Common Trout Species and Conservation Assessment for the Grand Mesa, Uncompahgre, and Gunnison National Forests

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INTRODUCTION

The purpose of this conservation assessment is to provide land managers and the general public with an overview of the distribution and status of common trout (brook trout *Salvelinus fontinalis*; brown trout *Salmo trutta*; and rainbow trout *Oncorhynchus mykiss*) on the Grand Mesa, Uncompahgre, and Gunnison National Forests (hereafter, GMUG). Common trout species are part of a suite of Management Indicator Species (MIS) "…which are monitored during forest plan implementation in order to assess the effects of management activities on their populations and the populations of other species with similar habitat needs which they may represent (Forest Service Manual 2620.5)." MIS assessments are revised every five years and each is a synthesis of the most recent field-based observations and peer-reviewed science pertaining to the species.

Common trout and Colorado River cutthroat trout (*O. clarkii stomias*) are MIS representing aquatic habitats on the GMUG. A variety of land management activities can affect lake and stream habitats, including traditional forestry practices, road construction and maintenance, fire and fuels management, and water development. The presence of MIS species in a watershed is not an obstacle to active forest management. On the contrary, MIS species are used by Forest personnel to gauge the response of the entire forest ecosystem to land management projects we implement. In particular, common trout were selected to assess effects of management on aquatic and riparian resources.

The designation "common trout" reflects the fact brook trout, brown trout, and rainbow trout are widely distributed on the GMUG NF, and across the United States. None of these species are native to the GMUG NF or Colorado. Brook trout are native to eastern North America, brown trout are native to Europe and western Asia, and rainbow trout are native to the west coast of North America, as far inland as Idaho. All three species were stocked intensively in Colorado streams throughout the 20th century. Rainbow trout continue to be stocked intensively to maintain recreational fisheries. Brook trout and brown trout are stocked less frequently; the former due to ecological concerns related to their impacts on native Colorado River cutthroat trout and the latter due to their propensity to establish self-sustaining populations and exist in relatively low densities. Recreational fisheries based on one or more of these species are often significant components of local economies.

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SUMMARY OF KEY FINDINGS

- Management indicator species (MIS) are required under the provisions of the Grand Mesa, Uncompahgre, and Gunnison National Forest Forest Plan. Colorado River cutthroat trout (*Oncorhynchus clarkii stomias*) along with a suite of three cold-water species, known collectively as "common trout," are the MIS fish species for the Grand Mesa, Uncompahgre, and Gunnison National Forest.
- The three common trout species are brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), and rainbow trout (*O. mykiss*). All three species were introduced to Colorado for the purpose of creating subsistence and later, recreational fisheries.
- USFS personnel have been collecting data on common trout populations since 2000. In that time we have collected population data on 63 brook trout populations, 24 brown trout populations, and 38 rainbow trout populations. All three common trout species are widely distributed on the GMUG (see Tables 1-3, Figure 1). Limited time series for common trout populations suggest all three species are stable or increasing on the GMUG.
- All three species are actively managed by Colorado Parks and Wildlife (CPW) and are important recreational resources on the GMUG and across Colorado. As such there is no evidence suggesting any common trout species will decline on GMUG lands in the future. Climate change, habitat fragmentation, and disease may affect common trout populations. These threats could affect each species differently and in the case of disease, rainbow trout are most susceptible. Maintaining a close working relationship with CPW biologists is the best the best way insure forest management activities do not negatively impact common trout populations.
- Common trout monitoring on the GMUG will be standardized by selecting a sub-set of the known populations (see Tables 1-3) of each species for long-term monitoring.

MANAGEMENT STATUS

Brook trout, brown trout, rainbow trout

- USDA Forest Service, Grand Mesa, Uncompahgre, and Gunnison National Forest Management Indicator Species (MIS)

Existing management and conservation frameworks

- Grand Mesa, Uncompahgre, and Gunnison National Forests Amended Land and Resource Plan, 1991.

NATURAL HISTORY

Information presented in the following sections was adapted from species descriptions presented in *Freshwater Fishes of Canada* (Scott and Crossman, 1973) and *Trout and Salmon of North America* (Behnke 2002).

Brook trout

General species description

Brook trout and other members of the genus *Salvelinus* are also known as char. These species are native to northern North America. Char are adapted to relatively cold water, preferring temperatures below 14 °C (58 °F); brook trout are the most "warm-adapted" of the char species. Brook trout are distinctive from most other salmonids in that they have wavy bands called vermiculations on the upper half of their body. Vermiculations, which are sometimes called "worm tracks," appear gray or pale yellow on an otherwise dark body. Vermiculations are also present on the dorsal fin and may be present on other fins. Additionally, brook trout are adorned with red dots surrounded by bluish halos.

