Final Report

Upper Teton River
Tributary Trout Population Assessment

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Executive Summary

Trout population monitoring by the Idaho Department of Fish and Game (IDFG) indicated a 95% decline in the native Yellowstone cutthroat trout (YCT) population in the Teton River from 1999 to 2003 (Shrader et al. 2003). In response to this substantial decline in the native fishery, Friends of the Teton River combined resources with numerous state, federal, and private agencies in order to develop a watershed-wide assessment of the YCT population remaining in the mountain portions of all significant Teton River tributaries. The ‘Teton Headwaters Cutthroat Trout Population Assessment’ survey was implemented during the summer of 2005 to quantify trout populations and species composition in the mountain sections of 15 Teton River tributaries. The survey was conducted on United States Forest Service (USFS) land. One hundred meter long sample sites were placed every two kilometers, spanning from the USFS boundary upstream to the upper extent of flowing water on all significant tributaries in all selected drainages. Single-pass and multi-pass depletion electro-fishing methodologies were utilized in order to quantitatively assess trout populations, densities, and species compositions. Habitat characteristics, including stream geometry, substrate characteristics, bank conditions, large woody debris (LWD) abundance, and riparian vegetation types were also assessed. The results of this study provide an inventory of trout populations, trout densities, and species compositions, and species ranges in all Teton River tributaries, and a large-scale assessment of riparian habitat throughout the region’s USFS land.

Four drainages, Bitch Creek, Badger Creek, South Leigh Creek, and Darby Creek, were found to contain only Yellowstone cutthroat trout (YCT). The lack of Eastern brook trout (EBT) invasion in these drainages can be explained by the characteristics of these tributaries’ connectivity to the Teton River, and the fact that the Teton River becomes too large to sustain EBT before it meets Bitch and Badger creeks. Additionally the unaltered hydrology of Bitch Creek favors YCT, and likely prevents rainbow trout (RBT) invasion of the system (Van Kirk, 2005). South Leigh and Darby Creeks have not been invaded by EBT, probably because they are seasonally dewatered for irrigation for a substantially long distance and time, respectively. Eight drainages, North Leigh, Teton, Moose, Trail, Little Pine, Mahogany, Horseshoe, and Packsaddle Creeks, were found to contain populations of both YCT and EBT. In all of these drainages, EBT dominate the system in terms of species composition, population size, and species range. A comparison of this survey’s results with a 1998 survey reveals that the YCT percentage of the total trout population in five of these tributaries has declined.

Introduction and Project Need

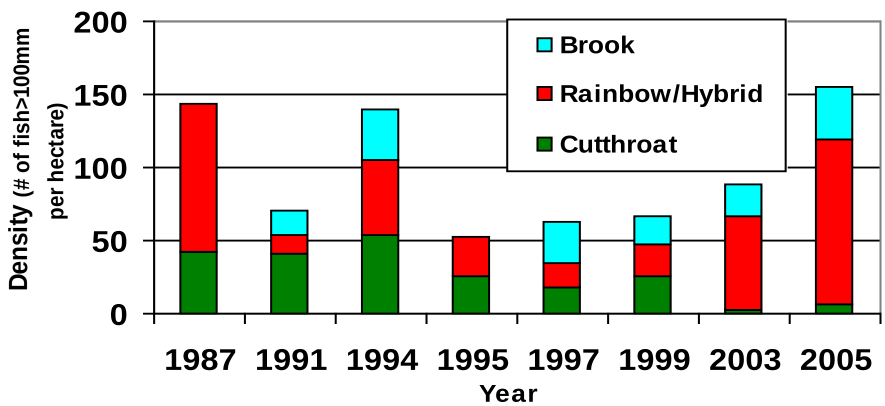
The Yellowstone cutthroat trout (YCT), *Oncorhynchus clarki bouvieri*, is the most abundant and widely dispersed species of native inland cutthroat trout. The historic range of the subspecies includes the Yellowstone River drainage in Montana and Wyoming upstream of the Tongue River, and the Snake River drainage in Wyoming, Idaho, Nevada, and Utah upstream of Shoshone Falls. Estimates of the percentage of historical range currently inhabited by YCT range from about 10% (Varley & Gresswell 1988) to about 43% (May et al. 2003). A large-scale quantitative evaluation estimated that YCT made up about 47% of the Upper Snake River Basin's estimated 2.2 million trout greater than 100 millimeters (Meyer et al. unpublished).

The decline of genetically pure YCT in Idaho is attributed to a combination of factors, including habitat degradation, genetic introgression, and nonnative competition (Varley & Gresswell 1988). Introduced eastern brook trout (EBT), *Salvelinus fontinalis,* are considered a serious threat because they almost always replace native cutthroat trout (Griffith 1972, Peterson et al. 2004), likely through direct and indirect competition that reduces YCT survival at the age-0 and age-1 stages. Chilcote (2004) quantitatively demonstrated that eastern brook trout were more aggressive than YCT, utilized more food resources and fed more often than YCT, and displaced YCT from shelter around large woody debris (LWD).

Hydrologic regime, specifically the ratio of the maximum peak spring flow to the winter minimum flow, has been linked to trout species composition in the upper Snake River watershed (Van Kirk 2005). High snowmelt spring flows in natural unaltered systems produce high maximum to minimum flow ratios. Conversely, low maximum to minimum flow ratios exist in altered systems where diversions remove water for irrigation or livestock, or where flows are controlled, as below reservoirs. Maximum to minimum flow ratios less than ten are associated with YCT absence and rainbow trout (RBT) presence, while ratios from ten to fifteen are associated with the presence of both species, and ratios greater than fifteen are associated with only YCT presence.

In the upper Teton River main stem, biannual monitoring by the Idaho Department of Fish and Game (IDFG) documented a 95% decline in the YCT population in conjunction with a 319% increase in the nonnative trout species population from 1999 to 2003 (Shrader 2003). Monitoring in 2005 revealed a subsequent increase in the abundance of all trout species, which is likely due to increases in annual precipitation. Figure 1 depicts the findings of IDFG biannual monitoring in the Teton River main stem.

Figure 1. Teton River Trends in Trout Density



The U.S. Forest Service (USFS) conducted a trout survey during 1997 and 1998 in upper Teton River tributaries (Kellogg 1998). The project revealed YCT presence in thirty-five of the forty-eight sampled stream segments, and found three streams (South Badger, Darby, and South Leigh creeks) that only contained YCT. The survey was a comprehensive effort to document the status of trout populations in Teton River tributaries on USFS land. The effort was a relative abundance survey, and has not yet been quantitatively analyzed. Since 1998 the USFS, IDFG, and the Wyoming Game and Fish Department (WGF) have conducted additional surveys on various portions of upper Teton River tributaries. Currently, the USFS recognizes the YCT as a 'Sensitive' species.

During the summer of 2005, Friends of the Teton River (FTR) conducted a comprehensive assessment of the upper Teton River's mountain tributary trout populations. FTR collaborated with the USFS, IDFG, and WGF in designing the project methodologies and protocol. Approximately five percent of the length of streams on USFS land was sampled in order to quantify trout populations, species composition, species range, and habitat parameters using the USFS protocol. Survey analysis also determined correlations between habitat characteristics and YCT presence. Fin clips collected during the survey (yet to be analyzed) will be used to assess the current genetic condition of YCT, specifically the level of rainbow trout introgression and the extent to which YCT are isolated, and will be reported separately.

Collaborators

The project was made possible only through the collaboration and support of numerous government agencies, non-profit organizations, private companies, and local citizens. We thank the following significant contributors: the Caribou-Targhee National Forest, Native Trout Subcommittee of the Henry's Fork Watershed Council, Idaho Fish and Game, Teton Valley Trout Unlimited, Nation Forest Foundation, Wyoming Game and Fish Department, Snake River Cutthroats, Federation of Fly Fishers, Henry's Fork Watershed Council, One Fly Foundation, Targhee Institute Environmental Foundation, Dr. Rob Van Kirk at Idaho State University, Karen Scheid, Community Foundation of Jackson Hole, and the National Fish and Wildlife Foundation Bring Back the Natives program.

Data Collection Methods

The fifteen largest tributaries of the upper Teton River watershed were identified for sampling. One hundred meter long survey sites were placed every two kilometers, spanning from the USFS boundary upstream to the extent of water. The location of the first site upstream of the USFS boundary was randomly selected. Sites were placed on all tributary forks that appeared on the 1:100,000 GIS stream layer (acquired from the National Hydrography Dataset website). Sites were placed in the middle of the mapped section of tributaries less than four kilometers in length. In the case of tributaries longer than four kilometers in length, a site was placed randomly within the first two kilometers of stream, and subsequent sites were placed every two kilometers up the drainage until the end of flowing water was reached.

All sample sites were located on the ground using the UTM coordinates that were determined during the GIS site selection process. On the ground UTM coordinates were recorded at the downstream end of each site in NAD 27, using a Garmin handheld GPS receiver. Ambient conductivity and water temperature were also measured at the downstream end of each site. A one hundred meter tape was then strung along the bank, and the upstream and downstream ends of the sample area were block netted to prevent fish from escaping or entering the sample section in order to ensure that sampling would occur on a closed population. All sites were sampled using a gas or battery operated backpack electro-fisher (Smith-Root 15-D type), except the sites located on the downstream portion of the main stem of Bitch Creek. These sites were snorkel surveyed because they were too large to effectively electro-fish.

The electro-fisher settings of voltage, frequency, and duty cycle were determined by the physical characteristics of each site (water conductivity, creek size, water volume, etc.). The lowest effective electro-fisher settings were used in order to minimize trout injury. The sample time, defined as the seconds during which the electro-fisher was activated, was also recorded.

Two thirds of the sites were sampled with single-pass electro-fishing. The other (randomly selected) third of the sites were sampled to depletion. At depletion sites, consecutive passes were conducted with the electro-fisher, with each pass resulting in the capture of fewer and fewer trout, until eventually most or all of the trout in the reach had been captured. Trout removal rates (per electro-fisher pass) from the multi-pass sites allowed for the calculation of capture efficiency.

All trout captured within the sample sites were identified, measured (fork length), and released. Fin clips were collected from all captured YCT, rainbow trout, and any potential hybridized cutthroat trout. These samples will be genetically analyzed in order to assess the level of rainbow trout introgression and the extent to which YCT populations are isolated.

After completion of the electro-fishing survey, habitat parameters were measured. The number of pool habitat units in the hundred-meter reach was counted. Pools were defined as slow water areas with a defined pool tail that occupied at least a third of the wetted width of the channel, and had no depth requirements. The maximum depth of the first three pools in each reach was recorded. The number of single LWD pieces in the bankful channel was counted, as was an estimation of the total number of pieces in any LWD aggregates located within the channel. The dominant and subdominant substrate types were visually estimated as being bedrock, boulder (>256mm), cobble (64-256mm), gravel (6-64mm), or fines (<6mm). The percent of surface fines located in pool tail habitat was visually estimated and averaged throughout the reach. The percent of stable banks in the reach was also visually estimated. Any bank sections that were actively eroding, slumping, or deteriorating were counted as unstable. Four cross sections were also measured in each sample reach, located at the downstream end, 33 meters upstream, 66 meters upstream, and at the upstream end. At each cross section, crews recorded measurements of wetted width, water depth at the thalweg, and water depth halfway between the thalweg and each wetted edge. Additional habitat characteristics that were measured or characterized included the dominant over-story and under-story species in the reach, the Rosgen Channel type (Rosgen 1985), the weather, air temperature, water temperature, time of day, and the participating crew members.

Photographs were taken, facing upstream and downstream, at both the top and the bottom of each sample reach. Additional photographs were taken of any unique or significant riparian habitat features located within the reach, such as mass wasting events, trail crossings, or potential fish barriers. Photographs were also taken of most captured YCT (and potential hybrids).

A ‘Stream Reach Inventory and Channel Stability Evaluation Form’ designed by Dale Pfankuch was completed at all multi-pass depletion sites in an effort to conduct a systematic evaluation of stream stability and capacity to recover from potential changes in flow and sediment production (Pfankuch 1978).

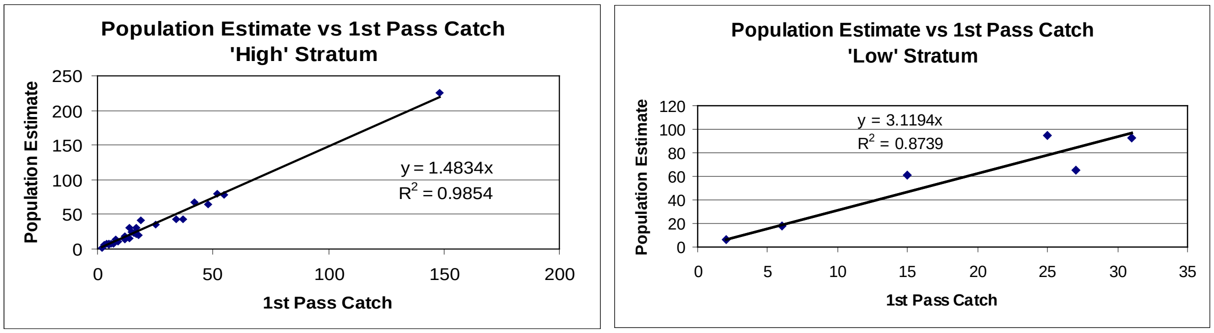
Data Analysis Methods

Electro-fishing data were used to calculate species compositions, trout populations, and trout densities in all sampled tributaries. One hundred and fifty three sites were sampled during this survey, thirty of which were multi-pass depletion sites. Trout removal patterns from all multi-pass depletion sites were analyzed using MicroFish 3.0, a software program that calculates capture probabilities and population estimates. Understanding the capture efficiency is important because a single pass with the electro-fisher typically did not remove all trout from the sample reach, and so did not effectively determine the reach population size. Crews did not have time to conduct depletion surveys at all reaches in order to pinpoint population sizes, but using the capture efficiency values it was possible to extrapolate the total population size at single-pass sample reaches.

All multi-pass depletion sites were divided into two strata, based upon their capture efficiency as calculated by MicroFish software. The two strata were analyzed separately, then the resulting population estimates were added to yield total population estimates. Separating the data into two strata meant that relatively little error was associated with the high capture efficiency stratum, which contained a majority of the sites, while the larger error was confined to the low capture efficiency stratum, which contained only a few sites. A stratum named ‘high’ contained all multi-pass sites with a capture probability of 0.4 or higher, and a stratum labeled ‘low’ contained the remaining multi-pass sites, which had capture probabilities below 0.4. All single pass sites were then associated with the multi-pass site that had the most similar characteristics, namely geographic proximity, sample date, and stream order. Single pass sites were then assigned to the same stratum that contained the associated multi-pass site.

Abundance estimates were calculated using two different methodologies. (A more technical description of abundance estimation methods can be found in Appendix A.) Firstly, a capture probability methodology involved dividing the number of trout captured at each single pass site by the average capture probability of the multi-pass sites in that stratum. Secondly, a ratio methodology involved plotting first pass catch verses MicroFish calculated population estimates for all multi-pass sites. A best-fit line was then assigned through the plotted points from both the ‘high’ and the ‘low’ stratum. The best-fit lines, their equations, and (R^2) a statistical measure of the regression lines’ fit to the data are depicted in Figure 2.

