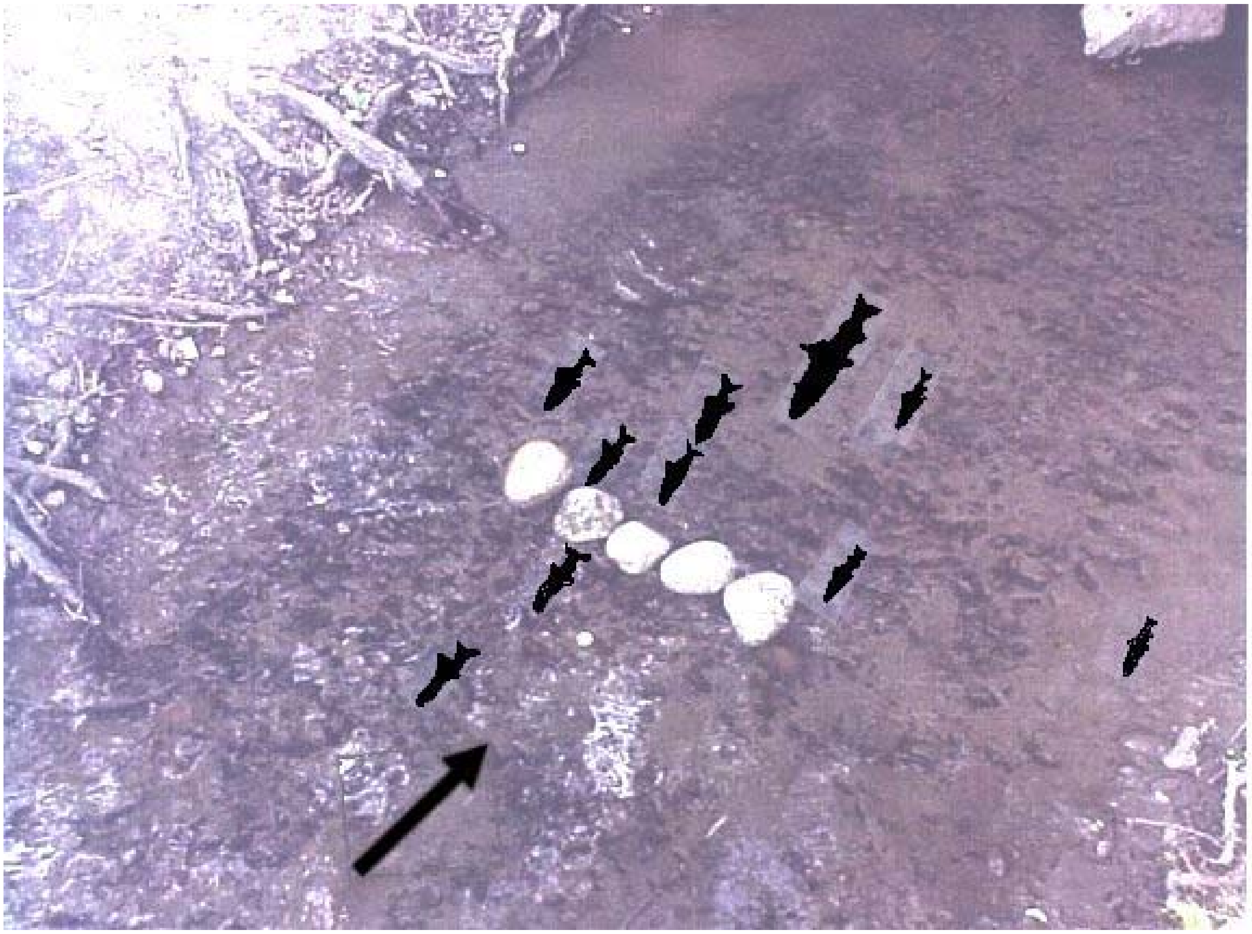


Figure D-7. “Tumble Back” MacDonald/Kelly

Wide band of cover downstream, small area of cover upstream.
Many smaller fish, with one or two large fish.
Five boulders, 2 to 5 tons each, placed close together.

- **Shoreline Protection:** Several areas within the Park system have unique erosion control problems. They are unique because they are in areas of high human usage, and undeveloped areas are not available in enough abundance to correct the problem. A bioengineering fix would not withstand the human pressure. Riprap solutions are aesthetically out of harmony with the Park’s natural corridor goal. Riprap is also hazardous to humans. The sharp angular rock can be unstable to work on, and is also difficult to access from the water. Riprap, for all practical purposes, provides only marginal fish habitat and obstructs the movement of birds, mammals, and amphibians to and from the water.

  The “freestone shoreline” displayed in figure D-7 is intended to mitigate environmental issues associated with shore protection. Difficult eroded banks in areas of intense human usage should be reconstructed using large, individually-placed boulders in a tiered effect. The shore alignment is designed to be natural and diverse. The first row of boulders is placed to establish the new shore alignment. The second, third, fourth, *etc.*, rows are placed to provide a suitable gradient to the top of the bank. Voids between the boulders are filled with soil, and planted with appropriate trees and shrubs. The intent of the tree and shrub plantings is to provide plants that can be used by wildlife and still be in harmony with the park setting. The trees and shrubs also provide a biological handrail for people to gain safe access to and from the river. The roots of the vegetation anchor the boulders, making them a more rigorous structure. The "freestone shoreline" provides an environmentally friendly, sustainable structure.

- **Spawning Graves:** A report on spawning graves, compiled by Wyoming Game and Fish Department, can be found as Appendix H.

- **Freestone Boulder Revetments.** Freestone boulder revetments are constructed with large boulders 3 to 6 feet in diameter or even larger. These boulders, which weigh 2.5 to 10 tons, are relatively inexpensive at approximately $20 per ton. Transport and placement, however, are more costly.

  The boulders are placed using a "track excavator." Backhoes and cranes are not adequate (Mike Peleisser, NRCS). Because of the mass of the rocks, maintenance and structural failure are very low. In most cases, the Corps' Nationwide Permit 13, *Bank Stabilization*, is applicable. Coordination with the county regulatory office in Boise is always encouraged.

  The "freestone boulder revetment" is constructed by placing the boulders along the desired shoreline alignment. The Park is encouraged to create an aesthetically pleasing design. The second row is placed landward until the boulders extend above the high water surface of the river. All voids are backfilled and planted with vegetation appropriate for the location. Photo 12 (in the main report) shows a home with a "freestone boulder revetment." The home is shown on Plate 2-12 in Appendix A. It is located on the right bank, and is identified as a cover type 11.

Appendix E

Tools to Assist in People Management

Marcus Whitman Fencing.

In 1836, the Whitman Mission was established on the Oregon Trail in eastern Washington. As emigrants began moving across the continent into the Pacific Northwest in the 1840s, the mission became an important station on the Oregon Trail. Fort Walla Walla was the next stop on the Trail after Fort Boise.

The Marcus Whitman Mission was founded among the Cayuse Indians. For part of the year, the Indians traveled to buffalo country, the camas meadows, and the salmon fisheries in search of food. Whitman realized that the mission could not fulfill its purpose if the Indians remained nomadic. Therefore, he introduced the Indians to farming, which required that the fields be fenced to protect them from livestock and wildlife. The Whitman design is very simply to construct, yet is rigid in structure (see photos E-1 and E-2). This fencing requires no nails, and can be constructed by volunteer groups and Park staff. It can also be moved quite easily.

Photo E-1. Whitman Fence

Rails are 4” x 4” x 10’
Jacks are 4” 4” x 6’ and are entrenched 12” in the ground.

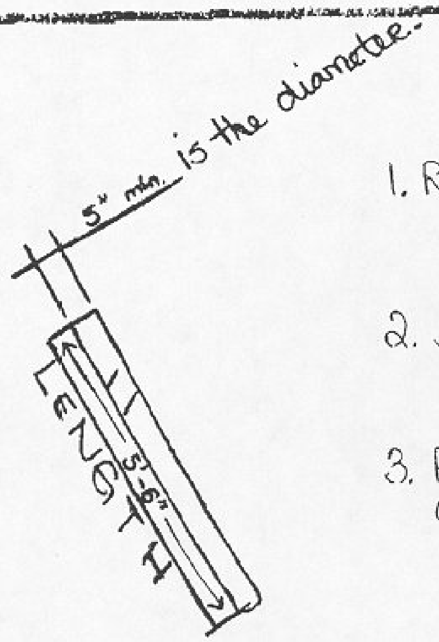
Photo E-2. Whitman Fence

Western Fence Inc.

P.O. Box 385
Rexburg, Idaho 83440

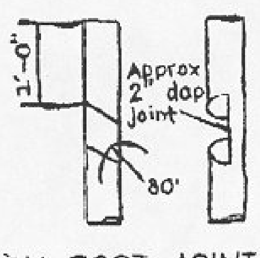
Owner: Glade Wasden
Phone : 208-356-3362
FAX : 208-356-3358

To: Bill MacDonald
Fax #: 509-527-7808
Total # of Pages (including this cover page): 2
Notes: General Buck and Rail



