2004 Boise Aquatic Management Indicator Species Monitoring Report

Introduction

In order to evaluate the effects of management practices on fisheries and wildlife resources, the U.S. Forest Service monitors select species whose population trends are believed to reflect the effects of management activities on Forest ecosystems. These species are termed "management indicator species" (MIS) and the rationale for MIS monitoring is outlined in federal regulation 36 CFR 219.19.

> *"In order to estimate the effects of each alternative on fish and wildlife populations, certain vertebrate and/or invertebrate species present in the area shall be identified and selected as management indicator species and the reasons for their selection will be stated. These species shall be selected because their population changes are believed to indicate the effects of management activities."*
>
> *"Population trends of the management indicator species will be monitored and relationships to habitat changes determined."*

An important criterion integral to the MIS foundation is that monitoring results must allow managers to answer questions about population trends. Historically, monitoring of habitat was used a surrogate for direct quantification of MIS populations. However, recent court cases (*Sierra Club v. Martin*, 168 F.3d 1 (11^{th} Cir. 1999)) have ruled that assessing changes in habitat will no longer be accepted as a substitute for direct monitoring of populations. The Forest Service has an obligation to collect and analyze quantitative population trend data at both the forest-plan and project level.

In response to issues raised by court challenges, the Sawtooth, Boise, and Payette National Forests revisited aquatic MIS species for the Draft Forest Plan EIS to determine if the population data were sufficient to determine trend at the Forest scale.

Following this reevaluation, bull trout was selected as the aquatic MIS species (For a full explanation of the MIS review, see Aquatic Management Indicator Species for the Boise, Payette, and Sawtooth Forest Plan Revision, 2003). Bull trout were selected because the species is sensitive to habitat changes, dependent upon habitat conditions that are important to many aquatic organisms, relatively well understood by Forest biologists, and widely distributed across the Ecogroup. In addition, local bull trout populations are not influenced by stocking and likely persist at relatively small spatial scales that do not extend beyond Forest boundaries. As a result, Forest bull trout populations are probably not heavily influenced by activities occurring outside Forest domains, and therefore changes in bull trout populations will more likely reflect local management activities.

Methods

Development of MIS Sampling Protocol for Bull Trout

An approach to monitoring MIS bull trout was developed with the Boise National Forest, Regional Office, and the Boise Rocky Mountain Research Station in 2004. The following provides a summary of this monitoring approach.

A key question that this approach addresses is how does one monitor trend? For aquatic species, trend is typically monitored using relative abundance estimates over time in a select set of streams. However, the challenge with abundance data is that it is often influenced by sampling error and natural variation (Platts and Nelson 1988; Maxell 1999; Dunham et al. 2001).

Given these well-known limitations, an alternative trend monitoring approach was developed that focuses on monitoring the spatial patterns of occurrence (distribution) through time. Monitoring distributions can be particularly appropriate for bull trout because it has very particular habitat requirements. Specifically, bull trout distributions are limited to cold water (Dunham et al. 2003), and suitably cold habitats are often patchily distributed throughout river networks (Poole et al. 2001). Dunham and Rieman (1999) found that bull trout populations in the Boise River basin were linked closely to available habitat "patches" or networks of cold water. A patch is defined for bull trout as the contiguous stream areas believed suitable for spawning and rearing (Rieman and

McIntyre, 1995). Rieman and McIntyre (1995) analyzed bull trout in the Boise River basin and found occurrence to be positively related to habitat size (stream width) and patch (stream catchment) area, as well as patch isolation and indices of watershed disruption. Patch size (area) was the single most important factor determining bull trout occurrence.

Spatial patterns can also provide information on population persistence, local extirpations, and recovery (recolonization). The stability and persistence of metapopulations are related to the number, size, degree of isolation, and relative distribution of populations (Dunham and Rieman 1999). Bull trout populations in larger, less isolated, and less disturbed habitats appear more likely to persist over time.

Based upon the above approach the following metrics for determining trend were used:

(1) The proportion of habitat patches that bull trout occupy within each subbasin across time.
(2) The spatial pattern of occupied bull trout patches within each subbasin across time.

It was assumed in the forest plans that as restoration and conservation activities are implemented, constraints on watershed processes and habitat condition would be reduced. This in turn would maintain or restore properly functioning subwatersheds and slowly improve degraded subwatersheds respectively. However, it was also realized that it would take time for populations to respond to restoration and conservation measures. This might be particularly true for bull trout, which have a relatively long generation time (5-10 years). Therefore, it was assumed that the number and distribution of strong or depressed bull trout populations would change relatively slowly over the 15 years of the forest plan.

We anticipate, then, that important changes in the distribution and proportion of occupied bull trout patches will only be apparent over time scales approximating the life of the forest plan. Bull trout may become more widely distributed in occupied patches as populations begin to expand, and recolonization of unoccupied patches may occur as barriers are removed. However, only with sustained restoration and sufficient time for natural recovery, are we likely to see substantial changes in the portion of occupied patches or increases in bull trout distributions within occupied patches.

The trend of occupied patches and spatial pattern will not explain why changes have occurred. As the CFR states, “Population trends of the management indicator species will be monitored and relationships to habitat changes determined.” Therefore, an approach is currently being developed to tie MIS monitoring with forest plan implementation and effectiveness monitoring to determine how habitats and individual populations change in relation to management activities.

Initial Determination of Bull Trout Patches

Bull trout patches were identified in two ways. First, several subbasins (e.g. Boise and Payette) already had patches delineated by existing work following Rieman and McIntyre (1995) and Dunham and Rieman (1999). For these subbasins, district and forest biologists reviewed patch designations to determine if they included all known or potential streams that could support bull trout. Second, for subbasins where patches had not been established, a consistent set of criteria was applied to delineate patches.

Forests used criteria similar to those used by the RMRS in the Boise and Payette subbasins. Patches were initially defined based on major physical gradients (patch size, as it related to stream size and elevation). Patches were identified as catchments above 1600 m and were delineated from U.S. Geological Survey 10 m Digital Elevation Models (DEM). The 1600 m elevation criteria was used because data from the Boise basin indicated that the frequency of juvenile bull trout (<150 mm) occurrence increased sharply at about 1,600 m (Rieman and McIntyre 1995; Dunham and Rieman 1999).

Subwatersheds that were above 1600 m, but less than 500 hectares, were not included because they rarely supported perennial streams large enough to support bull trout. Watson and Hillman (1997) only found bull trout in streams greater than two meters in width and studies in western Montana (Rich 1996) and southwest Idaho (Rieman and McIntyre 1995; Dunham and Rieman 1999) show bull trout are less likely to occur in streams less than two meters in width. We assumed that patches less than 500 hectares would have streams with a wetted width smaller than 2 m.

We initially assumed that 1,600 m elevation approximated the lower limits of habitat suitable for spawning and early rearing of bull trout. Because of the association with temperature, elevation should define habitat patches that are at least partially isolated by distance across warmer waters (Rieman and McIntyre, 1995). The 1600m elevation in the Boise and Payette subbasins currently forms the downstream boundary of each patch. However, in subbasins in higher latitudes, there may not be a clear elevation threshold. Therefore, further verification described below was completed.

Once delineated, district and forest biologists reviewed patch designations and made refinements based on stream temperature and presence of bull trout smaller than 150mm. Patches were defined as areas generally not isolated from the larger subbasin by a yearlong barrier (physical, chemical, etc.) to fish movements and by water temperatures no higher than 15 °C (7 day average summer maximum). Recent analysis of stream temperatures and bull trout occurrence indicates juvenile bull trout are unlikely to be found in stream sites with maximum summer temperatures of 18-19 °C (Dunham et al. 2003).

