2006 Boise NF Aquatic Management Indicator Species Monitoring Report

Adfluvial bull trout and kokanee salmon in Trail Creek – Deadwood Reservoir tributary.

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 (11th 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 population 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. 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 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 at 1600m in elevation.

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 <u>will</u> support a bull trout population, but they have not been detected or patches where bull trout have been detected, but observations are older than 7 years; (3) patches that have been surveyed and baseline conditions (i.e., stream temperature, etc.) likely will <u>not</u> 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.

Based on the 2005 update, there are 178 bull trout patches that occur within three basins (nine subbasins) on the Boise National Forest; 56 patches in category 1; 64 patches in category 2; 17 patches in category 3; and 41 unsurveyed patches in category 4 (Tables 1a & 1b).

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 periods). 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.

Patch Sampling Frequency

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).

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

Informal surveys will be done in all strata 1 patches where bull trout have been found in the past; if bull trout are not found, formal surveys will be done. 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 formal sampling will consist of a 100m double-pass transect 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

MIS monitoring for bull trout on the Boise N.F. occurred in 27 patches in 2006 (Figure 4 and Table 1). Bull trout were detected in 14 out of the 27 patches surveyed. For the 13 patches sampled in 2006 where no bull trout were captured, probability of patch occupancy ranged from 6-33%. The probability of detection calculations do not include sites where no fish were detected above natural barriers. The probability of detection estimates are based on equations from Peterson et. al. (2002) and observed detection rates from 101 single-pass electrofishing sites and 76 multiple-pass electrofishing sites sampled on the Boise N.F. during 2004-2006 (Table 2).

N.F./M.F. Boise subbasin

In the N.F./M.F. Boise subbasin, seven patches (Deadman, E.F. Swanholm, Bear River, Upper N.F. Boise River, Beaver Creek, Edna Creek, and Little Beaver Creek) in categories 1, 2 and 3 were surveyed. No juvenile bull trout were observed in these seven patches. One adult bull trout >150mm was found in Bear River, but not juveniles. Juvenile bull trout had previously been detected in Bear River and the Upper N. F. Boise River in 2002. Juvenile bull trout were detected in the Upper N. F. Boise River in 2005. However, the 2006 field season marked the second consecutive year that no juvenile bull trout were detected in Bear River.

The Boise N.F. Fisheries database has no record of juvenile bull trout detections in Deadman, E.F. Swanholm, Beaver Creek, Edna Creek, or Little Beaver Creek. During the 2006 field season, one site was sampled in Big Silver Creek (Upper N. F. Boise River patch) and two sites were sampled in the Deadman Creek patch. Based on these efforts, there is a 33% probability of undetected bull trout occupancy in the Upper N. F. Boise River patch and a 19% probability of undetected bull trout occupancy in the Deadman patch. It should be noted that juvenile bull trout were detected at six sites in the Upper N. F. Boise River patch during 2005, although none were detected at any of the three sites sampled in Big Silver Creek that year.   E.F. Swanholm, Beaver Creek, and Edna Creek each had three sites sampled during 2006. Based on this level of sampling, there is an estimated 10.5% probability of undetected bull trout occupancy in each. Little Beaver Creek and Bear River each had four sites sampled during 2006. Based on this level of sampling, there is an estimated 5.5% probability of undetected bull trout occupancy in each.

S.F. Boise subbasin

None of the patches in the S.F. Boise subbasin were surveyed in 2006. Three single-pass electrofishing sites were surveyed downstream of the Rattlesnake Creek patch, but all were less than 1600 meters in elevation and no bull trout were detected. Juvenile bull trout were last detected in the Rattlesnake Creek patch in 1999. Given there have been no juvenile bull trout detections in the last seven years, the classification (stratum) of the Rattlesnake Creek patch will be changed from strata 1 (occupied) to strata 2 (suitable, but unoccupied).

S.F. Payette subbasin

During 2006, four bull trout patches were sampled in the S.F. Payette subbasin (Deer, Eightmile, Canyon, Rock, and Scott). Bull trout were found in four of these patches using single-pass electrofishing (Deer, Eightmile, Canyon, and Scott). Crews from the Boise N.F. and/or Bureau of Reclamation had previously detected bull trout in all four of these patches. No bull trout were detected in multiple-pass electrofishing conducted at three sites on Rock Creek. This category 2 patch had previous surveys, none of which detected bull trout. Based on this level of sampling, there is an estimated 10.5% probability of undetected bull trout occupancy in Rock Creek. This year's ratio of patches containing bull trout in the South Fork Payette subbasin is high, because sampling was done mostly in patches where bull trout were known to exist in order to get tissue samples (fin clips) for a genetics study.

M.F. Payette subbasin

Three patches were surveyed in the Middle Fork Payette subbasin in 2006 (Upper Middle Fork Payette, Bull Creek and Sixteen-to-One). Bull trout were found at each of seven single pass electrofishing sites in these patches. Bull trout have been found here in the past with the most

recent surveys done in 2005 in the Upper Middle Fork Payette patch and 2001 in the Bull Creek and Sixteen-to-One patches.

<div align="center">Mores Creek subbasin</div>

No patches were surveyed in the Mores Creek subbasin in 2006.

<div align="center">Middle Fork Salmon</div>

Four patches were surveyed in the Middle Fork Salmon subbasin in 2006 (Sulphur, Bearskin, Cache, and Wyoming). Juvenile bull trout were detected in three of these patches (Bearskin, Cache, and Wyoming). The Bearskin and Cache patches each had two sites sampled; one site was sampled in Wyoming Creek. Juvenile bull trout were detected at all but the lower Cache Creek site. The Bearskin and Wyoming Creek patches were last sampled in 1999. The Cache Creek patch was last sampled in 2002. The previous sampling efforts had detected juvenile bull trout in all three of these patches. No bull trout were detected in single-pass electrofishing conducted at two sites on Sulphur Creek. Based on this level of sampling, there is an estimated 14.9% probability of undetected bull trout occupancy in Sulphur Creek. This category 2 patch had one previous survey on record (1994); no bull trout were detected during the prior sampling effort.

<div align="center">South Fork Salmon</div>

Five patches were surveyed in the South Fork Salmon subbasin in 2006 (Riordan, Trapper, Wardenhoff, Upper Johnson and Upper Burntlog). Juvenile bull trout were detected in three of these patches (Riordan, Trapper, and Upper Burntlog). The Riordan and Trapper Creek patches were last sampled in 1998. The Upper Burntlog patch was last sampled in 1992. The previous sampling efforts had detected juvenile bull trout in Riordan and Trapper Creek, but not in Upper Burntlog. No bull trout were detected in single-pass electrofishing conducted at two sites on Upper Johnson Creek and one site on Wardenhoff Creek. Based on this level of sampling, there is an estimated 14.9% and 29.6% probability of undetected bull trout occupancy in Upper Johnson Creek and Wardenhoff Creek, respectively. Upper Johnson Creek is a category 2 patch with two previous surveys on record (1994); no bull trout were detected during the prior sampling efforts. Numerous brook trout were detected in Johnson Creek during the 2006 sampling effort. Wardenhoff Creek is a category 4 patch (no prior sampling effort). Although no bull trout were detected, the 2006 sampling effort did capture several juvenile *O. mykiss*. However, the MIS survey crew located a natural high-gradient barrier immediately upstream of the 2006 sample site that may prevent fish passage to all but the lowermost 500 meters of Wardenhoff Creek.