Figure 2. Population Estimate verses First Pass Catch



In both strata, the Y-intercept was determined to be not statistically different from zero, so forcing it to zero was acceptable. The sum of the population estimates divided by the sum of the first pass catch (R hat) was then multiplied by the first pass catch at each single pass site.

Using both methodologies, the population estimates were derived by extrapolating from the total number of salmonids caught. Therefore, site specific population estimates were multiplied by the species composition of that site's catch in order to generate site specific species population estimates. This methodology assumes that there is no difference between the capture efficiency of different trout species. The benefit of this assumption is that extrapolations can be based upon the relatively large numbers of captured salmonids, rather than on each species' catch, which in some cases was just one or two individuals.

The total population estimate for each tributary was calculated from the population estimates at each sampled site. Each site was assumed to relate to a stream segment that reached halfway to the immediately downstream site and halfway to the immediately upstream site. The length (in meters) of these stream segments was calculated using a GIS analysis. Each population estimate was then linearly extrapolated to the corresponding stream segment, and all segments in each drainage were summed in order to obtain a drainage population estimate.

Trout densities in all drainages were calculated, and are presented in terms of trout per stream meter. Densities were calculated by dividing the population estimates for each species by the number of stream meters associated with sampled sites where each species was encountered.

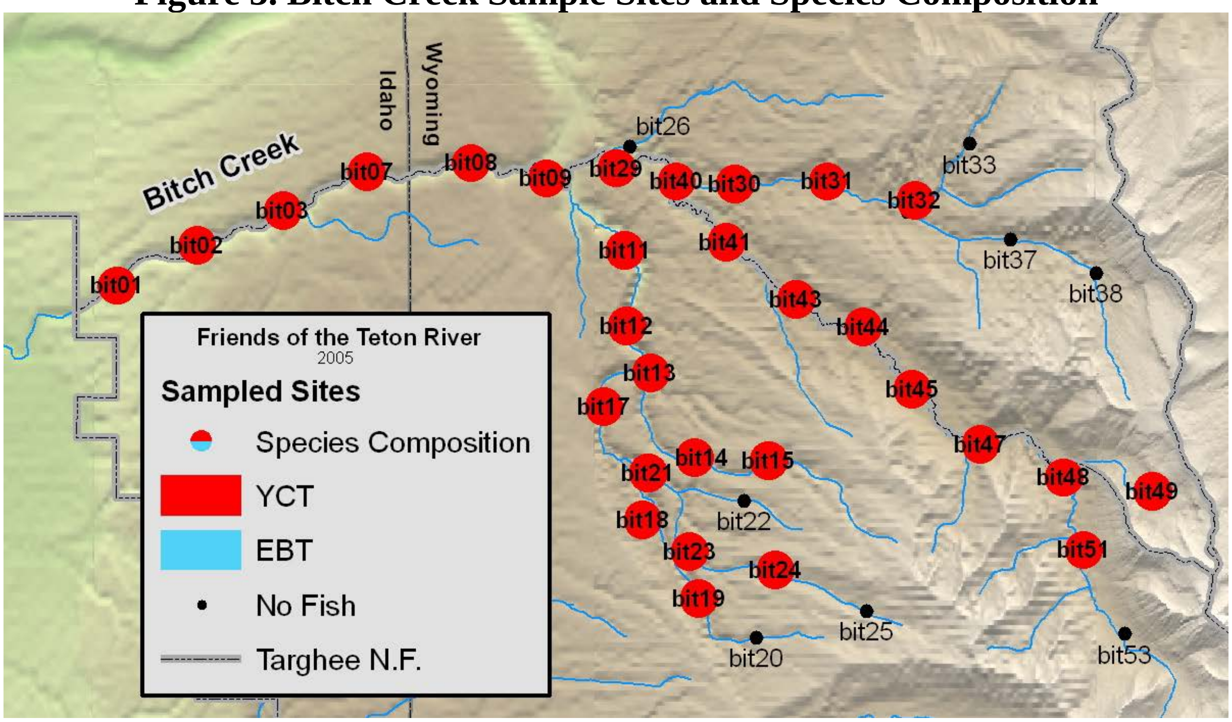
Tributary Level Results

Bitch Creek

Bitch Creek generally flows in a westerly direction, from its headwaters in the Jedediah Smith Wilderness to its confluence with the Teton River. Bitch Creek is one of the most pristine drainages in the upper Teton watershed. There are no irrigation diversions on Bitch Creek, and much of the drainage lies in the Jedediah Smith Wilderness area. The creek flows perennially (into the Teton River) from its headwaters to the mouth. The three main forks in the drainage are the North Fork, the South Fork, and Jackpine Creek. There are several smaller tributaries in the drainage.

Figure 3 depicts all sampled sites in the Bitch Creek drainage, identified by site number. Each site where trout were captured is represented by a small pie chart depicting the species composition of all captured trout. YCT are represented in red, and EBT are represented in blue, and sites where no trout were captured are represented by black dots.

Figure 3. Bitch Creek Sample Sites and Species Composition



Thirty-nine sites were sampled in the Bitch Creek drainage. Sites numbered one through nine, located at the downstream end of the mountainous portion of the drainage, were too large to effectively electro-fish. These sites were surveyed using the USFS snorkel survey methodology. Trout were captured throughout the drainage, with the highest concentrations located in Jackpine Creek and in the South Fork of Bitch Creek. The upper extent of trout throughout the drainage appears to be limited by the high gradient and minimal flows. Sites numbered eleven, fifteen, twenty-four, twenty-nine, thirty-two, forty, forty-three, forty-five, and forty-seven were sampled as multi-pass depletion sites. All depletion sites, and therefore all single pass sites, were in the 'high' capture efficiency strata for analysis purposes.

The Bitch Creek drainage, from the USFS boundary upstream, contains only one trout species, namely YCT. The drainage does not contain EBT, probably because the Teton River becomes too large to support EBT before its confluence with Bitch Creek. The drainage does not contain RBT, probably because the unaltered hydrology results in a high maximum to minimum flow ratio, which favors YCT and inhibits RBT (Van Kirk, 2005). The result of these factors is that Bitch Creek has not been invaded by exotic species, and the YCT populations in the Teton River and upper Bitch Creek are effectively connected by the main stem of Bitch Creek, which flows year round.

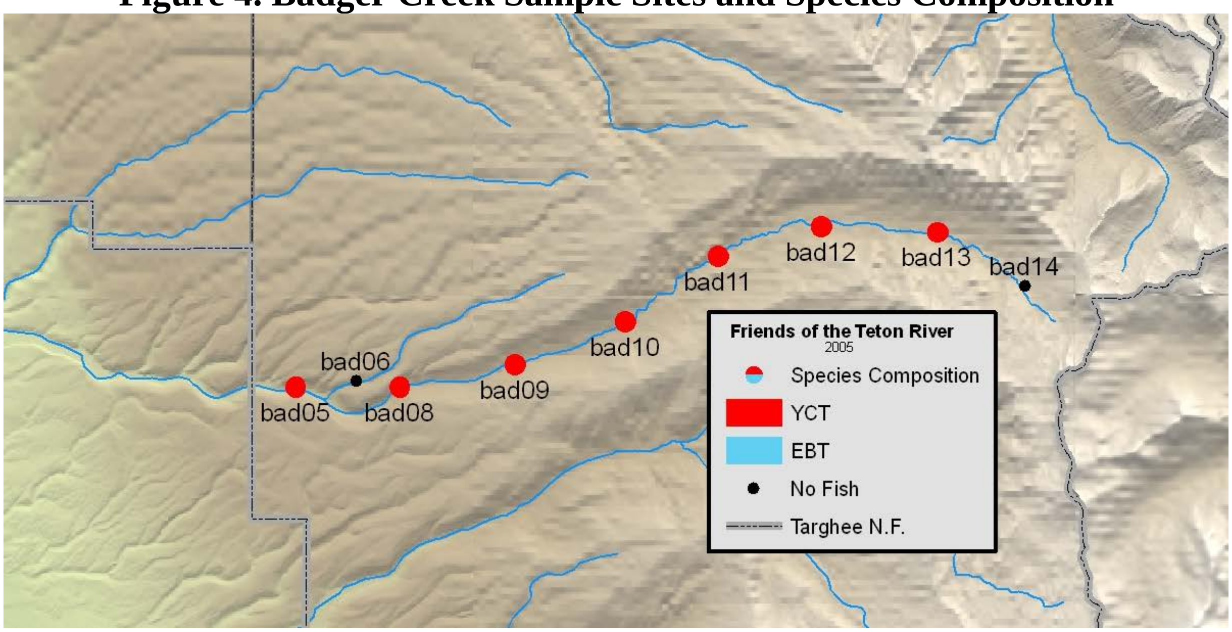
According to the 1:24000 hydrology GIS layer used during this survey, there are 113,561 meters of stream upstream of the USFS boundary in the Bitch Creek drainage. Sampling revealed that 52,676 meters of stream are dry or devoid of trout, while 61,703 meters of stream are inhabited by only YCT.

Badger Creek

Badger Creek generally flows in a westerly direction, from its headwaters in the Jedediah Smith Wilderness to its confluence with the Teton River. The South Fork of Badger Creek is the main stem in the drainage, and is referred to as such, while the tributaries to the north are small and dry during typical summer months.

Figure 4 depicts all sampled sites in the Badger Creek drainage, identified by site number. Each site where trout were captured is represented by a small pie chart depicting the species composition of all captured trout. YCT are represented in red, and EBT are represented in blue, and sites where no trout were captured are represented by black dots.

Figure 4. Badger Creek Sample Sites and Species Composition



Nine sites were sampled in the Badger Creek drainage. Sites numbered one through four, located on the North Fork of Badger Creek, were not sampled because they were dry or did not contain enough water to electro-fish. Trout were captured only on the main stem of Badger Creek. No trout were captured at the highest site in the drainage, which indicates that the upper extent of trout is probably limited by the increased gradient and minimal flows. Sites numbered eight and ten were sampled as multi-pass depletion sites. Both depletion sites, and therefore all single pass sites, were in the ‘high’ capture efficiency strata for analysis purposes.

The Badger Creek drainage, from the USFS boundary upstream, contains only one trout species, namely YCT. The drainage does not contain EBT, probably because the Teton River becomes too large to support EBT before its confluence with Badger Creek. The drainage does not contain RBT, probably because the middle section of Badger Creek is dry during much of the summer, and the relatively unaltered hydrologic regime of the upper and middle sections of the drainage results in a high maximum to minimum flow ratio that dissuades RBT invasion.

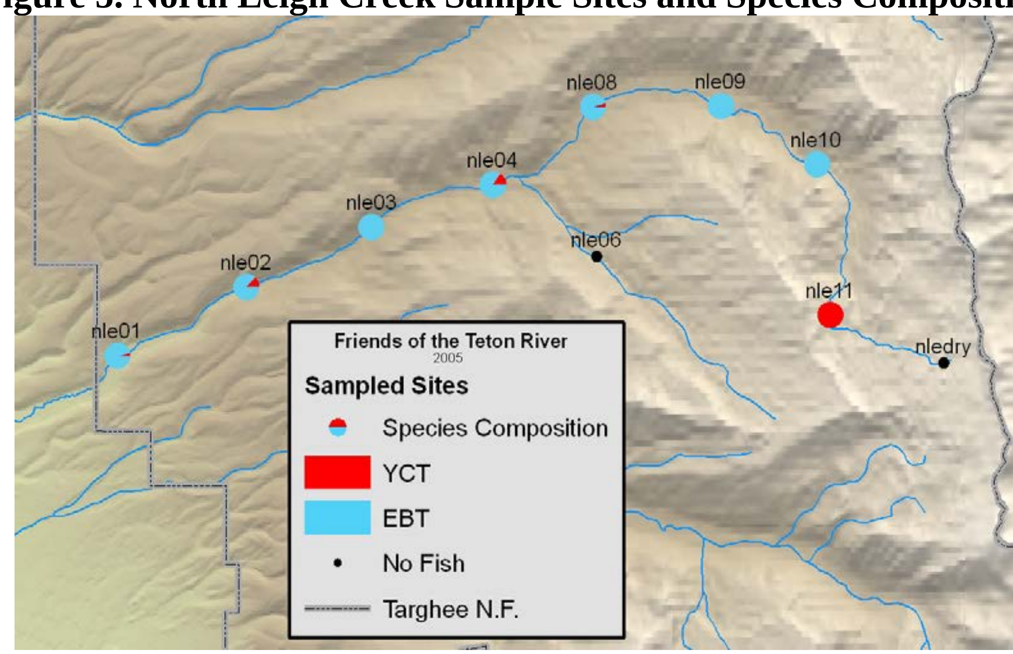
According to the 1:100,000 hydrology GIS layer used during this survey, there are 20,320 meters of stream upstream of the USFS boundary in the South Badger Creek drainage. Sampling revealed that 6,480 meters of stream are dry or devoid of trout, while 13,840 meters of stream are inhabited by only YCT.

North Leigh Creek

North Leigh Creek generally flows in a westerly direction, from its headwaters in the Jedediah Smith Wilderness to its confluence with the Teton River. The drainage is composed of one main stem that is joined from the south by a single smaller tributary named Tin Cup Creek. There is a trailhead parking area located roughly six kilometers above the USFS boundary, from where a trail heads east into the Jedediah Smith Wilderness. There is no motor vehicle traffic permitted in Wilderness areas, so only horse and foot travel are permitted in the headwaters of North Leigh Creek. There is a series of lakes high in the drainage named Green Lakes. Trout were allegedly stocked in these high mountain lakes, but the specifics regarding stocking date, location, and species are difficult to decipher from the historical stocking records.

Figure 5 depicts all sampled sites in the North Leigh Creek drainage, identified by site number. Each site where trout were captured is represented by a small pie chart depicting the species composition of all captured trout. YCT are represented in red, and EBT are represented in blue, and sites where no trout were captured are represented by black dots.

Figure 5. North Leigh Creek Sample Sites and Species Composition



Nine sites were sampled in the North Leigh Creek drainage, distributed throughout the system. Trout were found only on the main stem, but spanned from the USFS boundary up to the alpine lakes in the drainage headwaters. Sites numbered one and nine were sampled as multi-pass depletion sites. Both multi-pass depletion sites, and therefore all single pass sites, were in the ‘high’ capture efficiency strata for analysis purposes.

The North Leigh Creek drainage, from the USFS boundary upstream, contains both EBT and YCT. No trout were found in the Tin Cup Creek tributary. YCT were found in the lower section of the main stem, and in the Green Lakes basin high in the drainage. This basin is isolated from the lower section of the drainage by a stretch of very high gradient stream located a few hundred meters downstream of the lowest lake. YCT were reportedly historically stocked in these lakes, and currently exist allopatrically (in a geographic area devoid of other trout species) in the basin, protected from EBT invasion by an impassibly steep section of stream. A site located immediately above the upper most lake was not sampled because it did not contain enough water to electro-fish during the time of this survey.