BUCK POST

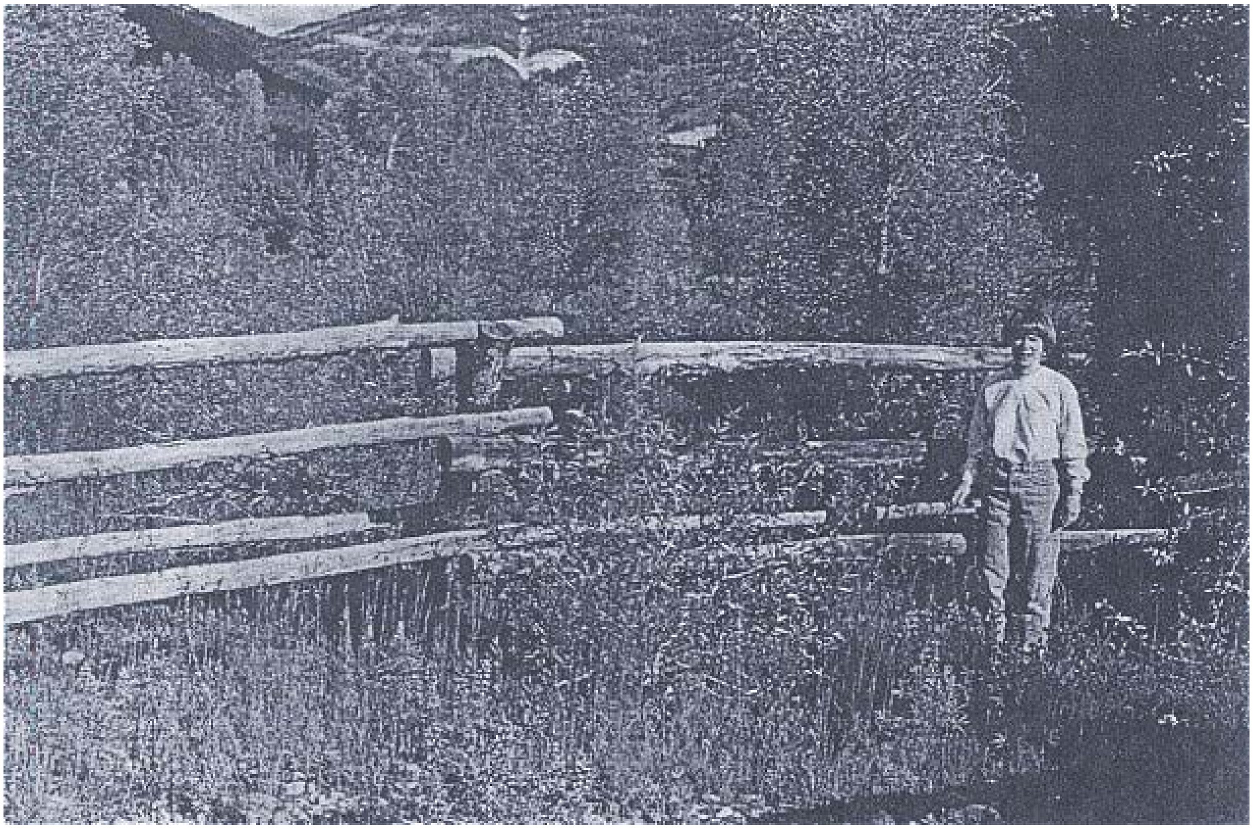
1. Rails: 13' long
   3" Tip min.
   Bark on
2. Jack Post: 5" min.
   5½' long
   Bark on.
3. Fence Stay:
   across bottom of Jack set.
   2"-4"
   Bark on
4. Nails:
   Ring Shank with 3" into Jack Post.
5. Jack Set on 12' center
6. Rails can be as many as you want on Fence.



BUCK POST JOINT DETAIL

?

BUCK POST
NOTCHED



Appendix F

Control of Noxious Weeds

Simplot PARTNERS
10730 Thornmint Road San Diego, California 927127-2411
(858) 675-2585 (800) 552-8873 Fax (858) 675-2588

Weed Control Proposal for Boise Green Belt

Area – 10 miles @ 275 feet or approximately 300 acres
Barber Park to Glenwood

Constraints:

Environmental, Adjacent homes and properties, Boise River, Foot Traffic, Local restrictions

Noxious Weeds Present:

Scotch Thistle
Purple Loostrife
Canada Thistle
Poison Hemlock
Puncturvine
Russian Knapweed

Suggested Programs:

Program # 1 - 1 oz Escort applied in late May (most environmentally soft program)
- Cost with non-ionic surfactant approximately 20.00 per acre

Program #2 - Curtail @ 3-4 quarts per acre (24-D + Clopyralid)
very strong on thistle and knapweeds, bust must be careful around certain trees
cost – approximately 32.00 per acre

Program #3 – 1 oz Escort + 1 quart 24-D (cost approximately 26.00 per acre)

Program #4 – 2 quarts Redeem R& P (Clopyralid + Triclopyr)
- excellent treatment sprectrum - cost approx 30.00 per acre

Bill, This just gives you some options to consider. I'll be in touch soon

Thank you,

Mark Hasquet (208)- 841-5095

Appendix G

Pest Control

1. Canada Goose Management

- **Hunting.** Liberal hunting seasons and increased bag limits could potentially reduce goose numbers. However, post-hunting and mid-summer survey counts conducted in the past by Idaho Department of Fish and Game and the Corps indicate that little impact to the overall populations has been made from an increased fall hunting opportunity in Clarkston, Washington, or Lewiston, Idaho (personal communication with Mike Butler, February 2002). A lengthened hunting season and larger bag limit do at least provide additional recreational opportunities, and could be further developed for disabled and youth hunters.

- **Shoreline Barriers.** Vegetative shoreline barriers, provided they are high and dense enough to limit visual acuity, can discourage geese from entering areas where they would be unwelcome. Without a clear visual sight plane, geese are unable to identify potential predators and are, therefore, unlikely to attempt to stage in these areas for any length of time.

- **Chemical and Trained Dog Usage.** In areas where the use of hunting and additional vegetative management are not possible to control nuisance goose populations (*i.e.*, park areas and golf courses), the use of trained dogs and chemical treatments may potentially keep geese populations under control. Methyl anthranilate is a goose deterrent, and has been used on public parks and golf courses for the past several years. If properly mixed and applied, methyl anthranilate makes green grass taste bitter to Canada geese. Repeat applications are required regularly, however, as irrigation flushes the chemical off of the grass.

- **Egg Addling.** Of all the suggested methods for reducing nuisance goose populations, egg addling (determining and disposing of fertilized eggs) offers the greatest potential, and should be considered in the study area. Egg addling is usually accomplished by spraying the eggs with vegetable oil, which suffocates the embryo; and should only be employed in areas of known concentrations of urbanized Canada geese. It is suggested that a 2-year egg addling program be planned. During this 2-year period, both additional hunting opportunities and egg addling programs could be conducted and evaluated to determine if they are, in fact, creating substantial decreases in the goose population structure (Mike Butler, 2002).

It is suggested that the US Fish and Wildlife Service be contacted to obtain any and all necessary permits for the egg addling program. The Park should take the position that these nuisance geese are several generations removed from a "wild" status, and are essentially non-migratory. It is also recommended that US Department of Agriculture, APHIS, Wildlife Services, personnel accompany Park and/or state wildlife biologists during the spring goose nest surveys in order to assist and monitor egg addling procedures.

2. Beaver Management.

Ada County and Boise Parks and Recreation have tried several methods of managing beavers, including killing, relocation, and spaying and neutering. The number of beavers fluctuates with the food sources. Beavers prefer willows, dogwoods, and cottonwoods for food. Beavers are not territorial if sufficient food is available.

Boise Parks and Recreation has had a beaver management contract for at least 5 years, which appears to be successful. The 1999 contract was estimated to cost approximately $8,000. This cost does not include the volunteer labor needed to wrap several hundred trees in wire mesh each year (Boise Parks, 1999).

The following recommendations, contained in the Parks Master Plan, should continue:

- Beavers should be managed aggressively. To keep the population from expanding and causing more damage, the spay and neuter program should continue. Some beavers should be destroyed. Aggressive management of beavers is necessary of a healthy riparian area is to be re-established and maintained.
- In consultation with biologists and ecologists, an acceptable beaver population level should be determined and a monitoring and control plan devised.
- Beaver management should be a component of the riparian management plan.
- The volunteer efforts to wrap a diverse age class of tree each year should continue.
- The Natural Resource and Conservation Service office in the Wood River Valley of Idaho should be consulted regarding their beaver relocation program.

Appendix H

Spawning Enhancement

WYOMING
GAME AND FISH DEPARTMENT

Jim Geringer, Governor — John Baughman, Director

"Conserving Wildlife — Serving People"

November 23, 2001

Bill

Enclosed are copies of a couple administrative reports relative to Spring Creek rehabilitation, primarily directed to spawning enhancement. The 1997 report is the one I was recalling when I talked with you on Wednesday. I trust they give you helpful information on your gravel questions. In general, the preferred size gravel is found on riffles or crossings that exhibit flows between 1.5 and 3 ft./sec. We try to consider these conditions in our restroration or gravel rejuvenation attempts.

Cheers,
Ralph

Ralph A-Hudelson

Headquarters: 5400 Bishop Boulevard, Cheyenne, WY 82006-0001
Fax: (307) 777-4610 Web Site: http://gf.state.wy.us

WYOMING GAME AND FISH DEPARTMENT

FISH DIVISION

ADMINISTRATIVE REPORT

Title : A History of the Snake River Spring Creek Spawning Tributaries

Author : John Kiefling

Personnel: John Kiefling, Jon Erickson, Ralph Hudelson, Rob Gipson

Date: January 1997

Abstract

The Snake River cutthroat trout, *Oncorhynchus clarki spp.*, is the native trout of the Snake River and its tributaries between Jackson Lake and Palisades Reservoir on the Wyoming-Idaho border. The limiting factors governing the Snake river wild trout fishery are winter flows, instream habitat (Snake River), and spawning gravel availability. Spawning activities are limited in the Snake River proper, and are for the most part restricted to adjoining spring creek tributaries. Cutthroat are recruited to the Snake River from natal spring creeks. In general, cutthroat found North of the Wilson Bridge spawn in the Northern spring creek systems. Conversely, this holds true for those fish South of the Wilson Bridge which generally spawn in the Southern tributaries.

Several studies in the late 1960s were prompted by concern for low densities of spawning cutthroat trout. The stocking of marked fingerlings, sub-catchables, and catchables proved to be unsuccessful. The lack of success in the stocking program, and apparent lack of spawning gravel availability provided initiation of a spring creek rehabilitation project on Three Channel Spring Creek. The success of that project led managers to more imaginative and diverse mechanical rehabilitation efforts on other spring creek systems in the valley. In addition to the mechanical rejuvenation of spawning habitat, the need to renew spawning runs in many of the tributaries led management personnel to stock eyed eggs in select tributaries. The combination of these management tools has been very successful.

Rehabilitation efforts comprised of egg stocking and mechanical rehabilitation have resulted in increased numbers of spawning cutthroat trout. The spawners increased 2.1 to 5.4 times greater than the systems had seen prior to rehabilitation efforts. In two cases, runs were initiated in spring creeks which had no historic spawning runs. The success of the rehabilitation activities had been noted, however, the spring creek systems are dependent upon man for maintenance on an irregular basis. Long-term maintenance of spring creek systems within Teton County will continue to be a problem due to economics and commercial development of riparian lands.

Introduction

The Snake River cutthroat trout, *Oncorhynchus clarki ssp.*, is the native trout of the Snake River and its tributaries between Jackson Lake and Palisades Reservoir on the Wyoming-Idaho border. This variety is different from other cutthroat trout because of its fine spotting pattern and ability to adapt to large river environments. However, DNA studies have indicated the Snake River and Yellowstone cutthroat trout are one and the same, or at least very close cousins.