Bull Trout Detection

Juvenile bull trout (<150mm) were detected in 14 of the 27 patches sampled on the Boise National Forest in 2006.   Juvenile bull trout were detected at the first sample site in 13 of these 14 patches. In one patch (Cache Creek), juvenile bull trout were not detected until the second electrofishing site. At all sites where juvenile bull trout were detected, they were observed during the first electrofishing pass 24 out of 24 times (Table 2).

<div align="center">9</div>

In 5 of the 14 patches where juvenile bull trout were detected in 2006, the field crew discontinued electrofishing after completing the first site. However, multiple sites (n=20) were electrofished in 9 of the 14 patches that had at least one juvenile bull trout detection in 2006. Although juvenile bull trout were confirmed present in these 9 patches, none were detected at 5% (n=1) of the sites. Cache Creek was the only one of these 9 patches where bull trout were detected at all [2] sites that were sampled. This indicates that bull trout were well distributed within occupied patches. The electrofishing results and spatial distribution of sample sites within these 9 patches indicate that juvenile bull trout were detected in greater abundance at higher elevations within patches (Figure 1).
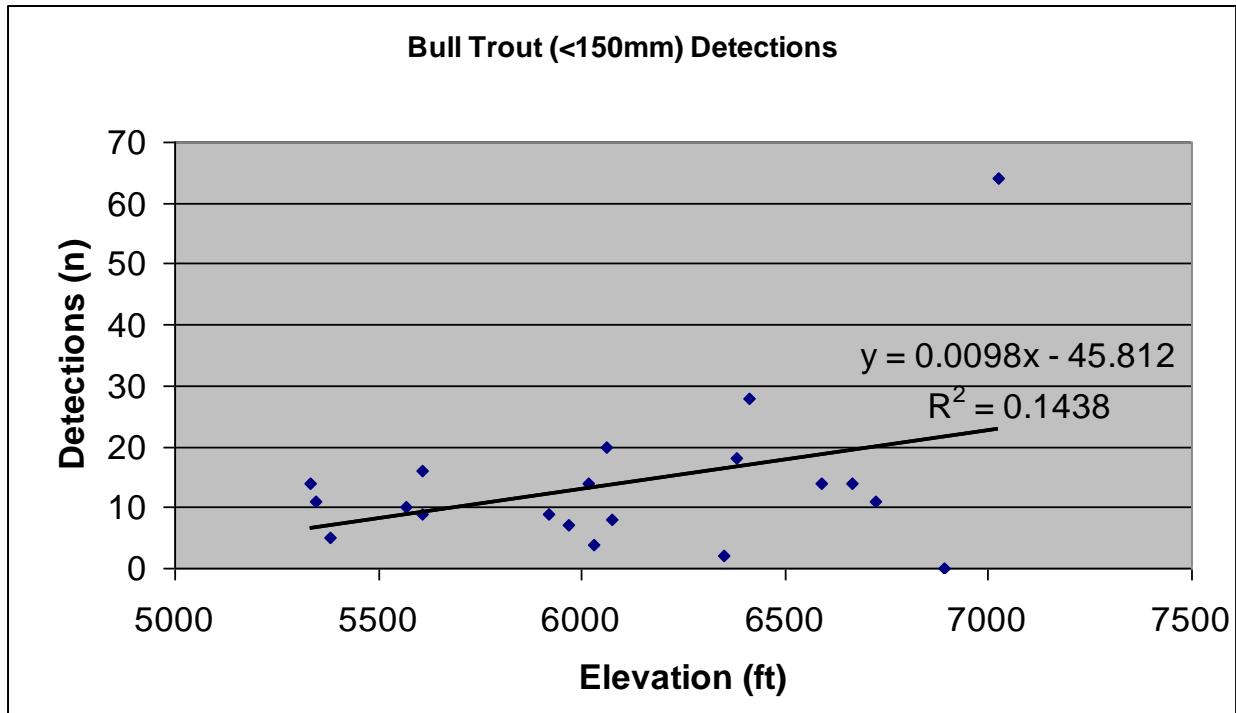
Bull Trout (<150mm) Detections

$y = 0.0098x - 45.812$

$R^2 = 0.1438$

Figure 1.   Bull trout detections by elevation for occupied patches with multiple sample sites in 2006.

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 2006, the Boise N.F. crew deployed 32 temperature loggers in 25 patches on the Boise N.F. Only 30 were retrieved this fall, one was lost and 2 were not accessible due to forest fires (Figures 5a-b). 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 (June) 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. Dunham (2003) found that the probability of bull trout occurrence was relatively high (>0.50) in streams with a maximum daily maximum temperature (MDMT, the warmest daily water temperature recorded during a given year or survey) <14-16° C.

Bull trout were detected in two of the patches where temperature loggers were deployed during the 2006 season, Trapper Creek and upper Burntlog Creek. These two occupied bull trout streams had MDMTs of 14.3°C and16.0°C, and MWMTs of 13.8°C and15.7°C at the lowest elevation within each patch (Figure 3a).

Temperature loggers were deployed at the lowest elevation in the patch (usually 1600m) and at other various elevations within certain patches. In addition to Trapper Creek and upper Burntlog Creek (discussed above), one other strata 1 patch (Wapiti Creek) had a temperature logger deployed in 2006. The Wapiti Creek MDMT was 14.7°C and the MWMT was 14.2°C (Figure 3b). Temperature loggers were also deployed in thirteen strata 2 patches (Rock, Cayuse, Whiskeyjack, EF Swanholm, Big Owl, Rocky, Elk, Fivemile, NF Dollar, Cabin, Warm Lake, Sheep and Sulphur), six strata 3 patches (Fall, Meadow, NF Rabbit, Grimes, Little Beaver, and Edna), and two strata 4 patches (Hayfork and Boundary). The summary data from these sites are presented in Figures 3a-d.

