Boise National Forest

Aquatic Management Indicator Species

2012 Monitoring Report

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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. Except for historic stocking of brook trout (*Salvelinus fontinalis*), a species known to hybridize with bull trout (Markle 1992, Leary et al. 1993). 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 meters (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 1600 m 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 1600 m 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 150 mm. 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, MWMT). 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 2012 update, there are 179 bull trout patches that occur within three basins (nine subbasins) on the Boise National Forest; 60 patches in strata 1; 62 patches in strata 2; 57 patches in strata 3; and 0 patches in strata 4 as of the end of the 2008 field season (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 strata 1 and 2, 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 strata (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 strata 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 strata 1 or 2 patch is actually strata 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 strata 3 patches have improved enough that the patch strata needs to be redefined to a strata 2.

Patch Sampling Frequency

How frequently a patch is sampled is dependent upon how many patches fall within each stratum 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 or 2 will be sampled at least twice over the life to the forest plan (2003 – 2018), while patches that fall within stratum 3 will be sampled at least once.

Within the first half of the forest plan (2003-2009), all patches in strata 1, 2 and 4 would be prioritized for inventory. Patches in strata 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 stratum 4 are surveyed, they would be reclassified (e.g. 1, 2, or 3). Likewise, if no bull trout were found where previously observed (strata 1 patch), it would be reclassified. If bull trout were still present then the patch would remain in strata 1.

In the second half (2010-2016) of the forest plan, all patches in strata 1 and 2 would be sampled. Patches in stratum 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.

Informal and Formal Surveys

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, MWMT), and access (no natural or anthropogenic barriers). All suitable habitats in each patch that meet 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 stratum 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 100 m double-pass transect with block nets. 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; 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 28 patches in 2012 (Figure 4a-4b and Table 1). Bull trout were detected in 15 out of the 28 patches surveyed this year. For the 12 patches sampled in 2012 where no bull trout were captured, probability of patch occupancy ranged from 0.38-0.255 (Table 2). 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. Follow up visits in 2012 to strata 1, occupied by juvenile bull trout, sites used previously known sample locations to increase the possibility of encountering bull trout and are not selected randomly. Detection rates in 2012 where no bull trout were captured were based on observed detection rates from 2004-2006.

<u>North Fork / Middle Fork Boise subbasin</u>

In the N.F./M.F. Boise subbasin, three patches (Little Queens River, Bear Creek, Eagle Creek). Juvenile bull trout were detected in Little Queens River, previously a strata 1 , maintaining it as a strata 1 occupied by juvenile bull trout. In Bear Creek, previously a strata 1 occupied by juvenile bull trout, no bull trout were captured in 3 formal and 3 informal surveys. Bear Creek changed to a stratum 2, suitable habitat conditions but bull trout were undetected. More sampling will be required in Bear Creek to answer questions of the absence of detection of bull trout previously surveyed within the patch. Eagle Creek a strata 2 suitable habitat conditions exist but bull trout are undetected, had only rainbow trout captured in the 2012 surveys. There is a culvert that is a barrier to fish where FSR# 268 and Eagle Creek cross at 1489 m in elevation near the confluence with the Middle Fork of the Boise River.

<u>Boise-Mores subbasin</u>

One patch was surveyed in the Boise-Mores subbasin in 2012 (Mores Creek). Adult bull trout were captured in 2011, and again in 2012, but no juvenile bull trout were captured in those surveys. Mores Creek patch was a stratum 1, occupied by juvenile bull trout in 2005 then changed to a stratum 2, suitable habitat conditions but juvenile bull trout were undetected after the 2011 and 2012 surveys.

<u>South Fork Boise subbasin</u>

Three patches in the S.F. Boise subbasin were surveyed in 2012 (Parks Creek, Bear Creek, and Dog Creek). Parks Creek was a strata 1 occupied juvenile bull trout in 2005. During the MIS sampling in 2011 with 5 informal surveys and in 2012 with 3 formal and 3 informal surveys, no bull trout were captured in the Parks Creek patch changing the patch designation to strata 2 suitable habitat conditions exist but bull trout were undetected. Dog creek was previously sampled in two locations in 2003 with only rainbow trout collected in the survey and was a strata 2 suitable habitat but no bull trout have been detected. Three formal surveys were conducted on Dog creek in 2012 with no detections of bull trout. Rainbow trout were captured and genetic material was collected. Analysis of the genetic material from the Dog Creek rainbow trout will give an indication if the rainbows were stocked or migrated to the headwaters of Dog Creek where there appears to be several large waterfalls near the 1600 meter elevation. Bear Creek was last sampled in 2003 with 4 formal surveys with only rainbow trout captured. Temperature probes were placed in the lower end of the patch in 2005 with a Maximum Weekly Maximum Temperature (MWMT) summer stream temperature of 16.7°C making Bear Creek a strata 3 unsuitable for bull trout exceeding their temperature preference. In 2010 another stream temperature probe was deployed in Bear Creek upstream from the previous location but still maintaining 500 hectares of drainage upstream of the probe. The MWMT for the temperature probe placed in 2010 was 13.8°C making Bear Creek a strata 2 suitable bull trout but undetected. In two formal surveys in 2012, 1 juvenile and 1 adult bull trout were captured changing the patch designation to a strata 1 occupied by juvenile bull trout.

