# 2013 Aquatic Surveys and Re-Assessment of Sites within the Middle Powder River Watershed

Bureau of Land Management - Miles City Field Office and
The Interagency BLM Aquatic Task Group

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# Executive Summary

This report integrates the project results of the 2011 study (Stagliano 2012) with 2012 fish surveys and 2013 intensive aquatic community sampling, and summarizes all years. Objectives in 2013 were to: 1**)** revisit six integrator sites established and sampled in 2005 and 2011 to assess aquatic community changes during this time period; 2) determine whether the macroinvertebrate communities have rebounded from low integrity levels reported in 2011 to 2012, as the fish community did; 3**)** perform targeted freshwater mussel surveys at these Powder River sites, five sites across the border into Wyoming and at six Tongue River coalbed natural gas (CBNG) monitoring sites; and 4**)** incorporate other agency data and interpret key community and watershed indicators (Observed vs. Expected (O/E) and Index of Biotic Integrity (IBI)) against reference condition standards to determine aquatic condition status and trends since the development of CBNG wells in the watershed. Additional fish surveys sites were added along the Powder River in Montana, as well as sites upstream into Wyoming for sturgeon chub and mussel occupancy surveys.

***Fish Communities:*** Fish surveys were performed in 2013 at each site using the same protocols during similar seasons and river flows as in 2012, 2011 and 2005. We captured 2,832 individuals and identified 12 native species at the eight Powder River sites. These surveys captured significantly more total individuals (eight times) and native species (three more) than recorded in 2011, and twice the number of individuals as in 2005. Native fish species averaged 8.2 per site in 2012 and 9.4 per site in 2013, whereas in 2005 and 2011, sites averaged 7.0 and 6.4 species per site, respectively. Flathead chubs were the dominant member of this river section's fish community in 2012 and 2013, averaging 55% and 45% of the individuals collected, respectively; by contrast, in 2005, sand shiners were the dominant species contributing ~60% of the total catch. The introduced plains killifish was not collected at any sites between 2011 and 2013 since it was last reported in 2005. The sturgeon chub, a Montana species of concern (SOC) previously common in this reach, was absent from 14 of 16 sampling site visits between 2005-2011, but have rebounded in 2012 and 2013 with detections at 11 of 17 site visits of up to 23 individuals per site. Fish communities across all sites scored higher with the fish IBI and O/E models in 2012 and 2013 (post-CBNG) than in 2005 or 2011 (active CBNG), averaging 67.1 vs.

58.4 and 1.2 vs. 0.85, respectively. These differences were significant with the Student's paired T-test (p = 0.02 and 0.007). There were no significant differences in the IBI or O/E between 2005 and 2011, averaging 58.4 vs. 54.5 and 0.84 vs. 0.78, respectively (T-test, p= 0.2 and 0.17). Fish community metrics calculated from 2012 and 2013 surveys were not significantly different from metrics reported in surveys collected pre-CBNG development (1975 and 2000) in this river section. Therefore, fish integrity declines documented during the 2005-2011 surveys have largely recovered during the last two years of monitoring. The fish O/E values calculated between 2005 and 2011 ranked six of the twelve site visits impaired (< 0.8), while no sites sampled since 2011 (n=16) were ranked impaired.

***Mussel Surveys***: Mussels were surveyed using visual encounter protocols at 12 Powder River and 12 Tongue River sites in 2013. We observed no live mussels in the Powder River, although we did record fatmucket (FAMU) (*Lampsilis siliquoidea*) shells at four sites during the visits. Mussel detection at Tongue River sites was 50% (6 of 12 sites reported live FAMU). The most abundant Tongue River mussel site was ~10 miles upstream of the Tongue River Reservoir at the Wyoming Route 338 bridge (18 FAMU individuals per hour), while sites below the reservoir averaged only one FAMU individual per hour. We could not find evidence of recent reproduction (juveniles <30 mm) at any sites with live mussels present, though this may have been related to slightly turbid sampling conditions. No relationship between mussel presence and CBNG activities can be inferred from this survey effort, but we now have improved baseline population distribution.

***Macroinvertebrate Communities***: Paired riffle and reach-wide, EPA-protocol, macroinvertebrate samples were collected at each site, replicating efforts from previous years (2011, 2005). Overall, 47 total taxa were reported in 2013, a significant decrease from 59 total taxa reported from these sites in 2005 and 64 taxa in 2011. Average macroinvertebrate taxa richness per site was 23.9 taxa in 2013 which is a significant decrease from 28 taxa per site in 2011 (T-test, p=0.005), but is not significantly different than the 23.4 taxa per site reported in 2005 (p >0.05). Taxa lost between the monitoring years included many of the more sensitive mayfly taxa, as indicated by significant decreases in the EPT index between years. In particular, the SOC mayfly, *Raptoheptagenia cruentata* which was collected at all six sites in 2005 (averaging seven

individuals per site) was found at only four of six sites in 2011 (avg. 0.5 per site) and at zero sites in 2013. In contrast, the stonefly *Acroneuria abnormis* has significantly increased its abundance across the study reach in recent years from less than one individual per sample in 2005 to more than eight per sample reported in 2013. Reach-wide EMAP samples collected two of the five species of rare sand-dwelling mayflies, *Homoeoneuria alleni* and *Anepeorus rusticus,* that were not sampled with the Targeted-Riffle Protocols.

All EMAP samples agreed in ranking the six Powder River sites non-impaired with DEQ's MMI index scores >37, but the O/E scores rank all sites below the impairment threshold. There were no discernible spatial trends in the MMI or O/E index scores from the Wyoming border to Broadus. Averaged 2013 MMI scores were significantly different (lower) than 2005 and 2011 scores, while 2013 O/E scores were not significantly different than 2005 or 2011. However, the occurrence and abundance of species of concern (SOC) mayfly species has decreased from the WY border to Broadus Bridge from 2005 to 2011 and this decline continued in 2013.

***Aquatic Community Summary:*** Multiple lines of evidence (fish and macroinvertebrates) showed significant declines in the biological integrity of the Powder River study reach between 2005, when monitoring began post-CBNG development, and 2011. This integrity decline was particularly documented for fish and SOC mayfly species between the Wyoming border and Moorhead Bridge. Since 2011, the fish community integrity has rebounded to levels not seen since pre-CBNG development (prior to 2003), but macroinvertebrate communities have not shown this corresponding recovery. Concurrent studies have found that the highest concentrations of alkalinity in the Powder River also occurred in this reach (Petersen et al. 2011), indicating possible cumulative effects from CBNG extraction-related outflows from upstream in Wyoming as contributors to this biological condition during the active CBNG period. Sturgeon chubs have returned to most surveyed sites throughout the study reach and 15 miles upstream into Wyoming. Community integrity results from the 2012 and 2013 fish and macroinvertebrate surveys combined to rank the Powder River reach at the Moorhead Bridge Site as the most biologically intact, followed by Powder River Site #5 upstream of Rough Creek (POW#5).

# Acknowledgements

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*All photos in the report were taken by MTNHP personnel, unless otherwise noted.*

*On the cover: Two native benthic-dwelling fish species collected in the Powder River study reach, sturgeon chub (lower left) and the shovelnose sturgeon (lower right).*

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# Introduction

The Powder River is a vast drainage in Wyoming and Montana, representing one of the last large, undammed, prairie rivers in the United States. During the last decade, the Powder River Basin in Wyoming has also undergone one of the world's largest coalbed natural gas (CBNG) developments with about 12,000 wells in place in 2003 and 14,200 in 2005. Predictions were made that as many as 70,000 new wells may be developed over the next 20 to 30 years (Davis and Bramblett 2006), but these projections have not come to fruition and CBNG development, in terms of both production and numbers of new wells, has declined within the Powder River Structural Basin since 2011 (WYDEQ 2012).

In southeastern Montana, the landscape through which the Powder River flows is not far removed from the pre-European settlement state of a naturally functioning, large prairie river with sweeping meanders across valley bottoms, side channels, oxbows, shifting sand islands and connectivity to the floodplain (Vance et al. 2006). The entire Powder River aquatic ecosystem supports many elements of a fully functioning, biologically intact prairie river system, including 25 native fish species, of which 19 have been found in Montana (Baxter and Stone 1995). Additionally, the Powder River was determined to provide substantial habitat for the sturgeon chub, an ESA Candidate species (Werdon 1993, USFWS 1994) and currently a Montana and Wyoming species of concern (SOC) and BLM Sensitive Species. The sturgeon chub (*Macrhybopsis gelida*) has been declining over much of its historic range in the last 50 years (Stagliano and Gould 2010). Numerous species of specialized, sand-dwelling insects also inhabit the Powder River, including globally rare (G1-G3; NatureServe 2013) and Montana SOC (MTNHP/MFWP 2008) mayflies and dragonflies that have evolved to exploit the shifting sand and gravel bar habitats common in large, unaltered, prairie rivers (personal communication, Dan Gustafson, MSU 1/12/2006, Stagliano 2006). Previous investigations (1999-2002) (Gustafson 2002, unpublished) indicate that some of these specialized mayflies are not only rare, but may already be in serious decline (Stagliano 2012). These species were probably once abundant in prairie rivers across the northern Great Plains, but have been eliminated across most of their historic range due to impoundments and other anthropogenic river alterations (Hubert 1993).

Unfortunately, there was inadequate pre-CBNG baseline data on the sand-dwelling invertebrates occurring in the Powder River (Frelich, J. response to the Powder River EIS, 2002) because these species are rarely collected in standardized bioassessment samples (Stagliano 2006, Petersen et

al. 2009). In 2011, we attempted to target these species with specialized collecting techniques to serve as baseline population estimates for future monitoring, but the absence of many of these taxa, previously collected throughout the study reach (Stagliano 2006, Gustafson, unpublished), does not bode well for species of concern conservation efforts in the Powder River.