Based on 2005 water temperature monitoring at the lowest elevation (6,388 feet) on Cook Creek, this occupied bull trout patch had a MDMT of 20.5 and a MWMT of 19.5. Bull trout were found in this patch in the immediate vicinity of an unnamed tributary in 2005 (elevation 6,700 feet). These observations indicated that this unnamed tributary may provide a cold water refuge (microsite) within an otherwise warm habitat patch. Three temperature loggers were deployed in 2006 to evaluate the influence of this unnamed Cook Creek tributary. As shown in Figure 2, the MWMT of the unnamed tributary was approximately 5°C colder than the mainstem of Cook Creek 10 meters upstream and downstream from the confluence.
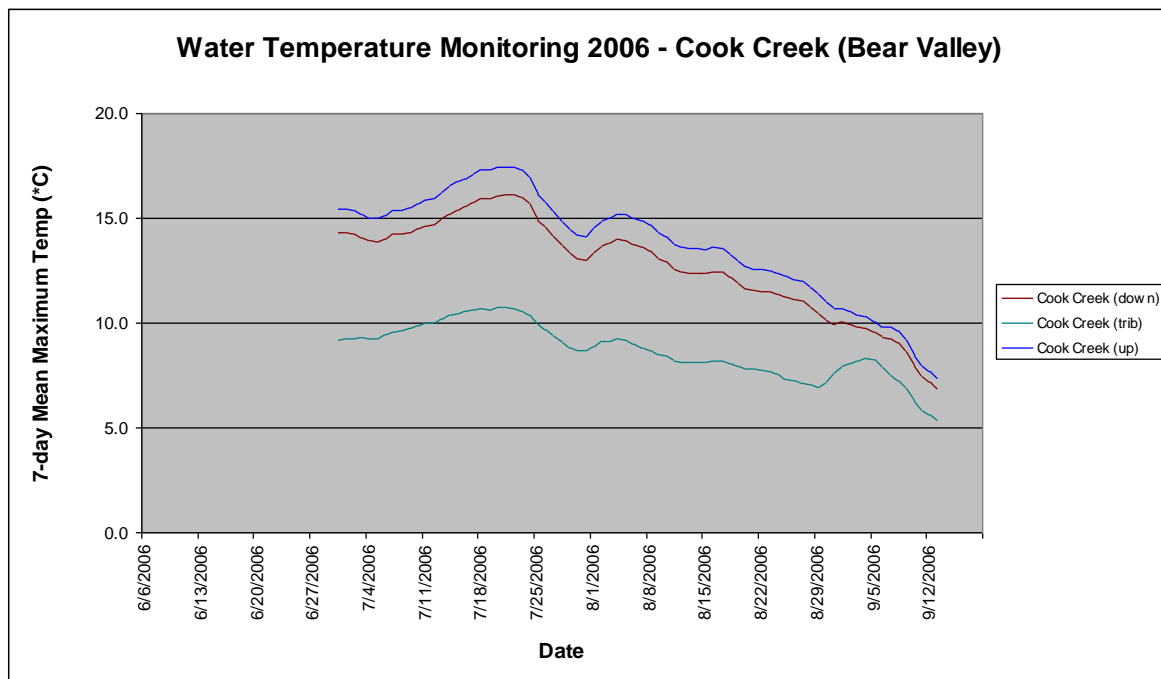
Figure 2. Water temperature monitoring results (MWMT) from Cook Creek – 2006.

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Figure 3a. 7-day average maximum water temperatures monitored in Salmon River patches in 2006.