Observations used to define patch boundaries were also based on the more restricted movements of small (less than 150 mm) bull trout. Although some bull trout may exhibit seasonal movements from natal habitats to wintering or foraging areas (e.g. larger rivers, lakes or reservoirs), fidelity to the natal environments is likely during spawning and initial rearing. Because spawning salmonids home to natal streams and even reaches (Quinn 1993), occupied patches separated by thermally unsuitable habitat are likely to represent populations with some reproductive isolation. Other information (e.g. genetic, mark-recapture, radio-telemetry, etc.) may be collected over time to determine distinctiveness of the populations associated with the patches we define.

Classification of Patches and Stratification of Sampling

Once bull trout patches were identified, they were classified into four categories to further focus sampling efforts over the life of the forest plan (2003 – 2018). These categories included: (1) patches known to support a bull trout population (i.e., spawning and/or early rearing has been documented) as indicated by past surveys (within the last 7 years); (2) patches that have been surveyed and baseline conditions likely will support a bull trout population, but they have not been detected or patches where bull trout have been detected, but observation are older than 7 years; (3) patches that have been surveyed and baseline conditions (i.e., stream temperature, etc.) likely will not support a bull trout population and bull trout have not been detected (i.e. we assume these patches are unsuitable and unoccupied); and (4) patches that have not been surveyed.

There are 170 bull trout patches that occur within nine subbasins on the Boise National Forest; 43 patches in category 1; 65 patches in category 2; 12 patches in category 3; and 50 patches that have not been surveyed in category 4 (Table 1).

Table 1. Number of bull trout patches on the Boise National Forest within each subbasin by category prior to 2004 sampling.

Category	Subbasin									
	S.F. Salmon	Upper M.F. Salmon	S.F. Boise	Payette (Squaw Creek)	N.F. Payette	M.F. Payette	S.F. Payette	N.F. M.F. Boise	Boise Mores	**Total**
1	6	7	2	3	0	3	11	9	2	**43**
2	10	1	14	1	1	4	13	19	2	**65**
3	1	1	2	0	0	0	0	8	0	**12**
4	6	2	10	0	0	5	13	9	5	**50**
Total	**23**	**11**	**28**	**4**	**1**	**12**	**37**	**45**	**9**	**170**

Changes to Bull Trout Patches

Expansion, contraction, or shifting distributions of bull trout within patches are likely to be influenced by changing environmental conditions. Water temperature is one of the most significant habitat parameters for bull trout and therefore will be important when evaluating patch boundaries over time. All patches falling into category 1, 2, or 4 will be sampled for bull trout at least twice over the life of the forest plan (e.g. at least once within the first and second 7 year period). In the year prior to sampling of a patch, at least one thermograph will be installed at the downstream patch boundary and at several other points upstream.

Annual temperature monitoring will also be conducted within specific patches in each category (e.g. 1, 2, and 3) over the life of the forest plan. With this information we can examine natural variation in stream temperatures, evaluate whether patch boundaries should be changed (e.g. elevated temperature due to an unusually hot summer) based on one year's monitoring, and determine if temperatures in select category 3 patches are improving enough to justify future sampling for bull trout.

The thermograph data will also help us evaluate whether a patch is still suitable for bull trout (i.e., whether a Category 1, 2, or 4 patch is actually Category 3 or whether the downstream (temperature-based) boundary of the patch is pushed upstream so far as to eliminate [because of the area criterion] the subject drainage from consideration as a patch). Thermograph data may also be used to determine if conditions within selected Category 3 patches have improved enough that the patch category needs to be redefined to a 2.

<u>Patch Sampling Frequency</u>

How frequently a patch is sampled is dependent upon how many patches fall within each strata and if some patches require more intensive sampling to establish presence or absence to the level of detection allowed by the methodology. All patches that fall within categories 1, 2 and 4 will be sampled at least twice over the life to the forest plan (2003 – 2018), while patches that fall within strata 3 will be sampled at least once.

Within the first half of the forest plan (0-7 years), all patches in strata 1, 2 and 4 would be prioritized for inventory. Patches in category 1 would be sampled no later than 7 years from the last documented bull trout observation. For example, if bull trout were last documented in 1999, then the patch would need to be sampled again no later than 2006. Patches within strata 2 and 4 would also be surveyed to help establish bull trout presence or absence to the level of certainty allowed by the methodology.

Depending on the survey results, patches may be reclassified. For example, once all patches in strata 4 are surveyed, they would be reclassified (e.g. 1, 2, or 3). Likewise, if no bull trout were found where previously observed (category 1 patch), it would be reclassified. If bull trout were still present then the patch would remain in category 1.

In the second half (8-15 years) of the forest plan, all patches in strata 1 and 2 would be sampled. Patches in strata 3 (degraded baselines with high stream temperatures, high amount of fine sediment, etc.) would only be sampled if environmental conditions or limiting factors (e.g. culvert barrier removed) improved, increasing the likelihood that the patch might support bull trout or if a neighboring patch were colonized by bull trout.

<u>Informal and Formal Surveys</u>

To maximize effort and facilitate fieldwork, we plan to use a combination of informal and formal surveys. Informal surveys may use any fish sampling method, but if informal surveys fail to detect bull trout, formal surveys must be completed. Formal surveys will follow a consistent protocol, sampling intensity, sampling effort, etc. designed to estimate the probability that bull trout actually occur in a site or patch given that they are not detected (i.e. a false absence).

Formal Surveys

The sample design (delineation of patches and sample sites within patches) attempts to focus on habitat that has the highest probability of supporting bull trout. While this design increases the probability of detecting bull trout, it does not guarantee it. Determination of bull trout presence is certain only when a bull trout is detected or captured (Peterson and Dunham 2002). Absence can never be certain (unless perhaps the stream is dewatered). Many patches within the Boise and Sawtooth National Forests are either believed to be unoccupied or have very low bull trout densities. If a species is not detected, then either it is truly absent or it is present but not detected during the survey. The goal is to sample in a way that allows the estimation of the probability of presence or absence in a patch given sampling effort and site characteristics that will influence the probability of detection when bull trout are actually present.

The general methods outlined by Peterson et al. (2002) or their extension by Peterson and Dunham (2003) will be used to estimate probability of bull trout presence in sampled patches. The probability of bull trout detection for each site will be estimated from Appendix 1, Table 3, in Peterson et al. 2002 or with empirical methods as discussed by Wintle et al. 2004. This protocol provides forest biologists with a pseudo-quantitative measure assessing the likelihood that sampling efforts were intensive enough to detect bull trout, assuming that they are present in the patch. If habitat conditions in a patch are known, biologists can determine the extent of sampling required to reach a predetermined level of confidence that bull trout are not present. In addition, calculating probabilities of detection following sampling efforts helps biologist to determine whether future sampling is necessary.

Selecting Sites within Patches

To focus sampling within a patch, only suitable habitat will be inventoried. Suitable habitat is defined according to wetted width (greater than 2 meters), stream gradient (less than 20%), water temperatures (15 °C or less, 7-day average summer maximum), and access (no natural or anthropogenic barriers). All suitable habitat in each patch that meets these criteria will be identified prior to surveying. For formal surveys, sites within each patch will be located by randomly selecting elevations within the extent of the suitable habitat. Randomizing sample sites within a patch will allow us to make conditioned inferences to all perennial streams greater than 2 meters within the patch.

Sampling within each site

Formal sampling will be based on a standardized electrofishing method selected to maximize the probability of detection within a patch by balancing the effort within a site against the number of sites within a patch. The minimum sampling will consist of a 100m single-pass transects with blocknets. Additional electrofishing passes can be completed if an index of abundance, sampling efficiency data, or other information is desired. If juvenile bull trout (i.e., less than 150 mm) are found within any site, bull trout will be declared present within that patch. If bull trout are not detected in the first sample site, additional sites will be sampled in each patch until bull trout are detected, until a desired probability of detection in the patch is reached, or until maximum allowable effort given logistical constraints is reached, which ever comes first. Additional sites can also be surveyed to describe distribution within the patch.

