2006 Sawtooth Aquatic Management Indicator Species Monitoring Report

Jeb Wofford – North Zone Aquatic Ecologist
John Chatel – Forest Aquatics Program Manager

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.

Protocol

Objectives

- Over the existing Forest Plan for the Boise, Sawtooth, and Payette National Forests, determine the status and trend in distribution of bull trout within and among patches of suitable habitat within each subbasin across the planning area.
- To the full extent practicable, use the best available peer-reviewed science to allow formal inferences about observed status and trends in the distribution of bull trout.

Rationale

Monitoring is focused on patterns of occurrence of juvenile and small resident bull trout (<150 mm) for two reasons. First, presence of small bull trout is an indicator of key spawning and rearing areas. These areas represent habitats that are essential for bull trout populations. Other habitats within stream networks may be important for ranging or migrating individuals, but tracking fish in these areas is much more difficult. Second, sampling patterns of occurrence requires less intense sampling that estimating abundance and is based on a peer-reviewed protocol for sampling of small bull trout (Peterson et al. 2002); similar protocols for larger, more mobile fish have not been developed. Key metrics for monitoring trends will be the proportion of habitat patches occupied in each subbasin across time and the spatial pattern of occupied patches. In the future we intend to explore indices of abundance and distribution within individual streams that may be useful to characterize linkages with local management.

Methods

Monitoring follows procedures specified by (Peterson et al. 2002)[1], with the following specific procedures and modifications.

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[1] Available at www.fisheries.org and www.fs.fed.us/rm/boise

Sampling frame. The fundamental unit for inference is a patch, defined following procedures outlined in Peterson, et al. (2002) and further clarified by the U.S. Fish and Wildlife Service Bull Trout Recovery Monitoring and Evaluation Group. The procedure involves delineating both down- and upstream limits to potentially suitable habitats for bull trout within stream networks, and thus the area for locating samples, and making inferences about presence.

Downstream patch boundaries were delineated by 1600 meter elevation contours in Boise and South Fork Payette River basins, based on previous research in the basins relating the distribution of small bull trout to elevation. Outside of these basins, downstream patch boundaries correspond to stream temperature <15^{o}C (highest seven-day moving average of maximum daily temperature). Downstream limits to patches may also correspond to a confluence with a stream that is classified as too large for bull trout spawning, based on observed relationships between spawning use and stream size, as revealed by redd counts, direct observation of fish, radio telemetry, or other evidence.

During monitoring, efforts will be made to distinguish between "realized" and "potential" patch boundaries. The term "realized" refers to actual habitat that is used by bull trout. This may less than potentially occupied habitat, due to the influence of other factors, such as nonnative brook trout, dewatering of stream channels, or habitat alterations that increase stream temperature. The term "potential" refers to the maximum extent of coldwater naturally attainable, absent of reversible human influences. This assumes the distribution of suitably cold water is the ultimate factor limiting the distribution of small bull trout.

In the upstream direction, stream networks will be truncated to include only those segments[2] with valley bottom slopes of less than 20%. Further, all headwater areas within catchments corresponding to a contributing area of less than 500 hectares will be removed from sampling frames, due to low probability of bull trout occurrence (Dunham and Rieman 1999, as cited in Peterson et al. 2002). Information on local barriers will also be considered in truncating stream networks. For example, it may not be necessary to sample upstream of high natural waterfalls that prevent upstream passage of bull trout.

Metadata. For each patch, criteria for delineating down- and up-stream boundaries of the stream network to be sampled will be documented as metadata to accompany spatial data.

Sample allocation. Individual samples will be allocated to all patches within a Forest or subbasin. Within patches, only suitable habitat will be inventoried for informal and formal surveys. 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). Sites within each patch will be located by dividing the suitable habitat into 100m segments and then randomly selecting the segments.

Sampling unit. The fundamental sampling unit will be a 100 meter length of stream.

Sampling method. Daytime electrofishing will be used to capture fish, with a variable number of passes, depending on conditions. Habitat variables needed to estimate sampling efficiencies will be measured. The sequence or order of sampling within patches is assumed to be unimportant, in terms of estimating probability of presence.

[2] Stream segments are defined as lengths of stream within drainage networks that are delineated on the up- and down-stream ends by tributary confluences.