Scientists, industry and the public have debated whether CBNG product water would severely disrupt ecosystem services, such as ground or surface water for drinking or irrigation (USEPA 2004). However, definitive information on the effects of CBNG product water on fish and aquatic invertebrates is lacking (Davis et al. 2009). Therefore, pre-development baseline data and monitoring are essential in assessing changes brought about by CBNG wells at the landscape or local reach scale. Despite numerous projects undertaken to document and monitor biological communities in Montana's Powder River watershed (Rehwinkle 1978, Confluence 2004; Stagliano 2006, 2012; Davis et al. 2009; Peterson et al. 2009, 2011; WYDEQ & MTDEQ 2012), gaps still exist in our basic knowledge of prairie river aquatic community spatial and temporal changes in situations not confounded by anthropogenic factors (Dodds et al 2004). Coincidentally with CBNG production increases, the Powder River basin, as with much of the intermountain west, was affected by serious drought conditions from 2001 through 2010 (USGS 2012). Additionally, the Powder River presents numerous challenges in evaluating its biological and chemical integrity. These include problems sampling a shifting gravel sand-bed stream, high variability in flow and naturally high conductivity and turbidity.

Multiple lines of evidence (fish and macroinvertebrates) have documented significant changes in the biological integrity of this Powder River study reach since monitoring began post-CBNG development (Stagliano 2006, Peterson et al. 2010), and in comparison to data collected pre-CBNG development (pre-2003). Data document a structural change in the fish assemblages from a flathead chub-dominated (*Platygobio gracilis*) assemblage in the 1970s (Rehwinkel 1978) to a sand shiner-dominated (*Notropis stramineus*) community during the early 2000's (Stagliano 2006, Peterson et al. 2010), with a shift back to flathead chub dominance more recently (Stagliano 2012). This shift was coupled with a continued decline of the sturgeon chub throughout the Powder River (Peterson et al. 2010, Stagliano and Gould 2010, Stagliano 2012),

declines of rare sand-dwelling mayflies, and a loss of macroinvertebrate community integrity (Stagliano 2012).

This study integrates the project results of the 2011 report (Stagliano 2012) with 2012 fish surveys and 2013 intensive aquatic community sampling, and summarizes all monitoring years. Objectives in 2013 were to: 1) revisit six integrator sites established and sampled in 2005 and 2011 (plus continuing two USGS sites) to assess aquatic community changes during this time period; 2) determine whether the macroinvertebrate communities have rebounded from low integrity levels reported in 2011, as the fish community did in 2012; 3**)** perform targeted freshwater mussel surveys at these Powder River sites, five sites across the border into Wyoming and at six Tongue River CBNG sites; and 4) interpret key community and watershed indicators against reference condition standards to determine aquatic condition status and trends since the development of CBNG wells in the watershed.

# Study Sites

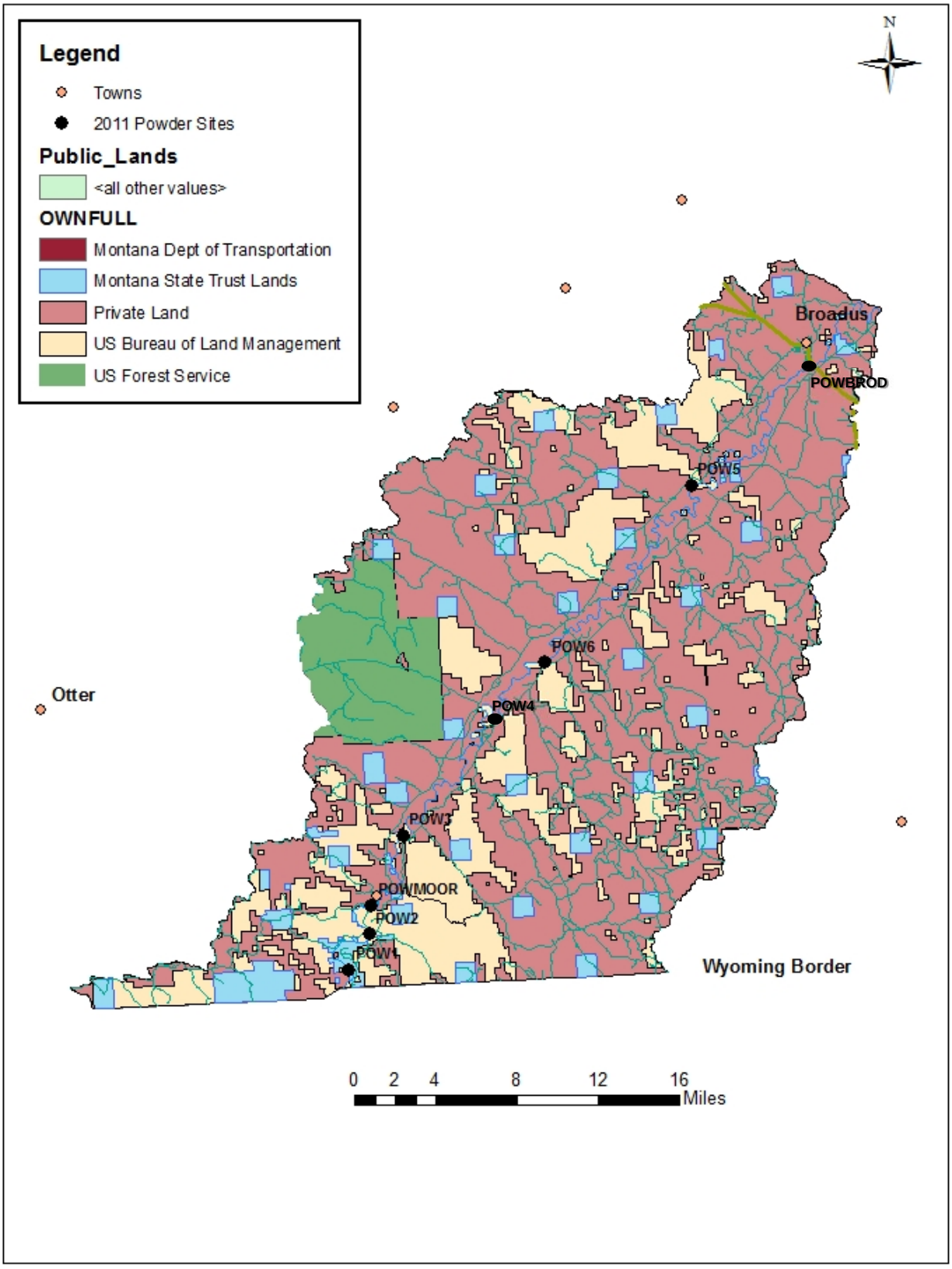
### Powder River Study Sites

Six mainstem Powder River sites were originally established in 2005 on BLM or state-owned riparian parcels that were accessible by passable road and would complement, but not overlap with, on-going USGS monitoring sites. Fish surveys were added at Powder River site #4, the Broadus Bridge and Powderville sites since 2011, as well as five USGS monitoring sites upstream into Wyoming for sturgeon chub and mussel occupancy surveys (2013) (Table 1). We kept the initial naming of sites despite inserting Site POW#6 upstream of Site POW#5 and adding sites POW14-POW18 upstream of previously established sites POW1-POWPOW (Map 1). We added the Moorhead Bridge USGS site in 2011 after conversations with Jake Chaffin (BLM Miles City) (Map 1).

**Table 1. Powder River Site locations sampled in 2012 and 2013.**
**U/S =upstream, D/S = downstream**

| Site Code | Site Description | River Mile | Latitude | Longitude | Elevation (ft) | Reach Gradient | Date Sampled |
|---|---|---|---|---|---|---|---|
| **POW14** | U/S Wild Horse Creek | 235 | 44.6576 | -106.129 | 3680 | 0.7% | 7/23/2013 |
| **POW15** | U/S of Ivy Creek | 230 | 44.809 | -106.087 | 3587 | 0.4% | 7/23/2013 |
| **POW16** | U/S of LX Creek | 226 | 44.927 | -105.985 | 3526 | 0.5% | 7/23/2013 |
| **POW17** | D/S of LX Creek | 225 | 44.9337 | -105.951 | 3502 | 0.5% | 7/23/2013 |
| **POW18** | U/S of WY border. Photo 12 | 222 | 44.9578 | -105.927 | 3446 | 0.5% | 7/23/2013 |
| **POW1** | D/S of WY border, Photo 1, 2 & 18 | 219 | 45.0128 | -105.9029 | 3426 | 0.5% | 7/21/2013<br>8/03/2012 |
| **POW2** | D/S of Dry Creek, Photo 3 | 215 | 45.0377 | -105.8809 | 3376 | 0.3% | 7/22/2013<br>8/03/2012 |
| **POWMOR** | U/S of Moorhead bridge. Photo 4 | 212 | 45.0578 | -105.8775 | 3350 | 0.4% | 7/23/2013<br>8/04/2012 |
| **POW3** | D/S Moorhead Site. Photo 5 | 206 | 45.1071 | -105.8421 | 3315 | 0.3% | 7/22/2013<br>8/03/2012 |
| **POW4** | D/S of POW3 | 198 | 45.3466 | -105.5333 | 3300 | 0.3% | 7/22/2013<br>8/04/2012 |
| **POW6** | At Buttermilk Creek. Photo 6 & 7 | 187 | 45.2256 | -105.6906 | 3185 | 0.4% | 7/22/2013<br>8/04/2012 |
| **POW5** | Near Rough Creek. Photo 8 & 9 | 166 | 45.3467 | -105.5333 | 3105 | 0.6% | 7/24/2013<br>8/05/2012 |
| **POWBROD** | U/S Broadus bridge. Photo 10 & 11 | 156 | 45.4269 | -105.4013 | 3069 | 0.5% | 7/23/2013<br>8/04/2012 |
| **POWPOW** | Powderville Bridge | 144 | 45.7521 | -105.0881 | 3050 | 0.4% | 8/05/2012 |

**Map 1**. **Aquatic sample sites in the Middle Powder River Watershed of Montana.**



## Tongue River Study Sites

Six mainstem Tongue River sites originally established in 2005 as USGS monitoring sites (Peterson et al. 2010) on private, BLM or state-owned riparian parcels were visited in 2013 for mussel occupancy surveys. We also surveyed four additional sites above the Tongue River reservoir and provided mussel data from two other sites sampled by D.L. Gustafson (2001 unpublished data) (Table 2).