South Fork Payette subbasin

During 2012, six bull trout patches were sampled in the S.F. Payette subbasin (Baron Creek, E.F. Pine Creek, Fruitcake Creek, Miller Creek, Sams Creek and Wolf Creek). Bull trout were found in Baron Creek using single-pass electrofishing. Baron Creek maintains its strata 1 status, occupied by juvenile bull trout. Crews from the Boise N.F. had previously detected bull trout in the Baron Creek patch in 2007. E.F. Big Pine Creek, Miller Creek and Fruitcake Creek were previously sampled in 2004 with only rainbow trout in the samples making them all strata 2 suitable habitat but without a bull trout detection. In 2012 the patches were resampled and again no bull trout were detected making them each strata 2 suitable habitat without a bull trout detection. Sams Creek and Wolf Creek were each sampled with 1 formal and 2 informal surveys in 2009 without any bull trout being detected making them strata 2 suitable but without bull trout being detected. They were each resampled with 2 formal surveys in each patch in 2012 without any bull trout being detected and each patch remaining strata 2. Wolf Creek and Sams Creek have been sampled twice each but because of the remote location they only have had 3 formal samples each between 2 years and need more sampling to say with a higher probability of detection if they could be occupied by bull trout.

Middle Fork Payette subbasin

Four patches were surveyed in the M.F. Payette subbasin in 2012 (16:1 Creek, Bull Creek, Upper M.F. Payette and Lightning Creek). 16:1 Creek, Bull Creek and Upper M.F. Payette patches were previously sampled in 2006 and were previously strata 1 occupied by juvenile bull trout. In the 2012 surveys all three had juvenile bull trout captured in them again making them strata 1 occupied by juvenile bull trout. Lightning Creek had not been previously sampled prior to 2012. No fish were captured in any of the 4 formal samplings in 2012. Though the conditions appear to be suitable by temperature and stream flow a geologic barrier consistent with nearby Onion Creek, Bulldog Creek and Rattlesnake Creek patches all have geologic barriers at or near the 1600 meters in elevation. Lightning Creek will change from strata 2 suitable but undetected to a strata 3 unsuitable because of a natural geologic barrier denying fish access.

North Fork Payette subbasin

No sampling occurred in the N. F. Payette subbasin.

Payette subbasin

One patch in the Payette subbasin (Third Fork) was surveyed in 2012, Third Fork of Squaw Creek was previously a strata 1 occupied by juvenile bull trout and was last surveyed in 2006. Juvenile bull trout were present again in the 2012 survey of Third Fork patch maintaining it as strata 1 occupied by juvenile bull trout.

Middle Fork Salmon

Five patches in the Middle Fork Salmon subbasin (Elk Meadows, Dagger Creek, Bearskin, Cache Creek and Boundary Creek) were surveyed in 2012. Elk Meadow and Dagger Creek were both strata 1 occupied by juvenile bull trout and were both last sampled in 2007. Elk Meadows and Dagger Creek had juvenile bull trout captured in the 2012 surveys. Bearskin and Cache Creek patches were both strata 1 occupied by juvenile bull trout and were each last sampled in 2006. Bearskin and Cache creek patches each had juvenile bull trout captured in the 2012 surveys maintaining their patch designation as strata 1 occupied by juvenile bull trout. Boundary Creek is a strata 3 unsuitable and undetected juvenile bull trout. It is thought that there is a geologic gradient barrier at the confluence with the Middle Fork of the Salmon River. In the Boundary Creek patch rainbow trout were the only fish captured in the 2012 surveys. Elk Meadows, Dagger Creek, Bearskin patches each had brook trout/bull trout hybrids phenotypically identified in the 2012 surveys.

South Fork Salmon

Five patches were surveyed in the South Fork Salmon subbasin in 2012 (Riordan, Upper Burntlog, Cabin, Sixbit and Wardenhoff). Riordan, Upper Burntlog, Cabin and Sixbit were previously strata 1 occupied by juvenile bull trout. Riordan and upper Burntlog patches were last sampled in 2006. Cabin and Sixbit patches were last sampled in 2007. Riordan, Upper Burntlog, Cabin, Sixbit patches all had juvenile bull trout captured in the 2012 surveys and remain strata 1 occupied by juvenile bull trout. Wardenhoff patch was previously a strata 3, unsuitable habitat conditions exist. Rainbow trout were the only fish captured Wardenhoff Creek during the 2012 survey. Wardenhoff Creek will remain a strata 3 unsuitable and bull trout undetected. Wardenhoff patch is thought to have a geologic gradient barrier preventing fish access at or near 1589 m in elevation.

Bull Trout Detection

Juvenile bull trout (<150 mm) were detected in 15 of the 28 patches sampled on the Boise National Forest in 2012. Juvenile bull trout were detected at the first sample site in 14 of the 15 patches that juvenile bull trout were observed. At 15 of 15 sites where juvenile bull trout were detected, they were observed during the first electrofishing pass. Follow up visits in 2012 to strata 1, occupied by juvenile bull trout, sites used previously known sample locations to increase the possibility of encountering juvenile bull trout and are not selected randomly. In 2012 strata 2, suitable bull trout habitat exists but bull trout are undetected, were selected randomly within the patch. Of the 12 strata 2 sites surveyed in 2012 Bear Creek SFB was the only patch that had juvenile bull trout captured in the 2012 surveys.

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. 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.

Factors other than water temperatures (i.e. groundwater inputs, over-wintering habitat, and habitat connectivity) are also likely influencing bull trout distribution. 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.

Rocky Mountain Research Station (RMRS) in Boise and Pacfish Infish Biological Opinion Effectiveness Monitoring Program (PIBO/EMP) have provided an abundance of stream temperature information that is relative to the BNF MIS program. Using the RMRS sentinel stream temperature database and PIBO/EMP stream database has reduced the total number of stream temperature probes that the BNF MIS has to deploy and retrieve. There is still the need to place stream temperature probes in specific locations within patches to discern the temperature effects of stream inputs higher in patches while still maintaining 500 hectares of watershed drainage.