Historical distribution

Brook trout are native northeastern North America including eastern Canada, the upper Great Lakes region, New England, and as far south as the southern Appalachian Mountains. Brook trout have been introduced throughout United States as well as other parts of the world because of their popularity as a gamefish.

Habitat associations

Brook trout are typically found in clear, cold streams (maximum summer temperature < 19 °C (66 °F)) throughout their historic and introduced range. Stream habitat in which brook trout populations thrive includes complex cover and healthy riparian areas. Brook trout populations do well in beaver ponds as the species has the ability to exist in higher densities than other salmonid species (Benjamin and Baxter 2010). Observations suggest brook trout prefer warmer water than native cutthroat trout and colder than that preferred by brown trout and rainbow trout.

Food habitats

Brook trout, like all salmonids, are opportunistic, sight-feeding predators. Brook trout, which are typically found in small streams, feed primarily on stream insects. Larger individuals will prey on fish and amphibians.

Life history and movements

Brook trout spawn in the fall, typically late September through November; however, there is indirect evidence that spawning by GMUG populations can occur as early as August (D. Kowalski, CPW, personal communication). Eggs hatch in the spring before those of native cutthroat trout that spawn in the spring. This aspect of the life history of brook trout is one factor in their success as an invasive species in western North America. Depending on environmental conditions, brook trout reach can sexual maturity in as little as one year but do so most frequently at age 2. Stream-dwelling brook trout have a lifespan of 3-4 years but will live longer in high-elevation lakes.

Historical life-history diversity of brook trout included resident, migratory, and anadromous forms. Brook trout populations on the GMUG are primarily stream dwelling; however, individuals from these populations can be highly mobile. Summer movements of stream-resident individuals are typically in the 10s to 100s of meters (Peterson and Fausch 2003) but upstream movements of greater than 1 km are not uncommon (Gowan and Fausch 1996). Like all other stream-dwelling salmonids on GMUG lands, mobility of brook trout at the landscape scale is governed by downstream barriers including natural barriers, culverts, and water diversions.

Brown trout

General species description

Stream-dwelling brown trout are characterized by black and red spots on a yellow or pale orange body. Brown trout are found in streams and lakes across the GMUG. Brown trout can attain sizes greater than those of brook trout or rainbow trout due to their tendency to become piscivorous (they feed on fish) as adults.

Historical distribution

Brown trout are native to Europe and western Asia and have been introduced throughout the world since the late 19th century. Brown trout were brought to the United States in 1883 and there are self-sustaining brown trout populations in 40 of the lower 48 states.

Habitat associations

Brown trout are found in clear, cold streams that have complex cover and healthy riparian areas. Brown trout are often associated with undercut banks and other bankside cover. Brown trout prefer warmer water than brook trout and native cutthroat trout. Studies show the optimum temperature range for brown trout is 18-24 °C (65-75 °F). A preference for warmer water allows brown trout to exploit lower elevation habitats. Observations suggest brown trout will tolerate lower-quality habitat than other trout species. Self-sustaining populations can be found in larger streams and rivers on the GMUG, including the Taylor River, a world-famous tailwater fishery, and the San Miguel River, near Telluride, CO.

Food habitats

Brown trout differ from brook trout and rainbow trout in that adults can become piscivorous, relying almost exclusively on fish for food. A switch to piscivory is not obligatory in brown trout but it does allow individuals to reach much great sizes than other stream-dwelling salmonids. Research suggests the switch to piscivory, along with differences in local-scale habitat preferences, allows brown trout to coexist with rainbow trout.

Life history and movements

Brown trout spawn in the late fall when water temperatures are lower than those that trigger spawning in brook trout, typically 7 °C (45-50 °F). Brown trout eggs hatch in the spring and brown trout reach sexual maturity in 2-3 years. Stream-dwelling individuals may live 4-5 years and may grow trout 250-300 mm (10-12 inches). However, individuals that become piscivorous will live much longer and achieve much greater sizes than those that rely on stream insects as their primary food source. Brown trout tend to establish populations that are lower density than brook trout, which is attributable to their piscivorous nature.

Brown trout have three native life-history forms: stream resident, migratory, and anadromous. Brown trout on the GMUG are typically stream residents. Movements by brown trout are commensurate to those of stream-dwelling brook trout and rainbow trout.