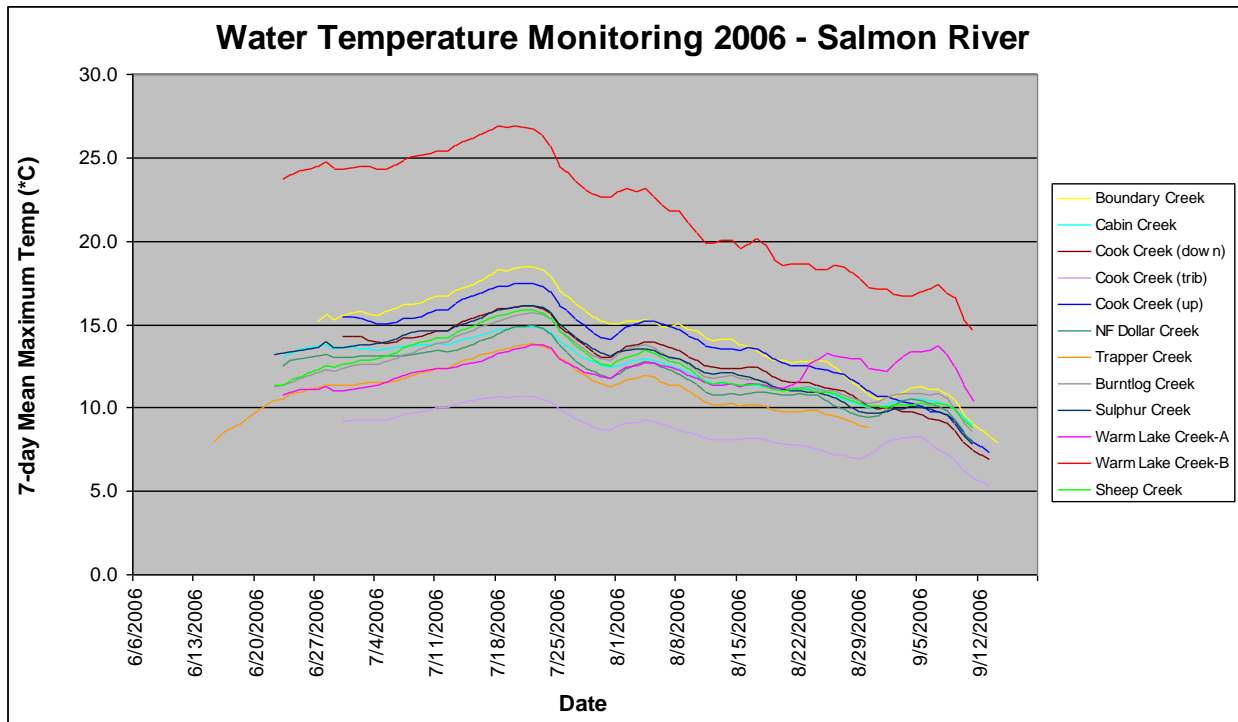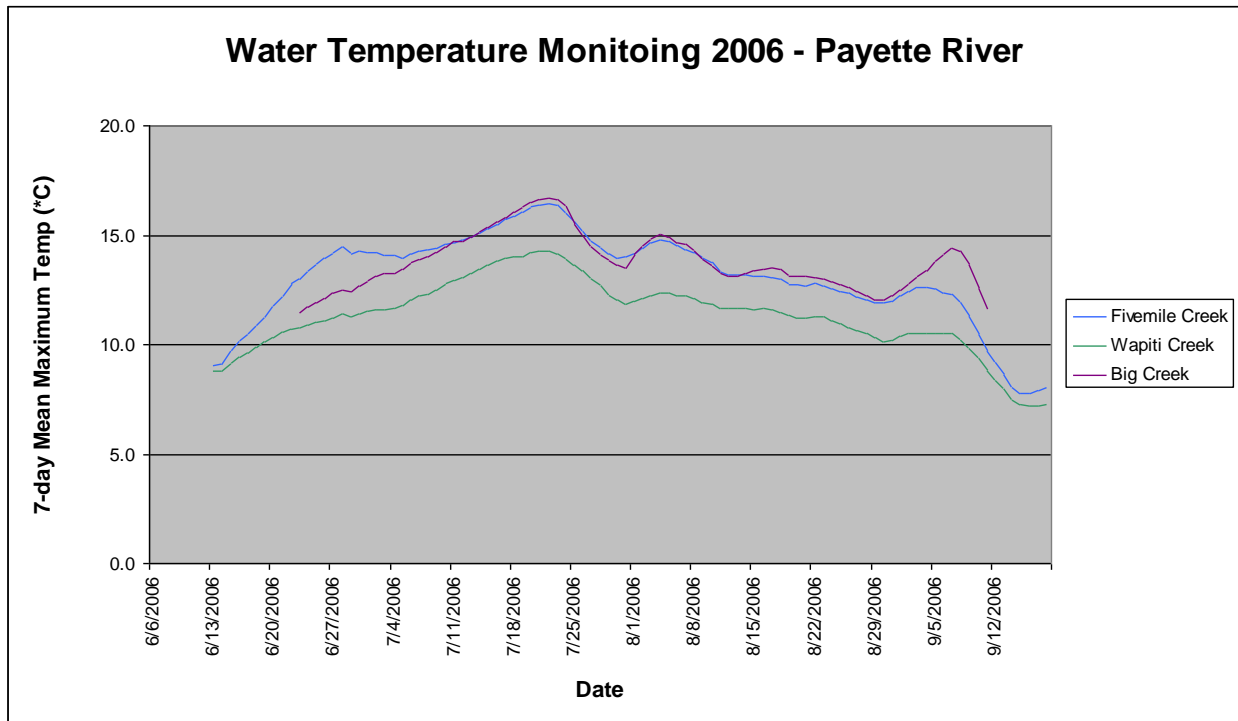**Figure 3b. 7-day average maximum water temperatures monitored in Payette River patches in 2006.**
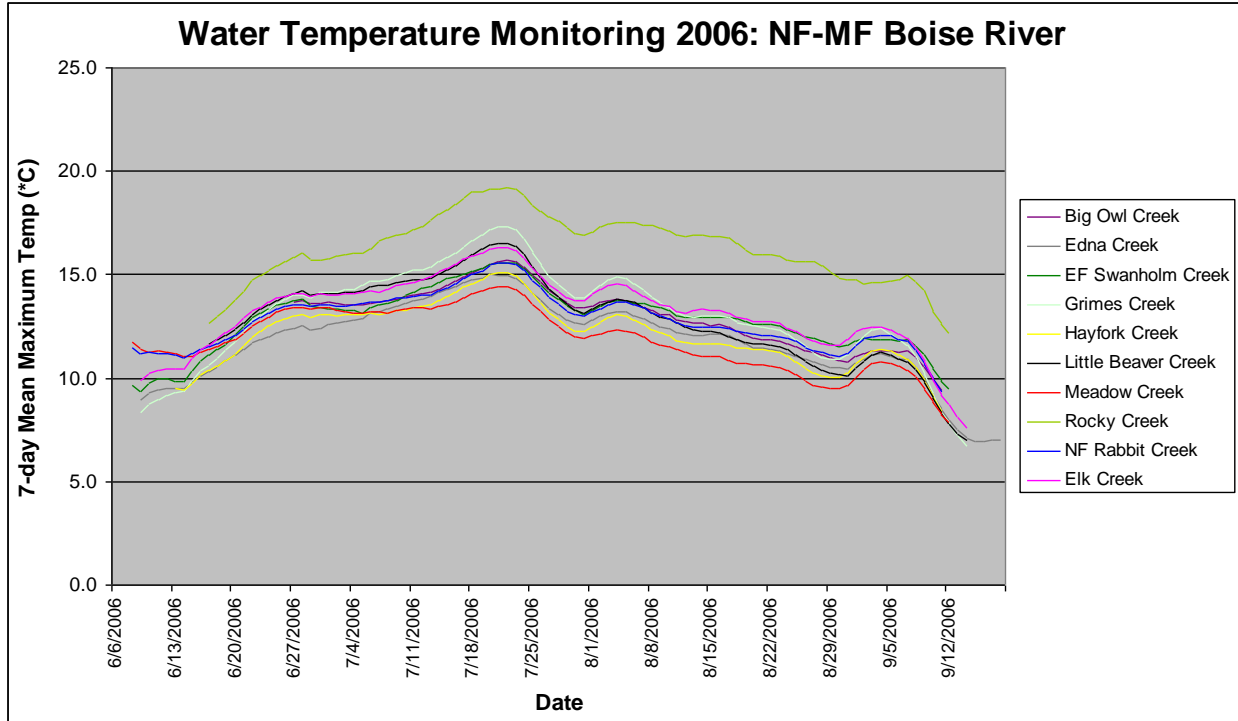
Figure 3c. 7-day average maximum water temperatures monitored in NF-MF Boise River patches in 2006.
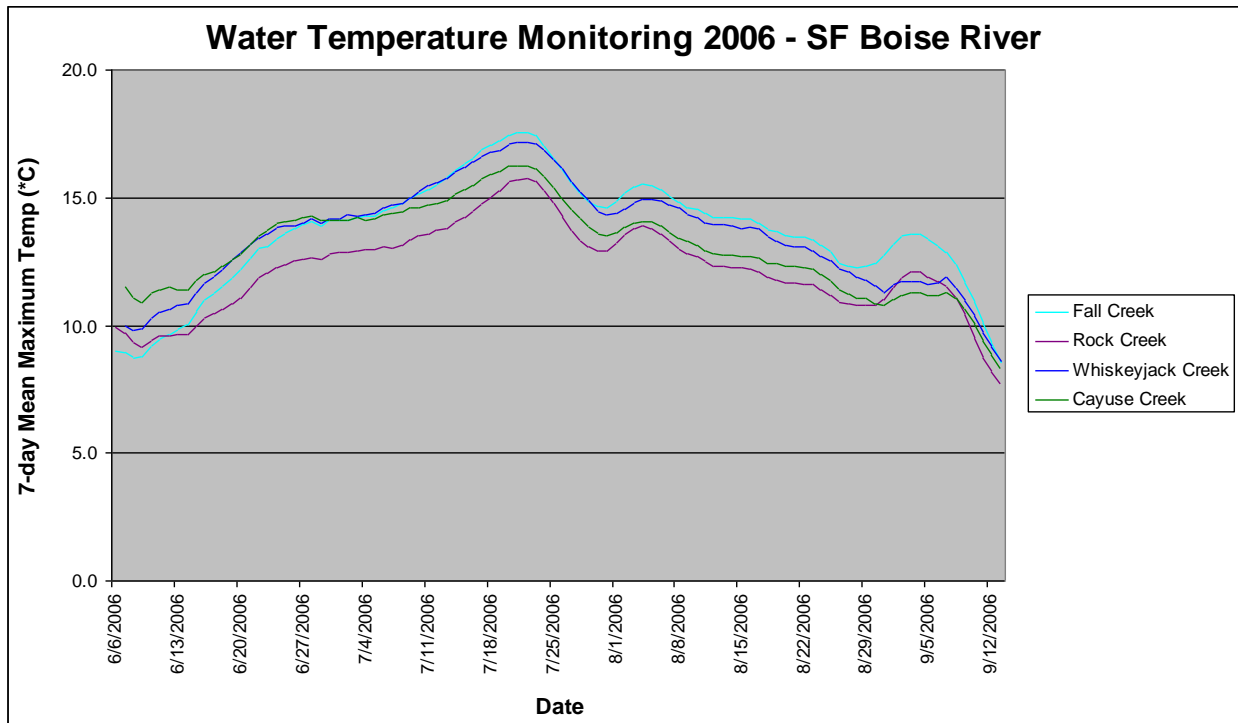