Sampling sites within a patch will be 100 m in length. In models used by the Rocky Mountain Research Station, 100 m sites had slightly higher densities of bull trout; and, thus, detectability of bull trout is greater, assuming equal sampling efficiencies.

Results and Discussion

Monitoring for bull trout on the Boise N.F. occurred in 28 patches in 2004 (Figure 4 and Table 2). The results are described by subbasin in the following narrative:

N.F.-M.F. Boise subbasin

In the N.F.-M.F. Boise subbasin, ten patches (Pikes Fork, Black Warrior, West Warrior, Lost, E.F. Swanholm, Eagle, China Fork, Bald Mountain, Lost Man, and Roaring River) in categories 1, 2 and 4 were surveyed. Bull trout were observed in two of these patches, Roaring River and Black Warrior Creek. Juvenile bull trout had previously been detected in Roaring River and Black Warrior Creek in 1993. Juvenile bull trout were also detected in the Bald Mountain, during post-wildfire monitoring in 2003. However, Bald Mountain Creek experienced debris torrents the following spring and the 2004 surveys were unsuccessful in finding any fish remaining in the patch despite extensive sampling.

Bull trout were not observed in Pikes Fork or Lost Man, despite surveys at four multiple pass electrofishing sites in each. This level of sampling resulted in probabilities of detection of 42%. The Boise National Forest and the Rocky Mountain Research Station had sampled Pikes Fork and Lost Man Creeks previously. Pikes Fork was electrofished a total of 21 times in 1993-1997 and 1999-2001 and Lost Man Creek was electrofished twice in 1993. Bull trout have not been documented in Lost Man Creek. Bull trout were detected in Pikes Fork in 1993 and 1995, but were not found during any of the subsequent surveys. This data indicates that there is a low probability that either patch currently supports bull trout.

Lost, China Fork, and E.F. Swanholm Creeks were each sampled at two multiple pass electrofishing sites. Bull trout were not observed in any of these three category 4 patches. This level of sampling resulted in a probability of detection of __%. Three multiple pass electrofishing sites were sampled in Eagle Creek, but no bull trout were observed in any of these three sites. The West Warrior patch was sampled at one multiple pass electrofishing site, but no bull trout were detected. West Warrior is a category 2 patch. Sampling in 1993 detected adult bull trout, but no juveniles. The West Warrior site sampled in 2004 was at the 5000' elevation (downstream-most elevation in the patch).

S.F. Payette subbasin

During 2004, thirteen bull trout patches were sampled in the S.F. Payette subbasin (Upper Deadwood, Deadwood Reservoir, Deer, Warm Springs, Whitehawk, No Man, Scott, S.F. Scott, Clear, Wapiti, E.F. Big Pine, Fruitcake, and Miller). Bull trout were found in eight of these patches using multiple-pass electrofishing (Upper Deadwood, Deadwood Reservoir, Deer, Warm Springs, Scott, S.F. Scott, Clear, Wapiti). Crews from the Boise N.F. and/or Bureau of Reclamation had previously surveyed all of these eight patches. S.F. Scott and Wapiti were in category 2; the other six were in category 1. Multiple-pass electrofishing was conducted at two sites in both No Man and Whitehawk. Both of these category 2 patches had numerous previous surveys, none of which detected bull trout. E.F. Big Pine, Fruitcake, and Miller Creeks were each sampled at three multiple pass electrofishing sites. Bull trout were not observed in any of these three category 4 patches. This level of sampling resulted in a probability of detection of __%.

S.F. Salmon subbasin

In the Upper Salmon subbasin, 5 of 23 patches in categories 1 and 2 were surveyed (Dollar, Curtis, Tyndall-Stolle, Lower Burntlog, and Warm Lake). Three-pass electrofishing detected bull trout in all five of these patches. In general, 2004 sampling results mirror past surveys. Boise N.F. crews had previously sampled within the Curtis, Tyndall-Stolle, Lower Burntlog, and Warm Lake patches with similar results. However, bull trout had not been previously documented in Dollar Creek.

Bull Trout Detection

Juvenile bull trout (<150mm) were detected in 15 of the 28 patches sampled on the Boise National Forest in 2004. Where juvenile bull trout were detected, they were observed during the first electrofishing pass of the first sample site within a patch 10 out of 15 times (Table 2). In two patches, juvenile bull trout were not detected until the second electrofishing pass of the first sample site. In the three patches where juvenile bull trout were not detected until the second or third site, the field crew started at the lowest randomly selected elevation and worked upstream.

In 5 of the 15 patches where juvenile bull trout were detected in 2004, the field crew discontinued electrofishing after completing the first site. However, multiple sites (n=46) were electrofished in10 of the 15 patches that had at least one juvenile bull trout detection in 2004. Although juvenile bull trout were confirmed present in these 10 patches, none were detected at 47% of the sites. Scott Creek was the only 1 of these 10 patches where bull trout were detected at all [5] sites that were sampled. This indicates that bull trout were not evenly distributed within occupied patches. The electrofishing results and spatial distribution of sample sites within these ten patches indicate that juvenile bull trout were detected more frequently and in greater abundance at higher elevations within patches (Figures 1 & 2).

For the 13 patches sampled in 2004 where no juvenile bull trout were captured, probability of detection of bull trout ranged from 5-52%.

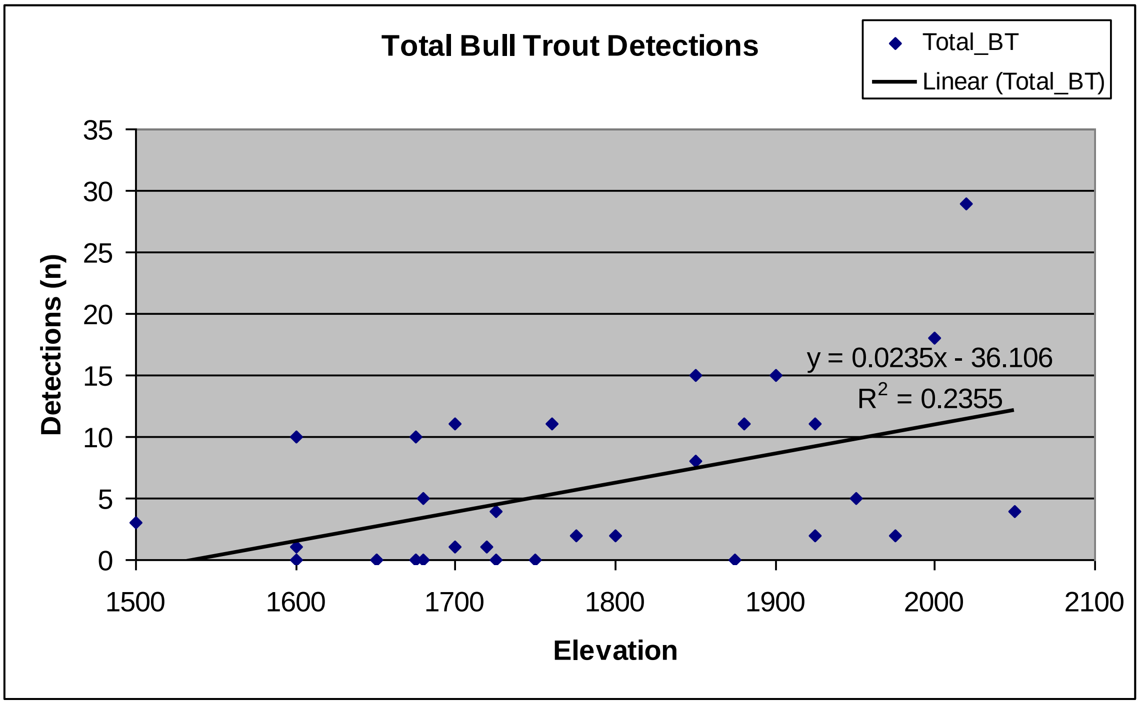

Figure 1. Bull trout detections by elevation for sites within occupied patches sampled in 2004.