Jackson Lake Dam serves as a source for irrigation needs in Wyoming and Idaho, and also as a flood control structure. Historically, when the need for water was greatest, huge releases from the dam created flooding conditions in the local valley as many as two to three times yearly. Due to such quick, large releases, the river began to lose its natural flow pattern and over a period between 1910 and 1940 channel expansion, due to lateral erosion became a reality. During flood stage, waters coursing through flood channels and from over-bank flooding would flush the silts and fines from spawning gravels within the spring creek systems and recharge them with new gravels. The army Corps of Engineers constructed a levee system between 1957 and 1964 (23 miles) which now precludes flushing of silts and the recharge of gravels. The levees were designed to control river flow and assist in bank stabilization. The semi-permeable levees have been constructed parallel to the shoreline of the river proper. Jetties, composed of large boulders, have been placed at various locations perpendicular to the bank in order to reduce velocities, protect the bank, and to contain or even change the thalweg of the stream. The present levee design promotes almost annual channelization which will ultimately determine the quantity and distribution of fish within the system.

The limiting factors governing the Snake River wild trout fishery are winter flows, instream habitat (Snake River), and spawning gravel availability. The maintenance of the blue ribbon wild trout fishery is wholly dependent upon the spawning habitat in the spring creek tributaries.

Spawning activities are limited in the Snake River proper, and are for the most part restricted to adjoining spring creek tributaries. The active spawning tributaries can generally be divided into two distinct groups based upon spawning period and area of recruitment. The division of spawning tributaries includes those north of the Wilson highway bridge, and those located south of the bridge (Figure 1).

The major tributaries located north of the Wilson bridge are Lower Bar BC Spring Creek, Three Channel Spring Creek, Blacktail Spring Creek, Upper Bar BC Spring Creek, and Cowboy Cabin Creek. In general, spawning occurs in these tributaries in May and June. Novak (1989) noted no spawning activity was observed North of Deadman's Bar.

Although the confluence of Fish Creek lies below the Wilson Bridge, its headwater is north of the bridge, and its spawning period coincides with the other northern tributaries. Tag returns, however, indicate Fish Creek progeny contribute to the segment of the Snake River below the Wilson Bridge.

Those tributaries of significance located south of the bridge are Blue Crane Creek and Spring Creek. In addition, spawning habitat has been enhanced in two small spring streams, Cody and Lamb Springs creeks. Spawning in this reach of the river is generally in April and May. The progeny of these fish largely recruit to that segment of the Snake River below the Wilson Bridge.

Initial investigations of spawning tributaries (Blue Crane, Lower Bar BC, and Fish creeks) within the Snake River system was conducted by Hayden (1967). These studies were prompted by concerns for low densities of spawning cutthroat trout.

Hayden found:

- Age I and II cutthroat trout comprised 46% of downstream-migrating fish in Blue Crane Creek.
- Snake River cutthroat trout have a strong homing tendency.
- Simon (Hayden 1967) indicated the run of spawning cutthroat trout in small spring-fed Snake River tributaries begins in mid-March, and that the time of spawning depends on the altitude and the consequent differences in water temperatures. Hayden did not correlate run timing with temperature characteristics of these streams, but he did note the mean water temperature in all three tributaries were at least five degrees F above the winter minimum temperatures before the spawning runs began. Cope (Hayden 1967) reported temperature characteristics in the Yellowstone Lake tributaries correlated with the timing of migration, but also indicated that the difference in timing may be due to genetic factors. Hayden further identifies differences in physical coloration between Bar BC and the Blue Crane-Fish Creek fish. He also suggests such differences may also reflect genetic diversity, and that genetic factors may be dictating maturation and period of spawning.
- Spawning cutthroat trout preferred gravels which varied from one to two and one-half inches in diameter.
- Egg pockets were usually covered by six or eight inches of gravel and two or more egg pockets were found per redd.
- Eighty to 90% of the spawning is by age III and IV Snake River cutthroat trout.
- Snake River cutthroat trout exhibit a 50% post-spawning mortality rate.
- Nearly 10% of the spawners are consecutive spawners, while other studies noted 3 to 7% were consecutive spawners. Alternate year spawners returned in greater percentage than did consecutive spawners.
- Hayden suggested continuation of releasing fin-clipped hatchery-reared fingerling cutthroat trout in Fish and Bar BC Spring Creek.

A total of 355,792 fingerlings and 14,183 sub-catchable/catchables were stocked in these tributaries between 1955 and 1974. This program proved unsuccessful when the marked fingerlings failed to recruit to the spring creeks upon maturity.

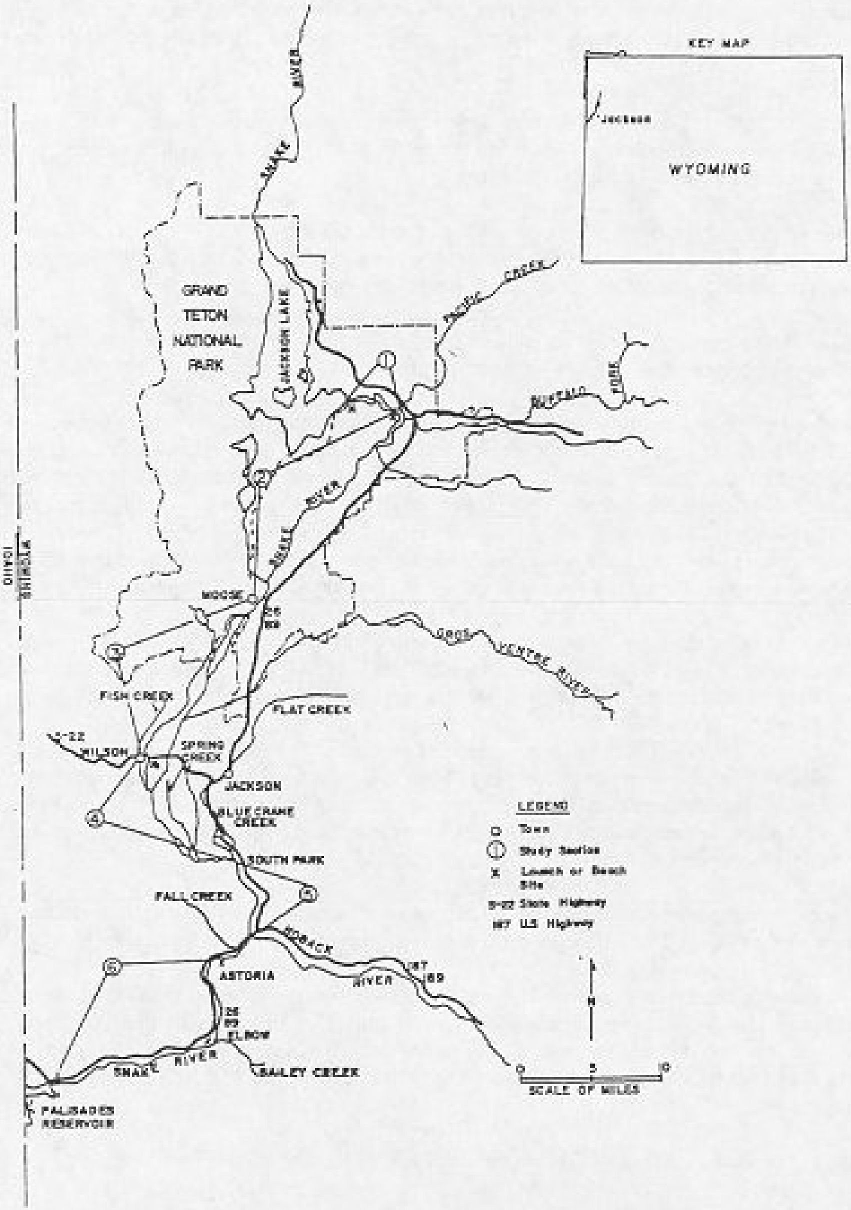


Figure 1. Snake River study sections and general tributary locations.

Three Channel Spring Creek.

In 1970, redd counts were conducted on several spring creeks. Three Channel Spring Creek was selected for intensive spawning channel improvement to determine the potential to increase and stabilize the spawning run with eyed egg plants. This study initiated the overall understanding of the needs of the spring creek systems and helped develop the current management ethics for same.

Redds were mapped on Three Channel Spring Creek and counted to determine the status of present use and set standards for future trend information. This spring-fed tributary system enters the Snake River from the East, while its confluence lies immediately upstream from that of the Gros Ventre River (Figure 2).

This spring creek system is surrounded by private property with limited public access. In 1970, the riparian habitat received heavy livestock use. The creek also receives overflow irrigation waters. Habitat has been considered marginal to good, with much of the stream composed of compacted cobbles with limited spawning potential.

The system is stable and, like all spring creek systems, is not influenced by run-off. Such stability has drawbacks when considering no spring flows means no cleansing of silts, nor recharge of gravels within the system.

Early redd count data indicated spawning was largely centered on the East Fork with lesser activity noted on the upper section of the Middle Fork. In 1970, redds were counted and mapped to determine relative abundance and use patterns within the system. A total of 38 redds were found in the East Fork, and 17 in the Main and Middle Forks. An estimated 50 and 112 cutthroat were utilizing the Main, Middle and East Fork respectively. Further observations indicated cutthroat were using all of the gravel riffles available and in many cases there was serious superimposition of redds (Erickson 1980). Eyed egg stocking was not deemed a feasible alternative since the present spawning areas were being used to the fullest extent. As a result, it was decided to rejuvenate the riffles void of gravel and provide additional spawning habitat.

The initial improvement work was done on the Main, Middle and West Forks of the system which exhibited the least amount of spawning. Initial excavation showed spawning gravels ranging from 0.25 to 3 inches in diameter underlay the compacted cobble rock stream bottom. The initial habitat rehabilitation started when a pool was excavated across

the width of the stream (approximately 30 feet), and the excavated gravels were spread immediately downstream of the pool to construct a spawning riffle. Three sites were constructed in 1971 in which the average pool depth was 5 feet while the width was approximately 10 feet. This produced a riffle with an average width of 18 feet and a depth of nearly 6 inches. Dead and down trees were placed in combination over the pools for cover. The large cobble was hand-picked from the gravel bed leaving only the better gravels exposed.

The newly constructed redds were used the following spring, and produced an increase of $\geq$200% in redds. From this point, a variety of rehabilitation methods and effort were developed to compliment the initial habitat measures.

Most notably, 9 sites were stocked with 125.2 tons of commercial washed gravels and developed as spawning riffles. Each new riffle was made by excavating a shallow hole approximately one foot in depth, then filling it with the commercial gravels. In some instances new gravels were dumped and spread over natural gravels to simply recharge the section. An additional 110.8 tons of gravel were used to construct five new spawning riffles in 1979, and 41.2 tons of commercial gravels were stocked in 1980.