Rainbow trout

General species description

Rainbow trout are one species of the diverse genus, *Oncorhynchus*, which includes cutthroat trout and Pacific salmon. Rainbow trout are characterized by many black spots on a silver or bluish body. The bodies of stream

resident individuals are iridescent with bands of pink and pale orange. Individual spots on rainbow trout are both more numerous and less distinct than that on brook trout or brown trout.

Historical distribution

Rainbow trout are native to western North American watersheds that drain into the Pacific. Inland populations are found in upper portions of the Columbia and Snake River watersheds. Rainbow trout are not native to Colorado. Rainbow trout are produced extensively in hatcheries for both recreational and commercial uses. In the last decade, scientists have taken to calling inland populations redband trout, due to body color that is much darker than that exhibited by coastal populations.

Habitat associations

Rainbow trout are found in clear, cold streams that have complex cover. Rainbow trout are habitat generalists but prefer warmer water than brook trout and native cutthroat trout. Studies show that rainbow trout prefer water temperatures at or below 21 °C (70 °F). Rainbow trout, therefore, can be found at lower elevations than brook trout or native cutthroat trout. Rainbow trout tend to be found in mid-channel habitats within streams. Rainbow trout may be found in streams that support brook trout and brown trout.

Food habitats

Rainbow trout, like all salmonids, are opportunistic, sight-feeding predators. Stream-dwelling individuals rely typically on stream insects for food. Larger individuals will prey on fish.

Life history and movements

There are many variations in the life history of rainbow trout. Age at sexual maturity, life span, and movement patterns vary considerably across the native and introduced range of the species. The plasticity the species exhibits, along with the fact it is easily produced in hatcheries, contributes to its popularity in recreational fishery management.

Rainbow trout, like other species in the genus, spawn in the spring. On the GMUG spawning can take place from May through July. Rainbow trout reach sexual maturity in 1-3 years and stream-dwelling individuals will live 3-5 years. Rainbow trout are stocked extensively on GMUG lands, often in places where they could never become self-sustaining, in order to support recreational fisheries.

Rainbow trout can live as stream residents or have a migratory life history. Steelhead, which are the anadromous form of rainbow trout, migrate thousands of kilometers throughout their life, moving from streams to the Pacific Ocean and then returning to spawn. Stream-dwelling rainbow trout are highly mobile and can move hundreds of meters per day during the summer. Like other salmonids on the GMUG, the landscape-scale mobility of rainbow trout is limited by barriers, including natural barriers, culverts, and water diversions.

COMMON TROUT STATUS ON THE GMUG

Distribution and abundance

The following tables summarize observations of common trout in GMUG streams between 2000 and 2012. Sampling intensity (the number of streams visited per year) varied between 1 (2000) and 39 (2005) streams visited per year. In most cases these observations were made by survey crews using backpack electrofishing equipment and

the purpose of sampling was to calculate a population estimate for one or more fish species. Surveys were conducted by either USFS or Colorado Parks and Wildlife personnel.

Table 1. Observations of brook trout (*Salvelinus fontinalis*) in GMUG streams between 2000 and 2012. Observations were made by USFS and Colorado Division of Wildlife survey crews. Observation years marked with an asterisk represent years in which brook trout were observed but no population estimate was performed.

Stream	Water code	Observation year(s)
Beaver Creek	39435	2003, 2008, 2010
Big Alder Creek	46981	2007
Calf Creek	49204	2009
Carbon Creek	38768	2011
Chavez Creek	38984	2004, 2009
Clear Creek	39649	2001
Clear Fork Muddy Creek	41753	2005
Coon Creek	19732	2005
Cow Creek	44381	2005
Crystal Creek	45058	2005, 2011
Deep Creek	39621	2005, 2006, 2007, 2008, 2012*
Deer Creek	47010	2009
Dyke Creek	39885	2001, 2003
East Beaver Creek	38326	2010
East Fork Dallas Creek	39568	2002
East Fork Crystal Creek	45058	2011
East Fork Escalante Creek	40066	2005
East Willow Creek	44076	2002
Elk Creek	39998	2009
Grove Creek	20545	2003
Henderson Creek	40600	2006
North Fork Henson Creek	40612	2001
Jones Creek	40840	2005
Little Cimarron River	39051	2002
Little Red Canyon Creek	42464	2005, 2009
Los Pinos Creek	49230	2006
Middle Fork Big Creek	27637	2005
Middle Willow Creek	44088	2002
Middle Quartz Creek	42274	2006
Millswitch Creek	37967	2006
Muddy Creek	44292	2003
North Quartz Creek	42286	2006
North Twin Creek	46238	2010
Nutras Creek	41905	2000
Owl Creek	41955	2007
Pauline Creek	42034	2006
Perfecto Creek	42046	2004, 2009
Razor Creek	42414	2009
Red Creek	42426	2005
Rock Creek	45870	2003, 2008
Silver Creek	43074	2005
South Fork San Miguel River	42995	2004, 2006
South Twin Creek	46240	2005, 2010*
Trail Gulch	46199	2005
Ward Creek	43947	2011
West Beaver Creek	38338	2008
West Fork West Beaver Creek	38064	2008
West Hubbard Creek	46676	2007, 2009
West Muddy Creek	41777	2007, 2009
West Willow Creek	44090	2002
Willow Creek	25723	2005, 2010
Young's Creek	44189	2005

