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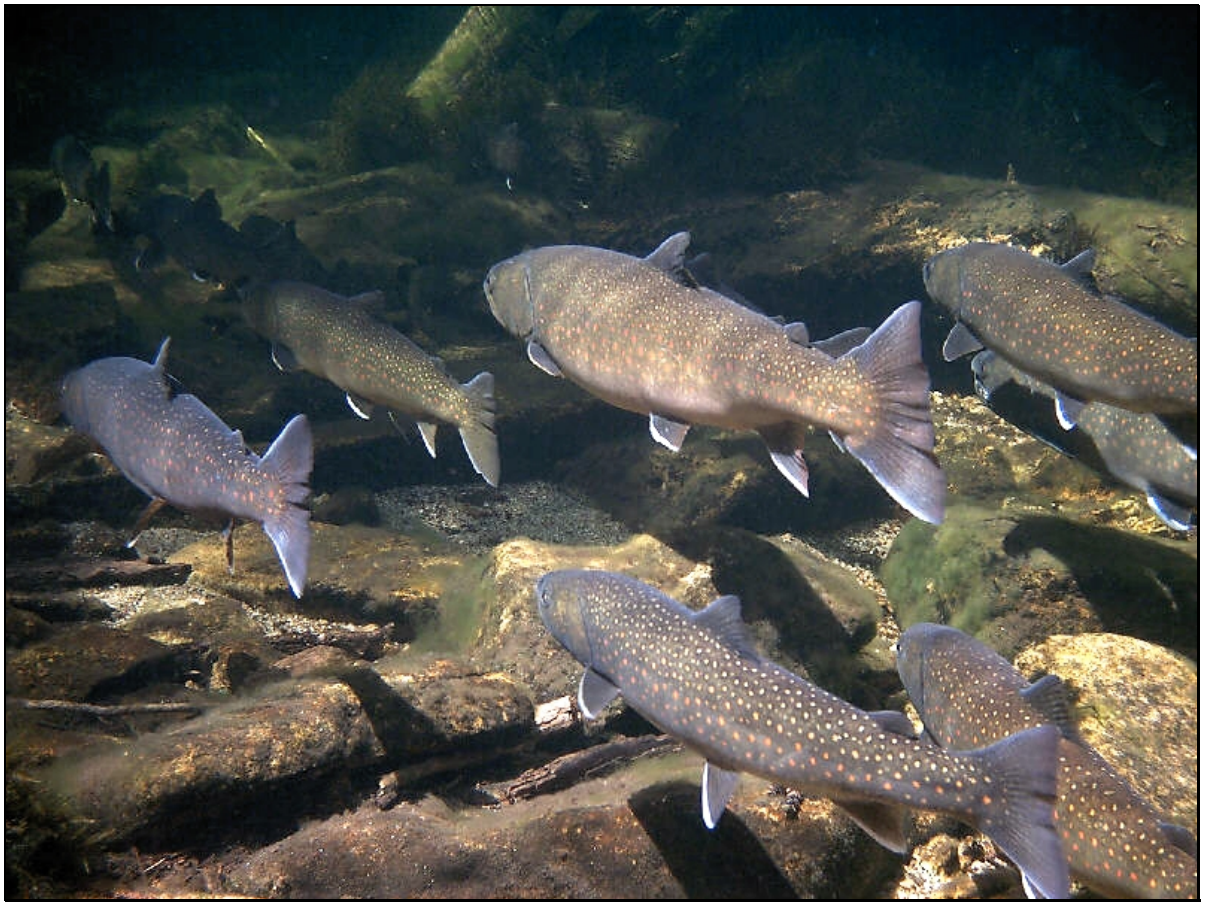
# Bull Trout Populations on the Payette National Forest



Migrating bull trout in Pete Creek in the Secesh River watershed

by
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## Abstract

This paper was developed by the fisheries biologists of the Payette National Forest (PNF or Forest) to evaluate the population trends and relative viability of Columbia River bull trout (*Salvelinus confluentus*) on the Forest. We infer that populations that are more fragmented have undergone long term population declines. We evaluated populations based on several quantitative criteria including the degree of fragmentation, the amount of habitat occupied, the number of life history forms in various watersheds, and other factors. Factors used in our evaluation include the number and extent of areas with bull trout, topographic relief to indicate areas with higher elevation and higher potential to support bull trout, the number of life stages of bull trout present, anthropogenic sources of fragmentation (*e.g.*, roads), the extent of sympatry with brook trout, and the number of potential food sources as indicated by the number of anadromous salmonids. Considerations such as genetic integrity are also evaluated. Quantitative evaluations were all restricted to values of attributes on the Payette National Forest, but it is likely that off-Forest attributes are important.

Insofar as viability varies among watersheds on the Payette National Forest in a fashion that we understand, several factors separating watersheds were useful for describing viability classes. We initially placed populations into viability classes based on a subjective evaluation of the factors we understood. Then, we illustrated this with the canonical discriminant analysis. The importance of road development as a discriminatory attribute indicates that low bull trout viability is related to increased roads. Because of this, we postulate that reduction in roads may to have a positive effect.

We postulated that time of disconnection from the sea is potentially an important determinant of bull trout viability. Although anadromous species presence or ubiquity and bull trout and life history expression are inherently biological factors, they can also be indicators of management-induced fragmentation. This is certainly true in the Weiser and Snake River watersheds where anadromous fish were excluded upstream of Hells Canyon dam in about 1965 and in the North Fork Payette River where Black Canyon Dam excluded anadromous species in about 1924 from the west side of the Forest. We have concluded that bull trout viability is low in these areas, with an inferred long term declining trend.

We do not know the extent to which bull trout viability is affected in the Salmon River basin by hybridization with brook trout. A genetic study of the Secesh River, and other easterly basins would help determine the level of hybridization and introgression that is occurring with brook trout. This information is important, because this geographic area is believed to have the most viable bull trout populations on the Forest. However, we do not know the trends of the Salmon River populations.

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## Introduction

This paper was developed by the fisheries biologists of the Payette National Forest (PNF or Forest) to evaluate the population trends and relative viability of Columbia River bull trout (*Salvelinus confluentus*, hereinafter referred to as bull trout) on the Forest. Bull trout were identified as the only aquatic Management Indicator Species (MIS) in the PNF's new Land and Resource Management Plan (LRMP; USFS 2003). Our assessment describes overall population trends on the Payette National Forest based on several quantitative criteria including degree of fragmentation, the amount of habitat occupied, the number of life history forms in various watersheds, and other factors. Genetic integrity is also considered.

The trends and population viability evaluated are those preceding the 2003 LRMP. They are not trends due to LRMP implementation, because the new LRMP has not been in effect sufficiently long to affect population trends or viability. However, this document establishes a baseline against which future population status can be evaluated.

The 1982 Planning Rule (Section 219.19, Fish and Wildlife Resources Planning regulations associated with the National Forest Management Act of 1976 (NFMA; PL 94-588) , states:

> Fish and wildlife habitat shall be managed to maintain viable populations of existing native and desired non-native vertebrate species in the planning area. For planning purposes, a viable population shall be regarded as one which has the estimated numbers and distribution of reproductive individuals to insure its continued existence is well distributed in the planning area. In order to insure that viable populations will be maintained, habitat must be provided to support, at least, a minimum number of reproductive individuals and that habitat must be well distributed so that those individuals can interact with others in the planning area.

Direction related to the monitoring of viable populations was also identified in the 1982 Planning Rule and states:

> Population trends of the management indicator species will be monitored and relationships to habitat changes determined. This monitoring will be done in cooperation with State fish and wildlife agencies, to the extent practical. (36 CFR 219.19(a)(6))

Bull trout was selected as the aquatic MIS for the LRMP in the Final Environmental Impact Statement (FEIS; Appendix F). With the exception of the North Fork Payette River, bull trout would be monitored in all subbasins as a MIS. A viability analysis was developed during Forest Plan revision and used in the FEIS and consultation on bull trout. Viability outcomes within 15 and 50 years by subbasins and recovery units were completed (FEIS pp 3-227 – 3-330).

In addition to implications from NFMA, bull trout have other legal standing. Bull trout were listed by the U.S. Fish and Wildlife Service (USFWS) as "threatened" under the Endangered

Species Act of 1973 (ESA; PL 93-205), as amended, on June 10, 1998 (63 FR 31647). The final rule for ESA implementation (FR 51106 p.19947, 1986) determined that biological assessments should contain:

(1) The results of an on-site inspection of the area affected by the action to determine if listed or proposed species are present or occur seasonally.
(2) The views of recognized experts on the species at issue.
(3) A review of the literature and other information.

According to the latter rule, biological assessments are used by the U.S. Fish and Wildlife Service, and National Marine Fisheries Service to prepare biological opinions "using the best scientific and commercial data available." The information in this paper will form the basis both for assessing trends in MIS abundance and for identifying the best scientific information available for use during consultation. A part of consultation documents evaluates bull trout populations.

## Synopsis of Bull Trout Biology and Distribution

Bull trout are commonly regarded as comprising metapopulations. Metapopulations are essentially super-populations, characterized by isolated or partially isolated subpopulations that periodically receive genetic input from neighboring subpopulations. In addition, it is possible for individual subpopulations to become extinct and be refounded by straying of individuals from neighboring subpopulations. In this way, metapopulations are more resistant to extinction compared to isolated populations. Increasing fragmentation (that is, isolation) of subpopulations can thus reduce the viability of a metapopulation by reducing the ability to refound subpopulations that become extinct through either anthropogenic or natural means. Bull trout seem to share some characteristics of metapopulations (Dunham and Rieman 1999; Rieman and Dunham 2000; Rieman and McIntyre 1993, 1995), and it is likely that connectivity among sub-populations is beneficial to population persistence overall and should be protected from anthropogenic reduction.

Bull trout distributions are believed to have declined over the past century or so, and we believe that their apparent naturally discontinuous or "patchy" distribution (Rieman and McIntyre 1995) provides some indirect evidence for this. For example, we expect the degree of discontinuity among subpopulations to be greater where there have been more anthropogenic stressors that are likely to have resulted in increased patchiness. In Japan, time since dam construction (*i.e.*, isolation time after habitat fragmentation) was shown to be related to extirpation of white-spotted or Japanese char (*Salvelinus leucomaenis*), a species closely related to bull trout (Westrich *et al*. 2002), populations (Morita and Yamamoto 2002). Building on these concepts, we evaluated a relationship between large-scale basin fragmentation and occupation of small stream watersheds, and were able to develop an index of population decline based on the elapsed time since various watersheds were completely cut off from their greater basin by water developments, dam construction (Burns *et al.* 2003). This approach evaluates trends based on occupancy of sixth-level hydrologic units (HUs), time, and intra-watershed diversity.

Rieman and McIntyre (1995) determined that the probability of bull trout presence increased with patch size, quite possibly because habitat diversity (*i.e.*, complexity) is also related to patch size. Bull trout were likely (>80%) to be found in patches larger 7,413 acres, unlikely (<10%) to be found in patches smaller than 2,471 acres.

Fragmentation decreases the likelihood of long-term persistence of bull trout populations making them more susceptible to extinction from habitat alteration such as climate change, exotic species, grazing, road occurrence (sedimentation and culverts), water diversions or impoundments, consumptive activities (timber harvest, mining), and random events such as debris torrents. Examples of fragmented bull trout populations can be found across the PNF and the levels of fragmentation vary greatly. Natural events have led to a baseline level of natural fragmentation, which has increased due to artificial barriers such that most fragmentation on the PNF must be considered to be anthropogenic. Naturally isolated populations have persisted since they were isolated despite lack of interchange with other populations, but anthropogenic fragmentation within the watersheds inhabited by these populations is probably reducing their long-term viability, particularly because the amount of

available suitable habitat is likely declining generally as a result of climate change (Keleher and Rahel 1996; Rieman *et al*. 1997; Nakano *et al.* 1996). As available habitat declines, connectivity among isolated populations becomes more important and simultaneously increases the likelihood of individual populations being extirpated while reducing the potential for their refounding. Increasing fragmentation thus probably reduces viability by reducing diversity, stability, and persistence (Rieman and McIntyre 1993). Isolated populations can and do persist but cannot be expected to persist as long as they would if they were not isolated (Morita and Yamamoto 2002).

Any estimate of population trends must include some evaluation of connectivity at various scales. It is easy to think in terms of isolation of large watersheds from their basins (Burns *et al.*, 2003), but it may be more important to consider fragmentation within interbreeding populations. In other words, we believe that a small watershed, perhaps at the scale of 6$^{th}$ level HU, that is highly fragmented will have a population subject to decline more than a less fragmented small watershed regardless of its relationship to the larger basin.

Lee *et al*. (1997) summarized the effects of roads and other development on fishes in the Columbia River basin. In their assessment of the distribution and status of fishes, they concluded that, "Variables potentially reflecting the degree of human disturbance within watersheds (roads, management cluster, dams) were important in the distributions of bull trout…" They also concluded that, "…the patterns in the current distributions of bull trout are consistent with existing knowledge and speculation on bull trout habitat relationships…Other variables in the model suggest that bull trout are more likely to be found in areas with lower road densities…" Therefore, we examined road densities across the PNF as one indicator related to bull trout populations and viability.

Fragmentation may affect the types of life histories that can persist in large river basins. Pratt (1992) described several life history variations for bull trout, including resident, fluvial and adfluvial types (some coastal populations are anadromous as well, but we are considering fluvial, adfluvial, and resident to represent the full range of life history expression for our purposes). Such variations are likely to be a hedge against stochastic environmental variation and increase the viability of a population or group of populations. Behnke (1992) succinctly summarized this point:

> Genetically based differences in anadromous spawning migrations allow distinctive populations of a species to coexist. Some reproductive isolation is accomplished by different timing of spawning runs. The homing instinct that returns fish to their natal streams also isolates spawning groups within the same drainage basin. These evolutionary strategies promote diversity of discrete stocks whose collective specializations exploit a river system's resources in time and space more thoroughly than a single stock…

Variation in life history within a river basin would increase the chances for viability of a bull trout population or group of populations, because it is unlikely that a localized event would negatively affect all the individuals in a large river basin; this situation is discussed with reference to wildfire by Rieman and Clayton (1997).

Rieman and McIntyre (1993) hypothesized that life history patterns can make a big difference in the relative significance of changes to habitat. A slow-growing resident population may not be able to handle even a modest habitat change whereas a migratory or fast-growing population might be able to withstand a similar or worse habitat change. Isolated populations are at risk of extinction, even if no further loss of habitat were to occur. Maintaining life history diversity in bull trout populations is important to their conservation because it gives the species an advantage by spreading the risk in a variable environment. It seems reasonable to presume that diversity in life history patterns is itself an adaptation to variation or unpredictable changes in habitat quality over time.

Bull trout on the PNF exhibit a continuum of life histories from resident to multiple migratory strategies (*i.e.*, from adfluvial to resident[1]) within and across drainages. There is a range of conditions that constrain life history diversity to various degrees. Life history diversity and genetic diversity are somehow interwoven, but we cannot quantify that relationship. Therefore, monitoring of population trends using metrics related to genetic integrity is important for detecting changes in population size; large populations protect against inbreeding and contribute to greater genetic diversity.

Rieman and McIntyre (1993) cited studies indicating that hybridization with brook trout is a common problem where isolated or remnant bull trout populations overlap with brook trout because both species spawn at about the same time, in the same places, and under similar conditions. Shifts in the fish community from one dominated by bull trout to one dominated by brook trout have been documented. This indicates that there may be a decrease in bull trout viability in streams where the two species exist (Rieman *et al*. 1997), though the presence of fluvial migrants may reduce the risk because migratory bull trout are more fecund and typically much larger than brook trout, which may limit hybridization. This process has been shown for other char that are even more closely related than these (Redenbach and Taylor 2003).

Adams *et al*. (2000) found that brook trout migrated up steeper stream channels at a greater rate than had been thought possible. This indicates a potentially greater effect from brook trout than previously thought to isolated headwater populations of bull trout. The Weiser and Brownlee basins are such locations; we now consider bull trout populations in the NFPR to be non-viable, because of the degree of bull trout isolation and ubiquity of brook trout.

In addition to sympatric species potentially causing declines in bull trout abundance, some may be necessary for stability or increasing populations. Rieman and McIntyre (1993) cited studies showing that other fishes are very important in the diet of bull trout, so bull trout distribution may parallel that of prey fish species. One study found that, in several river basins where bull trout coexisted with large populations of juvenile salmon, bull trout abundance declined when salmon declined. This indicates forage fish play a role in bull trout viability. So one metric that we evaluate is whether anadromous salmonids are coincident with the degree of bull trout population fragmentation.

[1] Although the term "fluvial" simply means that they are found in streams, we use the term to distinguish forms that live in larger streams and migrate to spawning grounds from resident forms.

We use several factors to evaluate trends in bull trout populations and relative viability. Those factors include the number and extent of areas with bull trout, topographic relief as an indicator of potential bull trout habitat associated with higher elevation, the number of life stages of bull trout present, the degree to which bull trout populations are fragmented, anthropogenic sources of fragmentation (*e.g.*, roads), the extent of sympatry with brook trout, and the number of potential food sources from anadromous salmonids. This also involved determining their prevalence within hydrographic units of various sizes, their potential for interaction with other populations, connectivity within populations, past and current management, topographic characteristics of the watersheds in which they live, and similar aspects of their environment. This approach allows for an evaluation of bull trout population trends and relative viability at the scale of the PNF, but does not evaluate the annual trend of bull trout in any single stream or hydrologic unit smaller than the 4$^{th}$ level. We infer that populations that are more fragmented have undergone long term population declines. From this initial and exploratory analysis, we expect to be able to describe how viability may be associated with future Forest actions in various watersheds where the relationships between populations and environmental conditions have been described.

We met as a facilitated group on September 28 through 30, 2004 in McCall, Idaho, with the purpose of initially classifying the relative viability of bull trout populations across the Payette National Forest. We subjectively classified large watersheds (Appendix 5) into high viability for the highest on the Forest, moderate viability for those watersheds with intermediate population viabilities, and low viability for the lowest on the Forest. The lower bound of viability was considered to be functional extinction; however, we remain uncertain about the long term status of other groups. The subjective classification was based on examination of the factors described above. However, we were not content to describe relative viability without further quantitative examination.

This effort called for some sorts of multivariate analyses, which we approached first as a blending of exercises in ordination and classification. These two concepts are similar, but ordination is typically used to locate the positions of items (usually some class of organism) along environmental gradients, while classification typically involves grouping (*i.e.*, determining relationships) of items. The items in this case were watersheds or subdivisions of watersheds, not organisms, characterized by several environmental attributes or variables (*e.g.*, area, bull trout presence, *etc*.). Because we already had an intuitive grouping, we decided to start with ordination and see how the arrangement of items in the ordination aligned with our *a priori* groupings. We then followed the ordination with a typical classification (cluster analysis) exercise to see what other or additional patterns might emerge. Although infrequently used in fish habitat analysis, multivariate procedures seem to becoming increasingly common; Nelson *et al*. (1992), one of the first of these, used a similar ordination method to evaluate important environmental gradients in the distribution of native Lahontan cutthroat trout (*Oncorhynchus lewisi henshawi*) and introduced Eastern brook trout (*S. fontinalis*) in northeastern Nevada.

Following the ordination, it seemed reasonable to try to develop discriminatory relationships among areas. Discriminant analysis requires *a priori* classification of the sites, which we

estimated and attempted to illustrate with the ordination and classification exercise. Some of this may be somewhat redundant, but we hope that it will strengthen our interpretation of apparent attribute and viability patterns for analysis areas and Section 7 watersheds across the Forest.

We have divided the Payette National Forest into eight generalized watersheds for the purposes of this paper (Figure 1 [next page]). The watersheds are called Section 7 watersheds, because they are synonymous with those upon which consultation is conducted with the United States Fish and Wildlife Service (USFWS) for forest management effects to bull trout. These Section 7 watersheds are:

- NF Payette River
- Weiser River
- Brownlee
- Deep Creek
- Little Salmon River
- Main Salmon River Tributaries LSR to SFSR
- South Fork Salmon River
- Main Salmon River tributaries SFSR to Middle Fork & Middle Fork tributaries

Except for Deep Creek, they are of a spatial scale similar to that of 4$^{th}$ level HUs.

The best available scientific information regarding bull trout in each of these watersheds is discussed in the following sections of the paper. After that discussion we include a multivariate analysis of factors affecting population trends, and viability.

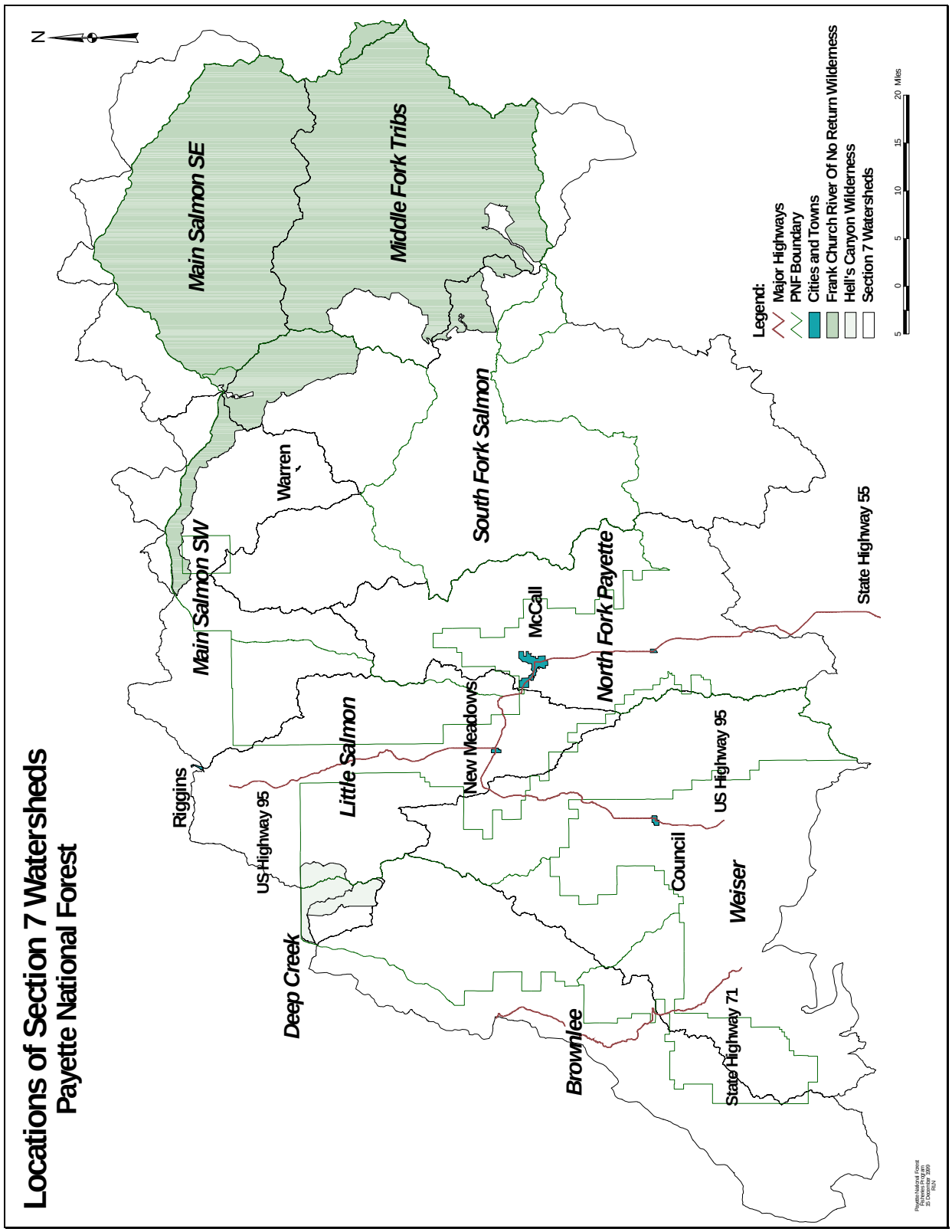


**Figure 1.—**Section 7 watersheds on the Payette National Forest.

## Summary of Best Scientific Data by Section 7 Watershed

### NF Payette River (NFPR)

The NFPR Section 7 watershed (Figure 1) covers 393,377 acres on the Payette and Boise National Forests (PNF and BNF), as well as a large portion of private, Bureau of Land Management (BLM), Bureau of Reclamation (BOR), and State of Idaho lands.

Three watersheds of the NFPR Section 7 watershed are partially on the PNF (4th level HU 17050123; all hydrologic unit codes are the codes used in the LRMP). Surveys have been conducted periodically in these watersheds to locate bull trout. Bull trout occurrences have dwindled from rare to none in the upper NFPR, Lake Fork Creek, and Kennally Creek watersheds (5th level HUs 1705012306, 1705012307, and 1705012309, respectively), and brook trout were found in all areas.

#### *Subwatersheds*

***Upper NFPR.—***Bull trout were documented in Fisher Creek and Sater Creek (a tributary to Fisher Creek) in 1983. Electrofishing at that time turned up five bull trout in Fisher Creek and four in Sater Creek (6th level HU 170501230603). Surveys were conducted six different years from 1994 through 2004 in five different subwatersheds (6th level HUs 170501230601, -02, -03, -05, -06) and no bull trout were found (survey data on file at PNF SO).

***Lake Fork Creek.—***Bull trout were documented in the North Fork of Lake Fork Creek by IDFG in 1998 (6th level HU 170501230704). At that time, three fish were found using electrofishing methods (Meyer 1999). Surveys were conducted in 1994, 1998, 2002 and 2003 in two subwatersheds (6th level HUs 170501230704, -05) and no bull trout were found. (Surveys on file at PNF SO.)

***Gold Fork River.—***Kennally Creek and its tributaries are on the Payette National Forest and are tributaries of the Gold Fork River (5th level HU 1705012310). A bull trout was documented in tributaries of the Gold Fork River on the BNF in 2002 (Apperson and Allen 2003) where several had been observed previously (Janssen *et al*. 2001), and IDFG concluded that the population was beyond recovery; bull trout have never been documented in the Gold Fork River tributaries on the PNF. Surveys on PNF streams were conducted in 1991, 1992, 1994, 1998, and 2002 in four subwatersheds on the PNF (6th level HUs 170501230901, -02, -03, -04) and no bull trout were found (survey data on file at PNF SO).

#### *Metapopulations and Fragmentation*

The Payette River watershed, including the NFPR, has undergone physical and biological alterations that have affected fish habitat since the mid-1800s including a commercial fishery in McCall and mining activities. Efforts to store, control, and divert water are one of the most significant changes that have altered natural habitat and passage for fish.

Bull trout population migration corridors that may have connected the North Fork Payette River with the lower Payette River were eliminated in 1923 by Black Canyon dam near Emmett, Idaho.

Numerous dams, impoundments and diversions within the NFPR have fragmented habitat and isolated fish populations. For example there are dams that create Cascade Reservoir, Payette Lake, upper Payette Lake, and Brown's Pond, and these all block upstream migration of bull trout. Movement between stream systems in the subbasin has also been prevented by the construction of irrigation dams. The dams also alter flows downstream from them that affect temperature and other habitat features. Roads and culverts have also contributed to this extensive habitat fragmentation. Consequently, there is presently little connectivity of habitat for re-founding subpopulations of bull trout in the subbasin.

***Life History and Genetics***

We would have expected all life history forms of bull trout to occur in the NFPR based on its relatively high elevation and abundance of lakes. Historic records of bull trout in the NFPR are rare. Accounts by Evermann (1896) did not document direct observations of bull trout but noted that they occurred here (then thought to be interior Dolly Varden [*Salvelinus malma*]). Sedell and McIntosh (1995) reviewed surveys conducted from 1938 though 1942 and neither bull trout nor Dolly Varden are mentioned. However, the fragmentation of the basin had already started before the latter surveys and brook trout stocking had already occurred (stocking data on file, PNF SO, McCall, Idaho.)