The number of redds increased in the Main Fork over 4,100% in ten years (Table 1). The Middle Fork and the East Fork of Three Channel Spring Creek increased similarly as a result of habitat enhancement, gravel rejuvenation, and use of commercial spawning gravels.

In general, the increased number of redds was believed indicative of improved spawning conditions (Kiefling 1984). The better distribution of spawning cutthroat trout should decrease the superimposition of redds resulting in decreased hatching mortality, and increased recruitment of cutthroat trout fry to the Snake River. Increased survival means increased stock density in the river proper. It is believed the increased number of fry did not experience excessive mortality after entering the Snake River proper. If the density levels of mature cutthroat in the river had been stable, the mortality of fingerlings entering the system would be significant. If this was the case, the return of mature fish in spawning runs would not have increased appreciably. This spawning habitat rehabilitation procedure has since been used on many of the spring creek systems throughout the valley.

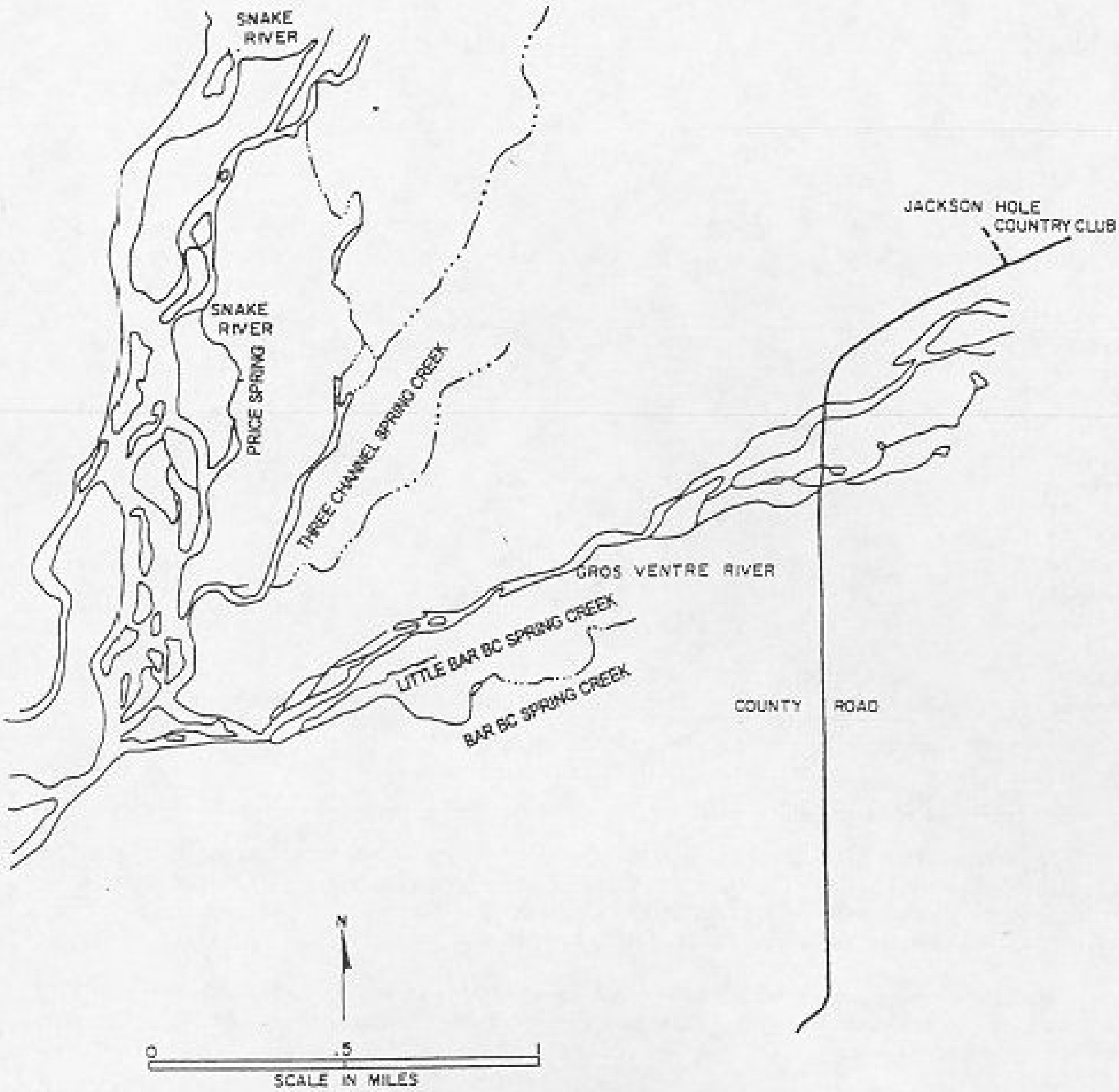


Figure 2. The northern spawning tributaries of Bar BC, Little Bar BC, Three Channel, and Price Spring Creeks.

5

Little Bar BC Spring Creek.

The proof-in-the-pudding in regard to the potential for the habitat work on other tributaries, and just how strong the homing tendencies in cutthroat are exemplified by similar work in a small tributary found near the Three Channel Spring Creek system, Little Bar BC Spring Creek. Little Bar BC Spring Creek is located immediately south-east of the Three Channel Spring Creek confluence (Figure 2). The confluence of Little Bar BC Spring Creek is located approximately one-quarter mile upstream from the Lower Bar BC

Table 1. Total number of redds and estimated minimum number of spawning cutthroat trout as determined by redd size, Three Channel Spring Creek, 1970-1980.

				YEAR							
SECTION (Length /Ft.)	*1970	**1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
East Fork (4,353)											
No. Redds	38	57	35	44	56	26	77	69	60	51	81
No. Spawners	103	154	95	119	151	70	208	186	162	138	219
Main Fork (2,315)											
No. Redds	2	6	20	16	23	64	65	65	80	76	85
No. Spawners	5	16	54	43	43	62	173	176	216	205	230
Middle Fork (1,482)											
No. Redds	5	7	13	6	10	11	39	44	32	26	41
No. Spawners	14	19	35	16	27	30	105	119	86	70	111
Middle Fork I (1,945)											
No. Redds	10	14	18	12	18	14	40	47	31	26	28
No. Spawners	27	38	49	32	49	38	108	127	84	70	76
Totals (10,095)											
No. Redds	55	84	86	78	100	74	220	225	203	179	235
No. Spawners	149	227	223	210	270	200	594	608	548	483	636

*Pre-improvement ** Initial Improvement (Main and Middle Forks)

confluence with the Gros Ventre River. It isn't an important spawning tributary, but was very important in depicting the success of applied habitat work on Three Channel Spring Creek. The creek originates from small springs that surface west of the Spring Gulch road, and flows in an old Gros Ventre River high water channel which is now protected by levees. The creek had limited spawning gravels, with less than 5 redds observed at any one time.

The average width of the stream is approximately 6.0 feet, and excluding a few pools, is only a few inches deep. In 1974, heavy equipment was used to excavate two holes and construct gravel riffles immediately downstream. Five riffles were also made with rejuvenated spawning gravels which were on site.

In one of the new riffles at the upper end of the creek, eggs were placed in a man-made redd. A small section of the open end of a barrel was placed over the hole to create an eddy and alleviate the flows from stacking up the eggs in hatching baskets. As each basket was filled with eyed eggs, it was placed into the hole, suspended from the bottom with a few large rocks, and covered with gravel. After each hatching basket was covered with gravel, the barrel section was removed. Four years later, cutthroat spawned on the same man-made riffle. That was the beginning of an intensive habitat restoration and eyed egg stocking program in the Snake River spring creek systems.

In 1975, 1976, and 1981, a total of nearly 213,000 eyed eggs were stocked in the upper gravel riffles of the creek. Significant runs developed by 1982, and record runs were noted in 1985. The total number of redds mapped in 1985 was 36, which represents an estimated minimum of 54 spawning pairs.

The size of the run was severely restricted with the loss of the lower one third of the channel due to flooding from the Gros Ventre River.

Blue Crane Creek.

Perhaps the most extensive system-wide approach to treating the spawning habitat was initiated in the Blue Crane-Spring Creek complex (Figure 3). The biological objective of this project was to rejuvenate and improve spawning gravel availability, and to re-establish historical spawning runs

From 1945 through 1955, an average of over 800 cutthroat spawners utilized this system from February through June. Channel changes near the confluence of Blue Crane Creek in 1956 blocked spawning runs to the tributary for a period of 5 years. An entire generation of spawning cutthroat trout was lost. This condition provided the impetus to improve access to this important spring creek system.

In 1961, a fish ladder was constructed at private expense with the technical advice of the Wyoming Game and Fish Department to re-establish the former spawning run. Although spawning cutthroat trout utilized the fish ladder, the numbers of trout using the system had dropped to approximately 200 fish during the months of April and May. Apparently the early spawning strain previously using the tributary had been lost.

In a further attempt to re-establish the early spawning strains of native trout to this system, the fisheries management crew initiated an eyed-egg stocking program in the headwaters of Blue Crane creek. It was hoped, by stocking the eggs in the upper reaches, there would be a greater chance of genetically engineering the run of fish to penetrate the system as high as possible. There are a number of natural conditions which would impede the return of spawning trout to the initial stocking area. The waters above this point have several reaches in which there are shallow riffles, and little overhead cover. Approximately one-quarter mile below the stocking site,an irrigation structure can impede upstream movement, while still allowing for drift of fish downstream. This nearly three mile journey would be a thorough test for the returning trout.

Although there are many theories of migratory cause and effect, research indicates eggs planted at the eyed stage become imprinted with the various trace elements in their environment. Those elements found in a dissolved state then imprint the fish as they are developing, and facilitates the return of these fish as adults to their natal waters. Crew personnel decided upon an 8 year (two generations of fish) experimental egg stocking

program. It was believed an 8 year program would provide enough mature fish for a natural spawning run to develop and sustain eventual recruitment.

The availability of excess eggs and the experimental nature of the project was the incentive for the use of eyed eggs in the system. The use of eggs included those from an early running strain of cutthroat taken from Nowlin Creek on the Nation Elk Refuge, State brood sources (Auburn and Dubois hatcheries), and from the Jackson Federal Hatchery. The brood stocks for these particular fish was established in 1955 using eggs from the same gene pool as originally found in the Spring Creek proper. Unfortunately wild stock was so limited that the pursuit of a wild source of eggs was dropped.