**Table 2. Tongue River locations sampled for mussels in 2013.**
**U/S =upstream, D/S = downstream**

| Site Code | Latitude | Longitude | State | County | Site Description |
|---|---|---|---|---|---|
| TRWY338 | 44.9445 | -106.9426 | WY | Sheridan | U/S of WY Route 338 bridge. Photo 14 & 15. |
| TR1 | 44.9859 | -106.8912 | WY | Sheridan | D/S of Youngs Creek |
| TR2 | 44.9877 | -106.8445 | WY | Sheridan | U/S of Prairie Creek |
| TR3 | 44.9957 | -106.8241 | WY | Sheridan | D/S of Prairie Creek |
| YL_S0049WY | 44.9966 | -106.8800 | WY | Sheridan | U/S into WY |
| TR4 | 45.0128 | -106.8157 | MT | Big Horn | U/S of Badger Creek. Photo 16 |
| YL_S0049abRc | 45.0211 | -106.8132 | MT | Big Horn | U/S of the TR reservoir. Photo 13. |
| YL_S0049abRb | 45.0287 | -106.8097 | MT | Big Horn | U/S of the TR reservoir. Photo 13. |
| YL_S0049x | 45.2704 | -106.6243 | MT | Big Horn | D/S RR-crossing |
| TR5 | 45.3190 | -106.5257 | MT | Big Horn | U/S of Hanging Woman Creek. Photo 17. |
| TR6 | 45.3233 | -106.5228 | MT | Big Horn | D/S of Hanging Woman Creek |
| YL_S0049RM | 46.3113 | -105.7647 | MT | Big Horn | Near confluence of Log creek |

# Methods

Fish, mussel, and macroinvertebrate aquatic communities were inventoried and assessed in 2013 using a combination of protocols and methodology from Montana Fish, Wildlife and Parks (MFWP) (fish), Montana Natural Heritage Program (MTNHP) (mussels) and BLM / Environmental Protection Agency (EPA) (macroinvertebrates and habitat assessments). These methods replicated those used during the July 2005, 2011 site visits at similar river flows (~400-500 cfs as recorded at the USGS Moorhead Gaging Station). Reach lengths were standardized at 300 m, but to encompass an additional set of riffle macrohabitats for the macroinvertebrate targeted-riffle sampling protocols were extended to 450 m. Results from previous fish and macroinvertebrate inventories conducted in the study reach by state agencies (MFWP: Rehwinkel 1978; MTNHP: Stagliano 2006, 2012), universities (Montana State University, MSU): Bramblett 2000, Gustafson 2006) and federal agencies (USGS; Petersen et al. 2008, 2010) were incorporated into the analysis for Powder Site #1, Moorhead and Broadus Bridge sites (2005) and site visits across the Wyoming border (Confluence 2004, Werdon 1992).

### *Habitat and Water Quality Collection and Analysis*

The assessment stream reach was divided into 10 equally spaced transects according to BLM protocols adopted from EMAP (Lazorchak et al. 1998). The downstream transect was marked (GPS, flagging and photo point) as the bottom of the reach and all ecological assessment protocols started from this point and continued upstream for 300 m to the designated assessment area (AA) at the top of the reach, which was also marked. Parameters recorded at each transect included: wetted width, three channel depth measurements, percent large woody debris and riparian shading. On-site habitat quality assessments (HQI) were conducted using the rapid assessment protocol developed for the EPA by Barbour et al. (1999) with modifications for the BLM by the National Aquatic Assessment Team (scores 0-24). Water quality measures: specific conductivity, pH, water temperature and dissolved oxygen concentration were taken on-site prior to biological sampling with a Yellow Springs Instruments, Inc. model 85 water meter calibrated to the higher conductivity level.

***Fish Collection and Analysis***

Fish surveys were performed using 300 meter seining protocols developed by Bramblett et al. (2005) for Montana Fish, Wildlife and Parks. This protocol calls for block nets at the upstream and downstream ends of the reach, but the width of the Powder River precluded the use of these. Instead, shallow riffle areas were used as barriers and appeared sufficient in preventing fish from escaping while the run and pool areas were being seined (Figure 1). Shallow riffle areas that could not be seined in the normal fashion because of cobble obstructions were "kick-seined" to capture fish inhabiting this microhabitat. We used 20 and 30 feet, ¼ inch mesh seines to cover most areas across the channel and all macrohabitats within the reach.

**Figure 1. Seining the Powder River near Broadus by beach seining (left) and kick-seining a riffle near Powder site #1 (right).**

Fish in each section were transferred to holding buckets, identified to species, enumerated in the field, examined for external anomalies (e.g. deformities, eroded fins, lesions, and tumors), and then released. Young-of-the-year fish less than 20 millimeters in length were noted on the field sheet (not included in the totals), and released. Voucher specimens were only taken in the case of uncertain field identifications of the silvery minnows, *Hybognathus* spp., which were preserved in 10% buffered formalin and identified in the lab. Vouchers will be submitted to the Montana State University fish collection.

To detect impairment or species loss in the biological integrity of the sites, analysis of the sampled fish communities was performed using Integrated Biotic Indices (IBI) (Bramblett et. al 2005) and derived Observed/Expected (O/E) fish models (Stagliano 2006). The IBI involved

calculation of a series of 10 metrics evaluating different attributes of the fish community (Table 3, Appendix B). Because fish species richness can be directly proportional criteria for good, fair, and poor biological integrity for these scores, so we relied on these scores for comparisons between years.

**Table 3. Characteristics, metrics and classification of fish species captured during the Powder River sampling.**
*** = species collected in 2013, but not in 2011. ^ = species collected in 2012, but not in 2013.**

| Species | Scientific Name | Trophic* | Feeding Habitat† | Litho-obligate Reproductive Guild‡ | Tol** | Origin †† |
|---|---|---|---|---|---|---|
| **Hiodontidae** | | | | | | |
| Goldeye | *Hiodon alosoides* | IN | WC | LO | INT | N |
| **Catostomidae** | | | | | | |
| Longnose Sucker* | *Catostomus catostomus* | IN | BE | LO | MOD | N |
| River Carpsucker* | *Carpiodes carpio* | OM | BE | LO | MOD | N |
| Shorthead Redhorse* | *Moxostoma macroledidotum* | IN | BE | LO | MOD | N |
| **Cyprinidae** | | | | | | |
| Common Carp* | *Cyprinus carpio* | OM | BE | | TOL | I |
| Emerald Shiner* | *Notropis atherinoides* | IN | WC | | MOD | I |
| Flathead Chub | *Platygobio gracilis* | IN | GE | | MOD | N |
| Longnose Dace | *Rhinichthys cataractae* | IN | BE | LO | INT | N |
| Plains Minnow | *Hybognathus placitus* | HB | BE | | MOD | N |
| Western silvery Minnow | *Hybognathus argyritis* | HB | BE | | MOD | N |
| Sand Shiner | *Notropis stramineus* | OM | GE | LO | MOD | N |
| Sturgeon Chub* | *Macrhybopsis gelida* | IN | BE | LO | INT | N |
| **Ictaluridae** | | | | | | |
| Channel Catfish | *Ictalurus punctatus* | IC | BE | TR§ | MOD | N |
| Stonecat | *Noturus flavus* | IC | BE | LO | INT | N |
| **Acipenseridae** | | | | | | |
| Shovelnose Sturgeon^ | *Scaphirhynchus platorynchus* | IC | BE | LO | MOD | N |
| **Centrarchidae** | | | | | | |
| Smallmouth bass^ | *Micropterus dolomieu* | IC | GE | TR§ | MOD | I |

HB = herbivore (>90% plants or detritus); IC = invertivore/carnivore (>25% both invertebrates and vertebrates); IN = invertivore; OM = omnivore (25-90% plants or detritus)
† BE = benthic; GE = generalist; WC = water column: Brown (1971); Scott and Crossman (1973); Becker (1983)
‡ Scott and Crossman (1973); Pflieger (1997); Barbour et al. (1999)
§ Tolerant reproductive strategists are not litho-obligates, use parental care at spawning site: Scott and Crossman (1973): Pflieger (1997)
** INT = intolerant; MOD = moderately tolerant: TOL = tolerant Barbour et al. (1999)
†† N = native; I = introduced: Brown (1971); Holton and Johnson (2003)

The O/E (Observed taxa at an evaluated site / Expected taxa for a reference site) model is a direct measure of the community completeness. We derived the expected fish community (E) for a Powder River reference site >30 river miles above confluence at 7.5 species (Stagliano 2006). Taxonomic completeness is a fundamental aspect of biological integrity and is defined here as the proportion of native taxa that one would expect in a random sample (E) that were found in an actual sample (O) (Jessup et al. 2005). Values of the ratio, O/E, theoretically can range from 0 to 1, with values of 1 implying reference conditions and values less than 1 implying some form of biological impairment; 0.8 is the typical threshold below which the site is considered impaired. In some cases, it is more ecologically meaningful than the IBI, but not always. Pairs of fish community scores were compared across years for significant differences by using Student's T-test for paired statistics (Brower and Zar 1984).