Brook trout have been stocked in the NFPR from the turn of the 19$^{th}$ century into the 20$^{th}$ century (USFWS 2002) and have become abundant in the subbasin, including the streams where bull trout were previously documented. Brook trout compete with bull trout for habitat resources and interbreed with them, creating hybrids that are likely to be sterile and have developmental problems (Rieman and McIntyre 1993). There have been numerous surveys in the NFPR watershed (data on file, PNF SO) finding brook trout to be widespread in the watershed

***Summary***

Based on the above information, we believe that bull trout likely no longer occur in subwatersheds of the North Fork Payette River subbasin on the PNF. Re-founding is prevented by little or no connectivity among suitable habitat patches, and reproductive potential is suppressed by large numbers of brook trout that are widely distributed. Bull trout are not a MIS in this watershed, and because they are likely extinct on the PNF portion of this watershed, we consider them to be non-viable here. On the PNF portion of this watershed, the population trend is inferred to have been declining until about 2000, when extinction apparently occurred. This watershed serves as a benchmark to frame the lower bound of trends in bull trout populations and viability.

**Deep Creek (DC)**

The Deep Creek watershed drains into the Snake River at T22N, R3W, Section 15, just downstream of Hells Canyon Dam, and constitutes the entire Section 7 watershed for PNF consultations. The watershed comprises approximately 19,000 acres and ranges from 1,500

feet in elevation at its confluence with the Snake River to nearly 7,800 feet in elevation at the headwaters.

Electrofishing surveys in the 1970s (Ralston and Katz 1978) found only rainbow/redband trout (*Oncorhynchus mykiss ssp.*) below the waterfall at stream mile 2.5; these were likely part of the larger Snake River steelhead metapopulation. This is the most upstream Snake River drainage retaining the potential to produce wild steelhead. In addition, Dave Hogen observed a hook and line survey that was conducted in 2003 by Idaho Power technicians upstream of the waterfall; redband trout were the only species collected.

Bull trout are known to occur in the Snake River between the mouth of the Imnaha River and Hells Canyon Dam, and IDFG personnel have observed bull trout in Idaho streams entering this reach of the Snake River at the mouth of Sheep, Granite, Deep and Wolf creeks (Buchanan *et al.* 1997). Surveys for bull trout within the Deep Creek watershed have not been performed, so their status has not been confirmed. However, a radio telemetry study conducted by Idaho Power in 2003 located a bull trout in Deep Creek (personal communication with Rick Wilkison, Idaho Power fisheries biologist, Boise, Idaho).

### *Metapopulations and Fragmentation*

Bull trout in lower Deep Creek may not ascend upstream of more than 2.5 miles upstream of the Snake River where a series of small waterfalls exist. The Red Ledge Mine potentially creates a seasonal barrier to fish movement as well. Except for the influences of the Red Ledge Mine, Deep Creek and its tributaries generally have excellent water quality, with low levels of nutrients and metals loading.

### *Life History and Genetics*

Because surveys have not found brook trout in the watershed any bull trout that exist there should potentially exhibit a full range of life histories, with the exception of adfluvial, and not be impaired by hybridization with brook trout.

### *Summary*

Because of natural barriers, small overall size, and some chemical contamination, bull trout viability in this watershed is probably no more than moderate, or intermediate compared to other watersheds on the PNF. Natural barriers and limited area naturally reduce viability and contamination exacerbates the problem.

## Main Salmon River Southwest (MSSW)

The MSSW Section 7 watershed is not a true watershed, but a grouping of several tributaries of the main Salmon River (Figure 2 [next page]) between the Little Salmon River (LSR) and the South Fork Salmon River (SFSR). The watershed comprises portions of six 5$^{th}$ level HUs in two 4$^{th}$ level HUs for a total area of 337,542 acres on both sides of the Salmon River; however, we are addressing only the PNF portion. The important tributaries on the PNF include Lake Creek, Partridge Creek, Elkhorn Creek, French Creek, Fall Creek, Carey Creek, California Creek, Rabbit Creek, and Warren Creek.

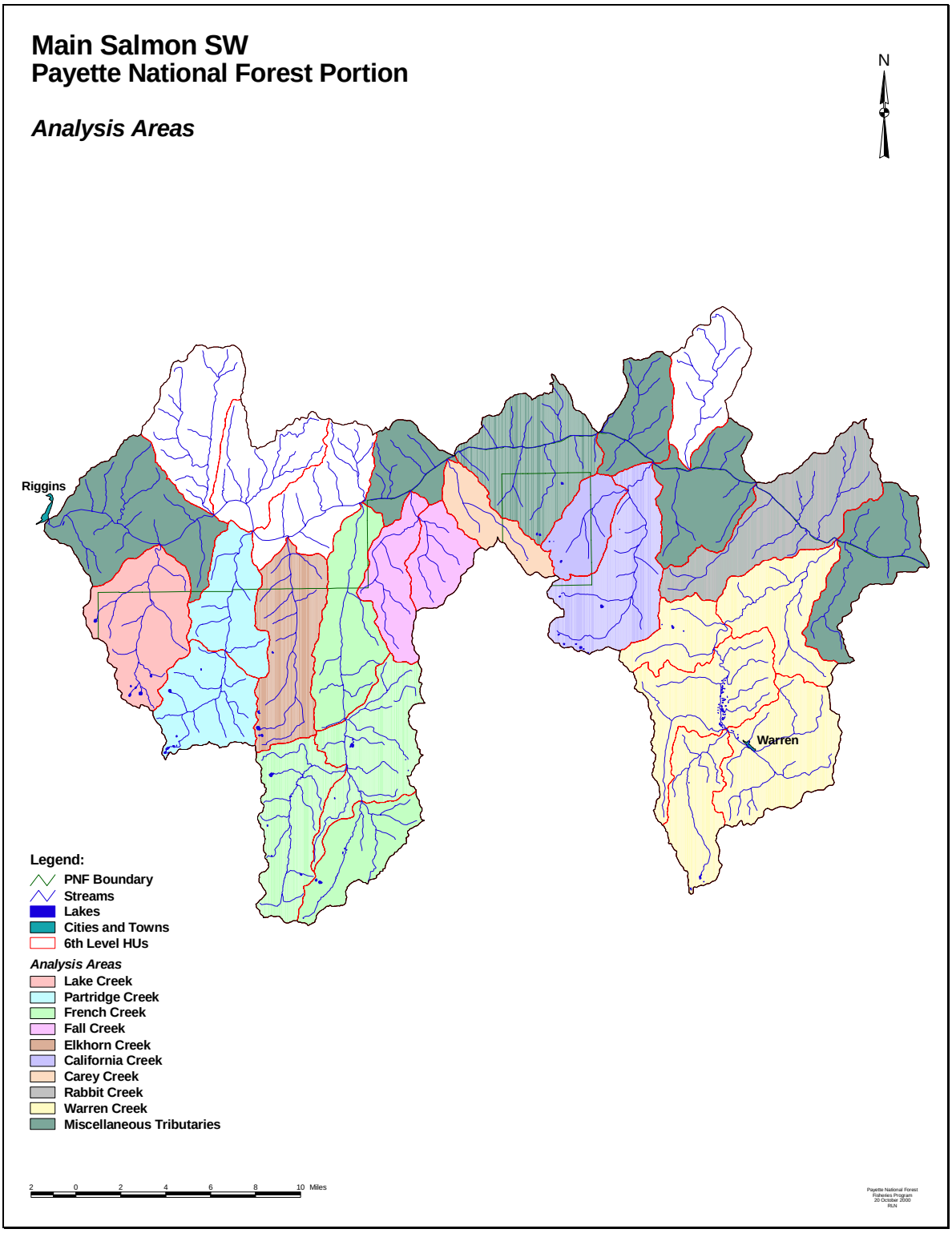


**Figure 2.—**Analysis areas, Main Salmon SW Section 7 Watershed.

A summary of bull trout (Table 1) is based on all available records documenting their presence through 2004.

***Subwatersheds***

***Lake Creek.—***Lake Creek contains bull trout and suitable habitat but has not been extensively surveyed for them. Two bull trout were found in the second reach (near Box Canyon to the West Fork Lake Creek confluence) during the 1992 BLM survey, and one bull trout was caught by PNF personnel using hook and line during 1997. Brook trout were observed in a 2002 survey of lower Lake Creek. We do not have sufficient data to know much about bull trout population dynamics in the analysis area, but the small size of the system, its inherent instability, and the presence of brook trout suggests lowered bull trout viability.

***Partridge Creek.—***No bull trout were positively identified in the 1994 survey, but one fish "with tan spots" was noted that may have been a bull trout (unpublished data on file, PNF SO, McCall, ID). In 1997, upper areas of Partridge Creek were surveyed from Hell Creek upstream, and bull trout as large as 7 inches were noted during this survey; no brook trout were seen. One bull trout was observed near the mouth in a 2002 survey. Again, we do not have sufficient data to know much about bull trout population dynamics in the analysis area, but its potential is probably similar to that of Lake Creek.

***Elkhorn Creek.—***Surveys were conducted in 1994, 1995 and 2002, but bull trout have not been documented in Elkhorn Creek. There are natural barriers a short distance upstream of the mouth, and brook trout occur throughout the watershed.

***French Creek.—***Surveys conducted in 1992 and 1995 found bull trout present in French Creek below the falls (BLM data on file, PNF SO) and near the mouth (Veach 1995). The lowermost falls on French Creek provide at least a partial barrier to fish movement upstream from the Salmon River (Uberuaga 1992a), though there have been isolated reports of chinook salmon above the barrier that may be able to ascend the falls when flows are low (Uberuaga 1992b); we also have some reports of bull trout in the vicinity of Jackson Creek, but it is not clear whether these sightings were made by individuals with sufficient knowledge to identify them. Brook and redband trout are common above the falls in French Creek and several tributaries (including Little French Creek). Brook trout are common in Little French Creek (personal observation R. Nelson).

***Fall Creek.—***A bull trout population exists above the falls on EF Fall Creek (Hurley 1996 and 2004 survey), and in Fall Creek (between the falls on Fall Creek and the mouth of EF Fall Creek); no trout or char have been found in Fall Creek above the mouth of East Fork Fall Creek, though there are no barriers to movement between these two streams. No other salmonid species have been found upstream of the barrier falls.

***Carey Creek.—***No bull trout have been reported from Carey Creek, but Hurley (1996) suggested that stream reaches that could not be investigated during his survey should be inspected closely because there appeared to be sufficient suitable habitat for bull trout. However, Carey Creek is very steep over the lower several miles of its course, and would present a very serious challenge to dispersal upstream where there is better habitat. Much of

the better habitat is on BLM land, and they have not found bull trout (Craig Johnson, Fisheries Biologist, Cottonwood District BLM, personal communication).

***California Creek.***—Bull trout were reported from California Creek on an old USFS map, but the source of this information was unclear and unverified. Since then, several surveys failed to find bull trout in the California Creek system upstream of its mouth, until 2001 when we documented some upstream of Union Creek (data on file, PNF SO).

***Rabbit Creek.***—Rabbit Creek is a fairly large stream and would seem to offer some potential for occupancy, though it is a steep system. We have very little survey data from Rabbit Creek, but we did look in the upper reaches in 2002 without finding bull trout; additional surveys are warranted.

***Warren Creek.***—Bull trout were found by snorkeling in 1994 in mainstem Warren Creek between Steamboat Creek and Maloney Creek (this is an area comprising many dredge mine tailings and ponds), and in several tributaries, including Mayflower Creek, Slaughter Creek, Guard Creek, and Schissler Creek (Raleigh 1995). Most other tributaries and the entire mainstem of Warren Creek were surveyed also with no bull trout found (Raleigh 1995). In 2002 bull trout were found in the lowermost reaches of Warren Creek, which is downstream of likely barriers near the mouth of Richardson Creek. In 2003 bull trout were again found in Mayflower Creek in a snorkel survey.

### *Metapopulations and Fragmentation*

Most of the tributary systems in MSSW exhibit substantial natural fragmentation as well as more recent fragmentation from anthropogenic actions. Natural barriers restrict upstream movements into Elkhorn Creek, Little French Creek, French Creek (partial), Fall Creek, Carey Creek, California Creek, Warren Creek (partial), and Rabbit Creek. They also have many very steep reaches that may not be regarded complete barriers but certainly limit movement. Warren Creek has been heavily altered by mining activity and the road network. This has certainly affected bull trout potential and seems likely to have increased fragmentation. Similarly, Fall Creek, particularly EF Fall Creek, has an extensive logging road network that increases fragmentation and sediment delivery to the system. Most other systems, with the probable exception of Maxwell Creek (a California Creek tributary) in the BLM mining area, actually have relatively low road densities and low natural sediment rates, and natural disturbances probably overwhelm anthropogenic disturbances.

This area is especially interesting because it contains subpopulations of bull trout that seem to have little proclivity for dispersing into accessible adjacent areas. Examples of this are Fall Creek, which contains no fish despite a small population in the adjacent EF Fall Creek, and California Creek, which has bull trout upstream of Union Creek, but apparently not in downstream reaches of California Creek or in Union Creek.

### *Life History and Genetics*

Fluvial bull trout from the East Fork SFSR (EFSFSR) have been found in the Main Salmon River (Hogen 2002); it is unclear whether fluvial fish spawn in this area even though they

exist downstream. In most cases, migratory individuals probably cannot reach resident populations in any streams except California Creek, Lake Creek, and Partridge Creek, because the others have barrier falls near their mouths. Overall, we know very little about biological integrity and life history expression, but small fish size suggests predominantly resident populations with little genetic exchange. Brook trout are widely distributed however, being found in most fish-bearing streams (EF Fall Creek is only apparent exception), which likely reduces viability through competition and hybridization.

***Summary***

In most cases, bull trout populations in this watershed are little affected by specific anthropogenic actions (Warren Creek is exceptional in this respect), but biological integrity has clearly been compromised by brook trout invasion. Overall, the bull trout in this watershed seem likely to have no more than moderate viability, or intermediate to other watersheds on the PNF.

**Little Salmon River (LSR)**

***Subwatersheds***

***Boulder Creek.—***The Boulder Creek watershed comprises a total of approximately 25,100 acres, which, except for 1,500 acres in the lower watershed, are primarily PNF lands (94 %). A natural falls at stream mile 4.4 in lower Boulder Creek restricts fish passage into the upper watershed to an unknown degree. An investigation of the falls was made in 1983, and, at that time, several large bull trout were observed immediately below the falls in a large deep pool (personal observation by Craig Johnson, BLM fisheries biologist, August 18, 1983 field notes). The bull trout observed were estimated at 20 inches in length. In addition, other smaller bull trout in the 13 to 18 inch range were observed. Several large bull trout were observed jumping but they did not ascend the falls. The barrier at that time consisted of a bedrock "beaver-slide" falls 7 feet in height and ten feet in length; the pool below the falls was estimated at 6 feet deep (personal observation by Craig Johnson, BLM, August 18, 1983 field notes). In 1985, the IDFG modified the falls through bedrock excavation of intermediate jumping pools. A 1991 inventory found 69% of bull trout (64 fish) in the middle reach near Yellow Jacket Creek; in a subsequent 1992 survey they were more uniformly distributed in the stream (Table 2).

***Hazard Creek and Hard Creek.—***The Upper Hazard Creek 6$^{th}$ level HU comprises 22.9 square miles, the Upper Hard Creek 6$^{th}$ level HU is 13.83 square miles, and the Lower Hard Creek 6$^{th}$ level HU encompasses 23.9 square miles.

A complete passage barrier exists at stream mile 3.7 in Hazard Creek. The IDFG documented the presence of bull trout in the lower reach of Hazard Creek during 1988 and 1990 ( K. Apperson, IDFG fisheries biologist, personal communication ). In addition, in 1988, while snorkeling at a monitoring station located at stream mile 1.8 in Hazard Creek, two bull trout in the 12 - 15 inch size range were observed (Craig Johnson, Fisheries Biologist, Cottonwood Resource Area, BLM, personal communication).

Adfluvial bull trout have been introduced to three mountain lakes in the upper Hazard Creek HU. The IDFG transplanted an adfluvial strain of bull trout (from the Lake Pend Oreille area) in Disappointment, Hazard, and Upper Hazard lakes during 1992 and 1993. Disappointment Lake was treated with rotenone in 1991 and stocked with bull trout in 1992, but was apparently unsuccessful: netting efforts in Disappointment Lake caught 10 bull trout and no brook trout in 1993, efforts in 1995 caught six bull trout and no brook trout in 1995, fishing efforts in 1998 caught only one bull trout. Similar netting efforts of Hazard Lake in 1993 did not catch any bull trout and netting efforts of Upper Hazard Lake in 1993 did not catch any bull trout, though in 1996 one bull trout was collected (Paul Janssen, IDFG regional fisheries biologist, personal communication).

A partial barrier also restricts bull trout fish passage at stream mile 0.6 on Hard Creek and a passage barrier occurs at stream mile 4.7. Bull trout do use the lower part of Hard Creek stream for rearing.

***Rapid River.—***The 80,347-acre Rapid River discharges at LSR river mile 4.2. Rapid River provides considerable spawning and rearing habitat for bull trout.

### *Metapopulations and Fragmentation*

Bull trout are widely distributed throughout Boulder Creek and Rapid River, but they are restricted to the lower reaches of Hard and Hazard Creeks by natural falls, and to the lower Little Salmon River by natural falls at river mile 21; distribution is summarized in (Tables 3 and 4). Although metapopulation structure is not well known for the entire LSR Section 7 watershed, fluvial bull trout movements and spawning have been monitored in Rapid River. Boulder Creek has had intensive timber harvest, and culverts preclude upstream movement in some Boulder Creek tributaries; elsewhere, however, bull trout can range freely and likely express the full range of life histories except adfluvial. Logging roads also contribute sediment above natural rates to Boulder Creek and possibly to Hard and Hazard Creeks above the barriers. The Little Salmon River itself is highly altered over most of its length by the presence of US Highway 95, rural communities, timber harvest, water diversions, and livestock use, so its potential to provide migratory habitat is likely impaired.

### *Life History and Genetics*

Brook trout are also widely distributed in the LSR, occurring in all of the tributaries discussed, and present a threat to the genetic integrity of bull trout. Rapid River, which is essentially pristine above the Rapid River hatchery, is probably least affected by hybridization because of the presence of fluvial migrants (Table 5). Conversely, the hybridization potential is probably highest in the Hard Creek and Hazard Creek drainages because of the numerous alpine lakes and limited habitat for bull trout. Fluvial bull trout from the Salmon River use Rapid River for spawning (Schill *et al.* 1994), which implies that resident forms exist in the watershed as well.

### *Summary*

This watershed has been highly disturbed by community development, road construction, and timber harvest and contains several natural barriers to fish movement; however, it also contains one large subwatershed that is relatively pristine and known to support a healthy bull trout population. Because most life history forms still persist, we suggest that bull trout viability in this watershed is moderate, or intermediate to others on the PNF.

## Middle Fork Salmon River (MFT)

This Section 7 watershed is not a true watershed, but groupings of tributaries that flow into the Middle Fork Salmon River. This watershed lies predominately within the Frank Church River of no Return Wilderness (FCRONRW).

The Middle Fork Salmon River tributaries watershed (MFT) includes Big Creek and its tributaries, and upper Marble Creek. Big Creek is within the Lower Middle Fork Salmon River 4$^{th}$ level HU (HUC 17060206). Upper Marble Creek is within the Upper Middle Fork Salmon River 4$^{th}$ level HU (HUC 17060205). Big Creek and Marble Creek flow into the Middle Fork Salmon River.

Thurow (1985) found bull trout in the Middle Fork in 1980-1983 using hook-and-line sampling and snorkeling. Bull trout have been noted by various sources throughout the Middle Fork tributaries of Big Creek and Marble Creek (Table 6).

The surveys below (Table 7) indicate that bull trout are widespread throughout the watershed and occur in most, if not all, subwatersheds; we also assume that bull trout occur in the areas between documented sightings. Both resident and fluvial life history forms occur and recent observations in the Wilson Lakes area in the headwaters of Big Creek suggest that adfluvial forms may also occur (P. Janssen, Fisheries Biologist, IDFG, personal communication). Roosevelt Lake in Monumental Creek is likely to have suitable habitat for adfluvial bull trout and has records of bull trout upstream and downstream from it.

Existing data consist of snorkeling inventories associated with R1/R4 stream habitat surveys and IDFG parr monitoring. The R1/R4 snorkel surveys were conducted on a sub-sample of habitat units inventoried for each reach.

### *Subwatersheds*

Surveys indicate that bull trout are widespread throughout the subwatersheds, and it is assumed that bull trout occur in the areas between documented sightings. Both resident and fluvial life history forms appear to occur, and adfluvial forms possibly occur.

### *Metapopulations and Fragmentation*

Bull trout are well distributed throughout this portion of the watershed. Suitable habitat is well connected within this watershed. Because this watershed lies primarily within wilderness, road density and other anthropogenic disturbances are very low. A recent culvert survey

(2003, data on file PNF SO, McCall, Idaho) shows some potential fish passage problems in some headwater streams; however, culverts may be above occupied habitat. The upper Big Creek area is exceptional in that it comprises the Edwardsburg Mining District and experienced extensive mining early in the 20th century. The headwaters of Monumental Creek, an important tributary to Big Creek, and upper Marble Creek were also mined extensively at Thunder Mountain near the turn of the last century.

Based on the authors' observations of large bull trout, we have made the assumption that fluvial bull trout are still present in the mainstem and probably exchange genetic material with the populations documented in some tributaries that we have assumed to be predominantly resident fish. It appears that the full range of bull trout life histories probably occur in this watershed.

### *Life History and Genetics*

Brook trout have been observed in this watershed, but only in the mainstem of Big Creek; the extent of hybridization, which must be assumed to occur, is unknown. Migratory bull trout are typically much larger than brook trout which may limit hybridization. The favorable conditions for bull trout and the probable expression of all life history forms suggests that genetic integrity (lack of brook trout introgression) remains high relative to other populations on the PNF.

### *Summary*

Because this watershed comprises primarily wilderness, is very large, and supports all life history forms, bull trout viability is considered to be high relative to other populations on the PNF.

## Salmon River from Middle Fork to South Fork (MSSE)

The Main Salmon Southeast watershed (MSSE) includes Chamberlain Creek and other tributaries that flow generally north into the Main Salmon River between the South Fork Salmon River and Middle Fork Salmon River, within the Middle Salmon-Chamberlain 4th level HU (HUC 17060207).

The surveys below indicate that bull trout are widespread throughout the watershed and occur in both subwatersheds (Table 8); we also assume that bull trout occur in the areas between documented sightings. Both resident and fluvial life history forms occur.

Existing data consist of snorkeling inventories associated with R1/R4 stream habitat surveys and IDFG parr monitoring. The R1/R4 snorkel surveys were conducted on a sub-sample of habitat units inventoried for each reach.

### *Subwatersheds*

Because this area is remote and few surveys exist we discuss subwatersheds here as a group. Populations of bull trout have not been extensively surveyed in this analysis area. Existing data are snorkeling inventories associated with R1/R4 stream habitat surveys. The snorkel

surveys were conducted on a sub-sample of habitat units inventoried for each reach. Burns (author's observation) observed a large (approximately 24 inches) and apparently fluvial bull trout at the mouth of McCalla Creek in 1985. Condition and trend of the meta-population in the main Salmon River tributaries is unknown. There is no documentation of status, however the assumption is made that fluvial bull trout are still present in the mainstem and resident populations are documented in some tributaries.

### *Metapopulations and Fragmentation*

Bull trout are well distributed throughout this watershed, and occupied and potentially occupied habitats are well connected. This watershed lies primarily within wilderness, so road density and other anthropogenic alteration is very low; however, a culvert under the Chamberlain airstrip is a fish passage barrier within Ranch Creek, a small tributary of Chamberlain Creek. Upper Whimstick Creek, a tributary of McCalla Creek, contains a naturally isolated population of bull trout; a steep cataract at about 5,000 ft elevation presents a fish barrier at low flows. Steep reaches of main Salmon River tributaries may have similar barriers. Fivemile Creek, a tributary near the downstream end of the watershed has a similar barrier (Reingold 1986) about a mile and a half upstream that may exclude bull trout from its upper reaches.

### *Life History and Genetics*

There have not been extensive fish surveys in the watershed, and brook trout have actually been observed only in Cottonwood Creek, where no bull trout have been found (unpublished data on file Payette National Forest SO, McCall, Idaho). We assume that all bull trout life history forms except adfluvial, for which we have no evidence, occur within the watershed and that the remote nature of the area has maintained connectivity and limited hybridization with brook trout.

### *Summary*

Because this watershed comprises primarily wilderness, is very large, and is believed to support all expected life history forms, bull trout viability is considered to be high relative to other watersheds on the PNF.

## South Fork Salmon River (SFSR)

The South Fork Salmon River (SFSR) watershed covers 721,926 acres on the PNF (594,432 acres) and BNF (104,427 acres) (Figure 3 [next page]).

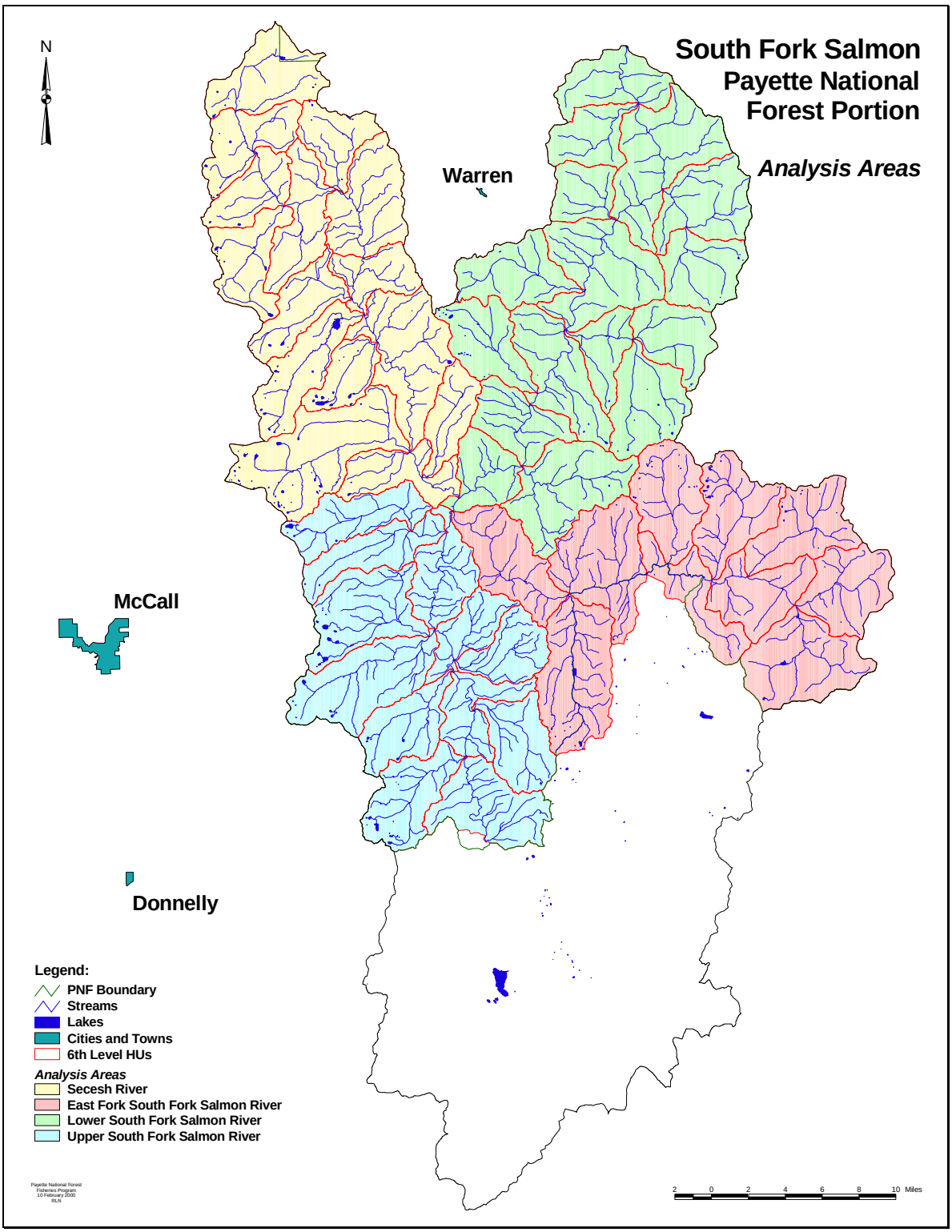


**Figure 3.—**Analysis areas, South Fork Salmon River Section 7 Watershed.

The SFSR flows generally north and enters the Salmon River near Mackay Bar, Idaho. Elevations range from 2,166 feet at the mouth to about 9,280 feet at North Loon Mountain.