Formal vs. informal sampling. Informal sampling will be used initially to determine presence of juvenile bull trout, when deemed appropriate by local biologists. If juvenile bull trout are detected the informal sampling effort can cease, unless the local biologists wants to better determine distribution within the patch. If juvenile bull trout are not detected, it will be necessary to conduct formal sampling, as prescribed to estimate probability of presence in cases where bull trout are not detected (Peterson et al. 2002, Peterson and Dunham 2003). Site level detection probabilities will be estimated as outlined in Peterson et al. (2002) or through empirical methods based on repeated sampling of occupied patches and habitat information collected throughout the monitoring effort. If juvenile bull trout are detected during formal sampling, crews may either elect to cease efforts and move to other patches or continue sampling to better determine distribution within the patch and augment the development of the empirical models.

Sampling schedule. Initially, four patch types will be recognized: 1) Known presence within last 7 years; 2) Likely present due to good habitat or detection > 7 years previous; 3) Likely not present due to poor habitat and bull trout not detected within last 7 years; 4) Patches without data. Patches will be defined relative to “potential” to support bull trout as defined above. Over the 2003-2018 Forest Plan timeline, targeted patches in categories 1, 2, and 4 will be sampled at least twice. Initial sampling will be completed within first and last 7 years of the Forest Plan, preferably with as much time as possible in-between successive samples for each patch. Patches in category 3 will be sampled at least once. Additional sampling or re-sampling will be conducted if there is specific reason to do so (e.g., passage restoration, habitat improvement). Based on results following sampling, patch strata will be updated yearly (Table 1).

Table 1. Number of bull trout patches on the Sawtooth National Forest within each subbasin by category prior to 2006 sampling.

Category	S.F. Boise Subbasin	M.F./N.F Boise Subbasin	S.F. Payette Subbasin	Upper Salmon Subbasin	Total
1	12	4	2	11	29
2	23	1	2	24	43
3	8	0	0	5	17
4	0	0	0	4	7
Total	43	5	4	44	96

Using data from the past 7 years (since 1999), all of the patches in the South Fork and Middle Fork/North Fork Boise River subbasins have been sampled. In the Upper Salmon 77% of the patches have been sampled, while 75% in the S.F. Payette on the Forest have been sampled (Table 2).

Table 2. Number of bull trout patches on the Sawtooth National Forest and the number surveyed within the past 7 years (since 1999) within each subbasin by category (category based on 2006 strata).

Category	**S.F. Boise Subbasin**		**N.F. and M.F. Boise Subbasin**		**S.F. Payette Subbasin**		**Upper Salmon Subbasin**		**Total**	
	Patches	Surveyed	Patches	Surveyed	Patches	Surveyed	Patches	Surveyed	Patches	Surveyed
1	12	12 (100%)	4	4 (100%)	2	2 (100%)	11	11 (100%)	29	29 (100%)
2	23	23 (100%)	1	1 (100%)	2	1 (50%)	24	21 (88%)	50	46 (92%)
3	8	8 (100%)	0	0	0	0	5	2 (40%)	13	10 (77%)
4	0	0	0	0	0	0	4	0	4	0 (0%)
Total	43	43 (100%)	5	5 (100%)	4	3 (75%)	44	34 (77%)	96	85 (89%)

2006 Results and Discussion

Monitoring for bull trout on the Sawtooth National Forest occurred in 20 patches in 2006 (Figure 1). In the Boise subbasins, six patches were surveyed. Of these patches, bull trout were observed in Boardman, Skeleton, Bear, and the upper S.F. Boise basin. In Skeleton and Boardman Creeks, bull trout were also detected in 2004 and 2005. Sampling in 2006 in these patches continued long term monitoring (since 2002) of these populations. Bull trout had been observed in Bear Creek during several surveys in the 1990's and early in the 2000's, so detecting them in 2006 was anticipated and confirmed.

Sampling in the upper S.F. of the Boise resulted in bull trout observations in the Johnson Creek drainage, but, somewhat surprisingly, not in the Ross Fork drainage (both Johnson Creek and Ross Fk. are in the upper S.F. Boise patch). Five sample sites failed to detect bull trout in Ross Fork, even though surveys in the early 1990's noted several locations in Ross Fork where bull trout were present. Electrofishing surveys in 2001 at seven sites in the subwatershed detected bull trout at only one of three locations in the North Fork Ross Fork. The only obvious habitat problem on the Ross Fork is a substantial section of seasonally-dewatered channel.

Approximately the upper three miles of the mainstem Ross Fork goes subsurface in late summer and fall of most years, as do the lower reaches of the North and South forks. The dewatering is from excessive bedload deposits in these reaches, as abundant water is present in the mid- to upper channels of the forks. The channel porosity appears to be of natural origin, although it is possible that it could be caused at least partially by historic placer mining. It seems unlikely, however, as upstream adult spawner movement should occur in late spring or early summer, when flows are adequate for passage. Further, this condition was presumably in place during the 1990's, when bull trout appeared to be fairly well-distributed. Additional surveys of the Ross Fork subwatershed are planned for 2007.