***Mussel Surveys***

To address a missed aquatic taxon monitoring opportunity for the BLM CNBG Aquatic Task Group, we included standardized mussel visual encounter surveys (methods in Stagliano 2010) at all of the previously monitored Tongue River (TR1-TR6), Montana Powder River (POW1-POW6) and the lower five Wyoming Powder River ATG sites (POW14-18) to collect baseline population estimates (Table 1 and 2). Fatmuckets (FAMU) (*Lampsilis siliquoidea*) are the only documented species to occupy the upper Tongue River and Powder River basins, although a shell fragment of the giant floater (*Pyganodon grandis*) was reported above Tongue River Reservoir in 2004 (Stagliano 2010). Juvenile FAMU mussels were found to be one of the organisms most sensitive to bicarbonate from CBNG-produced water in a toxicity study (Farag and Harper 2012). Thus, mussel density or population size structure differences (ie. missing juvenile size classes) between sites with or without CBNG outflows may provide another line of evidence that CBNG has had an adverse effect on some aquatic life in the basin.

***Macroinvertebrate Collection and Analysis***

Two standardized macroinvertebrate sampling methods were used for the mainstem Powder River monitoring: EMAP Targeted Riffle (8 composited riffle Surber samples, area sampled = 0.744 square meters) and the EMAP Reach-Wide sample which included all habitats within the sampling reach (10 transect dipnets, area sampled = ~0.93 square meters) (Lazorchak 1998, Peck et al. 2003) (Figure 2).

**Figure 2**. **Reach-wide EMAP macroinvertebrate sample (F pin center) at Powder River Site 2.**

These samples were collected within the MDEQ recommended sampling time frame (June 1st-September 15th), preserved in 1 liter Nalgene bottles with 95% ethanol and processed (sorting, identification and data analysis) at the MTNHP Helena lab following protocols used by the BLM Buglab (BLM 2008). Macroinvertebrates were identified to the genus/species taxonomic level, counted and the tabular data entered into spreadsheet and database forms. Data analysis included computation of indices of community structure such as proportion of EPT (Ephemeroptera, Plecoptera and Trichoptera taxa) and other biological metrics used in calculating the MDEQ multimetric macroinvertebrate (MMI) indices or used in the Observed / Expected (O/E) Models (Jessup et al. 2005, Feldman 2006). Metric results were then scored using the Montana DEQ bioassessment criteria and each sample categorized as non-impaired or impaired according to threshold values (Table 3). The macroinvertebrate MMI score is based upon a series of metrics that measure attributes of benthic macroinvertebrate communities regarding condition changes to a stream system (in the form of pollution or pollutants). Some invertebrate metrics include: EPT Taxa Richness (the sum of all Ephemeroptera, Plecoptera and Trichoptera taxa present in the sample), Percent EPT, and Predator Taxa Richness. The index score represents the condition of

the macroinvertebrate community at the time the sample was collected within that past year. If the index score is below the impairment threshold, the individual metrics can be used to provide insight as to why the communities are different from the reference condition (Barbour et. al 1999, Jessup et. al. 2005). The impairment thresholds set by Montana DEQ are 37 for the eastern plains stream MMI index and 0.8 for the O/E. Ideal O/E scores representing a "complete" community are between 0.8 and 1.2 where a score of 1.0 represents 100% of the expected species were actually collected. The O/E scores can be evaluated in two ways: first, where all the taxa expected to be present ($O/E_{p>0}$) at a site are summed, or summing only those taxa expected to be at the site greater than 50% of the time ($O/E_{p>0.5}$). This latter method has been found to eliminate the "eschewing" effect of counting too many rare taxa in the sample (Marchant 2002).

# RESULTS AND DISCUSSION

***Habitat and Water Quality Results and Analysis***

Powder River Sites #1 and #5 scored highest in habitat quality with the BLM assessment protocols (HQI), representing 75% and 80% of the best possible score, respectively (Table 4). Powder Site #5 also had the highest number of recorded channel depths greater than 50 cm, indicating deep run and pool holding areas for fish. Powder River Site #3 scored low in the habitat assessment scores despite having the second highest number of deep channel areas; unfortunately, many of these deep areas had unstable, unconsolidated substrate (silt, fine sand) which is not optimal fish habitat. Sites that scored less than optimal with the BLM HQI (POW2 and POW4) did so because of long stretches of shallow, unstable benthic habitat.

**Table 4. BLM Site Habitat Quality Index (max=24), physical & water chemistry parameters of Powder River 2013 sites. ChD =channel depths measured in 10 cross sections (n=30), # of ChD >50 cm reflects deep run or pool areas. Cond*= Conductivity in microsiemens/cm.**

| Site | BLM HQI | Avg wetted width (m) | Avg ChD (cm) | # ChD >50 cm | $H_2O$ Temp (°C) | pH | Cond* |
|---|---|---|---|---|---|---|---|
| Powder River 1 | 19 | 41.0 | 35.0 | 7 | 30.3 | 8.3 | 2485 |
| Powder River 2 | 15 | 36.5 | 40.0 | 8 | 19.3 | 8.4 | 2080 |
| Powder MOOR | 17 | 37.0 | 45.0 | 11 | 22.7 | 8.4 | 2141 |
| Powder River 3 | 16 | 45.0 | 44.0 | 14 | 21.4 | 8.2 | 2145 |
| Powder River 4 | 15 | 47.0 | 30.0 | 7 | 28.5 | 8.4 | 2440 |
| Powder River 6 | 18 | 45.0 | 34.0 | 8 | 26.1 | 8.2 | 2440 |
| Powder River 5 | 21 | 42.0 | 41.0 | 15 | 29.4 | 8.4 | 2784 |
| Powder BROD | 18 | 37.0 | 35.0 | 10 | 29.7 | 8.5 | 2963 |

Conductivity measurements were calibrated to the USGS field gauge at the Moorhead Bridge site. Average reach-wide conductivity values measured in 2013 were significantly higher (2345 µs/cm) than in 2011 or 2005 (FTEST, $p < 0.008$ and 0.001, respectively), while values in 2011 (1225 µs/cm) were slightly higher than in 2005 (1190 µs/cm), but were not significantly different (FTEST, $p > 0.05$).

### *Fish Community Results and Analysis*

We collected 4080 individuals and identified 16 (13 native) species from eight mainstem Powder River sites in 2012 (Table 5). In 2013, we captured 2832 individuals and identified 14 (12 native) species from these sites. These surveys captured significantly more total individuals (8 and 11 times, respectively) and native species than recorded in 2011, and two to three times the number of individuals recorded in 2005. Native fish species averaged 8.2 per site in 2012 and 9.4 in 2013, whereas in 2011 and 2005, collections averaged 6.4 and 7.0 species per site, respectively.

**Table 5. Fish collected, IBI and O/E index scores from the Powder River sites in 2012 and 2013.**
*** = species collected in 2012 or 2013, but not in 2011.**

| Sites | POW #1 | | POW #2 | | POWMOOR | | POW #3 | | POW #4 | | POW #6 | | POW #5 | | POWBROD | | POWPOW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2012 |
| Channel Catfish | 24 | 5 | 12 | 0 | 18 | 6 | 27 | 8 | 4 | 4 | 12 | 9 | 17 | 4 | 43 | 2 | 2 |
| Common Carp | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 2 |
| Emerald Shiner | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 42 | 0 | 0 | 24 |
| Flathead Chub | 130 | 42 | 100 | 59 | 206 | 278 | 105 | 548 | 88 | 220 | 175 | 252 | 133 | 163 | 324 | 486 | 228 |
| Goldeye | 0 | 29 | 0 | 0 | 6 | 6 | 4 | 2 | 2 | 1 | 2 | 40 | 1 | 0 | 1 | 0 | 0 |
| Longnose Dace | 1 | 3 | 1 | 7 | 4 | 12 | 3 | 24 | 4 | 8 | 2 | 2 | 2 | 6 | 1 | 34 | 0 |
| Longnose Sucker* | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| Plains Minnow | 0 | 1 | 2 | 2 | 18 | 2 | 5 | 6 | 8 | 8 | 42 | 5 | 15 | 1 | 17 | 0 | 12 |
| River Carpsucker* | 2 | 5 | 3 | 1 | 1 | 24 | 5 | 6 | 4 | 22 | 2 | 26 | 1 | 21 | 8 | 6 | 104 |
| Sand Shiner | 42 | 48 | 32 | 31 | 114 | 398 | 126 | 208 | 96 | 93 | 163 | 36 | 380 | 208 | 174 | 198 | 0 |
| Shorthead Redhorse* | 14 | 0 | 0 | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 5 | 0 | 5 | 2 | 10 | 0 | 0 |
| Smallmouth Bass* | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sturgeon Chub* | 0 | 2 | 2 | 1 | 0 | 2 | 0 | 8 | 2 | 2 | 12 | 0 | 4 | 0 | 23 | 18 | 0 |
| Shovelnose Sturgeon* | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Stonecat | 4 | 0 | 7 | 0 | 4 | 1 | 5 | 0 | 4 | 4 | 2 | 1 | 1 | 0 | 1 | 1 | 0 |
| Western Silvery Minnow | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 4 | 1 | 6 | 0 | 49 | 0 | 33 | 0 | 0 | 10 |
| **Total # species** | 9 | 10 | 9 | 5 | 9 | 11 | 10 | 9 | 11 | 10 | 10 | 9 | 12 | 10 | 10 | 7 | 8 |
| **Native Species** | 8 | 10 | 8 | 5 | 9 | 11 | 9 | 9 | 11 | 10 | 10 | 9 | 10 | 8 | 10 | 7 | 6 |
| **Total Individuals** | 220 | 140 | 160 | 101 | 373 | 1011 | 283 | 814 | 215 | 368 | 417 | 420 | 562 | 481 | 602 | 745 | 386 |
| **Fish IBI** | 65.0 | 68.8 | 61.7 | 59.3 | 68.4 | 70.9 | 66.2 | 67.2 | 73.0 | 67.3 | 70.6 | 66.4 | 70.7 | 63.5 | 68.7 | 66.6 | 58.7 |
| **O/E** | 1.07 | 1.33 | 1.07 | 0.8 | 1.2 | 1.33 | 1.2 | 1.2 | 1.47 | 1.33 | 1.33 | 1.2 | 1.33 | 1.07 | 1.33 | 0.93 | 0.8 |

Flathead chubs were the dominant member of this river section fish community in 2012 and 2013 averaging 55% and 45% of the individuals collected, respectively; whereas in 2005, sand shiners were the dominant species contributing ~60% of the total catch (Stagliano 2006, Peterson et al. 2009). The introduced plains killifish was not collected at any sites between 2011 and 2013 since last reported in 2005. The sturgeon chub, a Montana species of concern previously common in this reach, was absent from 14 of 16 sampling sites visited between 2005 and 2011, but it rebounded in 2012 and 2013 with detections at 11 of 17 sites visited (65%) with up to 23 individuals per site (Table 5). There was no significant difference in average sturgeon chub numbers by year between pre- and post-CBNG treatment, while active-CBNG treatment was significantly different than both pre- and post-CBNG ($p = 0.028$ and 0.002, respectively) (Figure 3). Additionally, we collected sturgeon chubs at three of five sites (average 2 individuals per site) across the border ~15 miles upstream into Wyoming (Table 6).