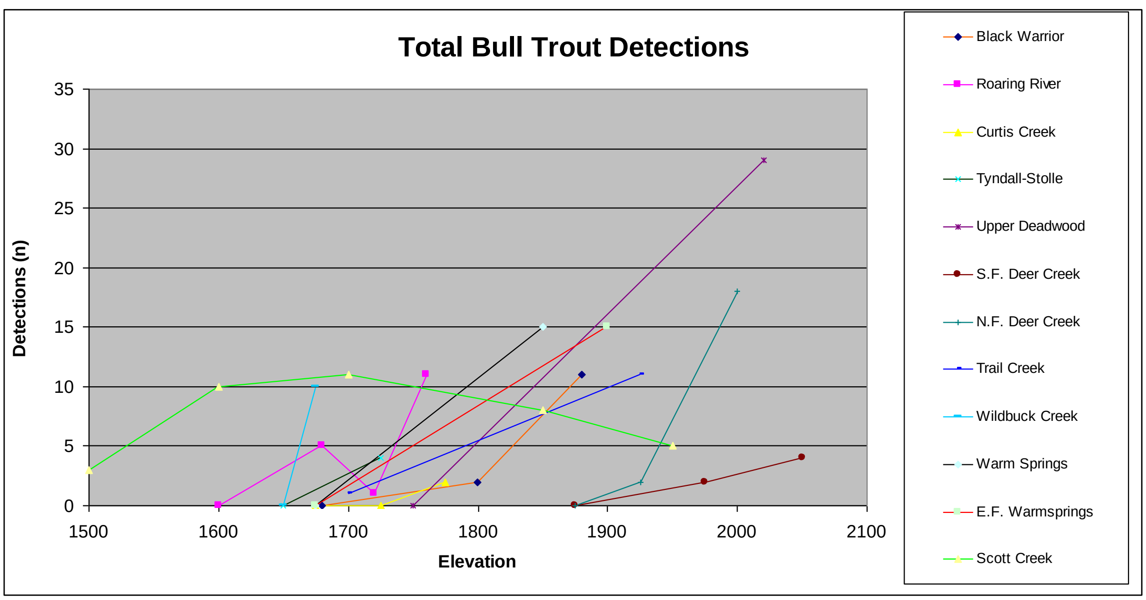

Figure 2. Bull trout detections increased with elevation at sites within occupied patches sampled in 2004.

Patch Stream Temperature Monitoring

Monitoring stream temperatures allows forest biologists to assess the influence of management practices on water temperatures (Meehan 1991), predict species distributions (Dunham 2003), and update MIS patch strata. As such, stream temperature monitoring plays a critical role in this aquatic MIS approach. During 2004, the Boise N.F. crew deployed 14 temperature loggers in 14 patches on the Boise N.F. (Figure 3). Most of these temperature loggers were placed in category 4 patches. BOR crews deployed an additional 13 temperature loggers in patches on the Boise N.F. in 2004 (Figure 3). Because maximum water temperatures on the Boise N.F. tend to occur between mid-July and mid-September (Boise NF unpublished data), water temperature loggers are deployed in early summer (early July) and recovered in early fall (after Sept 1). Gamett (2002) found that mean water temperature (July 1 to September 30) appeared to be the most effective in describing bull trout abundance in the Little Lost drainage. Maximum daily maximum temperature (MDMT) and maximum weekly maximum temperature (MWMT, the mean of daily maximum water temperatures measured over the warmest consecutive seven-day period) were calculated for each patch and provide important information for managers when classifying patches into strata or assessing the presence or absence of bull trout.

Bull trout were detected in four of the patches where temperature loggers were deployed during the 2004 season. Patches occupied by bull trout had mean temperatures of MDMT 14.8 °C (13.3-16.0 range) and MWMT 14.2 °C (12.9-15.0 range) at their confluence (Figure 4). In patches where no bull trout were detected, mean MDMT and MWMT were 14.8 °C (12.2-22.9 range) and 14.1 °C (11.7-22.0 range) respectively at their confluence (Figure 5).

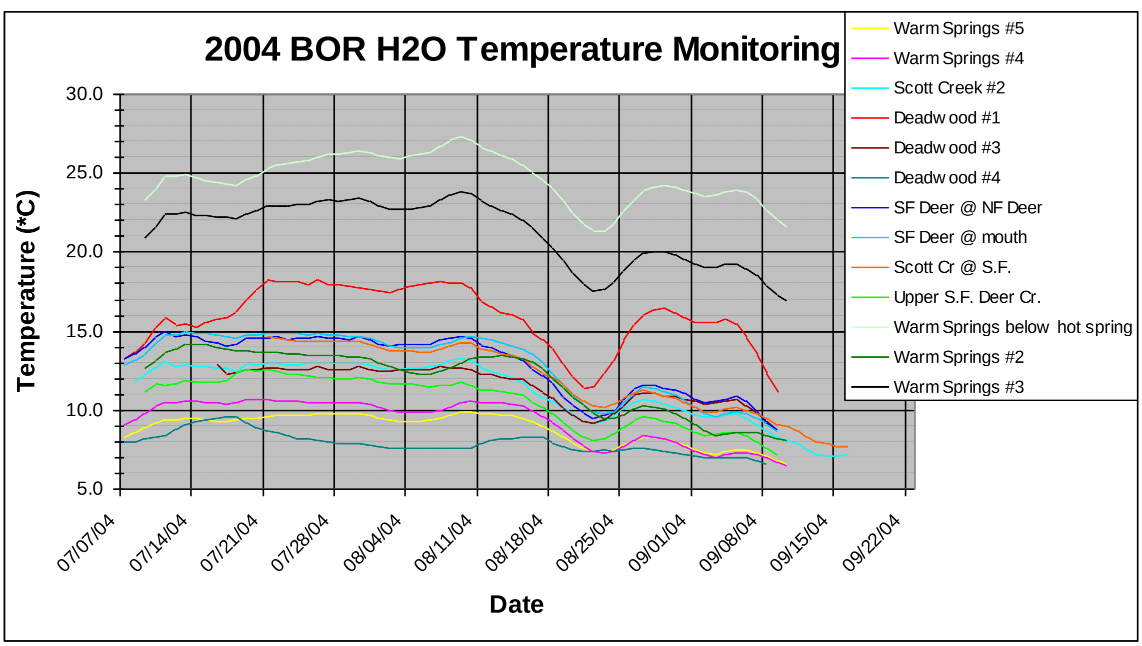

Figure 4. Water temperatures monitored in patches occupied by bull trout in 2004.

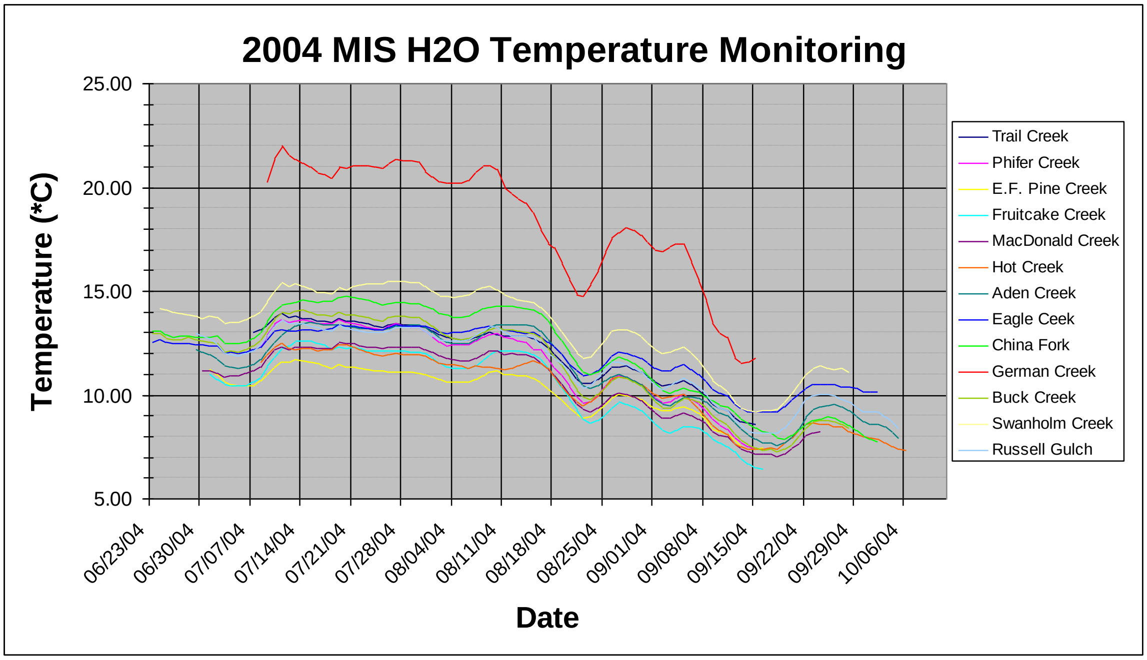

Figure 5. Water temperatures monitored in patches with no bull trout detections in 2004.