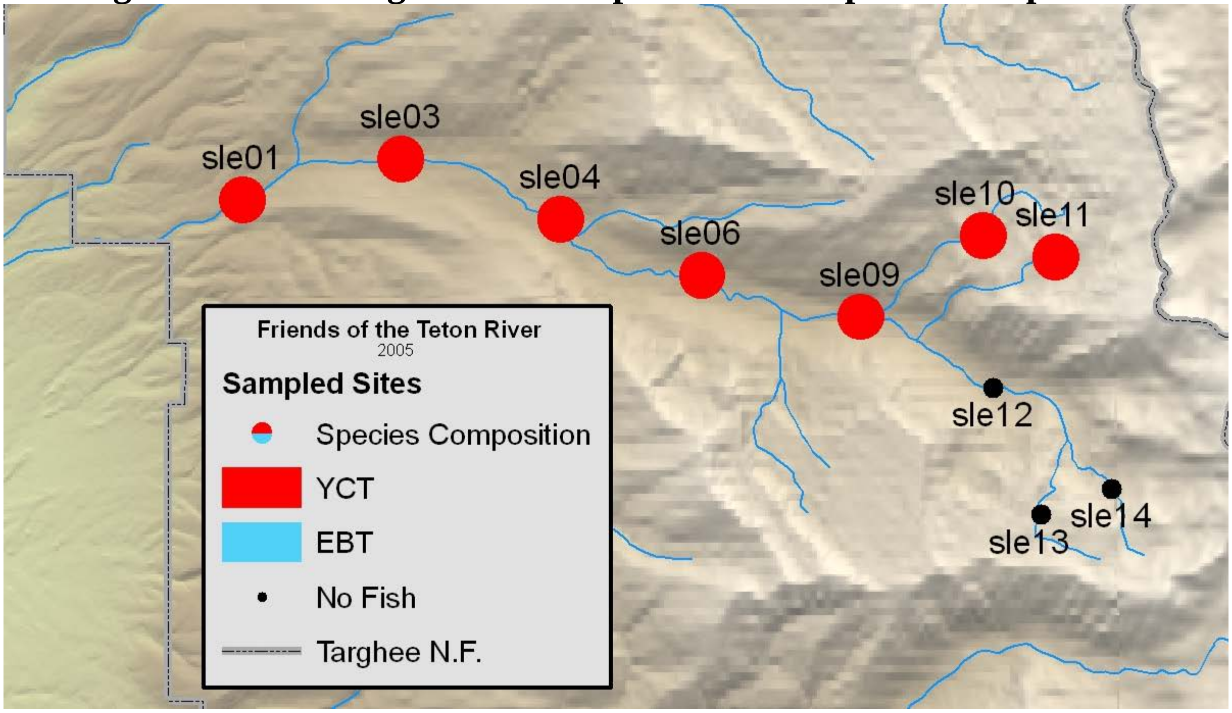
According to the 1:100,000 hydrology GIS layer used during this survey, there are 25,401 meters of stream upstream of the USFS boundary in the North Leigh Creek drainage. Sampling revealed that trout inhabit 16,407 stream meters in the drainage, while 8,994 meters of the drainage are dry or devoid of trout. EBT are present in the lower 14,107 meters of the main stem. YCT exist sympatrically (in the same geographic region) with EBT in the lowest 9,881 stream meters of the main stem. A likely isolated population of YCT exists in 2,300 meters of the drainage that is encompassed in the Green Lakes basin.

South Leigh Creek

South Leigh Creek generally flows in a westerly direction, from its headwaters in the Jedediah Smith Wilderness to its confluence with the Teton River. The drainage is composed of one main stem that is joined by several smaller tributaries. There is a trailhead parking area located upstream of the USFS boundary, from where a trail parallels South Leigh Creek and heads upstream into the Jedediah Smith Wilderness. There are two lake-filled cirques located high in the drainage, namely Granite Basin and South Leigh Lakes. Trout were allegedly stocked in these high mountain lakes, but the specifics regarding stocking date, location, and species are difficult to decipher from the historical records. Grand Targhee Ski Resort is located immediately west of the South Leigh Lakes basin.

Figure 6 depicts all sampled sites in the South Leigh Creek drainage, identified by site number. Each site where trout were captured is represented by a small pie chart depicting the species composition of all captured trout. YCT are represented in red, and EBT are represented in blue, and sites where no trout were captured are represented by black dots.

Figure 6. South Leigh Creek Sample Sites and Species Composition



Ten sites were sampled in the South Leigh Creek drainage, distributed throughout the system. Trout were found on the main stem spanning from the USFS boundary up to Granite Basin, but were not found in streams in the South Leigh Lakes basin. Sites numbered one and six were sampled as multi-pass depletion sites. Both multi-pass depletion sites, and therefore all single pass sites, were in the 'high' capture efficiency stratum for analysis purposes.

The South Leigh Creek drainage, from the USFS boundary upstream, contains only YCT. No EBT were found in the drainage. YCT were found in the main stem, and in the alpine lakes in Granite Basin. YCT were reportedly historically stocked in these lakes, which are isolated from the main stem of the drainage by a series of steep waterfalls and cascades.

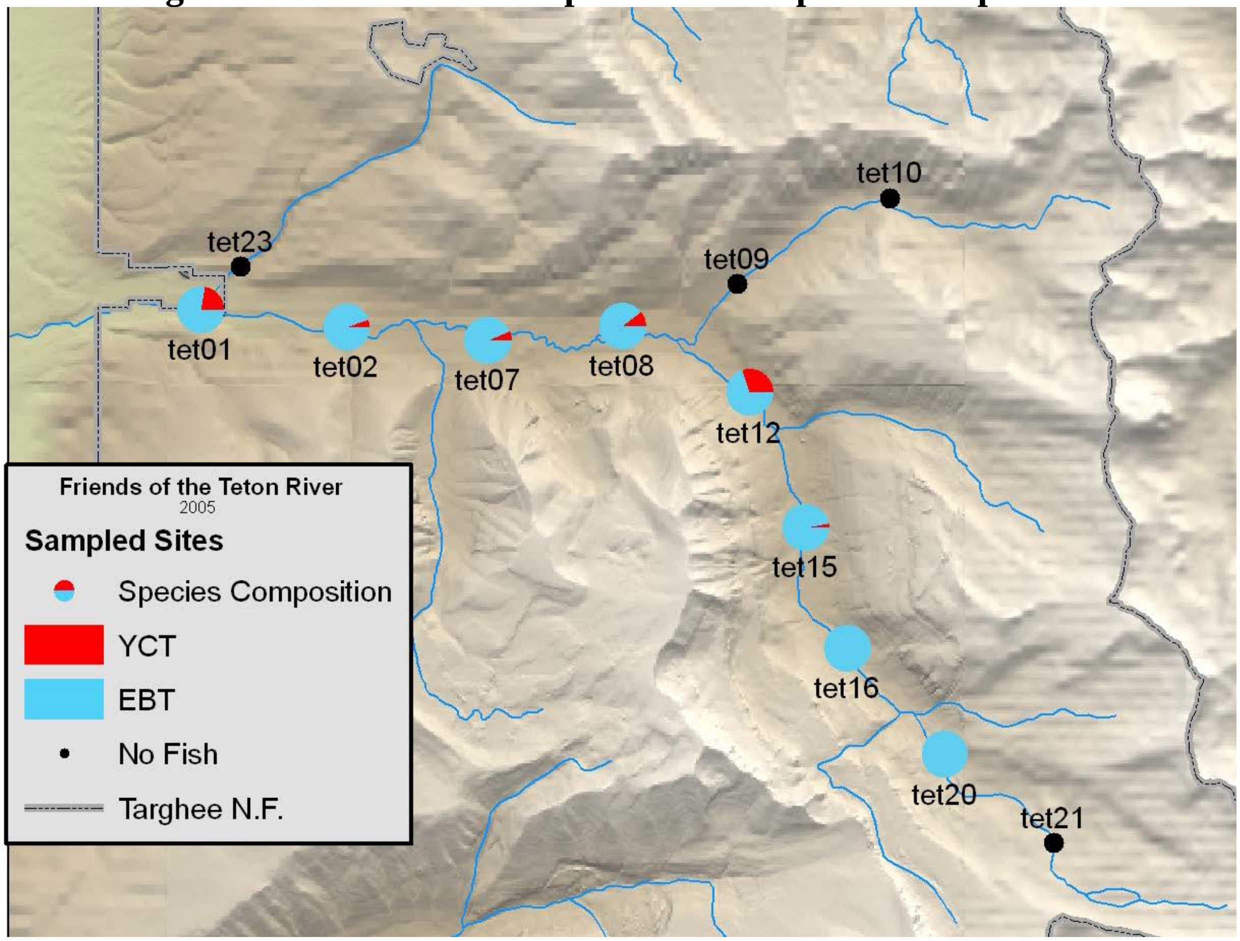
According to the 1:100,000 hydrology GIS layer used during this survey, there are 32,052 meters of stream upstream of the USFS boundary in the South Leigh Creek drainage. Sampling revealed that 16,312 meters of the drainage are dry or devoid of trout. YCT inhabit a total of 15,740 stream meters in the drainage. Roughly 5,505 of these YCT inhabited stream meters are located in the isolated Granite Basin.

Teton Creek

Teton Creek generally flows in a westerly direction, from its headwaters in the Jedediah Smith Wilderness to its confluence with the Teton River. The drainage is composed of one main stem that is joined several times by smaller tributaries. There is a USFS road that parallels Teton Creek until it ends at a trailhead roughly seven kilometers above the USFS boundary. A highly accessible trail heads up Teton Creek from this trailhead. Teton canyon hosts the most traffic of any non-thoroughfare canyon in Teton Valley. There are numerous trailheads, campgrounds, and recreation opportunities located throughout the Teton Creek drainage.

Figure 7 depicts all sampled sites in the Teton Creek drainage, identified by site number. Each site where trout were captured is represented by a small pie chart depicting the species composition of all captured trout. YCT are represented in red, and EBT are represented in blue, and sites where no trout were captured are represented by black dots.

Figure 7. Teton Creek Sample Sites and Species Composition



Twelve sites were sampled throughout the Teton Creek drainage, but trout were found only in the main stem. Sites numbered seven, twelve, and sixteen were sampled as multi-pass depletion sites. All multi-pass depletion sites, and therefore all single pass sites, were in the 'high' capture efficiency stratum for analysis purposes.

The Teton Creek drainage, from the USFS boundary upstream, contains YCT and EBT. The North Fork of Teton Creek contained no trout during this survey. YCT were found sympatrically with EBT at the lowest six out of eight sites on the main stem. YCT were greatly outnumbered by EBT at all of these sites.

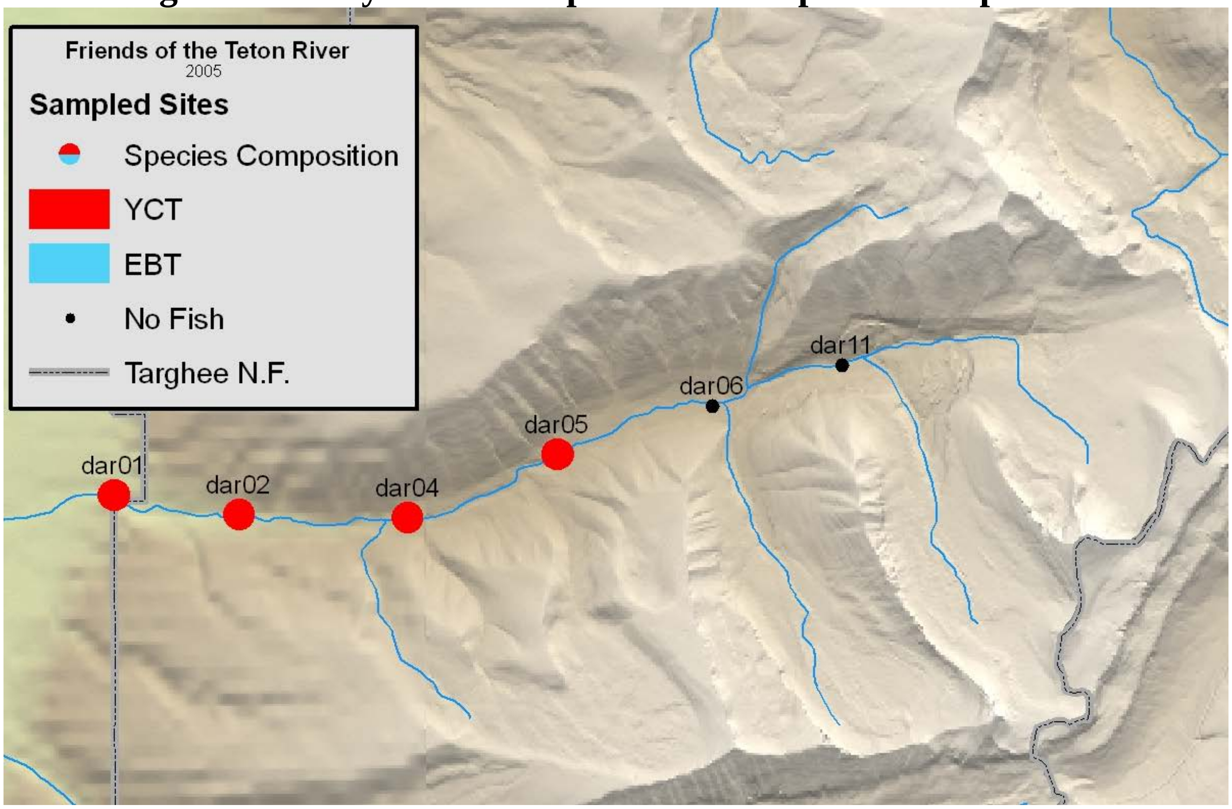
According to the 1:100,000 hydrology GIS layer used during this survey, there are 52,917 meters of stream upstream of the USFS boundary in the Teton Creek drainage. Sampling revealed that 36,059 meters of the drainage are dry or devoid of trout. EBT inhabit 16,221 stream meters in the drainage, and 12,356 of these stream meters are inhabited sympatrically with YCT.

Darby Creek

Darby Creek generally flows in a westerly direction, from its headwaters in the Jedediah Smith Wilderness to its confluence with the Teton River. There is one main fork in the Darby Creek drainage that is joined by several small tributaries on the north and the south.

Figure 8 depicts all sampled sites in the Darby Creek drainage, identified by site number. Each site where trout were captured is represented by a small pie chart depicting the species composition of all captured trout. YCT are represented in red, and EBT are represented in blue, and sites where no trout were captured are represented by black dots.

Figure 8. Darby Creek Sample Sites and Species Composition



Six sites were sampled in the Darby Creek drainage. Sites located on tributaries to the main stem were not sampled because they were either dry or did not contain enough water to electro-fish. Trout were captured in the lower section of the mountain tributary portion of Darby Creek, while the two highest sites revealed no trout during the survey. The upper extent of trout in this drainage appears to be limited by the increased gradient and minimal flows. Sites numbered one and five were sampled as multi-pass depletion sites. Both multi-pass depletion sites, and therefore all single pass sites, were in the 'high' capture efficiency stratum for analysis purposes.

The Darby Creek drainage, from the USFS boundary upstream, contains only one trout species, namely YCT. Darby Creek is too small to support RBT, and does not contain EBT because diversions dewater Darby Creek for a long period of time during the summer. There are also several fish barrier irrigation diversions in the system just downstream of the USFS boundary (FTR, 2005). The potentially impassable diversions and/or the dewatered section of the stream through Teton Valley have resulted in the existence of an isolated population of YCT in the headwaters.

