Response to the Watershed Analysis Amendment Request

Listed below are analysis and responses provided by the Middle Fork District to issues/concerns listed in the U.S.D.I. Fish and Wildlife Service November, 1996. In this portion of the analysis amendment, the original issue is listed, as stated by the Fish and Wildlife Service. Following this, the key question and issue from the 1996 Watershed Analysis is stated. Below each key question is the scientific, analytical, and professional response to these issues. In some cases the issue presented by the Fish and Wildlife Service do not related to the key issues presented in the original watershed analysis. In these situations a new key question is developed. For the most part, the original key questions are still valid with minor changes. Listed below are the eleven aquatic habitat condition concerns.

Eleven Listed Aquatic Concerns

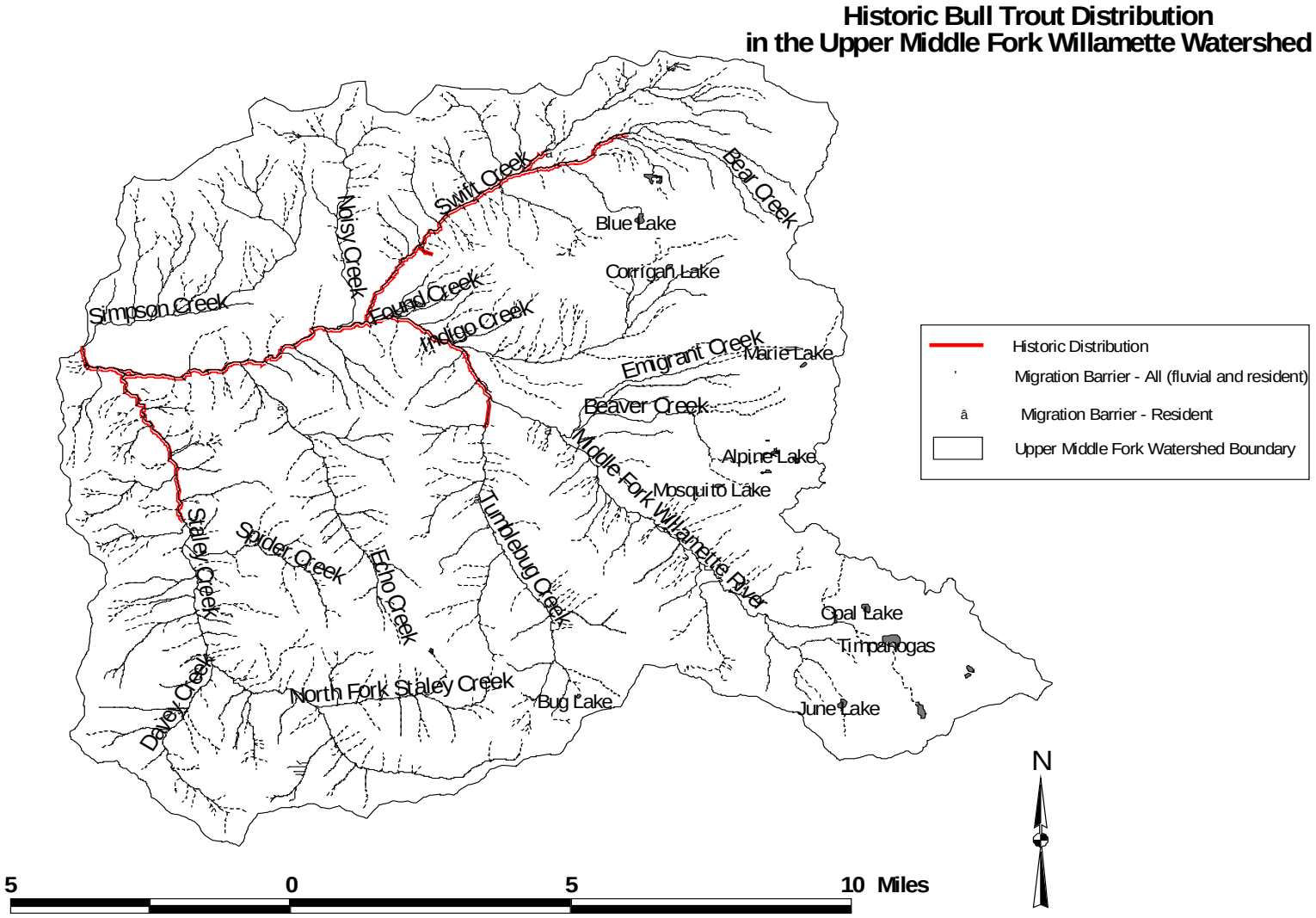
1. Identify and map important bull trout rearing and spawning habitat, as well as current and future re-introduction sites, and potential future distribution down to Hills Creek Reservoir – if this information is known or available.

Functional Relationship – Bull Trout Habitat

Historical references indicate that bull trout *Salvelinus confluentus* in Oregon were once distributed throughout 12 basins in the Klamath River and Columbia River systems. Bull trout were probably found throughout the Willamette Basin, however available documentation is limited (Buchanan et al. 1997). Bull trout in the upper Middle Fork Willamette Watershed likely ranged throughout the mainstem Middle Fork Willamette and associated larger tributaries (Figure 1-1, Historic Bull Trout Distribution Map). Reports of bull trout observations in the Upper Middle Fork Willamette Watershed gradually declined until the last known bull trout was photographed above Hills Creek Reservoir in 1990. In 1989, based on the decline of bull trout populations in much of their historic range the American Fisheries Society classified this fish as a "species of concern" (Ziller and Taylor 2001). In 1993, the Oregon Department of Fish and Wildlife (ODFW) listed all of the state's bull trout populations as "sensitive". Buchanan et al. (1997) listed bull trout populations in the Middle Fork Willamette as "probably extinct". On June 10, 1998, the US Fish and Wildlife Service (USFWS) listed the Columbia River bull trout population segment (including the Willamette Basin populations) as *Threatened* under the Endangered Species Act.

Bull trout require a narrow range of temperature conditions to reproduce and survive. Adults may begin migrating to spawning grounds in the spring and migrate slowly throughout the summer. Spawning occurs when water temperatures drop below 9-10 °C, (48.2-50°F) usually in late summer through early fall (August-November). Eggs are deposited in gravel, usually near shallow, slow moving water. After deposition bull trout embryos incubate in gravel substrate for several months before hatching in January. The alevins remain in the gravel, absorbing the yoke sac until about April. Emergence from the gravel to the fry stage usually takes approximately 200 days. Newly emerged fry average 25-30 mm (1-1.2 inches) and double their length in the first summer of growth. The extended period between egg deposition and emergence make bull trout extremely sensitive to increases in stream sediments and

Figure 1-1 Historic Bull Trout Distribution



Map

water quality. Therefore, bull trout are an excellent indicator species for the overall health of the entire aquatic ecosystem.

Most juvenile bull trout remain in the tributary streams for 1-3 years before emigrating to the larger river system. During stream residence juvenile bull trout are opportunistic feeders, primarily eating aquatic insects. Bull trout larger than 110 mm (4.3 inches) usually eat only other fish, but have been known to feed on frogs, garter snakes, mice, ducks and small children. The bull trout population in the upper Willamette system is largely migratory, growing to maturity in lakes or large rivers and migrating through the river system and into tributaries to spawn.

Limiting Factors that have adversely affected Upper Middle Fork Willamette bull trout populations include habitat alterations, especially impassable dams and culverts (Wevers et al. 1992). Ratliff and Howell (1992) list habitat degradation, passage barriers, over harvest, chemical treatment projects, and hybridization and competition with non-native brook trout as possible reasons for the decline or extirpation of Willamette Basin bull trout. The construction of Dexter, Lookout Point, and Hills Creek Dam in the 1950's and 1960's and chemical treatment projects prior to completion of Hills Creek Dam in 1961 to remove "rough fish" have undoubtedly had a significant impact on bull trout populations. Rough fish were directly targeted for removal by rotenone poison during these chemical treatments, however, salmonid species, which include bull trout were also killed (Appendix C). Habitat alterations from timber harvest and associated road construction, loss of juvenile spring chinook as an important food source, and over harvest from angling also contributed to the decline of the Middle Fork Willamette bull trout population.

Related Key Question

Where and to what extent has road density, condition, location, and use influenced aquatic species distribution and habitats?

Response: Description of Reintroduction Project

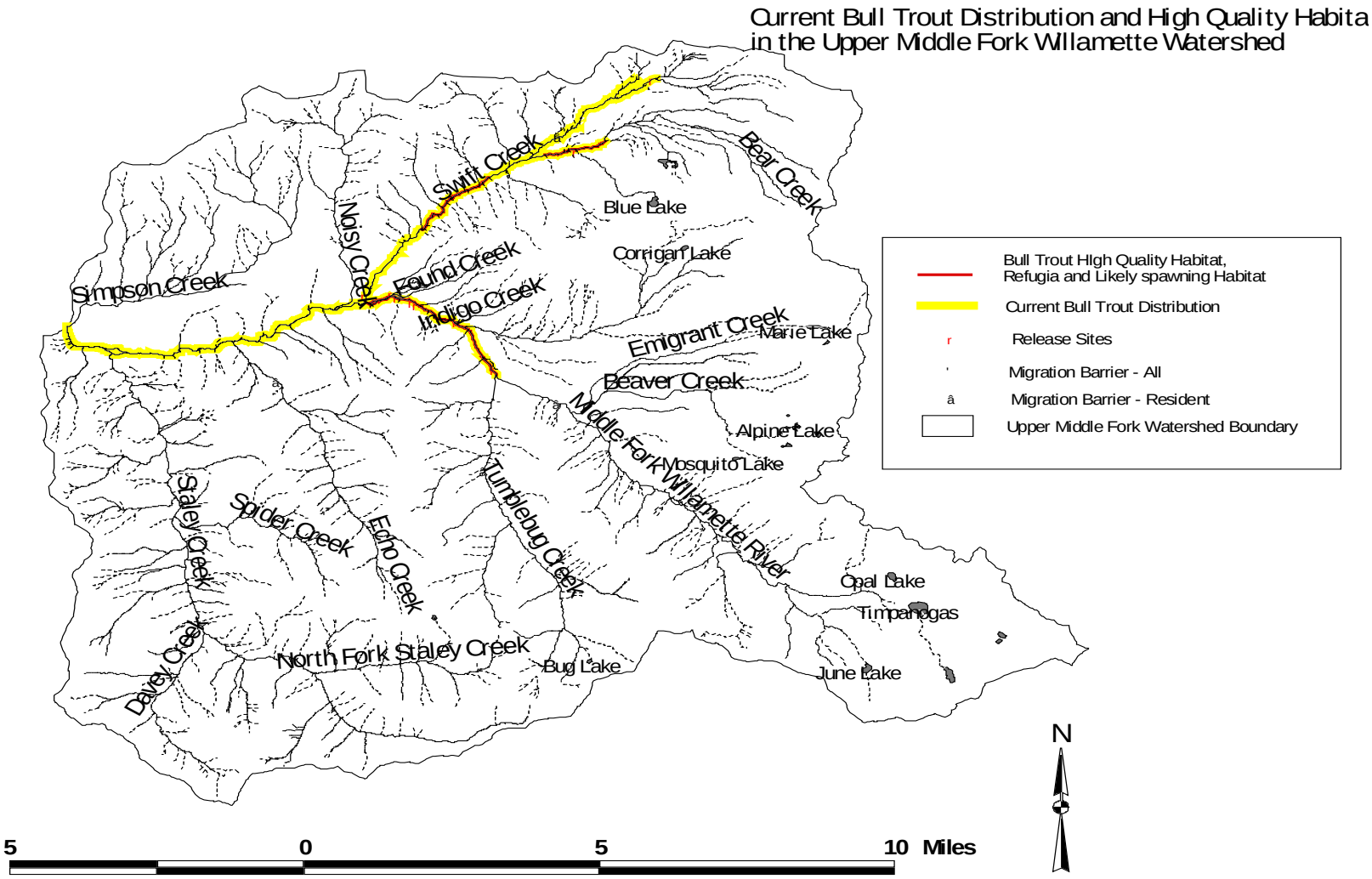
In a 1997-1998 cooperative effort with Oregon Department of Fish and Wildlife the U.S. Forest Service/Middle Fork Ranger District began analysis and feasibility studies for the selection of sites to reestablish bull trout in the Middle Fork Willamette Basin. Reintroduction sites were selected principally on criteria and life history information related to water temperature, juvenile rearing habitat and food availability. In May 1997, ODFW and the Middle Fork Ranger District transferred bull trout fry from Anderson Creek, a tributary of the McKenzie River, to three tributaries (Skunk Creek, Chuckle Springs, and Indigo Springs) of the Middle Fork Willamette River. Through 2001, five additional release sites (Iko Springs, Shadow Springs, Swift Creek, Bear Creek, and Found Creek) were identified and added to the reintroduction program. To date over 7800 bull trout fry have been released in the Upper Middle Fork Willamette Watershed.

High Quality Habitat

High quality bull trout spawning and rearing habitat exists in the Middle Fork Willamette and some associated tributaries (Figure 1-2, Current Distribution Map). High quality habitat includes refugial areas that offer protection during periods of extreme conditions, examples include low flow, high flow, and high

water temperatures. The area of the Middle Fork Willamette between Chuckle Springs and Found Creek is heavily influenced by natural cold-water springs. Water temperatures in some of the larger springs that are used for bull trout reintroduction sites typically range from 5.6 to 8.8°C (42 to 48°F). The main stem Middle Fork Willamette in this area generally remains below 10°C (50°F) year around. These cold-water tributaries provide outstanding habitat for bull trout fry and juveniles. The reintroduction sites themselves do not contain large areas that could be utilized for spawning, however, prior to the release of bull trout fry initial surveys documented several sites in the main stem Middle Fork Willamette that would be suitable for adult spawning. Ample spawning habitat is also available in the larger tributaries such as Swift Creek and Bear Creek. At this time it is not known precisely where returning bull trout will spawn. At the earliest, adult bull trout from the 1997 reintroduction should return to areas around their respective release sites in 2002.

Figure 1-2 Current Bull Trout Distribution Map



Monitoring

Monitoring of Middle Fork Willamette bull trout populations began shortly after the first reintroduction in 1997. The primary methods used to monitor bull trout are night snorkeling and various types of trapping techniques. The reintroduction program began in March 1997 with 178 bull trout fry released into Indigo Springs, Chuckle Springs and Skunk Creek by ODFW and the US Forest Service (Figure 1-2, above). After the initial release several attempts were made to observe and monitor growth of these fish. However, with one exception, near the Skunk Creek release site in October 1997, bull trout juveniles were not observed. Also, in the fall of 1997, Iko Springs and Shadow Springs were identified and assessed as unique areas that would likely be suitable for rearing juvenile bull trout. In March 1998, 938 and 150 bull trout fry were released in Iko Springs and Shadow Springs, respectively. In 1999 through 2001 Swift Creek, Bear Creek and Found Creek were added to the reintroduction schedule (Table 1-1). After release several efforts to observe these fish were made with few documented sightings in the reintroduction areas. Bull trout typically exhibit nocturnal behavior in all life stages. Young of the year fry generally rear in complex cover such as gravel, mosses, filamentous algae, wood, and detritus, which makes observation difficult. In October 1998, night snorkel surveys became much more effective at monitoring populations and growth as the fry became larger and less elusive. Subsequent surveys and trapping efforts through 2001 have resulted in numerous documented sightings of juvenile and sub-adult bull trout in all reintroduction sites and the mainstem Middle Fork Willamette.

