BENEFICIAL USE RECONNAISSANCE
MONITORING AND ASSESSMENT REPORT

Waterbody: Smiths Fork River Watershed: Green River

Hydrologic Unit Code: WYGR14040107 Segment: 017-3

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INTRODUCTION

The entire reach of the Smiths Fork of the Green River is classified by Chapter 1, Appendix A of the Water Quality Rules and Regulations as a Class 2, coldwater stream (WDEQ/WQD, 1990). Designated uses for the Smiths Fork include: agriculture, protection and propagation of fish (coldwater game fish) and wildlife, industry, human consumption, recreation, and scenic value. The Smiths Fork originates in the Uinta Mountains of northeastern Utah. The river flows north into Wyoming and then east before joining the Blacks Fork of the Green River (Class 3), east of Lyman, Wyoming. The Blacks Fork continues flowing east and then south to join the Green River as part of Flaming Gorge Reservoir (Class 2, coldwater).

A 3.10 mile segment of the Smiths Fork was included in the WDEQ/WQD Monitoring Program because inconclusive data suggested partial use support for cold water fish due to habitat loss and unknown causes from channelization and streambank degradation (WDEQ/WQD, 1996). The segment listed begins at the confluence with the Blacks Fork River and goes upstream to the confluence with Cottonwood Creek.

One bioassessment station (WB030) was established in the middle of the reach on October 27, 1998. The pre-monitoring evaluation suggested that a single bioassessment station, located immediately upstream of the Highway 80 Bypass crossing, would adequately provide a use assessment of this waterbody. This conclusion was based on the short length of the segment and the limited number of tributaries between the Blacks Fork and Cottonwood Creek. Water chemistry, biological (macroinvertebrates), and physical (habitat quality) data were collected at this site in accordance with the department's bioassessment sampling and analysis plan (King, 1993a), Nonpoint Source Program Quality Assurance Project Plan (WDEQ/WQD, 1993), and Surface Water Quality Assurance Project Plan (WDEQ/WQD, 1989).

The samplers noted that a precipitation event occurred at the station four days prior to sampling. Low turbidity (4.26 NTU) and total suspended solids (4 mg/l) in the adjacent Blacks Fork River (approximately 1 mile north-northwest of the Smiths Fork station) suggest storm-event runoff was not a factor at the time of the assessment.

DESCRIPTION OF BIOASSESSMENT STATIONS

The Smiths Fork bioassessment station (WB030) was established in the NE¼NE¼ Sec. 13, T.16N., R.135W., Unita County, Wyoming. Locational coordinates for the site are 41° 22' 22.72" north latitude and -110° 12' 51.41" west longitude. These coordinates were determined from a corrected global positioning system reading at the base of the sample riffle. The station was located approximately 100 yards upstream of the road crossing by Highway 80 Business Loop at an elevation of approximately 6,420 feet. The station is found on the *Turtle Hill* USGS 7½' Quadrangle and the *Evanston* 1:100,000 BLM Surface Management Status map.

RESULTS AND DISCUSSION

Physical Setting

The station is located in the plains landform area of the Wyoming Basins Ecoregion. The predominate geology in the immediate area of the sample station was determined to be marl and sandstone of the Bridger Formation (Tb) . The predominant soil type (series or association) at the station could not be determined. The state-wide digital soils map of Wyoming (Munn and Arneson, 1998) lists the general soil taxonomy (order/suborder/great group/subgroup) at this station to be Typic Torrifluevents and Typic Hapludalfs, loamy-skeletal, mixed, and frigid. Typic Torrifluevent soils are dry (torr), flood plain (fluv) entisols (mineral soils without natural horizons) representing the central concept of the great group (typic). Typic Hapludalfs are minimal horizonation (hapl), moist (ud) alfisols (moist mineral soils having no mollic epipedon or oxicor spodic horizon) representing the central concept of the great group (typic).

There has been considerable natural gas development in the Moxa Arch area immediately east of the Smiths Fork watershed while the Hickey Mountain and Sage Creek Basin gas fields are located in the upper reaches of tributaries to the Smiths Fork (De Bruin, 1996). The *Metallic and Industrial Minerals Map of Wyoming* map (Harris et al., 1985) identifies several construction aggregate pits, but no mineralized zones or outcrop strata in the watershed .

Livestock grazing was determined to be the primary land use at the station. Domestic sheep were observed grazing the riparian zone along the segment at the time of the sampling. No secondary land use was determined. Irrigation diversions, irrigation returns, road crossings, and connected roads were identified upstream of the bioassessment station. One point source discharge, Town of Mountain View waste water treatment plant, is located on the Smiths Fork approximately 15 miles upstream of the bioassessment station. This facility contributes less than 1% of the total flow at the station.

Discharge at the Smiths Fork bioassessment station was measured (mid-section method using a Global Flowprobe®) to be 95.77 cubic feet per second. The drainage area above the sample station was determined to be approximately 393.9 square miles. The Smiths Fork was determined to be an Order 5 stream at this location.

The Smiths Fork in the sample reach was determined to be an C6 stream type. This stream type is a slightly entrenched, meandering, silt-clay dominated, riffle-pool channel with a well developed floodplain. This stream type is very susceptible to shifts in both lateral and vertical stability caused by channel disturbance and changes in flow and sediment regimes of the contributing watershed. Rates of lateral adjustment are influenced by the presence and condition of riparian vegetation (Rosgen, 1996).