Bull trout were not observed in Carrie Creek or Upper Little Smoky despite detection probabilities of 0.91 and 0.84, respectively. Although both patches appear to maintain water temperatures that are cold enough to support bull trout populations (MWMT 14.6°C and 15.1°C respectively), these patches are relatively small in acreage (2196 ha and 1957 ha, respectively) when compared to patches where BLT have been observed (median = 5052 ha; Figure 2). Additionally, temperatures downstream of each patch have frequently been recorded in excess of 26 deg. C., perhaps creating a thermal barrier to migratory bull trout.

During 2006 in the Salmon subbasin, fourteen patches were electrofished or snorkeled using formal protocols. Of the patches sampled, eight patches were determined to be occupied by bull trout (Figure 1). Most of these patches were known to biologists as supporting relatively strong bull trout populations. A large fire (Valley Rd Fire) burned extensive portions of the Warm Springs Creek, Fourth of July, and Champion patches during 2005. 2006 sampling indicated that bull trout distributions were resilient to the effects of the fire as bull trout maintained (or reestablished) historic distributions in these drainages. In fact, bull trout densities measured in 2006 in Fourth of July Creek were higher than any other survey in the upper Salmon River.

Electrofishing surveys failed to detect bull trout in the Fisher, Williams, Vat, Cabin, or upper Salmon patches and snorkel surveys did not detect bull trout in the Elk Creek patch. Probabilities of detection in the patches ranged from 0.27 to 0.98. Bull trout were observed in Cabin Creek during snorkel surveys in 2000 and it is possible that the population has been extirpated (see below). The Elk Creek patch (POD = 0.27) was only sampled with two snorkel surveys and will likely be sampled again in 2007. All of these patches maintain large and widely distributed brook trout populations, which on the Sawtooth N.F., are correlated with bull trout absence (see 2005 Sawtooth N.F. MIS Report).

In addition, both Cabin Creek and Fisher Creek have historically been isolated from downstream waters. In the case of Cabin Creek, numerous modifications to the watershed have resulted in reduced flows in downstream reaches and the lower portions of Cabin Creek generally have no surface water connections with Alturas Lake. In 2006, in an attempt to improve flows in lower Cabin Creek, the Sawtooth NRA removed an abandoned diversion on upper Cabin Creek. It is hoped that this project will help lead to future connectivity between Cabin Creek and Alturas Lake and perhaps lead to reestablishment of a bull trout population. The lower reaches of Fisher Creek are consistently dewatered by irrigators in the Sawtooth Valley and connectivity with the Salmon River is lacking during most seasons. Similarly, Williams Creek is also heavily influenced by water withdrawals and though it is rarely fully dewatered, during some summers, only limited flows reach the Salmon River. It is possible that in both cases, bull trout would be present if flow regimes were such that connectivity with the mainstem was maintained during bull trout migratory periods.