Dunham (2003) found that the probability of bull trout occurrence was relatively high (>0.50) in streams with a maximum daily maximum temperature (MWMT, the warmest daily water temperature recorded during a given year or survey) <14-16° C.

Factors other than water temperatures (i.e. groundwater inputs, over-wintering habitat, and habitat connectivity) are also likely influencing bull trout distribution. In several of the 2004 patches, temperature appeared to be suitable for bull trout even though no bull trout were detected during summer sampling (Figure 5). Even so, the perceived absence of bull trout could be related to other factors including passage barriers and sampling error. It is likely that a larger sample size of patches is needed before strong associations between bull trout occurrence and stream temperature can be determined.

Barriers

MIS results will also help managers assess the influence of fish passage barriers on bull trout populations. Passage barriers can have a strong influence upon species distributions as well as the life-history expression of fish populations. Several of the patches sampled during 2004 contained barriers that could influence the presence or persistence of bull trout. Identified culvert barriers block access to the N.F. Dollar Creek, E.F. Pine Creek, Miller Creek, Banner Creek, Lost Creek, Eagle Creek, and Lost Man Creek, and no bull trout were detected in these patches. However, juvenile bull trout were detected in patches upstream of identified culvert barriers in six patches: Bear Creek, Trail Creek, N.F. Deer Creek, Scott Creek, Wapiti Creek, and Roaring River.

Barriers can also occur in less discrete locations as a result of thermal difference between stream sections. Thermal barriers (>20ºC) were verified in Warm Springs Creek and German Creek through water temperature monitoring in 2004. However, juvenile bull trout were detected in Warm Springs Creek upstream from the geothermal influence. Fish passage barriers can provide positive or negative influences on bull trout populations, depending upon a variety of factors, including the presence of exotic species, the size of the isolated population, habitat conditions above and below the barrier, etc. Further MIS monitoring will assist in the evaluation of the influence of barriers on the persistence of bull trout populations on the Boise N.F.

Hybridization

MIS monitoring did detect a variety of game and non-game species across the Boise N.F. (Table 3) including brook trout (*Salvelinus fontinalis*), a species know to hybridize with bull trout (Markle 1992, Leary et al. 1993). During the 2004 sampling season, two patches were found to have both bull trout and brook trout (Trail and Baron Creeks). In both patches, bull trout / brook trout hybrids were observed. Recent research indicates that bull trout/brook trout F1 generation hybrids can reproduce, though less successfully than pure crosses between parent species (Kanda et al 2002). Bull trout hybridization with *S. fontinalis* is recognized as a major threat to the persistence of bull trout, largely as a result of population-scale wasted reproductive effort and genetic introgression (Markle 1992, Leary et al. 1993, Kanda et al. 2002).

In Trail Cr., brook trout were only found in the lower portions of the patch and high gradient cascades may protect the upstream bull trout population from further hybridization. Nevertheless, the upstream bull trout population persists in a very short stream section (upstream bull trout distribution is limited by a large falls), so population stability may be limited. In the Baron patch, no barriers are present and brook trout appear to be widely distributed. Future MIS monitoring will be necessary to help managers assess the effects of brook trout on the bull trout populations in the Trail and Baron patches. Because brook trout are present throughout the Boise N.F., this information will certainly prove useful in future management decisions.

References

Bayley, P. B., and D. C. Dowling. 1993. The effects of habitat in biasing fish abundance and species richness estimates when using various sampling methods in streams. Polskie Archiwum Hydrobiologii 40: 5-14.

Bonar, S.A., M. Divens, and B. Bolding. 1997. Methods for sampling the distribution and abundance of bull trout/ dolly varden. Research Report RAD97-05. Washington Department of Fish and Wildlife, Olympia, Washington.

Dunham, J., B. Rieman and G. Chandler. 2003. Influences of temperature and environmental variables on the distribution of bull trout within streams at the southern margin of its range. North American Journal of Fisheries Management 23:894-904.

Dunham, J.B., and B.E. Rieman, 1999. Metapopulation structure of bull trout: Influences of physical, biotic, and geometrical landscape characteristics. Ecological Applications 9:642-655.

Dunham, J.B., Rieman, B.E., and Davis, K. (2001). Sources and magnitude of sampling error in redd counts for bull trout. North American Journal of Fisheries Management. 21:343-352.

Fausch, K. D., C. L. Hawkes, and M. G. Parsons. 1988. Models that predict standing crop of stream fish from habitat variables: 1950-1985. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, General Technical Report PNW-GTR-213, Portland, Oregon.

Gamett, B. L. 2002. The relationship between water temperature and bull trout distribution and abundance. Master's thesis. Utah State University, Logan.

He F., and K.J, Gaston. 2000. Estimating species abundance from occurrence. American Naturalist. 156: 533-559.

Kanda, N., R.F. Leary, and F.W. Allendorf. 2002. Evidence of introgressive hybridization between bull trout and brook trout. Transactions of the American Fisheries Society. 131:772-782.

Kunin, W.E., S. Hartley, and J.J. Lennon. 2000. Scaling down: on the challenge of estimating abundance from occurrence patterns. The American Naturalist. 156:560-566.

Leary, R.B., F.W. Allendorf, and S.H. Forbes. 1993. Conservation genetics of bull trout in the Columbia and Klamath River drainages. Conservation Biology 7:856-865.

Markle, D.F. 1992. Evidence of bull trout x brook trout hybrids in Oregon. Pages 58-67 *in* P.J. Howell and D.V. Buchanan, editors. Proceeding of the Gearhart Mountain bull trout workshop. American Fisheries Society, Oregon Chapter, Corvallis.

Maxell. 1999: A Power Analysis on the Monitoring of Bull Trout Stocks Using Redd Counts. North American Journal of Fisheries Management: Vol. 19, No. 3, pp. 860–866.

Meehan, W.R., ed., 1991, Influences of forest and rangeland management on salmonid fishes and their habitats, Special Publication 19, Bethesda, MD: American Fisheries Society, 751 p.

Partridge, F., K. Frank, and C. Warren. 2000. Southwest Idaho bull trout restoration (South Fork Boise River) completion report. Idaho Department of Fish and Game, Threatened and Endangered species report, Project E-21-1, Section 6, Endangered Species Act, August 2000.

Peterson et al. 2004. An Evaluation of Multipass Electrofishing for Estimating the

Abundance of Stream-Dwelling Salmonids. Transactions of the American Fisheries Society 133:462–475, 2004

Peterson, J. T. and Dunham, J.B. 2002. Combining Inferences from Models of Capture Efficiency, Detectability, and Suitable Habitat to Classify Landscapes for Conservation of Threatened Bull Trout. Conservation Biology, Pages 1070–1077, Volume 17, No. 4.