Table 1-1 Number of Bull Trout Transferred to the Upper Middle Fork Willamette Watershed

Year	Indigo Springs	Chuckle Springs	Skunk Creek	Iko Springs	Shadow Springs	Swift Creek	Found Creek	Bear Creek	Totals
1997	73	49	56						178
1998		411		938	150				1499
1999		302		1000	150	526			1978
2000	204	349		1075	53	822	285		2788
2001		269		418		96		673	1456
Totals	277	1380	56	3431	353	1444	285	673	7899

The bull trout reintroduction program is scheduled to continue through at least 2002. It is expected that between 2,000 and 3,000 fry will be transferred to the Middle Fork reintroduction area in 2002. These fry will likely be distributed at previous levels in Iko Springs, Chuckle Springs, Swift Creek and Bear Creek. The Forest Service and ODFW are currently investigating Echo Creek as a possible addition to the 2002 schedule. Echo Creek was assessed early in the program as a possible release site, however, due to an impassable culvert (Road 2143-325) downstream of suitable bull trout habitat it was not utilized. The culvert will be replaced in 2002 with an arch that will again provide fish passage upstream to bull trout habitat. With the removal of the culvert and an adequate supply of fry from Anderson Creek in 2002, Echo Creek may become a bull trout reintroduction program release site.

Although spring chinook salmon are endemic to the upper Middle Fork Willamette and surrounding drainages, artificial propagation and transportation is required to maintain existing

populations. The species was Federally listed as threatened in 1999, due in part to a decline in populations within the Upper Willamette River ESU. Available habitat has been reduced by construction of dams in the Middle Fork Willamette River Basin, and these dams have probably adversely affected remaining production via thermal effects (NMFS 1998). Upstream migration of spawning adults in the Middle Fork Willamette is blocked by three dams; Dexter at river-mile (RM) 192, Lookout Point (RM 195), and Hills Creek (RM 221). According to Mattson (1948) principal spawning areas on the Middle Fork Willamette were from the West Fir Bridge (RM 214), downstream five miles to Duval Creek (RM 209) and the extreme range is listed from the Rigdon Gauging Station to Duval Creek, all of which are several miles downstream of Hills Creek Dam. Current populations upstream of Dexter Dam are sustained solely by an ODFW trap and haul program.

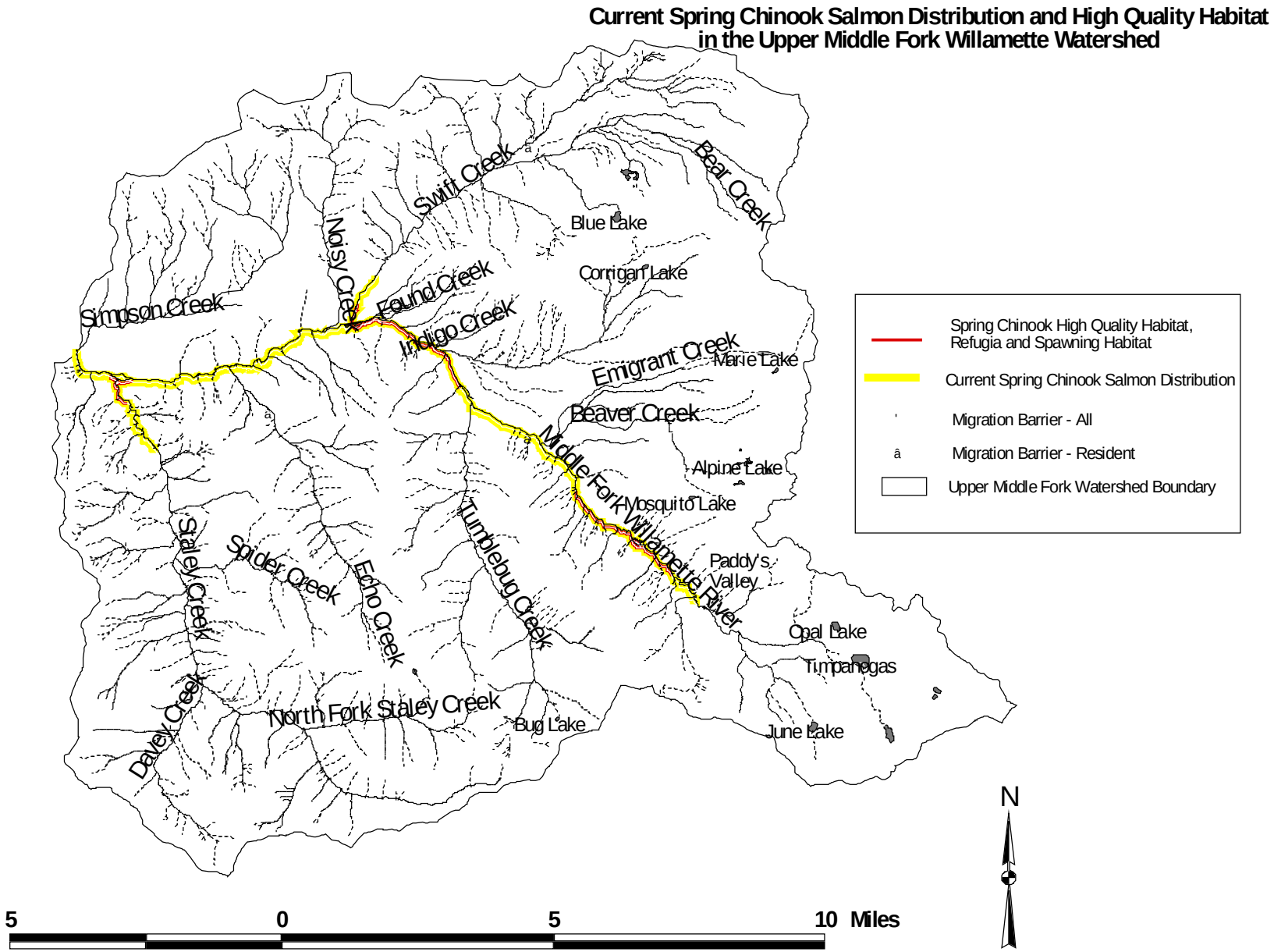
Spring chinook salmon are an integral component of bull trout diet. The selection of bull trout reintroductions sites strongly considered areas that already contained a high number of spring chinook salmon fry. Since 1993, ODFW has transported pre-spawned adult spring chinook salmon from downstream of Dexter Dam to the Middle Fork Willamette, upstream of Hills Creek Reservoir (Table I-2). Salmon redds and spawning have been documented since the project began, however, comprehensive surveys of redd counts, timing and preferred spawning were not completed until 1999. In the summer of 1999, ODFW transported 1073 of these pre-spawned adults to the Paddy's Valley area of the upper Middle Fork Willamette. Redd surveys were completed on approximately 1.75 miles of stream channel in Paddy's Valley. At least 44 redds were observed with the highest concentration within 0.8 miles upstream and 0.4 miles downstream of the release site. In many cases entire areas were covered with redds and it appeared that numerous salmon spawned in the same location. Given the number of fish released in the area it is likely that the actual number of redds was higher than recorded. The majority of redds were closely associated with accumulations of gravel collected by large woody material (LWM) in the stream channel. Redds were rarely observed in areas that lacked LWM in the stream. Of the 1073 adult fish transported to the area, 40 carcasses were observed during redd surveys. Carcass consumption by wildlife was evident in that many were observed pulled onto the bank or on top of logjams.

Table 1-2 Spring Chinook Salmon Released in the Upper Middle Fork Willamette

Year	Adults	Juveniles (Hills Creek Reservoir only)	Jacks	Location
1992		49,950		Near Echo Creek
1993	764		32	Near Echo Creek
1994	176		1	Near Echo Creek
1995	515	50,142	7	Near Echo Creek
1996	341	50,160	19	Near Echo Creek
1997	956			Near Echo Creek
1998	564		8	Near Echo Creek
1999	1049		24	Paddy's Valley
2000	1983		20	Paddy's Valley and near Echo Creek
2001	2261			Paddy's Valley and near Echo Creek
Totals	**8,609**	**150,252**	**111**	

Prime chinook salmon spawning and rearing habitat is located primarily in the mainstem Middle Fork Willamette and its major tributaries. Spawning and rearing also occurs in smaller streams close to or where they meet the Middle Fork Willamette. Areas of the mainstem Middle Fork Willamette that serve as principle spawning and rearing habitat are near Staley Creek, Swift Creek to Tumblebug Creek and the Paddy's Valley area (Figure 1-3, Current Salmon Dist Map). ODFW plans to continue releasing adult spring chinook salmon upstream of Hills Creek Reservoir. These salmon currently provide an important food source for bull trout and return essential organic nutrients to the entire watershed.

Figure 1-3 Current Spring Chinook Salmon Distribution



2). *Outline recovery objectives for bull trout in the Middle fork (i.e. self-sustaining populations in the spring area within 5 years and 5-10 years for the remainder of the basin- or something similar).*

Functional Relationship – Recovery of Bull Trout

Bull trout in the United States are distributed within a large area that encompasses five distinct population segments (DPSs). The U.S. Fish and Wildlife Service (Service) adopted a two-tiered approach to develop the recovery plan. The first tier addresses broad aspects of bull trout recovery that applies to the entire United States and DPSs. The second tier addresses aspects of bull trout recovery at the level of specific areas within a DPS (i.e., recovery units).

A recovery team was convened to address the first tier with members of Service biologists, a representative from fish and wildlife resource agencies in each of four northwestern states (Idaho, Montana, Oregon, and Washington), and a representative of the Upper Colombia River United Tribes (Confederated Tribes of the Colville Reservation, Coeur d' Alene Tribe, Kalispel Tribe, Kootenai Tribe of Idaho, and Spokane Tribe). To address the second tier, recovery unit teams were enlisted, one for each recovery unit or recovery subunit. Membership on the recovery unit teams consists of persons with technical expertise in various aspects of bull trout biology within each recovery unit. Primary functions of the recovery teams were to assist in addressing issues specific to an individual recovery unit. Members of the recovery team led recovery unit teams to ensure consistency among recovery units.

Related Key Question

Where and to what extent has road density, condition, location and use influenced aquatic species distribution and habitats?

Response: Bull Trout Recovery Objectives

The goal for recovery of bull trout in the Willamette Recovery Unit, which includes Middle Fork Willamette population, is to ensure the long-term persistence of self-sustaining, complex interacting groups of bull trout distributed across their historic range. In order to achieve this goal the following objectives have been identified for the Willamette Recovery Unit.

1). Current distribution of bull trout within the Upper Willamette basin is maintained and bull trout are re-established in previously occupied habitats.
2). Stable or increasing trends in abundance of bull trout in the Willamette Recovery Unit are maintained.
3). Suitable habitat conditions for all bull trout life history stages and strategies are restored and maintained.
4). Genetically diverse populations of bull trout within the Willamette Recovery Unit are conserved.

5). Improve public and agency awareness of bull trout value and importance of protection and restoration efforts.

Individual recovery units are "recovered" when the specified criteria in the recovery plan are met. The following list of key words and definitions describe important concepts and terminology specified in the recovery plan.

Distinct Population Segment – The US Fish and Wildlife Service has formally determined there are five bull trout DPSs across the species range within the coterminous United States; Klamath River, Columbia River (DPSs that includes upper Middle Fork Willamette population), Jarbidge River, Coastal-Puget sound, and St. Mary-Belly River. Each meets the test of discreteness and significance under joint policy of the service and National Marine fisheries Service (61 FR 4722), and these are the units against which recovery progress and delisting must currently be measured.

Core Area - The combination of core habitat (i.e., habitat that could supply all elements for the long-term security of bull trout and a core population (a group of one or more local populations that exist within core habitat) constitutes the basic unit on which to gauge recovery within a recovery unit. Core areas require both habitat and bull trout to function, and the number (replication) and characteristics of local populations inhabiting a core area represents the closest approximation of a biologically functioning unit for bull trout.

Core Population - A group of one or more bull trout local populations that exist within core habitat.

Local Population – A group of bull trout that spawn within a particular stream or portion of a stream system. Multiple local populations may exist within a core area. Until site-specific research indicates spatial, temporal, or genetic isolation, a local population will be considered as the smallest group of fish that is known to represent an interacting reproductive unit. For most waters where specific information is lacking, a local population may be represented by a single headwater tributary or complex of headwater tributaries. Gene flow may occur between local populations (e.g., those within a core population), but is assumed to be infrequent compared to that among individuals within a local population.

Recovery Unit – Recovery units are the major units for managing recovery efforts, with each recovery unit forming a separate chapter in the recovery plan. Most recovery units consist of one or more major river basins. Several factors were considered in identifying recovery units (e.g., biological and genetic factors, political boundaries, and ongoing conservation efforts). In most instances, recovery unit boundaries were modified to maximum efficiency of established watershed groups, encompass areas of common threats, or accommodate other logistic concerns. Biologically, recovery units are considered groupings of bull trout for which gene flow was historically or is currently possible.

Individual recovery units are recovered when the following criteria are met.

A). Bull Trout are distributed among six local populations in four core areas in the recovery unit. The four core areas would be McKenzie, Middle Fork Willamette, Santiam, and Clackamas. The six local populations would have 1) Mainstem McKenzie, 2) South Fork McKenzie, 3) **Upper Middle**

Fork Willamette, 4) Salt/Salmon/North Fork Willamette, 5) Upper North Santiam, 6) Clackamas. Estimated abundance of adult bull trout is at least 1200-2000 (300-500 individuals per core area) individuals distributed among four core areas in the recovery unit.

B)**.** Adult bull trout exhibit stable or increasing trends in abundance in the recovery unit.
Based on work by Maxell (1999), stable-increasing trend can be inferred by demonstrating a non-declining trend and achieving the abundance criterion. A 10-year time series (2 generations) is the likely minimum required for establishing a non-declining trend, which depends on variability of the abundance estimates and magnitude of the "true" trend.)

C). Specific barriers inhibiting recovery as listed in individual recovery unit chapters have been addressed.

Site-specific recommendations for the upper Middle Fork Willamette bull trout populations include a diversity of management actions and strategies to ensure that current distribution of bull trout within the Middle Fork Willamette and associated tributaries is maintained and continue to re-establish in historically occupied habitat. The following is a list of actions and recommendations from the Draft Bull Trout Recovery Plan that are relative to achieve recovery and enhance habitat in the Middle Fork Willamette bull trout population. These are just some of the recovery actions that appear in the Recovery Plan that are of primary importance and focus for the Upper Middle Fork Willamette Watershed (See Draft Bull Trout Recovery Plan for complete list of recovery actions).

1). Develop and implement tasks to protect, restore, and maintain suitable habitat conditions for all bull trout life-history stages and strategies.

- Maintain areas with adequate water quality and eliminate sources in areas with impaired water quality in bull trout core habitat or potential core habitat.

- Identify and reduce or eliminate sources of human induced fine sediment that may impair spawning success. For actions in the upper Willamette Basin of particular concern are completing access and travel management prioritization and inventory of dispersed recreation sites on federal lands.

1.2). Identify areas and structures that are barriers or sites of entrainment for bull trout and implement tasks to provide passage and entrainment.

- Correct barriers impeding bull trout access to suitable habitat, e.g. road culverts (Echo Creek Rd 2143-325; Swift Creek Rd 2300-422 and Rd 2300; Coal Creek Rd 2133 and 2133-228; and other culverts that may be identified in the future that create migration barriers to migrating bull trout of all life stages.

- Identify where stream channel and riparian area contributions to bull trout habitat is impaired and implement tasks to restore their appropriate functions.

- Re-vegetate to restore shade and canopy, and native vegetation.

- Restore, or allow recovery of, stream channel habitat complexity.

- Increase recruitment of large woody debris to improve in-stream spawning and rearing habitat.

- Restore habitat connectivity for all native species within the range of bull trout (i.e. prey base for bull trout including cutthroat and rainbow trout).

5). Conduct research and monitoring to facilitate implementation and evaluation of bull trout recovery activities consistent with an adaptive management approach using results of implemented, site-specific recovery tasks.

- Develop and conduct research and monitoring studies to improve information concerning the distribution and status of bull trout.