Bull trout populations have been documented throughout the SFSR watershed. Thurow (1986) documented the presence of both resident and fluvial stocks in all reaches and 18 tributaries that were surveyed. Fish densities for the mainstem and tributaries ranged from 0.26 to 0.51 fish per 100 $m^2$. Tributaries function as spawning and rearing areas for fluvial and resident stocks, and the mainstem SFSR serves as a migration corridor and overwintering area for both emigrating juveniles and adult fish. Thurow (1987) reported that bull trout populations are viable; however the status of discrete populations is unknown. Populations throughout the Upper Columbia River Basin have been affected by fishing pressure, water diversions, and habitat degradation (Fraley and Shepard 1989). Bull trout distribution is summarized in Tables 9 and 10.

***Subwatersheds***

***Lower SFSR. —*** The lower SFSR analysis area encompasses the area downstream from the Secesh River. Elevations range from 3,650 feet at the Secesh confluence to 2,166 feet at the Main Salmon River. The main SFSR in this area is primarily a migration corridor for and rearing area for anadromous species and fluvial bull trout, though we suspect that some important tributaries like Porphyry Creek and Sheep Creek may support resident populations and provide spawning and rearing habitat as well.

***East For South Fork Salmon River (EFSFSR).—***The PNF portion of the EFSFSR analysis area comprises about 130,000 acres (PNF portion) and enters the mainstem SFSR near the mouth of the Secesh River. Spawning and rearing habitat for bull trout occur throughout the river and its tributaries; Quartz Creek, Profile Creek, and Tamarack Creek are particularly important streams for spawning by fluvial bull trout, and adfluvial bull trout use the Yellow Pine Pit in the Stibnite area (Hogen, 2002).

***Secesh River.—***The Secesh River analysis area comprises about 158,000 acres. The river enters the mainstem SFSR about one mile downstream of the EFSFSR. Spawning and rearing habitat for bull trout occurs throughout the area, and fluvial bull trout are known to ascend Pete Creek and Threemile Creek, small tributaries of Lake Creek, a principal tributary of the Secesh River; in addition, Loon Lake supports adfluvial bull trout (Watry and Scarnnechia, 2004.)

***Upper SFSR.—***The Upper SFSR is that portion of the watershed above the confluence of the EFSFSR. In this area, the river alternates between V-shaped canyon sections and open U-shaped valley reaches. Low gradient reaches occur at Poverty Flats, Darling Cabin, Oxbow, and Glory areas, which are important spawning areas for anadromous species. Tributary streams have steeper gradients than the mainstem, but spawning and rearing habitat for bull trout occurs throughout the area.

***Metapopulations and Fragmentation***

With few exceptions (*e.g.*, Zena Creek, and Goat Creek) there is good habitat connectivity throughout the drainage. In addition, there are data from radio telemetry, passive integrated transponer (PIT) tagging, and screw traps that document long distance bull trout movement within the drainage (Hogen 2002; Watry and Scarnnechia 2004; Nez Perce tribe, unpublished

data). All three life histories are present in the SFSR. Fluvial individuals have been documented in the EFSFSR, some of which make extensive migrations, (Hogen 2002) and Secesh River (Watry and Scarnnechia 2004); in addition, Hogen (2002) and Watry and Scarnnechia (2004) documented adfluvial bull trout in the EFSFSR and Secesh River, respectively. These two studies were especially revealing in that they documented some unexpected behaviors: in both systems, adfluvial bull trout migrated downstream from a lake then moved upstream to spawning areas. In the case of the Secesh River population, some fish moved into a very small stream that we formerly thought would be unlikely to contain any fish (see title page figure); presumably, these fluvial bull trout are spawning with their natal population. In the case of the EFSFSR, not only was their unexpected downstream migration from the lake surprising, but the lake involved was the Yellow Pine Pit, a large artificial lake in the Stibnite mining area that was created after the heyday of the Stibnite Mine in the 1930s and 1940s; this demonstrates relatively rapid life history adaptation to take advantage new habitat opportunities.

Bull trout spawn from late August through mid-October in the SFSR and its tributaries (R. Thurow, Fisheries Scientist, Rocky Mountain Experimental Station, personal communication). Length frequencies of bull trout observed by snorkeling in tributaries in 1984 and 1985 averaged 19-20% less than 100mm, 37-43% 100 to 200mm, 21-34 200 to 300mm, 6-8% 300 to 400mm, and 2-10% larger than 400mm (Thurow 1986). Annual growth increments of bull trout sampled in headwaters tributaries of the SFSR in 1985 averaged 68mm for the first year and declined to 42 and 45mm the next two years. After the third year, average incremental growth increased to 63 and 67mm. Increased growth after age III may reflect movement of some fish from tributaries into the mainstem SFSR and Salmon River (Thurow 1986).

In the SFSR, migration of adult bull trout probably begins in March or April as adults move slowly upriver and arrive near spawning areas in July. Large bull trout were observed staging in some SFSR tributaries in August and September (Thurow 1986).

A recent tagging study of bull trout in the EFSFSR (Hogen, 2002) found the fish dispersed throughout the main river as well as in several tributaries, primarily Profile, Tamarack, and Sugar Creeks. Bull trout also moved further up into smaller tributaries of these three systems. Spawning occurred over a short, definite time period, from September 1 –15 with all spawning completed by September 20. Overwintering of fish tagged in the EFSFSR occurred in the EFSFSR and the main South Fork Salmon River, and extended into the main Salmon River as well (personal communication D.Hogen).

### *Life History and Genetics*

All bull trout life history strategies are present in the SFSR watershed, which contributes to long term population viability. There are very few human caused or natural barriers that fragment occupied or suitable bull trout habitat. Therefore, the populations of bull trout in the drainage are well connected, which enhances long term viability. There are data from the SFSR drainage showing areas of bull trout and brook trout overlap, and in these areas hybridization is likely, and, indeed, we have observed probable hybrids in some; viability is undoubtedly reduced in these areas.

Brook trout are widely distributed in the SFSR watershed; however, there has been surprisingly little increase in the distribution of brook trout since the 1970s (Adams *et al.* 2002). Given this and the fact that bull trout populations continue to express their full range of life history forms, resident and migratory bull trout stocks that have managed to maintain a high degree of genetic purity are unlikely to be at imminent risk of hybridization; however, the extent of hybridization in the watershed is unknown.

***Summary***

Overall, there appears to have been little reduction in viability due to anthropogenic actions in this watershed except the potential for hybridization with brook trout. All life history forms are present and the watershed can be considered a bull trout stronghold. It is one of the few watersheds known to support adfluvial bull trout, which occur in at least two of the four subwatersheds. The adfluvial population in the EFSFSR is unnatural, representing adaptation to new habitat created by historic mining activities; thus, it is even possible that viability is higher than might be expected naturally. However the presence of brook trout potentially compromises viability of bull trout similarly to other Salmon River tributaries. Overall, we rate bull trout viability as high in this watershed compared to other watersheds on the PNF.

**Brownlee Reservoir (BR)**

The Brownlee Reservoir watershed comprises several watersheds that are tributaries of the Snake River in the Hells Canyon complex reservoirs, Hells Canyon, Oxbow, and Brownlee. These large hydropower impoundments effectively isolated these tributary watersheds from each other since 1965 when Hells Canyon Dam was closed. This analysis includes Indian Creek, Bear Creek, and Wildhorse / Crooked River. Other areas probably do not support bull trout based on failures to find bull trout in some them (Greenway and McGee 2003, 2004; Moore *et al.* 2002; Williams and McGee 2001); surveys are summarized in Table 11.

***Subwatersheds***

***Indian Creek.—***The Indian Creek analysis area is in the northern part of the Brownlee Reservoir Subbasin. Indian Creek originates at Lake Winifred at about 7,400 feet (2,256 m) in the Seven Devils Mountains, and flows southwesterly for several miles before entering the Snake River shortly downstream from Oxbow Dam. The geology of the watershed is predominantly metasedimentary (Seven Devils Formation) near the headwaters and volcanic (Columbia River Basalts) elsewhere. Indian Creek has only one substantial tributary, Huntley Gulch, a fish-bearing stream that drains a small northwesterly oriented watershed that heads at about 5,200 feet and joins Indian Creek at about 4,000 feet. In the summer of 2003, a severe thunderstorm and subsequent debris flow reorganized much of upper Indian Creek destroying channel structure and habitat complexity. During the event, a waterfall passage barrier was created at the mouth of Camp Creek. Watershed area above 5,249 feet comprises approximately 4,257 acres and includes Camp Creek.

Bull trout have been repeatedly observed in the headwaters region of Indian Creek, including Camp Creek, a principal headwater tributary, and more recently at the mouth (Chandler *et al.*

2003). Our earliest documentation is from 1979 (Reid 1979), but habitat surveys in 1992 and many subsequent fish surveys indicate that they continue to occupy this area (unpublished data on file, PNF SO, McCall). In Camp Creek, casual observation by the District survey crew revealed 60 fish in over 1,500 feet (457 m) of stream. During a walk through survey in 2004 no fish were observed in Camp Creek. In 2004, five sites upstream of Landore were snorkeled. Migratory individuals have not been reported from Indian Creek (check Idaho Power Report Chandler *et al.* 2003), though bull trout do exist in the Hells Canyon reach of the Snake River (Buchanan et al. 1997) and investigations by Idaho Power have collected apparently downstream migrating bull trout near the mouth of Indian Creek in very small numbers (Chandler *et al.* 2003). Surveys were completed in 2003 both before the and after the flood event. Numbers of bull trout were substantially reduced by the flood.

***Bear Creek.***—Bull trout are apparently restricted to the upper reaches of Bear Creek, which contains 13.2 miles of intermittent streams and 25.7 miles of perennial streams. The analysis area contains 5,368 acres of contiguous habitat greater than 5,249 feet in elevation[2]. Canopy closure on Bear Creek increases moving upstream as forest vegetation becomes increasingly important, and accounts for about 75% of the vegetation in the Upper Bear Creek unit (Nelson and Burns 1998).

Electrofishing surveys were conducted in 1999, 2000, 2002, 2003, and bull trout were found to be present from the crossing of Bear Creek by Forest trail 228 (T5S, R2W, S3) upstream to the crossing of Forest development Road (FDR) 130 (Williams and Veach 1999; Williams and McGee 2001; Greenway and McGee 2003; Greenway and McGee 2004). In 2004, one of the sites previously electrofished was snorkeled and no bull trout were found. In 2000, an apparent hybrid was also collected in Bear Creek downstream of Bear Creek Falls.

***Crooked River.***—Crooked River contains 27 miles of intermittent streams and 22 miles of perennial streams. Crooked River arises on the northern flank of Cuddy Mountain at about 6,890 feet and flows generally northeastward until it joins Bear Creek to form the Wildhorse River. The Wildhorse River flows to Oxbow Reservoir.

Surveys were completed throughout the entire watershed using Bonar *et al.* (1997) methods; only one found bull trout. At the confluence of the Wildhorse River, Idaho Power Company maintained a weir to collect potential outmigrants between 1998 and 2001, which captured a single, apparently pure, bull trout in 2001 (Chandler *et al*. 2003). The bull trout population in Crooked River is considerably hybridized with brook trout (Spruell 2000).

### *Metapopulations and Fragmentation*

The original Brownlee Reservoir Section 7 Watershed Biological Assessment (Nelson and Burns 1998) addressed the lack of definitive information on bull trout distribution in the watershed by using known and suspected distribution coupled with a probabilistic approach based loosely on Rieman and McIntyre's (1995) evaluation of probability of occurrence in patches of connected habitat of various size to determine where bull trout were likely to be found. This analysis indicated that bull trout were most likely to occur in Crooked River and Bear Creek, Wildhorse River tributaries; it also indicated that Kinney Creek might support

[2] This is the English units equivalent of 1600 meters, the critical elevation described in Rieman and McIntyre (1995).

bull trout near the mouth. Since then, bull trout have been confirmed from Crooked River and Bear Creek but we have not investigated Kinney Creek; we have failed to find them in any tributaries previously determined to have low likelihood of occurrence (*e.g.*, Lick Creek, Brownlee Creek, No Business Creek) (Greenway and McGee 2003, 2004; Moore *et al.* 2002; Williams and McGee 2001).

These are small watersheds with considerable natural and anthropogenic disturbances. In July 2003, a high intensity rainstorm in Indian Creek resulted in a flood that caused a passable culvert near Landore to be modified to not allow upstream migration. The past surveys have shown that the majority of bull trout are located upstream of the culvert, but nine bull trout were collected immediately below the Landore culvert in 2004 after the flood; these were moved upstream of the culvert (USFS unpublished data). At the confluence of Camp Creek, the 2003 flood scoured the channel to make upstream passage difficult.

In Wildhorse / Crooked River there are two known culverts that are fish passage barriers on Crooked River. The Bear Creek Falls limits upstream migration into the upper reaches of Bear Creek, and there are probable thermal barriers on Wildhorse River (Nelson and Burns 1998). On Wesley Creek, there is a culvert that blocks approximately 0.5 miles of fish habitat.

***Life History and Genetics***

Brook trout and hybrids have been documented in all areas. In Bear Creek and Indian Creek, brook trout distribution currently does not extend into the uppermost reaches and genetic analysis of Bear Creek fish showed them to be primarily bull trout with some brook trout and bull trout x brook trout hybrids (Spruell 2000); illustrations of genetic similarity with other bull trout populations are presented in Spruell (2000). In Crooked River, the brook trout distribution includes the entire basin.

***Summary***

These results suggest that the Crooked River population may be less viable than the Bear Creek population because of brook trout invasion and small patch size. We would expect the Indian Creek population to be the most viable since it can potentially interact with the Pine Creek population in Oregon and Hells Canyon Reservoir may support an adfluvial life history; however, the recent floods may have significantly reduced their viability. Over all the fragmentation, low number of life histories and brook trout introgression lead us to conclude that the bull trout populations in this basin have low viability compared to other watersheds on the PNF.

**Weiser River (WR)**

Bull trout populations are on the PNF in the Weiser River subbasin are restricted to just a few headwater locations in the East Fork Weiser River (Table 12) and the Little Weiser River (Table 13); they also occur on Idaho Department of Lands property in the headwaters of Hornet Creek, which are not documented fully here.

### *Subwatersheds*

***East Fork Weiser River.—***The East Fork Weiser River analysis area contains two 6th level HUs (HUCs 170501241204 and 170501241205). The analysis area is approximately 20,900 acres in size, and contains some 30 miles of perennial streams and 54 miles of intermittent streams.

Bull trout occur in Dewey Creek and its tributaries and in the East Fork Weiser River upstream of Dewey Creek (Adams 1994; Hurley 1995; unpublished data from Rocky Mountain Research Station, Boise, Idaho; unpublished IDFG data, 1999 and 2001, USFS 2004). Bull trout were observed spawning in Dewey Creek and upper East Fork Weiser River on September 9, 2001, while conducting bull trout redd surveys (Watry and Hogen 2002a). Almost all bull trout in Dewey Creek have been less than 200 mm, with the one exception in 2001, when a bull trout was collected in the 220 – 229 mm size class (IDFG unpublished data from 2001 on file PNF SO, McCall, ID). In the upper East Fork Weiser River, the size of bull trout has also been predominately less than 200 mm. Snorkelers in 1994 observed two bull trout were estimated in the 200 – 300 mm size class (Hurley 1995). Brook trout are found throughout this and other Weiser River tributaries.

***Upper Little Weiser River.—***The Upper Little Weiser River analysis area contains two 6th level HUs (HUCs 170501241408 and 170501241409). The analysis area is approximately 20,470 acres in size, and contains two patches of contiguous habitat greater than 1,600 meters in elevation, both of which are occupied by bull trout. The analysis area contains 31 miles of perennial streams and 26 miles of intermittent streams.

In the Little Weiser River analysis area, bull trout occur in Sheep Creek, Little Weiser River from approximately the mouth of Wolf Creek upstream to the headwaters, and in Anderson Creek above and below a barrier culvert on road 835 (Adams 1994; unpublished data on record PNF SO, McCall Idaho).

***Miscellaneous Areas.—***Fish distribution surveys were conducted on the PNF in 1998 through 2004 in the Mill Creek, Middle Fork Weiser River, WF Weiser River, Weiser River and upper tributaries, Rush Creek, Beaver Creek, Pine Creek and tributaries, Johnson Creek, and Goodrich Creek, Cottonwood Creek, and Hornet Creek and tributaries, and no bull trout were observed (Williams and Veach 1999; Williams and McGee 2001; Moore *et al.* 2002; Greenway and McGee 2003, 2004. Outside of our analysis areas, bull trout have been found only in upper Hornet Creek and tributaries on State of Idaho lands (Dupont 1998, 2000) and figure only peripherally in this analysis, because these bull trout apparently do not occur on the PNF.

### *Metapopulations and Fragmentation*

There are two known fish passage barriers on the EF Weiser River (US Highway 95 and FDR 906) and one on Dewey Creek. The East Fork Ditch Company's irrigation diversion dam has prevented upstream migration for approximately 60 years. This dam was rehabilitated in the fall of 2003 and summer of 2004 to allow year-round fish passage and eliminate entrapment in the ditch. In the summer of 2002, cattle were excluded from bull trout spawning area of Dewey Creek and EF Weiser River.

In 1999, a weir was installed approximately one mile downstream of Dewey Creek (Figure 4) in an attempt to capture migratory bull trout, but no bull trout movement up or down the river was detected during the fall (September to November) (Zeilinsky 2000). In 2001, the weir was redesigned and reinstalled in the East Fork Weiser River (Moore *et al.* 2002). One bull trout (160 mm) was collected in the downstream weir located approximately two miles upstream of the point of diversion for the East Fork Irrigation Ditch. The fish was fin-clipped and genetically identified as a bull trout (personal communication with Paul Spruell, University of Montana). It is possible this one fish could have a migratory or resident life history. In 2002, two hybrids were collected at the weir (Watry and Hogen 2002b).

Fish distribution surveys have been completed in the lower portions of the East Fork Weiser River and tributaries (downstream of the confluence of Dewey Creek) (Hurley 1995; IDFG unpublished data from 2001; USFS unpublished data from 2000). Except for the one bull trout captured in the weir, no other bull trout have been documented. We have collected only small fish from this area, and it seems unlikely that the fish captured in the weir was a migrant; we believe this to be a resident population. Specific MIS surveys were conducted in EF Weiser River and Dewey Creek in 2004. Bull trout were documented in Dewey Creek in an area where bull trout had been previously documented. In the EF Weiser River, no bull trout were observed while snorkeling or electrofishing two reaches where bull trout were previously found.

There is one known fish passage barrier on Anderson Creek. The USFWS directed the USFS not to remove the culvert in 2001 due to the brook trout downstream in lower Anderson Creek and Little Weiser River. In the summer of 2002, cattle were excluded from bull trout spawning area of Anderson Creek, Little Weiser River, and Sheep Creek.

Bull trout in the Little Weiser analysis area appear to be more isolated then previously thought. In 2000, 2001, and 2002, a weir was operated in the Little Weiser River near the Forest boundary in an attempt to document migratory bull trout. During that time, no bull trout were captured (Smith and Hogen 2000; Moore *et al.* 2002; Watry and Hogen 2002b).

### *Life History and Genetics*

Previous surveys have indicated that bull trout in the EF Weiser River analysis area are isolated. Fish distribution surveys were conducted in Middle Weiser River and tributaries, East Pine Creek, Beaver Creek, Cottonwood Creek, and North Hornet Creek to determine presence or absence of bull trout, and no bull trout were documented in any of these surveys (Williams and Veach 1999; Williams and McGee 2001; Moore *et al*. 2002; USFS unpublished data from 2002 on file, PNF SO in McCall, ID).

Based on the surveys that have been completed, it is unlikely that large (> 250 mm) fluvial bull trout exist in the EF Weiser River analysis area or anywhere else in the Weiser River that could be a source of gametes for this isolated population. Brook trout, redband trout, brook trout x bull trout hybrid, and sculpin were documented in the lower portion of the East Fork Weiser River. Brook trout and hybrids have been documented throughout the EF Weiser River and in the lower reaches of Dewey Creek. In 1992 and 2004, bull trout were the only species documented in the upper two miles of Dewey Creek. Our weir studies have

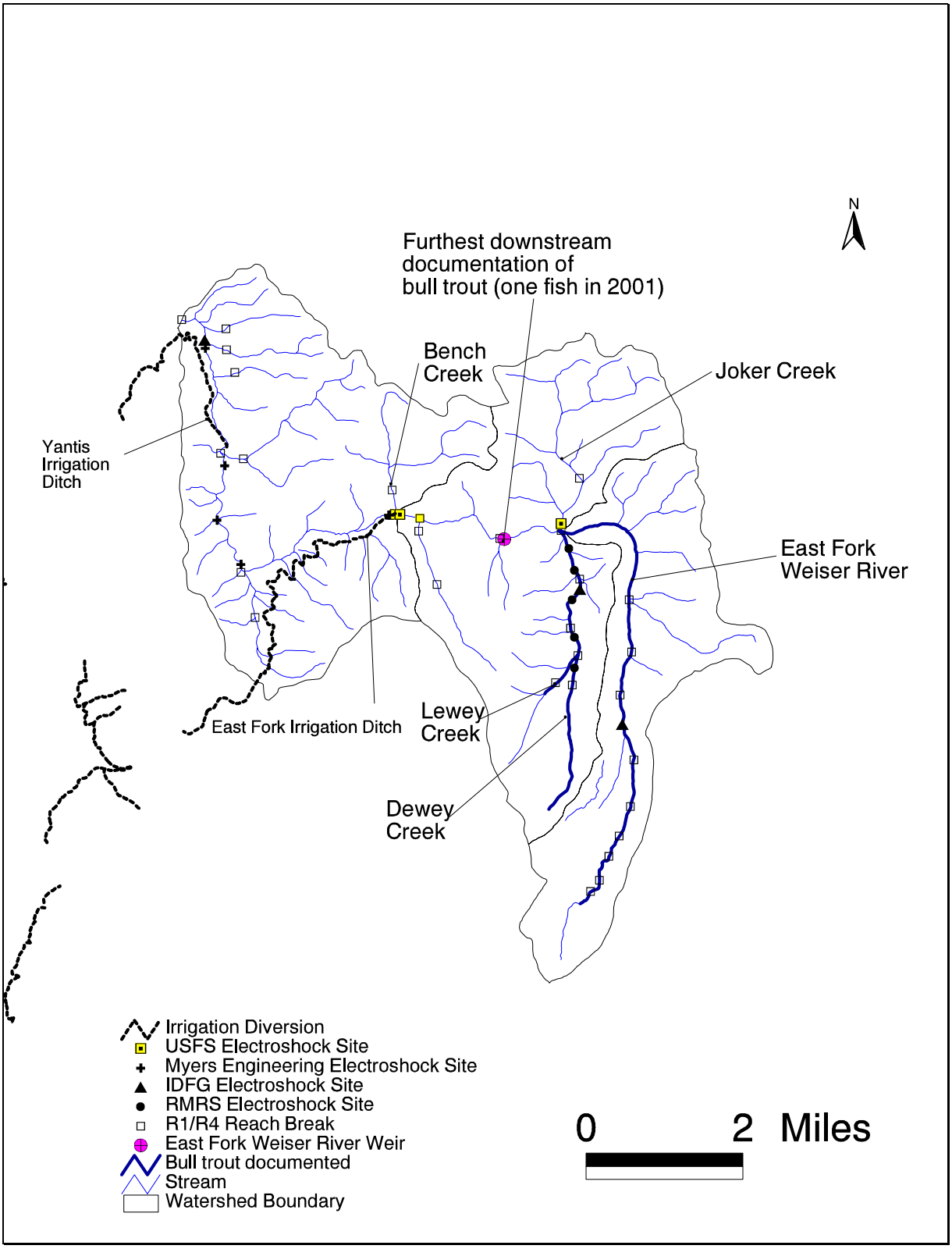


**Figure 4.—** Surveys completed to determine fish distribution and habitat condition in the East Fork Weiser River analysis area. Figure should be printed in color. See figure 3 for geographic references.

detected no presumptive migrants, and it seems likely that the East Fork Weiser River fish are strictly resident.

Brook trout and hybrids have been documented in the Little Weiser River. In the lower reaches of Anderson Creek, one brook trout was documented in two different years and one hybrid in one year. In the upper portion of Little Weiser River, only bull trout have been documented.

Brook trout occur in the Little Weiser River and hybrids have been observed as well (Adams 1994; Smith and Hogen 2000; Moore *et al*. 2002). Very few brook trout are suspected to reside in Anderson Creek or its tributaries. A single brook trout was observed while snorkeling in the lower reaches of Anderson Creek in 2000 and 2003 (Williams and McGee 2001; Greenway and McGee 2004). A hybrid was documented in 2004 in the same general area (unpublished data, 2004). Fin clips of bull trout collected in 1999 above and below the barrier culvert on road 835 were genetically analyzed, and no evidence of hybridization was reported (Spruell 2000). Bull trout were again found in 1999 by IDFG crews in the upper Little Weiser River and in Anderson Creek at two locations (IDFG unpublished data from 1999 on file, PNF SO, McCall, ID). The same report found brook trout in King Hill Creek, (elevations 4,710 and 5,740 feet) and redband rainbow trout in Grizzly Creek (elevation 4,320 feet). Both are tributaries to the lower Little Weiser River. In Sheep Creek and Anderson Creek (above the confluence of Sheep Creek) the only char documented is bull trout. The culvert on Anderson Creek limits upstream movement of all fish, including brook trout, into the headwaters.

***Summary***

This watershed is on the margin of potential bull trout range in our area because it is chiefly at low elevation with a southerly aspect. Added to that is the considerable development in the area for communities, agriculture, and timber harvest, with attendant road construction and water diversion. Brook trout exist in all areas and reduce potential bull trout viability. Given those factors and the fact that bull trout are restricted to very small headwaters areas in only three subwatersheds, viability is considered low compared to other watersheds on the PNF.

## Ordination and Classification of Section 7 Watersheds and Sub-watersheds for Assessing and Monitoring Bull Trout Viability

*In order to illustrate our subjective classification of bull trout relative viability across the PNF described on September 28-30, 2005, we conducted some further data sorting. The following section contains information that has been discussed in more detail above, but is reiterated here as it relates to this modeling exercise.*

### Payette National Forest Bull Trout Summary

#### *Forest-Wide Distribution*

Bull trout are widely distributed across the Forest. From the South Fork Salmon River drainage east, bull trout probably exhibit more or less their natural distribution. We don't believe that they are present in all watersheds that could support them because they seem to have patchy occurrence naturally as described for other areas by Rieman and McIntyre (1995), but most of the east side of the Forest has not been extensively developed and there are few barriers to dispersal. Of east-side streams, the South Fork Salmon River is the most developed, but bull trout are present in many tributary streams and often in substantial numbers. Along the mainstem Salmon River, many tributaries are steep and natural barriers to dispersal are common near their confluences with the Salmon River. Most of these streams do support small resident populations of bull trout despite these impediments. The largest of these streams, Warren Creek, supports several local populations. The Little Salmon River also has many small tributaries with barriers near their mouths, but also has a few larger tributaries, like Rapid River, which support a migratory component.

West of the Little Salmon River are tributaries to the Snake River. The Hells Canyon Dam complex was closed in 1965, but bull trout persist in three small streams that drain into that reach. The Weiser River, which enters the Snake River upstream of the tailwaters of Brownlee Reservoir, is a fairly large watershed with several small, isolated populations of bull trout in headwaters positions. The North Fork Payette River, part of the larger Payette River system that enters the Snake River even farther upstream than the Weiser River, was the first Forest watershed disconnected from the sea, no longer appears to support bull trout on the Forest.