Peterson, J., J. Dunham, P. Howell, R. Thurow, and S. Bonar. 2002. Protocol for detecting bull trout presence. Western Division of the American Fisheries Society. Available at http://www.fisheries.org/wd/committee/bull_trout/bull_trout_committee.htm (accessed 26 August 2002).

Peterson, JT., Banish, N.P, and Thurow, R.T. In Press. Are blocknets necessary ? Movements of stream-dwelling salmonids in response to three common survey methods.

Platts, W.S. and R.L. Nelson, 1988, Fluctuations in trout populations and their implications for land-use evaluation. North American Journal of Fisheries Management 8:333-345.

Poole, G., J. Dunham, M. Hicks, D. Keenan, J. Lockwood, E. Materna, D. McCullough, C. Mebane, J. Risley, S. Sauter, S. Spalding, and D. Sturdevant. 2001. Scientific issues relating to temperature criteria for salmon, trout, and charr native to the Pacific Northwest. U.S. Environmental Protection Agency, EPA 910-R-01-007, Seattle.

Quinn, T. P. 1993. A review of homing and straying of wild and hatchery produced salmon. Fisheries Research 18:29-44.

Rich, C. F. 1996. Influence of abiotic and biotic factors on occurrence of resident bull trout in fragmented habitats, western Montana. Master's thesis, Montana State University.

Rieman, B. E., and G. L. Chandler. 1999. Empirical evaluation of temperature effects on bull trout distribution in the Pacific Northwest. Final report to U. S. Environmental Protection Agency, Boise, ID.

Rieman, Bruce E. and John D. McIntyre, 1995, Occurrence of Bull Trout in Naturally Fragmented Habitat Patches of Varied Sizes, *Transactions of the American Fisheries Society*, Vol. 124, No. 3, pp. 285-296.

Riley, S. R. Haedrich and R. Gibson. 1993. Negative bias in removal estimates of Atlantic salmon parr relative to stream size. Journal of Freshwater Ecology 8: 97-101.

Royle, J.A. and J.D. Nichols. 2003. Estimating abundance from repeated presence-absence data or point counts. Ecology. 84 (3): 777-790.

Thompson, W. L., G. C. White, and C. Gowan. 1998. Monitoring vertebrate populations. Academic Press, New York.

Watson, G and T.W. Hillman. 1997. Factors affecting the distribution and abundance of bull trout: an investigation at hierarchical scales. North American Journal of Fisheries Management 17:237-246.

Wintle, B. A., M. A. McCarthy, K. M. Parris, and M. A. Burgman. 2004. Precision and bias of methods for estimating point survey detection probabilities. Ecological Applications. 14(3):703-712.

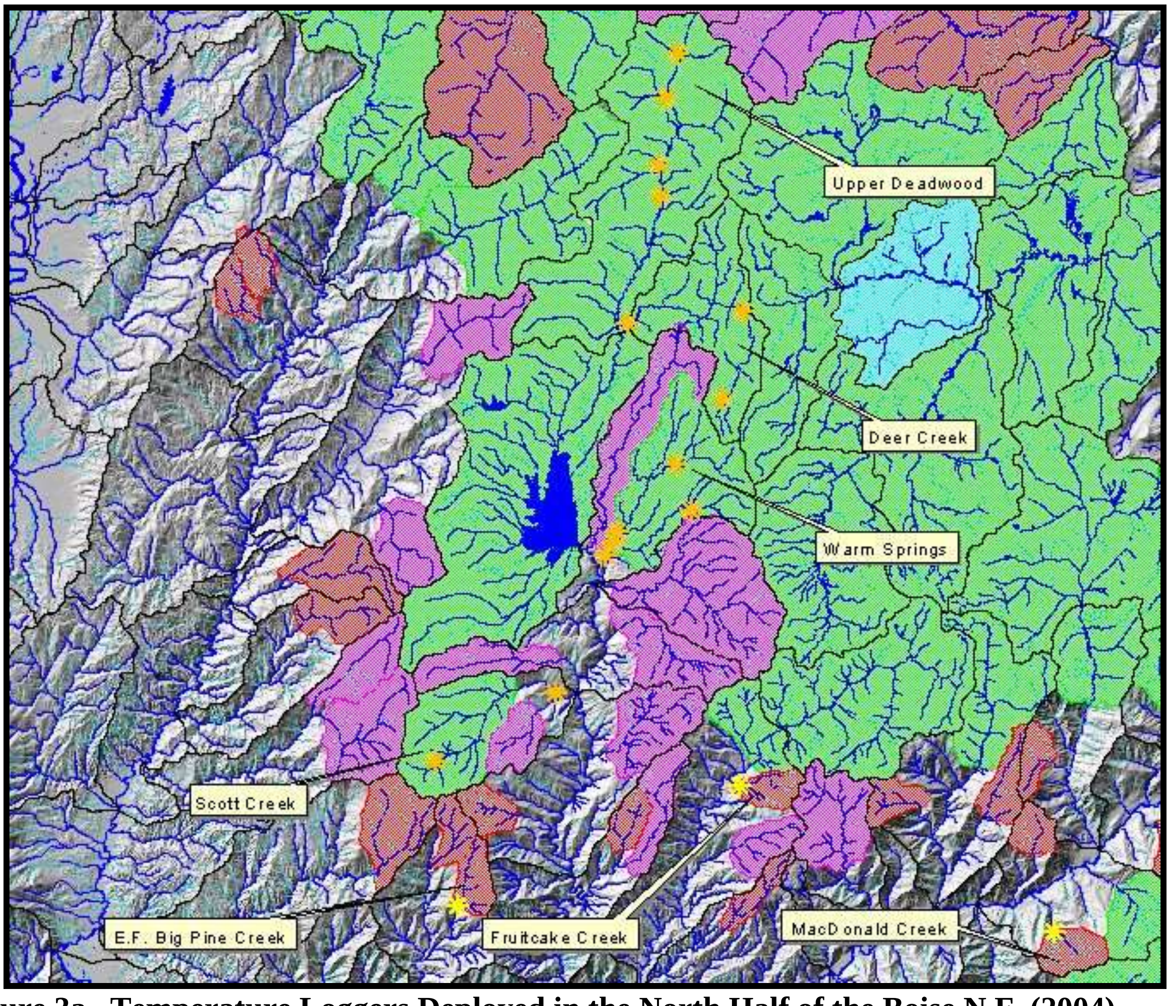

Figure 3a. Temperature Loggers Deployed in the North Half of the Boise N.F. (2004).