During 2012, the Boise N.F. crew deployed temperature loggers at the lowest elevation in the patch (usually 1600m) and at other various elevations within certain patches. Eight temperature loggers in 8 patches were deployed on the Boise N.F (Figures 5a-b). A total of 6 were retrieved at the end of the field season. Two temperature loggers malfunctioned possibly due to static electricity. Moores Creek and Rock Creek of the South Fork of the Boise River each had >60 days of stream temperatures > 15°C exceeding the tolerance range for bull trout. Rammage Meadows Creek of the Payette Squaw Creek subbasin had 55 days where the steam temperature was >15°C exceeding the tolerance for bull trout. No bull trout were captured in Rammage Meadows Creek with 3 formal and 3 informal surveys during the 2011 field season. Bull trout had been previously observed in surveys from 1993 and 2006 in Rammage Meadows. Box Canyon and McDonald creeks of the SFP and Goat Creek of the MFP had 0 days > 15°C and are each stratum 2 suitable but undetected. The summary data from these sites are presented in Figures 1.

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 2012 contained barriers that could influence the presence or persistence of bull trout.

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.

The U.S. Bureau of Reclamation supported studies of adult migratory bull trout from Arrowrock Reservoir in 1996 and 1997 (Flatter 1998) and from the Middle and North Fork Boise rivers in 2001 through 2003 (Monnot et al. 2008, Salow and Hostettler 2004). Radio-tagged adults captured in the reservoir and at weirs on the Middle and North Forks were tracked on the ground and using aircraft. The data from these studies are voluminous, but some of the key points of the research are 1) the adults migrated upstream from the reservoir as early as March but by mid-June, entered tributaries between late July and early August. Adults reaching tributaries in July find barriers to passage that might be passable to rainbow trout earlier in the year with higher flows. Other barriers restrict passage to all fish. The summary information on barriers can be seen in Figure 2.

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). Bearskin and Elk Meadows had bull trout/brook trout hybrids phenotypically confirmed in the 2012 surveys. During the 2012 sampling season, three patches were found to have both bull trout and brook trout (Baron, Bearskin and Mores). Baron has had bull trout/brook hybrid trout phenotypically identified in 2007. Patches that have had phenotypically identified bull trout / brook trout hybrids include Lodgepole SFS, Crooked River, Bear River NFB, Bearskin Creek, Rice Creek,Wyoming Creek, Bear Valley Creek, Elk Meadows Creek and Fir Creek. 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 NFB (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

A variety of factors influences the distribution of bull trout populations across the Boise National Forest. As has been reported in the literature, results from our MIS sampling indicate that patch size, stream temperature, patch connectivity, habitat condition, and the occurrence of brook trout can all influence the presence or absence of reproducing bull trout populations. Information collected over the past nine years has better defined bull trout distributions within patches and across each subbasin. At the subbasin scale it appears bull trout local populations have remained stable since 2003. We have also found more occupied patches than previously thought. However, this doesn't imply bull trout have expanded their range, only that we have confirmed their presence in streams that likely supported them all along. Still, the data indicates that bull trout presence is more robust than previously thought.

Strata changes that have the most importance to the MIS monitoring are changes from strata 1, occupied by juvenile bull trout to strata 2 suitable habitat but undetected juvenile bull trout. As the CFR states, "Population trends of the management indicator species will be monitored and relationships to habitat changes determined." In the case where a strata 1 patch was known to occupy juvenile bull trout then in subsequent surveys juvenile bull trout are undetected and the patch designation changes to a strata 2, suitable habitat but undetected, relationships to habitat changes need to be addressed individually with the best available scientific information.

Bear Creek NFB changed from a stratum 1 occupied to strata 2 suitable habitat, bull trout were undetected in the 2012 surveys. Bear Creek NFB had 3 formal surveys and 3 informal surveys all in locations where bull trout had been previously captured. Brook trout were captured in 3 of the six surveys on Bear Creek NFB in 2012. DNA studies have been done in the past by the United States Bureau of Reclamation showing a high percentage (29%) of bull trout were actually hybrids in Bear Creek NFB (Whiteley et al. 2003).

Parks Creek SFB changed from a stratum 1, occupied by juvenile bull trout to a strata 2, suitable habitat and undetected bull trout with 4 informal surveys in 2011 and 4 formal surveys in 2012. The one and only bull trout observed in Parks Creek patch was in 2005 at the confluence with Trinity Creek and < 30m from the boundary with the Trinity Creek patch. The two patches almost touch each other at the confluence of the two rivers. The observed bull trout from Parks Creek patch in 2005 was likely a part of the Trinity Creek patch

Bear Creek SFB changed from a stratum 2 suitable habitat but undetected to strata 1 occupied by juvenile bull trout. Bull trout were captured in two surveys in Bear Creek SFB in 2012. It is the first detection of bull trout in Bear Creek SFB in 12 separate surveys form over fifteen years of surveys.

References

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Figure 1. Water Temperature (°C) Monitoring Results for the BNF MIS 2012.

Stream	Basin	Ele (m)	Days	Deployed	Retrived	MWMT	Max	Avg	D>12	D>13	D>15	D>15.5	D>19	D>22
Rammage Meadows	PS	1619	261	1/1/2012	9/18/2012	18.88	19.48	5.08	74	68	55	51	0	0
Moores Creek	SFB	1616	70	6/27/2012	9/6/2012	22.97	24.05	15.68	64	64	64	64	60	21
Macdonald Creek	SFP	1598	81	6/12/2012	9/11/2012	11.68	11.88	9.08	0	0	0	0	0	0
Goat Creek	MFP	1670	89	6/19/2012	9/17/2012	11.65	12.07	8.93	0	0	0	0	0	0
Rock Creek	SFB	1601	70	6/27/2012	9/6/2012	19.76	20.20	13.22	64	64	64	62	9	0
Box Canyon	SFP	1687	73	7/2/2012	9/17/2012	13.56	13.93	9.26	45	9	0	0	0	0

Figure 2. Barriers excluding or limiting bull trout access.