The egg stocking program then became a research project. The state hatcheries became aware of our egg project and were quick to let us know there were significant numbers of eggs available which would otherwise be disposed of, and crew personnel decided to utilize whatever were available in the winter and summer. In addition, the intent to re-establish the early spawning runs with eggs taken in January was the primary interest, and the availability of later run eggs in July were of secondary interest. The thought that we could possibly establish a multifaceted spawning effort also came to mind, and crew personnel took whatever eggs that were available. In doing so, we took the good with the bad. Egg stocking records show a net total of 3,017,595 Snake River cutthroat trout eggs were stocked in January, and 1,046,208 were stocked in July during the eight year period. During the period of 1980 through 1989, a net total of over 4,000,000 eggs were stocked in the headwaters of Blue Crane Creek.

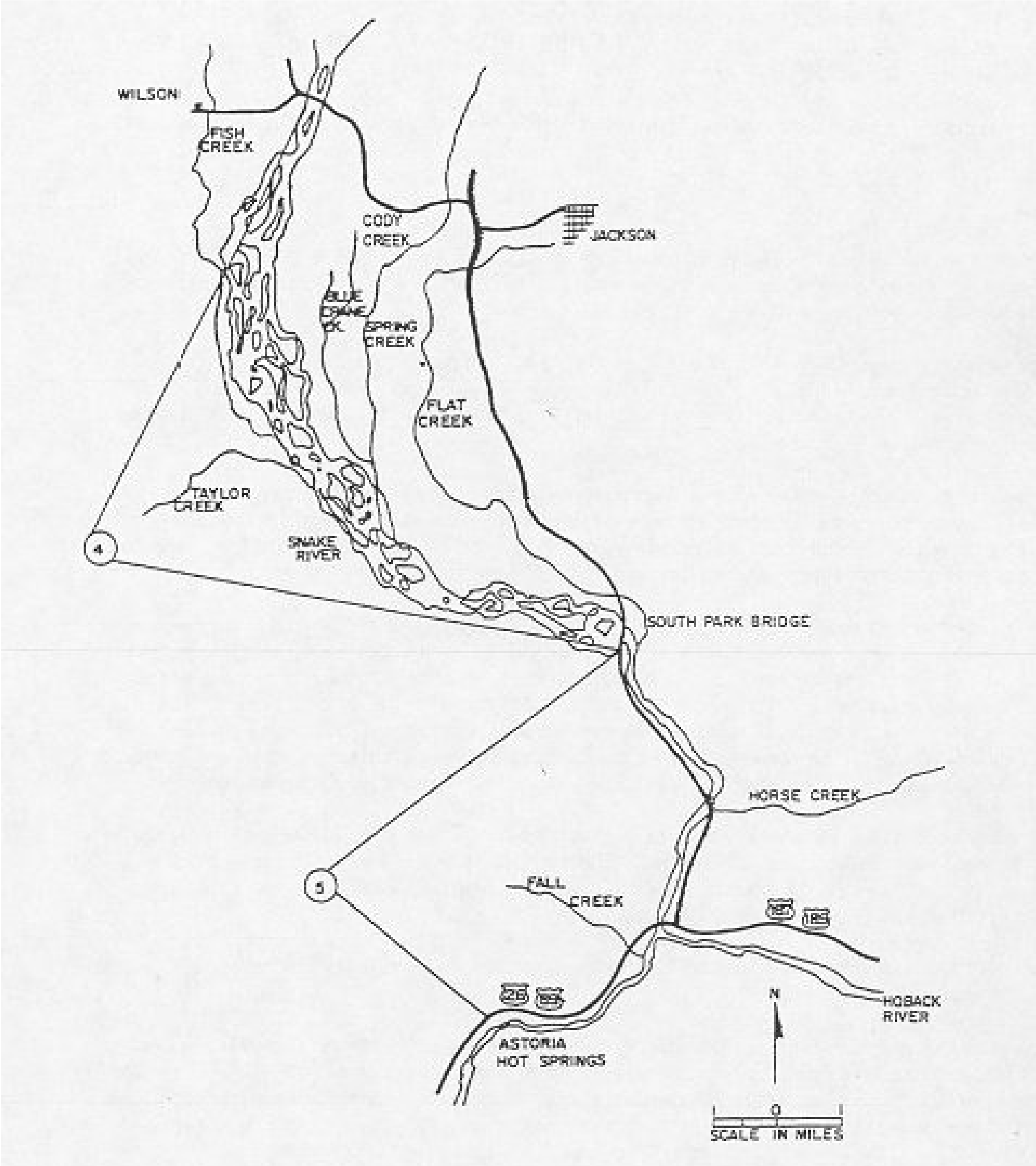


Figure 3. Blue Crane, Spring, Cody, and Fish creeks.

As many research efforts go, the rather unstructured nature of the project was exemplified by a wide variety of methods employed in stocking eyed eggs.

Early stocking in the East Fork of Blue Crane Creek was problematic due to a combination of low flows, warm water, and periodic oxygen lags. To overcome these conditions, an upstream V and a wide drop-over sill log were built to increase oxygen levels. However, the flow rates were too low to increase the oxygen levels. In addition, the Department Water Quality Lab conducted chemical analysis to determine the presence of heavy metals or other such limiting factors in this segment of the creek. Although no additional limiting factors were identified, this segment of the creek was abandoned to further egg stocking in 1984. The emphasis on egg stocking was then shifted to the West Fork.

The West Fork efforts were also found wanting due to low flows and space to install the egg troughs. The stocking program was moved 100 yards to a crossing with a cobble spill area in the main fork. The troughs were placed on a newly constructed (1982) gravel riffle found immediately below the cobble spill. The cooler water, increased flows, increased oxygen level, and use of hatching troughs, accounted for an immediate decrease in hatching mortality levels. The hatching mortality at this site ranged from 1.0 to less than 0.08%.

The end result of the eyed egg stocking program on the recruitment level of the migratory spawning fish is readily apparent. When comparing the basic redd count data from Blue Crane Creek, with the numbers of eggs stocked during the project (Figure 4), the modes depict significant increases in the numbers of spawning cutthroat trout in the period 1989 through 1992 (Table 2). This was in direct response to the heavy egg stocking from 1982 through 1989. The doubling of the spawning run could also have been attributed in part to the large scale habitat treatment of Blue Crane Creek and the adjacent Spring Creek system in 1985, in which commercial gravels were used to construct eight additional spawning riffles. In essence, the new gravels provided new spawning opportunity for migrating fish.

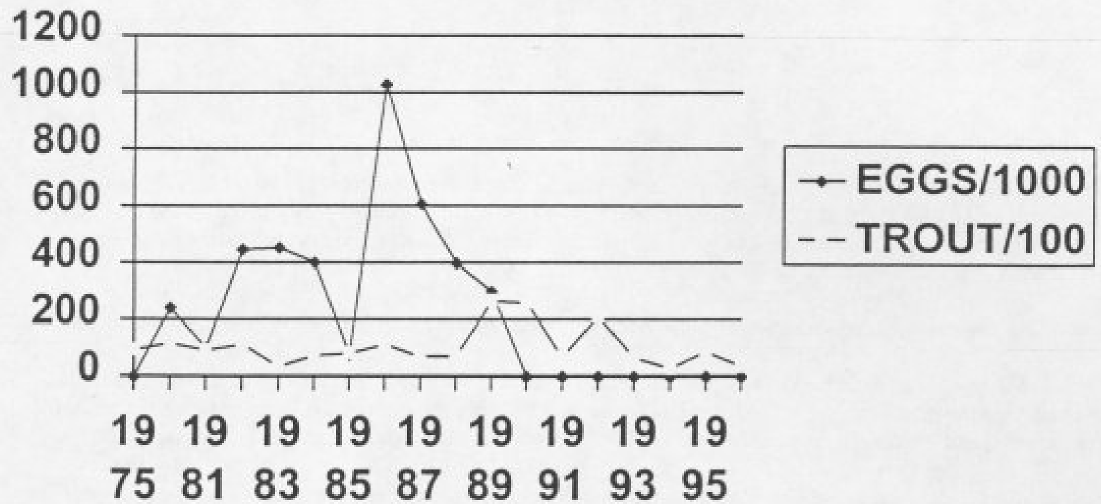


Figure 4. Comparison of cutthroat trout spawning density levels in regard to eyed egg stocking, Blue Crane Creek, 1975 through 1995.

Initial redd counts and electrofishing samples indicate the 1985 rehabilitation efforts on both Blue Crane Creek and Spring Creek were successful. The Blue Crane redd counts increased significantly in April of 1986, while the May counts were nearly the same, which may be a preliminary indication of the redevelopment of an early spawning strain of cutthroat trout. Newly rehabilitated spawning riffles were in use. Of major significance, was the presence of one redd immediately adjacent to the spawning troughs. Habitat restoration activities in the way of channelization and resting pools enabled these spawners to negotiate sections which were formerly inaccessible and to use an artificial riffle built (1981) with commercially washed gravels.

Table 2. Blue Crane Creek redd count data, 1975 through 1996.

Year	Number of Redds Mapped	Est. Minimum No. of Pairs	Est. Min. Total No. of Trout
1975	14	47	94
1976	23	36	72
1977		No Counts Made	
1978	19	45	90
1979	10	42	84
1980	26	59	118
1981	17	46	92
1982	30	57	114
1983	18	17	34
1984	21	37	74
1985	30	41	82
1986	34	57	114
1987	31	35	70
1988	18	35	70
1989	87	133	266
1990	91	130	260
199	15	34	68
1992	60	106	212
1993	25	33	66
1994	12	14	28
1995	30	44	88
1996	31	18	36

Compounding the analysis further is the density independent factor of water, or lack thereof. Drought conditions were prevalent in the area from 1988 through 1993, which affected the water table and resultant flows in the spring creeks during the spawning period. The seasonal lack of water in specific reaches of the spring creeks precluded some movement and spawning in the upper-most segments of the system.

The treatment of the system which provides viable gravels for spawning cutthroat was conducted in September of 1985.

A hydraulic track hoe was utilized during the construction period to treat 76 sites totaling 10,577 linear feet (2.0 miles). This project comprised the rehabilitation of 24 riffle sites for a total of 17,186 square feet, the construction or rehabilitation of 31 associated pools, and the development of 21 runs (374,757 square feet) to provide improved fish passage.

Blue Crane electrofishing data indicate a significant increase in all aspects of the fishery (Table 3). Young-of-the-year fish habitat was greatly improved by silt removal which seemed to increase watercress understory areas affording greater protection from predators.