Table 2. Observations of brown trout (*Salmo trutta*) in GMUG streams between 2001 and 2012. Observations were made by USFS and Colorado Division of Wildlife survey crews. Observation years marked with an asterisk represent years in which brown trout were observed but no population estimate was performed.

Stream	Water code	Observation year(s)
Chavez Creek	38984	2004, 2009
Clear Creek	39649	2001
Coal Creek	39152	2006, 2010*
Deep Creek	39671	2004
Deer Creek	47010	2009
East Fork Dry Creek	48168	2003
East Willow Creek	44076	2002
Flag Creek	46068	2011
Lee Creek	41070	2005
Little Red Canyon Creek	42464	2005, 2009
Marshall Creek	41214	2006
Middle Willow Creek	44088	2002
Middle Quartz Creek	42274	2006
North Anthracite Creek	38047	2002, 2005*
Pauline Creek	42034	2006
Perfecto Creek	42046	2009
Schaefer Creek	43000	2012
South Fork San Miguel River	42995	2004, 2006
Spring Creek	43264	2011
Taylor River	43531	2011
Ward Creek	43947	2011
West Willow Creek	44090	2002
Willow Creek	25723	2005
Willow Creek	46389	2005

Table 3. Observations of rainbow trout (*Oncorhynchus mykiss*) in GMUG streams between 2001 and 2012. Observations were made by USFS and Colorado Division of Wildlife survey crews. Observation years marked with an asterisk represent years in which rainbow trout were observed but no population estimate was performed.

Stream	Water code	Observation year(s)
Cimarron River	39013	2003
Big Dominguez Creek	39811	2004, 2010*
Red Canyon Creek	42452	2006
Coal Creek	39152	2006
Cottonwood Creek	39699	2008
Doughty Creek	38481	2009
Dry Fork Escalante Creek	49432	2005
East Fork Cimarron River	39025	2005
East Fork Escalante Creek	40066	2005
East Leroux Creek	38849	2009
East Naturita Creek	41816	2005
Elk Creek	39998	2009
Horsefly Creek	38132	2001, 2009
Keith Creek	45553	2011
LaFair Creek	40939	2004, 2010*
Lee Creek	41070	2005
Leroux Creek	41094	2009
Los Pinos Creek	49230	2006
Middle Fork Big Creek	27637	2005
Middle Fork Cimarron River	39037	2005
Middle Fork Escalante Creek	40078	2005
Monitor Creek	41727	2009
Naturita Creek	41804	2005
North Anthracite Creek	38047	2002
North Fork Tabeguache Creek	43492	2004, 2008
Second Creek	48771	2001
South Fork Mesa Creek	41549	2010
South Fork San Miguel River	42995	2004, 2006
Tabeguache Creek	43480	2008
West Beaver Creek	38338	2008
West Fork Cimarron River	39049	2005
West Fork West Beaver Creek	38064	2008

Stream	Water code	Observation year(s)
West Fork Terror Creek		2012*
West Leroux Creek	40262	2009
West Muddy Creek	41777	2007, 2009
West Naturita Creek	47034	2005
Young's Creek	44189	2005