#### *Life History Expression*

Although our knowledge of bull trout distribution across the Forest is incomplete, we do know that they exhibit three of their four general life histories. Life history expression is, however, related to anadromy. The watersheds that no longer support anadromous salmon and steelhead appear to support primarily resident life history forms of bull trout, with infrequent occurrence of adfluvial fish in Hells Canyon Reservoir and, potentially, Indian Creek. We have found no records of bull trout being anadromous, but the existence of other anadromous salmonids is an indicator of available migration routes and food sources from those other species. We don't believe that simple absence of anadromous fish is the reason for reduction in bull trout life history pattern, rather it seems that disconnection from the sea reflects increasing fragmentation within particular watersheds with time since initial

disconnection providing some use as a predictor of population viability within watersheds (Burns *et al*. 2003.) In watersheds that still support anadromous species, the fullest life history expression appears to be in the South Fork Salmon River and its tributaries. Loon Lake and the Glory Hole at Stibnite provide habitat for adfluvial individuals, a life history pattern that seems uncommon or absent in other watersheds[3][4]. Although maintenance of migratory corridors is important to bull trout persistence, resident populations occur in many streams above ancient natural barriers, evidence of early colonization of these watersheds (Meehan and Bjornn 1991).

### *Current Status and Potential Threats*

Although they are widely distributed, we actually know relatively little about the population status of bull trout Forest-wide; hence, this preliminary viability assessment. They appear to be least viable on the western side of the Forest where forest management and fragmentation have been most prevalent, but it is difficult to determine exactly why this is so. Fragmentation and effects of management have certainly been implicated as threats to bull trout persistence (Baxter *et al.* 1999; Burns *et al*. 2003; Dunham and Rieman 1999; Fraley *et al*. 1989), as has presence of brook trout (Leary *et al*. 1993), but cause and effect is often difficult to demonstrate. Brook trout are widely distributed across the Forest and presently inhabit many streams that were either known to support bull trout historically (*e.g.*, Lake Fork Creek in the North Fork Payette River watershed) or were likely present. Additionally, many areas that have seen extensive development (e.g., the Warren Creek watershed) continue to support bull trout populations and some, in fact, remain bull trout strongholds with complete life history expression (*e.g.*, the East Fork South Fork Salmon River).

The bull trout populations in the Weiser River and Brownlee reservoir Section 7 watersheds are small, isolated populations potentially at risk of stochastic events. Flooding in Indian Creek in 2003, substantially rearranged the channel leading to some direct mortality as well as re-distribution of individual fish (Greenway and McGee 2004). Subsequently, bull trout were found to still occupy Indian Creek, but the event served to illustrate the point that such events in places with very small and isolated populations put those populations at extreme risk of extinction. Elsewhere, bull trout have not been found in the upper East Fork Weiser River where they had been observed previously, and, although the potential for refounding from nearby Dewey Creek is possible, it is small and no migrants are known from anywhere in the watershed.

## Methods

What follows is an exploratory descriptive analysis with no explicit statistical testing of differences among analysis areas, watersheds, or viability classes. This approach requires iteration to determine what environmental attributes to include in subsequent analyses, and it presumes some subjectivity in interpretation of ecological relationships. The conclusions presented must be understood to be our interpretations of what appear to be underlying patterns rather than precise statements of environmental gradients or definitions of ecological

[3] Recent evidence suggests that their may be adfluvial fish in Big Creek that use a lake in the Wilson Peak area near Profile Gap (P. Janssen, Idaho Fish and Game, personal communication) and potentially in Roosevelt Lake.
[4] Adfluvial fish probably also occur in Hell's Canyon Reservoir

taxa. Numeric results of statistical procedures have been presented as output by SAS® with no attempt to determine how many decimal places should be appropriate.

### *The Data Matrices*

The tabular data provided what we thought likely to be of interest and derived some composite variables to augment the environmental matrix (Table 14). Some data were modified where there seemed to be confusion about their relationship to the GIS watershed coverage used during LRMP revision[5] or there was uncertainty about the accuracy or consistency of the provided information. Most of the derived variables were simply revised expressions of other variables. (*e.g.*, BULLRATE was the ratio of BULLHUCS [number of 6th level HUs with bull trout] to TOTHUCS [the total number of 6th level HUs in an area]).

We also included an estimate of current bull trout population viability derived from the annual PNF fisheries biologist meeting in 2004 (Appendix 5). This was a subjective categorical variable that reflected the general consensus of the biologists at the meeting based on our understanding of bull trout ecology and consideration of the factors evaluated in a non-quantitative manner. It was then used for classification purposes described below.

Analysis areas and Section 7 watersheds were identified by a simple code (Table 2) for display of analytical results and discussion.

### *Spatial Analysis*

We used ESRI™ GIS products[6] to derive spatial attributes (except aspect) of subbasins, watersheds, and subwatersheds. Specific spatial attributes thought to be of potential interest were area, aspect, area above 1600m, and topographic relief. Areas were computed either from cell counts of raster coverages or directly from shape area in polygon coverages; conversion factors are displayed in Appendix 3.

### *Data Reduction*

There were several variables that would intuitively be expected to convey similar or overlapping information because they were designed to be alternative expressions of certain potential indicators or because they were calculated from other variables. In an effort to determine which variables were most likely to adequately describe environmental gradients for ordination, we used the SAS® variable clustering procedure PROC VARCLUS. This procedure basically clusters variables based on extracted principal or centroid components (SAS Institute 1999); We investigated both extraction methods and decided that the centroid method produced the most effective groupings. Within a given cluster, the variables selected for ordination were selected based on having the smallest $1\text{-}R^2$ ratio (Nelson 2001).

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[5] The LRMP revision coverage is being used instead of newer coverages that reflect procedural changes in delineating and enumerating HUs for consistency with the revised LRMP.

[6] ESRI™ is a registered trademark of Environmental Systems Research Institute, Inc. The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture or the U.S. Environmental Protection Agency of any product or service to the exclusion of others that may be suitable.

### *Ordinations*

Ordination is a dimension reduction procedure that involves placing classes or taxa (in our case analysis areas or Section 7 watersheds) described by several or many attribute variables into dimensions defined by a reduced set of variables. The result should be placement of taxa in a low dimensional space that shows similar taxa close together and dissimilar taxa are farther apart (Gauch 1982). We used SAS® PROC FACTOR for principal components analysis to reduce the data space into three environmental dimensions based on the variables retained after preliminary reduction These dimensions were the principal components (or factors[7]) that were composites of the environmental variables that elucidate important environmental gradients. Each principal component is uncorrelated with other principal components (*i.e.*, they are orthogonal) and can therefore define independent gradients. We selected three dimensions, which explained most of the variation among samples, mainly for convenience in displaying the ordination.

***Analysis Area Scale.—***At this scale, the taxa were analysis areas essentially as for ESA consultation purposes. They areas vary in size depending upon the geographic scale deemed relevant for analysis, from entire 4$^{th}$ level HUs to as few as three 6$^{th}$ level HUs, but most are approximately at the 5$^{th}$ level HU scale. Data are from the authors based on their personal knowledge, and GIS.

***Section 7 Watershed Scale.—***At this scale, entire Section 7 watersheds, which often approximate 4$^{th}$ level HUs, constituted the class-level taxa. These still vary somewhat in size, but to a smaller extent than the analysis areas.

### *Clustering*

Cluster analysis using complete linkage clustering with the reduced data sets (size-related indicators excluded) was used at both the analysis area and section 7 watershed scales to see whether they clustered in a way that reflected our *a priori* viability classification. Hierarchical classification seemed reasonable because we expect some continuum from high viability to low viability; no viability may be a special case of low variability, but preliminary analyses suggest something more complicated.

### *Discriminant Analysis*

Discrimant analyses are classification procedures that use pre-defined taxa and attempt to summarize the differences among the sites within the classes. Often, equations are developed that allow unclassified items to be placed in the taxon with which it is most allied. We used SAS® PROC CANDISC to perform canonical discriminant analysis for this exercise. Canonical discriminant analysis has some properties that are similar to principal components analysis that result in a sort of blend of ordination and classification. We used our *a priori* estimates of viability as the taxa of interest (although we reclassified “None” to “Moderate” for the initial analysis) and extracted three canonical variates. These caconical variates are similar to principal components (though they are not orthogonal) and constitute the best linear

[7] Principal components analysis differs somewhat from factor analysis, but SAS® PROC FACTOR module produces a principal components analysis as its default method and the variates are called “factors.”

combinations of the input variables that summarize the differences among the classes. We think that this method has the potential to support our interpretations of the relationship between environmental gradients seen with the principal components analysis and relative viability at the analysis area and Section 7 watershed scales.

## Results

### *Data Reduction*

***Analysis Area Scale.—***At this scale, we extracted 9 variable clusters (Figure 5) to explain slightly more than 80% of the variation in the data, and assigned an approximate environmental feature described or indicated by the cluster as shown in Table 16. The variables chosen for ordination were selected based on having the smallest 1-$R^2$ ratio, with occasional exceptions, and are highlighted in gray; here the exceptions were using ANADRATE instead of ANADSPEC because the latter is a more expressive variable with greater numeric range, and using ROADMILE instead of BRUKHUCS because they functioned very similarly in their cluster and a hybridization variable (MIXDRATE) was used from cluster 1. Although there were occasions when different clusters contained what would at first glance appear to be related attributes (*e.g.*, BULLHUCS in cluster 2 and BULLRATE in cluster 7), similar variables generally clustered with each other for a meaningful method of reducing the data set to the most meaningful variables for subsequent analyses. One cluster (cluster 5) was clearly related to the size of the analysis area; size is an arbitrary measure at this analysis scale, so all analyses will be performed with and without the most important variable from this cluster (TOTACRES). It is interesting to note that two clusters contained invasive species variables (clusters 1 and 4), but the latter is also composed of road development measures; the road variable (ROADMILE) is used instead of BRUKHUCS because we want to include the management-related attribute in later analyses and the invasive species influence will be covered from cluster 1 (MIXDRATE). It should be pointed out here, however, that MIXDRATE involves some estimation as explained in Appendix 4.

***Section 7 Watershed Scale.—***At this scale, seven clusters (Figure 6) were obtained at the point where 80% of the variation was explained. One cluster was principally related to size (Table 17), but it expresses other attributes as well; we interpret this to mean that size is ecologically important at this scale (*i.e.*, size alone is not necessarily important, but the abundance and diversity of ecological characteristics potentially conferred by size likely are important for distinguishing among sites based on their potential to support viable bull trout populations). Again, two clusters contain invasive species variables, but because the clusters contain no other relevant variables, both (BRUKHUCS and MIXDHUCS) will be retained in subsequent analyses. We selected RELIEF over ANADRATE from cluster 4 because the latter takes only two values at this scale.

### *Ordination*

***Analysis Area Scale.—***At this scale, the first three principal components were able to explain just less than 76% of the variation among areas (Table 18), but the gradients suggested appeared to be meaningful. The first principal component (PC1) explained about 30% of the variance and was loaded on attributes that primarily describe ecological integrity, the most

important being ANADRATE, BULLDENS and, as a distinct contrast, ROADMILE. The second principal component (PC2) explained nearly as much of the variance as PC1 (~28%). It was related primarily to size metrics, mainly DROPAREA, RELSIZE (DROPAREA is a blend of relief and size), and ANADHUCS as contrasts. The third principal component (PC3) explained an additional 18% of the variance among areas and was essentially biological and loaded most heavily on BRUKRATE and AFLVRATE with no strong contrasts.

We produced and ordination of the analysis areas by plotting analysis areas on axes defined by the principal components, and we can see that there is separation between relatively undeveloped sites that we believe have conditions conducive to high bull trout viability (round symbols) compared to those with considerable development and conditions we think are incompatible with high viability (square or triangular symbols) (Figure 7). Producing an ordination based on axes of individual attribute variables (single-variable gradients) suggested by the PCA showed similar separation (Figure 8); note that we used ROADMILE in the ordination rather than the higher-loaded ADADSPEC because they were similarly correlated with PC1 and the former is directly related to management actions.

Initially, we reasoned that size metrics might be confounding elements at this scale because not all areas were defined with similar spatial extent. The importance of TOTACRES in PC2 lent some support to this idea, but a second PCA without size metrics produced much the same result; all three principal components extracted this way were similar to those extracted in the previous analysis (Table 19), with DROPAREA replacing TOTACRES in PC2. Where the analyses differed most obviously was in the relative importance of the components: PC1 explained more variance this way, and PC2 and PC3 became more similar in how much variance they explained. Initial ordination was graphically similar to the above (Figure 9), with, perhaps, less overlap among analysis areas and *a priori* estimates of viability. Plotting the analysis areas on attribute variable axes (Figure 10) clearly showed the separation of west side and NFPR sites with "low" *a priori* viability estimates from the east side "moderate" to "high" viability sites along the road development axis (V1) and the separation of most of the LSR-MSSW group from the SFSR, MFT, and MSSE sites along the relative relief axis.

***Section 7 Watershed Scale.***—At this scale, the effect of size as a dominating attribute is reduced with size-related variables correlated with a variety of environmentally important attributes. The data reduction produced seven clusters, and extracting three principal components from these variables produced two readily interpreted gradients (Table 20) based on topography and biological potential (PC1), with heavy loadings on RELIEF and FLUVRATE, with a contrast loading on BRUKHUCS. PC2 was related to topography and road development in contrasting fashion; the contrast here is likely a consequence of the lower level of development in high-elevation watersheds. The third principal component was another biological gradient related to co-occurrence of bull trout and brook trout.

Ordination of watersheds on the PCA axes (Figure 11) shows separation of the watersheds we believe to have high bull trout population viability and those with low population viability, but the presumed populations with "moderate" viability seem more like the "high" viability bull trout populations. The single-variable ordination (Figure 12) somewhat obscured differences among sites, but did show the NFPR (effectively extinct) at one extreme, with the

SFSR well removed along the BULLHUCS axis; the west-side sites were separated from the east side watersheds by ROADMILE and BULLHUCS.

### *Cluster Analysis Classification*

***Analysis Area Scale.—***With the size-related variable TOTACRES included, the resulting dendrogram showed 6 clusters joining at an $R^2$ of about 0.6 (Figure 13). In general, these clusters make some intuitive sense (*e.g.*, the East Fork Weiser River [EFWR] clusters with the Little Weiser River [LWR] and the Wildhorse River [BRW]), but there are some unusual groupings that probably result from including size as a variable. The best example is that North Fork Payette River [NFPR], although not in the same cluster as several SFSR areas, is most closely joined to the cluster that contains the Lower South Fork Salmon River (LSFSR) and the East Fork South Fork Salmon River (EFSF); other than size, it is difficult to imagine what these areas have in common. This concern seems substantiated when clustering is performed without TOTACRES (Figure 14), which groups NFPR with west side areas; although the areas are physically somewhat different, we would expect bull trout viability to be essentially similar. If we look at the seven clusters that result at an $R^2$ of about 0.7, the top one and the two fifth and sixth from the top probably represent high viability, the bottom group is probably low viability, and the others most likely indicate moderate viability. This is not cut and dried, however, and some groups undoubtedly have intergrades with adjacent viability classes and there are likely "misfits" in some groups. For example, the positioning of French Creek (MSRFR) with upper Marble Creek (MFUM) seems odd and may reflect data gaps.

***Section 7 Watershed Scale.—***At this scale, clustering showed three groups that intuitively make sense (Figure 15), with one group comprising the SFSR, the southwest part of MSR (MSSW), the LSR, and the Middle Fork Tributaries (MFT) watersheds. We would expect this to be the high viability group, except that we would have expected to find MSSE here and MSSW and LSR in the group with Deep Creek (DC); this may reflect data gaps or inappropriate estimations for some of the parameters (*e.g.*, invasive species or bull trout prevalence). The west side watersheds (BR and WR) and NFPR group together as expected.

### *Canonical Discriminant Analysis Classification*

***Analysis Area Scale.—***We started with TOTACRES included in the data and differences among canonical variate means were statistically significant (Table 21) and the three canonical variates showed considerable similarity to the principal components extracted during the principal components analysis. The first canonical variate (CAN1) leads to the best separation between the viability classes (Figure 16). As with PC1 with size metrics excluded, CAN1 was most highly correlated with ANADRATE (0.751393); it was also highly correlated with ANADHUCS and, as a contrast, ROADMILE. The contrast between anadromous fish presence and road development probably represents coincidence in that portions of the Forest without anadromous fish are more highly developed than areas where anadromous species persist. Neither the second canonical variate (CAN2), which was correlated most highly with TOTACRES (0.696214), nor the third variate (CAN3) were very helpful in discriminating among viability classes

The fact that our *a priori* viability estimates were readily separated by the variables correlated with CAN1 was not surprising, because our knowledge of the relative development and integrity of the various analysis areas contributed to our *a priori* estimates of the viability of bull trout populations in them. For example, ubiquity of anadromous fish is positively related to our perception of bull trout viability, whereas road development, which leads to increased fragmentation and possibly degradation of instream sediment conditions, has the opposite effect; however, the *a priori* estimates were based on subjective belief about the extent of these explanatory attributes, beliefs that attain some quantitative illustration from this analysis.

The canonical discriminant analysis after removing the size variable TOTACRES produced much the same result (Table 22). Differences among canonical variate means were significant and the three canonical variates showed considerable similarity to the principal components extracted during the principal components analysis. The first canonical variate (CAN1) led to separation among all viability classes (Figure 17), and, as with PC1 in the non-size metric principal components analysis, CAN1 was most highly correlated with ANADRATE (0.754708), and was also reasonably well correlated with ANADHUCS and, as a contrast, ROADMILE.

***Section 7 Watershed Scale.***—The attribute variable BULLHUCS contributed most to the CAN1 at this scale (Table 23) even though it was not very important in PC1 for this analysis scale, but other variables in PC1 were influential, particularly BRUKHUCS and ROADMILE as contrasts. The first canonical variate was again most useful for discriminating among all viability classes, but at this scale CAN2, which was most correlated with RELIEF and FLUVRATE was useful for discriminating low and high viability from moderate viability (Figure 18).

**Discussion**

We believe that this exercise has produced a reasonable framework within which to evaluate and display the relative viability and inferred trends of bull trout populations across the Forest. In the ordinations, it is clear that biological and Forest development factors are influential in explaining differences among analysis areas and watersheds. Insofar as viability varies among these watersheds in a fashion that we understand, the factors separating the analysis areas or watersheds would be useful for discriminating among viability classes; this is what we demonstrated with the canonical discriminant analysis.

The importance of road development as a discriminatory attribute indicates that any increase in roads is likely to decrease bull trout viability locally, whereas we postulate that reduction in roads is likely to have a positive effect. Although anadromous species presence or ubiquity and bull trout and life history expression are inherently biological factors, they can also be indicators of management-induced fragmentation, though in our analysis they would likely be from off-Forest actions. This is certainly true in the Weiser River and Snake River where anadromous fish were excluded in about 1965 with the closure of Hells Canyon dam and in the NFPR where Black Canyon Dam excluded anadromous species in about 1924. We have estimated bull trout viability to be low in these areas, though the potential for adfluvial fish might be mitigating the situation in Indian Creek (BRI).

Recovery of bull trout is often conceptualized in terms of recolonization of areas from which they've been lost (USFS 2003 [LRMP III-18]; USFWS 2002), thereby envisioning increase in occurrence of bull trout as recovery proceeds. While this is a reasonable concept, it assumes that the principal threats to bull trout are anthropogenic in nature and can therefore be corrected. In this view, habitat fragmentation and road development, often coincident with one another, are key players. This may largely be true, but viability and recovery potential are undoubtedly compromised by other factors as well. The most obvious factor is sympatry with brook trout, which was seen as an important component of the environmental gradients described.

Another potential determinant of bull trout viability, particularly in the Weiser River watershed, is climate change. Given their position in the food web as top predators, bull trout may be vulnerable to increasing temperatures because such climate change is expected to be harshest to top predators (Petchey *et al.* 1999). In addition, if temperatures continue warming, we would expect the downstream limits of bull trout to increase in elevation, shrinking the amount of habitat available to them; this has been modeled in the Japanese archipelago for Dolly Varden (*S. malma*) and white-spotted char (*S. leucomaenis*), two species closely related to bull trout, by Nakano *et al*. (1996). This would, of course, exacerbate the negative competitive effects of brook trout, which appear more thermally tolerant. Given these factors, recovery of bull trout in the Weiser River and Brownlee Reservoir Section 7 watersheds seems unlikely, though the potential for adfluvial populations in Hells Canyon Reservoir may slow the extinction process in the Indian Creek analysis area.

Another aspect of viability and recovery potential that should at least be mentioned is the theoretical metapopulation structure of bull trout. This is a compelling concept, but there is little direct evidence for recovery in time scales likely to be of interest to land or fishery managers. We have not seen bull trout populations established in streams without them even when adjacent to streams supporting bull trout, and can find few documented cases where this has occurred. One possible case exists on the Boise River, where fish entrained below Arrowrock Dam appear to spawn in Mores Creek because they cannot ascend the South Fork Boise River (Whitely *et al*. 2003); while this may be similar to metapopulation dynamics; it seems an aberrant situation in which fish cannot reach their natal areas rather than straying. Furthermore, a recent radio tracking study in British Columbia that recorded repeat spawning by several individuals showed them spawning in the same place in successive years (Bahr and Shrimpton 2004). The upshot is that bull trout viability Forest-wide may be reduced when any local population is lost or reduced if the metapopulation model does not function within relatively short time frames (*i.e.*, a forest planning cycle).

**Uncertainties and Data Needs**

Some considerations pertinent to refining this analysis in the future should be mentioned. The modeling was restricted to values of quantitative attributes on-Forest, but it is likely that off-Forest attributes are important. Road development, for example, is often higher on adjacent state or private lands than it is on the Forest, so future analyses should consider all ownerships within an analysis area or Section 7 watershed. Similarly, we have postulated that time of disconnection from the sea (a surrogate for the beginning of fragmentation) is potentially an

important determinant of bull trout viability. This should be more fully explored, though we took a preliminary look at it and noticed that elapsed time since disconnection tended to cluster with roads in the data reduction step at the analysis area scale and with a brook trout measure at the Section 7 watershed scale. We would also like to see some other management-related variables added, like grazed or mined acres, because most of the variables at this time are unrelated to past or present management activity; average temperatures at some selected elevation might also be interesting.

We do not know the extent to which bull trout viability is affected in the Salmon River basin by hybridization with brook trout. A genetic study of the Secesh River bull trout population(s), and other easterly basins would help determine what level of hybridization and introgression is taking place with brook trout. This information is critical, because this geographic area is believed to have the most viable bull trout populations on the Forest.

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# Appendix 1: Tables

**Table 1.—**Bull and brook trout presence in Main Salmon (SFSR to LSR) tributaries, 1994 to 2004 (unpublished data on File in the PNF SO, McCall, Idaho).

| Stream | Bull trout present | Brook trout present | Surveyed, no char |
|---|---|---|---|
| Lake Creek | Y | N | |
| Partridge Creek | Y | Y (lower reach) | |
| Elkhorn Creek | N | Y | |
| French Creek | Y | Y | |
| Fall Creek | Y | N | |
| Carey Creek | N | N | Y |
| California Creek | Y | Y | |
| Rabbit Creek | N | N | Y |
| Warren Creek | Y | Y | |

**Table 2.—**Distributions of various salmonid species in Boulder Creek, 1991 and 1992 (unpublished data from USFS Rocky Mountain Research Station, Boise, Idaho).

Table 3. Numbers of salmonid species observed in each study reach by survey year.

| Reach | (n) | | Chinook | | Steelhead | | Rainbows | | Bull Trout | | Brook Trout | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | 1991 | 1992 | 1991 | 1992 | 1991 | 1992 | 1991 | 1992 | 1991 | 1992 | 1991 | 1992 |
| 1 | 15 | 10 | 51 | 266 | 409 | 355 | 17 | 3 | 0 | 6 | 0 | 1 |
| 2 | 13 | 9 | 1 | 51 | 213 | 150 | 3 | 4 | 0 | 7 | 0 | 0 |
| 3 | 8 | 9 | 0 | 0 | 194 | 215 | 7 | 9 | 0 | 5 | 2 | 0 |
| 4 | 7 | 7 | 0 | 0 | 103 | 97 | 8 | 4 | 9 | 3 | 8 | 18 |
| 5 | 5 | 7 | 0 | 0 | 20 | 65 | 0 | 0 | 0 | 0 | 0 | 5 |
| 6 | 12 | 11 | 0 | 0 | 57 | 76 | 6 | 1 | 44 | 1 | 0 | 37 |
| 7 | 16 | 12 | 0 | 0 | 53 | 46 | 3 | 0 | 9 | 4 | 71 | 156 |
| 8 | 10 | 15 | 0 | 0 | 18 | 58 | 3 | 0 | 2 | 14 | 9 | 61 |
| Totals | 86 | 80 | 52 | 317 | 1067 | 1062 | 47 | 21 | 64 | 40 | 90 | 278 |

**Table 3.—**Numbers of Columbia River bull trout in the Boulder Creek watershed (Little Salmon River basin) on the Payette National Forest. The data source is referenced in the footnote for each data entry.

| Location | Year | | | | | |
|---|---|---|---|---|---|---|
| | 1989 | 1991 | 1994 | 1997 | 2002 | 2003 |
| | Number of bull trout observed/stream reach length in feet | | | | | |
| **Boulder Creek** T21N R1W S24 | 1 / 8031 ft[1] | 44 / ~299 ft [(2)] | | | | |
| **Boulder Creek** T21N R1W S24, 25, 26, 35 | 3 / 5892 ft[1] | 9 / ~303 ft [(2)] | 1 / 7392 ft[3] | | 17 / unknown[6] | |
| **Boulder Creek** T21N R1W S26 | 3 / 3102 ft[1] | | | | | |
| **Boulder Creek** T21N R1W S26 | 2 / 1421 ft[1] | | | | | |
| **Boulder Creek** T21N R1E S7, 18 | | 9 / ~175 ft [(2)] | | | | |
| **Boulder Creek** T20N R1W S3, 10 T21N R1W S35, 34 | | 2 / ~180 ft [(2)] | | | | |
| **Boulder Creek** T21N R1E S4, 8, 9 | | | | 1 / 239 ft[4] | | |
| **Boulder Creek** T20N R1W S3, 10 | | | | | 83 / unknown[5] | |
| **Boulder Creek** T20N R1W S10 | | | | | 4 / ~200 ft[6] | 2 / 328 ft[7] |

Footnotes:
1 - 1989 PNF data: Capurso, Hardy, Greter, on file at PNF SO
2 - 1991 RMRS R1/R4 inventory, on file at PNF SO
3 – PNF data: S. Adams, on file at PNF SO
4 – PNF data: Goodridge, Olsen, Williams, on file at PNF SO
5 – PNF data: Trainor, Hart, on file at PNF SO; presence/absence survey, length of habitat snorkeled not recorded
6 – PNF data: Adams, Cantor, on file at PNF SO; presence/absence survey, length of habitat snorkeled not always recorded
7 – PNF data: Adams, Trapp, on file at PNF SO

**Table 4.—**Numbers of Columbia River bull trout in the remainder of the Little Salmon River basin on the Payette National Forest . The data source is referenced in the footnote for each data entry.

| Location | Year | | | | | |
|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1994 | 2001 | 2002 | 2004 |
| | Number of bull trout observed/stream reach length in feet | | | | | |
| **Twin Forks Creek**<br>T20N R1W S3 | | | | | 2 / ~213 ft[1] | |
| **Star Creek**<br>T21N R1W S14, 22 | 8 / unknown[2] | | | | | |
| **Star Creek**<br>T21N R1W S14, 22 | 1 / unknown[2] | | | | | |
| **Ant Basin Creek**<br>T21N R2E S 26, 27 | | | | 18 / 751 ft[3] | 7 / unknown[4] | |
| **Hard Creek**<br>T21N R1E S1, 12 | | | | 1 / ~866 ft[5] | | |
| **Hard Creek**<br>T21N R2E S18, 19, 29, 30 | | | | 2 / ~3949 ft[5] | | |
| **Hazard Creek**<br>T21N R1E S1, 2 | | | | | | 2 / ~502 ft[7] |
| **Rapid River**<br>T22N R1W S11 | | 1 / ~101 ft[6] | | | | |
| **Rapid River**<br>T22N R1W S11, 15, 22 | | 9 / ~581 ft[6] | | | | |
| **Rapid River**<br>T22N R1W S22, 28, 33 | | 70 / ~777 ft[6] | | | | |
| **Rapid River**<br>T22N R1W S33 | | 7 / ~482 ft[6] | | | | |
| **Rapid River**<br>T21N R1W S4, 51<br>T22N R1W S33 | | 10 / ~367 ft[6] | | | | |
| **Rapid River**<br>T21N R1W S5 | | 18 / ~265 ft[6] | | | | |
| **Rapid River**<br>T21N R1W S8, 17 | | 18 / ~302 ft[6] | | | | |
| **Rapid River**<br>(Wyant site)<br>T3S R1W S2 | | | | | | 5 / ~252 ft[7] |
| **Rapid River**<br>(Rap2 site)<br>T3S R1W SS12 | | | | | | 1 / ~344 ft[7] |
| **Rapid River**<br>(Site 6)<br>T3S R1W S23 | | | | | | 2 / ~164 ft[7] |
| **Rapid River**<br>(Cliff hanger site)<br>T3S R1W S24 | | | | | | 1 / ~279 ft[7] |

| Location | Year | | | | | |
|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1994 | 2001 | 2002 | 2004 |
| | Number of bull trout observed/stream reach length in feet | | | | | |
| **Rapid River** (Site 4) T3S R1W S26 | | | | | | 2 / ~124 ft[7] |
| **Rapid River** (Cora site) T3S R1W S26 | | | | | | 1 / ~164 ft[7] |
| **Rapid River** (Copper Creek site) T4S R1W S15 | | | | | | 3 / ~206 ft[7] |
| **Rapid River** (Paradise site) T4S R1W S22 | | | | | | 8 / unknown[7] |