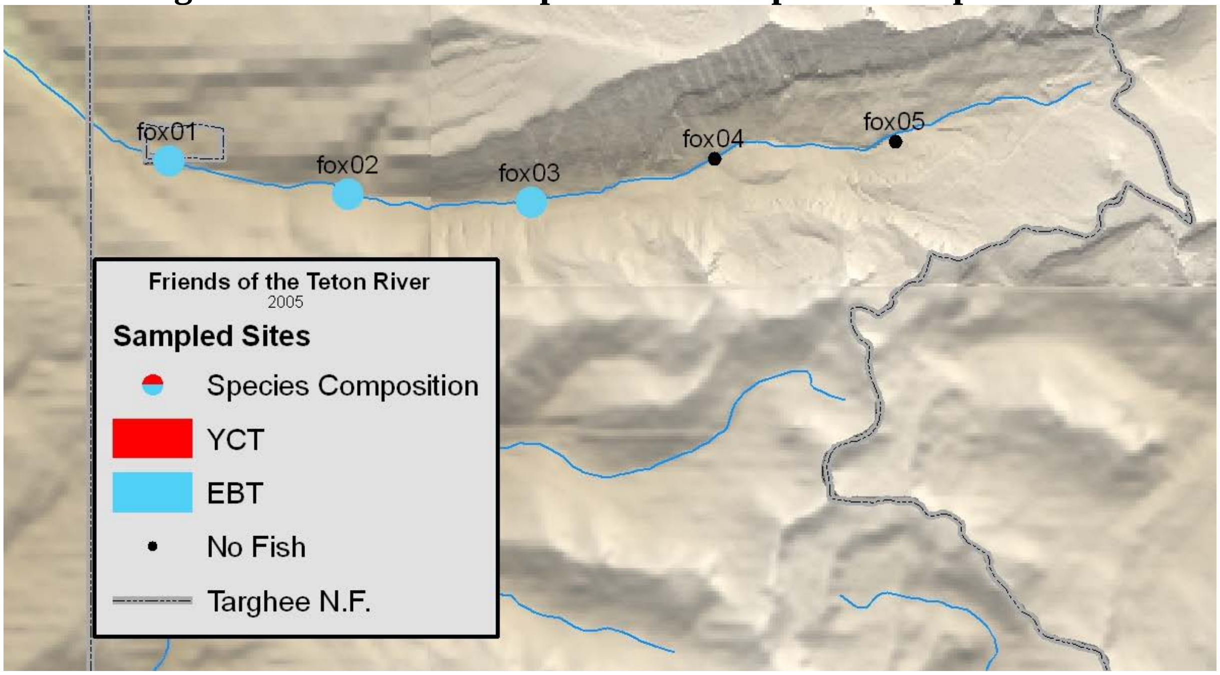
According to the 1:100,000 hydrology GIS layer used during this survey, there are 27,175 meters of stream upstream of the USFS boundary in the Darby Creek drainage. Sampling revealed that 20,597 meters of the drainage are dry or devoid of trout, while 6,579 meters of stream are inhabited by only YCT.

Fox Creek

Fox Creek generally flows in a westerly direction, from its headwaters in the Jedediah Smith Wilderness to its confluence with the Teton River. There is an active rock quarry located just upstream of the USFS boundary. Fox Creek enters the Jedediah Smith Wilderness just east of the quarry, which is the upstream limit of motor vehicle travel. There is one main stem in the Fox Creek drainage, with no significant tributaries.

Figure 9 depicts all sampled sites in the Fox Creek drainage, identified by site number. Each site where trout were captured is represented by a small pie chart depicting the species composition of all captured trout. YCT are represented in red, and EBT are represented in blue, and sites where no trout were captured are represented by black dots.

Figure 9. Fox Creek Sample Sites and Species Composition



Five sites were sampled in the Fox Creek drainage, all located on the main stem. Trout were captured in the lower section of the drainage, while the two highest sites revealed no trout during the survey. The upper extent of trout in this drainage appears to be limited by the increased gradient and minimal flows. Site number two was sampled as a multi-pass depletion site. The multi-pass site, and therefore all single pass sites, was in the 'high' capture efficiency stratum for analysis purposes.

The Fox Creek drainage, from the USFS boundary upstream, contains only one trout species, namely EBT. There are no YCT in the upper Fox Creek drainage.

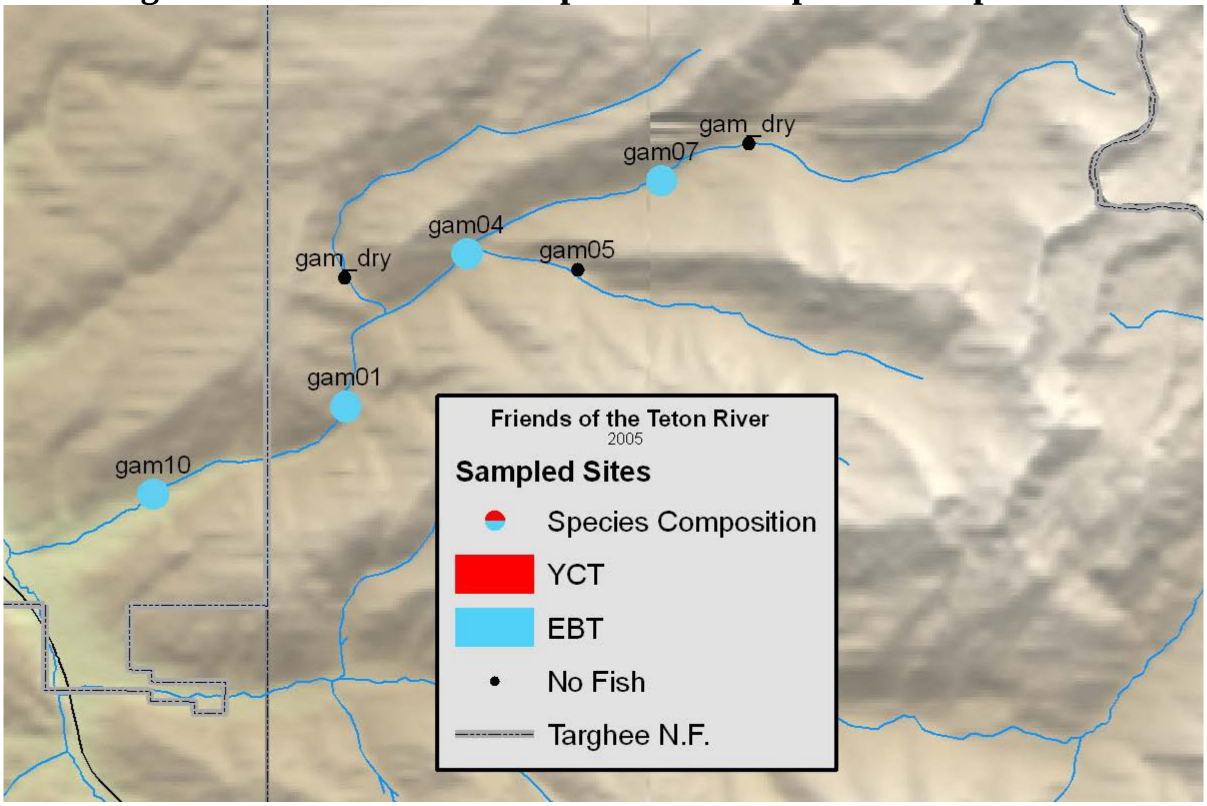
According to the 1:100,000 hydrology GIS layer used during this survey, there are 11,258 meters of stream upstream of the USFS boundary in the Fox Creek drainage. Sampling revealed that 5,295 meters of the drainage are dry or devoid of trout, while 5,964 meters of stream are inhabited by only EBT.

Game Creek

Game Creek generally flows in a southwesterly direction, from its headwaters in the Jedediah Smith Wilderness to its confluence with Trail Creek and the Teton River. There is no motor vehicle traffic in the upper Game Creek drainage, as the wilderness boundary lies just upstream of the USFS boundary. There is one main stem in the Game Creek drainage, as the North Fork is dry and South Fork contains minimal water.

Figure 10 depicts all sampled sites in the Game Creek drainage, identified by site number. Each site where trout were captured is represented by a small pie chart depicting the species composition of all captured trout. YCT are represented in red, and EBT are represented in blue, and sites where no trout were captured are represented by black dots.

Figure 10. Game Creek Sample Sites and Species Composition



Five sites were sampled in the Game Creek drainage, most of which were located on the main stem. Trout were captured in the main stem in the lower section of the drainage, while the tributaries and upper section of the main stem were dry or contained no trout. The upper extent of trout in this drainage appears to be limited by the lack of trout habitat resulting from increased gradient and minimal flows. The lowest sampled site in the drainage, site number 10, was located on BLM land immediately downstream of the USFS boundary. Sites numbered four and seven were sampled as multi-pass depletion sites. Both multi-pass sites, and therefore all single pass sites, were in the 'high' capture efficiency stratum for analysis purposes.

The Game Creek drainage, from the BLM boundary upstream, contains only one trout species, namely EBT. There are no YCT in the upper Game Creek drainage. The drainage was historically grazed by sheep, and appears heavily impacted. There are two large diversion structures located near the USFS boundary, and the stream, which is a tributary of Trail Creek, is typically disconnected from the Teton River main stem during the late summer and early fall.

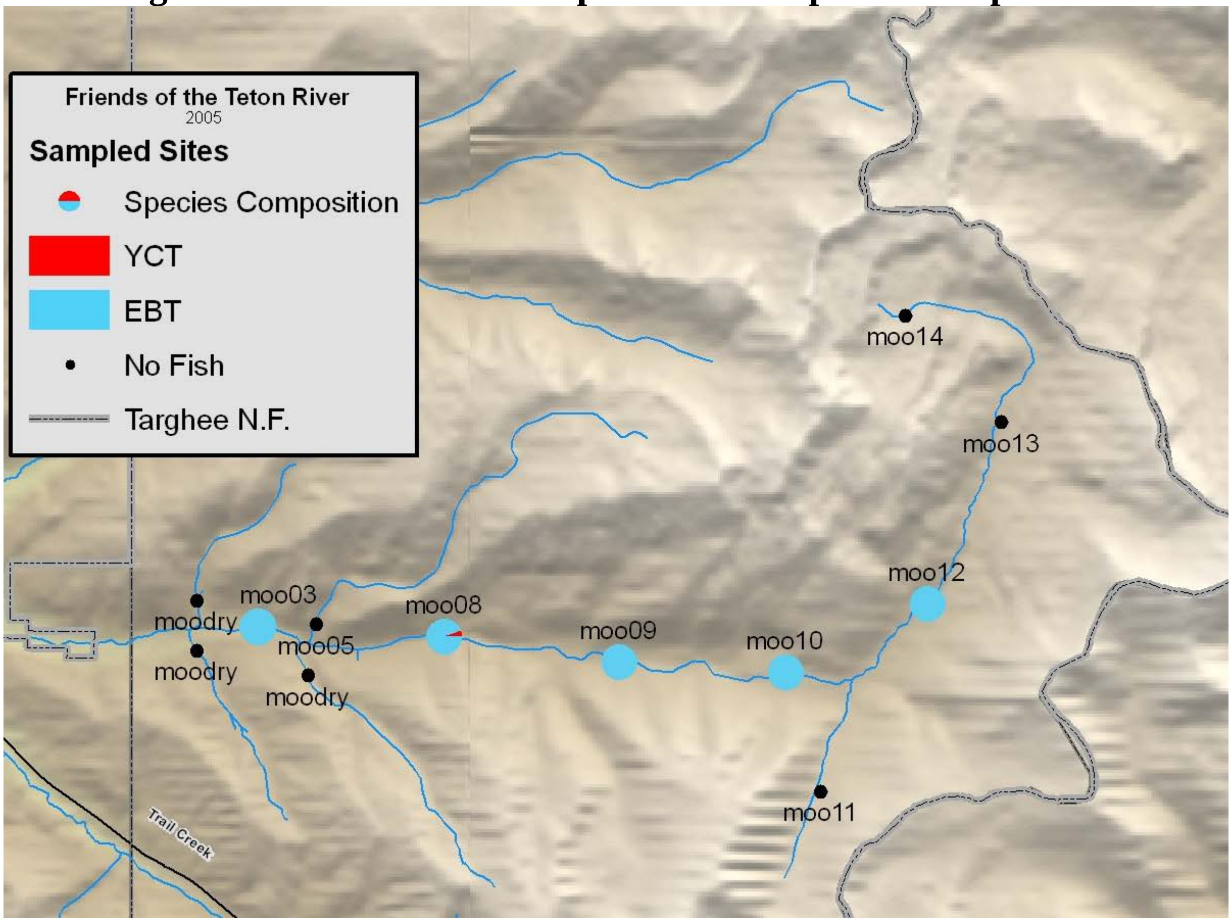
According to the 1:100,000 hydrology GIS layer used during this survey, there are 21,384 meters of stream upstream of the BLM boundary in the Game Creek drainage. Sampling revealed that 13,979 meters of the drainage are dry or devoid of trout, while 7,406 meters of stream are inhabited by only EBT.

Moose Creek

Moose Creek generally flows in a westerly direction, from its headwaters in the Jedediah Smith Wilderness to its confluence with Trail Creek and the Teton River. The drainage is composed of one main stem that is joined by several smaller tributaries. There is a trailhead parking area located just above the USFS boundary, from where a trail parallels Moose Creek and heads upstream into the Jedediah Smith Wilderness. There is no motor vehicle traffic permitted in this Wilderness area, so only horse and foot travel are permitted in the headwaters of Moose Creek.

Figure 11 depicts all sampled sites in the Moose Creek drainage, identified by site number. Each site where trout were captured is represented by a small pie chart depicting the species composition of all captured trout. YCT are represented in red, and EBT are represented in blue, and sites where no trout were captured are represented by black dots.

Figure 11. Moose Creek Sample Sites and Species Composition



Nine sites were sampled in the Moose Creek drainage, distributed throughout the system. The majority of the trout were found in the lower section of the main stem. Sites numbered eight and twelve were sampled as multi-pass depletion sites. Both multi-pass depletion sites, and therefore all single pass sites, were in the 'high' capture efficiency stratum for analysis purposes.

The Moose Creek drainage, from the USFS boundary upstream, contains both EBT and YCT. YCT were found at only one site in the drainage, where they were outnumbered by EBT roughly sixteen to one. The uppermost sites in this drainage did not contain trout, resulting in the conclusion that trout do not inhabit these tributaries to the upper extent of water. Instead, the upper extent of trout is probably limited by a lack of suitable habitat resulting from the increased gradient and minimal flows.

According to the 1:100,000 hydrology GIS layer used during this survey, there are 31,250 meters of stream upstream of the USFS boundary in the Moose Creek drainage. Sampling revealed that 20,273 meters of the drainage are dry or devoid of trout. EBT are present in 10,858 meters of the stream. YCT exist sympatrically with EBT in 2,037 stream meters in the Moose Creek drainage.