Table 3. Summary of number of trout collected by electrofishing, Blue Crane and Spring Creek, October 1895 and 1986.

Water	Year	Less Than 6 Inches	Greater Than 6 Inches	Station Length (Ft.)	Remarks
Blue Crane	1985	36	10	743	
	1986	153	27	743	
Spring	1985	0	14	339	6 sculpin; 2 dace
Creek	1986	32	18	339	Numerous

Spring Creek.

Thirteen sites on a segment of Spring Creek were also treated with a trac hoe in 1985 (Figure 3). This work entailed the rejuvenation of natural gravels which were compacted with silts, and were no longer available for spawning. During the fall of 1986, heavy equipment was utilized to treat 328 sites along the lower 5 miles of the creek. Treatment comprised the development of 148 pools, the rejuvenation of gravels at 113 sites, removal of silt from 51 areas, the channelization of 13 sites to allow greater migratory movement of spawning cutthroat, and the placement of commercial washed gravels in three locations.

The Spring Creek renovation activities were equally impressive (Table 3). There was a dramatic increase in fingerling cutthroat and small non-game fish. In 1985, the 14 cutthroat trout greater than 6 inches in length noted in Table 3, were found in one pool and were believed to represent nearly all of the trout in that segment of the stream (1.5 mi.). The presence of fingerling cutthroat trout was the result of development of spawning sites constructed in the 1985 rehabilitation work. Redd counts on this segment accounted for a minimum-maximum estimate of 31 to 57 pairs of spawners where no redds has been observed since the late 1950s. The success of the rehabilitation effort in this reach was demonstrated by electrofishing data collected from the HQI segment in which no fish had been observed prior to the habitat modifications. Seber method population sampling indicated the point estimates to be 47 trout, or 739 trout per mile. Migrating cutthroat trout found spawning habitat and an uninhabited segment of creek which they quickly occupied.

The increased availability of spawning habitat in the Blue Crane-Spring Creek complex resulted in the increased use of gravel. As a result, increased numbers of young-of-the-year cutthroat trout where also noted in large numbers where none had been found.

Within a 6 year period the habitat work was degrading due to increased siltation, and loss of spawning gravels. Gravel loss can be attributed to spawning activity, and physical displacement by migrating elk and summering cattle. Now, the lack of flushing flows and gravel displacement have resulted in a system in need of more habitat rejuvenation.

Cody Creek.

This small tributary lies between Spring Creek and Blue Crane Creek (Figure 3). It enters the upper section of Blue Crane Creek. Like many of the spring creeks in the valley, this one is little more than an irrigation system. This creek held some spawning potential and provided limited recreational fishing opportunity. The Cody Creek rehabilitation project was first proposed in 1991, and finally became a reality in 1994. The project was sponsored by the Oliver Estate, Jackson Hole Trout Unlimited, and the Wyoming Game and Fish Department.

Mrs. Emily Oliver provided access to the property, heavy equipment, and personnel to operate the equipment. Trout Unlimited funded the purchase and transport of commercial gravel. Fisheries personnel processed the necessary permits, mapped the creek, provided technical assistance, and coordinated the construction activities. Adjacent landowners provided access to their segments of the creek and constructed new fence gates for project access.

A total of 17 spawning riffles were constructed in the 1.5 mile study section. In addition, 27 pools and 20 small boulders were also developed in the creek. Several dead and down trees were used for overhead cover and the screening of riffles from excessive use by elk. After construction activities, the banks were re-seeded after the first snow fall to promote early growth and bank protection.

The following year the physical scars had disappeared, and although no redds were found, a limited number of mature cutthroat have become established within the creek system.

Trout Unlimited constructed, and donated two ice-box incubators for stocking eyed eggs. In 1995, a total of 50,000 Snake River cutthroat trout eyed eggs were the first in an 8 year series. Even though the development of sustained spawning runs are not anticipated until 1998 or 1999, four redds were found in the system in 1996, representing a minimum of 6 pairs of spawning cutthroat.

Even though this is a small system, the development of any plausible spawning sites is, and will be, a necessity in the maintenance of wild Snake River cutthroat densities in the future.

Fish Creek.

Many of the spring creek rehabilitation efforts are quite simple in scope and have been conducted by the landowners. One such effort was conducted on the upper reach of Fish Creek (Figure 3). Fish Creek enters the Snake River from the West bank some 3.5 miles south of the Wilson Bridge. The upper reach of this small spring creek flows through active pasture lands, and the banks were impacted by overgrazing. The riparian lands were characterized by sloughing banks, overgrazed willows, and impacted gravel crossings. The landowner contacted crew personnel about the fishery and its maintenance. The fencing of the riparian area was suggested as a first step, and additional habitat rehabilitation efforts were mapped for future activities.

Interestingly, this section of the creek and the magnitude of spawning activities therein, were not known to the crew prior to contact from the landowner. The initial redd counts on this segment of Fish Creek put estimates of the number of spawning cutthroat trout at approximately 180 to 200 fish.

An electric fence was installed along the riparian area in 1985. Before then, the banks could be easily accessed and walking posed no problem. The banks became nearly impenetrable by 1987, and it became a chore to walk the banks and make redd counts. With the re-growth of the willows along the creek bottom, the regeneration and repair of the banks followed quickly. Although there was no overt problem with the availability of spawning gravels, the activity of grazing cattle had put the future of the fishery in question. The fencing not only led to the recovery of the riparian area, but also kept the cattle from displacing and impacting the riffles during the spawning period. The estimated total number of spawning cutthroat nearly doubled by 1989, with a range of 407 to 553 by 1993. This small investment paid off significantly.

Additional habitat enhancement activities were conducted by another landowner in a reach of Fish Creek downstream of the town of Wilson. Landowner contact in 1972 resulted in habitat improvement techniques and suggestions for his consideration. The landowners processed the necessary permits and initiated the improvement project in 1973. A culvert was placed in a channel plug to provide flow to a dry high water channel. In addition, four low profile dams were constructed in another shallow high water channel. Several pools were constructed in Fish Creek proper, and two small low profile dams were constructed on a tributary spring creek. Between 1973 and 1981, spawning riffles and pools were constructed within the spring creek systems adjacent to Fish Creek proper. The landowners indicated their interest in the eyed egg stocking program to increase spawning activities in the rehabilitated spring creek sections.

Crew personnel had initiated a fingerling stocking program in 1966 to increase the spawning runs and stock density levels. The program proved ineffective and was discontinued in 1972. The availability of gravels and willingness of the landowners to conduct the eyed egg stocking program resulted in providing 30,000 excess eyed eggs. The landowner provided an ice-box incubator and has been conducting the program since 1991. Numerous spawning sized cutthroat trout were noted in the improvement area in 1996. The ranch manager had not previously seen redds in the small spring creek segments where habitat improvement activities were conducted. Numbers cutthroat spawners and numerous redds were noted. Ranch personnel did not attempt to quantify spawning activities. Crew personnel have been on site during rehabilitation efforts and can account for spawning cutthroat being present in segments where they were not formerly found.

Lamb Springs Creek.

Lamb Springs is another small spring creek system found in the lower reach of the Snake River between Astoria Hot Springs and Elbow (Figure 5). Access to the creek is through private property, while the creek itself lies on Forest Service lands. Historically, very limited spawning was noted in this tributary. Fishery biologists recognized the limited spawning potential of the this tributary, but also believed the development of any additional spawning within the system is needed as an investment in the system as a whole. The initial project development was finalized in 1990 and completed in 1991. This project was co-sponsored by the Forest Service, Trout Unlimited, and the Wyoming Game and Fish Department in cooperation with the landowner.

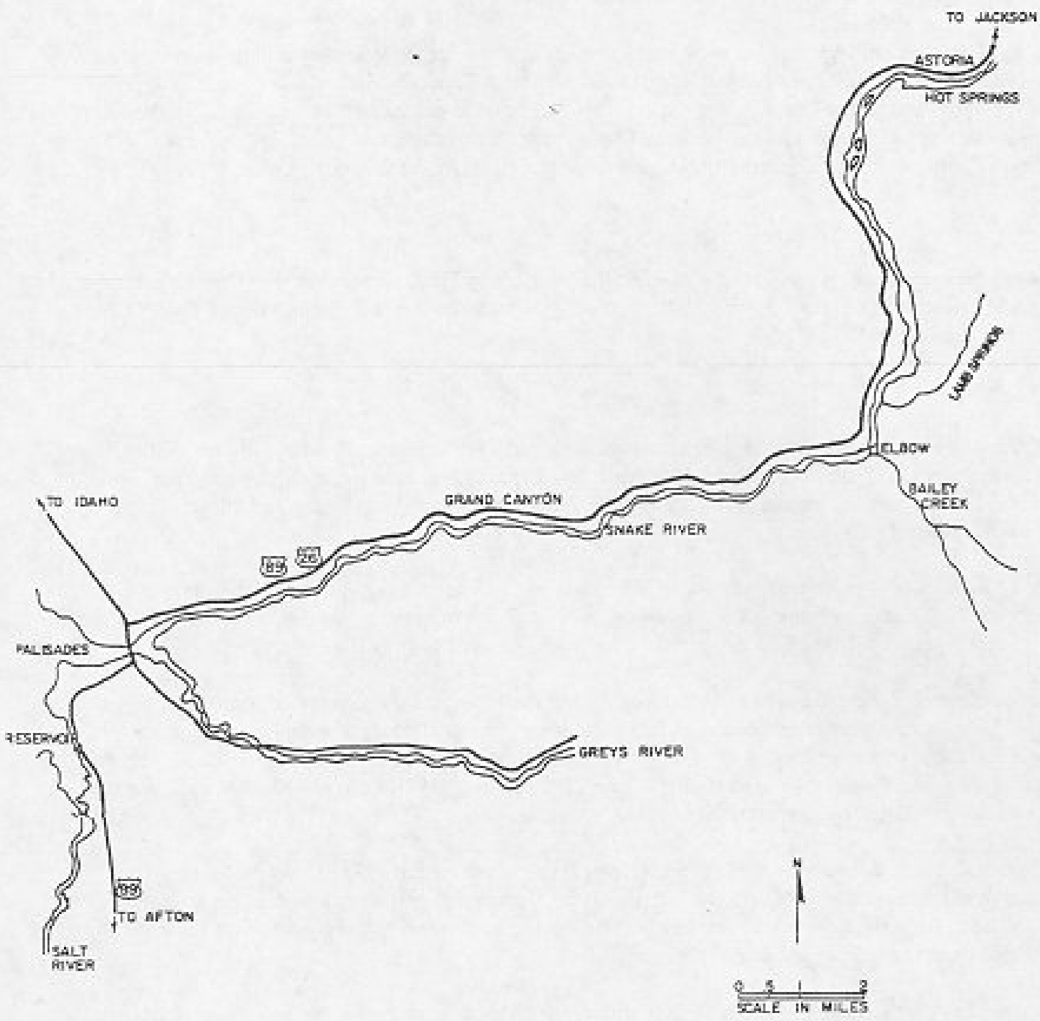


Figure 5. Lamb Spring Creek is found in Snake River Canyon.