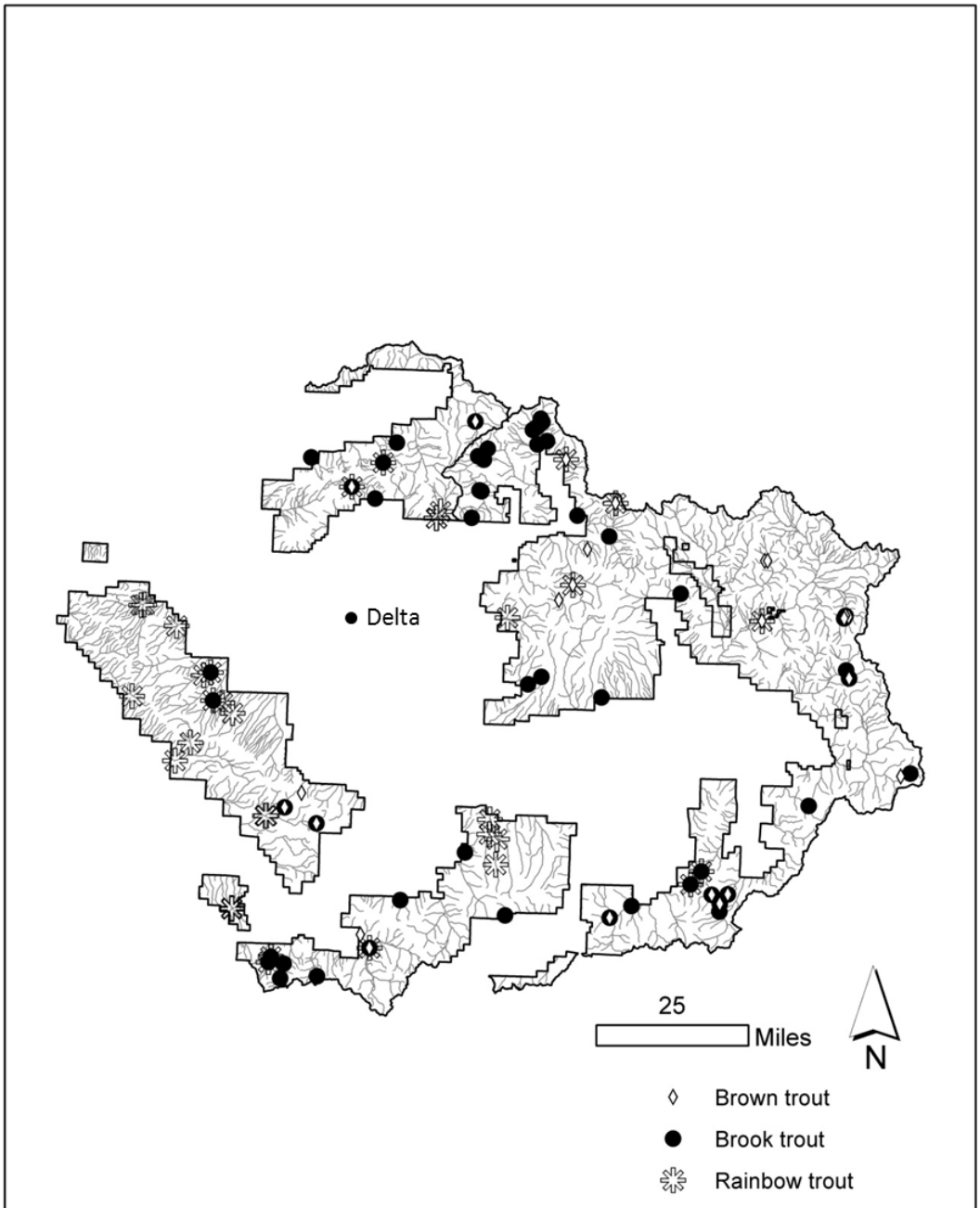

Figure 1. Common trout distribution on the GMUG. All three species are widely distributed on the Forest. Future monitoring will be conducted using the existing pool of sites listed in Tables 1 through 3.

Population trends

We lack data to compile rigorous estimates of population trend for most streams in which common trout have been observed. It is possible to draw conclusions from comparisons of population estimates made at different times in the same stream. The tables below list all streams for which there were observations of common trout species in at least two years. We calculated population estimates when the data permitted using CPW's Jakeomatic program (version 2.4.2). We present the lowest and highest population estimates from streams for which there were multiple observations in the same year. No attempt was made to determine if the observations were made at the same location each year.

There were several patterns in the population estimates for brook trout (Table 4). The data suggest brook trout populations increased dramatically in Chavez Creek, Little Red Canyon Creek, Perfecto Creek, Rock Creek, and West Muddy Creek. Brook trout may be on the decline in West Hubbard Creek. Data necessary to calculate population estimates were lacking for several streams and it is difficult to make defensible conclusions.

It should be noted that downstream section of Deep Creek, on the Paonia Ranger District, contains a sizeable number of brook trout. Observations made in 2005 and 2006 were incidental to the project objective of identifying the size and distribution of a population of native Colorado River cutthroat trout in the stream. In 2012 Forest Service personnel removed several hundred brook trout from the downstream portion of Deep Creek using electrofishing and CPW performed a chemical treatment to kill remaining brook trout. An additional chemical treatment will be necessary to eradicate brook trout from the downstream portion of this stream.