- Conduct periodic surveys where bull trout re-colonization is anticipated.

- Develop and maintain a centralized database for all bull trout distribution and monitoring.

- Conduct physical and biological surveys to determine current abundance of populations and factors precluding or limiting productivity.

- Identify evaluations needed to improve understanding of relations among genetic characteristics, phenotypic traits, and local populations of bull trout.

- Determine life history characteristics and habitat requirements of local resident and migratory bull trout populations.

7.2). Develop and implement a standardized monitoring program to evaluate the effectiveness of recovery efforts.

7.3). Revise scope of recovery as suggested by new information.

- Periodically assess the priority of actions in the context of how to emphasize actions in certain core areas.

Time Frame for Restoration

The time frame for restoration actions to be completed in the watershed is directly dependant on funding sources. In the past, primary sources of restoration funding have come from timber sale associated KV collections. Due to restrictions and regulations on how KV funding can be applied, restoration projects were not always focused in areas that provided the most utility to the aquatic habitat. In the last several years the District timber sale program has decreased substantially and with that KV funded restoration projects will also decrease. Funding sources that have fewer restrictions and could be used in areas of specific need are currently being pursued. The Payments to Counties program may provide opportunities to target predetermined areas of bull trout and spring chinook habitat that would benefit the most from

restoration and enhancement projects. The Middle Fork Willamette Watershed Council, Oregon Department of Fish and Wildlife and U.S. Fish and Wildlife Service have expressed interest in securing restoration funding through grants.

Much work could be done to augment existing bull trout and spring chinook habitat in the Middle Fork Willamette and associated tributaries. However, based on recent stream surveys and extensive observations it is thought that bull trout will find suitable spawning habitat in both the Middle Fork Willamette and associated tributaries. Bull trout that were first reintroduced in 1997 are known to persist in at least one release location and should begin to spawn in 2002. However, at this time, biologists are uncertain as to precisely where they will spawn. Bull trout are thought to spawn in limited areas of critical groundwater upwelling (C.V. Baxter 1997; J.S. Baxter 1997). In areas where winter conditions are severe, egg freezing is a possibility for fall-spawners. Since groundwater is typically warmer than surface water in the winter, the probability of embryo mortality can be minimized if a spawning site is built in a suitable location (Baxter and McPhail 1999). Comprehensive surveys to identify areas of groundwater upwelling that could be used for spawning have not been completed and given the difficult nature of this type of survey will likely remain unfulfilled. Once bull trout reach spawning age, surveys to identify high use areas will be completed and from there, emphasis can be placed on creating additional habitat in those areas that will provide the greatest benefit to the species.

3). *Identify and list potential threats to bull trout recovery in the upper basin, such as unstable roads which may affect critical habitat (add to list of culverts on p.42), temperature limitations, long-term food availability (i.e. prey base dependant on manual transport and release of Chinook?), impacts of dispersed recreation (i.e. effects of camping, angling pressure, etc.).*
and
6). *List priority restoration opportunities, such as identifying mid-slope roads constructed prior to 1985 in high-risk storm response areas (Figure 3 and recommendations section p. 98), in-stream habitat conditions (LWD, pools, spawning gravel, passage blocks, etc.). Restoration opportunities should be clearly tiered to the access and travel management plans currently being conducted and should be addressed in the recommendations section on p. 98 of the WA.*

Reader Notation: Questions #3 and #6 are combined because they complement one another in a problem/restoration opportunity format. The following section covers both of these questions.

Functional Relationship – Threats to Bull Trout Habitat Recovery and Restoration Opportunities

The Middle Fork Willamette has for sometime maintained a strong ability to rear salmon and bull trout from the egg and fry stage to smolts and sub-adult fish. Trapping data and snorkel surveys, from 1997-2001, for juvenile chinook salmon and bull trout show healthy year classes and emigration counts from the Middle Fork Willamette into Hills Creek Reservoir. Growth rates of bull trout fry, transferred from the McKenzie Basin may be greater in the first three years than growth rates of donor stock in Anderson Creek (Doug

Larson, USFS, personal communication September 17, 2001). *Risks are present in the rearing environment, however given the known level of mortality of juvenile fish passing through Hills Creek Dam and the inability to get adult spawning stock back to the spawning grounds it seems imperative for the recovery and sustained viability of these populations that both upstream and improved downstream fish passage at these dams is addressed.*

Direct Habitat Threats

Potential threats to spring chinook and bull trout in the watershed may include unstable roads, temperature limitations, long-term food availability, effects of camping and angling pressure. All of these potential threats pose some degree of risk to the recovery of salmon and bull trout. However, after several years of research on salmon and bull trout populations in the watershed it appears that other more significant threats must be addressed at the same time. These more significant threats are barriers to fish migration.

Barriers

The greatest threat to Middle Fork salmon and which poses some threat to bull trout recovery in the watershed is the inability to return to spawning areas after migrating downstream of Hills Creek, Lookout Point and Dexter dams. In addition, fish that pass through the turbine and or regulating outlets of Hills Creek Dam are known to suffer high rates of mortality. Hills Creek and Lookout Point reservoirs are likely responsible for prolonged delays in salmon smolt migration and bull trout seasonal movement patterns. Fish passage through Lookout Point Dam likely results in significant mortality levels as the overall design is similar to Hills Creek Dam. Dexter Dam is a power generating facility, however little is known about fish passage consequences at this facility.

Indirect Upland Threats

Much has been studied and written about the possible interactions of roads and the aquatic system. Roads modify natural drainage patterns and can increase peak streamflows and hillslope erosion resulting in down slope transport and deposition into the aquatic system. Roads can also fragment habitat of aquatic organisms.

The 1996 Upper Middle Fork Watershed Analysis identified where roads are located on steep ground with shallow, rocky soil. This document also mentions side-cast construction methods used on the older road system and lack of road maintenance funds as increasing the chances of initiation of debris slides. Although these assertions are valid, it became clear in the November, 1996 storm event that diversion of water at road / stream crossings and at relief culverts was a much larger factor. Rather than attempt a new analysis tool to address diversion potential in this update, it is far more useful to integrate this concept into all field surveys, reconstruction, maintenance and hydrologic stabilization projects that take place on forest roads.

Key Site Specific Salmon and Bull Trout Habitat

In the Upper Middle Fork Willamette Watershed, high quality habitat for all life stages of spring chinook salmon and bull trout occurs in the proximity of an extensive road network. Salmon and bull trout habitat overlaps primarily near the bull trout reintroduction sites. The highest quality spring chinook spawning habitat is located in Paddy's Valley with substantial rearing habitat available downstream to Hills Creek Reservoir. Chinook salmon redds are highly correlated with large wood in the stream channels. Paddy's Valley contains much more wood then the downstream sections of the Middle Fork Willamette, which creates conditions of high redd density in this section of the river.

The highest quality bull trout habitat is located from Chuckle Springs to about Skunk Creek. This area offers ample rearing habitat for juvenile and sub-adult bull trout. At this time it is not known where bull trout adults will return to spawn. However it is expected that the adults will return to or near their original release site. Water temperature will likely be the most significant factor that influences bull trout spawning. The release areas are influenced by numerous springs and provide the most conductive temperatures for spawning. Juvenile and sub-adults are known to occupy habitat downstream of the release sites in areas where water temperatures are warmer and outside the normal range of bull trout preference (50°F). Mainstem water temperatures near the Echo Creek confluence reach 57°F in the summer.

District monitoring shows that temperatures near high quality bull trout release sites remain at or below the 50°F threshold shown in Figure 1-3. Outside of these high quality areas, cool water habitat exists in the Middle Fork, from the bottom of the gorge below Paddy's Valley to Swift Creek. Temperatures in this reach are sufficient for bull trout rearing throughout nearly all of the thermal influence season. Temperature in the designated high quality bull trout habitat areas meet the needs of the species and are not limiting. There are undoubtedly other areas in the watershed, outside of high quality habitat areas, where canopy closure can be limited, which can have a deleterious affect on stream temperature. *Based on recent thermograph data, there are no temperature concerns for bull trout within their designated high quality habitat area (See Table 3-1, below).* However, within the current bull trout distribution area, in some areas outside of or adjacent to designated high quality habitat; stream temperatures are elevated above desirable temperature levels for some life stages.

Table 3-1 Upper Middle Fork of the Willamette River Seven-Day Moving Average of the Daily Maximum Summer Stream Temperatures in or Adjacent to High Quality Bull Trout Refugia and Spawning Habitat

Stream Name	Station Name	1997	1998	1999	2000	2001
Middle Fork Will. R. *	Below Swift Cr.		53.3			
Swift Creek *	At mouth	55.6	57.2	54.6		
Swift Creek *	Side channel near mouth		55.3	50.6		
Skunk Creek *	At mouth	55.2	56.8		58.9	
IKO Springs *	Tributary of M. Fork Will. R.		45.2	45.2		44.8
Chuckle Springs *	Tributary of M. Fork Will. R.	40.9	40.6			
Bear Creek *	At F.S. road 2149			44.5	44.4	
Shadow Springs *	Tributary of M. Fork Will. R.				42.3	
Middle Fork Will. R.	At F.S. road 272	56.5	57.6	56.5		
Echo Creek	At F.S. road 2100-315	56.0	57.6			
Middle Fork Will. R.	Below Staley Cr.				57.7	
Simpson Creek	At mouth	61.4	61.5	58.7		
Staley Creek	At mouth	63.6	65.5			
Noisy Creek	At mouth	62.9	63.1			
South Fork Staley Cr.	Above North Fork Staley			51.3		
North Fork Staley Cr.	Above South Fork Staley			52		
Spider Creek	At mouth			57.1		
Tumblebug Creek	At mouth		57.9			
Middle Fork Will. R.	At F.S. road 2153		52.3			
Davey Creek	At F.S. road 2136			52.3		
Middle Fork Will. R.	At Paddy's Valley				52.1	
*Areas within High Quality Habitat, Refugia, or Spawning Habitat						

Related Key Question and Response

1. Where and to what extent has road density, condition, location and use influenced erosion, hydrologic, and channel processes?

2. Where and to what extent have management practices influenced distribution and condition of aquatic species and their habitats?

Reader Notation: This response is related to both questions #3 and #6 listed above.

Response – Threats to Bull Trout and Analysis of Roads Density, Condition, and Location

The existing transportation system was evaluated for risk to high quality spawning and rearing habitat of Bull Trout and Spring Chinook by using a three-step process. Initially, an office-based analysis was performed using the Aquatic Risk Rating (Appendix E) system developed for the Access and Travel Management (ATM) process (Figure 5-1). This analysis method is GIS based and utilizes existing databases (primarily Soil Resource Inventory, Streams, Transportation, and Digital Elevation Model) to

determine a rating that can be interpreted as a gross estimation of road segments that may deliver sediment to the aquatic system. The results of this analysis are shown on Figures 3-1, fifth field map of aquatic risk. The second step of the evaluation process was to interview those knowledgeable of the transportation system of the area and combine this information with the results of the Aquatic Risk Rating described previously.

The third step was to evaluate in the field as much of the transportation system as time would allow with the emphasis being on road systems which could have a direct cause-effect relationship with the high quality spawning and rearing segments described previously. Parameters which were evaluated include (but were not limited to) slope angle, slope position, road grade, integrity and adequacy of the drainage system, construction type, construction materials, fill slope vegetation, cutslope ravel, fill slope stability, etc.

A comparison was made of the results of the Aquatic Risk Rating analysis with the local knowledge and field reconnaissance methods. It was apparent that the ARR tended to overrate most roads located in and near valley bottoms. This is likely due to the high values assigned to the ‘proximity to fish bearing stream’ parameter. Also, some mid-slope roads on steep ground were under-rated and many were over-rated. Consideration was given to changing the ARR analysis, but it was concluded that the model (with minor adjustments to the range associated with the High ranking) was adequate for an office based analysis as long as field validation takes place before conclusions are drawn. In other words, it is important to recognize the limitations of the analysis method and resist the temptation to apply landscape level analysis to site specific recommendations without ground based evaluation.

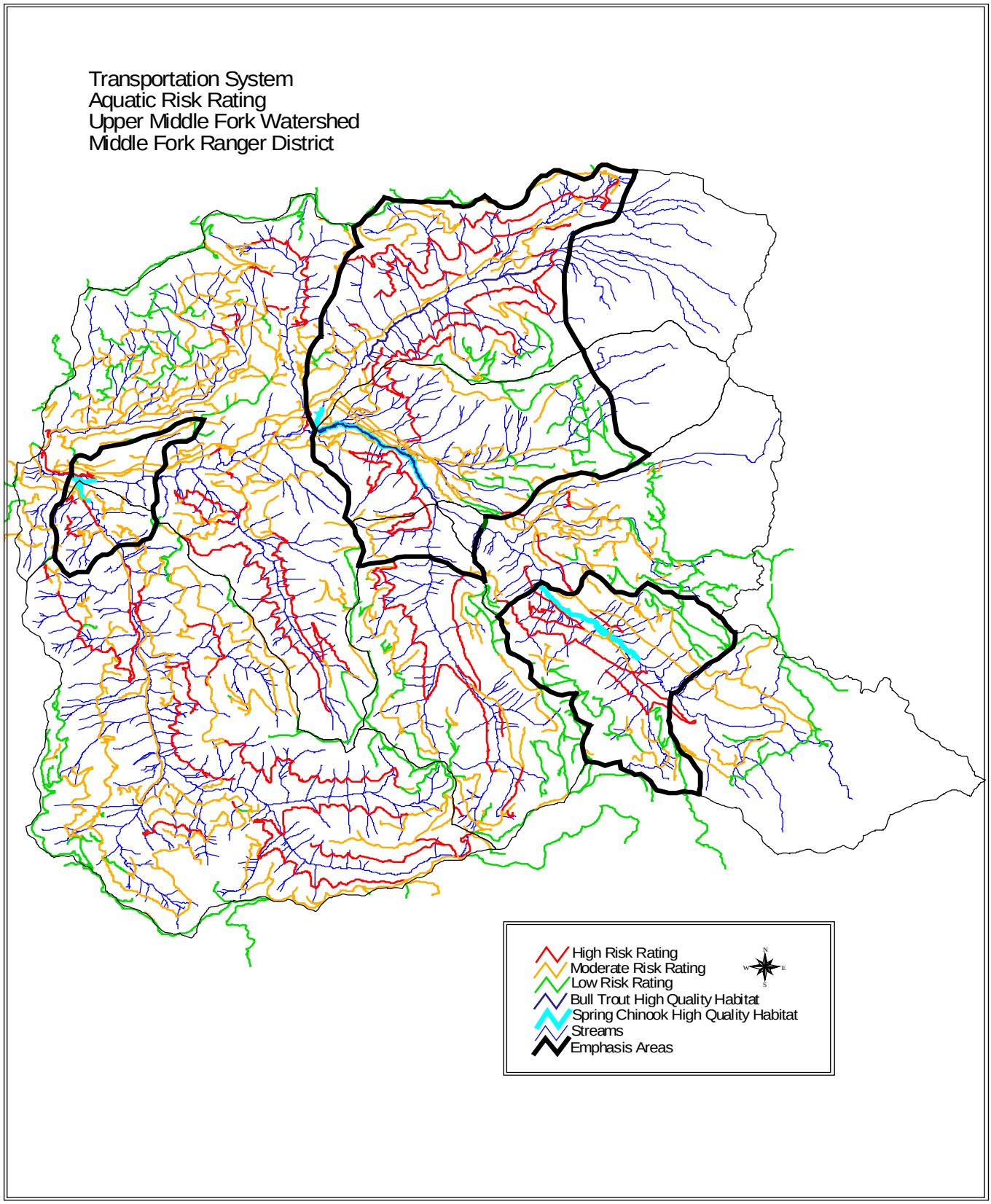


Figure 3-1 Aquatic Risk Rating Map for Upper Middle Fork Watershed

The 1996 watershed analysis did not consider the effect of hill slope position when assessing the potential for roads to contribute to increased sediment to streams or increases in peak flows. Jones et al. (2000) reporting on the H.J. Andrews Forest and vicinity, found that mid-slope roads were net sources of sediment to the stream network while valley floor roads were net sinks for sediment. In addition, Jones (2000) reported interception of subsurface flow by roads increased peak flows from 13 to 36 percent during runoff events with greater than a 1 year recurrence interval in seven of eight drainages with roads included in the study. The magnitude of the increase in flow was related to the density of roads on mid-slopes. Wemple (1994) found that roads may extend the stream network by 40 percent during storm events however she suggests that differences in the magnitude of these effects may depend on difference in hill slope position of roads in addition to road age, soil saturation, geologic substrate, and climate. Although roads on hill slopes have the potential to increase peak streamflows, this effect is likely most significant for events of relatively low magnitude with less than a 5 year recurrence interval (see response to aquatic concern number eight for additional information). Table 3-1 displays the density of roads on slopes greater than 30 percent by subwatershed. As shown in Table 3-1, Subwatersheds 23 1, 23 2, and 23 5 have the highest potential for mid-slope roads to influence peak streamflow.