**Figure 3. Powder River study reach sturgeon chub (STCH) numbers per unit effort by year for three treatments, pre-, active and post-CBNG. a = no significant difference between treatment.**

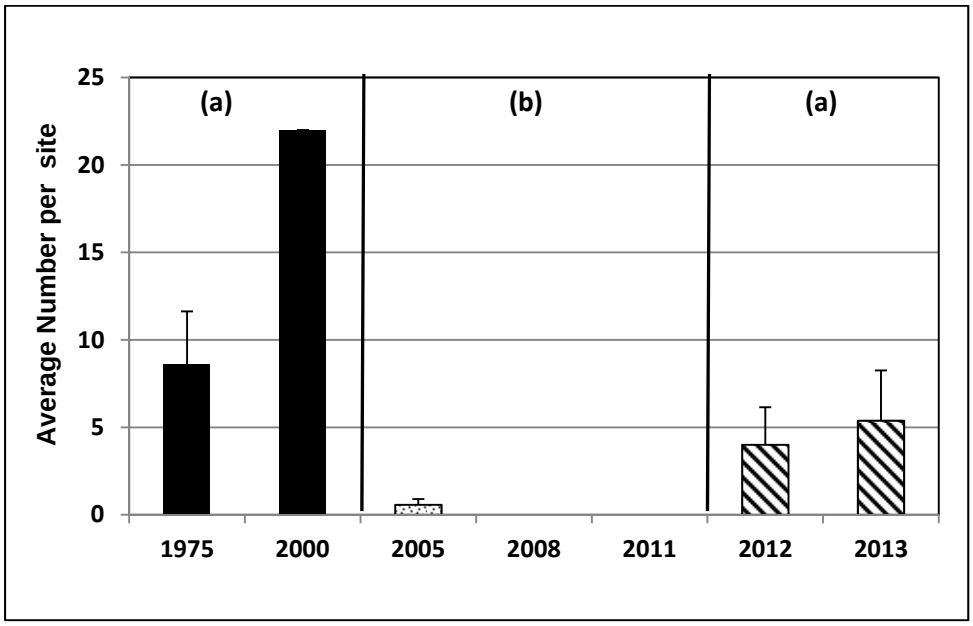


**Table 6. Fish collected from the Powder River Wyoming sites in 2013.**

| Species | POW #18 WY | POW #17 WY | POW #16 WY | POW #15 WY | POW #14 WY |
|---|---|---|---|---|---|
| Channel Catfish | 24 | 30 | 15 | 12 | 2 |
| Common Carp | 1 | 16 | 0 | 2 | 0 |
| Flathead Chub | 154 | 108 | 184 | 156 | 106 |
| Goldeye | 4 | 0 | 2 | 0 | 2 |
| Longnose Dace | 4 | 4 | 0 | 0 | 0 |
| Plains Minnow | 1 | 96 | 8 | 4 | 8 |
| River Carpsucker | 0 | 12 | 1 | 8 | 1 |
| Sand Shiner | 28 | 93 | 104 | 194 | 434 |
| Shorthead Redhorse | 0 | 0 | 1 | 2 | 0 |
| Smallmouth Bass | 1 | 3 | 4 | 0 | 0 |
| Sturgeon Chub | 4 | 0 | 4 | 0 | 2 |
| **Total # species** | 9 | 8 | 9 | 7 | 7 |
| **Native Species** | 7 | 6 | 8 | 6 | 7 |
| **Total Individuals** | 221 | 362 | 323 | 378 | 555 |

Fish communities across all sites scored significantly higher with the IBI and O/E models in 2012 and 2013 (post-CBNG treatment) than in 2005 or 2011 (active CBNG treatment), averaging 67.1 vs. 58.3 IBI and 0.85 vs. 1.2 O/E, respectively (Figures 4 and 5). These differences were significant with the Student's paired T-test ($p = 0.02$ and 0.007) (Table 7). Fish community O/E scores in 2012 and 2013 were not significantly different from those recorded from 1975 and 2000 (pre-CBNG development) (Figure 5). There were no significant differences in the IBI or O/E between 2011 and 2005, averaging 54.5 vs. 58.3 and 0.78 vs. 0.84, respectively) (T-test, $p = 0.2$ and 0.17). Therefore, fish integrity declines documented during the active-CBNG period (2005-2011 surveys) have largely recovered during the last two years of monitoring (Figure 5).

**Figure 4. Powder River study reach fish community IBI (top) and Observed/Expected (O/E) Scores (bottom) by site for 1975-2013. O/E impairment threshold line at 0.8.**

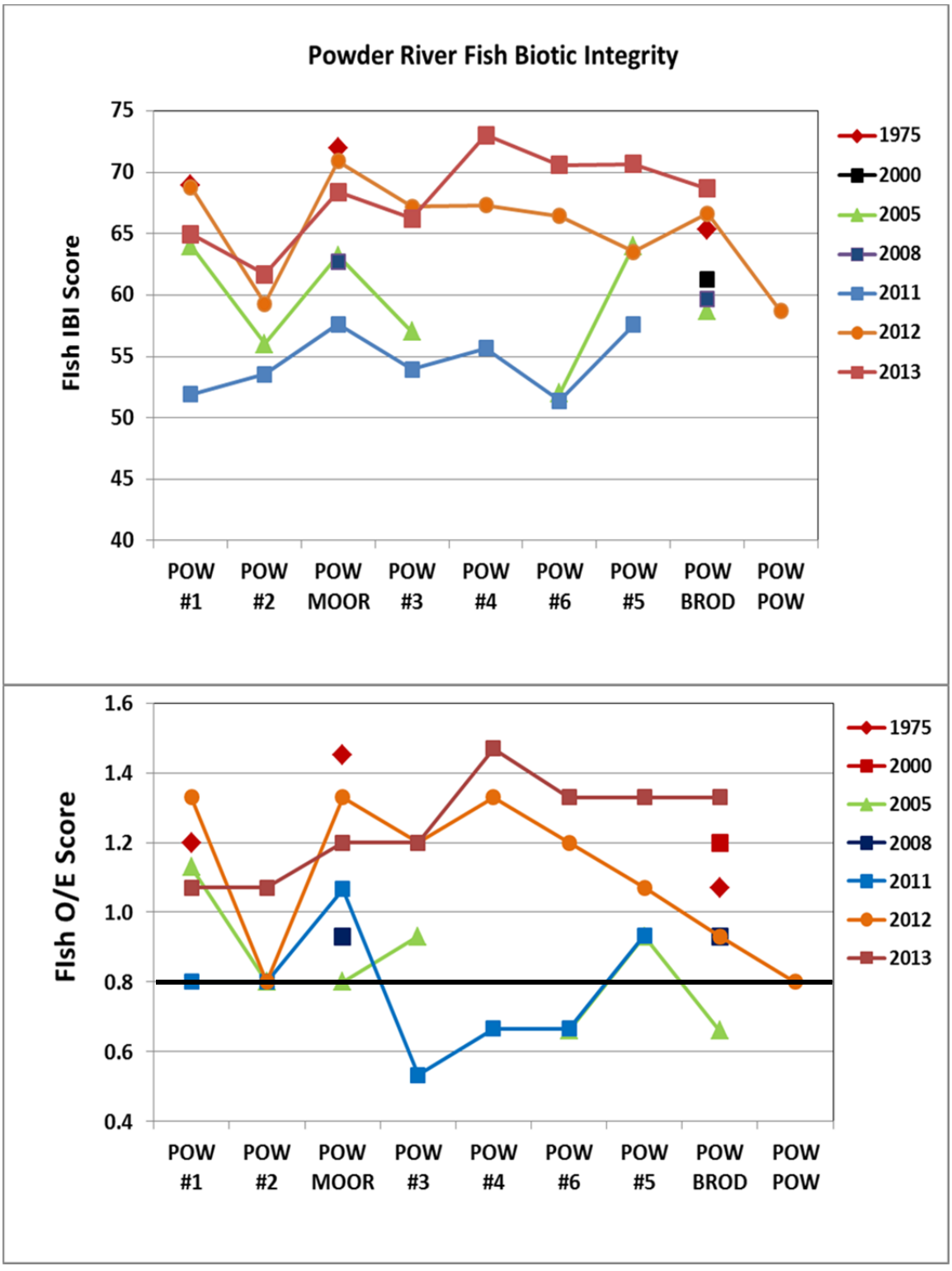


**Figure 5. Fish IBI (top) and O/E (bottom) average yearly scores from 1975-2013. a = no significant differences at p > 0.05 by CBNG treatment (see Methods). O/E impairment threshold line at 0.8.**