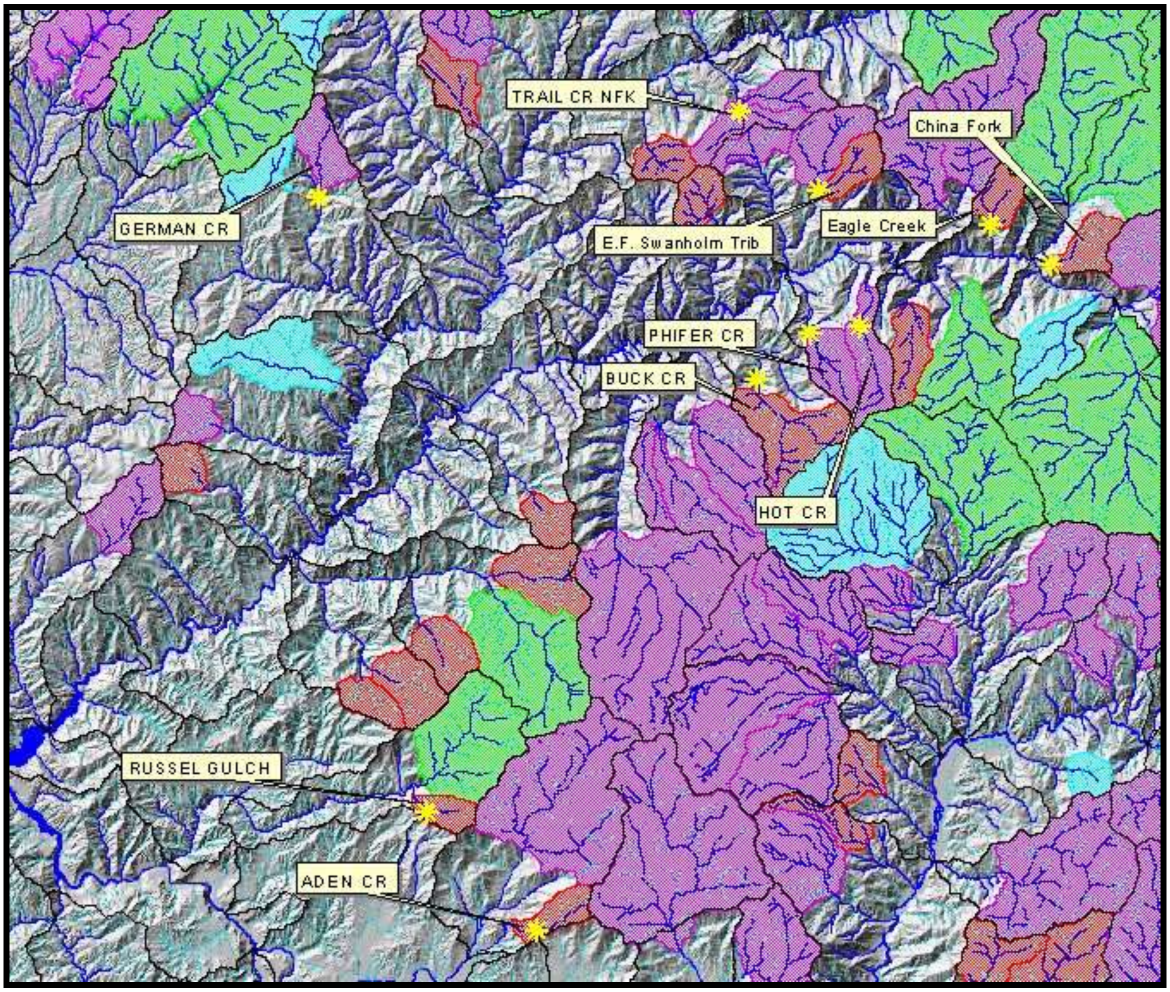

Figure 3b. Temperature Loggers Deployed in the South Half of the Boise N.F. (2004).