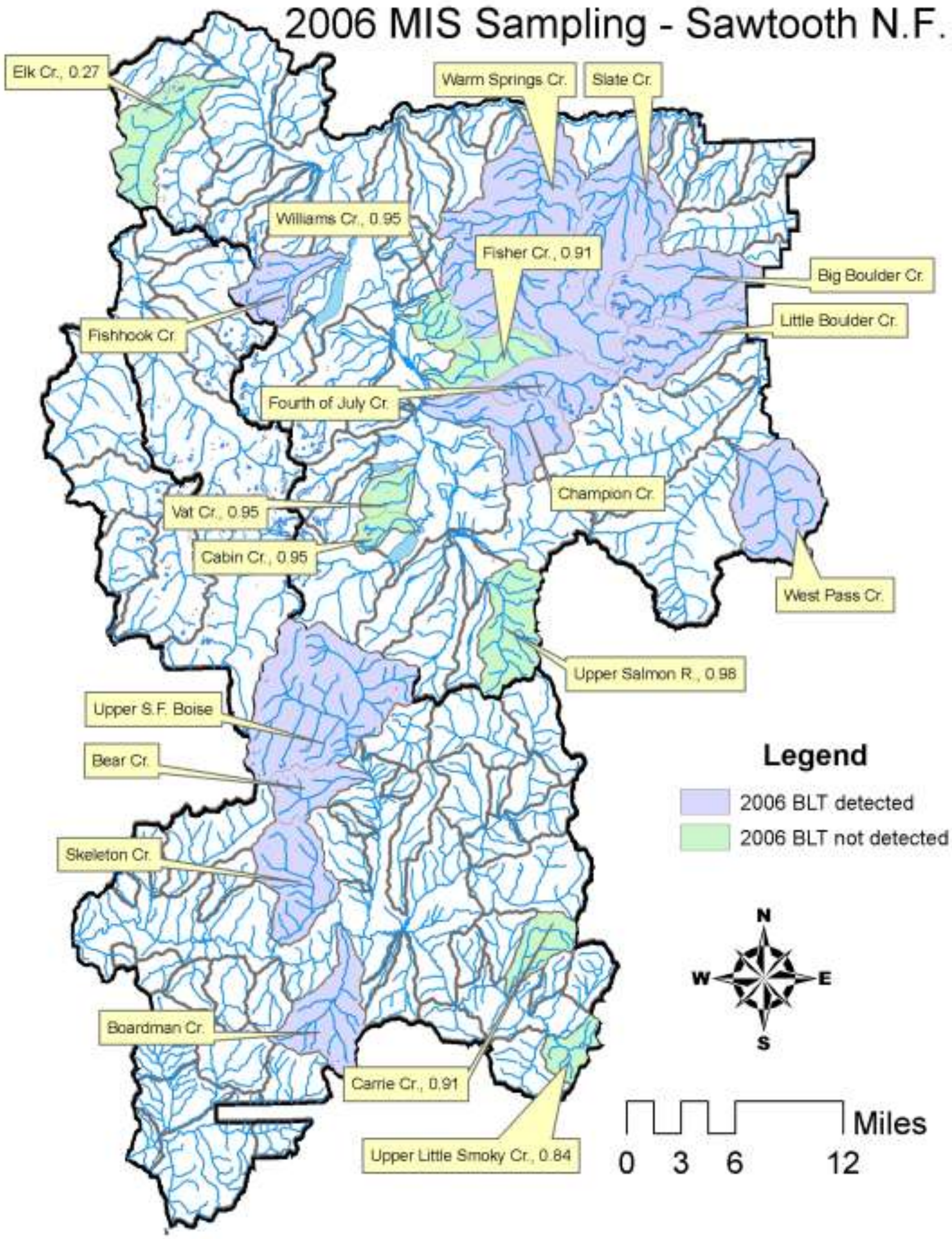

Figure 1 - Bull trout patches sampled and probabilities of detection on the North Zone of the Sawtooth N.F. (2006).

Bull Trout Detection Probabilities

Electrofishing data collected to date (2004-2006) allows for an empirical estimate of probability of detection that is independent from detection probabilities that are modeled by the WDAFS protocol. Empirical estimates are derived by randomly sampling in patches known to support a local bull trout population and then dividing the number of sites where juvenile bull trout were detected by the number of sites where juvenile bull trout were not observed (see Table 3). This estimate can then be used to assess the level of uncertainty associated with a patch where no juvenile bull trout are observed. As has been noted in other locations (Rieman and Kellett, personal communication), empirical estimates appear to be significantly higher than those estimated by WDAFS. With current empirical site-level estimates of detection probabilities, cumulative patch level probabilities approach 0.95 when 5 sample sites are sampled within a patch.

Table 3 - Overall site-level empirical estimate of bull trout detection probabilities.

Subbasin	Patch	# of Sites Sampled	# with BLT	# with Juv. BLT
Upper Salmon	West Pass	6	4	2
Upper Salmon	Big Boulder	4	2	2
Upper Salmon	Little Boulder	4	4	3
Upper Salmon	Slate	5	2	0
Upper Salmon	Fishhook	4	4	3
Upper Salmon	Crooked	7	1	1
S.F. Boise	Big Peak	5	5	5
S.F. Boise	N.F. Big Smoky	3	3	3
S.F. Boise	Bluff	1	1	1
S.F. Boise	Upper SF Boise	10	3	2
S.F. Boise	Bear	5	3	3
	Total	52	32	25
Empirical Estimate of Probability of Detection				25/52 = 0.46

Results and estimates of probabilities of detection for 2006 sample patches are noted in Table 4.

Table 4 - Summary of results from 2006 aquatic MIS sampling on the Sawtooth N.F.