Photographs taken at the sampling station include: upstream, downstream, panoramic, left bank, right bank, sediment deposition, point bar, salt precipitate, and channelization views. Additional photographs were taken on October 19, 1999 showing turbidity, bank condition and point bars at the Turtle Hill county bridge, sediment bed load in the dry channel of Cottonwood Creek, and bank and riparian condition near the location of the 1998 bioassessment station. These photographs can be found in the Smiths Fork assessment file.

Water Quality

Water quality samples at the single station were taken on October 27, 1998. Grab samples were collected, preserved, transported and analyzed in accordance with procedures outlined in the department's Surface Water Quality Assurance Project Plan (WDEQ/WQD, 1989). All water quality data were evaluated for quality assurance and quality control and met data quality objectives. Water quality parameters and results for the Smiths Fork station are found in Table 1.

The water temperature observed in the Smiths Fork (8.8° C) was well below the WDEQ/WQD (1990) maximum allowable stream temperature of 25.6° C for cold water fisheries.

The pH value observed in the Smiths Fork (8.53 standard units) was basic (greater than 7 standard units) but was below the WDEQ/WQD (1990) upper limit standard of 9.0 standard units. Somewhat elevated, afternoon pH readings are common in response to increased plant photosynthesis (King, 1993a), however, the relatively cool water temperature and high turbidity in the Smiths Fork at the time of sampling suggests photosynthesis would be low.

Conductivity is a field measurement used to evaluate the level of dissolved constituents in the water. The more dissolved substances present, the higher the conductivity measurement. There are no WDEQ/WQD surface water quality standards for conductivity, however King (1990) reported aquatic organism negative response when conductivities were greater than 6,900 µS/cm. The conductivity of the Smiths Fork (763 µS/cm) is below such a level, but is relatively high and suggests some dissolved salt loading. Photographs of salt deposition on the right bank support the presence of dissolved salts in the watershed.

Dissolved oxygen is the amount of free oxygen available to aquatic organisms. Dissolved oxygen levels observed in the Smiths Fork (7.47 mg/l) are greater than the 4.0 mg/l one day minimum coldwater criteria for non-early life stages (WDEQ/WQD, 1990).

Table 1. Water Quality Parameters and Results, Smiths Fork (WB030), October 27, 1998, One station.

Parameter (units)	**Results, Stn. 1**
Time (hours)	1215
Temperature (°C)	8.8
pH (Standard Units)	8.53
Conductivity (µS/cm)	763
Dissolved Oxygen (mg/l)	7.47
Turbidity (NTU)	178.3
Total Suspended Solids (mg/l)	232
Alkalinity (mg/l)	205
Chlorides (mg/l)	51
Sulfate (mg/l)	112
Total Hardness (mg/l)	220
Total Phosphorus (mg/l	0.3
Nitrate Nitrogen (mg/l)	< 0.1

Turbidity is an optical property of water where total suspended solids (TSS) and some dissolved material cause light to be scattered. An increase in turbidity and TSS has been shown to decrease the production and abundance of plant material, decrease abundance of fish food organisms, and decrease production and abundance of fish (Lloyd, 1987; Newcombe and Jensen, 1996). The WDEQ/WQD (1990) numeric standard for turbidity deals with turbidity increases attributable to the activities of man. The WDEQ/WQD (1990) narrative standard for floating and suspended solids states that activities attributable to man shall not cause significant degradation of habitat for aquatic life or adversely affect plant life or wildlife. Lloyd's (1987) literature review of the effects of turbidity on salmonids suggested that turbidity in the 10-25 NTU range and TSS concentrations near 35 mg/l can have deleterious effects on fish. Newcombe and Jensen's (1996) literature review suggest TSS values between 18 and 35 mg/l can result in reduced feeding and abundance, and TSS values in the range of 50 to 66 mg/l can result in reduced rates of weight gain and avoidance behavior in adult rainbow and cutthroat trout. The instantaneous turbidity (178.3 NTU) and TSS (232 mg/l) in the Smiths Fork are very high and suggest a negative effect on cold water game fish and aquatic life.

Alkalinity refers to the capacity of water to neutralize the addition of acid. Alkalinity is also important for primary production (bacteria and algae) in streams which directly affects the macroinvertebrate community. Generally, as alkalinity increases, stream production increases (King, 1993a). There is no numeric alkalinity standard in Wyoming, but a minimum limit of 20 mg/l has been suggested by the U.S. Environmental Protection Agency (1986). The Smith Fork's alkalinity level of 205 mg/l is well above this minimum threshold.

Chlorides and sulfates are the two principal dissolved components in water. Increased chloride or sulfate levels can have a negative effect on benthic macroinvertebrates. WDEQ/WQD (1990) water quality standards set aquatic life acute and chronic chloride standards of 860 mg/l and 230 mg/l, respectively. There is no surface water numeric standard for sulfates in Wyoming, however, King's (1993a) review suggests sulfate levels below 150 mg/l were optimal for macroinvertebrates. Acute chloride (51 mg/l) and sulfate (112 mg/l) levels in the Smiths Fork are elevated but do not suggest a negative impact to the aquatic life at the time of sampling.