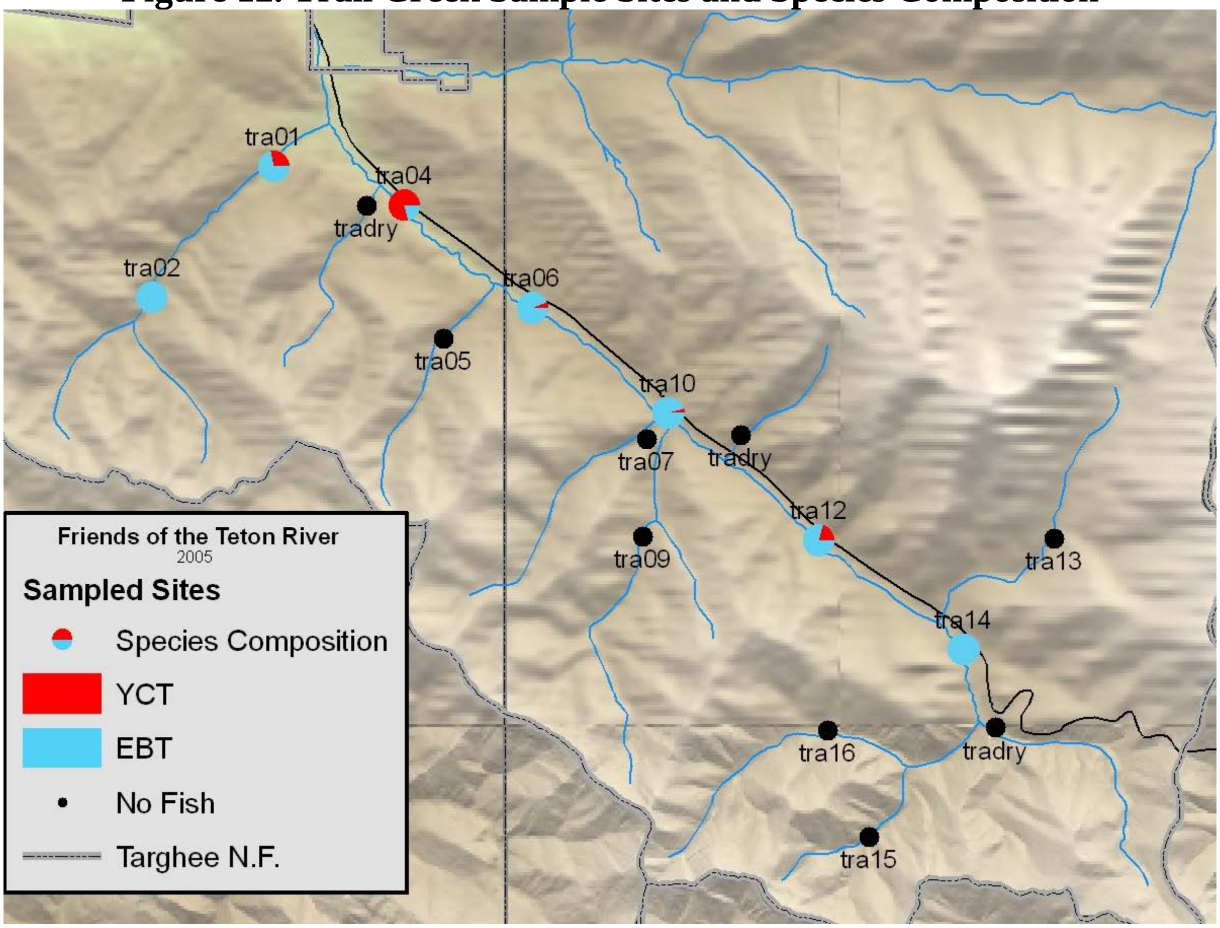
Trail Creek

Trail Creek generally flows in a northwesterly direction, from its headwaters in the Teton Mountains to its confluence with Moose Creek and the Teton River. The drainage is composed of one main stem that is joined several times by smaller tributaries. Highway 22 parallels Trail

Creek on its way over the Teton Mountains in order to connect Victor, ID, with Jackson, WY. The highway supports an ever increasing amount of traffic, and provides access to numerous trailheads and campgrounds in the Trail Creek drainage. The Jedediah Smith Wilderness boundary parallels Trail Creek to the north, and encompasses some of the headwater sections of the stream.

Figure 12 depicts all sampled sites in the Trail Creek drainage, identified by site number. Each site where trout were captured is represented by a small pie chart depicting the species composition of all captured trout. YCT are represented in red, and EBT are represented in blue, and sites where no trout were captured are represented by black dots.

Figure 12. Trail Creek Sample Sites and Species Composition



Thirteen sites were sampled in the Trail Creek drainage. Trout were found in the main stem, and in a north flowing tributary named Mike Harris Creek. Sites numbered four, six, and ten were sampled as multi-pass depletion sites. Multi-pass depletion sites numbered six and ten were assigned to the 'low' capture efficiency stratum. Multi-pass depletion site number four was assigned to the 'high' capture efficiency stratum. The higher capture efficiency at site number four was probably due to the fact that it was sampled almost two months later than all other sites in the drainage, after water levels had dropped significantly. For this reason, all single pass sites in the drainage were associated with the multi-pass sites that had similar sample dates, and were placed in the 'low' capture efficiency stratum.

The Trail Creek drainage, from the USFS boundary upstream, contains both YCT and EBT. One hundred and fifty three sites were sampled in the upper Teton River watershed. At twenty-four of these sites YCT and EBT were found to coexist. At only two of these sites did YCT outnumber EBT. Trail Creek site number four, located on the main stem just above the USFS boundary, was such a site. YCT individuals that were captured at this site were relatively large in size, so could possibly have been fluvial trout that had moved into Trail Creek to spawn, although they were not as large as positively identified fluvial YCT. The uppermost sites in this drainage did not contain trout. The upper extent of trout in the Trail Creek drainage is probably limited by the lack of suitable habitat resulting from the increased gradient and reduced flows associated with these upper mountain streams.

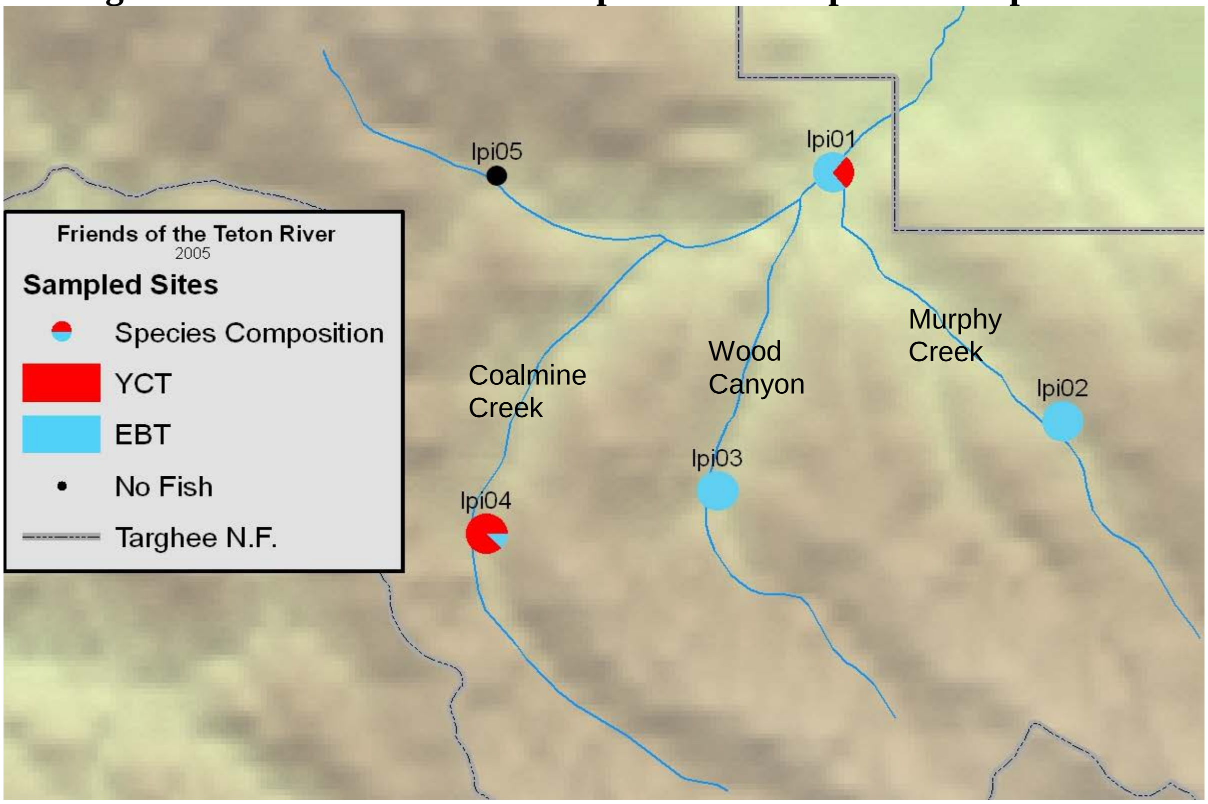
According to the 1:100,000 hydrology GIS layer used during this survey, there are 46,379 meters of stream upstream of the USFS boundary in the Trail Creek drainage. Sampling revealed that 27,934 meters of the drainage are dry or devoid of trout. EBT are present in 16,065 meters of the stream. YCT exist sympatrically with EBT in 10,596 stream meters in the Trail Creek drainage.

Little Pine Creek

Little Pine Creek generally flows in a northeasterly direction, from its headwaters in the Big Hole Mountains to its confluence with the Teton River. Three roughly parallel tributaries form the majority of the drainage, and join the main stem approximately one, one and a half, and two kilometers upstream of the USFS boundary. Highway 33 parallels the main stem of the drainage on its way over the Big Hole Mountains in order to connect Victor and Swan Valley. There are numerous trailheads, access points, and recreation sites throughout the system, which see significant recreational use, including motor vehicle traffic.

Figure 13 depicts all sampled sites in the Little Pine Creek drainage, identified by site number. Each site where trout were captured is represented by a small pie chart depicting the species composition of all captured trout. YCT are represented in red, and EBT are represented in blue, and sites where no trout were captured are represented by black dots.

Figure 13. Little Pine Creek Sample Sites and Species Composition



Five sites were sampled in the Little Pine Creek drainage, spread evenly across all tributaries. Trout were found in all tributaries in the drainage. Site number one was sampled as a multi-pass depletion site. The multi-pass depletion site, and therefore all single pass sites, was in the 'high' capture probability stratum for analysis purposes.

The Little Pine Creek drainage, from the USFS boundary upstream, contains both YCT and EBT. The upper main stem of Little Pine Creek does not contain trout, probably because it is small and steep. One hundred and fifty three sites were sampled in the upper Teton watershed. At twenty-four of these sites YCT and EBT were found to coexist, and at only two of these sites did YCT outnumber EBT. Little Pine site number 04, located midway up Coalmine Creek, was such a site. There is no obvious explanation for this isolated instance of YCT dominance, but it may have something to do with the limited possibility of EBT upstream migration through the steep and narrow Coalmine Creek. The other two tributaries in the drainage, Wood Canyon and Murphy Creek, contained only EBT. All three north-flowing tributaries in the drainage contained trout at their uppermost sites. The result is this survey's conclusion that trout inhabit these tributaries to the upper extent of water.

According to the 1:100,000 hydrology GIS layer used during this survey, there are 14,173 meters of stream upstream of the USFS boundary in the Little Pine Creek drainage. Sampling revealed that 4,718 meters of the drainage are dry or devoid of trout. EBT are present in 9,454 meters of the stream, and inhabit 4,364 meters sympatrically with YCT.

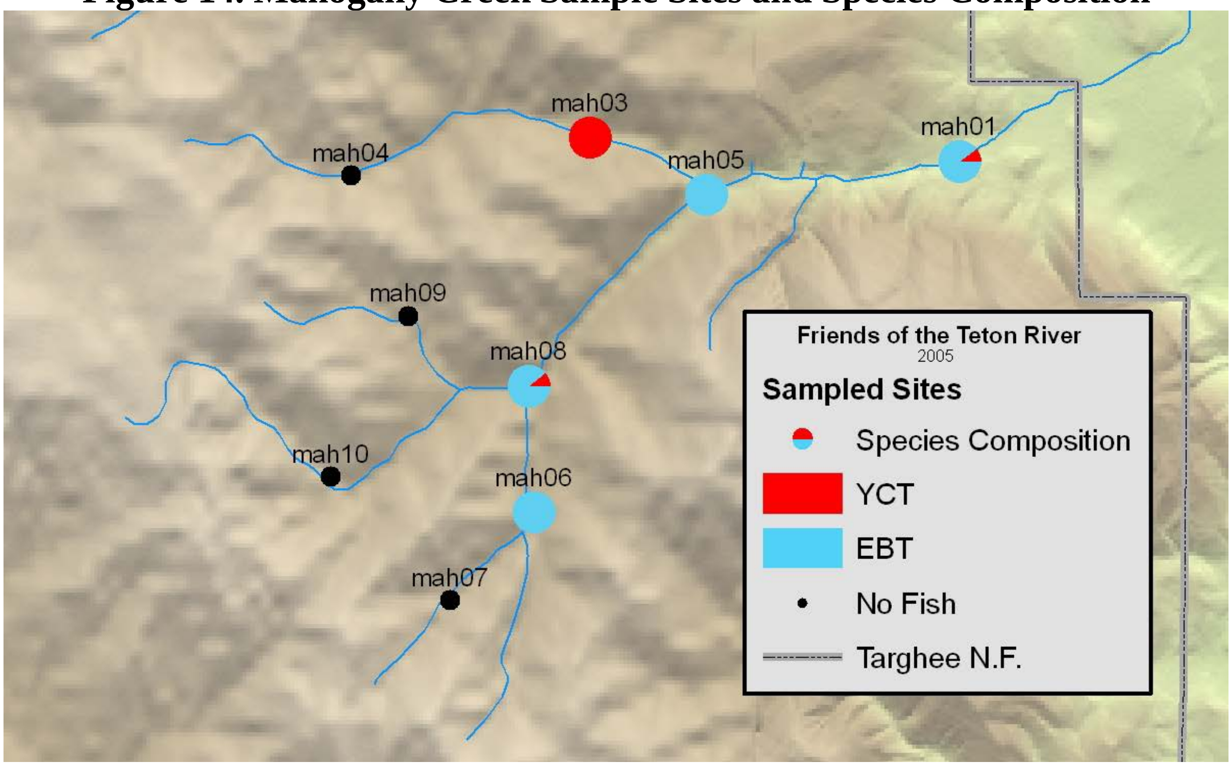
The only RBT observed in the sections of the upper Teton River tributaries sampled during this survey was captured at the lowest site on Little Pine Creek. The individual RBT was not statistically significant for watershed population analysis. However, the presence of the RBT does allude to Little Pine Creek's connectivity with the Teton River main stem.

Mahogany Creek

Mahogany Creek generally flows in a northeasterly direction, from its headwaters in the Big Hole Mountains to its confluence with the Teton River. The drainage is composed of two main stems, namely the North and the South Forks. Several smaller tributaries join the South Fork on USFS land. There is a trailhead located just above the USFS boundary, at which point a motorized vehicle trail crosses the stream and heads up the drainage, splitting to access both the North and South Forks. There is significant recreational use, including motorized vehicle traffic, throughout the Mahogany Creek drainage.

Figure 14 depicts all sampled sites in the Mahogany Creek drainage, identified by site number. Each site where trout were captured is represented by a small pie chart depicting the species composition of all captured trout. YCT are represented in red, and EBT are represented in blue, and sites where no trout were captured are represented by black dots.

Figure 14. Mahogany Creek Sample Sites and Species Composition



Nine sites were sampled in the Mahogany Creek drainage, spread evenly throughout the system. Trout were found in the North and South Forks, as well as the lower main stem. Sites numbered one, six, and eight were sampled as multi-pass depletion sites. Multi-pass sites numbered one and eight were in the 'low' capture efficiency stratum for analysis purposes. Single pass site number five was associated with these two depletion sites due to its close proximity and similar stream order, and so was also in the 'low' stratum. Multi-pass site number six was in the 'high' capture efficiency stratum for analysis purposes. The remaining single-pass sites were associated with this multi-pass site due to their similar stream order, and so were also in the 'high' stratum.