Subbasin	Patch	Strata (2005)	Bull Trout Detected	# Sites sampled	# Sites where Bull Trout < 150mm were found	Empirical Probability Of Detection
Upper Salmon	Upper Salmon	2	-	6	0	0.98
Upper Salmon	Fishhook	2	+	4	3	NA
Upper Salmon	Fisher	2	-	4	0	0.91
Upper Salmon	Williams	2	-	5	0	0.95
Upper Salmon	Warm Springs	1	+	6	3	NA
Upper Salmon	Vat	3	-	5	0	0.95
Upper Salmon	Cabin	1	-	5	0	0.95
Upper Salmon	Elk	1	-	2	0	0.27*
Upper Salmon	Big Boulder	1	+	6	2	NA
Upper Salmon	Little Boulder	1	+	4	3	NA
Upper Salmon	Champion	1	+	3	0	NA
Upper Salmon	Fourth of July	1	+	2	2	NA
Upper Salmon	West Pass	1	+	6	2	NA
Upper Salmon	Slate	1	+	6	0	NA
S.F. Boise	Upper Little Smoky	2	-	3	0	0.84
S.F. Boise	Bear	1	+	5	3	NA
S.F. Boise	Upper SF Boise	1	+	11	2	NA
S.F. Boise	Boardman	1	+	16	11	NA
S.F. Boise	Carrie	2	-	4	0	0.91
S.F. Boise	Skeleton	1	+	12	6	NA

*Notes: *Elk Creek probability of detection estimate derived from WDAFS snorkeling protocol.*

Interestingly, current data suggests that bull trout are detected more frequently in relatively large patches vs. smaller patches (Figure 2). This could be artifact of sampling error associated with patch delineations, or may provide further insight into the habitat requirements of bull trout on the Sawtooth N.F. For example, larger patches, due solely to their larger size, may have a higher probability of providing the habitat heterogeneity necessary for bull trout persistence.

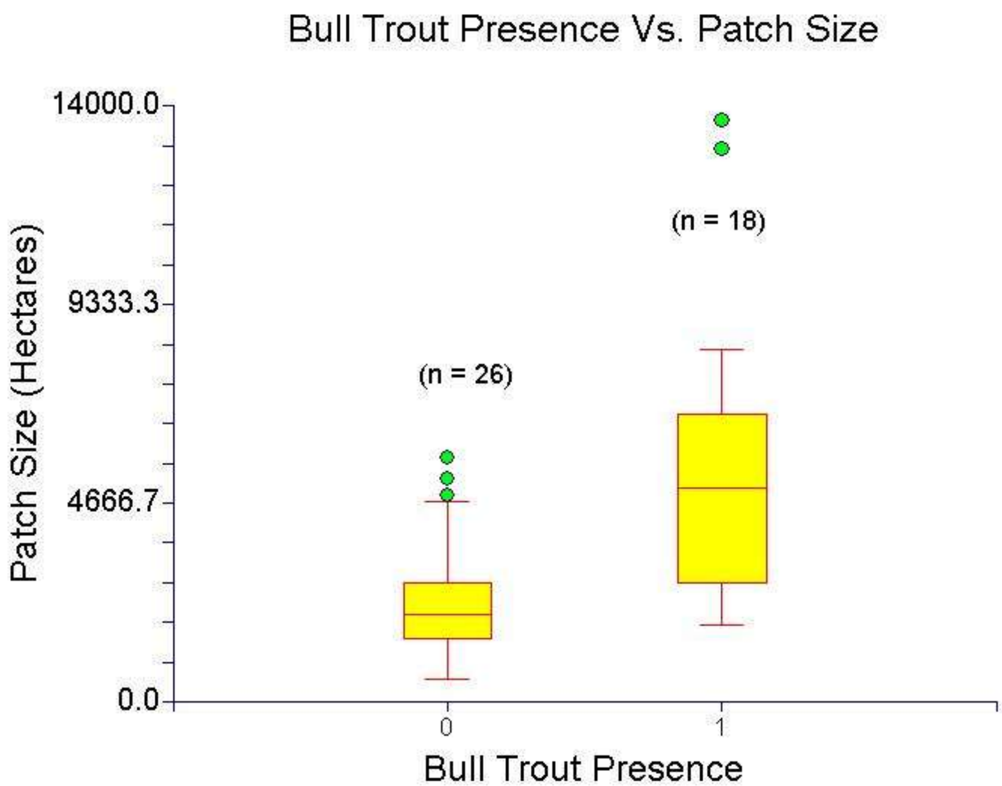

Figure 2 - Patch size (hectares) in patches where bull trout were detected (1) vs. those where bull trout were not observed (0). Figure includes 2004 – 2006 data. Warm Springs Creek (BLT = 1, 20961 hectares) was identified as a severe outlier and was removed from this figure.