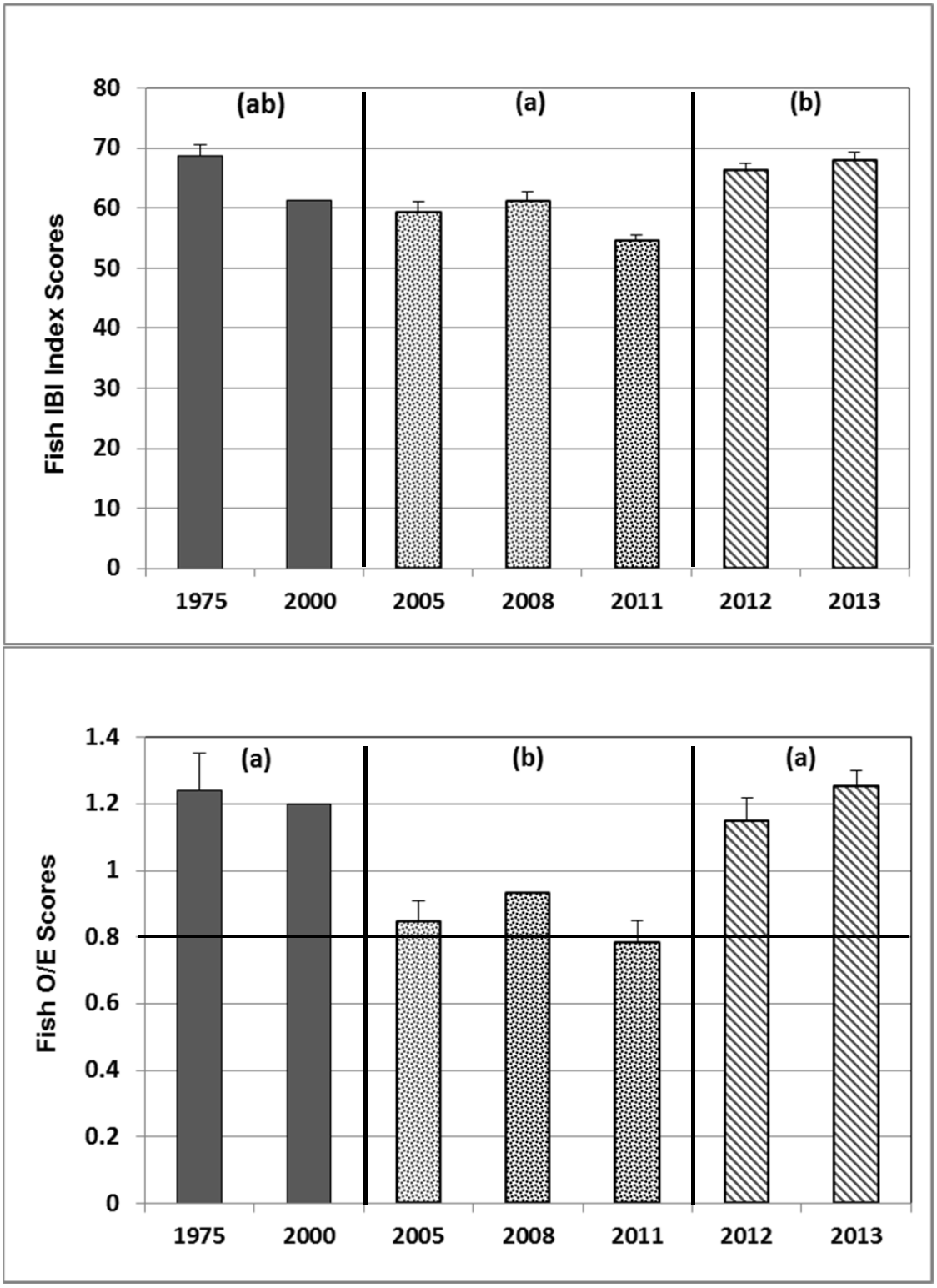


**Table 7. Fish metric statistical T-test p-value results for the IBI, O/E, and sturgeon chub (STCH) relative abundance by CBNG treatment (see Methods) from Powder River sites. Underlined p-values are significant at p < 0.05.**

| Treatment | n | df | IBI | O/E | STCH |
|---|---|---|---|---|---|
| **Pre-CBNG** | **4** | | | | |
| **Pre x Active** | | **1** | **0.09** | **<u>0.004</u>** | **<u>0.028</u>** |
| **Pre x Post** | | **1** | **0.32** | **0.37** | **0.12** |
| **Pre x Act/Post** | | **2** | **0.26** | **0.94** | **<u>0.05</u>** |
| **Active CBNG** | **16** | | | | |
| **Act. X Post** | | **1** | **<u>0.02</u>** | **<u>0.007</u>** | **<u>0.002</u>** |
| **Act. X Pre/Post** | | **2** | **<u>0.015</u>** | **<u>0.0003</u>** | **<u>0.012</u>** |
| **Post-CBNG** | **16** | | | | |

***Fish IBI vs. O/E***

The fish IBI is a good analysis tool for monitoring sites between years, but it tends to underestimate Powder River fish community integrity. The fish IBI ranked all Powder River sites on the high side of "fair" biological integrity (scores >25 and <75), even when sites had their complete native fish community present (Moorhead Bridge 1975, 2012; POW4 2013) (Figure 4). While overall average O/E values calculated in 2011 ranked impaired (<0.8), four of the six sites scored within the 1.2-0.8 unimpaired/good integrity threshold, while sites POW3 and POW6 ranked impaired with scores of 0.57 and 0.63 (Figure 4).

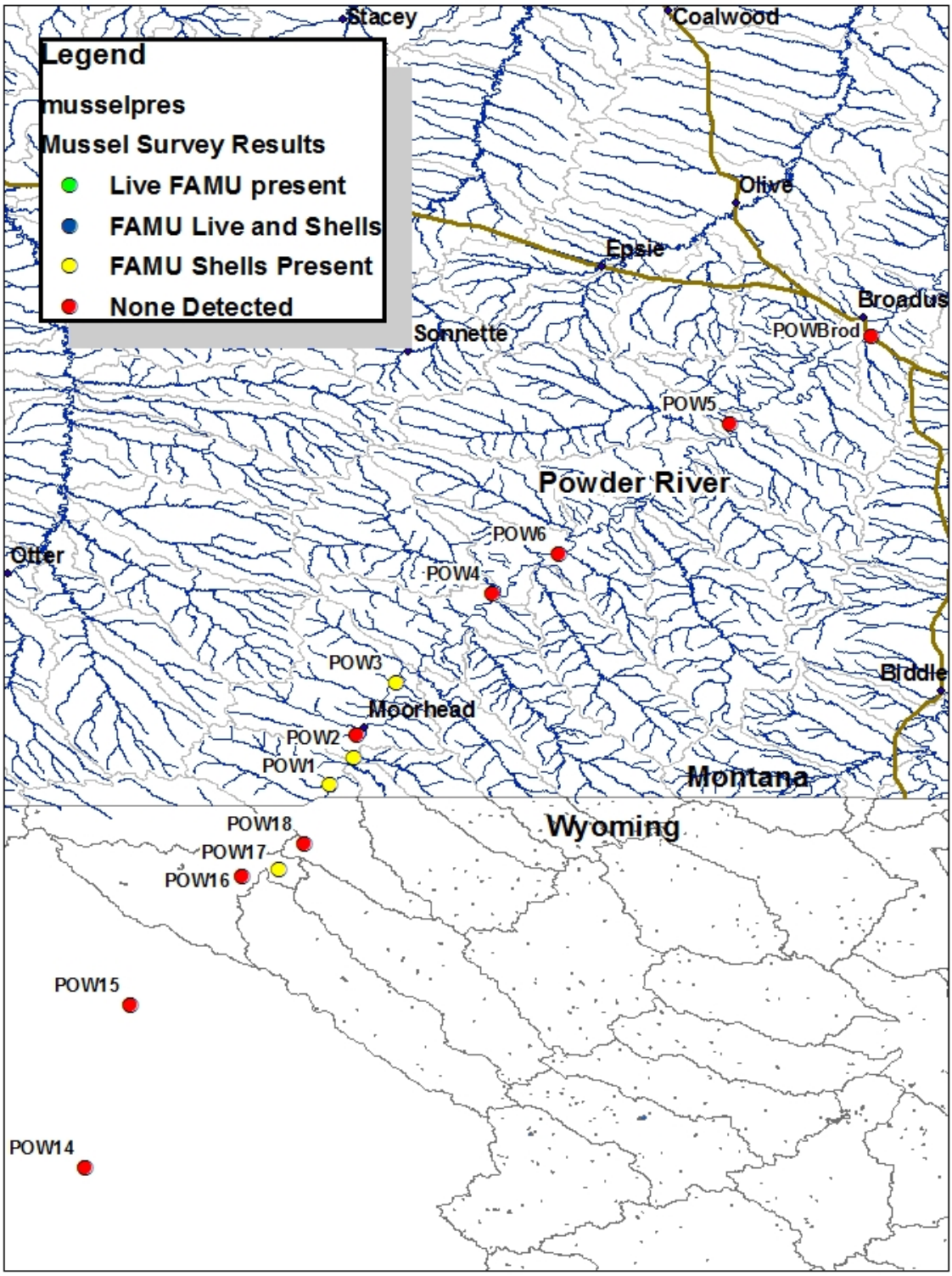
This IBI disparity can be explained, in part, because the lowest-scoring metrics were those with adjustments for catchment area, such as number of native species and number of native families. The Powder River is a diverse system, but failing to consider the existing fish community that has evolved within this unique system and instead just assuming a linear increase in fish species to watershed area is not a valid assumption. It would take a fish sample with all 20 native species found in the Powder with no tolerant individuals in a watershed this size to bring the IBI score over 70. This factor brings into question the suitability of this index to a watershed of this size. The largest catchment area of sites used by Bramblett et al. (2005) in developing the fish IBI was ~14,000 $km^2$, while catchment areas for our sites on the Powder River ranged from ~20,000 $km^2$ to well over 23,000 $km^2$. By extrapolating beyond the range of the calibration data, we risk serious prediction errors. By using the O/E model as a direct measure of the community completeness, the best expected overall fish community in the upper Powder River reaches

consists of 7.5 native species. Therefore, although the total species pool may be ~20 species, the chances of collecting all species in any given sample is minimal and in the best possible conditions the collector may only collect a subset of these species.