PATCH_NAME	SUBBASIN	JUSTIFY	STRATA12	BULL_JUV	BULL_ADULT
Meadow Creek NFK	NFB	BG1550	3	0	0
Meadow Creek SFK	SFB	BM	3	0	0
Boundary Creek MFS	MFS	EF12BG1600m	3	0	0
MacDonald Creek	SFP	EF2008: BG1500	3	0	0
Logging Gulch	BM	EF08:BG1550	3	0	0
Granite Creek	MFB	EF08:BG1540	3	0	0
Tenmile	BM	EF07:BG1545	3	0	0
Dollar Creek	SFS	BG1699	2	0	1
Fall Creek EFK	SFB	BM	3	0	0
Sheep Creek SFS	SFS	BG1823	3	0	0
Landmark	SFS	BG1823	3	0	0
Renwyck Creek	PS	BG1720	1	1	1
Upper MFK Boise River	MFB	BG1700	2	0	0
NF Dollar Creek	SFS	BG1630	2	0	0
Long Fork Silver	MFP	BG1620	3	0	0
Lightning Creek	MFP	BG1600:EF12	2	0	0
Onion Creek	MFP	BG1600	3	0	0
Goat Creek SNF	SFP	BG1550m	2	0	0
Lorenzo Creek	SFP	BG1550	2	0	0
Bulldog Creek	MFP	BG1545	3	0	0
EF Stevens Creek	SFP	BG1500	2	0	0
Stevens Creek	SFP	BG1492	3	0	0
Roaring Creek	SFS	BG1490	3	0	0
Smith Creek	SFB	BG1460:BM1540	3	0	0
Loosum Creek	SFS	BG1401	3	0	0
Hot Creek	MFB	BG	3	0	0
Phifer Creek	MFB	BG	3	0	0
Wardenhoff	SFS	BG1550	3	0	0
Reeves	SFS	BM1650	3	0	0
BG= barrier geologic and elevation in meters					
BM= barrier manmade					
EF= elec trofishing and year					

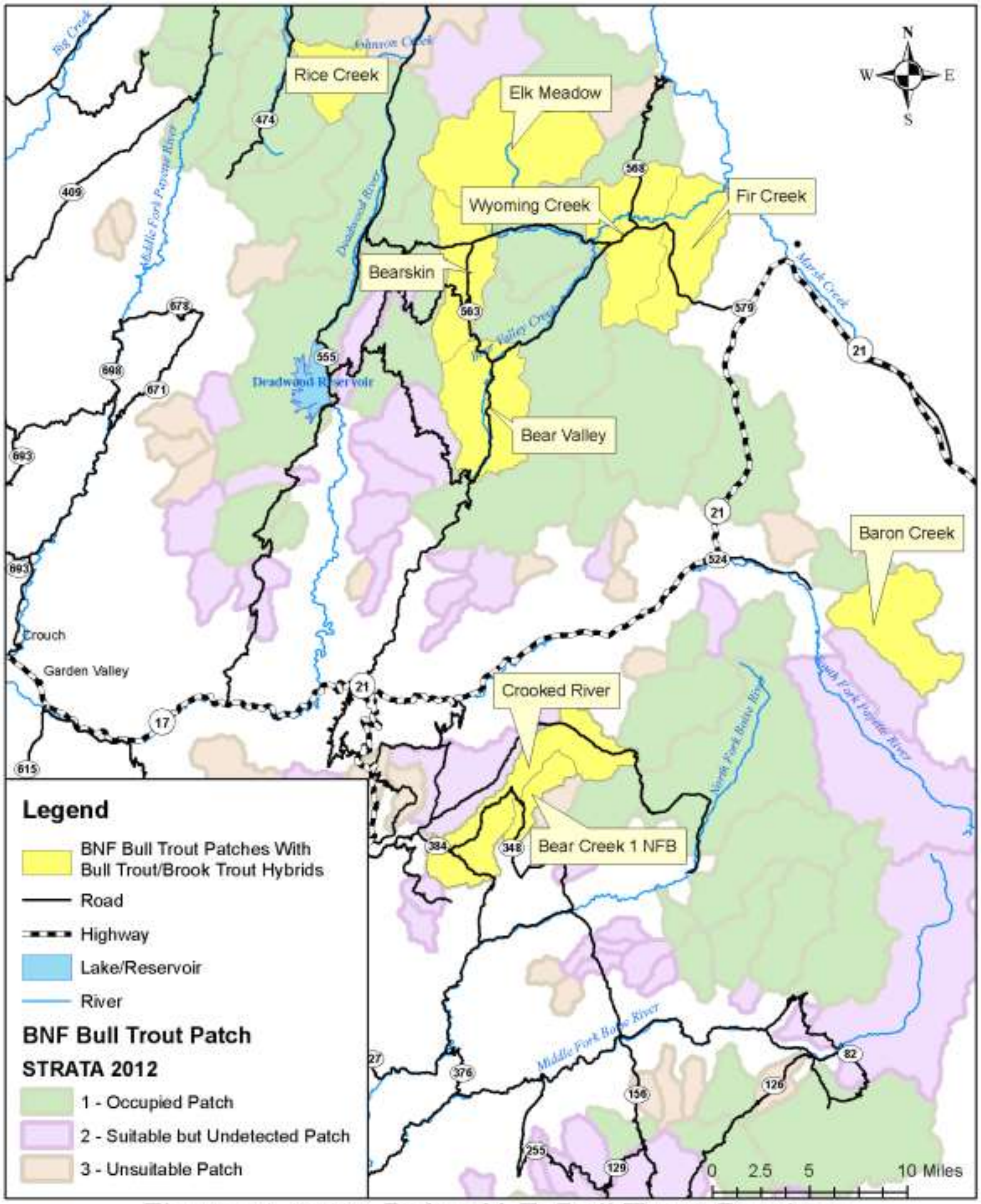


Figure 3, 2012 Boise N.F. Bull Trout Patches With Bull Trout /Brook Trout Hybrids Ralph Mitchell 1/27/2013