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 et al. 2003), and update MIS patch strata. As such, stream temperature monitoring plays a critical role in this aquatic MIS approach. During 2006 in the Boise and Salmon sub-basins, 77 temperature loggers were deployed in 34 patches (Figure 4). Because maximum water temperatures on the Sawtooth tend to occur between mid-July and mid-September (Sawtooth NF. unpublished data), water temperature loggers are deployed in early summer (prior to July 1) 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 river drainage. In addition, Dunham (2003) found that the probability of bull trout occurrence was relatively high (>0.50) in streams with a maximum daily maximum temperature (MWMT, the warmest daily water temperature recorded during a given year or survey) <14-16° C.

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. Even though no statistically significant relationship was observed (two sample T-test, α = 0.05), median MWMT temperatures where bull trout were observed were lower than median MWMT temperatures where bull trout were not observed (Figure 3)).

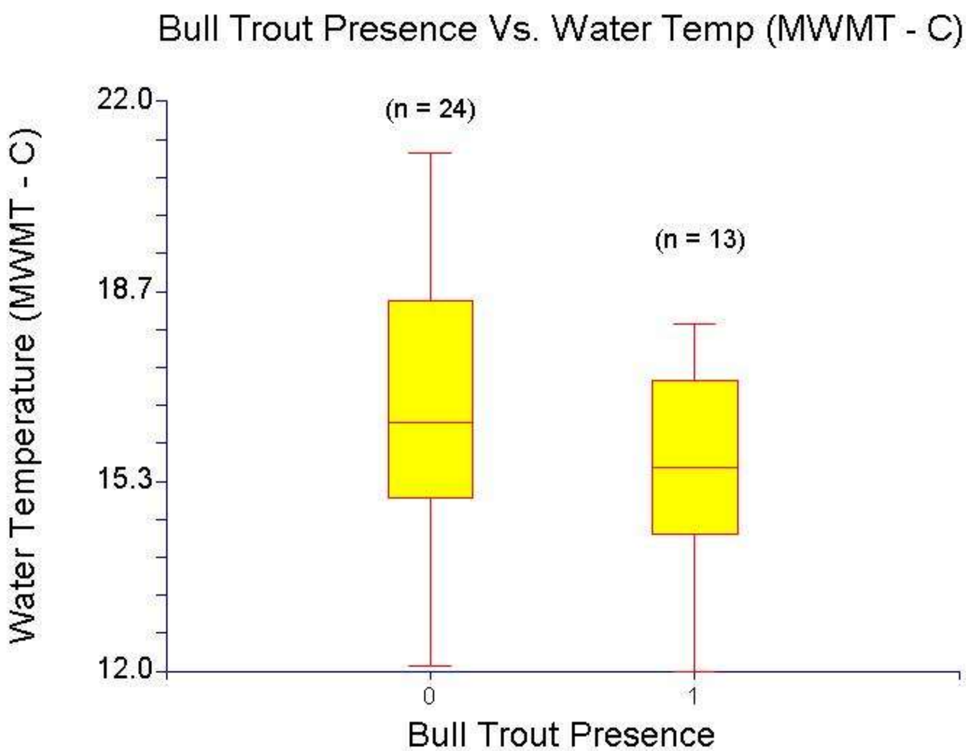

Figure 3 - Maximum weekly maximum temperature (MWMT - º C) as measured at the confluence of patches where bull trout were detected (1) vs. those where bull trout were not observed (0). Figure includes 2004 - 2006 data.