Table 4. Population data for brook trout observed in GMUG streams between 2003 and 2010. Streams where multiple locations were sampled include lowest and highest population estimate for that year. Population estimates were not performed for all streams.

Stream	Sampling year; N (range); #/km ± 95% CI
Beaver Creek	2003: 6 (112-215 mm) 2008: 6 (119-191 mm); 44±11 2010: 4 (160-215 mm)
Chavez Creek	2004: 93 (111-200 mm); 435±20 – 600±369 2009: 142 (55-183 mm); 524±38 – 1,835±65
Crystal Creek	2005: 68 (45-222 mm); 379±62 – 388±42 2011: 41 (70-256 mm); 446±43
Deep Creek, Paonia RD	2005: 3 (149-156 mm) 2006: 1 (185 mm)
Dyke Creek	2001: 99(25-285 mm); 95±76 – 296±160 2003: 65 (39-235 mm); 145±18 – 465±232
Little Red Canyon Creek	2005: 23 (135-222 mm); 72±54 – 226±283 2009: 85 (40-212 mm); 473±50 – 952±48
Perfecto Creek	2004: 27 (64-250 mm); 455±72 2009:66 (17-108 mm); 1,090±48
Rock Creek	2003: 14 (46-193 mm); 148±38 2008: 76 (44-172 mm); 1,218±112
South Fork San Miguel River	2004: 2 (125-360 mm) 2006: 9 (75-275 mm)
West Hubbard Creek	2007: 34 (47-222 mm); 354±122 2009: 14 (66-176 mm); 222±10
West Muddy Creek	2007: 15 (59-275 mm); 238±97 2009: 51 (54-316 mm); 431±400 – 690±217
Willow Creek	2005: 30 (105-240 mm); 258±28 2010: 17 (43-182 mm); 209±9 – 556±147

Brown trout have been observed in 24 streams since 2001 (Table 2). In that time brown trout have been observed multiple times in three streams (Table 5). No clear pattern is visible in the data. Brown trout are the least common of the three common trout species on the GMUG and this is the most likely reason there are limited data applicable to an analysis of population trend.

Table 5. Population data for brown trout observed in GMUG streams between 2004 and 2009. Streams where multiple locations were sampled include lowest and highest population estimate for that year. Population estimates were not performed for all streams.

Stream	Sampling year; N (range); #/km ± 95% CI
Chavez Creek	2004: 4 (58-261 mm); 44±32 2009: 7 (121-251 mm); 71±28
Little Red Canyon Creek	2005: 4 (135-215 mm) 2009: 4 (168-310 mm)
South Fork San Miguel River	2004: 5 (70-302 mm); 41±16 – 122±26 2006: 22 (75-320 mm); 138±128

In two streams for which there were multiple observations of rainbow trout it appears populations exploded between the first and second observation (Table 6). Rainbow trout appeared to be observed incidentally in the other two streams. It is difficult, given the lack of time series for rainbow trout, to make conclusions about Forest-level trends.

Table 6. Population data for rainbow trout observed in GMUG streams between 2001 and 2009. Streams where multiple locations were sampled include lowest and highest population estimate for that year. Population estimates were not performed for all streams.

Stream	Sampling year; N (range); #/km ± 95% CI
Horsefly Creek	2001: 13 (115-290 mm); 94±16 2009: 103 (36-325 mm); 255±127 – 1,345±64
North Fork Tabeguache Creek	2004: 38(78-226 mm); 280±13 2008: 111(79-224 mm); 1,021±42 – 1,357±166
South Fork San Miguel River	2004: 4(241-306 mm); 24±18 2006: 3(220-349 mm)
West Muddy Creek	2007: 2(159-275 mm) 2009: 7(33-156 mm)

The lack of time series for common trout populations is surprising considering the number of field site visits made by GMUG personnel since 2001. We were able to compare population estimates made over multiple years for 13 streams: nine for brook trout, two for brown trout, and two for rainbow trout. The dearth of time series for common trout species is indicative of the fact the focus of the GMUG fisheries program has been on identifying and quantifying native cutthroat trout populations. Going forward it is our plan to identify a subset of the streams that have been sampled previously as "sentinel" sites for brook trout, brown trout, and rainbow trout. Our goal is to revisit these sites every 5 to 7 years in order to monitor the status of common trout on the GMUG.