The Mahogany Creek drainage, from the USFS boundary upstream, contains both YCT and EBT. Sites located high in the drainage on smaller tributaries do not contain trout, probably because the streams are small and steep. Mahogany site number 03, located up the North Fork above a relatively large cascade, contained only YCT. The waterfall probably blocks upstream movement of EBT, and has thereby created an isolated population of YCT. The uppermost sites in this drainage did not contain trout, resulting in the conclusion that trout do not inhabit these tributaries to the upper extent of water. Instead, the upper extent of trout in this drainage appears to be limited by the lack of trout habitat resulting from increased gradient and minimal flows.

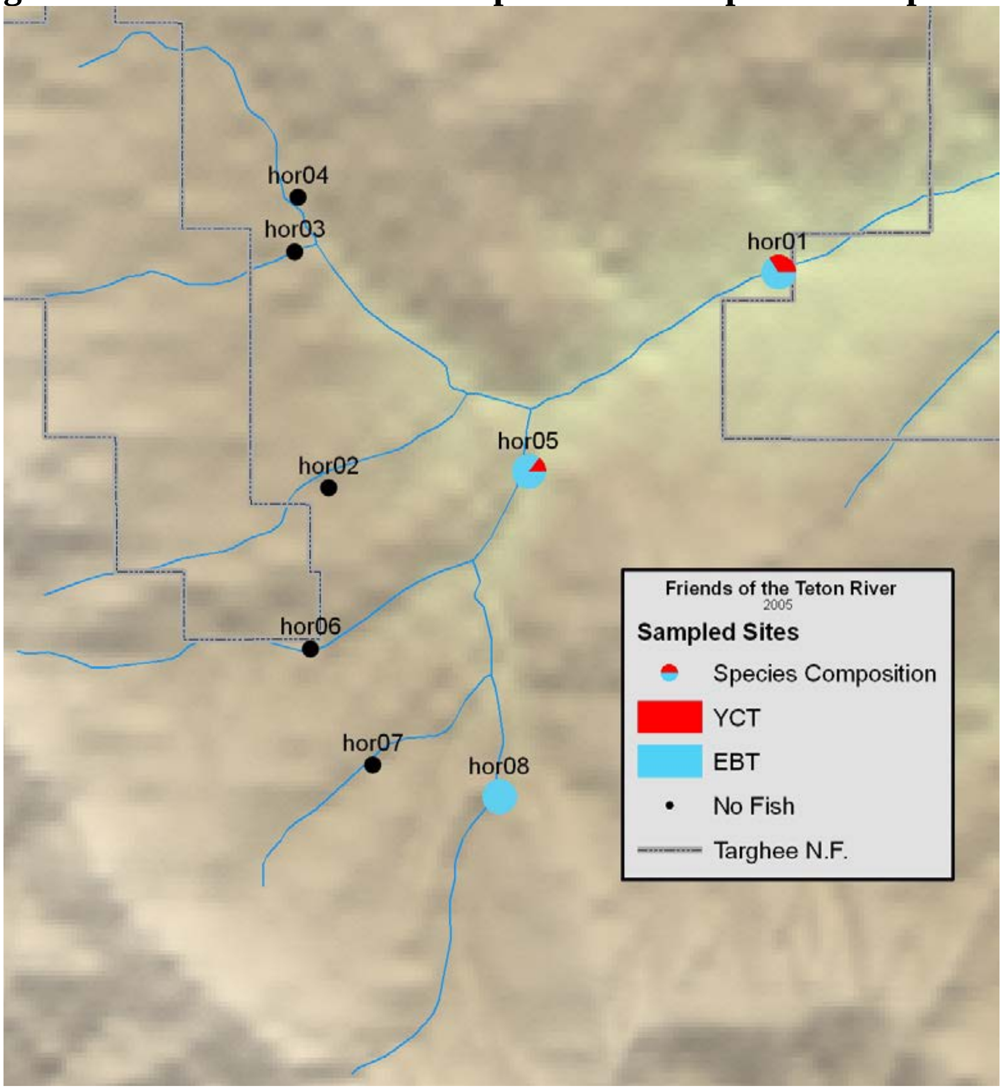
According to the 1:100,000 hydrology GIS layer used during this survey, there are 21,508 meters of stream upstream of the USFS boundary in the Mahogany Creek drainage. Sampling revealed that 11,431 meters of the drainage are dry or devoid of trout. EBT are present in 7,767 meters of the stream. YCT are the only trout species present up the North Fork, where they inhabit 1,970 meters of stream. EBT and YCT exist sympatrically in 5,404 stream meters in the Mahogany Creek drainage.

Horseshoe Creek

Horseshoe Creek generally flows in an east-northeast direction, from its headwaters in the Big Hole Mountains to its confluence with the Teton River. Motor vehicle traffic impacts the headwaters of Horseshoe Creek, as the Big Hole Mountains contain an extensive trail system that is open to motorized travel. There is a section of privately owned land in the headwaters of the system. There are two main forks in the Horseshoe Creek drainage, the North and South Forks, which are both joined by several smaller tributaries.

Figure 15 depicts all sampled sites in the Horseshoe Creek drainage, identified by site number. Each site where trout were captured is represented by a small pie chart depicting the species composition of all captured trout. YCT are represented in red, and EBT are represented in blue, and sites where no trout were captured are represented by black dots.

Figure 15. Horseshoe Creek Sample Sites and Species Composition



Eight sites were sampled in the Horseshoe Creek drainage, spread throughout the North and South Forks and their tributaries. The majority of trout were captured from the lower section of the drainage, while the tributaries and upper sections of the drainage were found to contain no trout. The upper extent of trout in this drainage appears to be limited by a lack of trout habitat resulting from increased gradient and minimal flows. Site number one was sampled as a multi-pass depletion site. The multi-pass depletion site, and therefore all single pass sites, was in the 'high' capture efficiency stratum for analysis purposes.

The Horseshoe Creek drainage, from the USFS boundary upstream, contains both YCT and EBT. The YCT were captured only at the lowest two sites in the drainage, while EBT extended slightly higher up the drainage.

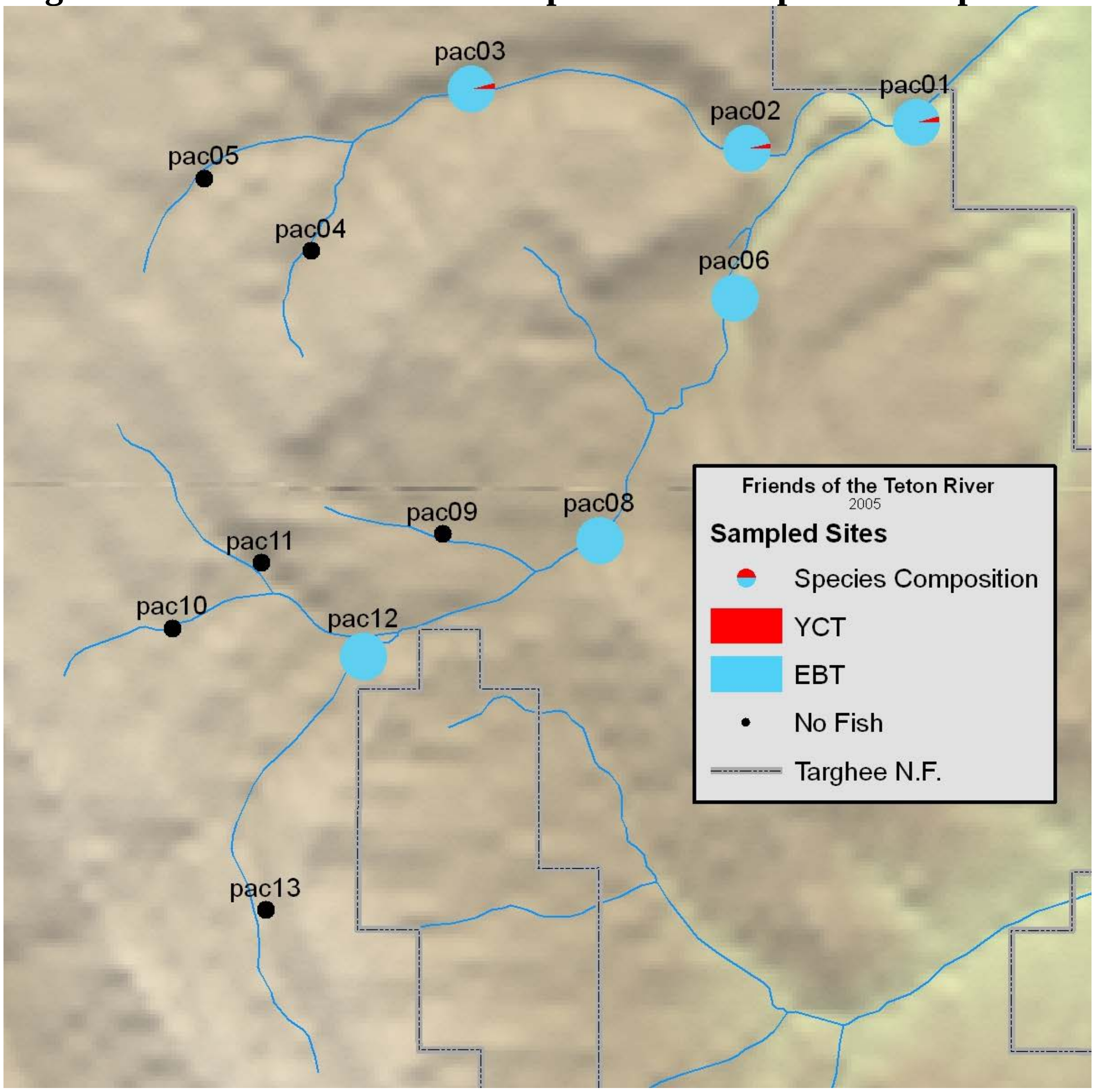
According to the 1:100,000 hydrology GIS layer used during this survey, there are 19,319 meters of stream upstream of the USFS boundary in the Horseshoe Creek drainage. Sampling revealed that 14,235 meters of the drainage are dry or devoid of trout. EBT are present in 5,103 meters of the stream, and inhabit the lowest 3,110 meters sympatrically with YCT.

Packsaddle Creek

Packsaddle Creek generally flows in a northeasterly direction, from its headwaters in the Big Hole Mountains to its confluence with the Teton River. The drainage is composed of two main stems, namely the North and South Forks, each of which is joined several times by smaller tributaries. There is a road that parallels the majority of the South Fork of Packsaddle Creek, until the road splits off and travels into the Horseshoe Creek drainage. There is an in-holding of private land high in the South Fork Packsaddle Creek drainage. There is also a lake located fairly high up the North Fork of Packsaddle Creek.

Figure 16 depicts all sampled sites in the Packsaddle Creek drainage, identified by site number. Each site where trout were captured is represented by a small pie chart depicting the species composition of all captured trout. YCT are represented in red, and EBT are represented in blue, and sites where no trout were captured are represented by black dots.

Figure 16. Packsaddle Creek Sample Sites and Species Composition



Twelve sites were sampled in the Packsaddle Creek drainage, distributed throughout the system. Trout were found on the main stem, and up the North and South Forks. Sites numbered two and twelve were sampled as multi-pass depletion sites. Both multi-pass depletion sites, and therefore all single pass sites, were in the 'low' capture efficiency stratum for analysis purposes.

The Packsaddle Creek drainage, from the USFS boundary upstream, contains YCT and EBT. YCT were found low on the main stem and up the North Fork, but were greatly outnumbered by EBT at all sites where the two species were found together.

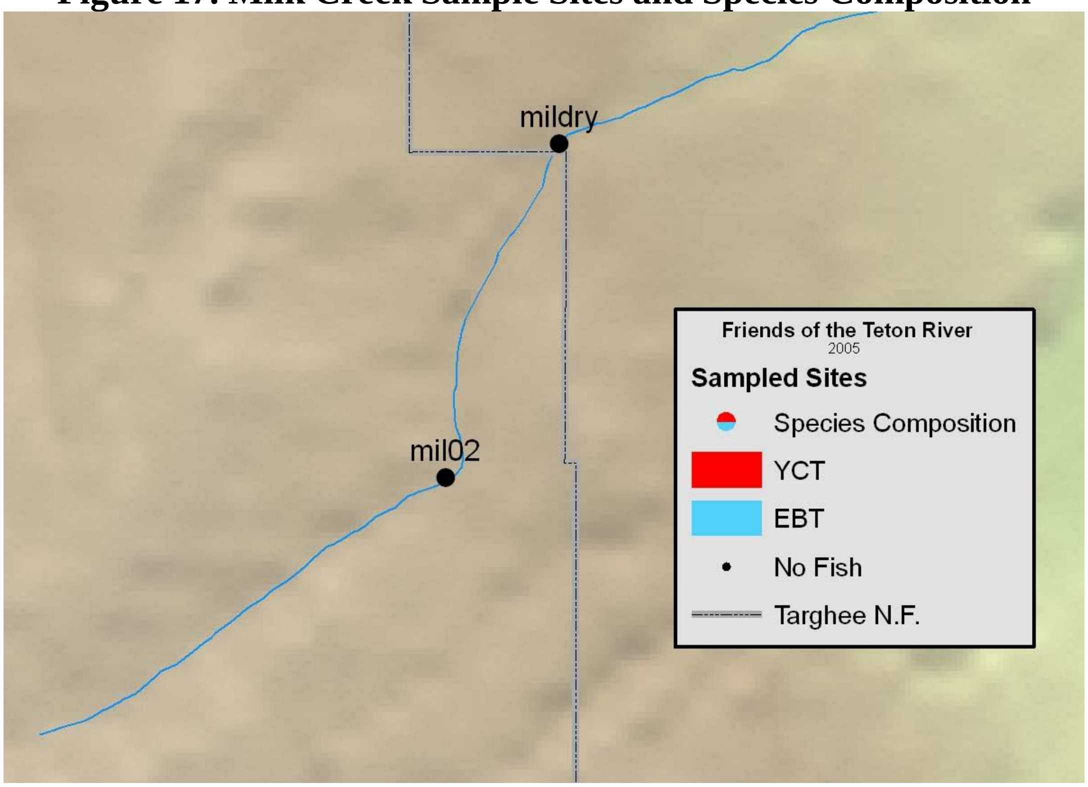
According to the 1:100,000 hydrology GIS layer used during this survey, there are 24,391 meters of stream upstream of the USFS boundary in the Packsaddle Creek drainage. Sampling revealed that 12,812 meters of the drainage are dry or devoid of trout. EBT inhabit 11,258 stream meters in the drainage, and 5,396 of these stream meters are inhabited sympatrically with YCT.

Milk Creek

Milk Creek generally flows in a northeasterly direction, from its headwaters in the Big Hole Mountains to its confluence with the Teton River. The drainage is composed of one main stem that is joined by no significant tributaries. The drainage is heavily impacted from both considerable grazing and motorized travel on an extensive road and trail network.

Figure 17 depicts all sampled sites in the Milk Creek drainage, identified by site number. Each site where trout were captured is represented by a small pie chart depicting the species composition of all captured trout. YCT are represented in red, and EBT are represented in blue, and sites where no trout were captured are represented by black dots.