Footnotes:
1 – PNF data: Trainor, Hart, on file at PNF SO
2 – PNF GAWS data: Swensson, Boarstad, on file at PNF SO; length of survey not recorded
3 – PNF data: Spurgeon, Thomas, on file at PNF SO
4 – PNF data: Trainor, Hart, on file at PNF SO; presence/absence survey, length of habitat snorkeled not recorded
5 – PNF data: Spurgeon, Lanspery, on file at PNF SO
6 - 1991 RMRS R1/R4 inventory, on file at PNF SO
7 – Idaho Fish and Game data, on file at PNF SO; site length not noted for Paradise site; all sites but Copper Creek and Paradise downstream of PNF lands

**Table 5.—**Adult bull trout collected at the Rapid River wier, 1972-2004 (unpublished data from Idaho Fish and Game).

| Year | Number | Year | Number | Year | Number |
|---|---|---|---|---|---|
| 1972 | 197 | 1983 | 123 | 1994 | 147 |
| 1973 | 114 | 1984 | 342 | 1995 | 234 |
| 1974 | 290 | 1985 | 153 | 1996 | 224 |
| 1975 | 451 | 1986 | 137 | 1997 | 119 |
| 1976 | 414 | 1987 | 128 | 1998 | 111 |
| 1977 | 212 | 1988 | 136 | 1999 | 163 |
| 1978 | 128 | 1989 | 170 | 2000 | 300 |
| 1979 | 260 | 1990 | 255 | 2001 | 360 |
| 1980 | 219 | 1991 | 326 | 2002 | 359 |
| 1981 | 134 | 1992 | 271 | 2003 | 139 |
| 1982 | 88 | 1993 | 148 | 2004 | 240 |

**Table 6.—**Documented bull trout occurrences in the Big Creek and Marble Creek subwatersheds.

| Stream | Source |
|---|---|
| Upper Marble Creek (near Cornish and Cottonwood Creeks.) | Thurow (1985), IDFG parr monitoring database 1986-1996 data on file PNF SO, McCall, ID. |
| Mainstem Big Creek | Mallet (1974), Thurow (1985), Raleigh (1993, 1994) |
| Rush Creek | Mallet (1974), IDFG (1997) |
| Cabin Creek | Mallet (1974) |
| Monumental Creek | Mallet (1974), Welsh *et al*. (1965), Thurow (1985), IDFG (1997), D. Faurot snorkel survey 1996 data on file Payette National Forest Supervior's Office, McCall, ID. |
| Snowslide Creek | Mallet (1974) |
| West Fork Monumental | Mallet (1974), IDFG (1997) |
| Crooked Creek | Mallet (1974), IDFG (1997) |
| Beaver Creek | Mallet (1974), Raleigh (1993, 1994), IDFG (1997) |
| Hand Creek | Raleigh (1993, 1994) |
| Boulder Creek | Raleigh (1993, 1994) |
| Smith Creek | IDFG (1997), Raleigh (1993, 1994) |
| Logan Creek | IDFG (1997), Raleigh (1993, 1994) |
| Belvidere Creek | Raleigh (1993, 1994) |

**Table 7.—**Numbers of Columbia River bull trout in the Middle Fork Salmon River Section 7 watershed on the Payette National Forest. The data source is referenced in the footnote for each data entry. UTM's are for lower boundary of reach.

| Location | Year | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** |
| | **Number of bull trout observed/stream reach length in feet** | | | | | | | | | | | |
| **Logan Creek** T21N, R9E, S34 | 3/6831 ft, R2 [1] | | | | | | | | | | | 2/330 ft, R2 [2] |
| **Logan Creek** T21N, R9E, S33,32 | 9/9593 ft, R3 [1] | | | | | | | | | | | 3/330 ft, R3 [2]<br>3/330 ft, R4 [2] |
| **Logan Creek** T21N, R9E, S31 | 5/ 11,332 ft, R4 [1] | | | | | | | | | | | 3/330 ft, R5 [2] |
| **Logan Creek** (Reach 5) T21N, R9E, S1, 11 | 14/ 7979 ft, R5 [1] | | | | | | | | | | | 37/330 ft, R6 [2] |
| **NF Logan** T21N, R9E, S32 | 5/5504 ft[1] | | | | | | | | | | | |
| **NF Logan Cr** T21N, R9E, S32 | | | | | | | 1/1155 ft, R1 [5] | | | | | |
| **Upper Big Creek** (mainstem) T21N, R9E, S10 | 6/3636 ft, R5 [1] | | | | | | | | | | | |
| **Upper Big Creek** (mainstem) T21N, R9E, S15,16 | 23/ 7310 ft R6 [1] | | | | | | | | | | | |
| **Upper Big Creek** (mainstem) T21N, R9E, S17,18 | 5/ 18,143 ft R7 [1] | | | | | | | | | | | |
| **Upper Big Creek** (mainstem) T21N, R9E, S24 | 1/9900 ft, R8 [1] | | | | | | | | | | | |
| **Belvidere Creek** T20N, R9E, S16 | 21/ 9956 ft, R1 [1] | | | | | | | | | | | |
| **Smith Creek** T21N, R9E, S13,14 | 14/ 8844 ft, R1 [1] | | | | | | | | | | 2/330 ft, R2[3]<br>11/330 ft, R3[3]<br>6/330 ft, R4[3] | |

| Location | Year | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** |
| | **Number of bull trout observed/stream reach length in feet** | | | | | | | | | | | |
| **Smith Creek**<br>T21N, R9E, S11, 2, 3 | 39/<br>12,998<br>ft R2 [1] | | | | | | | | | | 7/330 ft,<br>R5[3]<br>22/330 ft,<br>R6[3]<br>20/330 ft,<br>R7[3]<br>10/330 ft,<br>R8[3]<br>8/330 ft,<br>R9[3] | |
| **Smith Creek**<br>T21N, R9E, S3, 4, 9 | 8/1296 ft,<br>R3 [1] | | | | | | | | | | 24/330<br>ft,R1[3]<br>25/330<br>ft,R1[3]<br>21/330<br>ft,R1[3] | |
| **Placer Creek**<br>(Smith)<br>T21N, R9E, S11 | 2/2768 ft [1] | | | | | | | | | | | |
| **MF Smith Creek**<br>T21N, R9E, S8 | 1/3026m [1] | | | | | | | | | | | |
| **Beaver Creek**<br>T21N, R10E, S16 | | | | | | | | | | 1/330 ft,<br>R1[4] | | |
| **Beaver Creek**<br>T21N, R10E, S9 | | | | | | | | | | 4/330 ft,<br>R2[4]<br>7/330 ft,<br>R3[4]<br>5/330 ft,<br>R4[4] | | |

| Location | Year | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** |
| | **Number of bull trout observed/stream reach length in feet** | | | | | | | | | | | |
| **Beaver Creek**<br>T21N, R10E, S5, 6,<br>T22N, R10E, S31 | 2/10, 424 ft, R2 [1] | | | | | | | | | 8/330 ft, R5[4]<br>5/330 ft, R6[4]<br>6/330 ft, R7[4]<br>3/330 ft, R8[4]<br>7/330 ft, R9[4]<br>10/330 ft, R10[4]<br>10/330 ft, R11[4]<br>7/330 ft, R12[4]<br>9/330 ft, R13[4]<br>7/330 ft, R14[4] | | |
| **Beaver Creek**<br>T22N, R9E, S36, 25 | 4/9414 ft, R3 [1] | | | | | | | | | 3/330 ft, R15[4]<br>4/330 ft, R16[4] | | |
| **Beaver Creek**<br>T22N, R9E, S23, 24, 14 | 4/5583 ft, R4 [1] | | | | | | | | | 2/330 ft, R17[4]<br>1/330 ft,R22 | 6/330 ft,R2[3]<br>1/330 ft, R24 [3] | |
| **Beaver Creek**<br>T22N, R9E, S15 | 1/5481 ft, R6 [1] | | | | | | | | | | | |
| **Hand Creek**<br>(Beaver)<br>T22N, R9E, S24 | 10/ 4831 ft, R1 [1] | | | | | | | | | | | |
| **Hand Creek**<br>(Beaver)<br>T22N, R9E, S19, 7 | 35/ 15925 ft, R2 [1] | | | | | | | | | | | |
| **WF Beaver**<br>T22N, R9E, S15, 22 | | | | | | | | | | | 4/330 ft, R1[3] | |
| **Cave Creek**<br>T21N, R12E, S26 | | | | | | | | | | | 2/330 ft R1 [3] | |
| **Cave Creek**<br>T21N, R12E, S10 | | | | | | | | | | | 2/330 ft R7 [3] | |
| **Cabin Creek**<br>T21N, R12E, S25 | | | | | 2/5000ft. [6] | | | | | | 1/330 ft R2 [3] | |

| Location | Year | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
| | Number of bull trout observed/stream reach length in feet | | | | | | | | | | | |
| **Crooked Creek** T21N, R11E, S1 | | | | | | | | 7/5000 ft [7] | | | | |
| **Big Creek** (mainstem, Taylor Ranch) UTM N4995698, E678370 (IDFG L1) | 2/330 ft [9] | | | | | | 4/330 ft [9] | | | | | 7/330 ft [8] |
| **Big Creek** (mainstem, above Hogback) UTM N4999533, E632739 | | | | 1/310 ft [9] | | | | | | | 1/310 ftm [9] | 1/310 ft [8] |
| **Big Creek** (mainstem, above Jacobs Ladder) UTM N4993223, E630615 | | | 1/300ft [9] | 2/300ft [9] | | 2/300 ft [9] | | | 1/300 ft [9] | 1/300 ft [9] | 1/300 ft [9] | 2/300 ft [8] |
| **Big Creek** (mainstem, downstream of Logan Creek) UTM N4997309, E632214 | | 1/264 ft [9] | | | 3/264 ft [9] | 1/264 ft [9] | | 1/264 ft [9] | 1/264 ft [9] | 1/264 ft [9] | 1/264 ft [9] | 1/264 ft [8] |
| **Big Creek** (mainstem, Ford area) UTM N4995241, E631415 | 2/409 ft [9] | | | | 2/409 ft [9] | | 1/409 ft [9] | | | 3/409 ft [9] | 1/409 ft [9] | 6/409 ft [8] |
| **Big Creek,** (mainstem, above Beaver Creek) | | 1/330 ft[9] | | | | | | | | | | |
| **Big Creek** (mainstem, Hard Boil Bar) | | | | | | | | | | | | 7/330 ft [8] |
| **Big Creek** (mainstem, Cabin Ck mouth area) UTM N4998842, E662423 | | | | | | | | | | 1/330 ft [9] | | |
| **Big Creek** (mainstem, 75m below Rush Cr) UTM N4996614, E668390 (IDFG Taylor 1) | | | | | | | | | | 4/726 ft [9] | | |

| Location | Year | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** |
| | **Number of bull trout observed/stream reach length in feet** | | | | | | | | | | | |
| **Marble Creek** (145m below mouth of Cornish Cr) UTM N4976522, E649989 (IDFG MAR1) | | | | | | 2/528 ft [9] | | | | | 6/528 ft [9] | |
| **Marble Creek** (90m below Big Cottonwood Cr) UTM N4974598, E651573 (IDFG MAR2) | 1/297 ft [9] | 1/297 ft [9] | | 1/297 ft [9] | | 1/297 ft [9] | | | 3/297 ft [9] | | 3/297 ft [9] | |
| **Monumental Creek** (above Roosevelt Lake) UTM N4979390, E643640 (IDFG MON1) | | | | | | | | | 1/330 ft [9] | | | |
| **Monumental Creek** (near mouths of Trap and Fall Creeks) UTM N4982000, E644534 (IDFG MON3) | | | | | | | | | | | 1/495 ft [9] | |
| **Monumental Creek** (below Holy Terror Creek) UTM N4987811, E648240 (IDFG MON5) | | | | | | | | | 2/ 416 ft [9] | | 1/ 416 ft [9] | |

| Location | Year | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
| | Number of bull trout observed/stream reach length in feet | | | | | | | | | | | |
| **WF Monumental Creek** (300 yd upstream of mouth) (IDFG MON4) | | | | | | | | | 3/330 ft [9] | 1/330 ft [9] | | |

Footnotes:
1– Raleigh 1993-1994. R# denotes Reach number from survey.
2 – USFS Survey 2004 (Logan), Unpublished data on file at the Payette NF SO, McCall, ID. R# denotes Reach number from survey.
3 – USFS Survey 2003 (Smith, Cave, Cabin, Beaver), Unpublished data on file at the Payette NF SO, McCall, ID. R# denotes Reach number from survey.
4 – USFS Survey 2002 (Beaver), Unpublished data on file at the Payette NF SO, McCall, ID. R# denotes Reach number from survey.
5 – USFS Survey 1999, (NF Logan), Unpublished data on file at the Payette NF SO, McCall, ID.
6 – USFS Survey 1997, (Big, Cabin), Unpublished data on file at the Payette NF SO, McCall, ID
7 – USFS Survey 2000, (Crooked), Unpublished data on file at the Payette NF SO, McCall, ID
8 – IDFG snorkel data, M:\Project\WapitiVIIFollowup\ copyofqryJoinParrFishGpm99McCall2004.xls
9 – IDFG snorkel data, M:\Project\WapitiVIIFollowup\copyofqryJoinParrFishGpm99historicalto2003provisionaldata.xls
10 – USFS Survey 2003, (McCalla/Whimstick), Unpublished data on file at the Payette NF SO, McCall, ID

**Table 8.—**Numbers of Columbia River bull trout in the Main Salmon Southeast Section 7 watershed on the Payette National Forest. The data source is referenced in the footnote for each data entry. UTM's are for lower boundary of reach.

| **Location** | **Year** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** |
| | **Number of bull trout observed/stream reach length in feet** | | | | | | | | | | | |
| **Chamberlain Creek** (mainstem, south of airstrip and downstream of footbridge) UTM N5025592, E641145 (IDFG CHA 4) | | 5/330 ft [9] | | | | 1/330 ft [9] | | | 1/330 ft [9] | | 1/330 ft [9] | |
| **Chamberlain Creek** (mainstem, at SFk Rim Ck) (IDFG Forks) | | | 1/330ft [9] | | | | | | | | | |
| **Chamberlain Creek** (mainstem, above Hotzel) | | 7/330 ft [9] | | | | | | | | | | |

| Location | Year | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
| | Number of bull trout observed/stream reach length in feet | | | | | | | | | | | |
| **WF Chamberlain Creek** (Stonebreaker fence crosses creek) UTM N5027748, E641514 (IDFG CHA 2) | | 2/406 ft [9] | 2/406 ft [9] | 2/406 ft [9] | | 1/406 ft [9] | 4/406 ft [9] | | | 2/406 ft [9] | 3/406 ft [9] | 2/406 ft [9] |
| **WF Chamberlain Creek** (85m below Game Creek) UTM N5028434, E641443 (IDFG CHA 3) | | | 1/284 ft [9] | | | | | | | 2/284 ft [9] | 2/284 ft [9] | |
| **McCalla Creek** (mainstem, below Moose Meadows) UTM N5020238, E0647648 | | | | | | | | | | | 2/350 ft R4 [10] | |
| **McCalla Creek** (mainstem, above Moose Meadows) UTM N5018532, E0647520 | | | | | | | | | | | 7/336 ft R5 [10] | |
| **Whimstick Creek,** (above boulder cataract) UTM N5022962, E0655659 | | | | | | | | | | | 3/330 ft R4[10] | |
| **Whimstick Creek** (below Wapiti Creek) UTM N5022320, E0655335 | | | | | | | | | | | 1/330 ft R5 [10] | |
| **Whimstick Creek** (above Wapiti Creek) UTM N5021842, E0655056 | | | | | | | | | | | 1/330 ft R6 [10] | |
| **Whimstick Creek** (below Root Ranch) UTM N5020727, E06552161 | | | | | | | | | | | 1/330 ft R7 [10] | |
| **Whimstick Creek** (above Root Ranch) UTM N5018690, E0654593 | | | | | | | | | | | 21/429 ft R7 [10] | |

| Location | Year | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
| | Number of bull trout observed/stream reach length in feet | | | | | | | | | | | |
| **EF Whimstick Cr** (above mouth) UTM E0655376, N5018044 | | | | | | | | | | | 8/353 ft [10] | |
| **SF Whimstick, Cr** (above mouth) UTM E0654543, N5016894 | | | | | | | | | | | 73/330 ft [10] (this is correct, I checked the data!) | |
| **WF Whimstick Cr** (above mouth) UTM E0653480, N5016810 | | | | | | | | | | | 9/330 ft [10] | |

Footnotes:
1 – Raleigh 1993-1994. R# denotes Reach number from survey.
2 – USFS Survey 2004 (Logan), Unpublished data on file at the Payette NF SO, McCall, ID. R# denotes Reach number from survey.
3 – USFS Survey 2003 (Smith, Cave, Cabin, Beaver), Unpublished data on file at the Payette NF SO, McCall, ID. R# denotes Reach number from survey.
4 – USFS Survey 2002 (Beaver), Unpublished data on file at the Payette NF SO, McCall, ID. R# denotes Reach number from survey.
5 – USFS Survey 1999, (NF Logan), Unpublished data on file at the Payette NF SO, McCall, ID.
6 – USFS Survey 1997, (Big, Cabin), Unpublished data on file at the Payette NF SO, McCall, ID
7 – USFS Survey 2000, (Crooked), Unpublished data on file at the Payette NF SO, McCall, ID
8 – IDFG snorkel data, M:\Project\WapitiVIIFollowup\ copyofqryJoinParrFishGpm99McCall2004.xls
9 – IDFG snorkel data, M:\Project\WapitiVIIFollowup\copyofqryJoinParrFishGpm99historicalto2003provisionaldata.xls
10 – USFS Survey 2003, (McCalla/Whimstick), Unpublished data on file at the Payette NF SO, McCall, ID

**Table 9.—**Numbers of Columbia River bull trout in the East Fork and Upper South Fork Salmon River (SFSR Section 7 watershed) on the Payette National Forest. The data source is referenced in the footnote for each data entry. UTM's are for the lower boundary of the indicated reach.

| Location | Year | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
| | Number of bull trout observed/stream reach length in feet | | | | | | | | | | | |
| **East Fork SFSR** | | | | | | | | | | | | |
| **EFSFSR** (mainstem, above Quartz Cr) UTM N4980427, E620119 | | 1/260 ft[1] | | | | | | | | | | |
| **EFSFSR** (mainstem, below Sugar Cr) | | 2/132 ft [1] | | | | | | | | | | |
| **EFSFSR** (mainstem, below Salt Cr) UTM N4978762, E629301 | | 1/165 ft[1] | | | | | | | | | | |

| Location | Year | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
| | Number of bull trout observed/stream reach length in feet | | | | | | | | | | | |
| **EFSFSR** (mainstem, below Tamarack Cr) UTM N4979546, E626287 | | 1/264 ft[1] | | | | | | | | | | |
| **EFSFSR** (IDFG "3", 0.9 mi upstream of Tamarack Cr) | | 2/230 ft[1] | | 4/230ft[1] | 1/ 230 ft[1] | 3/ 230ft[1] | 1/ 230ft[1] | | 6/ 230ft[1] | 4/ 230ft[1] | 7/ 230ft[1] | 1/230ft[1] |
| **EFSFSR** (below Quartz Cr) UTM N4980440, E619760 | | 2/168 ft[1] | | | | | | | | | | |
| **NoMans Creek** UTM N4979489, E623318 | | 4/181 ft[1] | | | | | | | | | | |
| **Salt Creek** UTM N4978445, E630038 | | 1/102 ft[1] | | | | | | | | | | |
| **Profile Creek** UTM N4979181, E623864 | | 2/257ft[1] | | | | | | | | | | |
| **Sugar Creek** UTM N4977011, E631098 | | 2/330ft[1] | 1/330ft[1] | | 1/ 330ft[1] | 4/ 330 ft[1] | 7/ 330ft[1] | 3/ 330ft[1] | 21/ 330ft[1] | | 9/ 330ft[1] | 3/330ft[1] |
| **EFSFSR** (mainstem, above Johnson Cr) UTM N4979773, E618327 | | 3/135ft[1] | | | | | | | | | | |
| **EFSFSR** (mainstem, below Johnson Cr) UTM N4979674, E617865 | | 4/194ft[1] | | | | | | | | | | |
| **EFSFSR** (mainstem, near Parks Cr, IDFG "6") UTM N4978840, E615620 | 2/495ft[1] | 4/495ft[1] | 1/495ft[1] | | | 9/ 495ft[1] | 9/ 495ft[1] | 7/ 495ft[1] | 19/ 495ft[1] | 2/ 495ft[1] | 3/ 495ft[1] | |
| **EFSFSR** (mainstem, near Caton Cr, IDFG "7") UTM N4977868, E611363 | | 1/180ft[1] | | | 1/ 180ft[1] | 5/ 180ft[1] | 4/ 180ft[1] | 1/ 180ft[1] | 3/ 180ft[1] | | 2/ 180ft[1] | 3/180ft[1] |

| Location | Year | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
| | Number of bull trout observed/stream reach length in feet | | | | | | | | | | | |
| **EFSFSR** (mainstem, MP 35.8) UTM N4984293, E601652 | | | | | | 3/ 462ft[1] | 2/ 462ft[1] | 3/ 462ft[1] | | | 1/ 462ft[1] | 1/ 462ft[1] |
| **Meadow Creek** (at Blowout Cr ford) UTM N4972509, E631278 | | | | | | | | | 2/ 313ft[1] | | 2/ 313ft[1] | 1/ 313ft[1] |
| **Profile Creek** (0.5 mi above Missouri Cr) | | 9/330 ft [1] | | | | | | | | | | |
| **Profile Creek** (0.5 mi above mouth) | | 2/330ft[1] | | | | | | | | | | |
| **Profile Creek** (1mi above mouth) | | 6/330ft[1] | | | | | | | | | | |
| **Profile Creek** (2mi above mouth) | | 6/330ft[1] | | | | | | | | | | |
| **Profile Creek** (3mi above mouth) | | 17/ 330ft[1] | | | | | | | | | | |
| **Profile Creek** (below Missouri Cr) | | 9/330ft[1] | | | | | | | | | | |
| **Tamarack Creek** (0.5 mi above mouth) | | 4/330ft[1] | | | | | | | | | | |
| **Tamarack Creek** (100m above mouth) | | | | | 2/ 330ft[1] | | | | | | | |
| **NoMans Creek** T19N R8E S26 | | | | | | | | | | 6/344[2] 6 fish in 3 units out of 14 snorkeled. | | |
| **Pepper Creek** T19N R9E S33 | | | | | | | | | | 3/332[2] 3 fish in 3 units out of 14 snorkeled. | | |
| **Bishop Creek** T19N R9E S30 | | | | | | | | | | 2/346[2] 2 fish in 2 units out of 16 snorkeled. | | |

| Location | Year | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
| | Number of bull trout observed/stream reach length in feet | | | | | | | | | | | |
| **Quartz Creek** (R1) T19N R8E S21, 15, 10 | | | | | | | | | | 29/397[2] 29 fish found in 7 units out of 7 snorkeled. | | |
| **Quartz Creek** (R2) T19N R8E S3, 4 | | | | | | | | | | 14/422[2] 14 fish in 5 units out of 7 snorkeled. | | |
| **Quartz Creek** (R3) T20N R8E S33, 28 | | | | | | | | | | 4/462[2] 4 fish in 4 units out of 14 snorkeled. | | |
| **Parks Creek** (R1) T19N R8E S30 | | | | | | | | | | 2/348[2] 2 fish in 1 unit out of 7 snorkeled. | | |
| **Vein Creek** T19N R8E S3 | | | | | | | | | | 13/385[2] 13 fish in 4 units out of 4 snorkeled. | | |
| **Upper SFSR** | | | | | | | | | | | | |
| **SFSR** (mainstem, near Fourmile Cr., IDFG "11") UTM N4967209, E603233 | | | | 1/ 290ft[1] | | | | | | | | |
| **SFSR** (mainstem, near Buckhorn Cr, IDFG "14") UTM N4975589, E599281 | | | | | | | 2/345ft[1] | | 1/345ft[1] | | | |
| **SFSR** (mainstem, near Fitsum Cr, IDFG "16") UTM N4983823, E601034 | | 1/ 237ft[1] | | | | | | 3/237ft[1] | | 1/237ft[1] | | |

| Location | Year | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
| | Number of bull trout observed/stream reach length in feet | | | | | | | | | | | |
| **SFSR** (mainstem, near Threemile Cr) UTM N4988889, E605309 | | | | | | | | 2/300ft[1] | | | | |
| **SFSR** (mainstem, below Hamilton Cr) UTM N4986979, E602946 | | 1/340ft[1] | | | | | | | | | | |
| **Fitsum Creek** (Reach 2) UTM E0596716, N4985703 | | | | | | | | | | 1/95ft[3] | | |
| **Fitsum Creek** (Reach 1) UTM E0599725, N4982453 | | | | | | | | | | 2/95ft[3] | | |
| **NF Fitsum Creek** (Reach 1) UTM E0591763, N4984318 | | | | | | | | | | | 7/330ft[3] | |
| **NF Fitsum Creek** (Reach 2, 1 mile above Reach 1) | | | | | | | | | | | 3/330ft[3] | |
| **Buckhorn Creek** (Reach 2, from mouth of Little buckhorn upstream approx. 1 mile to unnamed stream entering from west) T18N, R5E, S7, 8 | 18/7300ft[4] | | | | | | | | | | | |
| **Buckhorn Creek** (Reach 3, from end of Reach 2 upstream 0.5 mile) T18N, R5E, S7, 13 | 18/ 3758ft[4] | | | | | | | | | | | |
| **Buckhorn Creek** (Reach 4, from end of Reach 3 upstream 2 miles to unnamed trib in section 14) T18N, R5E, S13, 14 | 3/12045ft[4] | | | | | | | | | | | |

| Location | Year | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
| | Number of bull trout observed/stream reach length in feet | | | | | | | | | | | |
| **Buckhorn Creek** (Reach 5, from end of Reach 4 upstream into Section 21) T18N, R5E, S14, 22, 21 | 50/39718ft[4] | | | | | | | | | | | |
| **SF Buckhorn Creek** (Reach 1) T18N, R5E, S22, 27 | 1/6761ft[4] | | | | | | | | | | | |
| **SF Buckhorn Creek** (Reach 2) T18N, R5E, S27, 34 | 16/6306ft[4] | | | | | | | | | | | |
| **Fourmile Creek** (Reach 1, mouth to culvert) | | | | | | | 2/2500ft[5] | | | | | |
| **Fourmile Creek** (Reach 2, culvert upstream 600m) | | | | | | | | | 10/1980ft[5] | | | |
| **Lower SFSR** | | | | | | | | | | | | |
| **Elk Creek** (Reach 3) T21N R8E S19 | | | | 1/7498[6] 1 fish in 1 unit of 2 snorkeled. | | | | | | | | |
| **Elk Creek** (150 m US of Site E030) T21N R7E | | | | | | 2/394[7] snorkeled US and DS of first (blown out) bridge. | | | | | | |
| **Pony Creek** T21N R7E S2 | | | | | | 1/426[7] snorkeled US and DS of lower Pony Cr. bridge | | | | | | |

Footnotes:
1 – IDFG snorkel data (unpublished data on file, PNF SO, McCall, ID).
2 – Survey performed by field crew, 2002.
3 – USFS Survey 2002-2003 (Fitsum), Unpublished data on file at the PNF SO, McCall, ID.
4 – USFS Survey 1993-1994 (Buckhorn), Unpublished data on file at the PNF SO, McCall, ID
5 – USFS Survey 1999, 2001 (Fourmile), Unpublished data on file at the PNF SO, McCall, ID.
6 – Survey performed by D. Hogen and T. Adams.
7 – Survey performed by D. Faurot and T. Clouser.