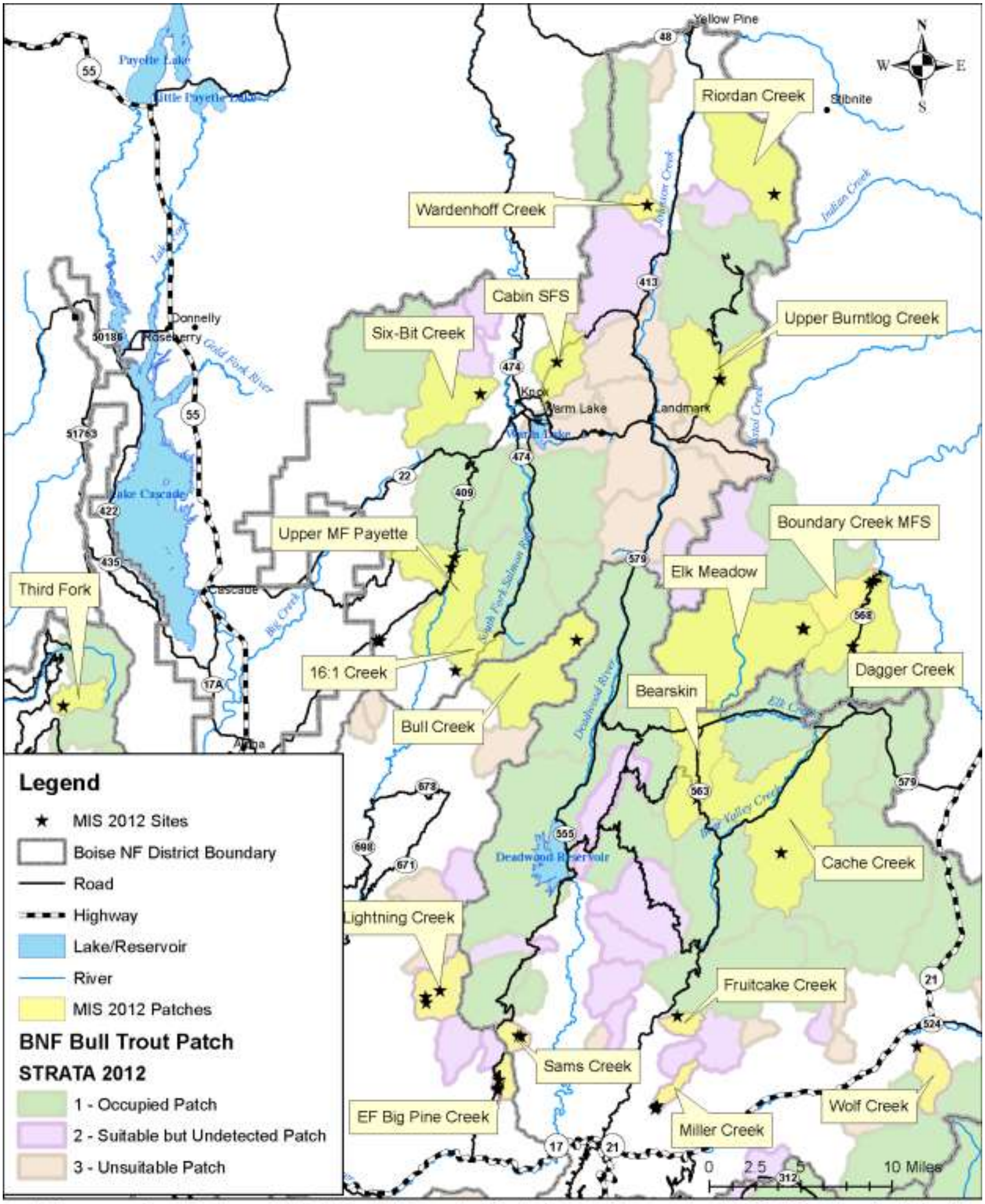


Figure 4a Boise N.F. Bull Trout Patches Sampled 2012 North Half

Ralph Mitchell 1/27/2013

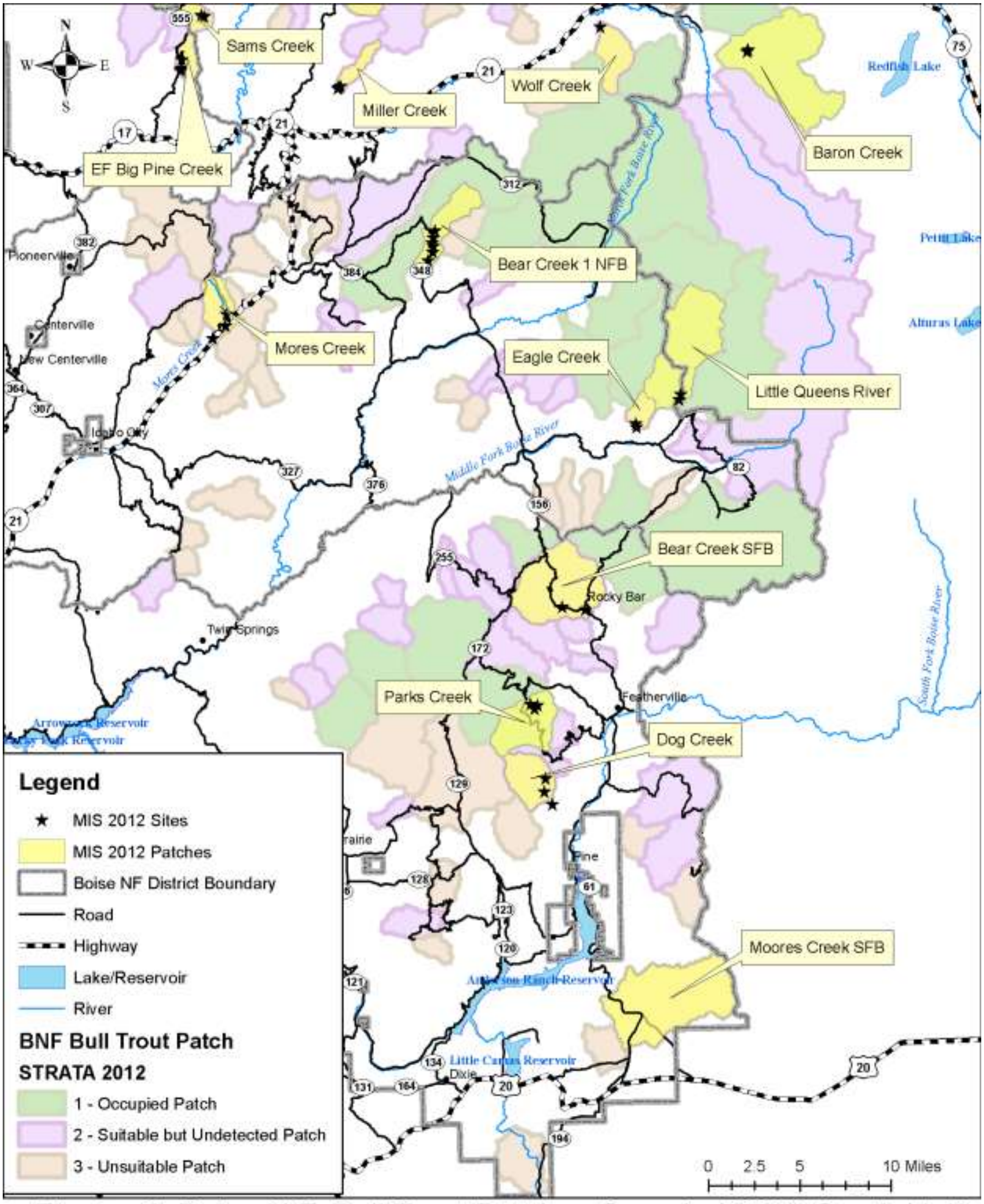


Figure 4b Boise N.F. Bull Trout Patches Sampled 2012 South Half

Ralph Mitchell 1/27/2013