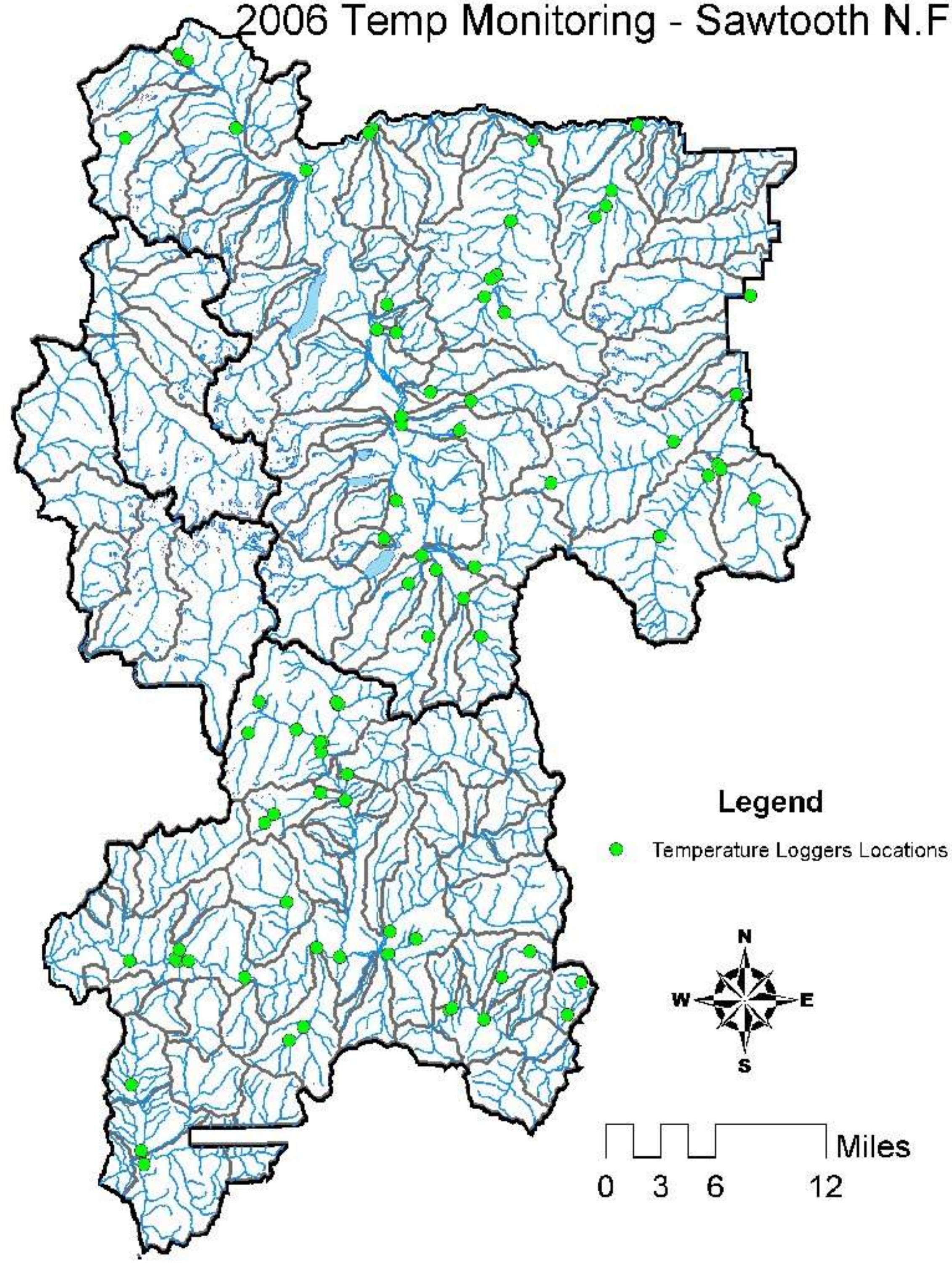

Figure 4 - Temperature Loggers Deployed on the North Zone of the Sawtooth N.F. (2006)

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. Current results suggest that patches must be large in order for isolated bull trout populations to persist and barriers that isolate small watersheds might prevent bull trout persistence (Figure 5). 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 Sawtooth N.F.