Figure 3d. 7-day average maximum water temperatures monitored in SF Boise River patches in 2006.

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 2006 patches, temperature appeared to be suitable for bull trout even though no bull trout were detected during summer sampling. 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 associations between bull trout occurrence and stream temperature can be better defined.

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 2006 contained barriers that could influence the presence or persistence of bull trout. Identified culvert barriers block access to Rock SFP, Edna, and Little Beaver, and no bull trout were detected in these patches. However, juvenile bull trout were detected in portions of four patches upstream of identified culvert barriers: Bearskin, NF Deer, NF Canyon, and Scott Creek. One natural barrier (waterfall) was also found in the Wardenhoff patch during surveys this year.

Barriers can also occur as a result of thermal difference between stream sections. A thermal barriers (>20ºC) was verified in Warm Lake Creek through water temperature monitoring in 2006. 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 detected a variety of game and non-game species across the Boise N.F. (Table 3) including brook trout (*Salvelinus fontinalis*), a species known to hybridize with bull trout (Markle 1992, Leary et al. 1993). During the 2006 sampling season, three patches were found to have both bull trout and brook trout (Cache, Bearskin, and Wyoming) and four patches were found to support brook trout but no bull trout (Beaver, Little Beaver, Edna, and Johnson). Bull trout / brook trout hybrids were not phenotypically confirmed, but fin clips were taken for DNA verification. DNA studies have been done in the past by the USBR showing a high percentage (29%) of bull trout were actually hybrids in Bear Creek (Whiteley et al. 2003). 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).

Strata Changes
The strata of four patches changed as a result of sampling in 2006. Wardenhoff Creek changed from strata 4 to strata 3 because of a natural barrier (waterfall). Rocky Creek changed

from stratum 2 to 3, due to high temperatures. Upper Johnson Creek changed from stratum 2 to stratum 3, due to allopatric brook trout. Juvenile bull trout were found in 1 patch where they had not previously been detected. As a result, Upper Burntlog Creek was changed from strata 2 to strata 1.

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.