Total hardness in stream water is related to the concentration of metals (metallic ions). Common metallic ions that contribute to hardness include calcium and magnesium. When the hardness is numerically greater than the sum of carbonate and bicarbonate alkalinity, the excess is called noncarbonate hardness. Other metallic ions included in the noncarbonated hardness fraction may include aluminum, iron, strontium, zinc, and manganese. There is no total hardness water quality standard in Wyoming, however, if a large disparity between total hardness concentrations are observed between reference streams and the stream being assessed, sampling for specific metal should be conducted (King, 1993a). The total hardness of the Smiths Fork (220 mg/l) indicates "hard" water. This hardness is slightly higher than the carbonate alkalinity of 205 mg/l. Mean total hardness values for eleven Wyoming Basin reference streams is 133 mg/l, and for 8 sub-reference streams is 175 mg/l. The total hardness in the Smiths Fork is higher than that observed in reference and sub-reference streams in the Wyoming Basin. This appears to reflect a higher carbonate and bicarbonate level in the Smiths Fork and not a metallic ion issue due to the low noncarbonate hardness level.

Phosphorus is an essential element for plant growth and is considered one of two primary nutrients associated with human induced pollution. Even low levels of phosphorus (>0.2 mg/l) can stimulate growth of algae, periphyton, and bacteria. Naturally occurring phosphorus enters the stream primarily by soil erosion and sediment transport. Additional sources of phosphorus can include municipal and industrial effluents, and runoff from animal feeding areas and fertilized lands (King, 1993a). Wyoming has not established water quality standards for phosphorus, however, King's (1993a) literature review suggests total phosphorus levels should not exceed 0.05 mg/l in a stream that enters a lake or reservoir and suggests a target total phosphorus concentration of $\leq$1.0 mg/l for streams that do not directly enter lakes. The total phosphorus level in the Smiths Fork was 0.3 mg/l. The total phosphorus levels in the Blacks Fork River, immediately upstream of the confluence with the Smiths Fork, and in the Hams Fork immediately upstream of the confluence with the Blacks Fork, were < 0.1 mg/l. The total phosphorus levels in the Blacks Fork below the confluence with the Smiths Fork and also immediately above Flaming Gorge Reservoir were 0.2 mg/l. These data suggest that the Smiths Fork is a significant contributor to total phosphorus loading in Flaming Gorge Reservoir.

Several forms of nitrate nitrogen are present in nature. WDEQ bioassessments sample and analyze nitrate → nitrite nitrogen. Nitrate is considered the other of the two primary nutrients associated with human induced pollution. Sources of human induced nitrate concentrations can be from municipal and industrial effluents, animal feeding operations, fertilizer use, and other human and animal waste runoff (King, 1993a). Wyoming does not have a nitrate standard for aquatic life, however, the human health standard for nitrate nitrogen is 10 mg/l (WDEQ/WQD, 1990). Nitrate nitrogen levels in the Smiths Fork were less than 0.1 mg/l.

The Smiths Fork exhibited an intermittent surface sheen, was brown in color, and had an organic odor at the time of the bioassessment sampling. Observations from the October 19, 1999 site visit indicated that the Smiths Fork was turbid, green-brown in color, and exhibited some surface foam.

Macroinvertebrates and Biological Condition

Macroinvertebrate samples were taken from a 100-foot long riffle. Eight surber samples were randomly located at this riffle site and a composite sample was obtained. Samples were collected and preserved according to WDEQ/WQD bioassessment protocols (King, 1993a).

Macroinvertebrate samples were sent to WDEQ/WQD's contract laboratory (Aquatic Biology Associates, Corvallis, OR) where they were processed and subsampled according to WDEQ/WQD protocol and standard taxonomic effort (King, 1993a). All biological data were evaluated for quality assurance and quality control and met data quality objectives.

Wyoming Department of Environmental Quality biological, water quality, and physical habitat data from 1992 to 1997 were analyzed to construct a regionally-calibrated multi-metric biotic index (Stribling et al., 2000). This analysis resulted in the delineation of four separate bioregions (areas with similar biological attributes). The Smiths Fork site falls into the "Basins" Bioregion. Ten core metrics with pronounced discrimination efficiency (degree of separation between metric value distributions of reference and degraded sites) were used to construct the multi-metric biological index The metrics for the Smiths Fork and the resulting index scoring are presented in Table 2. Total scores above the 25th Percentile of the Basins Bioregion "reference" index data were rated as "good" (61.8 - 80.9) or "very good" (> 80.9). Index score values below the 25th Percentile are rated as "fair" (41.1 - 61.7), "poor" (20.6 - 41.0), or "very poor" (< 20.6). A "good" or "very good" multi-metric rating suggests full support of aquatic life use. A "fair" multi-metric rating suggests partial support of aquatic life use, and "poor" and "very poor" ratings suggest non-support of aquatic life.

The Index score for the Smiths Fork (27.6) is the lower-middle of the "poor" category (20.6 - 41.0) for the Basins Bioregion.

Table 2. Core Metrics. Basin bioregion reference condition metric values; Smiths Fork (WB-030) metric values, metric scores, index score, and rating.