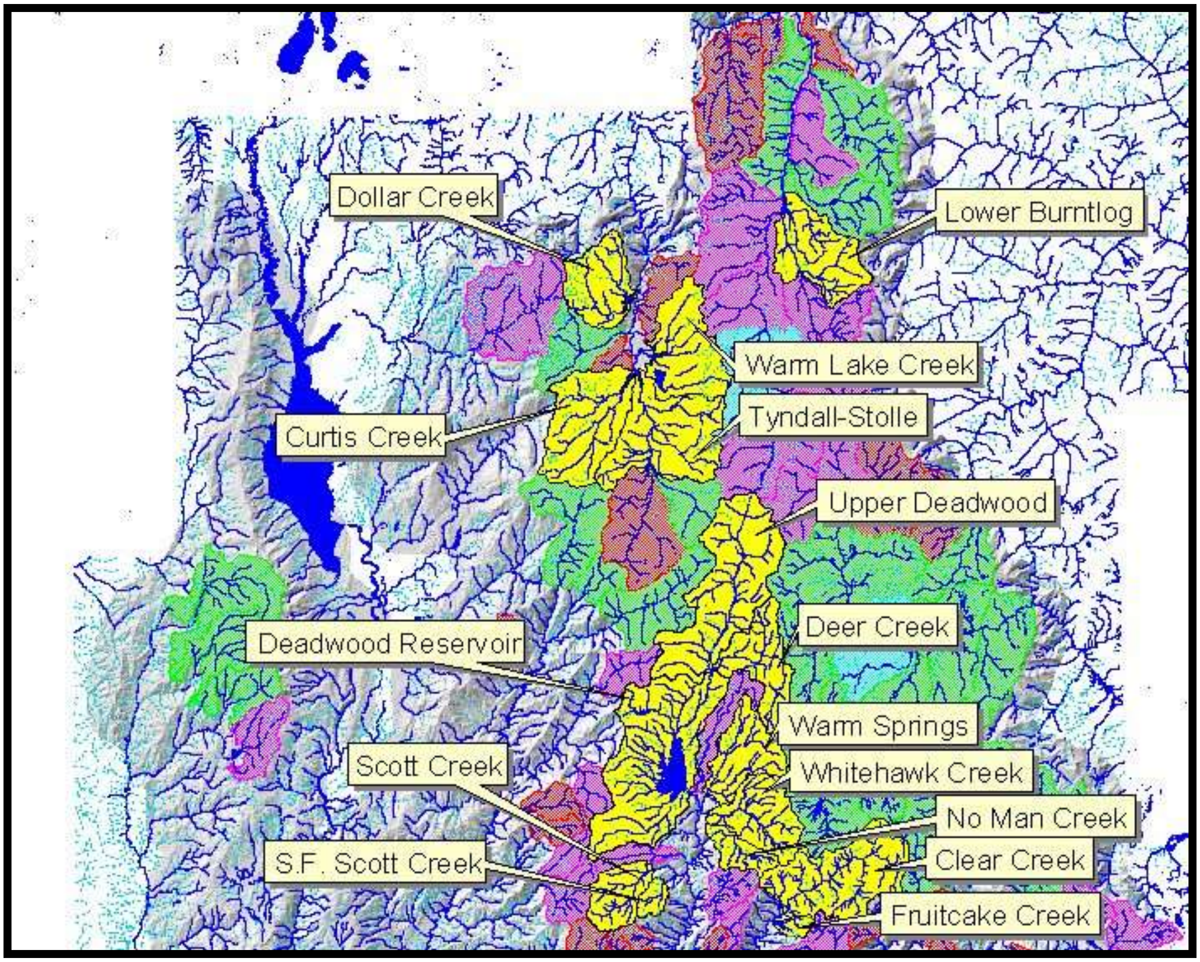

Figure 4a. Bull Trout Patches Sampled on the Boise N.F. during 2004 – North Half

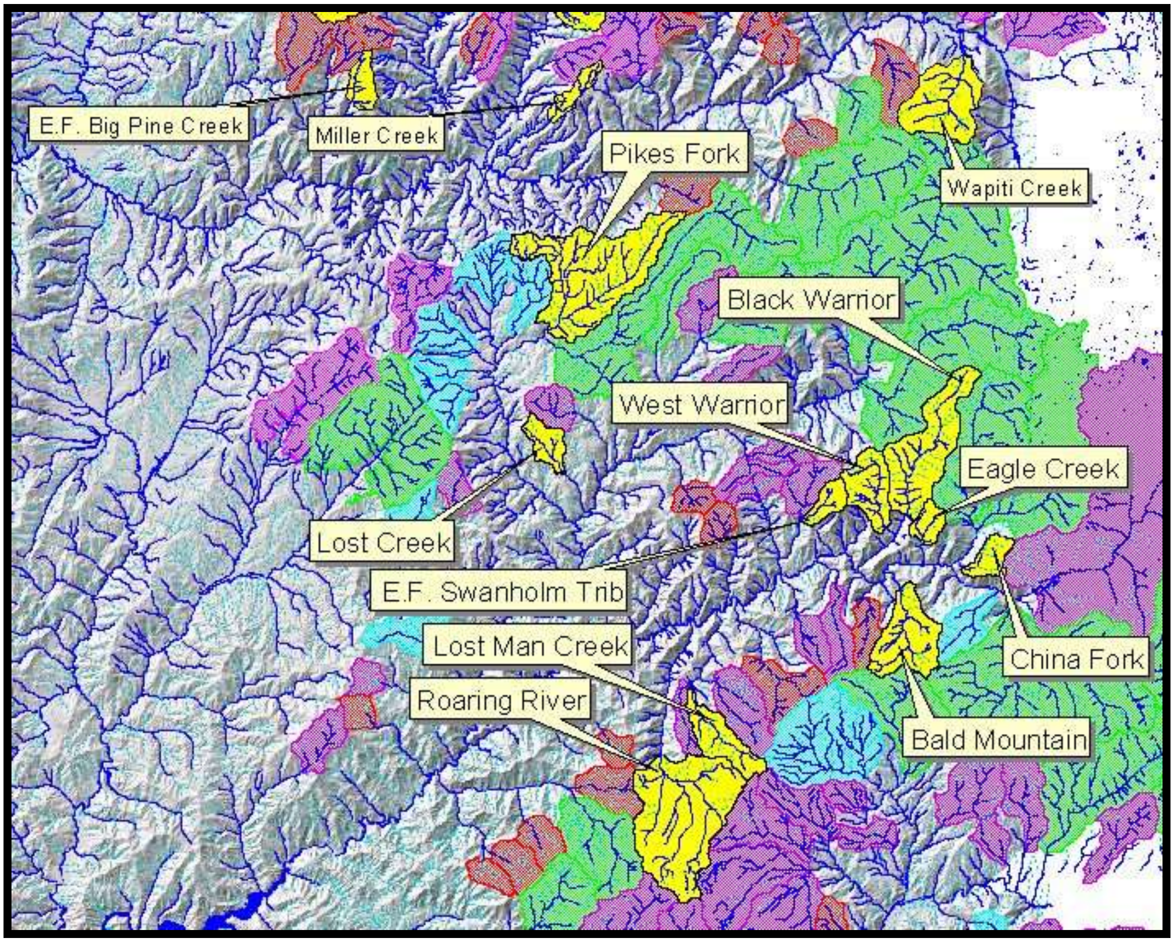

Figure 4b. Bull Trout Patches Sampled on the Boise N.F. during 2004 – South Half

Table 2. Summary of results from 2004 aquatic MIS sampling on the Boise N.F.

Subbasin	Patch Name	Category (2003)	Patch Size (ha)	Sampling Method (#of sites)	Bull Trout Detected	Probability of Detection*	# Sites where Bull Trout < 150mm were found	Electrofish Site when Bull Trout were First Detected	Electrofish Pass when Bull Trout were First Dectected
N.F. M.F. Boise	Pikes Fork	2	5194	3-pass (4)	No		0	NA	NA
N.F. M.F. Boise	Black Warrior	2	3103	3-pass (4)	Yes	NA	2	3	2
N.F. M.F. Boise	Lost Creek	4	719	3-pass (2)	No		0	NA	NA
N.F. M.F. Boise	West Warrior	2	1357	3-pass (1)	No		0	NA	NA
N.F. M.F. Boise	E.F. Swanholm Trib	4	553	3-pass (2)	No		0	NA	NA
N.F. M.F. Boise	Eagle Creek	4	522	3-pass (4)	No		0	NA	NA
N.F. M.F. Boise	China Fork	4	631	3-pass (2)	No		0	NA	NA
N.F. M.F. Boise	Bald Mountain	1	2058	3-pass (4)	No		0	NA	NA
N.F. M.F. Boise	Lost Man Creek	2	1355	3-pass (4)	No		0	NA	NA
N.F. M.F. Boise	Roaring River	2	5482	3-pass (8)	Yes	NA	3	2	1
S.F. Salmon	Lower Burntlog	2	5611	3-pass (1)	Yes	NA	1	1	1
S.F. Salmon	Dollar Creek	2	4178	3-pass (2)	Yes	NA	1	1	1
S.F. Salmon	Warm Lake	2	5866	3-pass (1)	Yes	NA	1	1	2
S.F. Salmon	Curtis Creek	2	7015	3-pass (3)	Yes	NA	1	3	1
S.F. Salmon	Tyndall-Stolle	2	8038	3-pass (4)	Yes	NA	3	1	1
S.F. Payette	Upper Deadwood	1	10848	3-pass (4)	Yes	NA	1	1	1
S.F. Payette	Deer Creek	1	4349	3-pass (7)	Yes	NA	4	1	1
S.F. Payette	Deadwood Reservoir	1	13044	3-pass (6)	Yes	NA	2	1	1
S.F. Payette	Warm Springs	1	4270	3-pass (3)	Yes	NA	2	1	1
S.F. Payette	Whitehawk Creek	2	4393	3-pass (2)	No		0	NA	NA
S.F. Payette	Clear Creek	1	8061	3-pass (1)	Yes	NA	1	1	1
S.F. Payette	No Man Creek	2	1678	3-pass (2)	No		0	NA	NA
S.F. Payette	Scott Creek	1	2876	3-pass (5)	Yes	NA	5	1	1
S.F. Payette	S.F. Scott Creek	2	784	3-pass (1)	Yes	NA	1	1	1
S.F. Payette	Fruitcake Creek	4	556	3-pass (3)	No		0	NA	NA
S.F. Payette	E.F. Big Pine Creek	4	624	3-pass (3)	No		0	NA	NA
S.F. Payette	Wapiti Creek	2	2470	3-pass (1)	Yes	NA	1	1	2
S.F. Payette	Miller Creek	4	527	3-pass (3)	No		0	NA	NA

Note: Probability of detection calculated from Petersen et al. (2002). * Probabilities of detection were calculated only when bull trout were not found. ** Based on spot temperature measurements.

Table 3. Fish species detected during 2004 MIS sampling on the Boise N.F.

		Species Observed												
Subbasin	**Patch**	**BLT**	**BKT**	**BLTxBKT**	**RBT**	**CCT**	**RBTxCCT**	**SCP**	**MWF**	**NPM**	**LND**	**LSS**	**CHS**	**RSS**
S.F. Payette	Trail	+	+	+	+		+	+						
S.F. Payette	Baron	+	+	+	+	+			+					
Upper Salmon	Germainia	+			+									
S.F. Boise	Big Peak	+			+			+						
S.F. Boise	Boardman	+			+			+						
S.F. Boise	Skeleton	+			+			+						
S.F. Payette	Goat	-	+		+	+								
Upper Salmon	Yellow Belly	-	+		+	+				+	+	+	+	+
Upper Salmon	Rough	-	+			+		+						
Upper Salmon	Holman	-			+	+								
Upper Salmon	French	-				+								
Upper Salmon	Wickiup	-				+								
S.F. Boise	Beaver	-			+									
S.F. Boise	Bowns	-	+		+									
S.F. Boise	Skillern	-			+			+						

Note: BLT = bull trout, BKT = brook trout, BLTxBKT = bull trout / brook trout hybrid, RBT = redband/rainbow trout, CCT = cutthroat trout, RBTxCCT = redband / cutthroat hybrid, SCP = sculpin, MWF = mountain whitefish, NPM = northern pikeminnow, LND = long-nosed dace, LSS = large scale sucker, CHS = Chinook salmon, RSS = redsided shiner.

Table 4. Number of bull trout patches on the Boise National Forest and the number surveyed in 2004 within each subbasin by category. The percent of patches that have been surveyed are displayed in parentheses.

Category	**S.F. Boise Subbasin**		**N.F. and M.F. Boise Subbasin**		**S.F. Payette Subbasin**		**Upper Salmon Subbasin**		**Total**	
	Patches	Surveyed	Patches	Surveyed	Patches	Surveyed	Patches	Surveyed	Patches	Surveyed
1	11	2 (18%)	4	0	0	0	6	1 (17%)	21	3 (14%)
2	22	4 (18%)	1	0	4	3 (75%)	28	4 (14%)	54	11 (20%)
3	11	0	0	0	0	0	3	0	14	0
4	0	0	0	0	0	0	8	1 (13%)	8	1 (13%)
Total	44	6 (14%)	5	0	4	3 (75%)	45	6 (13%)	98	15 (15%)