Whiteley, A. R., P. Spruell, and F. W. Allendorf. 2003 Population Genetics of Boise Basin Bull Trout (*Salvlinus confluentus).* Final Report to United States Bureau of Reclamation Contract 1425-01FG107420.
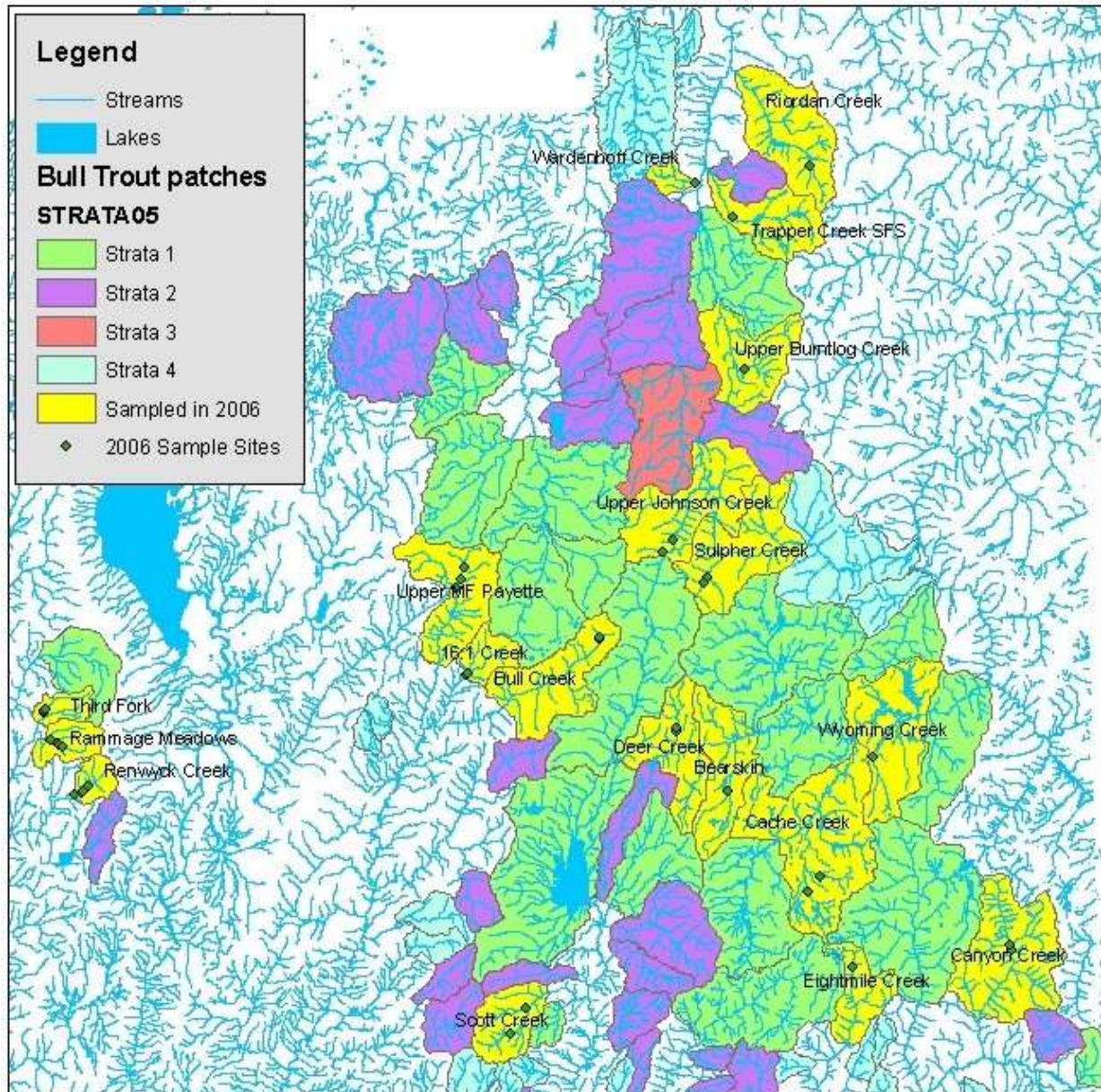
Figure 4a. Bull Trout Patches Sampled on the Boise N.F. in 2006 – North Half
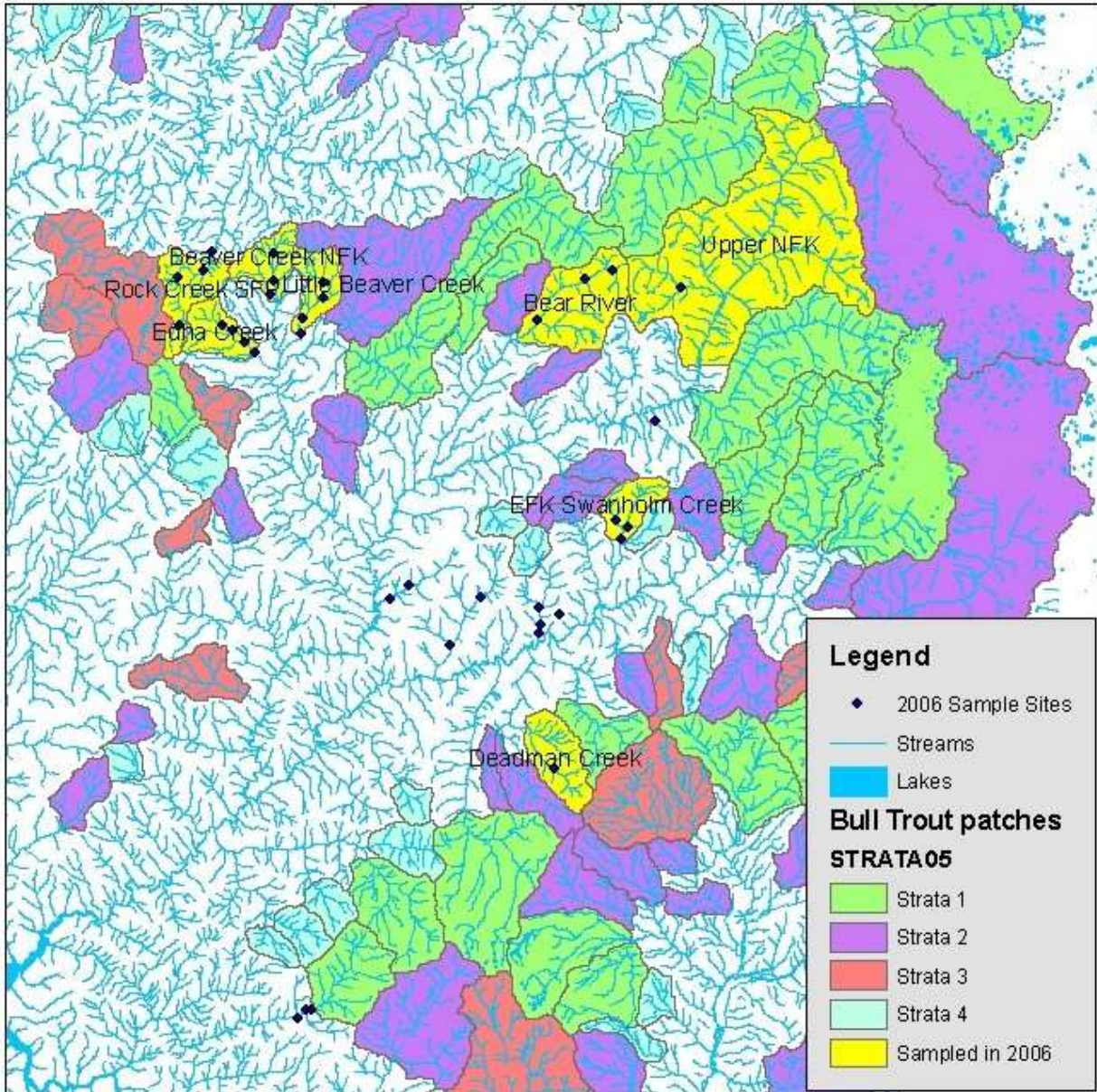
Figure 4b. Bull Trout Patches Sampled on the Boise N.F. in 2006 – South Half
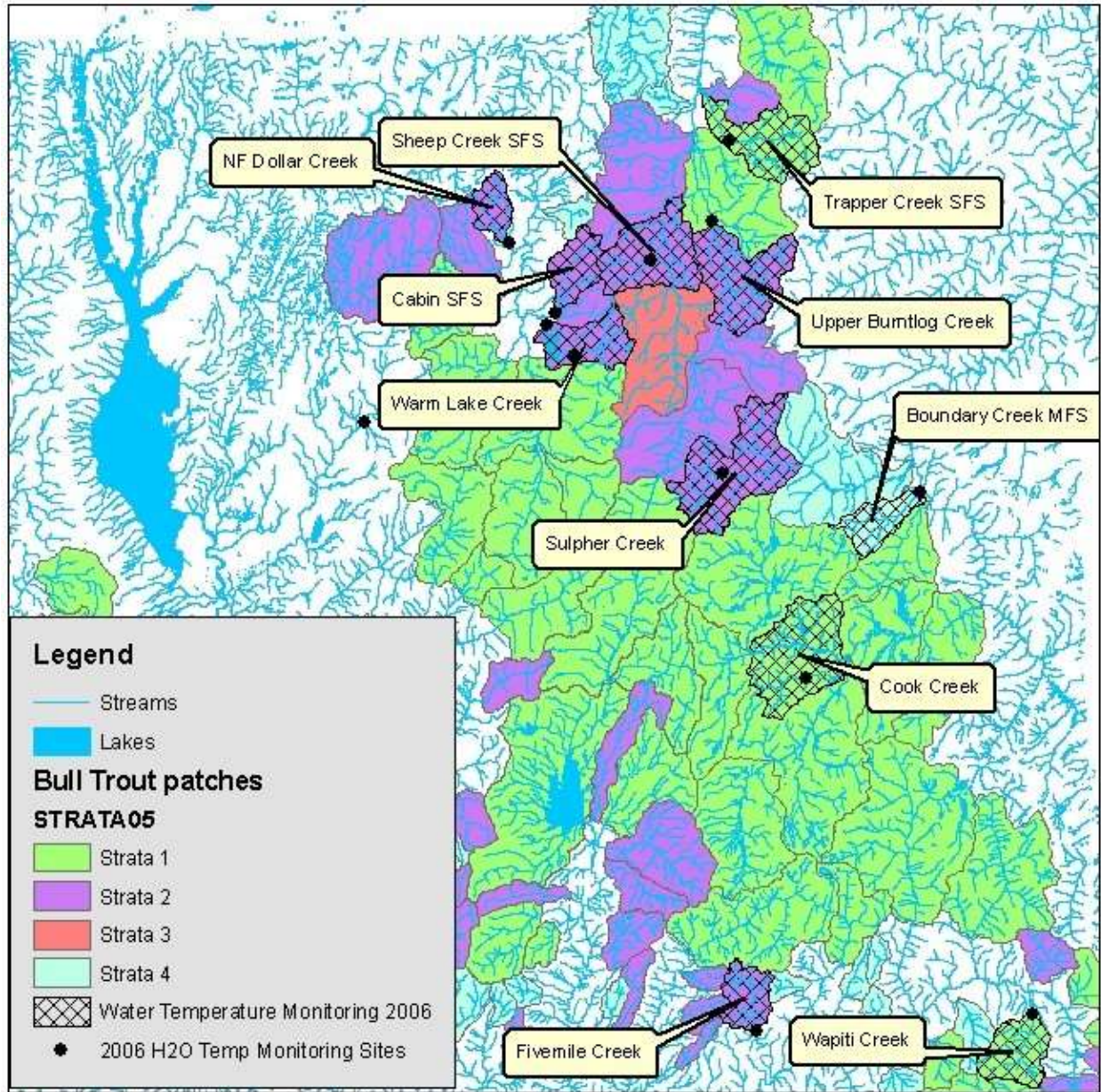
Figure 5a. Bull Trout Patch Water Temperature Monitoring 2006
Boise N.F. – North Half