Core Metric	**Basin Bioregion Reference Condition (95th or 5th Percentile)**	**Smiths Fork Metric Value**	**Smiths Fork Metric Score**
Total Number Taxa	45	20	44.4
Ephemeroptera Taxa	9	3	33.3
Plecoptera Taxa	7	1	14.3
Trichoptera Taxa	10	2	20.0
% Plecoptera	16.5	1.06	6.4
% Non-insects*	0.04	2.13	91.5
BCI CTQa*	62.6	101.4	14.5
% 10 Dominant Taxa*	71	93.26	23.2
% Collector-gatherers*	13	75.54	28.1
No. Scraper Taxa	8	0	0
Index Score ($\sum$ /10)			27.6
Rating			Poor

* Metric where the trend increases with increasing stress (positive TwI). Higher values indicate a negative response. Reference Condition 5th percentile is utilized to calculate the score for positive TwI metrics.

Taxa richness refers to the total number of taxa in the sample. The number of taxa generally decreases with decreasing water quality. An exception are high quality, low productivity mountain streams with naturally low concentrations of dissolved constituents and correspondently low taxa richness (King, 1993). Taxa richness (18 taxa of insects and 2 non-insect taxa) for the Smiths Fork is significantly lower than the Basin Bioregion reference condition (95th percentile) of 45 taxa and results in a metric score of 44.4. The Smiths Fork site is located in the Basins Bioregion where dissolved constituents are not limiting (as observed in the water quality data), so the referenced exception does not apply.

The Order Ephemeroptera (mayflies) contains approximately 700 species in North America. Because of the large number of species, mayflies will normally be found in most samples collected in stream riffles habitats during any time of the year. Their presence in riffle habitats is generally associated with good to excellent water quality while their absence from riffle habitats is a strong indicator of poor water quality (King, 1993b). The functional feeding groupings of mayflies are primarily scrapers, collector gatherers, or shredders. The number of Ephemerotera taxa (3) found in the Smiths Fork is significantly lower than the Basin Bioregion reference condition (95th percentile) of 9 taxa and results in a metric score of 33.3.

Taxa in the Order Plecoptera (stoneflies) are found in cool, well-oxygenated streams with good to excellent water quality. These taxa are most sensitive of all aquatic macroinvertebrates to water pollutants and their presence is considered a barometer of good water quality. Because of this, the presence of numerous stonefly taxa and a significant percentage of stonefly density are good indicators of good to excellent water quality (King, 1993b). The number of Plecoptera taxa (1) found in the Smiths Fork is significantly lower than the Basin Bioregion reference condition upper value (95th percentile) of 7 taxa and results in a metric score of 14.3. The percentage of Plecoptera in the Smiths Fork sample (1.06 %) is significantly lower than the Basin Bioregion reference condition (95th percentile) of 16.5 % and results in a metric score of 6.4.

Taxa of the Order Trichoptera (caddisflies) are commonly found in most aquatic habitats. These taxa should be found in all riffle samples with the exception of streams with very poor water quality. Caddisflies either live in cases or are free-living (without cases). It is not unusual to find from 5 to 10 different types of caddisflies in stream riffles with good water quality (King, 1993b). The number of Trichoptera taxa (2) is significantly lower than the Basin Bioregion reference condition (95th percentile) of 10 taxa and results in a metric score of 20.0.

A high percentage of non-insects, commonly pollutant tolerant members of the Phyla Annelida (segmented worms) and Platyhelminthes (flatworms), generally indicates poor water quality. The percentage of non-insects in the Smiths Fork (2.13%) was higher than observed in the Basin Bioregion reference condition (5th percentile), but was still relatively low and resulted in a metric score of 91.5. Generally such a low non-insect population would suggest good water quality. However, the relatively high percentage of pollutant-tolerant taxa in the Smiths Fork sample

(38.5%) does not support that hypothesis. The low percent non-insects may be more indicative of riffle substrate (cobble and coarse gravels) sampled than of good water quality.

The percent contribution of the dominant taxa is an indication of community balance. A community dominated by a single taxon or by relatively few taxa indicates environmental stress due to poor water quality or habitat quality (King, 1993a). The ten dominant taxa in the Smiths Fork comprised 93.26% of the total organisms found. The percent ten dominant taxa (5^{th} percentile) for Basin Bioregion reference condition was 71%. The Smiths Fork ten dominant taxa percentage is significantly higher than the reference condition value and results in a low metric score of 23.2.

The Biotic Condition Index (BCI), Actual Community Tolerance Quotient (CTQ_a) is the product of values derived from the taxon's tolerance levels of alkalinity and sulfate plus selectivity for or against fine texture substrate materials and low stream gradients. Values range from 2 to slightly greater than 100 with the larger values indicating greater taxon tolerance (Winget and Mangum, 1979; Platts et. al, 1983). The BCI - CTQ_a value for the Smiths Fork (101.4) was significantly higher than the Basin Bioregion reference condition (5^{th} percentile) of 62.5. This value indicates a high degree of tolerance for taxa collected in the Smiths Fork and results in the low metric score of 14.5.