Rehabilitation efforts were consistent with other spawning construction. Riffles were constructed and pools were excavated in the channel proper. Channels which had been filled with silts and choked with vegetation were cleaned for fish movement. A total of 22 holes and 14 spawning riffles were constructed with over 25 tons of commercially washed gravels. In addition, work was conducted on a side channel to alleviate the threat of flooding from the Snake River proper during high water. Tree revetments and rock weirs were among the features used to address the potential flood threat.

The constructed riffles are small and have marginal flows during the spawning period. It is hoped the end of the drought period will recharge the aquifer and increase flows.

Trout Unlimited also constructed and donated two ice-box incubators for use in Lamb Springs. The incubators are placed in the headwaters of the spring creek and stocked annually with 100,000 eyed eggs. The first of an eight year period of eyed egg stocking was initiated in 1992. The first return of mature fish was noted in 1996 with the presence of 6 redds (minimum of 7 pairs), all of the redds were found on the constructed riffles.

Martin Creek is small tributary to Lamb Springs Creek, which has been diverted for irrigation use and no longer enters Lamb Springs Creek. The landowner has indicated his desire to return Martin Creek into its historic channel and put additional waters into the upper reaches of Lamb Spring Creek. It is believed the enhanced flows would allow the full potential for development of a spawning run into the system. This will also mean the eyed egg stocking program will have to be extended in order to facilitate the development of two generations of stock from the eyed egg plants.

Streams North Of Wilson Bridge.

Other tributaries of note which are found North of the Wilson Bridge, excluding Three Channel Spring Creek, include Lower Bar BC Spring and Price Spring Creek (Figure 2). Other tributaries include Blacktail Spring, Upper Bar BC Spring, and Cowboy Cabin Creeks (Figure 6).

Lower Bar BC Spring Creek.

This important spring creek lies approximately 0.25 mile upstream from the Gros Ventre confluence with the Snake River (Figure 2). A fish trap was installed in the lower reach of the creek and trapping was initiated in 1965. Fish from Lower Bar BC have been used as brood stock replacements for Lake of the Woods, and for re-establishing the Snake River brood stock at the Jackson Federal Hatchery.

Information indicated the number of fish trapped was about 226 fish in 1965. The number of fish moving through the upstream trap was fairly stable and ranged from 118 to 184 through 1972. Runs of over 200 cutthroat began in 1973 and were believed to have been in response to the first experimental use of 5,265 eyed eggs in 1969.

Crew personnel had long recognized the need to re-establish a spawning run in this tributary, and had been stocking fish in the system since 1950. The most intensive efforts began in 1963, and involved the planting of over 19,000 marked cutthroat trout ranging from 1 to 4 inches in length. By 1970, it was readily apparent the stocking had failed to increase runs when no marked fish were found during survey activities. From 1971 through 1979 a total of 820,474 eggs were stocked in the system which represented two generations of cutthroat trout.

As in Three Channel Spring Creek, the inadequacy of the spawning gravels was noted in 1991. Crew personnel unsuccessfully attempted to excavate shallow gravel bars with a shovel. Compacted gravels required heavy equipment to rehabilitate the system. The initial habitat work on the creek began with the excavation of three pools with adjacent spawning riffles, and the construction of two additional gravel riffles.

By 1978, increased recruitment of spawners by the eyed egg program were now overwhelming the newly constructed riffles and the natural riffles below the weir. The resultant superimposition of redds made it readily apparent new gravel would be necessary to provide adequate gravels for spawning.

The increased number of spawners, in relation to the eyed egg program, mirrored the Three Channel Spring Creek interpretation of data which seemed to indicate the segment of the Snake River which recruits to this tributary has not reached its carrying capacity.

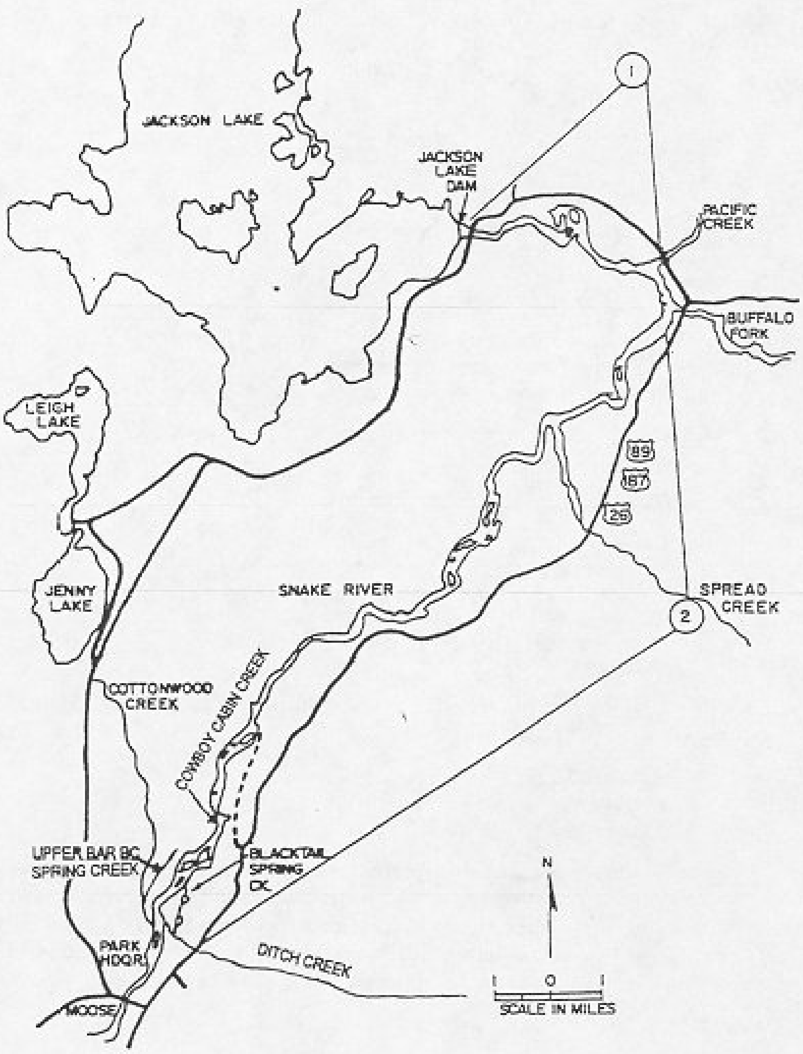


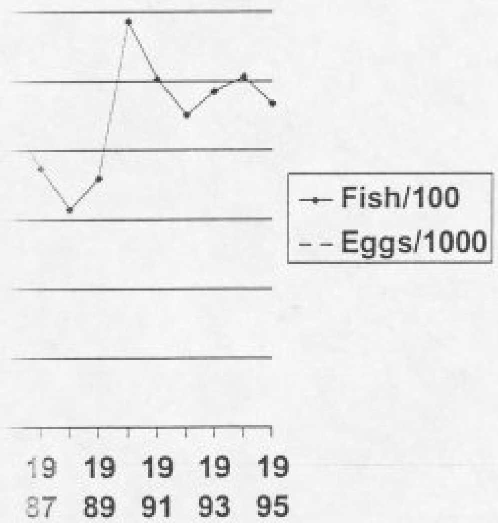
Figure 6. Northern spawning tributaries of Blacktail Spring Creek, Upper Bar BC Spring Creek, and Cowboy Cabin Creek.

The superimposition of redds was the first indicator of the lack of spawning materials. After the commercial gravels were stocked, the general increase of spawning activities after habitat renovation led personnel to conclude a limiting factor to the carrying capacity of the Snake River was spawning gravel availability.

ed gravels were placed in six newly constructed riffles above the dditional overhead cover for spawning cutthroat trout. The f 12 redds on the first riffle upstream from the weir.

ged as high as 588 since the advent of the eyed egg stocking

Snake River system (Figure 7).



evels in regard to eyed egg stocking, Lower Bar BC Spring Creek,

rew personnel began the search for new spring creek systems which h led to an old high water channel and spring creek complex creek originates from springs and was also fed by subbing from the ed amounts of adequate spawning gravels. In 1974, brook trout oat found near the confluence. This unnamed high water channel

nd habitat investigation began. Fourteen redds represented a ed the system.

nitted and approved by the landowner, and the Department's heavy es and utilized trees as overhead cover at four locations. Spawning ar.

ed to have a short life span, and the gravels were displaced and nstructed in the same manner as in other tributaries, excavating a er end of these riffles are buttressed with cobbles to prevent the loss wners were requesting additional technical assistance in providing

Major habitat activities were conducted in 1988. This work included the construction of riffles, excavation of pools, the narrowing of the channel, and random boulder placement. Commercial gravels were utilized in riffle construction, and trees were strategically utilized as a source of overhead cover.

By 1994, there was a total of 76 redds mapped. This represents an estimated minimum-maximum of 113 to 146 spawning cutthroat trout respectively. This was another case of a very positive measured response with a minimal investment.

This particular spring creek has undergone physical change due to flooding from the Snake River and development of the adjoining lands.

Blacktail Spring.

Blacktail Spring in located immediately next to the confluence of Ditch Creek and the Snake River (Figure 6).

Prior to 1971, this system was little more than a series of beaver ponds with limited spawning runs. During the high-water period of 1971, Ditch Creek flooded over into the lower section of the creek about 50 yards above the confluence. The floodwaters washed out and widened what had been a 200 yard silt ridden pond, and turned the segment into a creek with ideal gravel riffles. During weekly counts in 1967, the largest number of redds noted was 18.

The "new" spawning run was not recognized until 1973, and has increased substantially since. In 1995, the five year average for spawning in the system accounts for an average of 160 redds, a minimum of 242 pairs of cutthroat, and a maximum of 288 pairs. This would put the total estimated number of spawners at 513 fish. The continued expanded use of this tributary continues to demonstrate gravels to be a limiting factor for Snake River cutthroat trout density levels.

Upper Bar BC Spring Creek.