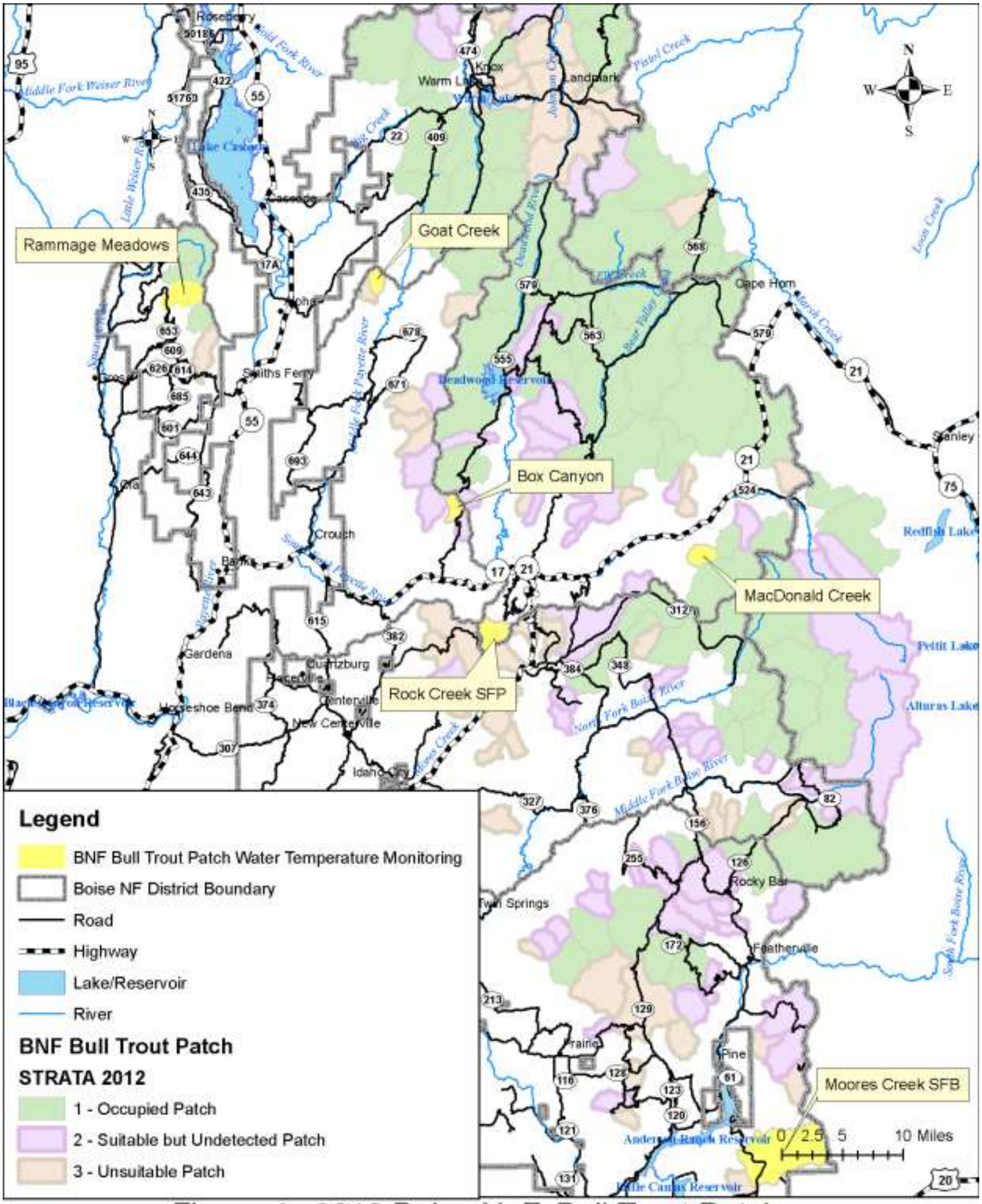


Figure 4c 2012 Boise N. F. Bull Trout Patches
Stream Temperature Monitoring

Ralph Mitchell 1/26/2013

Table 1a. Number of bull trout patches on the Boise National Forest within each basin by strata based on 2012 update.