Scrapers are the functional feeding group of macroinvertebrate taxa that scrape rock, twig, and leaf surfaces for food such as periphyton (King, 1993b). Taxa in this function feeding group tend to be relatively intolerant to stressors such as sediment that reduce or eliminate their feeding areas. Even though the Smiths Fork sample riffle was comprised of 39.38 % cobble and 21.88 % coarse gravel, zero scraper taxa were collected. The number of scraper taxa for the Basin Bioregion reference condition (95^{th} percentile) is 8 taxa. The absence of scrapers in the Smiths Fork resulted in a metric score of 0.

Collector - Gatherers are a functional feeding group of macroinvertebrate taxa that eat decomposing fine organic matter such as decayed plants, leaves and materials in stream bottom sediments. A high percentage of collector - gatherer taxa can be indicative of organic enrichment from vegetative material, manure, or sewage. An increase in this functional feeding group may also indicate increased stream sedimentation (King, 1993b). The percentage of collector - gatherer taxa in the Smiths Fork was 75.54 %. The value (5^{th} percentile) for percent collector - gatherer taxa for Basin Bioregion reference condition is 13 %. The high percentage of collector - gatherer taxa in the Smiths Fork suggests organic enrichment and/or sedimentation and resulted in a low metric score of 28.1.

Additional biological metrics were calculated for the Smith Fork station. Even though these metrics did not have as high discrimination efficiencies as the core metrics previously discussed, these data are useful in further understanding the biological community in the Smiths Fork.

These metrics are presented in Table 3.

Table 3. Supplemental Metric Values, Smiths Fork (WB030).

Supplemental Metrics	Metric Value
Modified HBI	5.48
Ratio EPT Taxa / Chironomidae Abundance	0.93
% Collector - Filterer	18.08
% Hydropsychidae / Total Trichoptera	99.0
Community Loss Index (Smith Fork to New Fork)	0.61
% Multivoltine	44.15
% Univoltine	55.85
% Semivoltine	0.00

The modified Hilsenhoff Biotic Index (HBI) involves summation of the pollution tolerances of organisms into a single value. Tolerance values ranging from 0 to 10 are assigned to each organism contained in the sample. Organisms assigned higher values are more tolerant to organic and possibly nutrient and sediment pollutants. A high HBI value indicates that the macroinvertebrate community is comprised of organisms with greater tolerance to pollutants. King (1993a) provides references and additional discussion on this index. A modified HBI for the Smiths Fork of 5.48 is relatively high, suggesting a significant percentage of the taxa collected are pollution tolerant.

The ratio of EPT (Ephemeroptera, Plecoptera, and Trichoptera) to Chironomidae abundance is an assessment of community balance. EPT taxa are relatively sensitive to water pollution while Chironomidae (midges) are generally less sensitive and increase in abundance due to increases in organics and sediment. A balanced community will have a fairly even distribution of each of the four groups with a substantial representation of EPT taxa (King, 1993a). A greater proportion of the generally tolerant Chironomidae to the more sensitive EPT taxa generally indicates impacts due to water pollution. This ratio for the Smiths Fork station was 0.93, indicating more Chironomidae taxa than all EPT taxa combined. This represents an uneven distribution and unbalanced community.

The Collector - Filterer functional feeding group consists of those taxa that eat fine particulate material suspended in the water by filtering the food from the water. Examples of Collector - Filterer feeding group taxa are mosquitoes and blackflies. Like Collector - Gatherer taxa, a high percentage of Collector - Filterer taxa is an indicator of organic enrichment from manure and/or sewage and increased sedimentation (King, 1993b). The Collector - Filterer functional feeding group comprises 18.08 % of the organisms collected in the Smiths Fork. When combined with the Collector - Gatherer functional feeding group, an extremely high 93.6 % of all the organisms collected from the Smiths Fork are in one of these two functional feeding groups.

Percent Hydropsychidae to total Trichoptera is a metric that measures the density of the generally mild pollution tolerant Hydropsychidae family (primarily filtering collectors) to the density of total Trichoptera (relatively sensitive to water pollution)(King, 1993a). King (1993a) assigns the highest biological score to samples where density of Hydropsychidae is less than 20% of the total Trichoptera. In the Smiths Fork, Hydropsychidae comprised 99 % of the total Trichoptera, correlating to the lowest biological condition scoring value described by King.

The Community Loss Index compares macroinvertebrate communities at two locations where at least one location represents a reference or control. The index measures the loss of taxa between the reference location and the comparison location with index values increasing as the degree of dissimilarity with the reference location increases. King (1993a) provides additional discussion on
the specifics of this index. The macroinvertebrate community in the Smiths Fork was compared with the community in the New Fork of the Green River (East Fork Station WB-055, below the confluence with the East Fork). The New Fork was chosen as the community loss comparison location because this reference station, like the Smiths Fork, is in the basin a considerable distance from its mountain headwaters, there is one municipality upstream of the station, and there is a considerable amount of irrigated hayland, livestock feeding, and wildlife use in the watershed above the station. The New Fork (45 total taxa) and the Smiths Fork (20 total taxa) had 11 common taxa. These values result in a community loss index of 1.70. King (1993a) reports a community loss index of <0.5 as having the highest biological scoring and a community loss index of >4.0 as having the lowest biological scoring. The community loss index value of 1.7 is found in the second lowest of the four biological scoring groupings (1.5 - 4.0). This index suggests a moderately high loss of taxa in the Smiths Fork, when compared to the New Fork reference station