Legend

— Streams
▪ Lakes

Bull Trout patches
STRATA05

▪ Strata 1
▪ Strata 2
▪ Strata 3
▪ Strata 4
▨ Water Temperature Monitoring 2006
● 2006 H2O Temp Monitoring Sites

NF Dollar Creek
Sheep Creek SFS
Trapper Creek SFS
Cabin SFS
Upper Burntlog Creek
Warm Lake Creek
Boundary Creek MFS
Sulpher Creek
Cook Creek
Fivemile Creek
Wapiti Creek

Figure 5b. Bull Trout Patch Water Temperature Monitoring 2006
Boise N.F. – South Half

Table 1a. Number of bull trout patches on the Boise National Forest within each basin by category based on 2005 update.

Strata	Boise Basin		Payette Basin		Salmon Basin		Forest Total	
	Patches	Surveyed	Patches	Surveyed	Patches	Surveyed	Patches	Surveyed
1	17	2 (12%)	22	10 (45%)	17	6 (35%)	56	18 (32%)
2	31	2 (7%)	21	1 (5%)	12	3 (25%)	64	6 (9%)
3	16	3 (19%)	0	0	1	0	17	3 (18%)
4	21	0	15	0	5	0	41	0
Total	**85**	7 (9%)	**58**	11 (19%)	**35**	9 (26%)	**178**	27 (15%)

Table 1b. Number of bull trout patches on the Boise National Forest and the number surveyed in 2006 within each subbasin by strata. The percent of patches that have been surveyed are displayed in parentheses.

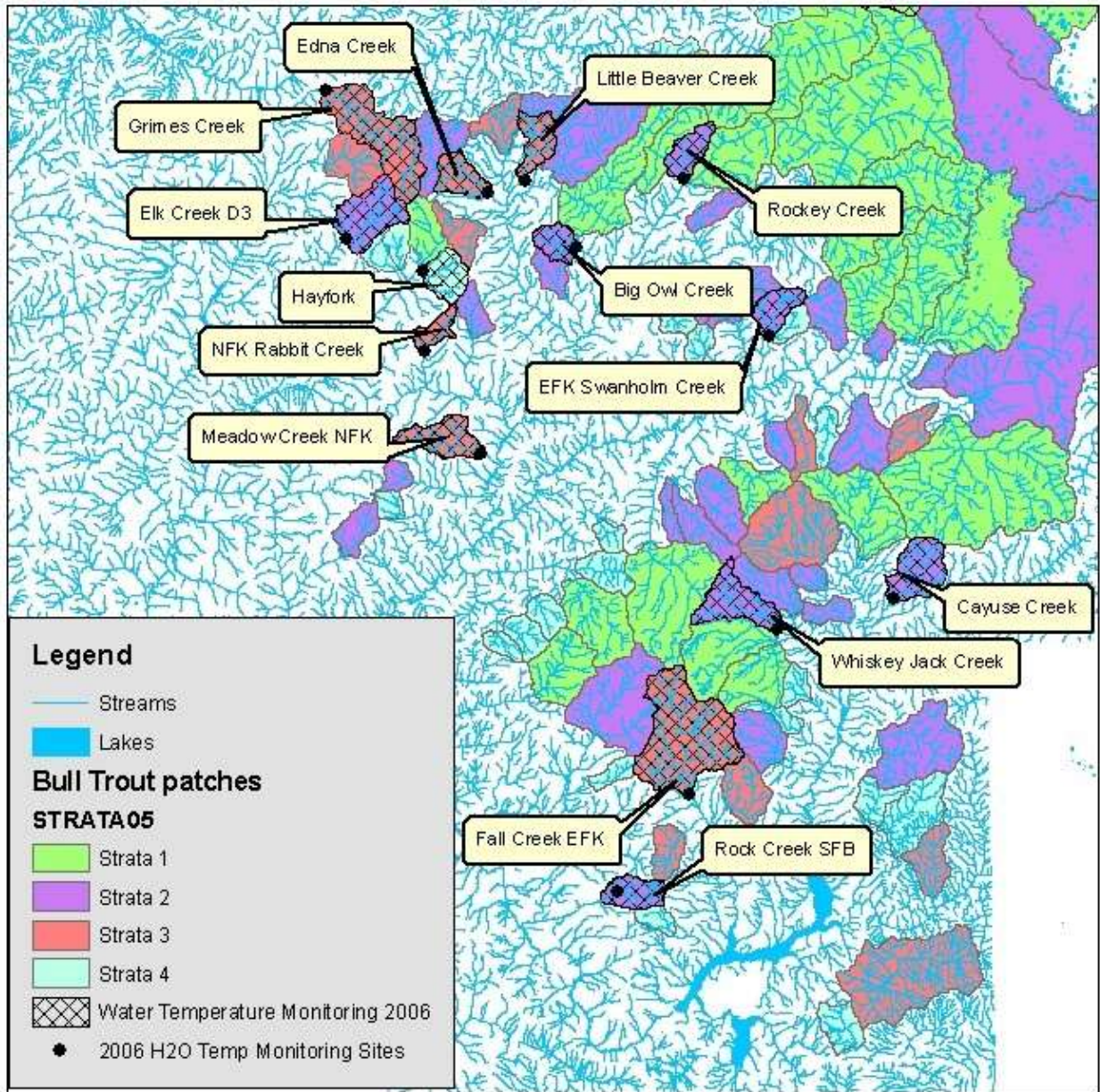| Strata	S.F. Boise Subbasin		N.F. and M.F. Boise Subbasin		Boise Mores Subbasin		Boise Basin Total	
	Patches	Surveyed	Patches	Surveyed	Patches	Surveyed	Patches	Surveyed
1	4	0	11	2 (18%)	2	0	17	2 (12%)
2	9	0	20	2 (10%)	2	0	31	2 (7%)
3	6	0	8	3 (38%)	2	0	16	3 (19%)
4	8	0	5	0	8	0	21	0
Total	**27**	0	**44**	7 (16%)	**14**	0	**85**	7 (8%)