**Table 10.—**Numbers of Columbia River bull trout in the Secesh River basin on the Payette National Forest. The data source is referenced in the footnote for each data entry.

| Location | Year | | | | | |
|---|---|---|---|---|---|---|
| | Number of bull trout observed/stream reach length in feet | | | | | |
| | 1993 | 1995 | 1998 | 2001 | 2002 | 2003 |
| **Lake Creek** (Reach 1) T22N R4E S12 | 1/8517[5.)] One fish in 1 unit out of 14 snorkeled. | | | | | |
| **Lake Creek** (Reach 3) T22N R4E S2, T23N R4E S35 | 4/11377[5.)] 4 fish in 4 units out of 7 snorkeled. | | | | | |
| **Lake Creek** (Reach 4) T23N R4E S26 | 1/9492 [5.)] [1] fish in 1 unit out of 6 snorkeled. | | | | | |
| **Lake Creek** (Reach 5) T23N R4E S22 | 4/7658 [5.)] 4 fish in 4 units out of 8 snorkeled. | | | | | |
| **Lake Creek** (Reach 7) T23N R4E S15 | 2/5603 [5.)] 2 fish in 1 unit out of 12 snorkeled. | | | | | |
| **Lake Creek** (Reach 8) T23N R4E S10 | 4/9803 [5.)] 4 fish in 2 units out of 21 snorkeled. | | | | | |
| **Sand Creek** (Reach 1) T23N R5E S27 | | | | 1/ ?? [1.)] One fish in 1 reach out of 11 snorkeled. | | |
| **Sand Creek** (Reach 2) T23N R5E S27 | | | | 2/?? [1.)] 2 fish in 2 units out of 11 snorkeled. | | |
| **Sand Creek** (Reach 3) T23N R5E S22 | | | | 16/?? [1.)] 16 fish in 9 units out of 19 snorkeled. | | |
| **Sand Creek** (Reach 4) T23N R5E S22 | | | | 23/ ?? [1.)] 23 fish in 11 units out of 19 snorkeled. | | |
| **Sand Creek** (Reach 5) T23N R5E S21, | | | | 26/1320 [1.)] 26 fish in 10 units out of 15 snorkeled. | | |
| **Sand Creek** (Reach 1) T23N R5E S27 | | 18 /3478 [7.)] 18 fish in 10 units out of 15 snorkeled. | | | | |
| **Sand Creek** (Reach 2) T23N R5E S22 | | 89/7349 [7.)] 89 fish in 22 units out of 25 snorkeled. | | | | |

| Location | Year | | | | | |
|---|---|---|---|---|---|---|
| | Number of bull trout observed/stream reach length in feet | | | | | |
| | 1993 | 1995 | 1998 | 2001 | 2002 | 2003 |
| **Sand Creek** (Reach 3) T23N R5E S22 | | 14/1377 [7.)] 14 fish in 5 units out of 7 snorkeled. | | | | |
| **Sand Creek** (Reach 4) T23N R5E S21 | | 52/4167 [7.)] 52 fish in 11 units out of 12 snorkeled. | | | | |
| **Sand Creek** (Reach 5) T23N R5E S21 | | 15/1706 [7.)] 15 fish in 6 units out of 10 snorkeled. | | | | |
| **Sand Creek** (Reach 6) T23N R5E S21 | | 25/853 [7.)] 25 fish in 6 units out of 6 snorkeled. | | | | |
| **Sand Creek** (Reach 7) T23N R5E S21 | | 10/2165 [7.)] 10 fish in 7 units out of 9 snorkeled. | | | | |
| **Lake Creek** T23N R4E S2 | | | | 7/?? [4.)] 7 fish in 4 units out of 27 snorkeled. | | |
| **Josephine Creek** T22N R4E S21, 22, 23 | 5" bull trout, 8"bull trout, several other BT sightings. [6.)] | | | | | |
| **Flat Creek** (Reach 4) T 23N R5E S32 | | 1/5577[7.)] One fish in one unit out of 24 snorkeled. | | | | |
| **Grouse Creek** (Reach 2) T22N R5E S3 | | 2/2477[7.)] Two fish in 2 units out of 11 snorkeled. | | | | |
| **Grouse Creek** (Reach 4) T23N R5E S34 | | 5/2264 [7.)] Five fish in 5 units out of 17 snorkeled. | | | | |
| **Grouse Creek** (Reach 5) T23N R5E S34 | | 15/6148 [7.)] 15 fish in 8 units out of 19 snorkeled. | | | | |
| **Grouse Creek** (Reach 6) T23N R5E S27 | | 9/1667 [7.)] 9 fish in 5 units out of 6 snorkeled. | | | | |
| **Grouse Creek** (Reach 7) T23N R5E S26 | | 30/8218 [7.)] 30 fish in 13 units out of 31 snorkeled. | | | | |
| **Grouse Creek Trib.1** T23N R5E S33, 34 | | 4/7841 [7.)] 4 fish in 4 units out of 25 snorkeled. | | | | |
| **Grouse Creek** (Reach 1) T22N R5E S3 | | | | 22/10,161 [1.)] 22 fish in 15 units out of 44 snorkeled. | | |

| Location | Year | | | | | |
|---|---|---|---|---|---|---|
| | Number of bull trout observed/stream reach length in feet | | | | | |
| | 1993 | 1995 | 1998 | 2001 | 2002 | 2003 |
| **Grouse Creek** (Reach 2) T23N R5E S34 | | | | 6/1883 [1.)] 6 fish in 5 units out of 11 snorkeled. | | |
| **Grouse Creek** (Reach 3) T23N R5E S34 | | | | 7/1817 [1.)] 7 fish in 6 units out of 15 snorkeled. | | |
| **Grouse Creek** (Reach 4) T23N R5E S34, 27 | | | | 5/4130 [1.)] 5 fish in 5 units out of 24 snorkeled. | | |
| **Grouse Creek** (Reach 5) T23N R5E S23 | | | | 3/3176 [1.)] 3 fish in 3 units out of 15 snorkeled. | | |
| **Grouse Cr. Trib. 1** T23N R5E S33 | | | | 6/ 3281 [1.)] 6 fish in 5 units out of 10 snorkeled. | | |
| **Grouse Cr. Trib. 2** T23N R5E S33 | | | | 3/3281 [1.)] 3 fish in 3 units out of 11 snorkeled. | | |
| **Loon Creek** T22N R5E S10 | | | Bull trout observed during redd surveys [8.)] | | | |
| **Ruby Creek** T22N R4E S36,31 | | | Two bull trout observed during redd surveys. [8.)] | | | |
| **Willow Creek** T23N R4E S12 | | | | Bull trout observed in a 3280-3937 ft. reach. [8.)] | | |
| **Nethker Creek** T22N R4E S16 | | | 7 fish observed. Unknown survey length.[8.)] | | | |
| **Threemile Creek** T23N R4E S26 | | | | Bull trout observed US of campground[8.)] | | |
| **Josephine Creek** T22N R4E S21 | | | | Three bull trout observed. [8.)] | | |
| **Summit Creek** T21N R4E S2 | | | Three bull trout observed. [8.)] | | | |
| **Victor Creek** T21N R4E S13 | | | Ten bull trout observed. [8.)] | | | |

Footnotes:
1 – Survey performed by field crew 2001.
4 – Survey performed by field crew, 2001. Assoc. w/ Scarrow's property.
5 – Survey performed by field crew 1993. Need to figure out reach lengths.
6 – H&R survey for Soulens allotment.
7 – Hurley's survey, 1995
8 – Surveys for spawning bull trout and redds in relation to allotments and trailing routes. D.Hogen, T. Adams, Hershenow, Clouser, B.Thomas, etc. 1998 and 2001.

**Table 11. —**Numbers of Columbia River bull trout in the Brownlee Reservoir basin on the Payette National Forest. The data source is referenced in the footnote for each data entry.

| Location | Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1979 | 1992 | 1997 | 1998 | 1999 | 2001 | 2002 | 2003 | 2004 |
| | Number of bull trout observed/stream reach length in feet | | | | | | | | |
| **Indian Creek** (split Landore Culvert) T21N R2W S30 SE SW | | | | | | 1/ 20 in the pool below Rd 105 culvert [4] | 15/528 first pass 4/528 second pass[10] | | |
| **Indian Creek** (Landore Ford) T21N R2W S30 SW NE, Site 35 | 6/ 75 [12] | | 8 / 520 [13] | 24 / 528 first pass 3 / 528 second pass[14] | 6 | | 46 / 528 first pass 17 / 528 second pass[10] | 4 / 328 pre-flood 0 / 328 post-flood[15] | |
| **Indian Creek** T21N R2W S29 NW NW, Site 44 | | 7 bull trout caught | | | | 3 / 4800 [4] | | 7 / 328 pre-flood [15] | 4 / 328 [7] |
| **Indian Creek** T21N R2W S30 NE NE, Site 43 | | One bull trout observed | | | | | | 11 / 328 pre-flood 0 / 328 post-flood[15] | |
| **Indian Creek** T21N R2W S20 NW SE, Site 45 | | | | | | | | 9 / 328 pre-flood[15] | |
| **Indian Creek** T19N R4W S16 NW NE | | | | | 2 BT collected at mouth of Indian Cr in weir[16] | | | | |
| **Camp Creek** T21N R2W S30 NE | | 4 bull trout caught[17] | | | | | | | |
| **Bear Creek** Patch 29, Site 4 T20N R2W S3 NW NW | | | 0 / 450 [5] | | 3 / 328 [1] | | | | |
| **Bear Creek** Patch 29, Site 5 T20N R2W S3 NE NW | | | | | 1 / 328 [1] | | | | |
| **Bear Creek** Patch 29, Site 9 T21N R2W S26 NE SW | | | | 2 / 656 [6] | 7 / 100 [1] | Several occularly observed / 1000 [4] | | | 3 / 328 [9] |

| Location | Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1979 | 1992 | 1997 | 1998 | 1999 | 2001 | 2002 | 2003 | 2004 |
| | Number of bull trout observed/stream reach length in feet | | | | | | | | |
| **Bear Creek** Patch 29, Site 10 T21N R2W S26 NE SE | | | | | 2 / 328 [1] | | | | |
| **Crooked River** T18N R3W S15 just US of FR 061 | | | | 0 / 400 [6] | 1 / 328 [1] | | | | |
| **Crooked River** (Patch 1, Site 5) T18N R3W S28 SW | | | | | | 1 / 328 [2] | | | |
| **Crooked River** (Patch 1, Site 6) T18N R3W S28 SW | | | | 0 / 900 [6] | | 6 / 328 [2] | | | |
| **Crooked River** Patch 1 Site 7 T18N R3W S33 SW | | | | | 5 / 328 [1] | 1 / 328 first pass<br>1 / 328 second pass<br>0 / 328 third pass[2] | | | |
| **Crooked River** (Patch 1, Site 9) T18N R3W S33 SW | | | | | | 2 / 328 [2] | | | |
| **Crooked River** (Patch 1, Site 11) T17N R3W S5 NW | | | | | 9 / 328 [1] | 1 / 328 [2] | | | |
| **Crooked River** T19N R3W S36 SW SW | | | 0 / 328 [5] | | 1 / unknown distance[1] | | | | |
| **Crooked River** (Patch 1, Site 8) T18N R3W S33 NE SW | | | | | 12 / 328 [1] | 6 / 328 [2] | | | 1 / 328 [8] |
| **Wesley Creek** | | | | | | | Bull trout documented present. No numbers of bull trout recorded or length of survey completed.[3] | | |

| Location | Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1979 | 1992 | 1997 | 1998 | 1999 | 2001 | 2002 | 2003 | 2004 |
| | Number of bull trout observed/stream reach length in feet | | | | | | | | |
| **Oxbow reach of Hells Canyon Reservoir** (off USFS, adfluvial habitat) | | | | Two BT radio tagged in OXB[11] | Two BT radio tagged in OXB[11] | | | | |
| **Hells Canyon Reservoir** (off USFS, adfluvial habitat) | | | | One BT radio tagged in HCR[11] | One BT radio tagged in HCR[11] | | | | |

Footnotes:

1 – Williams, C. and E. Veach. 1999. Are bull trout, *Salvelinus confluentus*, present in the Middle Fork Weiser River Drainage, Bear Creek Drainage, and Crooked River Drainage: a study completed by Payette National Forest, Council Ranger District.
2 – Moore, J., C. Watry, and M. McGee. 2002. A summary of biological surveys on the West Zone of the Payette National Forest, 2001. Council Ranger District, Council, Idaho.
3 – Greenway, J. and M. McGee. 2003. A summary of biological surveys on the West Zone of the Payette National Forest, 2002. Council Ranger District, Council, Idaho.
4 – Watry, C. B. and D. M. Hogen. 2002. A summary of results from bull trout spawning surveys conducted on the West Zone of the Payette National Forest, September 2001, Council Ranger District, Idaho.
5 – Snorkel data sheets from 9/11/97 and 9/10/97. Data sheet on file at Council RD.
6 – Snorkel data sheets from 9/16/98 and 9/24/98 by Doug Bradley. Data sheet on file at Council RD.
7 – Snorkel data sheet from 7/27/04 by WZ fish crew. Sampled 100 m. Data sheet on file at Council RD.
8 – Snorkel data sheet from 8/10/04 by WZ fish crew. Sampled 100 m. Data sheet on file at Council RD.
9 – Snorkel data sheet from 8/4/04 by M. McGee. Sampled 100 m. Data sheet on file at Council RD.
10 – Idaho Power Electrofishing Data in Indian Creek. 2002
11 – Chandler, J. A., R. A. Wilkison, and T. J. Richter. 2003. Distribution, status, life history, and limiting factors of redband trout and bull trout associated with the Hells Canyon Complex. Technical Report Appendix E.3.1-7, Chapter 4. Hells Canyon Complex FERC No. 1971.
12 – Reid, W. 1979. Idaho Department of Fish and Game Memo to Dave Burns regarding fish sampling in Indian Creek, 1979.
13 – Janssen, P. 1997. IDFG fish survey data, Indian Creek, 1997. Data collected on 7/11/97.
14 – Janssen, P. 1998. IDFG and USFS fish survey data, Indian Creek, 1998. Doug Bradley assisted IDFG. Data collected on 8/6/98.
15 – Greenway, J. and M. McGee. 2004. A summary of biological surveys on the West Zone of the Payette National Forest, 2003. Council Ranger District, Council, Idaho.
16 – Idaho Power Corp. 2003. Hells Canyon Complex FERC No. 1971 License Application, Exhibit E, Environmental Report.
17 – USFS GAWS Survey. 1992. Data on file at S.O., McCall, Idaho.

**Table 12. —**Numbers of Columbia River bull trout in the East Fork Weiser River watershed on the Payette National Forest. The data source is referenced in the footnote for each data entry.

| Location | Year | | | | | |
|---|---|---|---|---|---|---|
| | 1991 | 1992 | 1994 | 1998 | 2001 | 2004 |
| | Number of bull trout observed/stream reach length in feet | | | | | |
| **EF Weiser River** T16N R1E S30 | 1 bull trout below culvert on FR 906[3] | | | | | No bull trout observed[5] |
| **EF Weiser River** (Reach 6) T17N R1E S13 | | | 3 / 11,625 ft of R1/R4 snorkel surveys[1] | | | |

| Location | Year | | | | | |
|---|---|---|---|---|---|---|
| | 1991 | 1992 | 1994 | 1998 | 2001 | 2004 |
| | Number of bull trout observed/stream reach length in feet | | | | | |
| **EF Weiser River** (Reach 7) T17n R2E S19 | | | 1 / 4,968 ft of R1/R4 snorkel surveys[1] | | | |
| **EF Weiser River** (Reach 8) T17N R2E S30 | | | 10 / 3,408 ft of R1/R4 snorkel surveys[1] | | | |
| **EF Weiser River** (Reach 9) T17N R2E S30 | | | 12 / 7,039 ft of R1/R4 snorkel surveys[1] | | | |
| **EF Weiser River** (Reach 10) T17N R2E S31 | | | 2 / 3,097 ft of R1/R4 snorkel surveys[1] | | | |
| **EF Weiser River** (Reach 11) T16N R2E S6 | | | 10 / 3,373 ft of R1/R4 snorkel surveys[1] | | | |
| **EF Weiser River** (Reach 13) T16N R2E S6 | | | 2 / 2,037 ft of R1/R4 snorkel surveys[1] | | | |
| **EF Weiser River Weir** T17N R1E S14 | | | | | 1 bull trout captured [2] | |
| **EF Weiser River** UTM N-49.577 E-5.584 | | | | 1 / 328 ft electrofishing[4] | | |
| **Dewey Creek** T17N R1E S24, 25 | | 3.4 /100m$^2$ in R1 and 0.01 / 100m$^2$ R2[3] | | | | |
| **Dewey Creek** (Reach 1) T17N R1E S13 | | | 4 / 1,683 ft of R1/R4 snorkel surveys[1] | | | |
| **Dewey Creek** (Reach 2) T17N R1E S13 | | | 6 / 1,050 ft of R1/R4 snorkel surveys[1] | | | |
| **Dewey Creek** (Reach 3) T17N R1E S25 | | | 7 / 974 ft of R1/R4 snorkel surveys[1] | | | |
| **Dewey Creek** (Reach 4) T17N R1E S25 | | | 2 / 804 ft of R1/R4 snorkel surveys[1] | | | |
| **Dewey Creek** (Reach 4) T17N R1E S25 | | | | | | 8 / 328 ft snorkel survey[5] |
| **Dewey Creek** (Reach 1) T17N R1E S13, 24, 25 | | | | | Bull trout observed throughout reach[6] | |

| Location | Year | | | | | |
|---|---|---|---|---|---|---|
| | 1991 | 1992 | 1994 | 1998 | 2001 | 2004 |
| | Number of bull trout observed/stream reach length in feet | | | | | |
| **Dewey Creek** (Reach 2) T17N R1E S25 &36 | | | | | 3 / 2,460 ft observed[6] | |
| **Lewey Creek** (Tributary to Dewey Creek) T17N R1E S25 | | | 3 bull trout collected in minnow traps.[1] | | | |

Footnotes:

1 – Hurley, M. 1995b. Report on the basin wide survey of the East Fork Weiser River. Contract Fulfillment to Payette National Forest. Contract # 53-0256-4-21. Data are on file in the PNF SO, McCall, ID.

2 – Watry, C. B. and D. M. Hogen. 2002. A summary of results from the operation of the East Fork Weiser River and Little Weiser River weirs, 2002. Council Ranger District, Council, Idaho.

3 – Adams, S. 1994. Bull trout distribution and habitat use in the Weiser River drainage, Idaho. M.S. Thesis, Univ. of Idaho, Moscow, ID. 84 p. Fish in Dewey Creek were calculated as #/100m$^2$ in pools in reach 1 and reach 2. No bull trout observed in reach 3.

4 – Meyer, K. A. 1999. Assessment of Native Salmonids above Hells Canyon Dam, Idaho. IDFG Report Number 99-16.

5 – Dave Hogen and Adam Schmoeger MIS transect. Data are on file in the PNF SO, McCall, ID.

6 – Watry, C. B. and D. M. Hogen. 2002. A summary of results from bull trout spawning surveys conducted on the West Zone of the Payette National Forest, September 2001. Reach delineations differ from R1/R4 surveys.

**Table 13.—**Numbers of Columbia River bull trout in the Little Weiser River watershed on the Payette National Forest. The data source is referenced in the footnote for each data entry.

| Location | Year | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1992 | 1993 | 1994 | 1999 | 2001 | 2002 | 2003 | 2004 |
| | Number of bull trout observed/stream reach* length in feet (Reach numbers from different sources do not necessarily represent the same section of stream as investigators may have delineated reaches based on different objectives) | | | | | | | |
| **Anderson Creek** (Reach 2) | 0.4/100 m$^2$ bull trout density[13] | | | | | | | |
| **Anderson Creek** (Reach 3) | 5.7/100m$^2$ bull trout density[13] | | | | | | | |
| **Anderson Creek** (Reach 4) | 9.5/100m$^2$ bull trout density[13] | | | | | | | |
| **Anderson Creek** (Reach 5) | 5.7/100m$^2$ bull trout density[13] | | | | | | | |
| **Anderson Creek** (Reach 2) T14N R2E S29 | | 13 / 1125 ft of R1/R4 snorkel surveys[9] | | | | | | |
| **Anderson Creek** (Reach 3) T14N R2E S15, 3 | | 14 / 785 ft of R1/R4 snorkel surveys[9] | | | | | | |
| **Anderson Creek** (Reach 4) T14N R2E S3 | | 9 / 334 ft of R1/R4 snorkel surveys[9] | | | | | | |

| Location | Year | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1992 | 1993 | 1994 | 1999 | 2001 | 2002 | 2003 | 2004 |
| | Number of bull trout observed/stream reach* length in feet (Reach numbers from different sources do not necessarily represent the same section of stream as investigators may have delineated reaches based on different objectives) | | | | | | | |
| **Anderson Creek** (Reach 5) T14N R2E S3 | | 16 / 355 ft of R1/R4 snorkel surveys[9] | | | | | | |
| **Anderson Creek** T14N R2E S15 | | | | 8 / 328 ft of snorkel survey[10] | | | | |
| **Anderson Creek** T14N R2E S3 SE SW | | | | 12 / 328 ft of snorkel survey[10] | | | | |
| **Anderson Creek** (Reach ends in pool below culvert at crossing of FR 835) T14N R2E S3 | | | | 11 / 328 ft of snorkel survey[10] | | | | |
| **Anderson Creek** T14N R2E S3,34,36 | | | | | Several bull trout observed from Xing of FR 835 to headwaters[11] | | | |
| **Anderson Creek** T14N R2E S3,34,36 | | | | | Several bull trout observed from Xing of FR 835 to headwaters[12] | | | |
| **Little Weiser River** (mainstem) T14N R2E S5 | Bull trout found up stream in the NW ¼ of Section 5 to headwaters[13] | | | | | | | |
| **Little Weiser River** (mainstem, Reach 6) T14N R2E S5, 32, 33, 28, 22, 21 | 40 / 1580 ft of R1/R4 snorkel surveys[1] | | | | | | | |
| **Little Weiser River** T15N R2E S14, 23 | | | | | Several bull trout observed in Sections 14 and 23[11] | | | |
| **Little Weiser River** T15N R2E S23 | | | | | | Bull trout observed in right bank trib of S23[15] | Bull trout observed in right bank trib of S23[15] | |
| **Little Weiser River** T15N R2e S28 | | | | | | | | 6 / 328 ft MIS snorkel survey[14] |
| **Sheep Creek** (Reach 1) | 4.9/100m$^2$ bull trout density[13] | | | | | | | |
| **Sheep Creek** (Reach 2) | 5.8/100m$^2$ bull trout density[13] | | | | | | | |

| Location | Year | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1992 | 1993 | 1994 | 1999 | 2001 | 2002 | 2003 | 2004 |
| | Number of bull trout observed/stream reach* length in feet (Reach numbers from different sources do not necessarily represent the same section of stream as investigators may have delineated reaches based on different objectives) | | | | | | | |
| **Sheep Creek** (Reach 3) | 5.1/100m$^2$ bull trout density[13] | | | | | | | |
| **Sheep Creek** (Reach 4) | 3.9/100m$^2$ bull trout density[13] | | | | | | | |
| **Sheep Creek** (Reach 3) T14N R2E S27 | | 6 / 338 ft of R1/R4 snorkel surveys[1] | | | | | | |
| **Sheep Creek** (Reach 4) T14N R2E S27 | | 0 / 164 ft of R1/R4 snorkel surveys[1] | | | | | | |
| **Sheep Creek** (Reach 5) T14N R2E S27 | | 6 / 232 ft of R1/R4 snorkel surveys[1] | | | | | | |
| **Sheep Creek** (Reach 10) T14N R2E S16 | | | 2 / 492 ft of snorkel survey[2] | | 4 / 328 ft snorkel survey[4] | No bull trout observed[5] | 2 / 328 snorkel surveys[6] | No bull trout observed[8] |
| **Sheep Creek** (Reach 11) T14N R2E S16 | | | | | 4 / 328 ft snorkel survey[4] | 1 / 328 ft snorkel survey[5] | 5 / 328 ft snorkel survey[6] | 1 / 328 ft snorkel survey[8] |
| **Sheep Creek** (Meadows) T14N R2E S27 | | | | Bull trout observed during snorkel training.[3] | | | 100 / 30 ft in beaver pond[7] | |

Footnotes:

1 – R1/R4 reach delineations. Reach numbers different from annual species distribution surveys. Data are on file in the PNF SO, McCall, ID.
2 – Susan Adams, Note is on file in the PNF SO, McCall, ID.
3 – Eric Veach lead snorkel training, note by Jason Greenway and Michael McGee is on file in the PNF SO, McCall, ID.
4 – Moore, J. and M. McGee. 2002. A Summary of Biological Surveys on the West Zone of the Payette National Forest, 2001.
5 – Greenway, J. and M. McGee. 2003. A Summary of Biological Surveys on the West Zone of the Payette National Forest, 2002.
6 – Greenway, J. and M. McGee. 2004. A Summary of Biological Surveys on the West Zone of the Payette National Forest, 2003.
7 – Jason Greenway and Betsy Hatfield snorkeling upstream of hobo at site W16840. Data are on file in the PNF SO, McCall, ID.
8 – Snorkel data sheet from 7/26/04 by WZ fish crew. Sampled 100 m. Data are on file in the PNF SO, McCall, ID.
9 – R1/R4 Data are on file in the PNF SO, McCall, ID.
10 – Snorkel data sheets from 9/24/99 by WZ fish crew. Sampled 100 m. Data are on file in the PNF SO, McCall, ID.
11 – Watry, C. B. and D. M. Hogen. 2002. A summary of results from bull trout spawning surveys conducted on the West Zone of the Payette National Forest, September 2001. Reach delineations differ from R1/R4 surveys.
12 – Site visit data from Dave Hogen 6/15/01. Data are on file in the PNF SO, McCall, ID.
13 – Adams, S. 1994. Bull trout distribution and habitat use in the Weiser River drainage, Idaho. M.S. Thesis, Univ. of Idaho, Moscow, ID. 84 p.
14 – Mike McGee and Dave Hogen. MIS transect. Data are on file in the PNF SO, McCall, ID.
15 – Exclosure surveys. Data are on file in the PNF SO, McCall, ID.