Community voltinism is a measure of the distribution of taxa with various life cycle requirements. Multivoltine taxa are those that exhibit several life cycles during a single year. Univoltine taxa are those requiring a year to complete a single life cycle, while semivoltine taxa are those that require several years to complete a life cycle. An even distribution of these three assemblages suggests a stable community. The dominance of multivoltine taxa suggest possible seasonal degradation of water quality or periodic pulses of pollutants through the system have limited the survival of univoltine and semivoltine taxa. The Smiths Fork station exhibited 44.15 % multivoltine taxa, 55.85 % univoltine taxa, and 0.00% semivoltine taxa. These data do not suggest a stable community with respect to life cycle assemblages. The complete absence of semivoltine taxa suggest that some environmental condition(s) in the Smiths Fork are not suitable for survival of long-lived organisms.

The investigators made the following biosurvey observations on the Smiths Fork: filamentous algae was not observed; floating macrophytes were not observed; rooted macrophytes were commonly observed; periphyton was commonly observed; slimes were rarely observed; and, fish were rarely observed. The single fish observed could not be identified as a game or non-game fish due to high turbidity.

Habitat Quality

Physical (habitat quality) data were collected and analyzed according to WDEQ/WQD bioassessment protocols (King, 1993a). All data were evaluated for quality assurance and quality control and met data quality objectives.

Substrate composition and silt cover (embeddedness) were recorded at eight, one square foot sample points within the riffle where macroinvertebrates were collected. Water velocity was also recorded at each of these points. A summary of these data are presented in Table 4.

The most common substrate component in the Smiths Fork sample riffle was cobble (39 %), followed by coarse gravel (22 %) and fine gravel (18 %). Fines were comprised primarily of clay (12 %) and silt (8 %) with a minor amount of sand (1%) substrate being noted. The presence of rock and gravel in flowing streams is generally considered the most desirable habitat (Plafkin et al., 1989). Substrate, such as found in the Smiths Fork sample riffle, should reflect a diverse and balanced macroinvertebrate community. These substrate data suggest that the poor macroinvertebrate data discussed earlier are a factor of water quality stressors and not the selection of an inferior substrate riffle for sample collection.

Weighted embeddedness (silt covering) in the sample riffle can range from 20 (complete silt cover) to 100 (void of silt cover). The weighted embeddedness at the Smiths Fork sample riffle (75.9) was quite high considering the poor macroinvertebrate data and the high turbidity of the water. The high turbidity in the Smiths Fork at the time of the sampling prevented the samplers from observing the substrate in-place. Individual cobbles had to be gently removed from the stream bottom in order to estimate silt covering. This procedure may have underestimated silt covering by discounting silt coverage on gravels not picked up and by the possibility of silt being washed away by the current as the cobbles were lifted from the stream bottom. The relatively high weighted embeddedness may also be a factor of the high mean water velocity (2.39 feet / second) in the sample riffle.

The condition of upland, riparian, and instream habitat influences water quality and macroinvertebrate community structure. Habitat quality is strongly related to biological condition and may also limit biological potential (King, 1993a). The qualitative habitat quality assessment for the Smiths Fork covered a segment approximately 1,500 feet upstream of the sampling station (to the property boundary at the south half of Section 13). Thirteen habitat assessment parameters were evaluated. Evaluation of these parameters allow for a total habitat score ranging from zero to 200 points. High total point scores equate to high quality habitat. Specifics of the individual habitat parameters are contained in King (1993a) and the department's procedures paper *Beneficial Use Reconnaissance Project - Wadable Stream Monitoring Methodology* (WDEQ/WQD, 1998).

Table 4. Mean Substrate Composition, Weighted Embeddedness, and Water Velocity at the Smiths Fork Sample Riffle.

Mean Percent Substrate (Eight 1 ft.^{2} Quadrats)							
Cobble (2.5-10")	Coarse Gravel (1 - 2.5")	Fine Gravel (0.3 - 1")	Sand (<0.3", gritty)	Silt* (<0.3", fine)	Clay (Hard Pack)	Organic (fine, black)	Precipitate (Oil, WWTF)
39	22	18	1	8	12	0	0
Weighted Embeddedness - Silt Coverage (Range 20 to 100) Eight 1 ft.^{2} Quadrats				**Mean Water Velocity (ft./sec.)** Eight Quadrat Locations			
75.9				2.39			

* Silt substrate is where the silt covering is greater than 1/4 inch deep

Habitat Scores for Smiths Fork and the mean and standard deviation of eleven Wyoming Basins reference streams are contained in Table 5. The Smiths Fork had a total habitat score of 78 points. This score is 54.2 % the mean score for the eleven Wyoming Basins reference streams and 63.2 % of the mean score minus one standard deviation for the eleven reference streams. King (1993a) suggests streams with $\leq$ 59 % comparability with reference streams be assessed as non-supporting and streams with 60 - 74 % comparability with reference streams be assessed as partially supporting. Low scores were recorded for: instream cover for fish, channel flow status, width to depth, bank vegetation protection, disruptive pressure to riparian zone immediately adjacent to the stream, and riparian vegetation width / loss of riparian vegetation due to land use activities.