***Mussel Survey Results***

We used visual encounter surveys to search for mussels at 12 Powder River and 12 Tongue River sites in 2013. We observed no live mussels in the Powder River; however, we recorded fatmucket (FAMU) (*Lampsilis siliquoidea*) shells at four sites during the visits (Map 2). These mussel shells have only been recorded at Powder River sites near the Wyoming border (POW18, POW1, 2 and 3) during the last three years of CBNG monitoring. Thus, we speculate that a living FAMU mussel population may only be present in Clear Creek or the Powder River downstream from Clear Creek (Wyoming) because of occasional host fish (sauger, shovelnose sturgeon) reproduction migrations to this tributary through the years (Appendix D Photo 2). This isolated FAMU population continues to supply fresh dead shells during high run-off events, especially in 2011, to sites downstream into Montana. Clear Creek provides a significant pulse of fresh water into an otherwise highly saline, alkaline and chlorine Powder River environment. Previous studies have found significant increases in water quality and biological integrity downstream of Clear Creek (Peterson et al. 2010, 2011, 2012; Stagliano et al 2013). Furthermore, live mussels have never been reported at the Moorhead or Broadus Bridge Powder River sites, despite numerous visits by biologists in the decades before CBNG (Rehwinkel 1978, D. Gustafson, pers. comm.). Therefore, no relationship between FAMU mussel presence/absence and CBNG activities in the Powder River basin can be inferred from this survey effort, but we now have a better understanding of the potential distribution dynamics involved.

**Map 2. Mussel survey sites in the Middle Powder River Watershed. FAMU= fatmucket.**

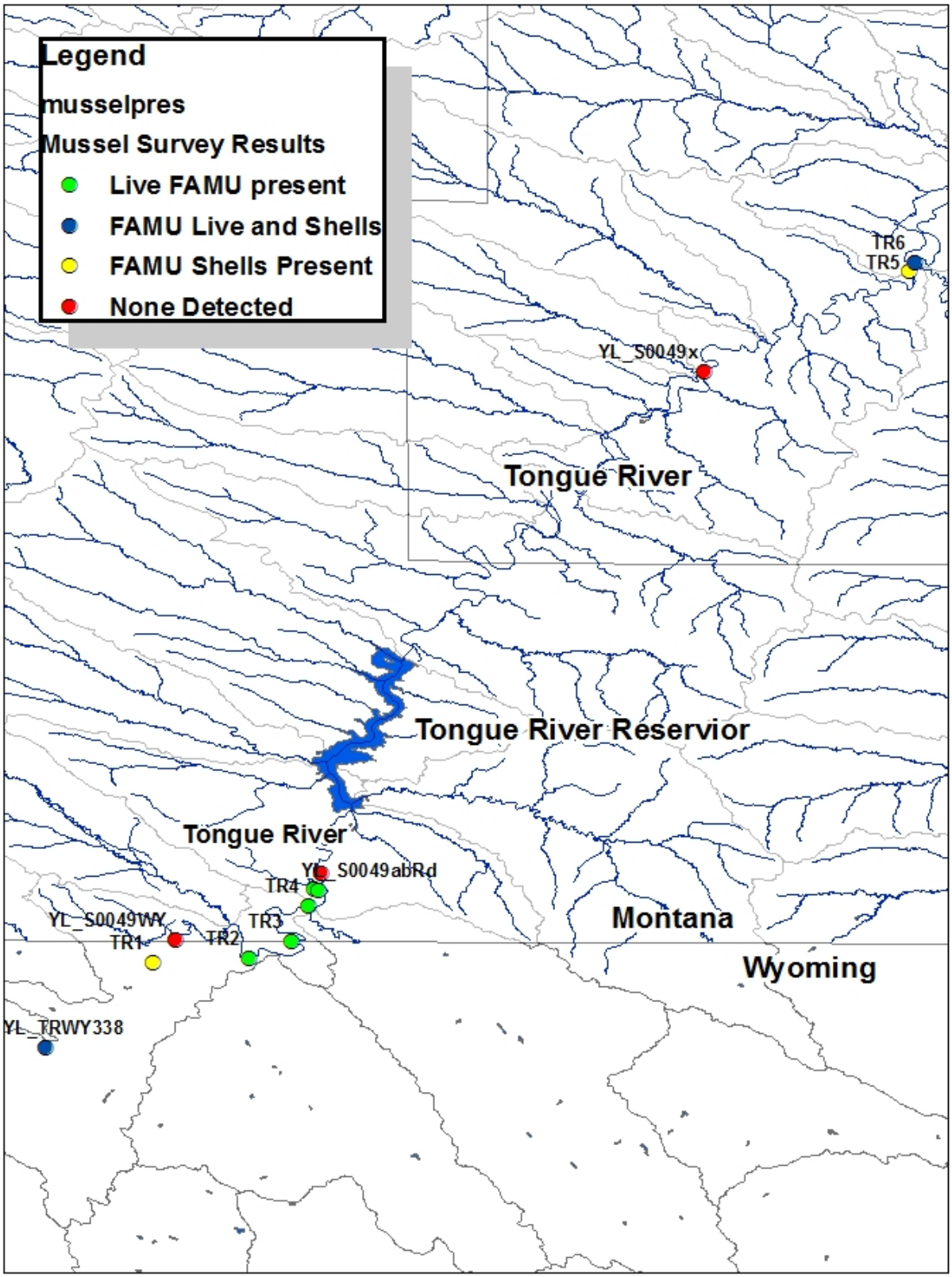


Mussels were detected at 50% of Tongue River sites surveyed (live FAMU observed at 6 of the 12 sites) (Map 3). The most abundant Tongue River mussel population was ~10 river miles upstream of the Tongue River Reservoir at the Wyoming RT 338 bridge: 18 FAMU individuals/hour. Sites closer to the reservoir (TR2, TR3 and TR4) averaged 3.1 FAMU individuals/hour, and sites below the reservoir (TR5 and TR6) averaged only one FAMU individual/hour (Table 8). We could find no evidence of recent reproduction (juveniles <30 mm) at any sites reporting live mussels, though this may have been related to slightly turbid sampling conditions. Because live FAMU adults (no juveniles) were found at sites TR2, TR3 and TR4 in similar low densities, no relationship between mussel presence and CBNG activities can be inferred from this survey effort. Prairie Dog Creek enters the Tongue River between sites TR2 and TR3, has significant CBNG development and has been previously implicated at reducing water quality and biotic integrity at downstream Tongue River sites (Stagliano et al. 2013; Kinsey and Nimick 2011). Therefore, if significant differences in mussel presence or densities had been reported between TR2 and TR3, we may have inferred a CBNG relationship. The results of these standardized mussel surveys have now provided the BLM, MDEQ and other agencies a baseline population distribution with which to monitor into the future.

**Table 8. Fatmucket (FAMU) records (x = live, shells present, individuals per hour) from Tongue River sites arranged from upstream in WY to downstream below the reservoir (MT).**

| Site Code | Live FAMU | FAMU Shells | FAMU ind. $hr^{-1}$ |
|---|---|---|---|
| TRWY338 | X | X | 18 |
| TR1 | – | X | – |
| TR2 | X | – | 2 |
| TR3 | X | – | 3 |
| YL_S0049WY | – | – | – |
| TR4 | X | – | 6 |
| YL_S0049abRc | X | – | 2 |
| YL_S0049abRb | – | – | – |
| YL_S0049x | – | – | – |
| TR5 | – | X | – |
| TR6 | X | X | 2 |
| YL_S0049RM | X | – | 0.5 |

**Map 3. Mussel survey sites in the Tongue River Watershed. FAMU= fatmucket.**



***Macroinvertebrate Community Analysis***

Overall, 47 total taxa were reported in 2013, a significant decrease from 64 total taxa reported from these sites in 2011 and 59 taxa in 2005 (Table 9). Average macroinvertebrate taxa richness per site in 2013 was 23.9 taxa, which is a significant decrease from 28 taxa per site in 2011 (T Test, $p = 0.005$), but not significantly different than 23.4 taxa per site reported in 2005 ($p = 0.22$) (Table 10). Taxa lost between the monitoring years included many of the sensitive mayfly taxa. EPT taxa reported in 2013 averaged 14 taxa across sites (Table 9), this was significantly different than in 2011 or 2005 (Table 10). In particular, the SOC mayfly *Raptoheptagenia cruentata* was collected at all six sites in 2005 (avg. 7 individuals per site), four of six sites in 2011 (avg. 0.5 per site) and at zero sites in 2013 (Figure 6). In contrast, the stonefly, *Acroneuria abnormis* has significantly increased its abundance in recent years, especially at sites furthest from the Wyoming border, from less than one individual per sample in 2005 to more than eight per sample reported in 2013 (Figure 6). Reach-Wide EMAP samples sampled two of the five species of rare sand-dwelling mayflies, *Anepeorus rusticus* (G2S1) and *Homoeoneuria alleni* (G4S2) not collected with the Targeted-Riffle Protocols (Appendix C). Targeted sandbar sampling for the rare sand-dwelling mayfly community in 2011 and 2012 with an over-sized dipnet proved laborious and ineffective at increasing occurrence records or estimating densities.