**Table 14.—**Environmental classification and attribute variables used in the analysis (grayed items were not part of the original data request from the districts; all derived variables were additional).

| Source | Type | Variable | Description |
|---|---|---|---|
| Input Variables | Class | SEC7SHED | Standard map code for section 7 watershed |
| | | SUBSHED | Analysis area as defined by district biologist |
| | | VIABLE | Our *a priori* estimate of current viability |
| | Attribute | CONNECT | Indicator of connectivity with external drainages |
| | | TOTHUCS | Total number of 6th level HUs |
| | | TOTACRES | Analysis area acres total |
| | | BULLHUCS | Number of 6th level HUs with any bull trout |
| | | BULLAREA | Acres with bull trout |
| | | ANADHUCS | Number of 6th level HUs with anadromous species |
| | | FLUVHUCS | Number of 6th level HUs with fluvial bull trout |
| | | AFLVHUCS | Number of 6th level HUs with adfluvial bull trout |
| | | BRUKHUCS | Number of 6th level HUs with brook trout |
| | | MIXDHUCS | Number of 6th level HUs with bull x brook hybrids |
| | | AREA1600 | Area above 1600m |
| | | ANADSPEC | Number of anadromous species |
| | | ROADMILE | Miles of road in analysis area on-Forest |
| | | ASPECT | Estimated orientation relative to North in degrees |
| | | RELIEF | Difference between maximum and minimum elevation |
| Derived Variables | Attribute | BULLRATE | Ratio of BULLHUCS to TOTHUCS as percent |
| | | FLUVRATE | Ratio of FLUVHUCS to TOTHUCS as percent |
| | | AFLVRATE | Ratio of AFLVHUCS to TOTHUCS as percent |
| | | BRUKRATE | Ratio of BRUKHUCS to TOTHUCS as percent |
| | | MIXDRATE | Ratio of MIXDHUCS to TOTHUCS as percent |
| | | ANADRATE | Ratio of ANADHUCS to TOTHUCS as percent |
| | | BULLDENS | Ratio of BULLAREA to TOTACRES as percent |
| | | RELSIZE | Ratio of TOTACRES to Σ(TOTACRES) as percent |
| | | ROADDENS | Ratio of ROADMILE to TOTACRES in $mi/mi^2$ |
| | | PCT1600 | Ratio of AREA1600 to TOTACRES as percent |
| | | DROPAREA | Ratio of Relief to TOTACRES |

**Table 15.—**Codes for watersheds and analysis areas.

| Section 7 Watershed | | Analysis Area | |
|---|---|---|---|
| **Name** | **Acronym** | **Name** | **Acronym** |
| South Fork Salmon River | SFSR | Upper South Fork Salmon River | USFSR |
| | | Lower South Fork Salmon River | LSFSR |
| | | East Fork South Fork Salmon River | EFSF |
| | | Upper Secesh River | USEC |
| | | Lower Secesh River | LSEC |
| North Fork Payette River | NFPR | North Fork Payette River | NFPR |
| Deep Creek | DC | Deep Creek | DC |
| Weiser River | WR | East Fork Weiser River | EFWR |
| | | Little Weiser River | LWR |
| Main Salmon Southwest | MSSW | California Creek | MSRC |
| | | Fall Creek | MSRF |
| | | Warren Creek | MSRW |
| | | French Creek | MSRFR |
| | | Partridge-Lake | MSRPL |
| Brownlee Reservoir | BR | Indian Creek | BRI |
| | | Bear Creek | BRB |
| | | Wildhorse River | BRW |
| Little Salmon River | LSR | Boulder Creek | LSRB |
| | | Rapid River | LSRR |
| | | Hard-Hazard | LSRH |
| Main Salmon Southeast | MSSE | Chamberlain Creek | MSCC |
| | | McCalla Creek | MSMC |
| Middle Fork Tributaries | MFT | Cabin-Canyon | MFCC |
| | | Crooked-Buck | MFCB |
| | | Monumental | MFMN |
| | | Beaver-Gold | MFBG |
| | | Upper Big | MFUB |
| | | Upper Marble Creek | MFUM |

**Table 16.—**Data reduction clustering for ordination at analysis area scale (proportion of variance explained = 0.8082).

| Variable Cluster | Variable Name | $R^2$ Comparison With | | | Environmental Indicator Type |
|---|---|---|---|---|---|
| | | Own Cluster | Closest Cluster | $1-R^2$ Ratio | |
| Cluster 1 | MIXDHUCS | 0.9019 | 0.2664 | 0.1337 | Hybridization |
| | MIXDRATE | 0.9019 | 0.2145 | 0.1249 | |
| Cluster 2 | BULLHUCS | 0.8805 | 0.3027 | 0.1714 | Bull Trout Habitat Availability |
| | FLUVHUCS | 0.8603 | 0.4061 | 0.2352 | |
| | ANADHUCS | 0.9035 | 0.4245 | 0.1677 | |
| | BULLACRE | 0.8736 | 0.3255 | 0.1874 | |
| Cluster 3 | AFLVHUCS | 0.9809 | 0.1911 | 0.0236 | Life History Expression |
| | AFLVRATE | 0.9809 | 0.1224 | 0.0217 | |
| Cluster 4 | BRUKHUCS | 0.6709 | 0.2064 | 0.4146 | Development |
| | ROADMILE | 0.8016 | 0.5731 | 0.4647 | |
| | BRUKRATE | 0.6939 | 0.4478 | 0.5544 | |
| | ROADDENS | 0.6740 | 0.6443 | 0.9166 | |
| Cluster 5 | TOTACRES | 0.9821 | 0.4960 | 0.0356 | Size |
| | AREA1600 | 0.9292 | 0.4655 | 0.1325 | |
| | TOTHUCS | 0.9032 | 0.3551 | 0.1501 | |
| | RELSIZE | 0.9821 | 0.4960 | 0.0356 | |
| Cluster 6 | DROPAREA | 1.0000 | 0.4755 | 0.0000 | Topography |
| Cluster 7 | RELIEF | 0.3186 | 0.2556 | 0.9153 | Bull Trout Prevalence |
| | BULLRATE | 0.7767 | 0.2467 | 0.2965 | |
| | BULLDENS | 0.7322 | 0.2336 | 0.3495 | |
| Cluster 8 | CONNECT | 0.5582 | 0.3105 | 0.6408 | Connectivity |
| | ANADSPEC | 0.8904 | 0.5454 | 0.2411 | |
| | ANADRATE | 0.8201 | 0.3256 | 0.2667 | |
| | FLUVRATE | 0.6277 | 0.2727 | 0.5119 | |
| Cluster 9 | ASPECT | 1.0000 | 0.1746 | 0.0000 | Orientation |

**Table 17.—**Data reduction clustering for ordination at Section 7 watershed scale (proportion of variance explained = 0.8143).

| Variable Cluster | Variable Name | $R^2$ Comparison With | | | Environmental Indicator Type |
|---|---|---|---|---|---|
| | | Own Cluster | Closest Cluster | $1-R^2$ Ratio | |
| Cluster 1 | TOTACRES | 0.8377 | 0.1330 | 0.1871 | Size |
| | AREA1600 | 0.8453 | 0.1755 | 0.1876 | |
| | TOTHUCS | 0.6337 | 0.1908 | 0.4527 | |
| | BULLHUCS | 0.9345 | 0.2800 | 0.0909 | |
| | FLUVHUCS | 0.8481 | 0.3495 | 0.2336 | |
| | AFLVHUCS | 0.8324 | 0.2200 | 0.2148 | |
| | MIXDHUCS | 0.6360 | 0.7811 | 1.6626 | |
| | ANADHUCS | 0.9093 | 0.3308 | 0.1355 | |
| | BULLACRE | 0.9254 | 0.3348 | 0.1121 | |
| | AFLVRATE | 0.6265 | 0.3585 | 0.5823 | |
| Cluster 2 | ASPECT | 0.1721 | 0.2900 | 1.1661 | Habitat Potential |
| | BULLRATE | 0.8851 | 0.4382 | 0.2046 | |
| | ANADRATE | 0.8363 | 0.4636 | 0.3052 | |
| | FLUVRATE | 0.9463 | 0.3508 | 0.0827 | |
| | BULLDENS | 0.7971 | 0.5730 | 0.4751 | |
| | DROPAREA | 0.8023 | 0.3007 | 0.2827 | |
| Cluster 3 | BRUKHUCS | 0.9101 | 0.3436 | 0.1369 | Biological Integrity |
| | BRUKRATE | 0.9101 | 0.4479 | 0.1628 | |
| Cluster 4 | ANADSPEC | 0.9290 | 0.4991 | 0.1418 | Physical Integrity |
| | RELIEF | 0.7013 | 0.4157 | 0.5113 | |
| | CONNECT | 0.7905 | 0.4631 | 0.3902 | |
| Cluster 5 | ROADDENS | 0.9604 | 0.6191 | 0.1039 | Development |
| | ROADMILE | 0.9604 | 0.5000 | 0.0791 | |
| Cluster 6 | PCT1600 | 1.0000 | 0.5810 | 0.0000 | Elevation |
| Cluster 7 | MIXDRATE | 1.0000 | 0.2541 | 0.0000 | Biological Integrity |

**Table 18.—**First three principal components, rotated, derived from the nine environmental variables selected after variable clustering, analysis area scale.

| Selected Variable | Rotated Factor Pattern | | |
|---|---|---|---|
| | PC1 Development | PC2 Size and Habitat Availability | PC3 Biology |
| MIXDRATE | -0.12690 | -0.15898 | 0.76273 |
| ANADHUCS | 0.55185 | 0.75457 | 0.02556 |
| AFLVHUCS | -0.00480 | 0.39584 | 0.63085 |
| ROADMILE | -0.84257 | 0.19514 | 0.12823 |
| TOTACRES | -0.01694 | 0.93215 | -0.17081 |
| DROPAREA | 0.21141 | -0.83854 | -0.11464 |
| BULLRATE | 0.62603 | -0.20502 | 0.62077 |
| ANADRATE | 0.86511 | 0.20245 | 0.21453 |
| ASPECT | -0.59719 | -0.00953 | 0.34386 |
| Proportion of Variance Explained | 0.2969 | 0.2632 | 0.1739 |
| Cumulative Proportion Explained | 0.2969 | 0.5601 | 0.7340 |

**Table 19.—**First three principal components, rotated, derived from the nine environmental variables selected after variable clustering, size metrics excluded, analysis area scale.

| Selected Variable | Rotated Factor Pattern | | |
|---|---|---|---|
| | PC1 Development | PC2 Habitat Availability | PC3 Biology |
| MIXDRATE | -0.16656 | 0.03430 | 0.77697 |
| ANADHUCS | 0.55404 | -0.74086 | -0.07224 |
| AFLVHUCS | -0.03637 | -0.53317 | 0.53270 |
| ROADMILE | -0.84622 | -0.18758 | 0.06151 |
| DROPAREA | 0.21332 | 0.86489 | 0.05330 |
| BULLRATE | 0.59304 | 0.11903 | 0.69225 |
| ANADRATE | 0.85388 | -0.24242 | 0.21977 |
| ASPECT | -0.61401 | -0.04380 | 0.31093 |
| Proportion of Variance Explained | 0.3279 | 0.2151 | 0.1784 |
| Cumulative Proportion Explained | 0.3279 | 0.5430 | 0.7214 |

**Table 20.—**First three principal components, rotated, derived from the nine environmental variables selected after variable clustering, Section 7 watershed scale.

| Selected Variable | Rotated Factor Pattern | | |
|---|---|---|---|
| | PC1 Topography | PC2 Development | PC3 Biology |
| BULLHUCS | 0.21653 | 0.16996 | 0.85577 |
| FLUVRATE | 0.75277 | 0.35469 | -0.10747 |
| RELIEF | 0.90047 | -0.12321 | 0.26290 |
| BRUKHUCS | -0.79235 | -0.08574 | 0.49181 |
| ROADMILE | -0.32472 | -0.84470 | 0.01342 |
| PCT1600 | -0.11883 | 0.96426 | 0.02331 |
| MIXDRATE | -0.28287 | -0.15564 | 0.78856 |
| Proportion of Variance Explained | 0.3765 | 0.2367 | 0.2116 |
| Cumulative Proportion Explained | 0.3765 | 0.6132 | 0.8249 |

**Table 21.—**First three canonical variates derived from the nine environmental variables selected after variable clustering, analysis area scale (MANOVA, Wilk's Lambda, P < 0.0001).

| Selected Variable | Total Canonical Structure | | |
|---|---|---|---|
| | CAN1 | CAN2 | CAN3 |
| MIXDRATE | -0.077845 | -0.540665 | -0.215923 |
| ANADHUCS | 0.710517 | 0.504786 | -0.145587 |
| AFLVHUCS | 0.332630 | 0.100502 | -0.211538 |
| ROADMILE | -0.613383 | 0.406390 | 0.102949 |
| TOTACRES | 0.373274 | 0.696214 | 0.439765 |
| DROPAREA | -0.499215 | -0.396271 | -0.348466 |
| BULLRATE | 0.404234 | -0.432843 | -0.475230 |
| ANADRATE | 0.751393 | -0.232222 | -0.035191 |
| ASPECT | -0.242130 | 0.102663 | 0.129458 |

**Table 22.—**First three canonical variates derived from the eight environmental variables selected after variable clustering, analysis area scale, size metrics excluded (MANOVA, Wilk's Lambda, P < 0.0001).

| Selected Variable | Total Canonical Structure | | |
|---|---|---|---|
| | CAN1 | CAN2 | CAN3 |
| MIXDRATE | -0.077919 | -0.541014 | 0.489308 |
| ANADHUCS | 0.713306 | 0.506786 | 0.365438 |
| AFLVHUCS | 0.334000 | 0.101402 | 0.245700 |
| ROADMILE | -0.616193 | 0.404890 | -0.064627 |
| DROPAREA | -0.501155 | -0.397688 | 0.249140 |
| BULLRATE | 0.406165 | -0.431898 | 0.465524 |
| ANADRATE | 0.754708 | -0.230313 | 0.149230 |
| ASPECT | -0.243211 | 0.102055 | -0.213792 |

**Table 23.—**First three canonical variates derived from the seven environmental variables selected after variable clustering, Section 7 watershed scale.

| Selected Variable | Total Canonical Structure | | |
|---|---|---|---|
| | CAN1 | CAN2 | CAN3 |
| BULLHUCS | 0.653277 | -0.209859 | -0.336572 |
| FLUVRATE | 0.354307 | 0.592378 | 0.559315 |
| RELIEF | 0.498069 | 0.601189 | -0.060768 |
| BRUKHUCS | -0.400546 | -0.420304 | -0.586355 |
| ROADMILE | -0.562368 | -0.326341 | 0.032888 |
| PCT1600 | 0.504272 | 0.110684 | -0.094939 |
| MIXDRATE | 0.054388 | -0.331449 | -0.315780 |

[a] All computed F-ratios in multivariate analysis of variance testing canonical variate means.

# Appendix 2: Figures

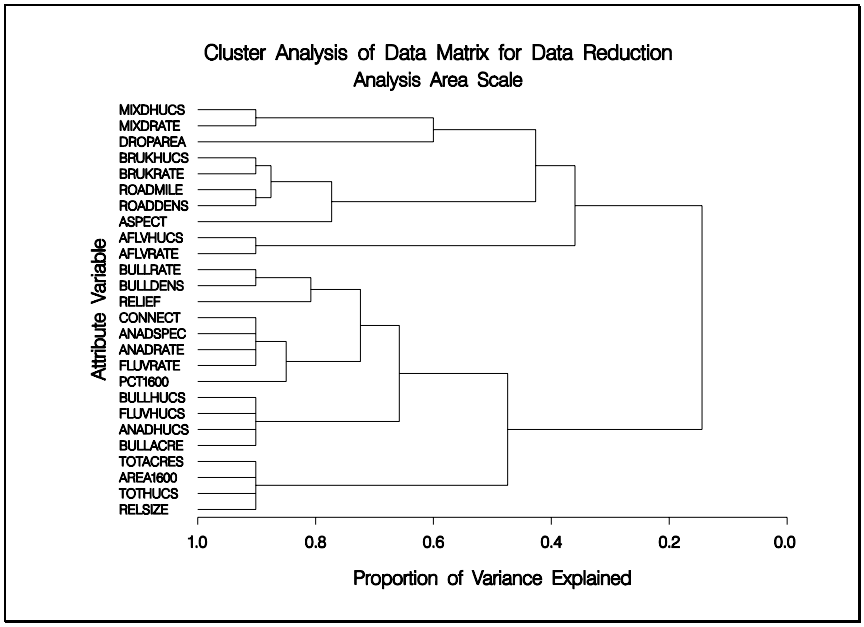


**Figure 5.—**Cluster analysis of environmental variables for preliminary data reduction, analysis area scale.

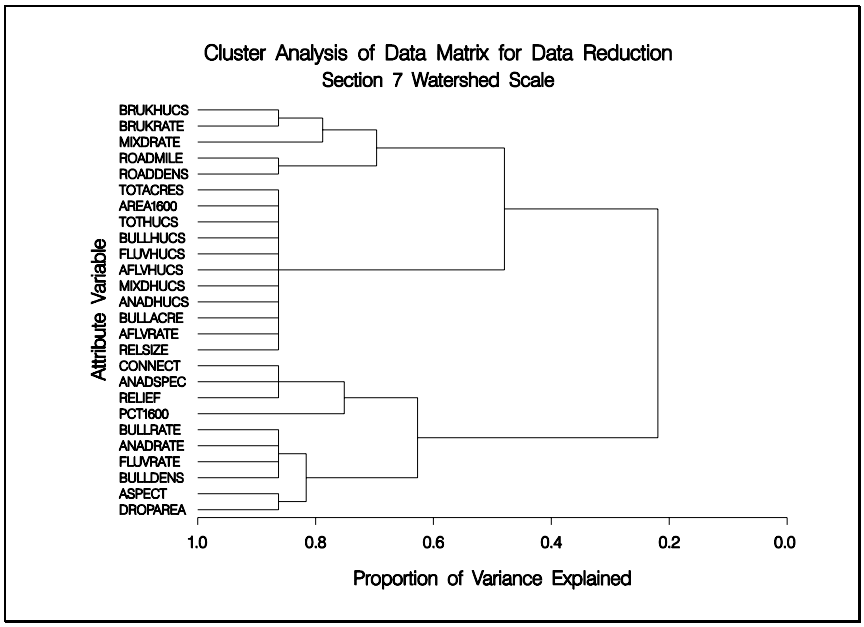


**Figure 6.—**Cluster analysis of environmental variables for preliminary data reduction, section 7 watershed scale.

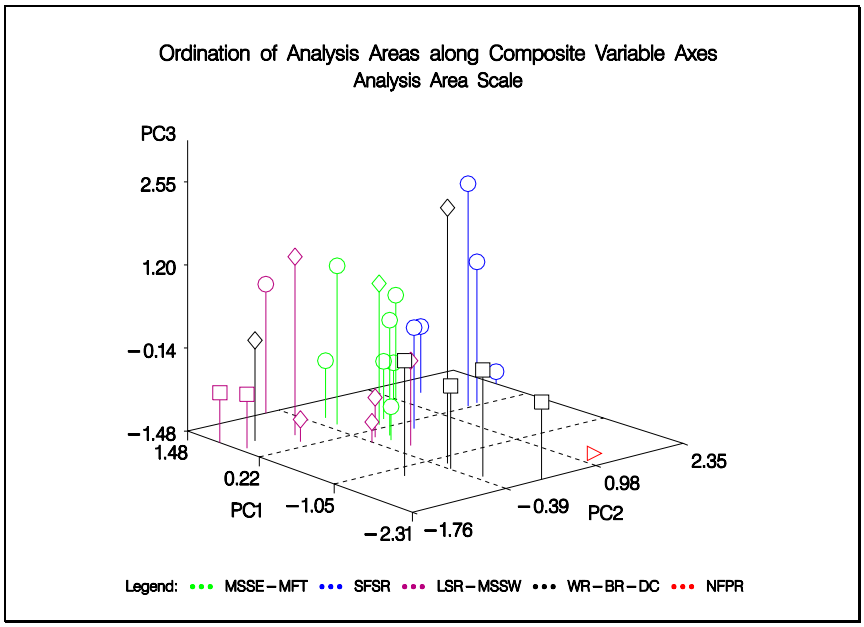


**Figure 7.**—Ordination of analysis areas; these axes approximately reflect gradients of development, habitat availability, and biological potential.

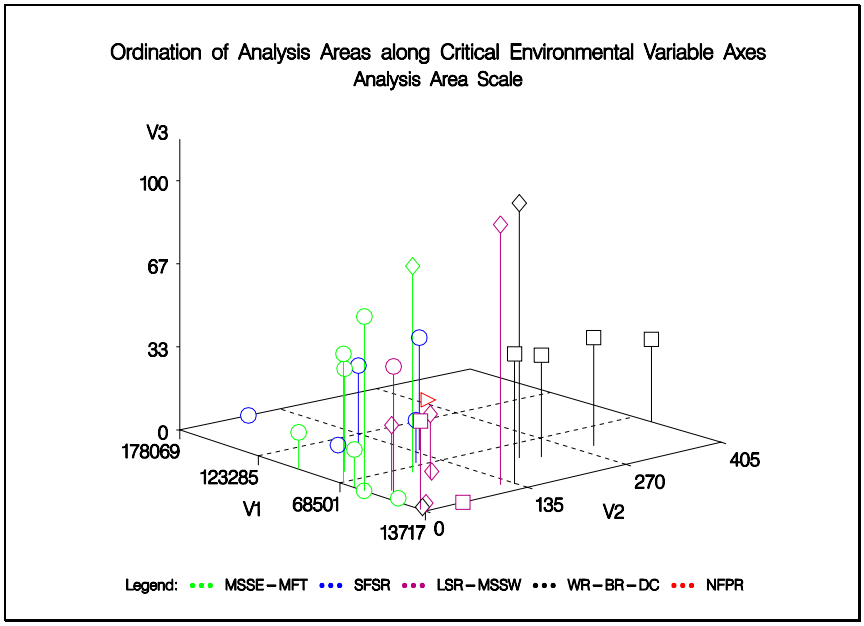


**Figure 8.**—Ordination of analysis areas on gradients by important variables in the axes derived from principal components analyses (V1 = TOTACRES, V2 = ROADMILE, V3 = MIXDRATE).

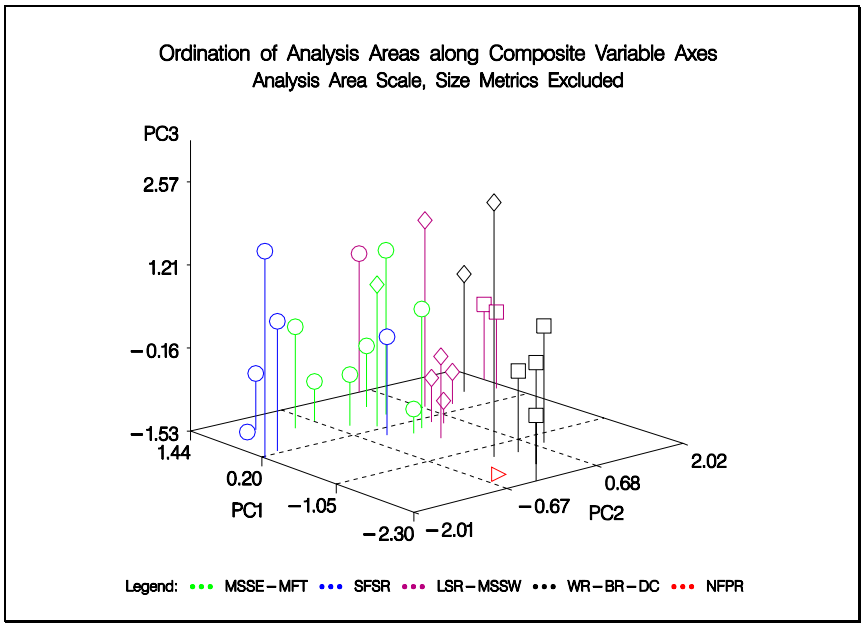


**Figure 9.**—Ordination of analysis areas with size-related variables excluded; these axes approximately reflect gradients of development, habitat availability, and biological potential.

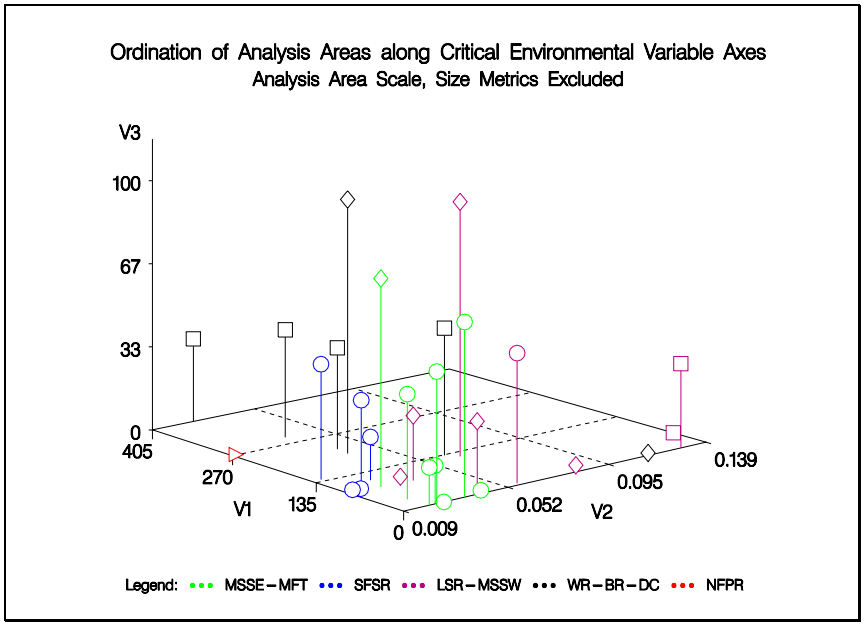


**Figure 10.**—Ordination of analysis areas on gradients by important variables in the axes derived from principal components analyses (V1 = ROADMILE, V2 = DROPAREA, V3 = MIXDRATE).

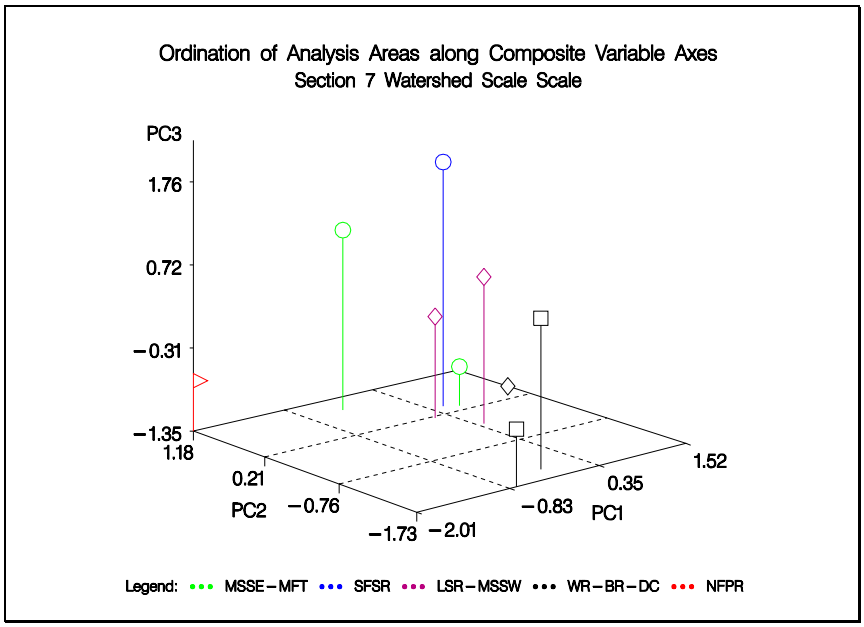


**Figure 11.**—Ordination of Section 7 watersheds; these axes approximately reflect gradients of topography, development, and biological potential.

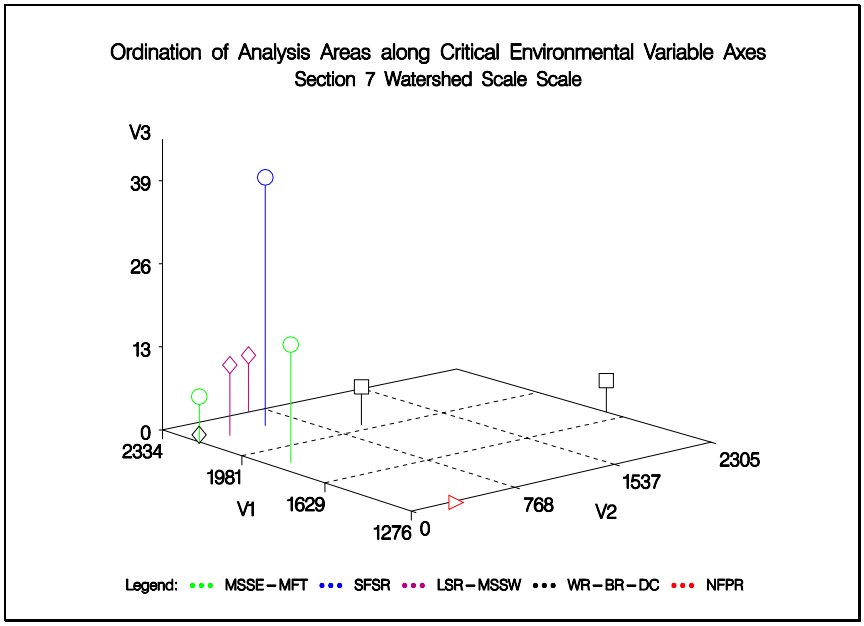


**Figure 12.**—Ordination of analysis areas on gradients by important variables in the axes derived from principal components analyses (V1 = RELIEF, V2 = ROADMILE, V3 = BULLHUCS).