Table 3-1. Roads on Slopes greater than 30 percent

Subwatershed	**Percent of Subwatershed with Slopes >30 Percent**	**Total Road Miles on Slopes >30%**	**Road Density on Slopes >30% (miles/mile^2)**
23 1 Staley Cr.	**65**	**55**	**2.10**
23 2 Tumblebug Cr.	**61**	**23**	**2.27**
23 3 Paddy's Valley	**35**	**23**	**1.64**
23 4 Indigo Springs	**48**	**11**	**1.29**
23 5 Swift Cr.	**55**	**33**	**2.30**
23 6 Echo Cr. (Simpson - north)	**42**	**20**	**2.30**
23 6 Echo Cr. (Echo - south)	**64**	**15**	**1.55**

The next step in identifying potential threats to critical spawning and rearing habitat for Bull Trout and Spring Chinook was to stratify the watershed based on the potential for cause-effect relationships that may exist, both directly and indirectly. This was accomplished by delineating polygons that include the "High Quality Habitat" for both species and all tributaries that feed directly into these stream segments and the tributaries which enter the mainstems within 1 mile upstream (See Figure 3-1). These polygons are intended to represent the area in which a debris slide generated upslope has the potential for direct deposition of slide material and a greater likelihood of negatively impacting the habitat for at least the short term.

The purpose of this stratification was to provide for prioritizing field analysis, road maintenance and hydrologic stabilization opportunities. In Fiscal Years 2000 and 2001, approximately 16 miles of High and Medium Risk roads have been maintained or hydrologicly stabilized within the direct cause-effect polygon,

23 miles of road are in the indirect cause-effect polygon. In addition to these work accomplishments, a proposal was submitted for Payments to the County funding for more extensive work in the Upper Middle Fork watershed.

Salmon/Bull Trout Restoration Projects and Opportunities

In FY 2000, 12 culverts on fish bearing streams in the Watershed Analysis area were analyzed for fish passage capability (Region 6 Fish Passage Survey Protocol). In the analysis, 11 of the 12 were judged to be fish passage barriers when considered for "all species, all life stages." This prognosis is predictable, given that the analysis is set up so that any culvert that has over a 4-inch jump height or over a 2% grade will not meet the fish passage criteria (Paul Bennett, pers. comm. 4/01). Using an outlet jump height of greater than 4 feet as an indicator, 3 to 4 of the 12 culverts analyzed are barriers to adult Bull Trout. These barriers are located on Roads 2143-325 (Echo Cr), 2135-283 (Simpson Cr- Private), 2300-422 (Swift Cr) and 2300 (Swift Cr). Currently, the Echo Creek culvert is scheduled for replacement in FY-02 and the two on Swift Creek have been submitted for funding as high priority replacements. Also, ERFO repair is scheduled for FY-02 to replace the only road related fish passage barrier on Tumblebug Creek. The table below outlines and prioritizes these culverts to be replaced.

Table 3-2 Prioritized Culvert Replacement Projects in the Upper Middle Fork

Road Number And Mile Post	Mile Post	Ranking	Creek Name	Species of Primary Concern
2300	17.1	H	Swift Creek	Bull Trout
2300-422	0.12	H	Swift Creek	Bull Trout
2143-325	0.4	H*	Echo Creek	Bull Trout
2300	19.75	M	Swift Creek	Bull Trout
2100	26.6	M	Noisy Creek	Bull Trout
2136-300	0.4	M	Staley Creek	Resident Fish
2154-380	0.1	M	Beaver Creek	Resident Fish
2134	0.85	L	Maple Creek	Resident Fish
2134-240	0.31	L	Maple Creek	Resident Fish
2135-283	0.9	L	Simpson Creek	Resident Fish
2135-283	5.3	L	Simpson Creek	Resident Fish

* Funded for replacement in F.Y. 2002

Dispersed Recreation Sites

There are 6 inventoried dispersed recreation sites located within the terrestrial riparian zone adjacent to "High Quality Habitat" for Bull Trout and Spring Chinook in the watershed. These sites are accessed by roads and in some cases also by a hiking trail. In general, access roads and dispersed recreation sites have the potential to result in increased sediment delivery to aquatic systems. Numerous factors including climate, topography, and type of use determine the magnitude of erosion from this source. Research studies have shown that erosion rates are highly variable depending on site-specific conditions (USDA Forest Service, 2000). In the Upper Middle Fork Watershed, several factors combine to result in a low risk of a

significant increase in sediment delivery to streams adjacent to dispersed recreation sites. These sites represent a very small portion of the Riparian Reserves in the watershed (.009%). Most of these sites are located in flat terrain with well developed vegetation adjacent to them and have porous soil which favors infiltration rather than overland routing. In addition, the heaviest period of use of these sites is during the summer dry season. When considering soil erosion and transport of soil into the aquatic system, these sites and the access routes associated with them have, for the most part, negligible impacts to the aquatic habitat.

Aquatic Species Distribution, Passages Issues, and Habitat Fragmentation

Spring Chinook and bull trout habitat likely overlap in most of the upper Middle Fork Willamette downstream of the reintroduction sites, including Hills Creek Reservoir. Spring chinook occupy habitat from Paddy's Valley to the reservoir and also migrate through the turbine and regulating outlets of Hills Creek Dam. At this time it is not known if spring chinook continue to migrate through Lookout Point and Dexter Dam, however, based on research from Hills Creek Dam and the similarities between the design and operation of the others it is probable that progeny of spring chinook that spawn in the upper Middle Fork Willamette migrate through the entire system to reach the sea. Excerpts of conducted studies are included below.

> "A study to assess spring chinook habitat usage that included, spawning distribution, migration tendencies and emigration survival through Hills Creek Dam in the upper Middle Fork Willamette River was conducted from July 1999 to January 2000. Radio telemetry was used to determine spatial and temporal spawning trends of adult salmon. Spring chinook spawned from late August and continued through late September. Water temperature and flow remained relatively constant throughout the spawning season. Five radio-tagged salmon captured downstream of Dexter Dam and released at Sand Prairie Campground on 12 July, migrated 8.5 miles upstream and 1.3 miles downstream to Hills Creek Reservoir. Five implanted salmon released on 12 July in Paddy's Valley migrated 0.8 miles upstream and 0.4 miles downstream. Five additional implanted salmon were released 2.5 miles downstream of a series of falls, near Tumblebug Creek, that may be a migration barrier on 02 September. The purpose of this release was to assess the likelihood of upstream passage of migrating fish over the falls and into Paddy's Valley. These salmon migrated 1.0 miles upstream and 15.9 miles downstream to Hills Creek Reservoir. No fish migrated upstream of the falls. Forty-eight redds were observed with the highest concentration in Paddy's Valley. Spawning habitat is less common below the falls although, prime habitat is available in the mainstem Middle Fork Willamette River and at the confluence of several tributaries".
>
> "Emigration sampling through Hills Creek Dam showed substantial numbers of salmon pass through the outlets. Estimates of salmon passing through the turbines and regulating outlet were 5,473 and 3,328 with 59 and 32% mortality, respectively. These results indicate spring chinook salmon effectively reproduce upstream of the dam in the Middle Fork Willamette and that passage survival through the dam outlets does occur. Alterations in the operating schedule of the dam could potentially reduce mortality in juvenile salmon".

Comprehensive studies similar to the one described above have not been completed for upper Middle Fork Willamette bull trout. However, several efforts are ongoing to monitor bull trout distribution and dispersal from the reintroduction sites. The bull trout reintroduction is currently in the fifth year and no spawning

surveys will be conducted until 2002. The most recent snorkel survey and trapping data on bull trout distribution shows that juveniles and sub-adults have moved approximately 0.25 miles upstream of Chuckle Springs and occupy habitat downstream to Hills Creek Reservoir. This entire area could be considered bull trout foraging habitat. In June 2000 a sub-adult bull trout was captured by an angler in the Middle Fork Willamette near Oakridge. It is not likely that bull trout have persisted downstream of the dam as no other observations have been made for over 30 years. The most likely explanation is that the bull trout migrated to Hills Creek Reservoir as a juvenile and subsequently went through the turbine or regulating outlet of Hills Creek Dam and reared in the mainstem Middle fork Willamette or possibly Lookout Point Reservoir. Once fish pass through Hills Creek Dam additional habitat in the North Fork of the Middle Fork Willamette, Salt Creek and Salmon Creek becomes available. Additional efforts to locate bull trout downstream of Hills Creek Dam have been unsuccessful. In 2002 the Forest Service will in stall a Vaki-River Watcher near the reintroduction sites in an effort to record adult bull trout returning to spawn.

4). *Identify potential bull trout refugia and develop long-term goals for these areas (address in the WA recommendations section p.98). How will future management activities affect these areas?*

Functional Relationship-Bull Trout Refugia and Long-Term Goals For Recovery

Important bull trout refugia in the Upper Middle Fork Willamette Watershed is depicted in the map of "Current Bull Trout Distribution" (Figure3-2). The areas represented as "High Quality Habitat" on the map were selected from information relative to known bull trout presence, water temperature, juvenile rearing habitat, etc. Areas listed as "High Quality Habitat" will likely be the same areas bull trout will use for refugia. Much more information and data will be required before biologists can accurately assess the specific boundaries of bull trout distribution. The bull trout reintroduction is in the fifth year and a large amount of data has been collected, however, codified assumptions about life history and range of habitat cannot be accurately assessed at this time. The bull trout in the Upper Middle Fork Willamette Watershed may adapt to habitat outside established parameters that apply to other geographic areas where the majority of bull trout research has occurred, specifically Montana and Idaho. Historic bull trout distribution in the Middle Fork Willamette and other tributaries was poorly documented up until the species was likely extirpated in the early 1990's. Accurate assessments and analysis of historic Middle Fork Willamette bull trout distribution range, spawning habitat, and rearing areas do not exist, which further compounds efforts to identify these areas today. Biologists are closely monitoring the reintroduced population to collect data relative to these questions. However, it will likely take several generations of bull trout to disperse and return before all habitat requirements are understood in the Upper Middle Fork Willamette Watershed.

Related Key Question

Where and to what extent has road density, condition, location and use influenced aquatic species distribution and habitats?

Response- Bull Trout Refugia and Long-Term Goals For Recovery

Research shows that bull trout spawn from late August through November in most geographic areas. Spawning is initiated when water temperatures reach 9-10 °C, (48.2-50°F). Given these temperature requirements and the seasonal nature of spawning, a large portion of the Middle Fork Willamette may be conducive to bull trout spawning when temperature alone is considered. However, data collected from spring chinook salmon spawning surveys shows that a large portion of the Middle Fork Willamette lacks substantial spawning habitat for large salmonids. The most likely explanation for the lack of spawning habitat is the overall absence of channel complexity and associated large wood in the stream channel to capture and hold appropriate size gravel. Chinook salmon redd location in the upper Middle Fork Willamette are typically associated with accumulations of gravel collected by large wood in the stream channel. The Paddy's Valley area contains highly productive chinook salmon spawning habitat, which is primarily related to increased amounts of large wood in relation to downstream areas. Salmonid spawning habitat could be improved in areas downstream of the bull trout reintroduction sites.

The U.S. Fish and Wildlife Service Draft Bull Trout Recovery Plan outlines specific requirements related to restoration and recovery of bull trout and their habitat. The following is a list of actions and recommendations relative to the Middle Fork Willamette from the Draft Bull Trout Recovery Plan that will assist and led to the restoration and enhancement of habitat in the Middle Fork Willamette bull trout population (See Draft Bull Trout Recovery Plan for complete list of recovery actions).

1). Develop and implement tasks to protect, restore, and maintain suitable habitat conditions for all bull trout life-history stages and strategies.

- Maintain areas with adequate water quality and eliminate sources in areas with impaired water quality in bull trout core habitat or potential core habitat.

- Identify and reduce or eliminate sources of human induced fine sediment that may impair spawning success. For actions in the upper Willamette Basin of particular concern are completing access and travel management prioritization and inventory of dispersed recreation sites on federal lands.

1.2). Identify areas and structures that are barriers or sites of entrainment for bull trout and implement tasks to provide passage and entrainment.

- Correct barriers impeding bull trout access to suitable habitat, e.g. road culverts (Echo Creek Rd 2143-325; Swift Creek Rd 2300-422 and Rd 2300; Coal Creek Rd 2133 and 2133-228; and other culverts that may be identified in the future that create migration barriers to migrating bull trout of all life stages.

1.3). Identify where stream channel and riparian area contributions to bull trout habitats is impaired and implement tasks to restore their appropriate functions.

- Re-vegetate to restore shade and canopy, and native vegetation.

- Restore, or allow recovery of, stream channel habitat complexity.

- Increase recruitment of large woody debris to improve in-stream spawning and rearing habitat.

- Restore habitat connectivity for all native species within the range of bull trout (i.e. prey base for bull trout including cutthroat and rainbow trout).

1.6). Identify where conditions outside the riparian areas (i.e. uplands) are negatively affecting bull trout habitats and implement tasks to restore appropriate functions.

- Identify existing road systems that have a high risk of adversely affecting utilized bull trout streams (e.g. through changes in sediment delivery and natural drainage networks, interception of ground water, interception of woody material delivery). Develop road management plans to modify, reduce, or eliminate these roads.

3).Establish fisheries management goals and practices compatible with bull trout recovery and implement practices and tasks to achieve goals.

- Develop and implement native fish management plans integrating research adaptively into fishery management programs.

- Restore historic prey base reintroducing spring Chinook salmon into habitats occupied by bull trout. Priority areas remaining in the Willamette Basin include the North Fork of the Middle Fork Willamette, Salt Creek, and Salmon Creek.

- Evaluate and prevent over harvest and incidental angling mortality of bull trout.

- Reduce angler pressure in areas where incidental mortality continues to be detrimental to recovery. (Utilize innovative techniques such as seasonal or permanent road closures). For example, restore dispersed campsites along the Middle Fork Willamette with temporary or permanent closure. Consider removal or relocation where risk of resource impacts are unacceptable.

5.2). Conduct research evaluating relations among bull trout habitat , and recovery tasks.

- Evaluate effectiveness of active and passive habitat restoration techniques in restoring watershed function and to recover local bull trout populations.

- Determine suitability of temperature regimes in potentially restorable bull trout habitat.

- Determine range of temperature tolerances for bull trout life stages in various habitats. Use results of ongoing temperature studies to address the adequacy of existing State rules.

- Identify and develop needed technologies, e.g., remediation, and evaluation methodologies.

6). Use all available conservation programs and regulations to protect and conserve bull trout and bull trout habitats.

- Use partnerships and collaborative processes to protect, maintain, and restore functioning core areas for bull trout.

- Designate core areas essential to recovery (similar to critical habitat) for the purpose of habitat protection and restoration.