The historic Bar BC Guest Ranch is located two miles north of Grand Teton National Park headquarters at Moose. The ranch catered to the whims and wishes of vacationing dudes, and provided opportunities to ride horses, hike, fish, and swim. The ranch swimming pool was one of two springs from which Upper Bar BC Spring Creek (Figure 6) originates.

Crew personnel initially inspected the spring creek in 1973 to evaluate the potential for spawning activities and future egg stocking.

Between 1975 and 1981, over one million, excess eyed eggs were stocked in the creek to assess the potential spawning level of the system. Eggs were placed in hatching baskets and either buried in the available gravels or suspended over small cobble and covered with watercress. Those egg baskets suspended over small cobble had a hatching mortality of about 8 % or less, while the buried baskets suffered hatching mortalities of about 80 %. The excessive mortality of buried eggs was due to excessive fines in the gravels and insufficient flows which provides the necessary oxygen levels for egg development.

Although the egg stocking program produced a moderate increase in the numbers of spawning cutthroat utilizing the system with an increase of nearly 100 redds, there were natural physical constraints to any potential significant increase. Through the cooperation of the landowner, some low profile habitat activities were realized. Cobble was hand picked from riffles, four small pools were excavated to capitalize on existing bank cover, and limbs were placed along several sections for escape cover. No major rehabilitation activities were initiated because National Park Service policy prohibited mechanized improvement.

Crew personnel submitted a plan for spawning habitat improvement to the Grand Teton Park's superintendent in 1993 for further consideration. This project would actually fit into the National Park Service mandate of resource protection by providing native species additional opportunities to maintain themselves. In addition, the ranch lands surrounding the creek proper were already influenced by man and would not significantly alter the natural environment. The plan was mentioned in the Park's 1996 Snake River Management Plan as a potential development for maintenance.

Cowboy Cabin Creek.

Cowboy Cabin Creek is the last of the known spawning tributaries in the reach of the Snake River North of Wilson Bridge (Figure 6). This small tributary is a reminder of what the natural system must have been prior to the construction of the levee system. Seasonal flooding continually rejuvenates the gravels and flushes the silts, thereby maintaining the viability of its spawning potential. Occasional beaver dams render portions of the creek unusable, however spring flows have thus far maintained its existence.

The system is relatively stable with an average of 45 redds, and an average of 49 pairs of spawning cutthroat trout.

Summary

Spring creek systems are inherently stable, with no seasonal flushing flows to cleanse silts and recharge gravels. However, the stability of such systems is also problematic for the same reasons. The silts found in spring creeks originated from past overflow of the Snake River, irrigation, and general erosion by wildlife, livestock, and man. This silt chokes spawning gravels and promotes the growth of aquatic vegetation which leaves gravels unavailable for spawning. Silt is also deposited in pools and slow moving runs which reduces available cover and fish passage. Spawning cutthroat were found to have a 50% post spawning mortality rate (Hayden, 1967), and any reduction in habitat and channels for fish movement can have a negative effect on fish stocks. Without flushing flows, the spring creek system will always require human assistance to maintain systems for reproduction and maintenance of stock density.

Over 264,000 marked fingerling Snake River cutthroat trout were stocked in tributaries between 1963 and 1971 in an effort to enhance spawning runs (Table 4). None of the marked fish returned. Stocking activities such as this are often unsuccessful because the fish are not imprinted with trace elements found in the respective spring creeks. Without imprinting, there is no response to natal waters. The first experimental eyed egg stocking and subsequent increase in mature cutthroat set the stage for the present egg stocking program. This has proven to be an inexpensive and efficient method of maintaining cutthroat stocks (Table 5).

Table 4. Numbers of marked fingerling cutthroat trout stocked in select tributaries to promote increased spawning runs.

WATER	YEARS	NUMBER
Three Channel Spring Creek	1963 - 1967	11,781
Blue Crane Creek	1967 - 1968	10,043
Spring Creek	1967 - 1968	10,043
Fish Creek	1967 - 1971	212,511
Lower Bar BC Spring Creek	1963 - 1969	19,985
Total	1963 - 1971	264,363

Table 5. Estimated minimal number of spawning cutthroat trout before rehabilitation, and their peak range after rehabilitation of Snake River spring creek systems, 1965 through 1996.

WATER	NUMBER OF SPAWNERS BEFORE	AFTER
Three Channel Spring Creek	1970 - 149	1980 - 636
Little Bar BC Spring Creek	1973 - 10	1985 - 54
Blue Crane Creek	1975 - 94	1989 - 266
Spring Creek	1975 - 358	1990 - 578
Cody Creek	1994 - 0	1996 - 12
Fish Creek	1984 - 180	1993 - 407
Lamb Spring Creek	1990 - 0	1996 - 14
Lower Bar BC Spring Creek	1965 - 226	1994 - 588
Price Spring Creek	1975 - 44	1994 - 226
Upper Bar BC Spring Creek	1974 - 164	-1989 - 360

The popularity of the Teton/Yellowstone Park area has resulted in increased development of former ranch lands, and subsequently the maintenance of spawning tributaries will become a bigger problem in the future. Currently, Cowboy Cabin and Blacktail Spring Creek are the only natural spring creek systems wholly dependent upon the whims of nature for maintenance. Even though all of the spring creeks will require some kind of maintenance from time to time, four creeks will need regular attention (Table 6).

The Blue Crane - Spring Creek complex will require maintenance on a 6 to 10 year time frame. The utilization of irrigation waters pulled from the Snake River during high water deposits large quantities of fines into the system. Silt catch basins have been constructed and cleaned on several occasions by the Department, or special interest groups (Trout Unlimited, Teton County Natural Resources District, etc.) on an several occasions. There is a tremendous amount of fines brought into the system which could be removed on an annual basis with the landowners permission if funding were available.

An estimated total of 26,783 fishermen fished the Snake River in 1994 (Gipson, 1995). The average daily expenditure by anglers in the State of Wyoming is $57.00, and is appreciably more in the Jackson area. If we use the average expenditure figure, the Snake River fishery contributes nearly $1,527,000 per year to the economy. A major contribution to the economy of Teton County and the State of Wyoming.

Table 6. Summary of habitat techniques used on individual Snake River spawning tributaries, 1971 through 1994.

WATER	REHABILITATION
Three Channel Spring Creek	Pool excavation; riffle construction; Addition of commercial washed gravel; Cover logs; and, Silt removal.
Little Bar BC Spring Creek*	Pool excavation; Riffle construction; and, Addition of commercial washed gravel.
Blue Crane Creek*	Pool excavation; Riffle construction; Addition of commercial washed gravel; Cover logs; and, Silt removal.
Spring Creek*	Pool excavation; Riffle construction; Addition of commercial washed gravel; Cover logs; and, Silt removal.
Cody Creek	Pool excavation; Riffle construction; Addition of commercial washed gravel; Cover logs; Silt removal; and, Log barriers.
Fish Creek (Upper)	Electric fence along banks
Fish Creek (Lower)	Pool excavation; Riffle construction; Addition of commercial washed gravel; Cover logs; and, Silt removal.
Lamb Spring Creek	Pool excavation; Riffle construction; Addition of commercial washed gravel; Cover logs; Silt removal; and, Bank stabilization.
Lower Bar BC Spring Creek*	Pool excavation; Riffle construction; Addition of commercial washed gravel; Cover logs; and, Silt removal.
Price Spring Creek.	Pool excavation; Riffle construction; Addition of commercial washed gravel; Cover logs; Narrowed channel; and, Random boulder placement
Upper Bar BC Spring Creek	Pool excavation; Cover logs; and Remove cobble from riffles.

*Tributaries requiring rehabilitation on a 6 - 10 year basis.

It costs the Wyoming Game and Fish Department $ 1.57 to produce a single catchable (8.25 in.) cutthroat trout. For example, in order to maintain a catchable fishery in the adjacent Hoback River the Department stocks over 20,000 catchable Snake River cutthroat trout at a cost of about $31,400 annually. So, from a theoretical standpoint, the estimated increase in spawning cutthroat shown in Table 5, gives rise to an estimate of a total increase of 1,916 mature fish after the rehabilitation projects. If we assume half of the pairs were females, and each female produces 3,000 eggs, a total of 2,874,000 progeny will be produced. Furthermore, if we assume a total mortality rate of 60 %, is assumed about 1,724,400 would survive for perpetuation of the system and angler enjoyment. This stock, at $1.57 each, would be worth $2,707,308 if the Department had to produce a like fishery.

From an economic standpoint, the cost of maintenance projects such as the $15,000 used for the Blue Crane-Spring Creek project, pale in comparison to the need of large numbers of catchables to maintain a large river system such as the Snake River.

Most of the existing spring creek systems are quite vulnerable, and will be in continual need of habitat rehabilitation to maintain their productivity. The rehabilitation needs are expensive, and few alternatives are available to meet the habitat needs of the spring creeks. The economics of maintaining the spring creeks is indeed a bitter pill in the maintenance of native trout. However, without an investment in their future, the embattled Snake River and its fishery will also be in doubt.

LITERATURE CITED

Erickson, J.A. 1980. Give Them Gravel, Wyoming Wildlife 44(5): 30-34

Gipson, R.D. 1995. Snake River Creel Survey, 1994. Wyoming Game and Fish Department, Administrative Report 01-00-001, 21 p.

Hayden, P.S. 1967. The reproductive behavior of the Snake River cutthroat in three tributary streams in Wyoming. Wyoming Game and Fish Commission, Cooperative Research Project 4, 105 p.

Kiefling, J.W. 1978. Studies on the ecology of the Snake River cutthroat trout. Wyoming Game and Fish Department, Fisheries Technical Bulletin No. 3, Project Completion Report f-37-r, 198 p.

Kiefling, J.W. 1984. Restoration of a Spring Creek. Paper presented at the Third Wild Trout Symposium. Yellowstone National Park, Mammoth, Wyoming, September 24-25, 1984.

Kiefling, J.W. 1986. Spring Creek Spawning Habitat Restoration. Wyoming Game and Fish Department, Administrative Report 1085-13-6103, 6 p.

Kiefling, J.W. 1986. Spring Creek Spawning Habitat Restoration. Wyoming Game and Fish Department , Administrative Report 1086-13-6103, 10 p.

Novak, Mark A. 1989. Investigations Of Cutthroat Trout Spawning In The Snake River Fishery, Grand Teton National Park. U.S. Department of Interior, National Park Service, Grand Teton National Park and Wyoming Game and Fish Department, 39 pp.

Wyoming Game And Fish Department. 1964-1996. Annual Fisheries Progress Reports, Work Schedule. WGFD, Fish Division, Cheyenne, Wyoming.