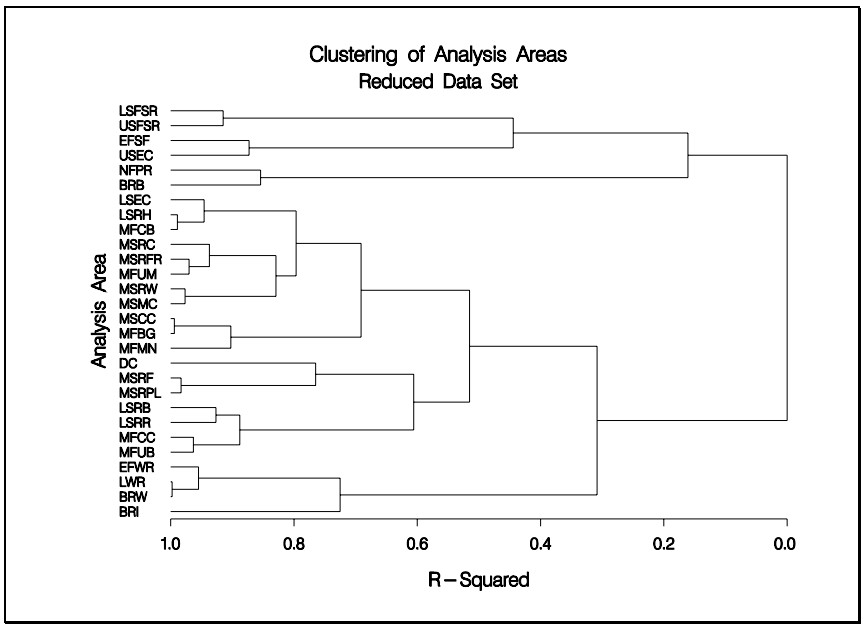


**Figure 13.—**Complete linkage clustering of analysis areas using key variables from reduction reduction.

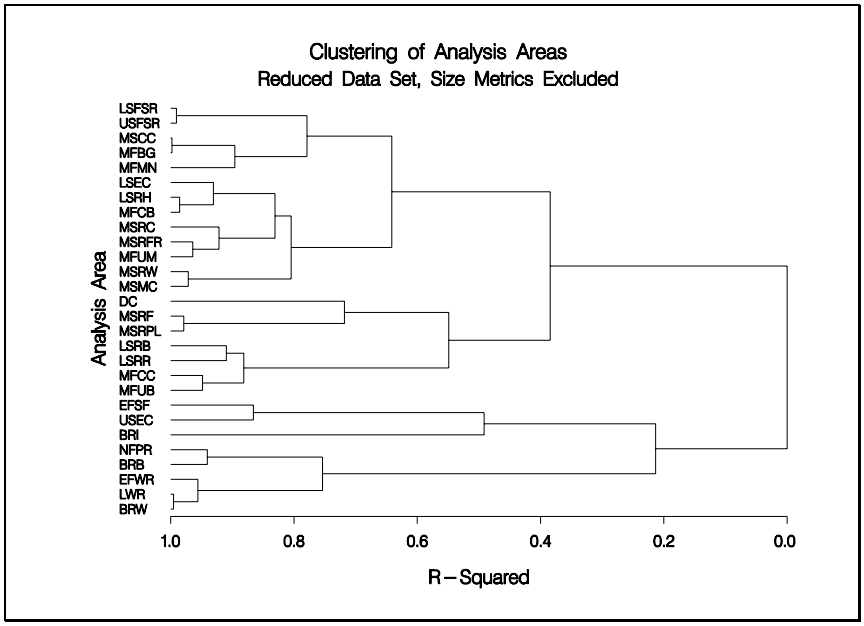


**Figure 14.—**Complete linkage clustering of analysis areas using key variables from data reduction, size metrics excluded.

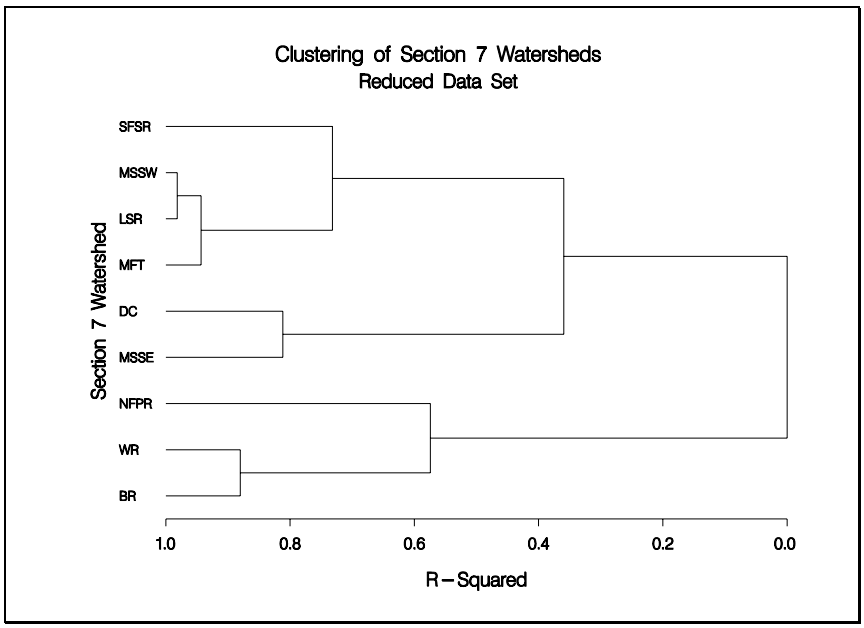


**Figure 15.**—Complete linkage clustering of Section 7 watersheds using key variables from variable reduction.

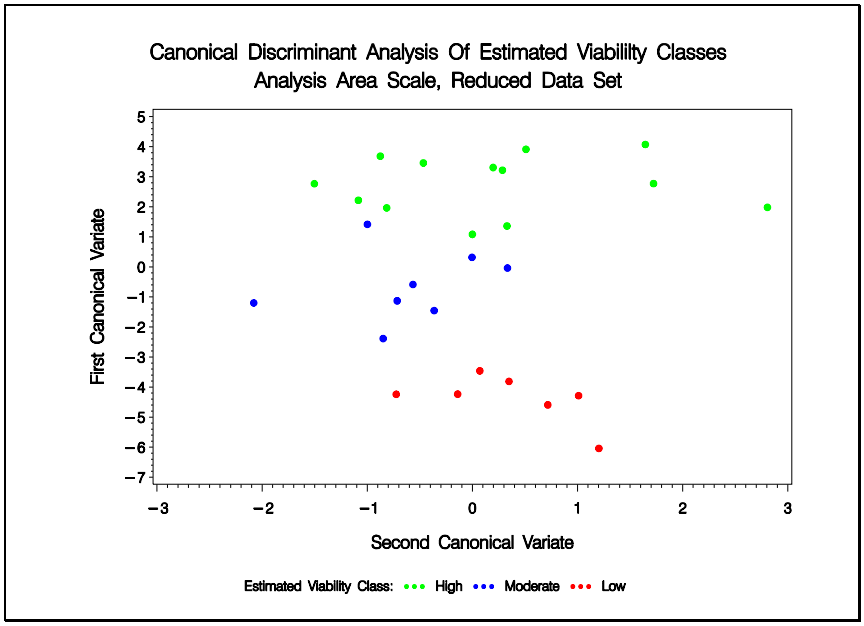


**Figure 16.**—Canonical discriminant analysis of analysis areas based on *a priori* viability estimates illustrating separation along first and second canonical variates.

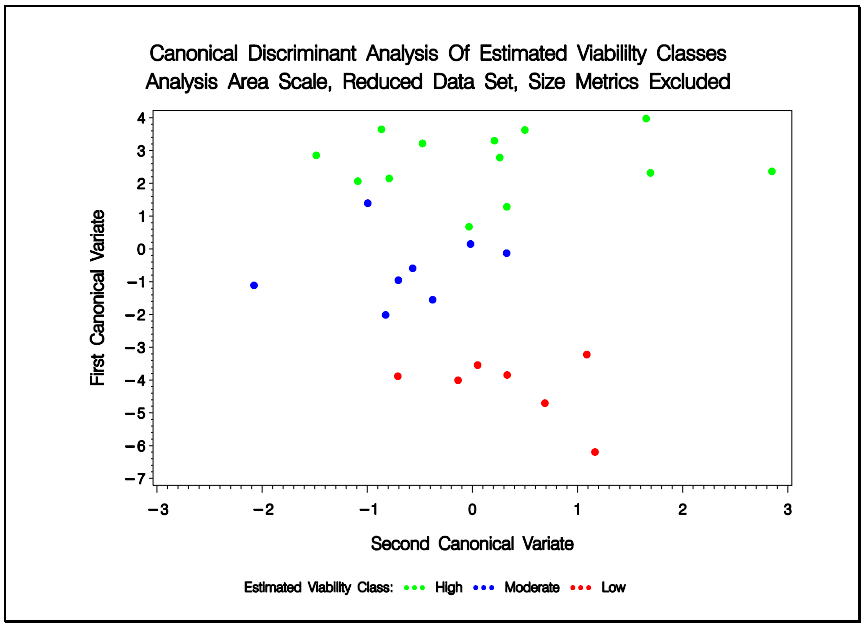


**Figure 17.**—Canonical discriminant analysis of analysis areas based on *a priori* viability estimates illustrating separation along first and second canonical variates, size metrics excluded.

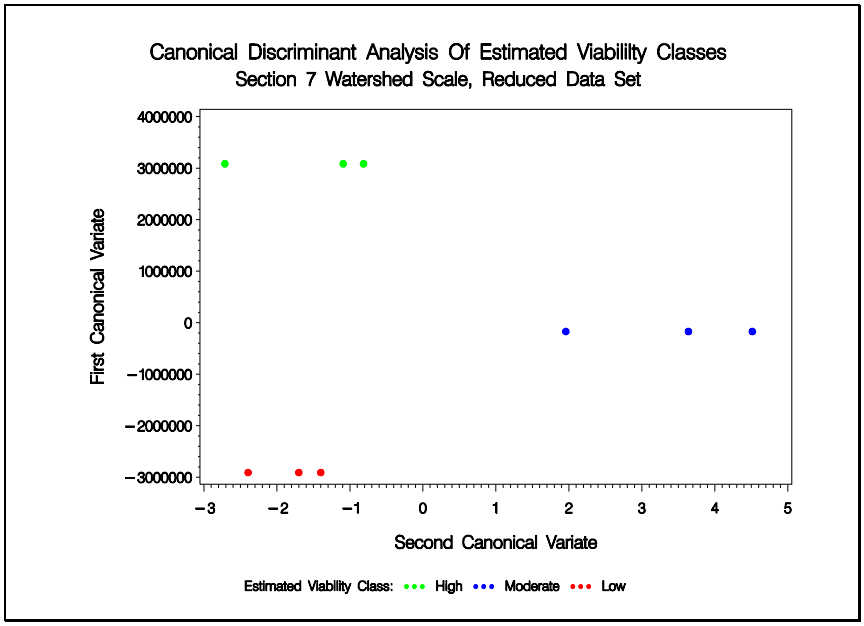


**Figure 18.**—Canonical discriminant analysis of Section 7 watersheds based on *a priori* viability estimates illustrating separation along first and second canonical variates.

## Appendix 3: Acronyms, Symbols, and Conversions

### Abbreviations, Acronyms, and Symbols

| | |
|---|---|
| **BNF** | Boise National Forest. |
| **BR** | Brownlee Reservoir Section 7 Watershed. |
| **BRB** | Bear Creek Analysis Area. |
| **BRI** | Indian Creek Analysis Area. |
| **BRW** | Wildhorse River Analysis Area. |
| **CAN1** | First Canonical Variate. |
| **CAN2** | Second Canonical Variate. |
| **CDA** | Canonical Discriminant Analysis. |
| **CFR** | Code of Federal Regulations. |
| **DC** | Deep Creek Section 7 Watershed or Analysis Area. |
| **EF** | East Fork. |
| **EFSF** | East Fork South Fork Salmon River Analysis Area. |
| **EFWR** | East Fork Weiser River Analysis Area. |
| **ESA** | Endangered Species Act. |
| **FCRONRW** | Frank Church River Of No Return Wilderness. |
| **FDR** | Forest Development Road. |
| **FR** | Federal Register. |
| **HU** | Hydrologic Unit. |
| **HUC** | Hydrologic Unit Code. |
| **IDFG** | Idaho Department of Fish and Game. |
| **LRMP** | Land and Resource Management Plan. |
| **LSEC** | Lower Secesh River Analysis Area. |

**LSFSR** Lower South Fork Salmon River Analysis Area.

**LSR** Little Salmon River Section 7 Watershed.

**LSRB** Boulder Creek Analysis Area.

**LSRH** Hard-Hazard Analysis Area.

**LSRR** Rapid River Analysis Area.

**LWR** Little Weiser River Analysis Area.

**MANOVA** Multivariate Analysis of Variance.

**MFBG** Beaver-Gold Analysis Area.

**MFCB** Crooked-Buck Analysis Area.

**MFCC** Cabin-Canyon Analysis Area.

**MFMN** Monumental Creek Analysis Area.

**MFT** Middle Fork Tributaries Section 7 Watershed.

**MFUB** Upper Big Creek Analysis Area.

**MFUM** Upper Marble Creek Analysis Area.

**MIS** Management Indicator Species.

**MSCC** Chamberlain Creek Analysis Area.

**MSMC** McCalla Creek Analysis Area.

**MSRC** California Creek Analysis Area.

**MSRF** Fall Creek Analysis Area.

**MSRFR** French Creek Analysis Area.

**MSRPL** Partridge-Lake Analysis Area.

**MSRW** Warren Creek Analysis Area.

**MSSE** Main Salmon Southeast Section 7 Watershed.

| | |
|---|---|
| **MSSW** | Main Salmon Southwest Section 7 Watershed. |
| **NF** | North Fork. |
| **NFMA** | National Forest Management Act. |
| **NFPR** | North Fork Payette River Analysis Area or Section 7 watershed. |
| **P** | Probability. |
| **PC1** | First Principal Component. |
| **PC2** | Second Principal Component. |
| **PCA** | Principal Components Analysis. |
| **PIT** | Passive Integrated Transponder. |
| **PL** | Public Law. |
| **PNF** | Payette National Forest. |
| **SF** | South Fork. |
| **SFSR** | South Fork Salmon River Section 7 Watershed. |
| **SO** | Supervisor's Office |
| **USEC** | Upper Secesh River Analysis Area. |
| **USFS** | United States Forest Service. |
| **USFSR** | Upper South Fork Salmon River Analysis Area. |
| **USFWS** | United States Fish and Wildlife Service. |
| **WF** | West Fork. |
| **WR** | Weiser River Section 7 Watershed. |

**Symbols**

| | |
|---|---|
| **§** | Section |
| **Σ** | Summation. |

| | |
|---|---|
| **ac** | Acre. |
| **km** | Kilometer. |
| **m** | Meter. |
| **mi** | Mile. |
| **$mi^2$** | Square Miles. |

**Conversions**

**1 ac** = 4.49661 grid cells

**1 mi** = 1.609 km

**1 mi** = 1,609 m

## Appendix 4: Notes on Coverages, Statistical Methods, and Quality Assurance for Ordination and Classification Exercise

*(Documentation by Rodger L. Nelson on the spatial and statistical analyses)*

### Spatial Data

#### *Analysis Areas*

I could not always determine exactly what area was being used for an analysis area. Much of my time was spent ensuring that spatial data corresponded to the correct collection of HUs that determined an analysis area, which may have resulted in my redefining some of them.

#### *Area Issues*

There were certain issues to be described in the area data used. I tried not to contradict the District input with new calculations, but in some cases I did recalculate areas to ensure consistency:

- I ignored non-FS inclusions within analysis areas and Section 7 watersheds. I was sometimes able to use District-supplied analysis area acreages to help me interpret the extent of an analysis area, but there was frequently some disagreement with the acreage I calculated. Possible reasons for this include:

    - Inconsistency with including non-FS inclusions; I always ignored them.

    - Potentially, use of different GIS watershed coverages (the original cross tabulation of acreages and HUs did not seem to be consistent), so I redid them using the ones in the GIS library from Forest Plan Revision. In the "watershed" coverage, these included "watershed region.huc6_fpr" and "watershed region.huc5_fpr" (the "fpr" indicates Forest Plan Revision).

- I accepted the District estimate of "Bull Trout Acres" unless I needed to reinterpret the analysis area (*e.g.*, I changed "Partridge-Lake" to "Partridge," restricting it to the two HUs containing Partridge Creek, because I couldn't interpret what area Partridge-Lake was).

Other area-related issues include:

- Some areas, particularly Section 7 watershed area above 1600m, were based on raster cell counts. Areas computed from cell counts in Section 7 watersheds and areas based on their polygon representations were identical except for the Little Salmon, Weiser, Brownlee, and North Fork Payette watersheds. The discrepancies resulted from the fact that the raster coverages were incomplete and were 4%, 3%, 23%, and 10%, respectively.

- On-Forest watershed areas were generally determined by clipping the appropriate collection of HUs to the Forest boundary GIS library coverage "forest_bdy polygon," except that a special polygon coverage of areas higher than 1600m was created and used

by clipping it to an analysis area to determine on-Forest analysis area acreages above 1600m.

- In several cases, area above 1600m was the same for an analysis area overall and when restricted to the Forest boundary, even when relatively large portions of the analysis area were off-Forest.

***Other Spatial Details***

- Relief was estimated from raster elevation coverage and was the difference between the highest and lowest values in an analysis area or Section 7 watershed divided by the acreage.

- Aspect was estimated visually by looking at the direction the main stream in it flowed using a 360° scale with 0° as North and 90° as East. There were exceptions for Section 7 watersheds that spanned the Salmon and Snake Rivers, where aspect was taken to be the flow direction of the principal tributaries:

    - The Wildhorse River also presented a special case and was assigned 180° as the average of 45° for Crooked River and 270° for the Wildhorse River itself.

    - Indian Creek was given the orientation of only Indian Creek, ignoring Hell's Canyon Reservoir and other small tributaries in the analysis area.

    - It would be desirable to compute a relief value that incorporates horizontal distance over which the elevation decreases from maximum to minimum.

- I recalculated road mileage from the "travel route" library coverage (the arc component). For the on-Forest data, I clipped this coverage to the Forest boundary and intersected it with the "watershed region.huc6_fpr" polygon coverage; I then intersected this with "watershed region.section7" for on-Forest Section 7 watershed mileages. I selected for the field "system" to have the value "road" and for the "status" field to be "blank," "open"or"special use":

    - This includes "non-system" roads but excludes decommissioned roads.
    - I spot checked this with the table used by the district biologists and values were similar; major discrepancies (*e.g.*, Bear Creek analysis area) were likely due to re-defining analysis areas (see above).

***Specific Anomalies***

- I could not interpret what arrangement of HUs comprised the "Little Weiser" in the District-provided table; no combination of 6$^{th}$ HUs seemed to match the reported acreage. Also, I couldn't figure how 3 HUs could contain bull trout when our mapping and the bull trout numbers table in the District document accounted for only 2 HUs. I decided to use

all HUs with acreage on-Forest for the on-Forest analysis area, which should comport with the road mileage given.

# Appendix 5: Input Data Matrices

## Analysis Area Scale

| Section 7 Watershed | Subdivision | Connected | Viability | Aspect | Acres | Acres >1600 | 6th HUs | Bull Trout HUs | Fluvial HUs | Adfluvial HUs | Brook Trout HUs | Hybrid HUs | Anadromous HUs | Anadromous Species | Bull Trout Acres | Relief | Road Miles |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SFSR | Mid-Lower | 2 | High | 45 | 178069 | 122191 | 16 | 8 | 6 | 0 | 0 | 0 | 12 | 2 | 94322 | 2156 | 92 |
| SFSR | Upper | 2 | High | 0 | 103307 | 97253 | 12 | 8 | 8 | 0 | 4 | 4 | 11 | 2 | 85302 | 1677 | 94 |
| SFSR | East Fork | 2 | High | 270 | 115030 | 107356 | 10 | 9 | 5 | 3 | 0 | 0 | 8 | 2 | 106500 | 1722 | 90 |
| SFSR | Lower Secesh | 2 | High | 135 | 72099 | 61942 | 6 | 5 | 2 | 1 | 2 | 1 | 3 | 2 | 72099 | 1716 | 108 |
| SFSR | Upper Secesh | 2 | High | 135 | 86379 | 86379 | 9 | 9 | 5 | 5 | 9 | 4 | 7 | 2 | 86379 | 1058 | 142 |
| NFPR | PNF | 0 | Extinct | 180 | 150100 | 148922 | 19 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 1276 | 276 |
| DC | PNF | 1 | Mod | 315 | 18926 | 14711 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 2 | 18926 | 2174 | 7 |
| WEISER | East Fork | 0 | Low | 315 | 20877 | 14977 | 2 | 1 | 0 | 0 | 2 | 1 | 0 | 0 | 12435 | 1291 | 133 |
| WEISER | Little Weiser | 0 | Low | 270 | 44225 | 24885 | 7 | 3 | 0 | 0 | 5 | 3 | 0 | 0 | 20495 | 1610 | 293 |
| MSSW | California | 2 | Mod | 45 | 22559 | 17777 | 2 | 1 | 1 | 0 | 1 | 0 | 1 | 2 | 15666 | 1952 | 19 |
| MSSW | Fall | 1 | Low | 0 | 13717 | 9341 | 2 | 2 | 0 | 0 | 0 | 0 | 1 | 1 | 13587 | 1905 | 49 |
| MSSW | Warren | 2 | Mod | 0 | 57488 | 52851 | 5 | 4 | 0 | 0 | 5 | 0 | 1 | 2 | 46855 | 1948 | 99 |
| MSSW | French | 1 | Mod | 0 | 45914 | 41465 | 4 | 1 | 1 | 0 | 1 | 1 | 1 | 2 | 9597 | 2071 | 22 |
| MSSW | Partridge | 2 | Low | 0 | 16772 | 14175 | 3 | 2 | 1 | 0 | 1 | 1 | 1 | 2 | 16772 | 2138 | 0 |
| BR | Indian | 2 | Mod | 225 | 49960 | 14123 | 6 | 6 | 0 | 3 | 6 | 6 | 0 | 0 | 49960 | 1953 | 202 |
| BR | Wildhorse | 1 | Low | 180 | 45145 | 14951 | 5 | 2 | 0 | 0 | 2 | 2 | 0 | 0 | 13599 | 1807 | 222 |
| BR | Bear Creek | 1 | Low | 225 | 57351 | 26328 | 6 | 1 | 0 | 0 | 6 | 2 | 0 | 0 | 10959 | 1474 | 405 |
| LSR | Boulder | 2 | Mod | 45 | 23605 | 16217 | 2 | 2 | 1 | 0 | 2 | 2 | 2 | 2 | 23581 | 1534 | 120 |
| LSR | Rapid | 2 | High | 0 | 36837 | 30785 | 4 | 5 | 5 | 0 | 2 | 2 | 4 | 2 | 35080 | 2118 | 6 |
| LSR | Hard-Hazard | 1 | Mod | 270 | 49237 | 44646 | 4 | 2 | 2 | 0 | 1 | 1 | 2 | 2 | 14172 | 1679 | 80 |
| MSSE | Chamberlain | 2 | High | 45 | 95935 | 88094 | 7 | 4 | 3 | 0 | 1 | 1 | 6 | 2 | 65225 | 1827 | 0 |
| MSSE | McCalla | 2 | High | 0 | 52848 | 47473 | 3 | 3 | 1 | 0 | 0 | 0 | 2 | 2 | 52804 | 1322 | 0 |
| MFT | Cabin-Canyon | 2 | High | 225 | 52626 | 40706 | 3 | 3 | 2 | 0 | 2 | 2 | 3 | 2 | 24733 | 1773 | 0 |
| MFT | Crooked-Buck | 2 | High | 225 | 66255 | 58049 | 4 | 3 | 1 | 0 | 2 | 2 | 2 | 2 | 49192 | 1466 | 0 |
| MFT | Monumental | 2 | High | 0 | 80493 | 79012 | 5 | 3 | 2 | 2 | 2 | 2 | 5 | 2 | 49692 | 1457 | 30 |
| MFT | Beaver-Gold | 2 | High | 135 | 60131 | 58012 | 7 | 4 | 2 | 0 | 1 | 1 | 5 | 2 | 38711 | 1324 | 2 |
| MFT | Upper Big | 2 | Mod | 90 | 61613 | 61435 | 5 | 4 | 2 | 0 | 4 | 4 | 4 | 2 | 61612 | 1304 | 82 |
| MFT | Upper Marble | 2 | High | 135 | 35276 | 35276 | 5 | 1 | 1 | 1 | 0 | 0 | 2 | 2 | 16877 | 1517 | 9 |

## Section 7 Watershed Scale

| Section 7 Watershed | Connected | Viability | Aspect | Acres | Acres > 1600 | 6th HUs | Bull Trout HUs | Fluvial HUs | Adfluvial HUs | Brook Trout HUs | Hybrid HUs | Anadromous HUs | Anadromous Species | Bull Trout Acres | Maximum Relief | Road Miles |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SFSR | 2 | High | 45 | 579820 | 475755 | 55 | 39 | 26 | 9 | 15 | 9 | 41 | 2 | 438243 | 2188 | 528 |
| NFPR | 0 | None | 180 | 150100 | 148922 | 19 | 0 | 0 | 1 | 19 | 2 | 0 | 0 | 0 | 1276 | 276 |
| DC | 1 | High | 315 | 18926 | 14711 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 2 | 18926 | 2174 | 7 |
| WR | 0 | Low | 180 | 352862 | 177518 | 50 | 5 | 0 | 0 | 13 | 4 | 0 | 0 | 40723 | 1696 | 2305 |
| MSSW | 1 | Mod | 0 | 223580 | 172599 | 25 | 11 | 4 | 0 | 11 | 2 | 5 | 2 | 121021 | 2167 | 225 |
| BR | 0 | Low | 270 | 193686 | 76174 | 28 | 6 | 0 | 3 | 13 | 7 | 0 | 0 | 46687 | 2024 | 978 |
| LSR | 1 | Mod | 0 | 189272 | 144922 | 26 | 9 | 8 | 0 | 11 | 5 | 8 | 2 | 72833 | 2334 | 650 |
| MSSE | 2 | High | 45 | 319588 | 257457 | 29 | 7 | 4 | 0 | 1 | 1 | 8 | 2 | 118029 | 2169 | 0 |
| MFT | 2 | High | 90 | 416511 | 388965 | 42 | 18 | 10 | 3 | 11 | 11 | 21 | 2 | 240817 | 1843 | 123 |

Color Code Key:

- Gray: Spatial data derived in SO.
- Pink: Viability estimate derived from September 28-30, 2004 meeting; High means the highest on the Payette National Forest, Moderate means of intermediate value compared to other watersheds, and Low means the lowest on the Forest.
- Yellow: Aspect estimate made by visual inspection of maps.
- Blue: Spatial data derived in SO and based on raster cell counts.
- Purple: Areas based on polygon areas, mostly derived in SO.
- Green: Not restricted to Forest Boundary.
- Orange: Based on fish distribution mapping and estimation, usually with district information augmented or modified by SO.

## Appendix 6. Credits & Author Information


### Acknowledgements

We thank Peter Johnson for his sage advice regarding making scientific documents usable to managers, concise, credible & honest. We weren't always concise, but used all of the information to which we had access for legal reasons. Our great appreciation is also extended to Jack McIntyre for his wisdom regarding what constitutes the "best available science" & he provided critical advice during peer review of the draft of this paper. Bruce Rieman provided critical advice during peer review of the draft of this paper, and he added information to the effort. Also, Dale Allen provided support and advice during peer review of the draft of this paper; in addition to assisting with acquiring data from the Idaho Department of Fish and Game. Don Martin provided key facilitation during the September 28-30, 2004 meeting, and he kept us focused on the task at hand. Karen Ketchu provided record keeping, note taking, and other administrative assistance. Chans O'Brien provided assistance with GIS products that facilitated quantitative illustration of some of our conclusions.

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