Stratum	Boise Basin		Payette Basin		Salmon Basin		Forest Total	
	Patches	Surveyed	Patches	Surveyed	Patches	Surveyed	Patches	Surveyed
1	18	4	22	5	20	8	60	17
2	34	3	23	6	5	0	62	9
3	34	1	13	0	10	2	57	3
4	0	0	0	0	0	0	0	0
Total	**86**	8	**58**	11	**35**	10	**179**	29

Table 1b. Number of bull trout patches within the Boise basin.

Stratum	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	1	13	2	1	0	18	4
2	13	2	16	1	5	1	34	3
3	10	1	16	0	8	0	34	1
4	0	0	0	0	0	0	0	0
Total	**27**	4	**45**	3	**14**	1	**86**	8

Table 1c. Number of bull trout patches within the Payette basin.

Stratum	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	1	3	3	3	1	1	0	22	5
2	19	5	3	1	1	0	0	0	23	6
3	6	0	6	0	1	0	0	0	13	0
4	0	0	1	0	0	0	0	0	0	0
Total	**40**	6	**12**	4	**5**	1	**1**	0	**58**	11

Table 1d. Number of bull trout patches within the Salmon basin.

Stratum	South Fork Salmon Subbasin		Middle Fork Salmon Subbasin		Salmon Basin Total	
	Patches	Surveyed	Patches	Surveyed	Patches	Surveyed
1	11	4	9	4	20	8
2	4	0	1	0	5	0
3	9	1	1	1	10	2
4	0	0	0	0	0	0
Total	**24**	5	**11**	0	**35**	10

Table 2. Summary of results from 2012 aquatic MIS sampling on the Boise N.F.

Subbasin	Patch Name	Category (2012)	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
S.F. Payette	Baron	1	5735	1-pass (2)	Yes	N/A	2	1	1
N.F. Boise	Bear Creek	2	1554	Depletion (3)	No	0.038	0	-	-
S.F.Boise	Bear Creek	1	4191	Depletion (3)	Yes	N/A	1	1	1
M.F. Salmon	Bearskin	1	4549	Depletion (1)	Yes	N/A	1	1	1
M.F. Salmon	Boundary Creek	2	1841	Depletion (2)	No	0.255	0	-	-
M.F. Payette	Bull Creek	1	5264	1-pass (1)	Yes	N/A	1	1	1
S.F. Salmon	Cabin Creek	1	1951	Depletion (1)	Yes	N/A	1	1	1
M.F. Salmon	Cache Creek	1	10349	Depletion (1)	Yes	N/A	1	1	1
M.F. Salmon	Dagger Creek	1	3239	Depletion (1)	Yes	N/A	1	1	1
S.F. Boise	Dog	2	1597	Depletion (3)	No	0.760	0	-	-
S.F. Payette	E.F. Big Pine	2	624	Depletion (3)	No	0.190	0	-	-
M. F. Boise	Eagle	2	522	Depletion (2)	No	0.100	0	-	-
M.F. Salmon	Elk Meadows	1	10571	Depletion (2)	Yes	N/A	2	1	1
S.F. Payette	Fruitcake	2	556	Depletion (1)	No	0.255	0	-	-
M.F. Payette	Lightning	3	2032	Depletion (3)	No	No fish	0	-	-
M.F. Boise	Little Queens	1	4433	Depletion (2)	Yes	N/A	1	1	1
S.F.Payette	Miller	2	527	Depletion (3)	No	0.140	0	-	-
B.Moores	Mores	2	1223	Depletion (3)	Yes	N/A	0	1	1
S.F. Salmon	Riordan	1	5792	Depletion (1)	Yes	N/A	1	1	1
S.F. Payette	Sams	2	580	Depletion (2)	No	No fish	0	-	-
S.F. Salmon	Six Bit	1	3318	1-pass (1)	Yes	N/A	1	1	1
M.F. Payette	Sixteen to One	1	1500	Depletion (1)	Yes	N/A	1	1	1
Payette Squaw	Thirdfork	1	1046	Depletion (1)	Yes	N/A	1	1	1
M.F. Payette	UMF Payette	1	5050	Depletion (2)	Yes	N/A	2	1	1
S.F. Salmon	Upper Burntlog	1	4580	Depletion (2)	Yes	N/A	2	1	1
S.F. Boise	W.F. Parks	2	2162	Depletion (3)	No	0.054	0	-	-
S.F. Salmon	Wardenhoff	2	696	Depletion (2)	No	0.410	0	-	-
S.F. Payette	Wolf	2	1268	Depletion (2)	No	0.255	0	-	-

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.

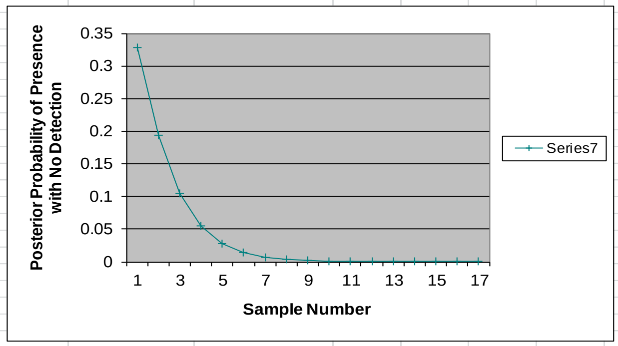
Table 3. Fish species detected during 2012 MIS sampling on the Boise N.F.