All three species are widespread on the Forest and in the cases of brook trout and rainbow trout, there is evidence that some populations are growing vigorously. Using these data, as well as informal consultation with CPW biologists whose jurisdiction overlaps the GMUG, we can state it is unlikely any of these species is subject to declines in Forest-level viability for the foreseeable future.

Habitat quantity and quality

The ubiquity of all three common trout species in GMUG watersheds suggests the Forest contains ample habitat for them. Since 2001 brook trout have been observed in 63 streams (Table 1), brown trout in 24 streams (Table 2), and rainbow trout in 38 streams (Table 3). Self-sustaining populations of all three species can be found across the GMUG and CPW maintains rainbow trout populations in a number of streams, lakes, and reservoirs. There is no evidence to suggest land management activities or other human impacts will affect the amount of habitat available to common trout species at the Forest scale.

Stream habitat quality is variable on the GMUG. In 2006 GMUG personnel completed a broad-scale assessment of stream and riparian habitat conditions using the PACFISH/INFISH Biological Opinion (PIBO) protocol (Adams 2006). Habitat data were collected in 19 reference watersheds. Reference watersheds were those exhibiting the least human influence and represented the most "natural" conditions on the Forest. Within each watershed a variety of abiotic and biotic data were collected in a response reach (Table 7).

Table 7. Reach-scale stream habitat characteristics collected in response reaches of 19 reference watersheds on the GMUG NF. Data were collected using the PACFISH/INFISH Biological Opinion (PIBO) protocol (Kershner et al., 2004). Table adapted from Adams 2006.

Attribute	Mean (SD)	Range
Residual pool depth (m)	0.28 (0.13)	0.12 – 0.69
Undercut depth (m)	0.68 (0.60)	0.19 – 3.02
Undercut banks (%)	30.30 (15.13)	4.76 – 60.00
Bank angle	107.45 (14.05)	76.00 – 132.31
Bank stability (%)	95.95 (5.04)	78.57 – 100.00
Width to depth ratio	22.03 (4.99)	8.02 – 36.34
Pool fines, < 2 mm (%)	14.20 (24.14)	0.00 – 99.33
Pool fines, < 6 mm (%)	16.20 (24.31)	0.00 – 99.43
D50 (mm)	61.29 (40.49)	2 – 134
D85 (mm)	143.66 (100.00)	6.84 – 350
Conductivity	97.90 (74.58)	30 – 270
Alkalinity	90.79 (45.54)	20 – 240

The data in Table 7 represent baseline microhabitat information for streams on the Forest. Future management activities may impact stream and riparian habitat conditions in streams supporting common trout. It is likely that stream habitat surveys will be prompted by project proposals that include management activities which may affect streams and riparian areas. Baseline information is necessary to insure best-management practices and mitigation measures are effective in maintaining habitat conditions conducive to healthy stream fish populations.

Threats

Climate change

Climate warming is a major long-term threat to cold-water fishes, including the three common trout species (Rieman and Isaak, 2010; Haak et al., 2012). All three common trout species can tolerate warmer water than native cutthroat trout (see above); however, under extreme climate warming scenarios low-elevation habitat could become unavailable during the warmest part of the year. Additionally, climate warming could result in increased fire, post-fire disturbances, and decreased water quantity, all of which could impact stream habitat. It is logical to assume common trout species would attempt to move upstream to higher elevation and presumably colder habitat.

However, natural and human-made barriers, as well as a limit to the amount of habitat available could limit the ability of common trout species to adapt to climate warming.

Fragmentation

The effects of habitat fragmentation and isolation on stream fish populations are well documented (Dunham et al., 1997). Habitat fragmentation reduces the long-term persistence probability of a population by reducing the population size and restricting life history diversity. Habitat fragmentation also increases the probability that a single disturbance event (e.g., fire or debris flow) could eliminate an entire population (Dunham et al., 2003).

On the GMUG, habitat fragmentation and isolation result from poorly designed road crossings and water diversion structures. In streams where these structures are present fish are often able to move downstream but are precluded from returning by the structure.

Disease

Whirling disease has the ability to cause dramatic reductions in trout populations. Rainbow trout and other species in the genus *Oncorhynchus* are particularly susceptible to whirling disease (Nehring and Walker 1996; Vincent 1996). Vectors that carry the disease are associated with silt deposits and muddy habitats. The disease can be spread by anglers wearing wading gear laden with infected sediments. Whirling disease is present in the Colorado River and Gunnison River basins. Whirling disease is present on the Grand Mesa and may have caused the extirpation of some cutthroat trout and rainbow trout populations located there (L. Martin, CPW, personal communication). Colorado Parks and Wildlife is experimenting with rainbow trout that are resistant to whirling disease, stocking them in streams known to harbor the disease.