5.) Identify and map limitations for natural recruitment of large wood (>21" dbh), such as location of stream-adjacent mature forest (>80 yrs.) which are intercepted by roads, or important areas which lack intact riparian vegetation (p.64). Section KQ6 (p. 82) should include discussions on habitat conditions/limitations for bull trout.

Functional Relationship – Riparian Large Woody Debris Condition and Recruitment

Large wood is critical to the proper functioning condition of upland forest streams. Large wood is a stabilizing and stream energy buffer in the aquatic ecosystem. Potential for deposition of large wood in stream systems is tied to disturbance regimes in adjacent forest. These include fire regimes, mass wasting, landslides; and small scale disturbance such as forest insects, wind throw, and disease. Wood in streams can be delivered in small amounts over time through stream channel dynamics and undercutting, or in large pulses from stand replacing wildfire. Wood presence decreases stream energy and increases channel

complexity. Complex channels lead to development of aquatic food chains, and spawning and rearing habitat.

Related Key Question:

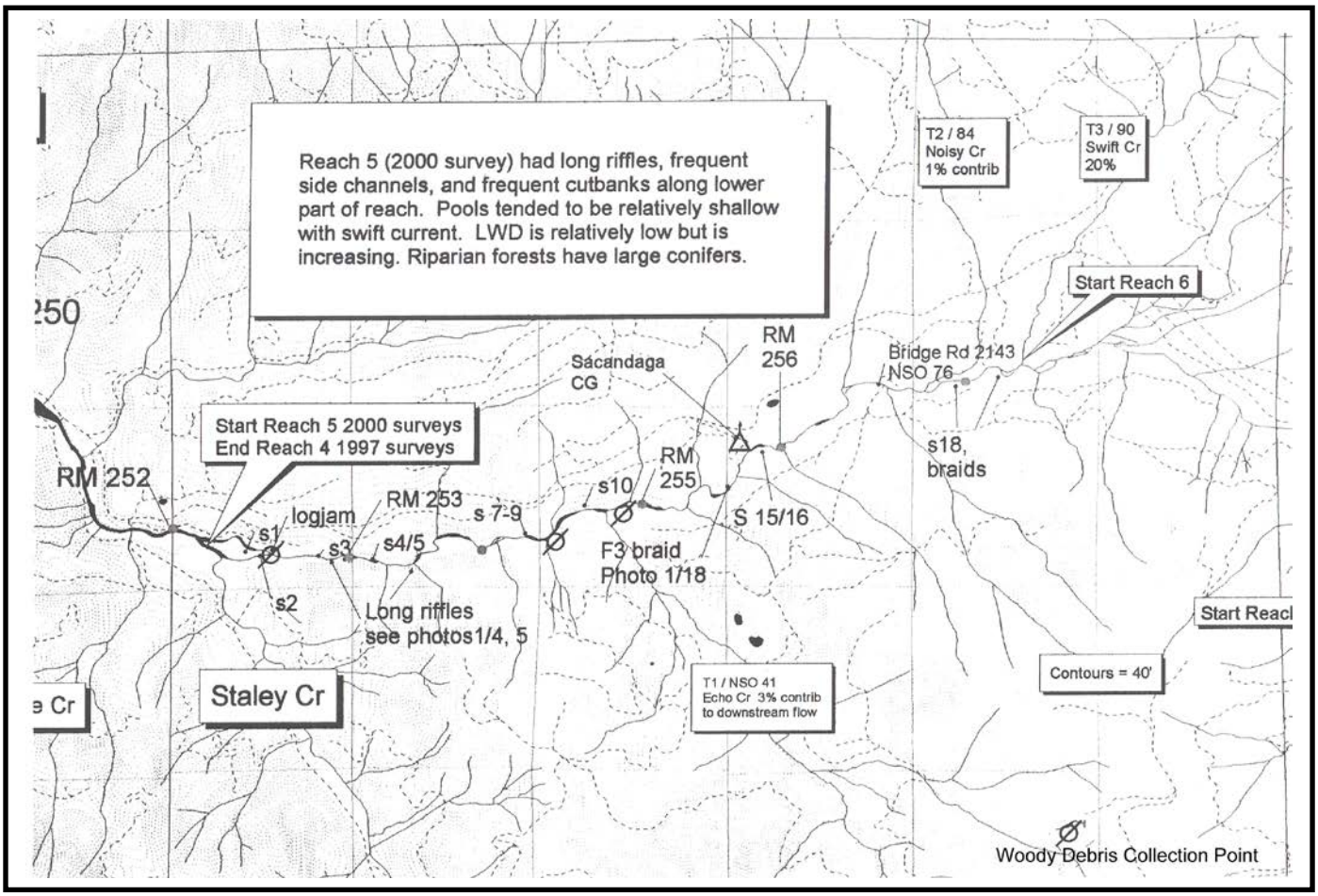
1. *Where and to what extent has road density, condition, location influenced erosion, hydrologic, and channel processes?*

Response– Riparian Large Woody Debris Condition and Recruitment

Recruitment of large wood in the main stem of Upper Middle Fork of the Willamette occurs via upslope delivery in first through third order streams (Lyons, Bechta, 1983). Two mechanisms involving initiation of debris delivery of large wood exist in the Upper Middle Fork, these include road initiated sloughs or slumps or, in the second situation, those that originate from natural stands. Sloughs and slumps that make it to stream channels from upper and mid slope positions can result in initiation of debris flows.

High energy debris torrents are the prime delivery mechanism for large wood from uplands to the Middle Fork of the Willamette and valley bottoms. Such debris torrents deliver large levels of sediments, spawning gravels, spawning cobbles, and large wood. Short-term affects to the watershed include increased turbidity, sediment pulses, and channel scour. Long term affects of these debris torrents is deposition of wood jams on river bars, channel nick points, and in flood plains on the main stem of the Middle Fork. This wood leads to desirable conditions such as channel complexity, pool creation, side channel development, and retention of organic material. These riparian hardwoods play a large role in nutrient delivery for the aquatic food chain (Hibbs, 1996). Riparian forests can provide natural wood levees that lead to future aggredation of flood related large wood and flood debris, leading to a dynamic stability in the Upper Middle Fork of the Willamette River main stem (Johnson et.al., 1999). This dynamic stability leads to desirable habitat conditions for salmonids and Bull Trout. Figures 5-1 thru 5-3 depict new information and show the existing woody debris collection points that exist in the main stem of the Upper Middle Fork (Ecosystems Northwest, 2001).

Figure 5-1 Current Large Wood Concentration Points, Reaches 4-6



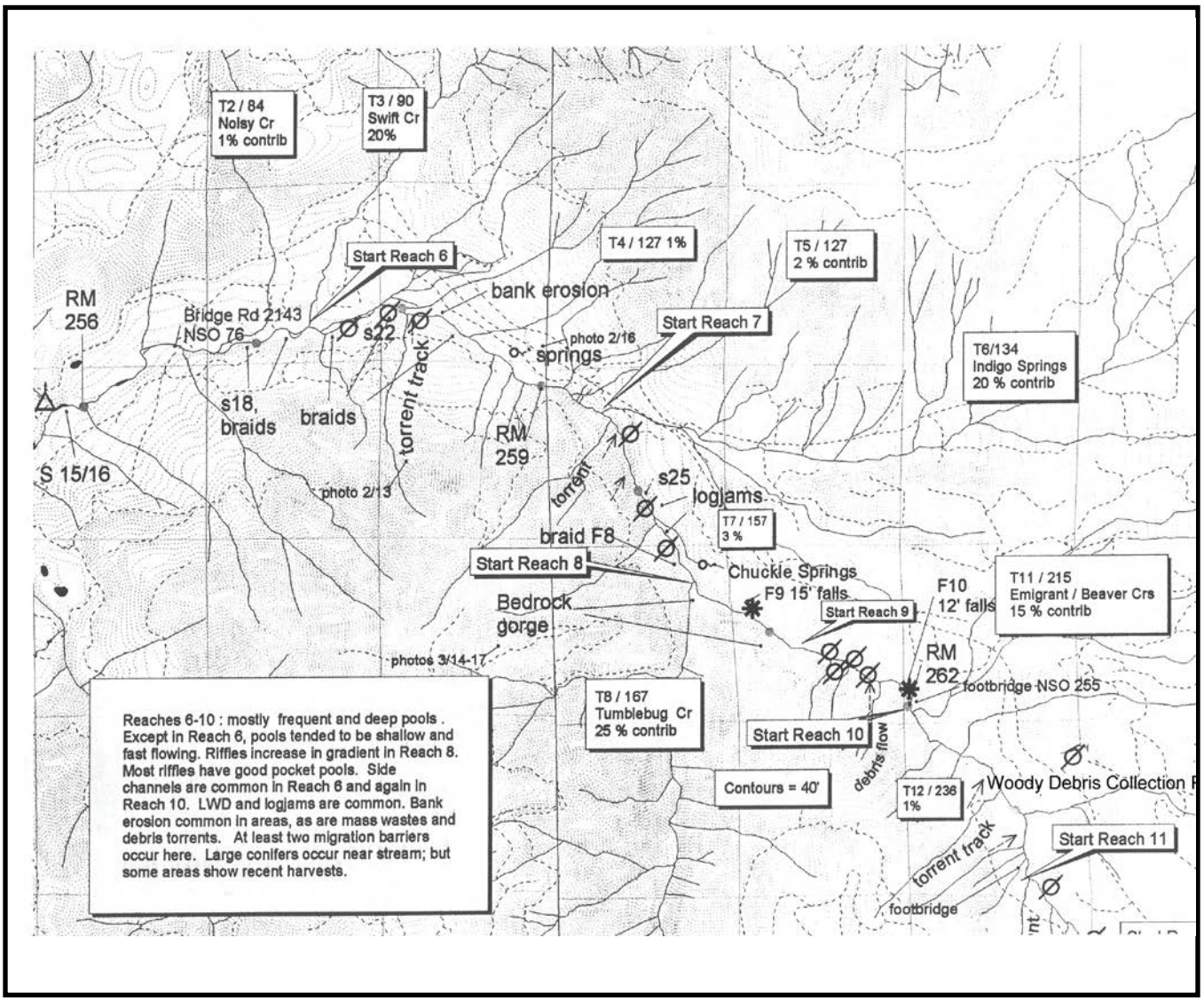


Figure 5-2 Current Large Wood Concentration Points, Reaches 6-10

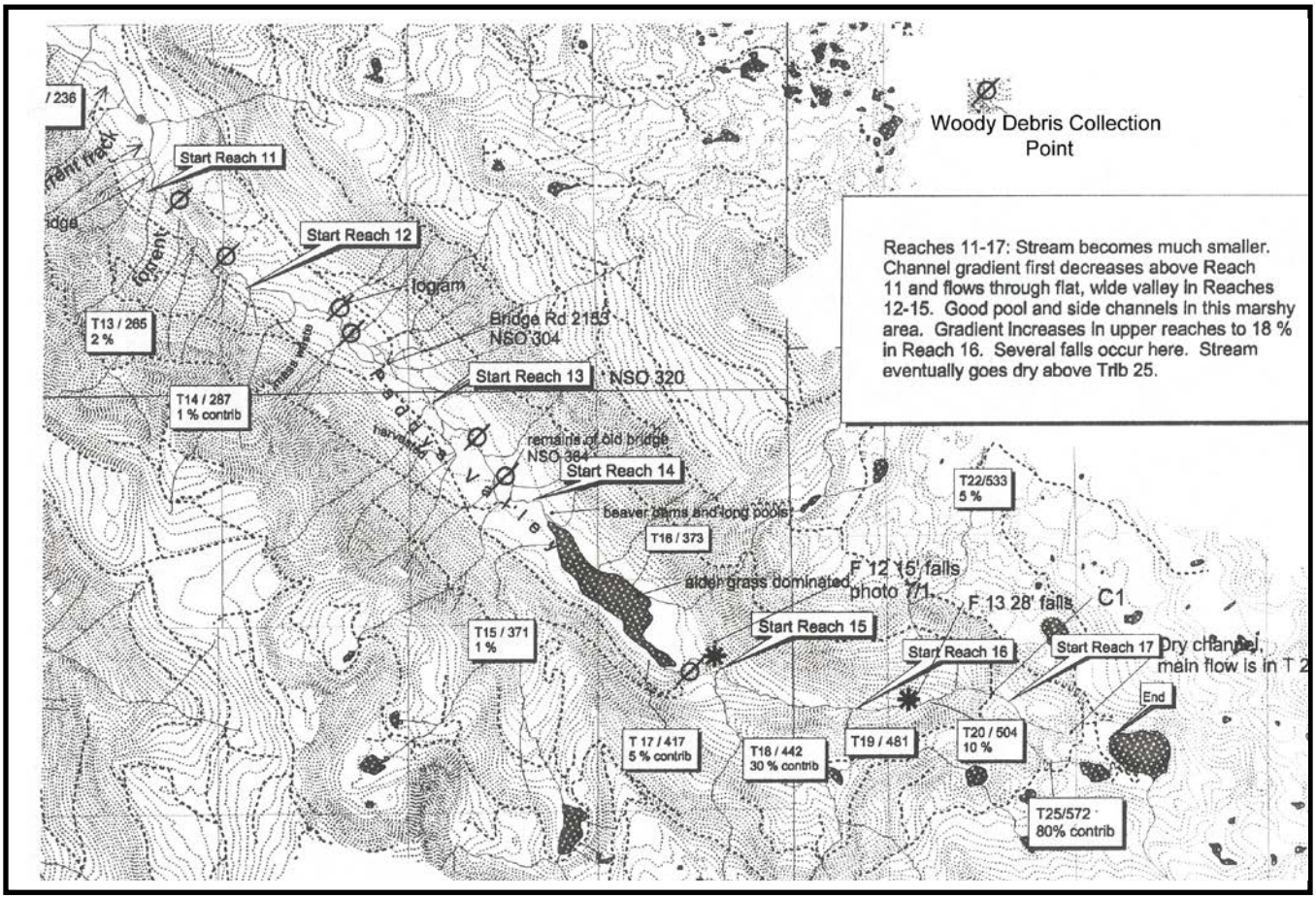


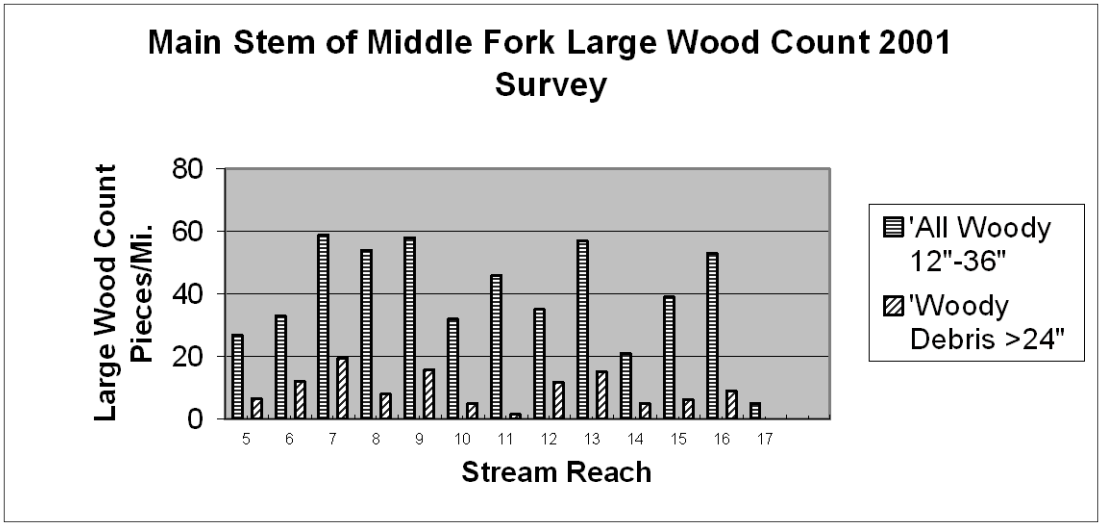
Figure 5-3 Current Large Woody Concentration Points, Reaches 11-17

The above maps spatially depict the distribution of wood in the Middle Fork. The 2000 stream survey (Ecosystems Northwest) also completed a large wood tally by stream reach in the Upper Middle Fork. This presence and distribution of large wood is important to Bull Trout and Spring Chinook Salmon habitat.