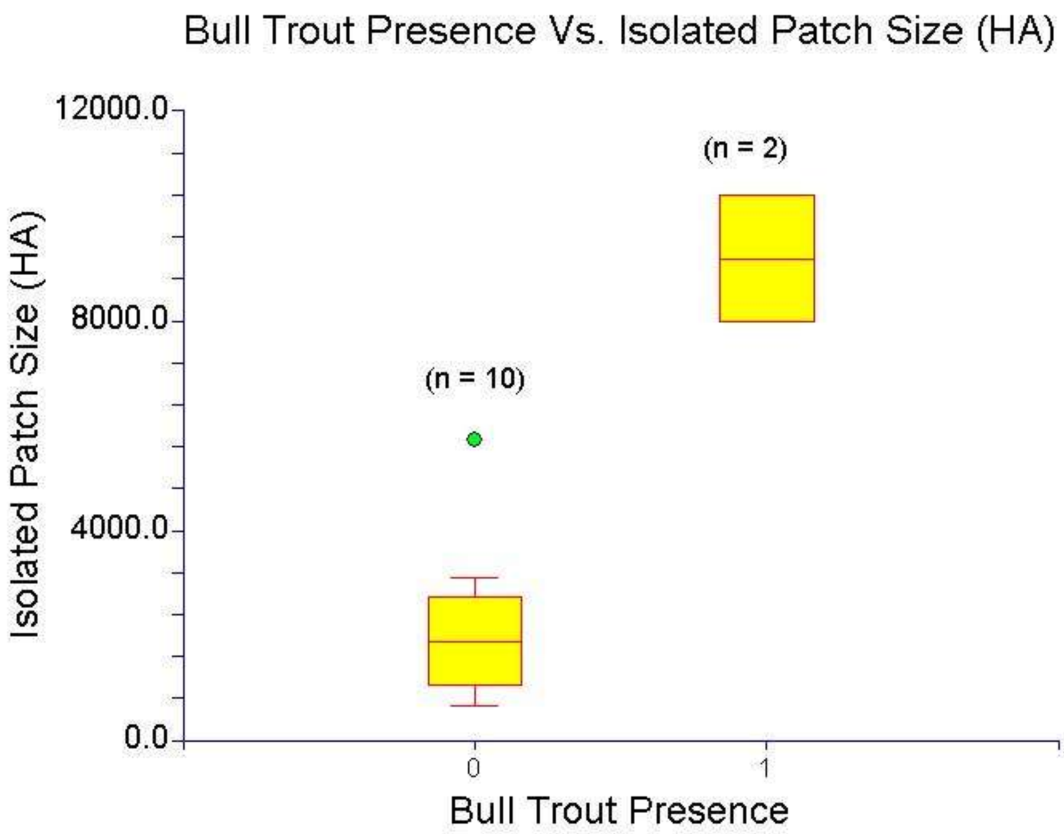

Figure 5 - Isolated patch size where bull trout were detected (1) or were not observed (0). Figure includes 2004-2006 data.

Conclusion

A variety of factors can influence the distribution of bull trout populations. As has been reported in the literature, results from MIS sampling on the Sawtooth N.F. indicates that patch size, stream temperature, fish passage barriers, and the occurrence of brook trout can all be associated with bull trout presence and persistence. In 2006, one patch that historically contained bull trout now appears to have lost that population (Cabin Creek), possibly as a result of isolation from downstream waters as well as competition and hybridization with brook trout. Within the upper S.F. Boise, it is possible that bull trout distributions were reduced within the patch as no bull trout were observed in Ross Fk., a historically occupied stream.

In other locations on the Forest, bull trout populations continue to occupy historically occupied patches, including Big and Little Boulder Creeks, West Pass Creek, Warm Springs Cr, Fourth of July Creek, Champion Creek, Fishhook Creek, Boardman Creek, Skeleton Creek, Bear Creek, and the upper S.F. Boise. Of particular note, several of these populations maintained or quickly reestablished historic distributions following a large wildfire, thus displaying resilience to a large scale natural disturbance. Additional sampling over the life of the forest plan will help further refine the habitat requirements and characteristics of bull trout populations on the Sawtooth N.F. Ultimately, this information will help inform proper land management decisions.

Table 5 - Fish species detected during 2006 MIS sampling on the Sawtooth N.F.

		Species Observed						
Subbasin	**Patch**	**BLT**	**BKT**	**RBT**	**CCT**	**CHS**	**SCP**	**WHF**
Upper Salmon	Upper Salmon		+		+		+	
Upper Salmon	Fishhook	+	+	+	+		+	
Upper Salmon	Fisher		+		+		+	
Upper Salmon	Williams		+			+	+	
Upper Salmon	Warm Springs	+			+			
Upper Salmon	Vat		+			+		
Upper Salmon	Cabin		+	+	+	+		
Upper Salmon	Elk		+	+	+			+
Upper Salmon	Big Boulder	+		+	+			
Upper Salmon	Little Boulder	+			+			
Upper Salmon	Champion	+	+	+	+	+		
Upper Salmon	Fourth of July	+			+		+	
Upper Salmon	West Pass	+		+			+	
Upper Salmon	Slate	+	+	+	+	+	+	+
S.F. Boise	Upper Little Smoky			+			+	
S.F. Boise	Bear	+		+			+	
S.F. Boise	Upper SFB	+		+			+	
S.F. Boise	Boardman	+		+			+	
S.F. Boise	Carrie			+				
S.F. Boise	Skeleton	+		+				

Note: BLT = bull trout, BKT = brook trout, RBT = redband/rainbow trout, CCT = cutthroat trout, CHS = Chinook salmon, SCP = sculpin, whitefish = WHF.

References

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., B. E. 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 Aquaculture **23**:894-904.

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

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

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

Meehan, W. R. 1991. Influences of forest and rangeland management on salmonid fishes and their habitat. American Fisheries Society, Bethesda, Maryland.

Peterson, B. J., J. Dunham, P. Howell, R. F. Thurow, and S. Bonar. 2002. Protocol for determining bull trout presence. Western Division of the American Fisheries Society.

Peterson, J. T., and J. B. Dunham. 2003. Combining inferences from models of capture efficiency, detectability, and suitable habitat to classify landscapes for conservation of threatened bull trout. Conservation Biology **17**:1070-1077.