Figure 17. Milk Creek Sample Sites and Species Composition



One site was sampled in the Milk Creek drainage. A site lower in the drainage near the USFS boundary did not contain enough water to sample during the time of this survey. Site number two, located roughly two kilometers upstream of the USFS boundary, was surveyed as a single pass site.

The Milk Creek drainage, from the USFS boundary upstream, contained no trout during this survey, probably due to the fact that the stream is small, contains very little water, and is heavily impacted by cattle.

According to the 1:100,000 hydrology GIS layer used during this survey, there are 4358 meters of stream upstream of the USFS boundary in the Milk Creek drainage. Sampling revealed that all 4358 meters of the drainage are dry or devoid of trout.

Watershed Level Results and Discussion

The mountain sections of Badger, Bitch, South Leigh, and Darby Creeks contain only YCT. The mountain sections of eight streams, namely Horseshoe, Little Pine, Mahogany, Moose, North Leigh, Packsaddle, Teton, and Trail Creeks, contain mixed trout populations of YCT and EBT. The mountain sections of Fox and Game Creeks contain only EBT. Milk Creek yielded no trout during this survey.

Four tributaries contain only YCT, a condition that can be explained by each system's hydrologic regime and connectivity to the main Teton River. EBT are not present in Badger and Bitch Creeks because the drainages reach the Teton River just north of Felt, Idaho, where the Teton River is too large to sustain EBT. RBT are not present in Bitch Creek because the hydrologic regime of Bitch Creek is unaltered, the result being a high maximum to minimum flow ratio that inhibits RBT invasion. RBT are not present in Badger Creek either, which also has a relatively unaltered hydrologic regime, and therefore a high maximum to minimum flow ratio.

South Leigh and Darby creeks also contain only YCT. South Leigh and Darby creeks do not connect to the Teton River continuously throughout the year. This lack of connectivity protects the YCT populations from non-native trout invasion, but it also restricts fluvial YCT from migrating into the systems. Of the significant upper Teton River tributaries, South Leigh Creek is dewatered for the longest distance of any, and Darby Creek is dewatered for the longest time (Van Kirk, 2005).

Two drainages sampled during the 2005 tributary trout population assessment, Fox and Game creeks, contain only EBT. No YCT were found in either of these drainages. The 1998 USFS survey also recorded only EBT in these drainages.

Horseshoe, Little Pine, Mahogany, Moose, North Leigh, Packsaddle, Teton, and Trail creeks, contain mixed trout populations of YCT and EBT. Figure 18 depicts the species composition in all eight drainages that contain both YCT and EBT. In all of these drainages, EBT populations are much larger than sympatric (occupying the same geographic area) YCT populations, EBT inhabit larger ranges (more stream meters) than do YCT, and EBT exist in much higher densities than do YCT.

Figure 18. Trout Species Composition by Drainage

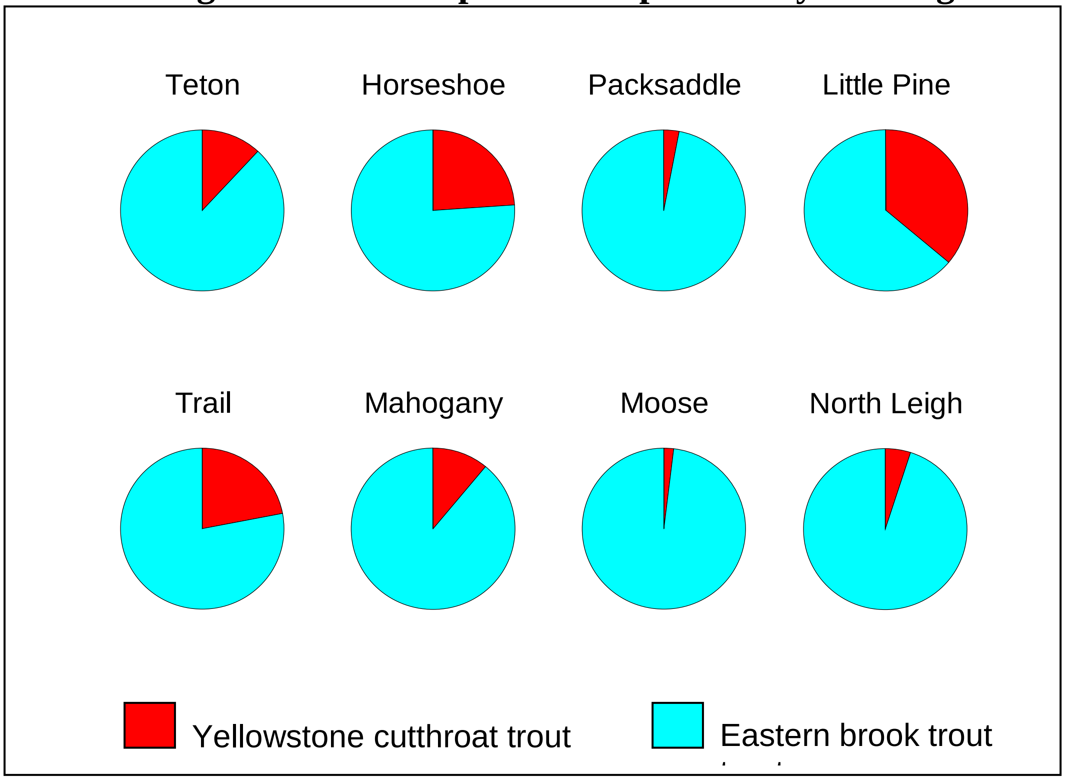
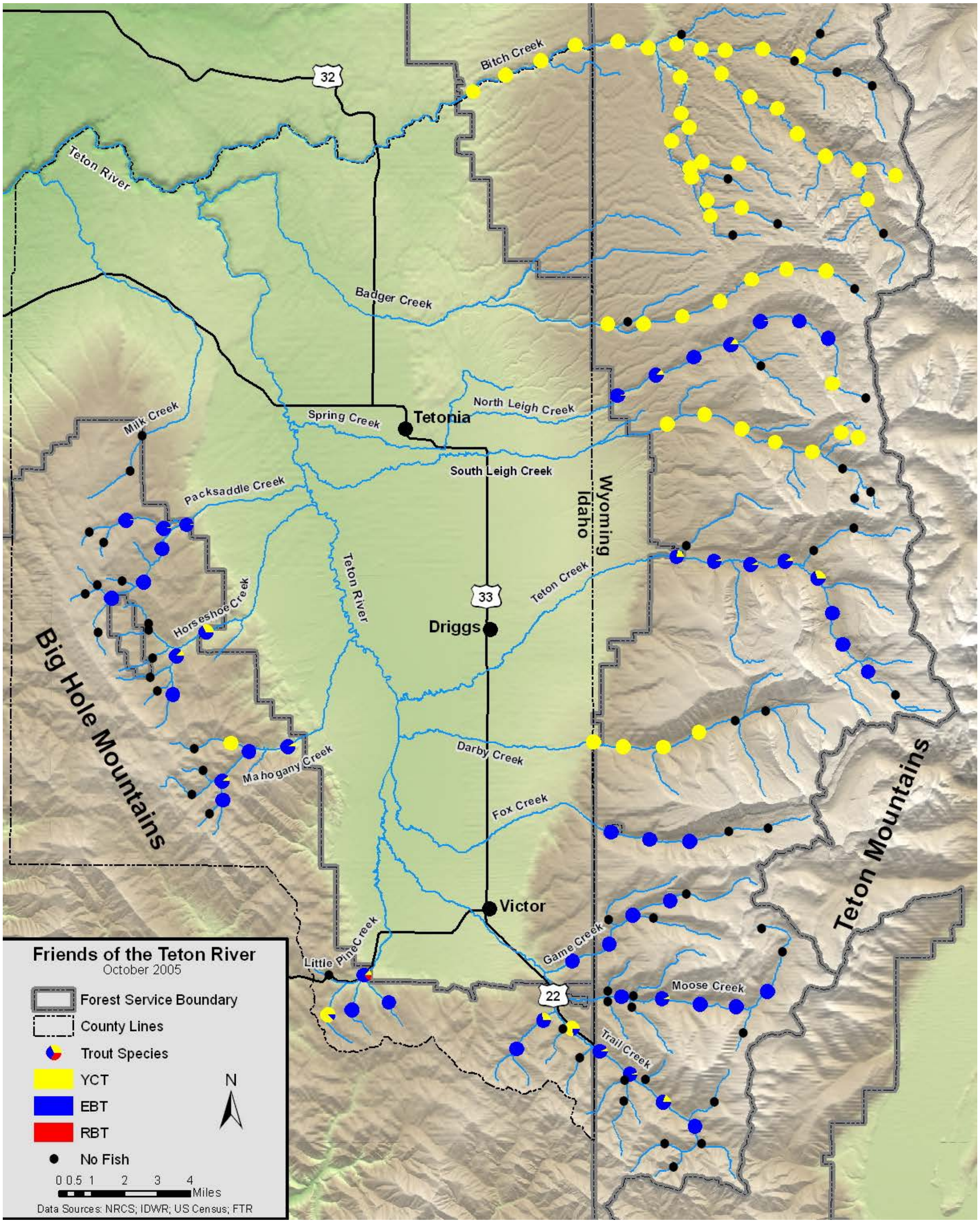


Figure 18 shows that EBT dominate the species composition in all eight drainages where they exist sympatrically with YCT. In all such drainages except Little Pine, EBT make up more than 75% of the trout population. EBT have successfully invaded these eight drainages, either by migrating from the Teton River main stem up tributaries during times of connectivity, or through historical stocking practices that released EBT directly into tributaries. Since entering the tributaries, EBT have replaced YCT to the extent that EBT now dominate the species composition in all such tributary systems.

Figure 19. Sample Sites and Trout Species Composition in Upper Teton River Tributaries on USFS Land



One hundred and fifty three sites were sampled in the upper Teton River watershed. Figure 19 depicts the distribution of sample sites in all sampled drainages. Species composition at each site is depicted by a small pie chart, in which YCT are represented by yellow and EBT are represented by blue, and dry sites and sites that were sampled but yielded no trout are represented by black dots. The figure shows that in drainages where EBT and YCT coexist, EBT dominate the species composition throughout the length of the system. At only two of the twenty-four sites where YCT and EBT coexist did YCT account for a majority of the trout population. One site where YCT outnumbered EBT was on Trail Creek at site number four, located on the main stem just above the USFS boundary. YCT individuals that were captured at this site were relatively large in size, so could possibly have been fluvial trout that had moved into Trail Creek to spawn, although captured YCT were not as large as positively identified fluvial YCT. The other site where YCT outnumbered EBT was Little Pine site number four, located midway up Coalmine Creek. There is no obvious explanation for this instance of YCT dominance, but it may be related to the limited possibility of upstream EBT migration through the steep and narrow Coalmine Creek.

All eight drainages with mixed populations of YCT and EBT that were assessed during this survey were also sampled during the 1998 USFS survey. During the 1998 USFS survey, sites were distributed in a different manner than were sites in 2005. In 1998, 5 sample sites were spread across identified stream reaches, while in 2005 sample sites were spread evenly across the entire flowing portion of streams. Figure 20 depicts changes in the percentages of captured trout that were YCT, from 1998 to 2005. In an attempt to compensate for the fact that the two surveys covered different stream lengths, YCT percent of trout population in the following comparison are derived from all captured fish within each system.

Figure 20. Trends in Percent YCT from 1998 to 2005

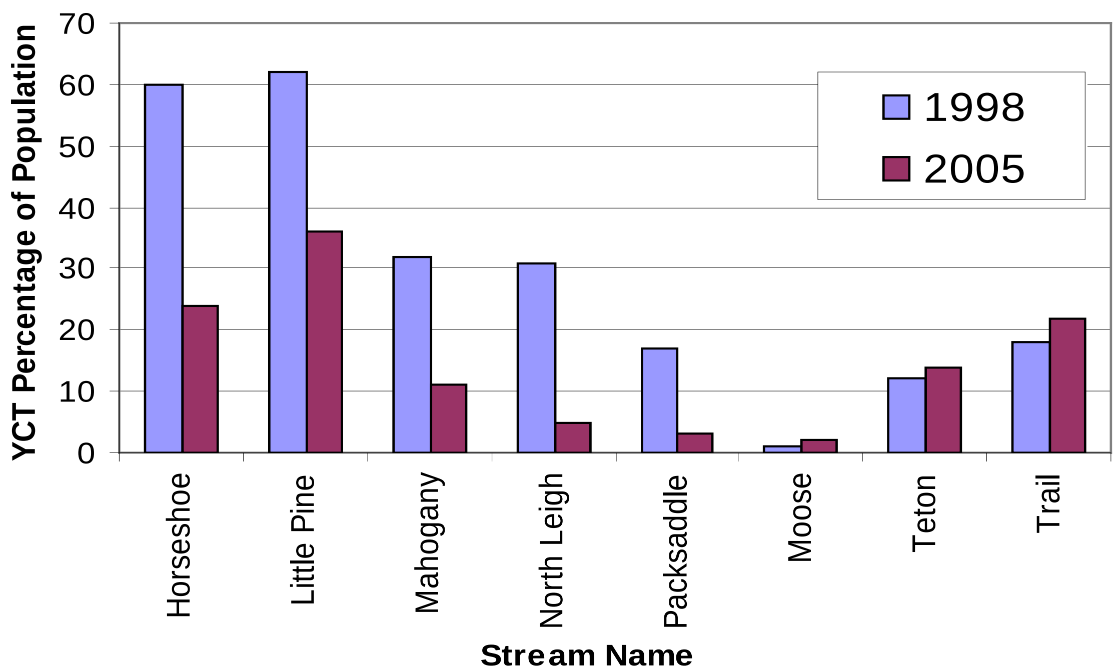


Figure 20 depicts a drop in YCT percentage of trout population from 1998 to 2005 in a majority of the drainages in which YCT and EBT exist sympatrically, demonstrating that non-native EBT have continued to replace native YCT in these tributaries during the seven year span. The relatively constant YCT percentages in Moose, Trail, and Teton creeks could be related to the relatively large size of the three tributaries, which may allow YCT to more successfully compete with EBT.