Large Woody Count By Stream Reach

The existing large wood count for the Upper Middle Fork stem by reach is outlined in the graph below. Counts range from 5 to 59 pieces/mile, counts were lowest in reaches 5 and 6, but also low in reaches 10, 14, and 17. Total piece count (>12”) is significantly higher than piece counts of >24”. Large wood greater than 24” appears to be at a premium in the main stem of the Middle Fork.

Figure 5-4 Large Woody Debris Presence in Upper Middle Fork -Year 2000 Stream Survey



Adjacent Riparian Vegetation Along the Main Stem of the Upper Middle Fork

The riparian zone vegetation along the Middle Fork is in a variety of disturbed vegetative conditions. This is due to the fact that the flood zone is routinely affected by peak flows and floods that can lead to desirable riparian conditions such as side channels, river bars, and natural levees (Bechta, Gregory, 1997.). The year 2000 stream survey indicated the following conditions; reaches 6-10 contain the highest density of large trees (21-32"DBH) within 100 feet of the bank channel, reaches 16 and 17 had a mixture of large and small trees. The graph below outlines the size classes of large wood in direct contact with the main stem of the Middle Fork (Ecosystems Northwest, 2001).

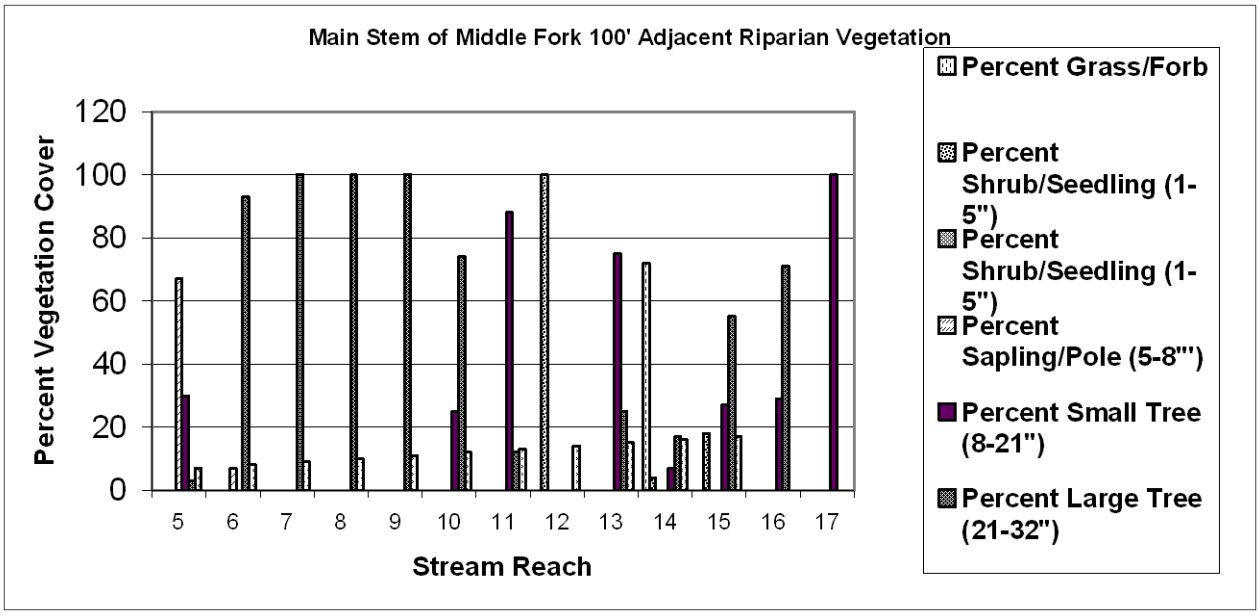


Figure 5-5 Upper Middle Fork Riparian Vegetation Condition

The density of large trees adjacent to the Upper Middle Fork of the Willamette are not uniformly distributed, most of the stream bank vegetation is flood derived riparian second growth due to the active nature of the channel and past riparian harvest. The flood terraces are nearly all dominated by riparian hardwoods and small conifers. This limits the size of wood available for input into the system from forest adjacent to the Middle Fork. Peak flows in the 1964 flood dramatically increased channel widths, these river widths returned to pre-flood levels within ten years of the 1964 flood, leaving only 40 year old vegetation adjacent to the active channel on many reaches (Bechta, 1983). Currently, only a small portion of the wood in the main channel comes from undercutting and bank movement of the main channel, most wood is delivered to the channel from upslope debris torrents and slope failures (Leverton, Pers. Comm.).

Upslope Riparian Large Wood Sources

The sixth field watersheds that feed large wood into the main channel of the Upper Middle Fork of the Willamette are in a variety of vegetation conditions. These conditions have been driven by land management practices, historic fire presence, and disturbance elements including insects and forest disease.

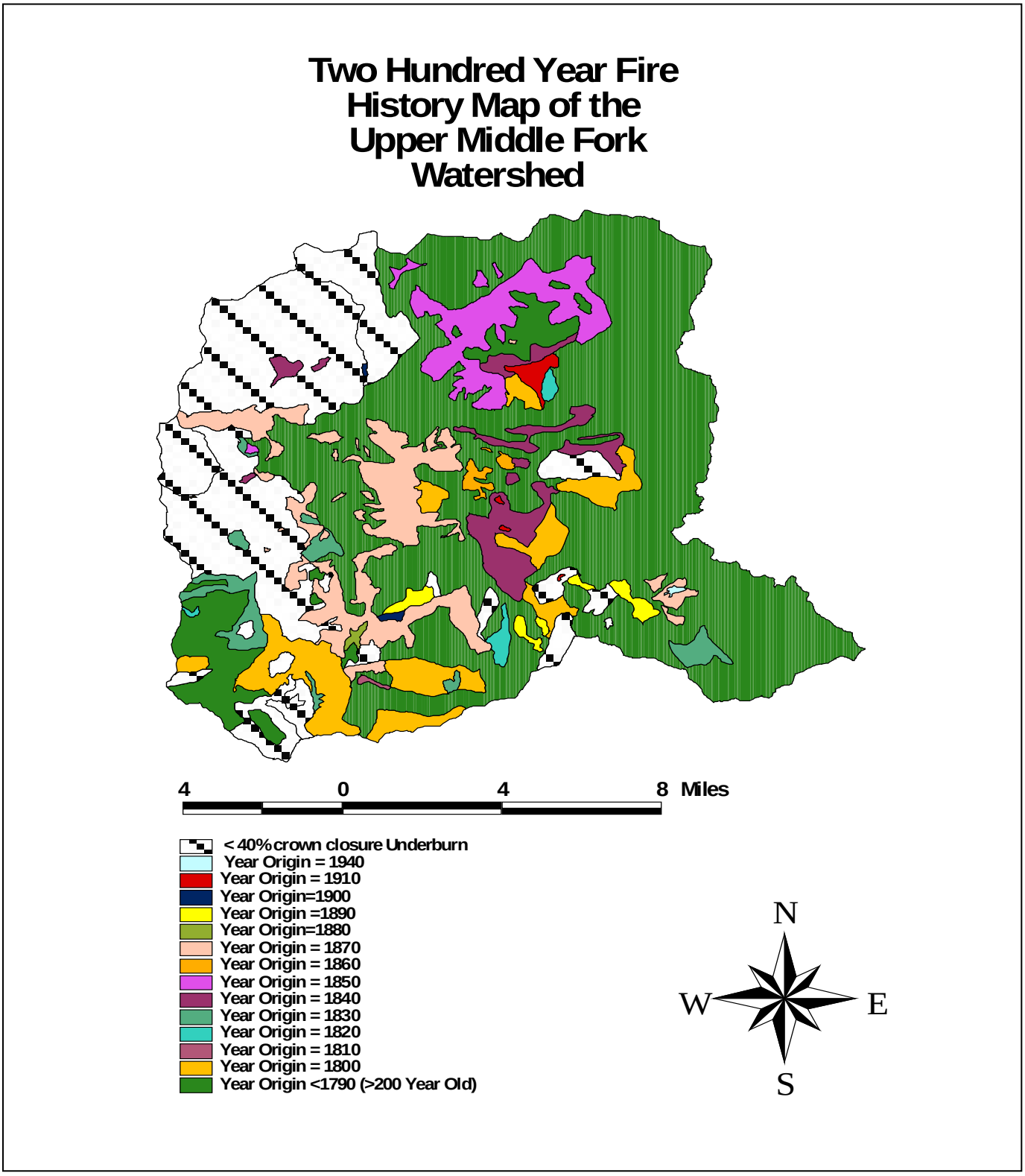
Fire Affects

Fire history sets the stage for upslope vegetation condition and delivery of large wood. A complete fire history map was generated for the Upper Middle Fork watershed using historic aerial photos, coring of trees in the field, and local stand information; this history was recorded back a total of 200 years (Agar, 1999). Several general trends were identified. These fires burned with increasing intensity from the lower slope, to the mid slope, and into upper slopes. From these photos and this study, it was noticed that fires routinely burn through riparian reserves at the mid and upper slopes. Two factors lead to the active presence of fire in riparian reserves in the Upper Middle Fork. This is explained by organic matter which accumulates at the bottom of steep draws, and that these same draws funnel upslope and downslope diurnal winds in a “chimney affect”, carrying fire in this fuel bed. (Agee). In this respect, the riparian reserves in the upper elevations are and have been transport mechanisms for fire (Tollefson, 2001). An analysis was conducted by combining a fire history layer and stream network of reserves to calculate the amount of area within current riparian reserves that have been burned in the last 200 years. By combining stream information and fire history across the fifth field watershed, trends were analyzed by sixth field watershed. Over the last 200 years, fires have stand replaced an average of 55 percent of the riparian reserve network on the watershed.

In this sense, a casual forest observation leads one to believe that historically, the watershed was always covered by older forest. When in reality, the watershed was in a perpetually disturbed condition where the only steady state phenomena was disturbance from constant burning and re-burning. Below is a map showing the extent of this fire history.

Below is the 200 year fire history map of the Upper Middle Fork.

Figure 5-6 Upper Middle Fork Two Hundred Year Fire History

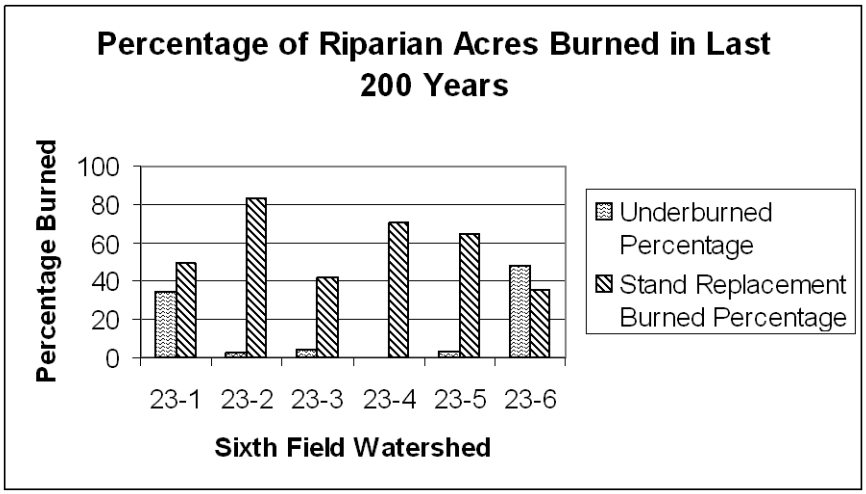


It is important to recognize the relative significance of this map of fire history (stand replacement fires) to Bull Trout and Spring Chinook Salmon in the watershed and their ability to survive in a fire disturbed landscape. At times in the past, before the advent of European forestry practices, the landscape was at equal or greater levels of disturbance than they are today. This fire history would periodically reduce shade and increase stream temperatures. Re-burns are common on this landscape. Re-burns are a result of fires that did not burn hot enough in the initial fire to consume the existing fuel, and re-burn a series of years later in a severe fire sets the stage for forest development under a condition of low levels of fuel loading. These re-burns tended to consume all carbon on the site, in some stands even stumps are consumed, leaving nothing but mineral soil and soil micro-organisms to re-inoculate the site. Severe re-burn fire intensity in many of these stands is evidenced by a lack of snags, downed wood, and stumps. In many second-growth fire stands, severe re-burns left the Middle Fork forest in a far worse condition than even clearcut harvesting in the 1970s. In re-burn situations, all forest biomass was consumed on the ground, whereas clearcut harvesting left brush, duff, stumps, and non-merchantable large wood in place on the site. Up until the early 1980s, it was standard practice to leave cull large woody material in place in both riparian areas, and on upslope logged stands.

Underburns provided frequent low levels of new snags and downed wood in valley bottoms; whereas stand replacement fires provide infrequent large pulses of downed wood to riparian areas from related upslope debris torrents.

Fifth field watershed 23-2 (Tumblebug) had the highest level of burned riparian area in the watershed.

Figure 5-7 Percentage of Burned Riparian Area in Last 200 Years in Upper Middle Fork Watershed



Management Related Affects on Riparian Reserves

A near- term affect on large wood levels has been timber harvest within what is now, designated, riparian reserve (ROD, April, 1994). This has resulted in reduced shade in some harvested areas. Regeneration harvesting from the 1930- through the mid 1980s inside these areas in the Upper Middle Fork watershed has resulted in a degradation of shade levels and large wood sources. After the mid 1980s, 50-100' buffers were left on perennial streams (Moody, Pers. Comm). These small buffers provided a relatively small amount of shade but a near natural level of large wood sources since 80% of large wood comes from within 50' of the

stream channel (Bechta, 1997). Graphed below are the cumulative historical affects of riparian timber harvest by stream class and sixth field watershed.