Table 5. Habitat Scores for the Smiths Fork as Compared with Eleven Wyoming Basins Reference Streams.

	Smiths Fork (WB-030)	**11 Wyoming Basins Reference Sites**	
		Mean	**Standard Deviation**

Total Habitat Score	78	144	20.6

Pool quality data, as related to fish habitat, were collected at four consecutive pool habitats above the sample riffle in accordance with the department's procedures paper *Beneficial Use Reconnaissance Project - Wadable Stream Monitoring Methodology* (WDEQ/WQD, 1998). Pool quality scores can range from 0 to 10, with the higher point values representing higher quality pools for fish habitat. Pool quality scores for the four pools examined on the Smiths Fork were 2, 1, 1, and 2 points, respectively. The low scores reflected the dominance of gravel and fines as pool substrate, the lack of overhead and subsurface cover, and the low amount of bank cover along the length of the pool. The predominance of fines in the pools suggest considerable sediment transport in the Smiths Fork.

Additionally, unstable banks, mid channel bars, and non-vegetated point bars were observed in the reach suggesting that the Smiths Fork is not in balance with the water and sediment being supplied by the watershed. Deltas, bars, and fan deposits along the margins of the river indicate that the upland watershed is contributing to stream degradation.

Historical and Ancillary Information

The Wyoming Game and Fish Department (Remmick, 1981) describes the aquatic environment of the lower sections of the Smiths Fork (Blacks Fork confluence to the town of Mountain View) and the Blacks Fork (Flaming Gorge Reservoir to the Smiths Fork) as: "High water temperatures during the summer months, extreme siltation and high alkalinity perpetuate an adverse habitat not conducive to game fish production." Remmick discusses the presence of channelization and irrigation diversions in the Smiths Fork watershed but does not speculate whether the noted adverse water quality conditions are human induced or naturally occurring. However, Remmick notes significant differences in rainbow trout standing crops in 1976 at four locations bracketing an area of stream channelization in Sec. 30, T.14N., R.115W. (upstream of Robertson) (Table 6) .

The Wyoming Game and Fish Lakes and Streams database (edit date 07/24/97) reports the Smiths Fork as having rainbow trout, brook trout, Colorado River cutthroat trout, redside shinner, speckled dace, mountain sucker, and mottled sculpin present in Sec.6, T.16N., R.113W. (downstream of the sample location near the confluence with the Blacks Fork).

Table 6. Rainbow Trout Standing Crop at Four Locations on the Smiths Fork, 1976 (Remmick, 1981).

Location	Standing Crop (lbs./ac.)
Above Channelized Area (Sec. 30, T.14N., R.115W.)	29.6
Channelized Area (Sec. 30, T.14N., R.115W.)	4.7

1.6 km below Channelized Area	10.0
3.2 km below Channelized Area	118.8

The United States Forest Service (Young et. al, 1996) reports known populations of Colorado River cutthroat trout in upper tributaries to the Smiths Fork (Cottonwood Creek, Sage Creek, Swamp Creek, Willow Creek, East Fork Smiths Fork, Gilbert Creek, Little Gilbert Creek, West Fork Smiths Fork, and Archie Creek). The presence of this widely distributed native species in these headwater streams suggests that the lower segment of the Smiths Fork historically allowed passage of these trout.

The United States Geological Survey historically collected water quality (1974 - 1989), sediment (1975 - 1978), and biological (1974 - 1982) samples from Station 09221650, Smith Fork near Lyman (NW¼NW¼ Sec.13, T.16N., R.114W), immediately downstream of the sample riffle. Data from these sample events were obtained electronically from the University of Wyoming, College of Engineering *Water Resources Data System (WRDS).* The specific sampling procedures, analysis methods, and quality assurance/quality control on these data are not known, and therefore these are considered as “evaluated” information only. The age of these data make them “historic” information. Historical USGS data of particular interest to this report were: temperature, turbidity, total phosphorus, total dissolved solids, total suspended solids, and fecal coliform bacteria.

Field water temperature was collected in the U.S.G.S. data set a total of 87 separate sampling events. Field water temperatures ranged from 0.0°C to 28.0°C. Field water temperatures in the Smiths Fork exceeded the state maximum cold water game fish (Class 2 waters) lethal temperature of 25.6°C on 4 separate sampling events. Field water temperatures greater than 20°C occurred primarily during the months of June through August when discharge was relatively low.

U.S.G.S. turbidity data (Jackson turbidity units) were collected for 92 separate sample events. Turbidity values ranged from 1 JTU to 4,500 JTU. Note: Jackson (JTU) and nephelometric (NTU) turbidity units are roughly equivalent (U.S.E.P.A., 1983). Lloyd’s (1987) literature review on the effects of turbidity on salmonids presents citations that report salmonid stress (respiratory distress) and altered behavior (listlessness) occurring at turbidities between 15 and 27 JTU, altered behavior (feeding) at turbidity levels of 25 JTU, and altered behavior (visual) at turbidity levels of 25 - 30 JTU.