Figure 21. Abundance Estimates from Capture Efficiency Method

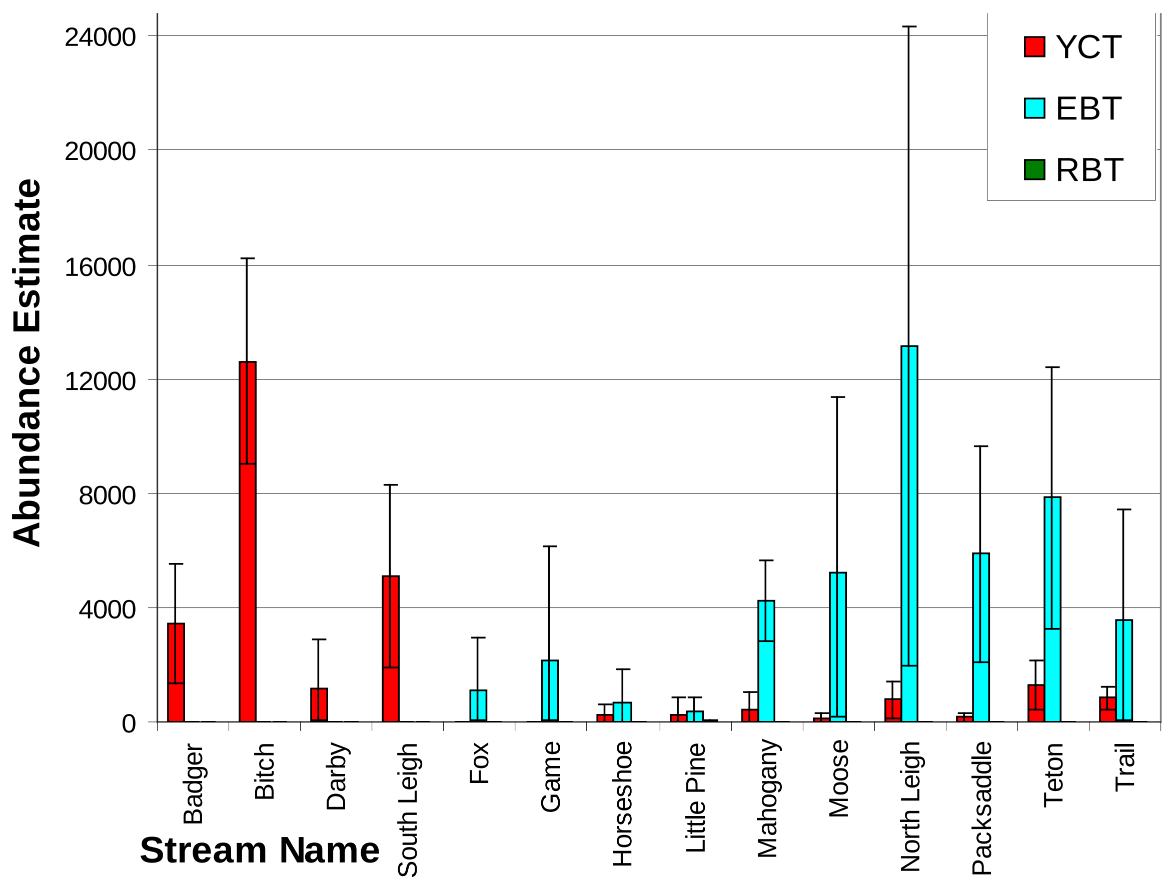


Figure 21 depicts abundance estimates (from the capture efficiency method) for all sampled drainages, with 95% confidence intervals. The largest allopatric (occurring in a geographic area devoid of other trout species) population of YCT is in Bitch Creek. Bitch Creek is the largest drainage sampled, and much of it is in the Jedediah Smith Wilderness in pristine condition. Two life histories, including the migratory fluvial and resident behaviors, probably co-exist in the Bitch Creek drainage, which connects to the Teton River year round. Darby Creek contains the smallest population of allopatric YCT. Its small size means that the Darby Creek YCT population may be at risk of extinction due to genetic degradation or stochastic events. Similar small YCT populations coexist with relatively large populations of EBT in Mahogany, Moose, North Leigh, Packsaddle, Teton, and Trail creeks. YCT populations in all of these tributaries need to be closely monitored. If these YCT populations are to persist, some type of active management may be needed to control the EBT population while reinforcing the YCT population.

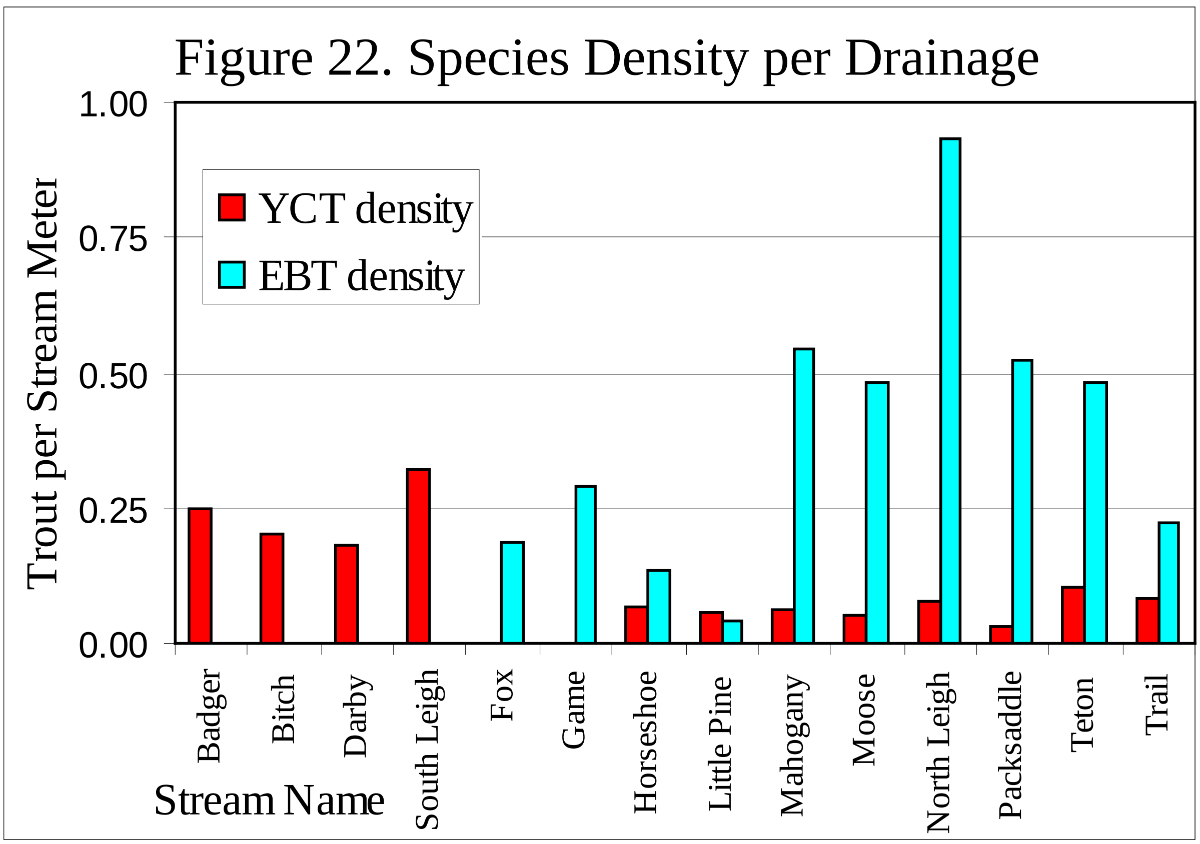
Table 1. YCT Abundance Estimates (Number of Trout) Ratio Method			
Stream	YCT Abundance	Upper 95% CI	Lower 95% CI
Badger	3530	5610	1450
Bitch	13202	16587	9818
Darby	1218	2971	48
Fox	0	0	0
Game	0	0	0
Horseshoe	224	643	8
Little Pine	260	890	8
Mahogany	466	1088	20
Moose	103	336	4
North Leigh	805	1475	135
Packsaddle	166	300	32
South Leigh	5249	8440	2057
Teton	1342	2199	484
Trail	893	1344	441
TOTALS	27457	41882	14505
Note: The lower limit of the 95% confidence interval is equal to either the number of trout caught or the calculated lower 95% confidence interval, whichever is greater.			

Table 1 depicts YCT abundance estimates and lower 95% confidence intervals for all sampled streams, and the watershed as a whole. The abundance estimates derived using the ratio methodology are used for assessing the viability of YCT populations because the ratio methodology is established in the literature and is well accepted. Survey results indicate that with 95% confidence, there are a total of at least 14,505 YCT in the upper Teton watershed mountain tributaries.

Shepard et al. (2005) identify four categories of extinction risk based on population size for west slope cutthroat trout. Populations greater than 2000 adults are at low risk, populations from 500 to 2000 adults are at medium-low risk, populations from 50 to 500 adults are at medium-high risk, and populations of less than 50 adults are at high risk. Using these categories, six of the upper Teton River tributary YCT populations, those in Darby, Horseshoe, Little Pine, Mahogany, Moose, and Packsaddle creeks, may be at a high risk of extinction due to the fact that, at the low confidence interval, abundance estimates are below 50 adults. Additionally, YCT populations in North Leigh, Teton, and Trail creeks may be at medium-high risk of extinction due to the fact that, at the low confidence interval, abundance estimates are below 500 adults.

Badger and South Leigh creeks have allopatric YCT populations with lower 95% confidence intervals between 500 and 2000 individuals. This means that these populations may be at medium-low risk of extinction. Bitch Creek has the strongest YCT population in the upper Teton River watershed, and is the only tributary with a YCT population that has a lower confidence interval greater than 2000. The Bitch Creek YCT population, even at the low confidence interval, is at a low risk of extinction.

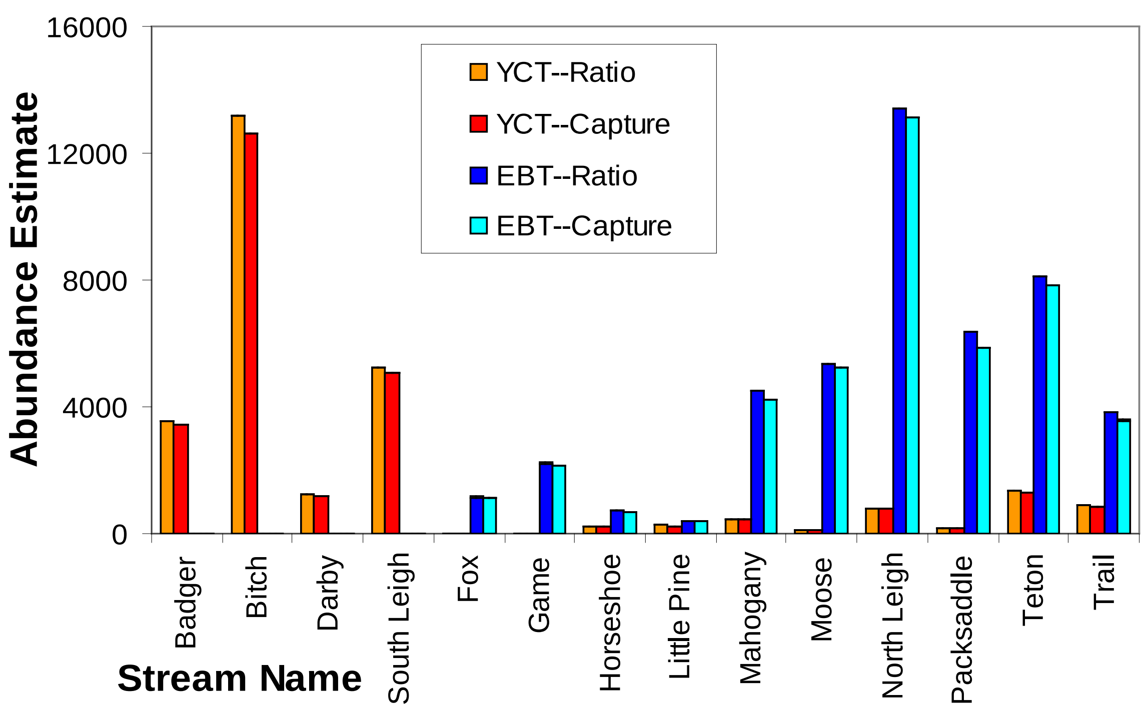
The 50/500 rule is an assessment standard for the genetic viability of populations which states that 50 individuals are required in order to avoid inbreeding depression in the short term, while at least 500 individuals are required in order to avoid genetic drift and maintain genetic variation in the long term (Franklin 1980; Soule 1980). By this assessment, YCT populations in Darby, Horseshoe, Little Pine, Mahogany, Moose, and Packsaddle creeks may face inbreeding depression in the short term, as their lower confidence abundance estimates are all less than 50 individuals. North Leigh, Teton, and Trail creeks face threats from genetic drift and a lack of genetic variation in the long term, as their lower confidence abundance estimates are below 500 individuals. Meyer et al. (unpublished) suggests that depressed genetically pure YCT populations of fewer than 500 adults may warrant temporary trout translocation programs in order to avoid threats from inbreeding depression. Improving the connectivity of tributaries to the Teton River may also benefit small tributary YCT populations. In Teton Creek for example, improving the connectivity to the Teton River will likely help the YCT population, and will probably not dramatically change the non-native trout population, as EBT are already present in the drainage, and the maximum to minimum flow ratio of Teton Creek is too high to sustain RBT.



The trout densities of YCT and EBT in all drainages are expressed in Figure 22 in terms of trout per stream meter, which does not account for stream width. Badger, Bitch, and Darby creeks contain allopatric YCT populations with similar densities. South Leigh Creek contains the densest (trout per meter) allopatric YCT population in the upper Teton River watershed. Five tributaries (Mahogany, Moose, North Leigh, Packsaddle, and Teton creeks) contain mixed species populations in which EBT densities are higher than Teton Valley's densest YCT population.

Population estimates for all drainages were calculated using two methods, namely a ratio-based method and a capture efficiency-based method (as described in the 'analysis methods' section). The population estimates from the two analytical methods are similar, but the ratio method produces slightly higher population estimates. This is because the ratio method weights the population extrapolation calculation by the number of captured trout. The ratio method is based on the value of 'R', which is the sum of the population estimates divided by the sum of the first pass catch for all multi-pass sites. Therefore sites with higher population estimates are given more weight in the determination of the value of R. The capture efficiency-based method averages capture efficiencies from all multi-pass sites evenly, and does not weight the values based upon how many trout were caught. The population estimates produced by both analytical methods (described in the analysis methodologies section) are displayed in Figure 23, in which the 'ratio' data is from the ratio-based method and the 'capture' data is from the capture efficiency-based method.

Figure 23. Abundance Estimates from Both Analytical Methods



In addition to population calculation and analysis, size class histograms were created from each drainage's captured trout fork length data (Appendix C). In drainages with mixed species populations, young of the year were left out of the histograms because they could not be definitively identified to the species level. In drainages with only one species present, young of the year were included in the size class histogram. In many cases, insufficient numbers of YCT were captured to generate adequate size class histograms. In several tributaries where sufficient numbers of YCT were captured to generate suitable size class histograms, the YCT populations appear to be dominated by mid-sized to relatively large-sized individuals.

Conclusions

This survey quantifies and characterizes trout populations in the mountain portions of the fifteen major upper Teton River watershed tributaries. YCT are greatly outnumbered by non-native EBT in a majority of the mountain sections of Teton River tributaries. There are numerous conditions threatening the persistence of YCT throughout the entire upper Teton River watershed, including non-native competition, altered hydrology, degraded and dewatered habitat, and fish passage barriers. In the four drainages where YCT exist allopatrically in the mountain sections, their populations should be carefully monitored. If further declines occur, active management practices designed to benefit the YCT populations may be required in order to assure YCT persistence. The current diversion practices and fish passage conditions, primarily located downstream of USFS land, along these four drainages should not be altered until some mechanism is in place to protect the native trout populations from non-native invasion. Restoration efforts need to be concentrated on the eight tributaries in which the mountain sections currently contain mixed trout species populations. Removing fish passage barriers and restoring flow to the intermediate sections of these tributaries will provide means by which fluvial trout can move into the mountain sections. Additionally, restoring the connectivity of these tributaries to the main Teton River through flow restoration will increase available spawning habitat, including the primary historical spawning areas located in the riparian cottonwood corridors that connect the mountain sections to the perennial spring fed sections. The long-term survival of Teton Valley YCT populations requires complete and sustained fish passage throughout the upper Teton River watershed, a condition that can be attained through the implementation of flow restoration, fish passage restoration, and stream bank restoration projects.

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