Figure 5-8 Seral Stage of Riparian Reserve in Sixth Field 23-1

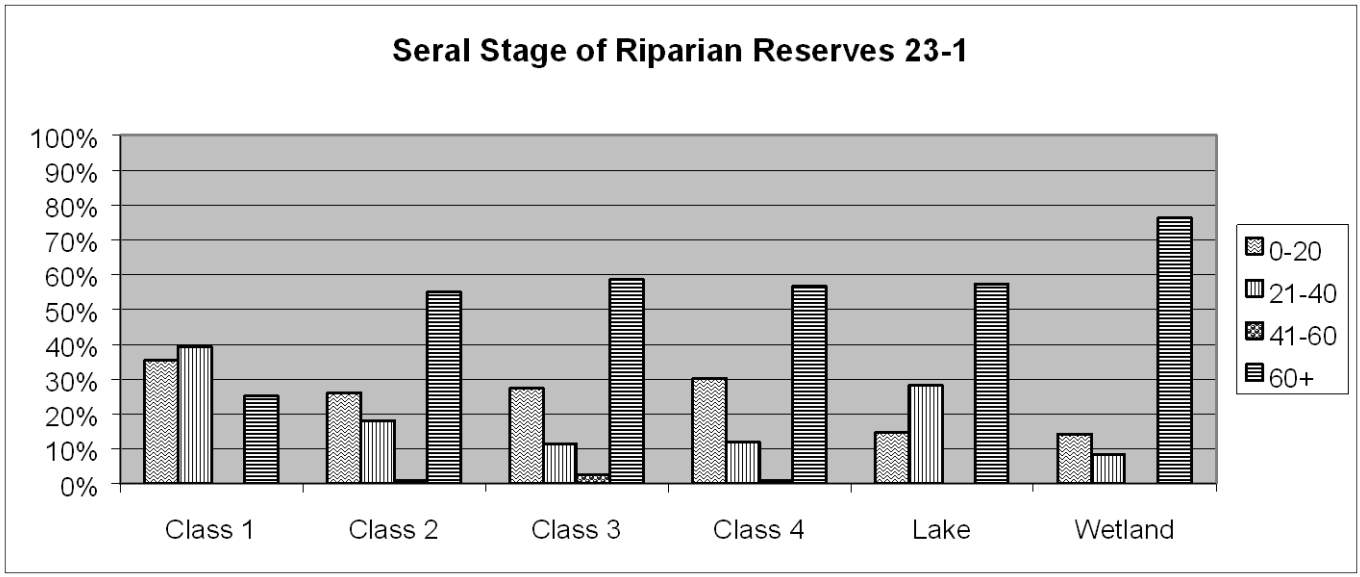


Figure 5-9 Seral Stage of Riparian Reserve in Sixth Field 23-2

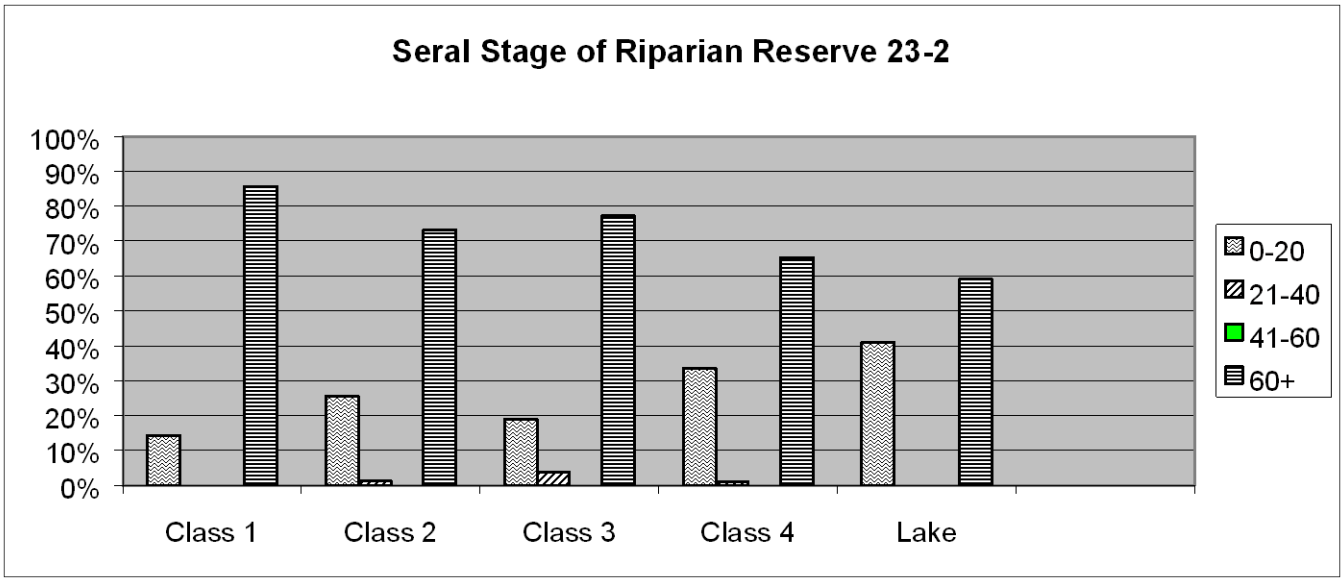


Figure 5-10 Seral Stage of Riparian Reserve Sixth Field 23-3

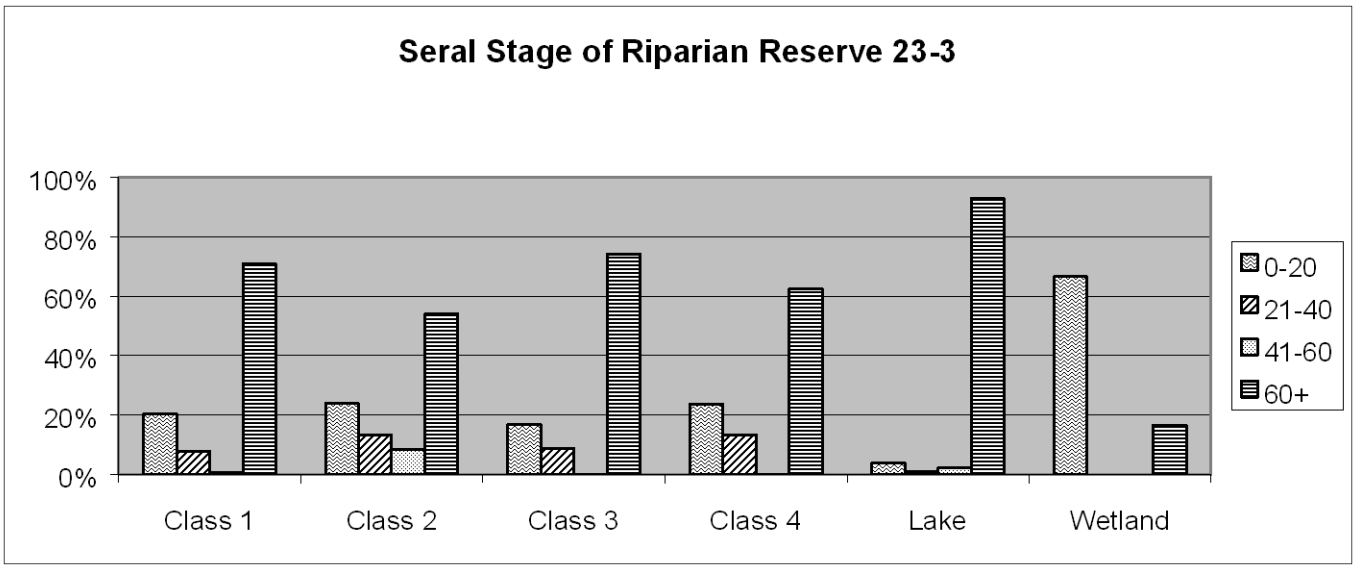


Figure 5-11 Seral Stage of Riparian Reserve 23-4

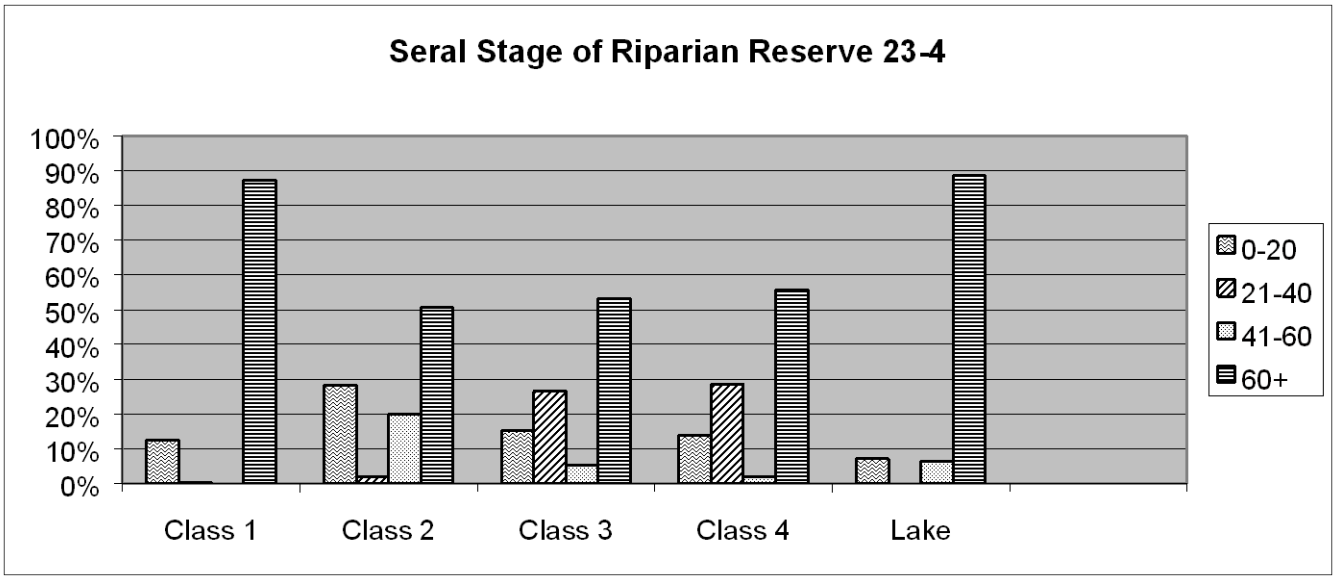


Figure 5-12 Seral Stage of Riparian Reserve 23-5

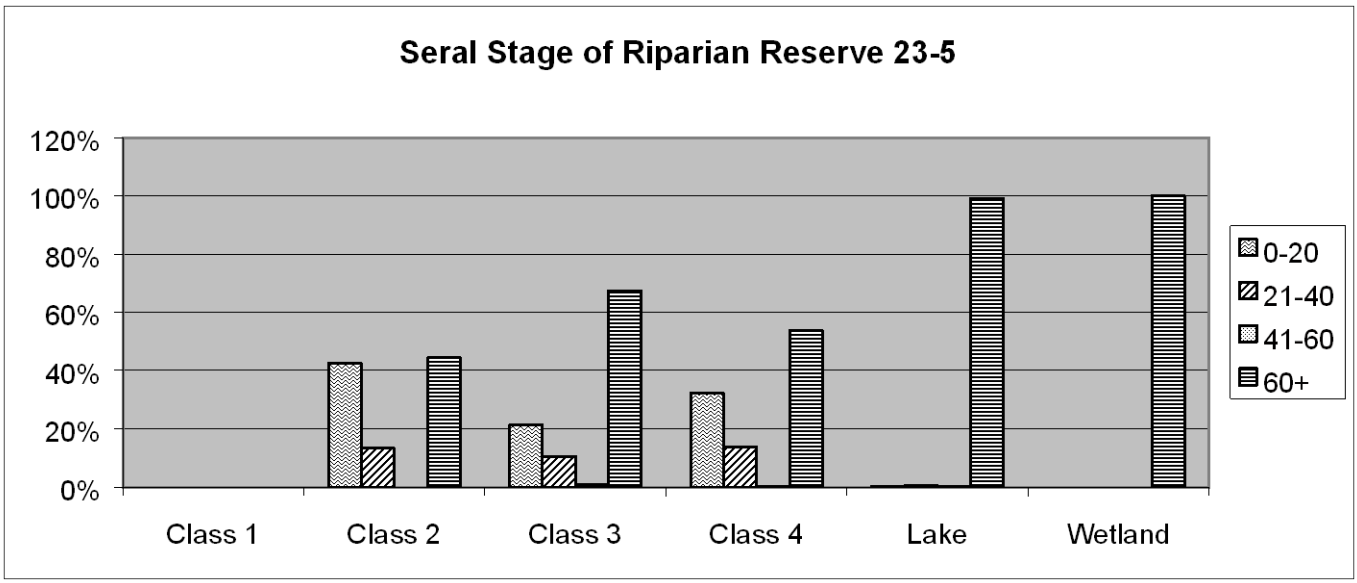
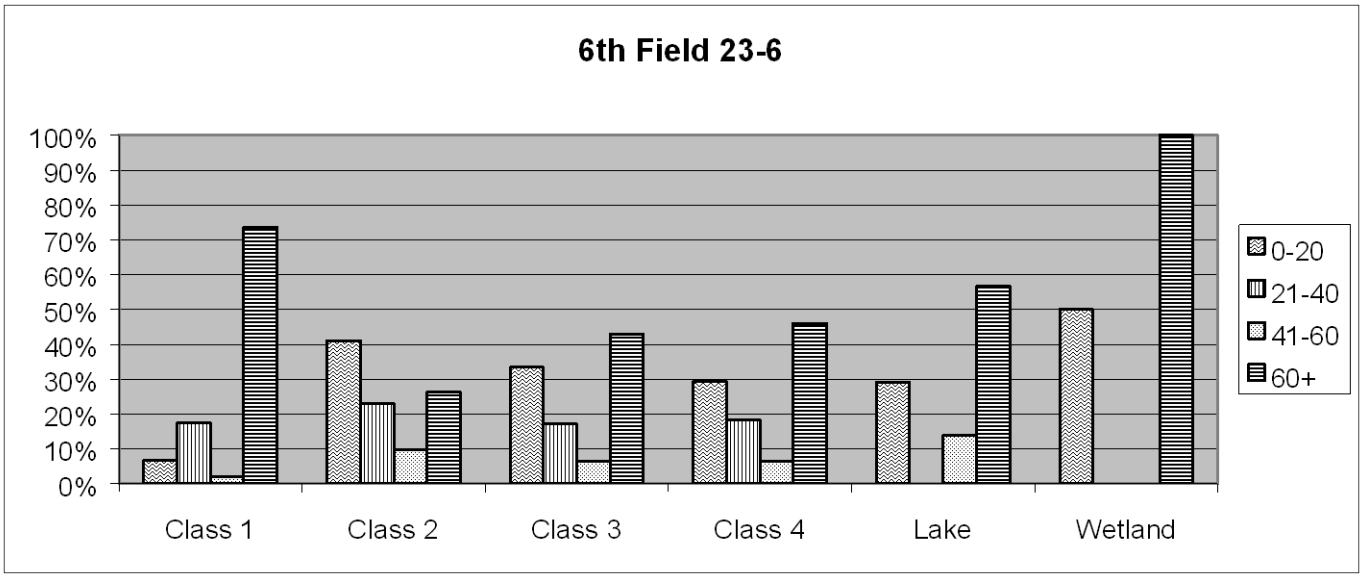


Figure 5-13 Seral Stage of Riparian Reserve 23-6



In addition to the graphical representation of this condition, the induced management condition of these riparian areas is mapped below.