Strata	S.F. Payette Subbasin		Middle Fork Payette Subbasin		Payette (Squaw Creek) Subbasin		North Fork Payette Subbasin		Payette Basin Total	
	Patches	Surveyed	Patches	Surveyed	Patches	Surveyed	Patches	Surveyed	Patches	Surveyed
1	15	4 (27%)	3	3 (100%)	4	3 (75%)	0	0	22	10 (45%)
2	15	1 (7%)	4	0	1	0	1	0	21	1 (5%)
3	0	0	0	0	0	0	0	0	0	0
4	10	0	5	0	0	0	0	0	15	0
Total	**40**	5 (13%)	**12**	3 (25%)	**5**	3 (60%)	**1**	0	**58**	11 (19%)

Strata	South Fork Salmon Subbasin		Middle Fork Salmon Subbasin		Salmon Basin Total	
	Patches	Surveyed	Patches	Surveyed	Patches	Surveyed
1	9	3 (33%)	8	3 (38%)	17	6 (35%)
2	11	2 (18%)	1	1 (100%)	12	3 (25%)
3	1	0	0	0	1	0
4	3	0	2	0	5	0
Total	**24**	5 (21%)	**11**	4 (36%)	**35**	9 (26%)

Table 2. Summary of results from 2006 aquatic MIS sampling on the Boise N.F.

Subbasin	Patch Name	Category (2005)	Patch Size (ha)	Sampling Method (#of sites)	Bull Trout Detected	Probability of Occupancy Given No Detection*	# Sites where Bull Trout < 150mm were found	Electrofish Site when Bull Trout were First Detected	Electrofish Pass when Bull Trout were First Detected
SFS	Riordan Creek	1	5792	Depletion	Yes	N/A	1	1	1
SFS	Wardenhoff Creek	4	696	1-pass	No	**	0	N/A	N/A
SFS	Trapper Creek SFS	1	3749	Depletion	Yes	N/A	1	1	1
SFS	Upper Burntlog Creek	2	4580	Depletion	Yes	N/A	1	1	1
SFS	Upper Johnson Creek	2	6209	1-pass	No	15%	0	N/A	N/A
MFS	Sulpher Creek	2	6131	1-pass	No	15%	0	N/A	N/A
MFS	Wyoming Creek	1	6653	Depletion	Yes	N/A	1	1	1
MFS	Bearskin	1	4549	Depletions	Yes	N/A	2	1	1
MFS	Cache Creek	1	10349	Depletion	Yes	N/A	1	2	1
PAY	Third Fork	1	1046	1-pass	Yes	N/A	3	1	1
PAY	Rammage Meadows	1	1596	Depletion	No	5.5%	0	N/A	N/A
PAY	Renwyck Creek	1	1072	Depletion	No	5.5%	0	N/A	N/A
SFP	Scott Creek	1	2876	1-pass	Yes	N/A	2	1	1
SFP	Deer Creek	1	4349	1-pass	Yes	N/A	2	1	1
SFP	Canyon Creek	1	7569	1-pass	Yes	N/A	2	1	1
SFP	Rock Creek SFP	2	1611	Depletion	No	10.5%	0	N/A	N/A
SFP	Eightmile Creek	1	2706	1-pass	Yes	N/A	1	1	1
MFP	Upper MF Payette	1	5050	1-pass	Yes	N/A	3	1	1
MFP	Bull Creek	1	5264	1-pass	Yes	N/A	2	1	1

MFP	16:1 Creek	1	1500	1-pass	Yes	N/A	2	1	1
NFB	Upper NFK	1	13501	Depletion	No	32.9%	0	N/A	N/A
NFB	Beaver Creek NFK	3	1134	Depletion	No	10.5%	0	N/A	N/A
NFB	Little Beaver Creek	3	1167	Depletion	No	5.5%	0	N/A	N/A
NFB	Bear River	1	2965	Depletion	No	5.5%	0	N/A	N/A
NFB	Edna Creek	3	3749	Depletion	No	10.5%	0	N/A	N/A
	EFK								
MFB	Swanholm Creek	2	1033	Depletion	No	10.5%	0	N/A	N/A
MFB	Deadman Creek	2	1672	Depletion	No	19.4%	0	N/A	N/A

Note: Probability of detection calculated from Petersen et al. (2002). * Probabilities of detection were calculated only when bull trout were not found. ** Natural barriers were identified. N/A - Bull trout were found so a probability of detection is not needed.

Table 3. Fish species detected during 2006 MIS sampling on the Boise N.F.

Subbasin	Patch	Strata	BLT	BKT	RBT	CCT	RBTxCCT	SCP
SFS	Riordan Creek	1	+		+			
SFS	Wardenhoff Creek	4			+			
SFS	Trapper Creek SFS	1	+					
SFS	Upper Burntlog Creek	2	+		+			
SFS	Upper Johnson Creek	2		+				
MFS	Sulpher Creek	2			+			+
MFS	Wyoming Creek	1	+	+				
MFS	Bearskin	1	+	+	+			
MFS	Cache Creek	1	+	+	+			+
PAY	Third Fork	1	+		+			
PAY	Rammage Meadows	1	+		+			
PAY	Renwyck Creek	1			+			
SFP	Scott Creek	1	+					
SFP	Deer Creek	1	+		+			
SFP	Canyon Creek	1	+					
SFP	Rock Creek SFP	2			+			
SFP	Eightmile Creek	1	+					
MFP	Upper MF Payette	1	+		+			
MFP	Bull Creek	1	+					
MFP	16:1 Creek	1	+		+			
NFB	Upper NFK	1			+			
NFB	Beaver Creek NFK	3		+	+			
NFB	Little Beaver Creek	3		+	+			+
NFB	Bear River	1	+		+			
NFB	Edna Creek	3		+	+			+
MFB	EFK Swanholm Creek	2			+			
MFB	Deadman Creek	2			+			

Note: BLT = bull trout, BKT = brook trout, RBT = redband/rainbow trout, CCT = cutthroat trout, RBTxCCT = redband / cutthroat hybrid, SCP = sculpin.