Stream	Drainage	RBT	CT	WTF	BLT	BKT	BLT/BKT	SC
Baron	S.F. Payette	X	X	0	X	X	0	0
Bear Creek	N.F. Boise	X	X	0	0	X	0	X
Bear Creek	S.F.Boise	X	0	0	X	0	0	X
Bearskin	Bear Valley	0	0	0	X	X	X	
Boundary Creek	M.F. Salmon	X	0	0	0	0	0	0
Bull Creek	M.F. Payette	0	0	0	X	0	0	0
Cabin Creek	S.F. Salmon	0	0	0	X	0	0	0
Cache Creek	Bear Valley	X	0	0	X	0	0	0
Dagger Creek	M.F. Salmon	X	0	0	X	0	0	X
Dog	S.F. Boise	X	0	0	0	0	0	0
E.F. Big Pine	S.F. Payette	X	0	0	0	0	0	0
Eagle	M. F. Boise	X	0	0	0	0	0	0
Elk Meadows	Bear Valley	X	X	0	X	0	X	0
Fruitcake	S.F. Payette	X	0	0	0	0	0	0
Lightning	M.F. Payette	0	0	0	0	0	0	0
Little Queens	M.F. Boise	X	0	X	X	0	0	0
Miller	S.F.Payette	X	0	0	0	0	0	0
Mores	B.Moores	X	0	0	X	X	0	0
Riordan	S.F. Salmon	X	0	0	X	0	0	0
Sams	Deadwood	0	0	0	0	0	0	0
Six Bit	S.F. Salmon	0	0	0	X	0	0	0
Sixteen to One	M.F. Payette	X	0	0	X	0	0	0
Thirdfork	Squaw	X	0	0	X	0	0	0
UMF Payette	M.F. Payette	0	0	0	X	0	0	0
Upper Burntlog	S.F. Salmon	X	X	0	X	0	0	0
Wardenhoff	S.F. Salmon	X	0	0	0	0	0	0
WF Parks	S.F.Boise	X	0	0	0	0	0	0
Wolf	S.F. Payette	X	0	0	0	0	0	0

Note: RBT = redband/rainbow trout, CT = cutthroat trout, WTF =mountain whitefish, BLT = bull trout, BKT = brook trout, BLT/BKT = bull trout x brook trout hybrid, SC = sculpin.

Appendix 1. Peterson and Dunham (2003)

	Multiple Pass					
	dj	*d (Eqn 1)*	*P(F)*	*P(~F)*	*P(Co|F) = 1-d*	*P(F|Co) - Eqn 2*
	Unit-Specific I	**Cumulative Probability of Detection Within Patch**	**Prior Probabilit**	Prior Probability o	Probability of Not De	Posterior Probability of Patch Occupancy, Given No Detection
1	0.51	**0.51**	**0.5**	0.5	0.49	0.32885906
2	0.51	**0.7599**	**0.5**	0.5	0.2401	0.193613418
3	0.51	**0.882351**	**0.5**	0.5	0.117649	0.105264712
4	0.51	**0.94235199**	**0.5**	0.5	0.05764801	0.054505856
5	0.51	**0.971752475**	**0.5**	0.5	0.028247525	0.027471522
6	0.51	**0.986158713**	**0.5**	0.5	0.013841287	0.013652321
7	0.51	**0.993217769**	**0.5**	0.5	0.006782231	0.006736542
8	0.51	**0.996676707**	**0.5**	0.5	0.003323293	0.003312285
9	0.51	**0.998371586**	**0.5**	0.5	0.001628414	0.001625766
10	0.51	**0.999202077**	**0.5**	0.5	0.000797923	0.000797286
11	0.51	**0.999609018**	**0.5**	0.5	0.000390982	0.000390829
12	0.51	**0.999808419**	**0.5**	0.5	0.000191581	0.000191545
13	0.51	**0.999906125**	**0.5**	0.5	9.38748E-05	9.3866E-05
14	0.51	**0.999954001**	**0.5**	0.5	4.59987E-05	4.59965E-05
15	0.51	**0.999977461**	**0.5**	0.5	2.25393E-05	2.25388E-05
16	0.51	**0.999988956**	**0.5**	0.5	1.10443E-05	1.10442E-05
17	0.51	**0.999994588**	**0.5**	0.5	5.4117E-06	5.41167E-06



	Single Pass					
	dj	*d (Eqn 1)*	*P(F)*	*P(~F)*	*P(Co|F) = 1-d*	*P(F|Co) - Eqn 2*
	Unit-Specific I	**Cumulative Probability of Detection Within Patch**	**Prior Probabilit**	Prior Probability o	Probability of Not De	Posterior Probability of Patch Occupancy, Given No Detection
1	0.58	**0.58**	**0.5**	0.5	0.42	0.295774648
2	0.58	**0.8236**	**0.5**	0.5	0.1764	0.149948997
3	0.58	**0.925912**	**0.5**	0.5	0.074088	0.068977588
4	0.58	**0.96888304**	**0.5**	0.5	0.03111696	0.030177915
5	0.58	**0.986930877**	**0.5**	0.5	0.013069123	0.012900525
6	0.58	**0.994510968**	**0.5**	0.5	0.005489032	0.005459067
7	0.58	**0.993217769**	**0.5**	0.5	0.006782231	0.006736542
8	0.58	**0.996676707**	**0.5**	0.5	0.003323293	0.003312285
9	0.58	**0.998371586**	**0.5**	0.5	0.001628414	0.001625766
10	0.58	**0.999202077**	**0.5**	0.5	0.000797923	0.000797286
11	0.58	**0.999609018**	**0.5**	0.5	0.000390982	0.000390829
12	0.58	**0.999835788**	**0.5**	0.5	0.000164212	0.000164186
13	0.58	**0.999931031**	**0.5**	0.5	6.89692E-05	6.89645E-05
14	0.58	**0.999971033**	**0.5**	0.5	2.89671E-05	2.89662E-05
15	0.58	**0.999987834**	**0.5**	0.5	1.21662E-05	1.2166E-05
16	0.58	**0.99999489**	**0.5**	0.5	5.10979E-06	5.10977E-06
17	0.58	**0.999997854**	**0.5**	0.5	2.14611E-06	2.14611E-06