Low turbidity in the Smiths Fork was commonly observed during periods of low flow, generally during the winter but also during the summer when flows were extremely low, presumably because of irrigation withdraws. Turbidity values of 30 JTU or greater were observed in 40 of the 92 U.S.G.S. observations. Sixteen observations had turbidity levels of 200 JTU or greater. The elevated turbidities were commonly observed during higher flows in the spring and summer, assumably following runoff events from snowmelt or precipitation events.

Total phosphorus samples were collect by the U.S.G.S. for 54 separate sampling events at the Smiths Fork station. Total phosphorus levels ranged from 0.02 mg/l to 13.0 mg/l. As stated previously, total phosphorus levels greater than 0.05 mg/l constitute a potential nutrient problem for waterbodies that enter a lake or reservoir and levels greater than 1.0 mg/l constitute a potential nutrient problem for waters that do not directly enter a lake or reservoir. Total phosphorus levels exceeded 0.05 mg/l a total of 39 of 54 observations. Total phosphorus levels exceeded 1.0 mg/l a total of 8 of 54 observations. Again, low total phosphorus levels were more common during the winter low water period when sediment delivery was low. Higher levels occurred during spring and summer higher flow periods when sediment delivery was high. Even taking into account possible dilutions from the Blacks Fork and Hams Fork rivers, these historic data suggest potential total phosphorus loading in Flaming Gorge Reservoir from the Smiths Fork watershed.

U.S.G.S. suspended sediment data were collected for 40 separate sample events. Suspended sediment values ranged from 22 mg/l to 16,200 mg/l. Based on discharge and concentration, total sediment delivery in the Smiths Fork ranged from 0.14 tons/day to 1,850 tons/day. Suspended sediment levels were at or greater than the earlier referenced stress-causing TSS level of 35 mg/l in 36 of the 40 readings. Suspended sediment levels greater than 100 mg/l were observed in 24 of the 40 readings. Again, low suspended sediment values were most commonly observed during low flows in the winter and late summer.

Total dissolved solids (TDS) data were collected by the U.S.G.S. on 96 separate sampling events. TDS values ranged from 221 mg/l to 2,000 mg/l. Based on discharge and concentration, total dissolved solids delivery in the Smiths Fork ranged from 0.54 to 488 tons per day. Again, elevated TDS values corresponded to low flow winter months while elevated TDS values generally corresponded to moderate flows during late summer (July through September). Sodium was the major cation observed in these samples, while sulfate was the major anion.

Fecal coliform bacteria data were collected by the U.S.G.S. on 95 separate sampling events. Fecal coliform bacteria counts ranged from 1 to 5,200 colonies / 100ml. Fecal coliform bacteria counts exceeded 200 colonies / 100ml on 25 occasions and exceeded 400 colonies / 100ml on 12 occasions. Elevated colony counts occurred across a wide variety of flow regimes, but were most commonly observed during early summer and fall. These historic bacteria data suggest further bacteriological investigation of the Smiths Fork is warranted when the Blacks Fork River is investigated in 2000.

SUMMARY AND CONCLUSIONS

Classification

The Smiths Fork is correctly classified as a Class 2, Coldwater game fish stream. This conclusion is based on data from the Wyoming Game and Fish Stream and Lake database which identifies trout species present in the lower reaches of this segment, Wyoming Game and Fish published data that describe the presence of trout in the Smiths Fork approximately 20 stream miles upstream of the reach, and United States Forest Service indicating the distribution of indigenous Colorado River cutthroat trout in numerous Smiths Fork headwater streams.

Water Quality

Water quality data collected from the Smiths Fork on October 27, 1998 do not identify any numeric water quality standards exceedences. Elevated turbidity (178.3 NTU), total suspended solids (232 mg/l), and total phosphorus (0.3 mg/l) all suggest a potential sediment problem in the Smiths Fork. Historical data also indicate that temperature, sediment, total phosphorus, and dissolved constituents have been significant factors in the past.

Macroinvertebrates and Biological Condition

Bioassessment core metrics indicate the Smiths Fork macroinvertebrate community is significantly depressed as compared to Wyoming Basin reference stream condition. All core metrics, with the exception of percent non-insects, scored low. The overall metric index score of 27.6 indicates a “poor” or “impaired” biological condition. Additional biometrics examined supported this poor rating. Functional feeding group data suggest a sediment impairment.

Physical and Habitat Quality

The physical assessment score for the Smiths Fork (78 points) is significantly less than the mean assessment score of 11 Wyoming Basins reference streams (144 points). Pool quality was low due to poor substrate and instream, overhead and bank cover. Many of the physical habitat observations indicates the presence of an erosive system where sediment delivery exceeds the stream’s ability to transport it through the watershed. Erosional features and riparian condition immediately adjacent to the Smiths Fork suggests sediment contribution from upland areas

FINAL ASSESSMENT AND SIGNATURES

Review of the chemical, biological, and physical data collected on the Smiths Fork on October 27, 1998 indicates that the Smiths Fork, a tributary of the Blacks Fork of the Green River, is a Class 2 (cold water) waterbody. The Smiths Fork is impacted by natural or man-induced activities and is non- supporting of coldwater game fish protection and propagation designated use due to sediment and habitat degradation.

Sampler (signature and printed name) Date

Sampler (signature and printed name) Date

____ ____________________
Monitoring Supervisor (signature and printed name) Date

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