COMMON TROUT CONSERVATION ON THE GMUG

Common trout exist on the GMUG as a recreational resource and management of common trout populations is primarily the responsibility of the state game management agency, Colorado Parks and Wildlife. However, the ecological niches of brook trout, brown trout, and rainbow trout mean their status is an excellent barometer of riparian health, stream habitat condition, and water quality. The Forest has an active culvert replacement program in which stream habitat connectivity and riparian function are considerations in planning and replacing culverts and other road-stream crossings. Forest personnel are also using tools to evaluate riparian area condition throughout the Forest. While we do not actively manage fish populations, federal actions such as the authorization of timber management or road construction activities can affect stream fish populations and watershed health. Our primary conservation action, therefore, is to monitor common trout populations at the project and forest scales.

In the last decade GMUG personnel have collected a substantial amount of data on common trout populations. However, the focus of the fisheries program is conservation of native cutthroat trout. Therefore, common trout observations are often made incidentally during native cutthroat trout surveys. Going forward, it is our goal to establish a network of common trout monitoring sites using a subset of the streams listed in Tables 1 through 3. The network will include streams distributed throughout the Forest. We will establish permanent sampling stations at each site in order to insure the highest quality long-term data.

We are using a network of stream temperature sensors to collect data in order to better understand how climate warming may affect stream habitat and stream fish populations. The data collected by temperature loggers can be used to model how stream temperatures may change in response to a variety of climate change scenarios; stream temperature being the primary determinant of habitat suitability for stream fish. In addition to use by GMUG

personnel, these data will be made available to researchers working on regional climate change models, including efforts at the USFS Rocky Mountain Research Station and Colorado State University.

REFERENCES

Adams, P. M. 2006. Evaluation of watershed conditions within the Grand Mesa, Uncompahgre, and Gunnison National Forests. M. S. Thesis. Utah State University, Logan.

Behnke, R. J. 2002. Trout and salmon of North America. The Free Press, New York.

Benjamin, J. R., and C. V. Baxter. 2010. Do nonnative salmonines exhibit greater density and production than the natives they replace? A comparison of nonnative brook trout and cutthroat troutl. Transactions of the American Fisheries Society 139:641-651.

Dunham, J. B., G. L. Vinyard, and B. E. Rieman. 1997. Habitat fragmentation and extinction risk of Lahontan cutthroat trout. North American Journal of Fisheries Management 17:1126-1133.

Dunham, J. B., M. K. Young, R. E. Gresswell, and B. E. Rieman. 2003. Effects of fire on fish populations: landscape perspectives on persistence of native fishes and nonnative fish invasions. Forest Ecology and Management 178:183-196.

Haak, A. L. and J. E. Williams. 2012. Spreading the risk: native trout management in a warmer and less-certain future. North American Journal of Fisheries Management 32:387-401.

Kershner, J. L., M. Coles-Ritchie, E. Cowley, R. C. Henderson, K. Kratz, C. Quimby, D. M. Turner, L. C. Ulmer, and M. R. Vinson. 2004. Guide to effective monitoring of aquatic and riparian resources. General Technical Report RMRS-GTR-121. U. S. Department of Agriculture, Rocky Mountain Research Station, Fort Collins, CO.

Nehring, R. B., and P. G. Walker. 1996. Whirling disease in the wild: the new reality in the Intermountain West. Fisheries 21(6):28-30.

Rieman, B. E. and D. J. Isaak. 2010. Climate change, aquatic ecosystems, and fishes in the Rocky Mountain West: implications and alternatives for management. U.S.D.A. Forest Service, Rocky Mountain Research Station. RMRS-GTR-250. Ft. Collins, Colorado.

Scott, W.B., and E.J. Crossman. 1973. Freshwater fishes of Canada. Bulletin 184. Fisheries Research Board of Canada, Ottawa.

USDA Forest Service. 2005. Aquatic, riparian, and wetland ecosystem and current landscape condition assessments. Grand Mesa, Uncompahgre, and Gunnison and San Juan National Forests.

U. S. Fish and Wildlife Service. 1998. Greenback cutthroat trout recovery plan. U.S. Fish and Wildlife Service, Denver, Colorado.

Vincent, E. R. 1996. Whirling disease and wild trout: the Montana experience. Fisheries 21(6):32-33.