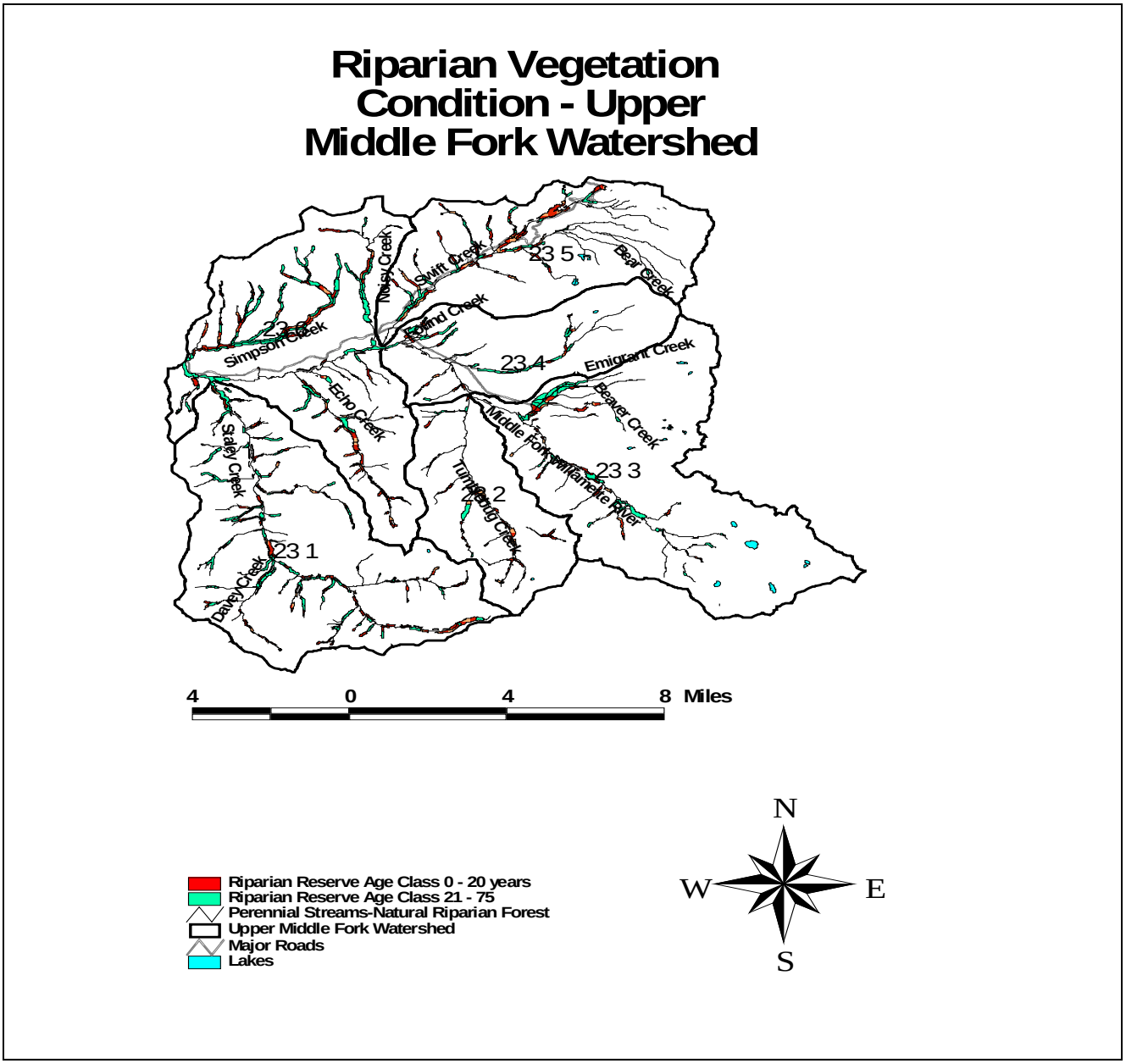


Figure 5-14 Mapped Riparian Condition of Fifth Field Watershed 23

Large Woody Debris Migration and Interception Points

Floods during the winter of 1996 created at least 51 debris torrents within the Upper Middle Fork watershed. Many of these debris torrents originated from road failures caused by re-routing of water. These are the most common affects of roads on debris torrent frequency and intensity (Swanson et. al., 1999). If these slope failures made it to class II, III or IV streams, they were synergized and resulted in complete alteration of steam channels from origination point to valley bottom, regardless of downstream road interception points.

A second source of debris torrents originates from roads when culverts plug due to undersized culverts or culverts that are not maintained. This results in release of entire road fills and debris in a large pulse of energy. The extended riparian system created by road interception of overland flow and faster release of this flow, leads to increased risk of culvert and road failures (Swanson, et.al., 1999). Most of this activity occurred on shallow steep slopes with hollows of unconsolidated colluvial soils in the Upper Middle Fork (Appendix A Upper Middle Fork WA, August, 1996). Many small landslides made it to creeks during the 1996 storm and then matured into large fast moving debris torrents downslope to higher order streams.

In the Upper Middle Fork, this is especially true in the upper Swift Creek area in the location of Mossy Creek and Baboon Creek where a concentration of debris torrents originated off of ridge top roads, sluiced through mid slope roads overrunning culverts and taking fills downslope, crossing valley bottom roads and finally dumping soils, gravels, debris, wood, trees, and root wads into Swift Creek. Much of this debris today is slowly migrating down to the Middle Fork through the Swift Creek drainage. Road densities in the area range from 5-7 miles per square mile. This same area produced the highest density of debris torrents in the Upper Middle Fork, approximately 10 debris torrent tracks were produced in an eight square mile area. A major debris/large wood jam currently exists 200 yards above the junction of Swift Creek and the Middle Fork of the Willamette. During the fall of 2000, a concentration of hatchery introduced adult Chinook salmon were observed using these structures in pools (Leverton, Pers.Comm.).

The quality of large wood does seem to be affected by road interception, observations from district storm monitoring teams shows that short wood pieces (<25’) clear roads successfully but that larger pieces (>25’) get hung up on road prisms.

Nearly all culverts in the watershed will not pass a tree length size piece of large wood and depending on the orientation of smaller pieces and size of the culvert, debris torrent sizes of large wood will not pass these culverts either. This can and does lead to road failures and delivery of debris down-slope. Open arches, bridges, rolling dips, and drivable dips are newer road designs used to facilitate passage of large wood associated with debris torrents in riparian reserves.

Large woody debris restoration projects on the district are designed to mitigate the natural wood delivery mechanisms that have been altered by historical riparian harvest. Stream surveys are designed to inventory streams and identify areas deficit in large wood. Since 1990 several large wood mitigation projects in watershed 23 have occurred, these are listed below:

Table 5-1 Upper Middle Fork Large Wood Restoration Projects

Upper Middle Fork Watershed Large Wood Restoration Projects				
Stream System	Stream Reach Distance	Number of Structures	Number of Pieces	Restored Density Per Mile
Beaver Creek Reach A - 1996	.75	18	106	141 pieces/Mile
Beaver Creek Reach B - 1996	.5	11		22 Structures /Mile
Middle Fork – Echo Ck to Found Ck.1994	4.0	60	----------	15 Structures /Mile
South Fork Staley Ck. 1995	3.0	56	124	19 Structures /Mile
Middle Fork – 1988 Pine to Buck Creek, Lower Buck Ck.	1.5	44	201	134 pieces/Mile
Middle Fork – 1999 Indian Ck.- Cone Ck., Snake Creek1.0	1.0	6	105	105 pieces/Mile
Staley Creek 1999	1.2	7	110	91 pieces/Mile
Swift Creek 1993	.5	10	70	140 pieces/Mile

Although the types, kinds, and randomness of delivery of large wood to riparian systems via restoration projects is different than that provided by debris torrents, these above listed projects could potentially ameliorate for lost wood sources along riparian reserves that were regeneration harvested. The degree to which these projects substitute for delivery of natural sources of large wood is unknown at this time. Perhaps the greatest change in stream dynamics and hydraulics in the Upper Middle Fork is the removal of large wood jams, channel spanning logs, and salvage logging in riparian reserves after the 1964 flood (Gregory, Pers.Comm.)

7.) Identify the process for possible changes in the riparian buffer widths around important bull trout recovery areas. Areas which are key are those around the springs (Iko, Chuckle, Shadow, and Indigo) where upstream buffer widths may be inadequate because of intermittent status.

Functional Relationship – Riparian Buffer Widths

Buffer widths on key riparian areas such as cold water springs and Bull Trout refugia are key to preserving water quality. Buffer widths function to protect riparian values such as shade, water temperature, rooting strength of the soils, solar radiation, affect of wind, filtering of overland flow, and amelioration of climatic regimes. Vegetation that influences riparian conditions generally does not extend beyond the distance of one site potential tree from riparian areas (FEMAT) . Buffer widths that extend beyond a site potential tree function meet terrestrial dispersal needs (FEMAT). Since these systems are class II streams and could be classed as class I streams due to recovery of threatened and endangered species, they would get a 340' buffer. This distance extends well beyond the aquatic influence zone. Intermittent status streams would be buffered 170', also well beyond the aquatic influence zone.

Related Key Question:

5. Where and to what extent have management practices influenced stream temperature? (UMFWA – 25).

Response – Adjustment of Riparian Buffer Widths

The first attempt at establishing riparian reserve widths was done under the Forest Ecosystem Management Assessment Team (FEMAT, July 1993). The team of scientists examined the impact and affects of the preferred alternative (Option 9) on aquatic species at risk (July 1993). At the time this first assessment was made, only half site potential tree heights were planned for retention on class III and IV streams (75') while full site potential tree heights would be left on class I and II streams (150'). All of the alternatives were evaluated for attaining an outcome of, " aquatic habitat will be widely distributed on federal lands throughout the range of the northern spotted owl" (Outcome A). Outcome A has a requirement for "clean gravels, cool waters (generally less than 68 degrees) and diverse and complex habitat." (FEMAT V-67,). All the fish in the species/groups for which assessments were made are salmonids, including Bull Trout.

At the time FEMAT was written, options 2,3,5,6,9, and 10 all had a 70% likelihood of perpetuating outcome A for all races/ species/ groups of salmonids at risk. At the time of the analysis, riparian reserves were one-half a site potential tree width (FEMAT V-68) . Outcomes for Options 1 and 4, which employed full site potential tree buffers predicted an 80% likelihood of achieving well distributed habitat for anadromous & resident salmonids and bull trout(FEMAT V-68). Since Option 9 was modified to employ full riparian buffers (equal to Options 1 and 4), it would offer the same level of protection as Options 1 and 4 (FEMAT,

p.V-67 and V-68), that is, well distributed habitat would be maintained at over 80% for all race/species/ groups of concern. For Bull Trout, the likelihood of widely distributed habitat would remain between 85% and 90%, for Spring Chinook Salmon, the likelihood of widely distributed habitat would remain between 80% and 85% (FEMAT V-69, Table V-11).

Riparian Reserve Widths as They Relate to Aquatic Organisms

The preceding description tracks the history of riparian buffer widths and the associated species viability assessment. The following description shows how variables such as root strength, large wood delivery to streams, large wood delivery to riparian areas, leaf and organic matter input, and shade relate to riparian reserve widths. Nearly all of these parameters are fully buffered within a buffer width of one site potential tree.

Rooting Strength- Rooting strength for bank stability provided by live trees, is generally fully realized at ½ a site potential tree (FEMAT V-27). With a full site potential tree width, all rooting strength is retained and only marginally compromised with density management treatments. Therefore, all benefits of retaining rooting strength is realized within the full site potential tree width. See Figure below.

Large Wood Delivery to Streams- Large wood delivery to streams is based on probability that when a tree falls, it will intersect the stream channel to later be incorporated into the wetted channel (Bechta). This probability is dependent on distance of the tree to the stream. Fifty percent of all streamside woody input comes from within a .4 site potential tree height (80') of the stream channel, and eighty percent of all streamside woody input comes from within a .75 site potential tree height (130') of the stream channel. With a full site potential tree width, all wood delivery options are retained. Density management treatments creates condition favorable to development of large wood sources within this effective input zone. Nearly all woody debris input comes from within one site potential tree (FEMAT V-27). Therefore, all benefits of retaining large wood sources are realized within the full site potential tree width. See Figure below.

Large Wood Delivery to Riparian Areas – This variable follows the same pattern above as outline for large wood delivery to streams, it is dependent on adjacent forest edge (FEMAT V-27). Therefore, all benefits of retaining woody debris sources are realized within the full site potential tree width. See Figure below.

Leaf and other particulate organic matter input – This variable is also distance dependent, beyond a one-half site potential tree height from the stream channel, litter input is greatly diminished (FEMAT V-27). Therefore, all benefits of leaf litter sources are realized within the full site potential tree width. See Figure below.

Shade – The shade variable is dependent on vegetation height, canopy opening above the channel, topography, forest structure type. For native forest structure, buffer width correlates closely with degree or percent of shading (Bechta, et. al., 1987). At a 100' distance up to 100% of the shade levels are maintained. Solar radiation is the only efficient mechanisms for heating water, a lack of shade in upslope forests generating heated convective winds, are ineffective at heating mountain streams (Johnson). Therefore, all benefits of retaining stream temperature are realized within the full site potential tree width. See Figure below.

Below is shown a graphical representation of riparian forest effect on streams as a function of buffer widths. Current forest plan buffer widths exceed the zones of influence in all areas of riparian function. Based on the variable discussed on page 45, there is no aquatic driver for increasing the width of riparian zones around spring areas such as Iko, Chuckle, Shadow, and Indigo springs.

Figure 7-1 Riparian Width Buffering Curves

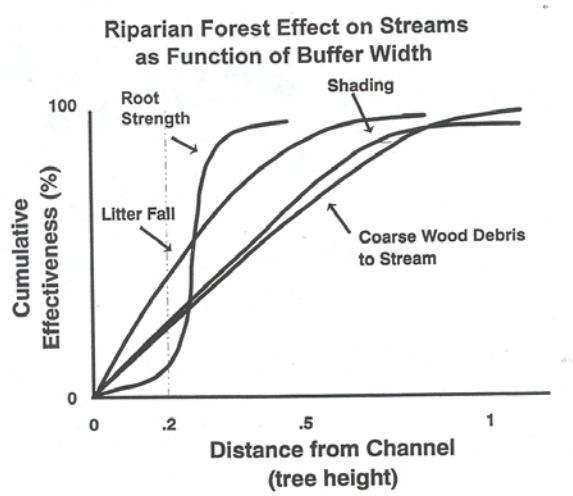


Figure V-12. Generalized curves indicating percent of riparian ecological functions and processes occurring within varying distances from the edge of a forest stand.

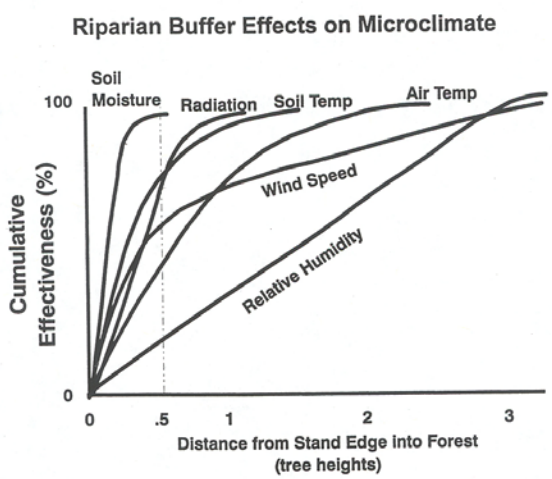


Figure V-13. Generalized curves indicating percent of microclimatic attributes occurring within varying distances of the edge of a riparian forest stand (after Chen, J 1991).

Riparian Reserve Widths as They Relate to Terrestrial Dispersal Needs

The Watershed Analysis update team reviewed the landscape condition in the area of Iko, Indigo, Chuckle, and Shadow springs, no definitive benefit could be positively stated as to why dispersal or upland connectivity would be enhanced by widening these buffer widths. Therefore, these widths were not recommended for change.

8. *Verify previous harvest rates in relation to hydrologic recovery (ARP). Are the standards used to determine the ARP ratings consistent and appropriate?*

Functional Relationship – Hydrologic Recovery, Current/Trend ARP Ratings

In recent years additional research examining the issue of effects of clearcut harvesting and road construction on peak flows has been published (Jones and Grant 1996, Thomas and Magahan 1998, and Beschta et al. 2000). Results of these studies is generally consistent in predicting increases in peak flows in small watersheds for runoff events with 0.4 to 5 year return intervals. Differences in interpretation of results appear in these studies relating to the effects of forest harvest and roads in large watersheds and for large magnitude events. The results of Thomas and Megahan (1998) and the results from Beschta et al. (2000) do not support the conclusion that there is clear evidence that regeneration harvest and roads increase the magnitude of peakflow events in large watersheds. In addition the latter two studies do not support the conclusion that forest practices increase the size of large magnitude events in either large or small watersheds. Jones (2000) suggests that in at least three of the 100 percent clearcut basins in her study of H.J. Andrews, increases in peak flows associated with large rain-on-snow events appear to be smaller than the percent increase in size of smaller events.

Related Key Questions

4. Where and to what extent have management practices influenced erosion processes, hydrologic recovery, and channel processes?

Response- Hydrologic Recovery, Current/Trend ARP Ratings

In November of 1997, watershed specialists from the Willamette National Forest met to develop a common methodology for calculating hydrologic recovery to be used for the entire Willamette National Forest. Aggregate Recovery Percentages (ARP) calculated using the revised methodology are displayed in Table 2. One of the significant differences between the method used in the 1996 watershed analysis and that currently used is how natural openings are considered. In addition to young stands and roads, the 1996 watershed analysis categorized as hydrologically unrecovered areas including “natural” openings such as