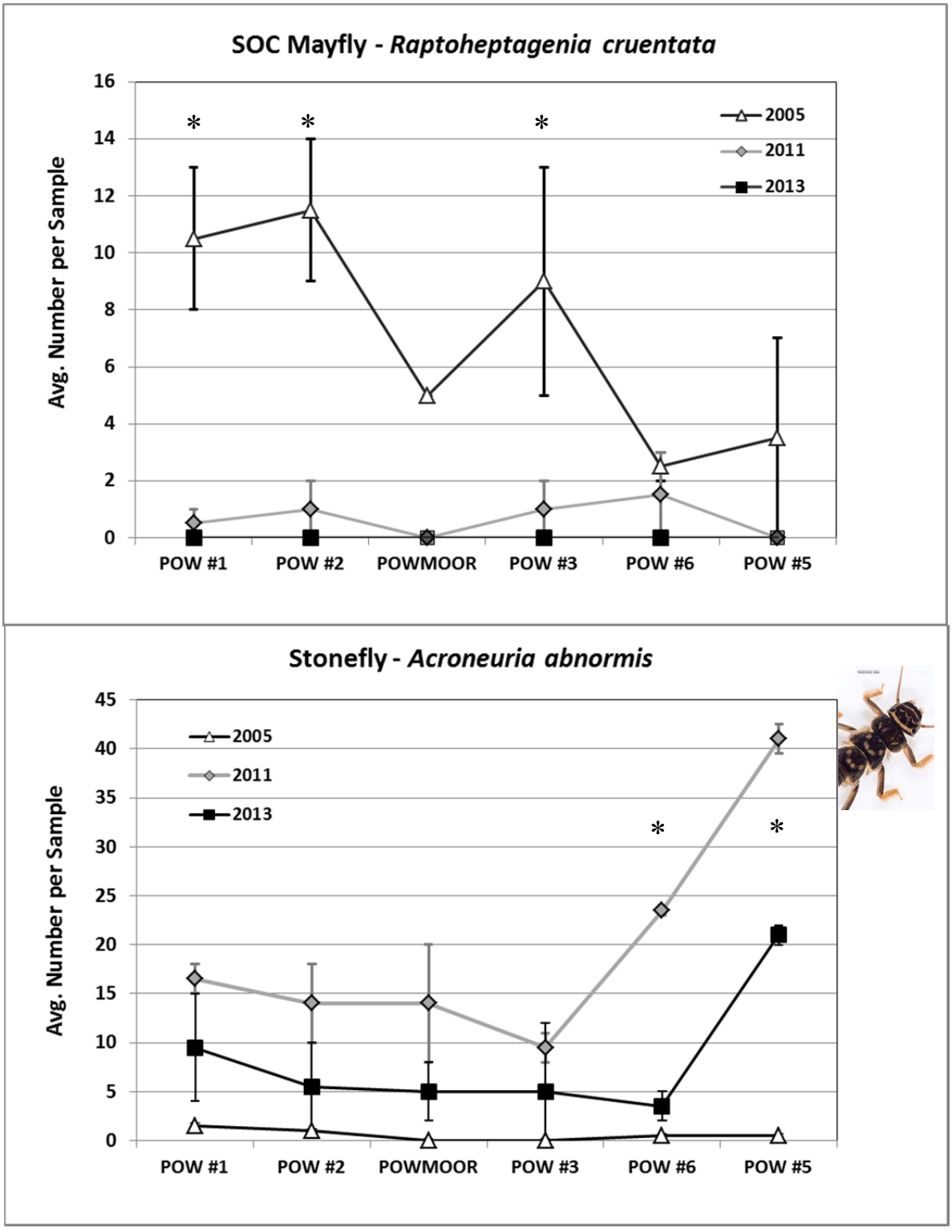
**Table 9. EMAP macroinvertebrate results (TR=Targeted Riffle, RW=Reach-wide). EPT = Ephemeroptera, Plecoptera, and Trichoptera taxa in sample DEQ MMI = multimetric index score**

| Site_code | EMAP Method | Date Sampled | Total Number | Total Taxa | EPT Taxa | DEQ MMI | DEQ Status | O/E | O/E Status |
|---|---|---|---|---|---|---|---|---|---|
| YL_SPOW1 | TR-500 | 7/21/2013 | 768 | 29 | 16 | 48.7 | Non-Impaired | 0.37 | Impaired |
| YL_SPOW1Q | RW-500 | 7/21/2013 | 554 | 25 | 18 | 50.2 | Non-Impaired | 0.12 | Impaired |
| YL_SPOW2 | TR-500 | 7/22/2013 | 515 | 26 | 15 | 43.9 | Non-Impaired | 0.50 | Impaired |
| YL_SPOW2Q | RW-500 | 7/22/2013 | 646 | 23 | 15 | 51.9 | Non-Impaired | 0.12 | Impaired |
| YL_SPOWM | TR-500 | 7/23/2013 | 866 | 21 | 14 | 40.4 | Non-Impaired | 0.37 | Impaired |
| YL_SPOWMQ | RW-500 | 7/23/2013 | 615 | 20 | 14 | 47.4 | Non-Impaired | 0.25 | Impaired |
| YL_SPOW3 | TR-500 | 7/23/2013 | 780 | 24 | 13 | 41.7 | Non-Impaired | 0.25 | Impaired |
| YL_SPOW3Q | RW-500 | 7/23/2013 | 410 | 21 | 13 | 38.2 | Non-Impaired | 0.25 | Impaired |
| YL_SPOW6 | TR-500 | 7/23/2013 | 592 | 23 | 15 | 47.5 | Non-Impaired | 0.37 | Impaired |
| YL_SPOW6Q | RW-500 | 7/23/2013 | 508 | 24 | 13 | 45.6 | Non-Impaired | 0.37 | Impaired |
| YL_SPOW5 | TR-500 | 7/24/2013 | 776 | 28 | 14 | 42.3 | Non-Impaired | 0.50 | Impaired |
| YL SPOW5Q | RW-500 | 7/24/2013 | 391 | 23 | 12 | 43.1 | Non-Impaired | 0.37 | Impaired |
| | | | **Avg.** | **23.9** | **14.3** | **45.1** | | **0.3** | |

**Table 10. Macroinvertebrate metric T-test p-values for Total taxa, EPT Taxa, MMI, O/E, and relative abundance of the mayfly, *Raptoheptagenia cruentata* (RACR) by year and CBNG treatment (see Methods) from Powder River sites in 2012 and 2013. Underlined p-values are significant at p < 0.05.**

| Treatment | n | df | Total Taxa | EPT Taxa | MMI | O/E | RACR |
|---|---|---|---|---|---|---|---|
| **Pre-CBNG** | **0** | | | | | | |
| **Active CBNG** | **24** | | | | | | |
| **2005 x 2011** | | **1** | **<u>0.002</u>** | **0.11** | **0.34** | **<u>0.0002</u>** | **<u>0.005</u>** |
| **2005 x 2013** | | **1** | **0.22** | **<u>0.009</u>** | **<u>0.0004</u>** | **0.43** | **<u>0.003</u>** |
| **2011 x 2013** | | **1** | **<u>0.005</u>** | **<u>0.0002</u>** | **<u>0.0001</u>** | **0.075** | **<u>0.022</u>** |
| **Active x Post** | | **2** | **0.12** | **<u>0.0005</u>** | **<u>0.0003</u>** | **0.21** | **<u>0.022</u>** |
| **Post-CBNG** | **12** | | | | | | |

**Figure 6. Individual species response across sites and years of a SOC mayfly (top) and golden stonefly (bottom).**
*** = significant difference between years at a site (T-test, p<0.05). Error bars = ± SE.**



***Macroinvertebrate IBI vs. O/E***

There was no discernible spatial trend in the macroinvertebrate DEQ MMI index scores from the Wyoming Border to Broadus in 2013 (Figure 7), but the 2013 MMI values were significantly different (lower) than recorded in 2005 and 2011 (T-test $p = 0.0003$) (Figure 8 and Table 10). O/E scores in 2013 were not significantly different from the previous two sample years ($p > 0.05$), but a significant decrease was detected between 2005 and 2011 (Figure 8 and Table 10). Spatially, $O/E_{p>0.5}$ scores had a slight decreasing trend as you proceed downstream toward the mid-reach with more variability in the upper sites near the Wyoming border with some increases in 2013 by targeted-riffle samples and increases in scores downstream towards POW #5 (Figure 7). As in 2005 and 2011, biological condition as measured by the MDEQ MMI assessed all Powder River sites as non-impaired in 2013 (Figure 7). But when applying the $O/E_{p>0.5}$ model all samples fall below the impairment threshold indicating a significant departure (i.e. taxa loss or replacement) from expected biological community conditions (Figure 7, Figure 8). Selected site patterns in biological condition observed in 2005 and 2011 were repeated in 2013 with declines in the MDEQ MMI across most sites, except an increase in the scores only in the EMAP RW samples at sites POW2 and POW Moorhead site (Figure 7).

All EMAP samples were in agreement in ranking the six Powder River sites non-impaired with DEQ MMI index scores >37, but the $O/E_{p>0.5}$ scores report all sites significantly lacking the number of expected species, and are below the impairment threshold (Table 9, Figure 8). However, the two EMAP protocols yielded different community composition measures, variability of O/E scores between sample methods (TR vs. RW {Q}) and the within-site sampling method variability was greater than similar-method across site variability (Figure 7). The number of individuals obtained in a targeted riffle (TR) sample was significantly higher than the reach-wide (RW) EMAP samples (F Test, $p < 0.001$). All TR samples had to be sub-sampled to reduce the number of organisms for the targeted 500 count, while two of the RW samples failed to reach 500 organisms after picking 100% of the sample (Table 9).

There were no discernible trends in the MMI or O/E index scores from the Wyoming Border to Broadus. However, the occurrence and abundance of a sensitive Species of Concern (SOC)

mayfly has significantly decreased from the Wyoming Border to Broadus Bridge from 2005 to 2011 and this decline continued in 2013 (Figure 7, Table 10).

**Figure 7. Powder River study reach targeted riffle and reach-wide (Q) macroinvertebrate samples DEQ MMI (top) and O/E scores (bottom) by site and year. Bold horizontal line is the impairment threshold. O/E threshold is 0.8.**

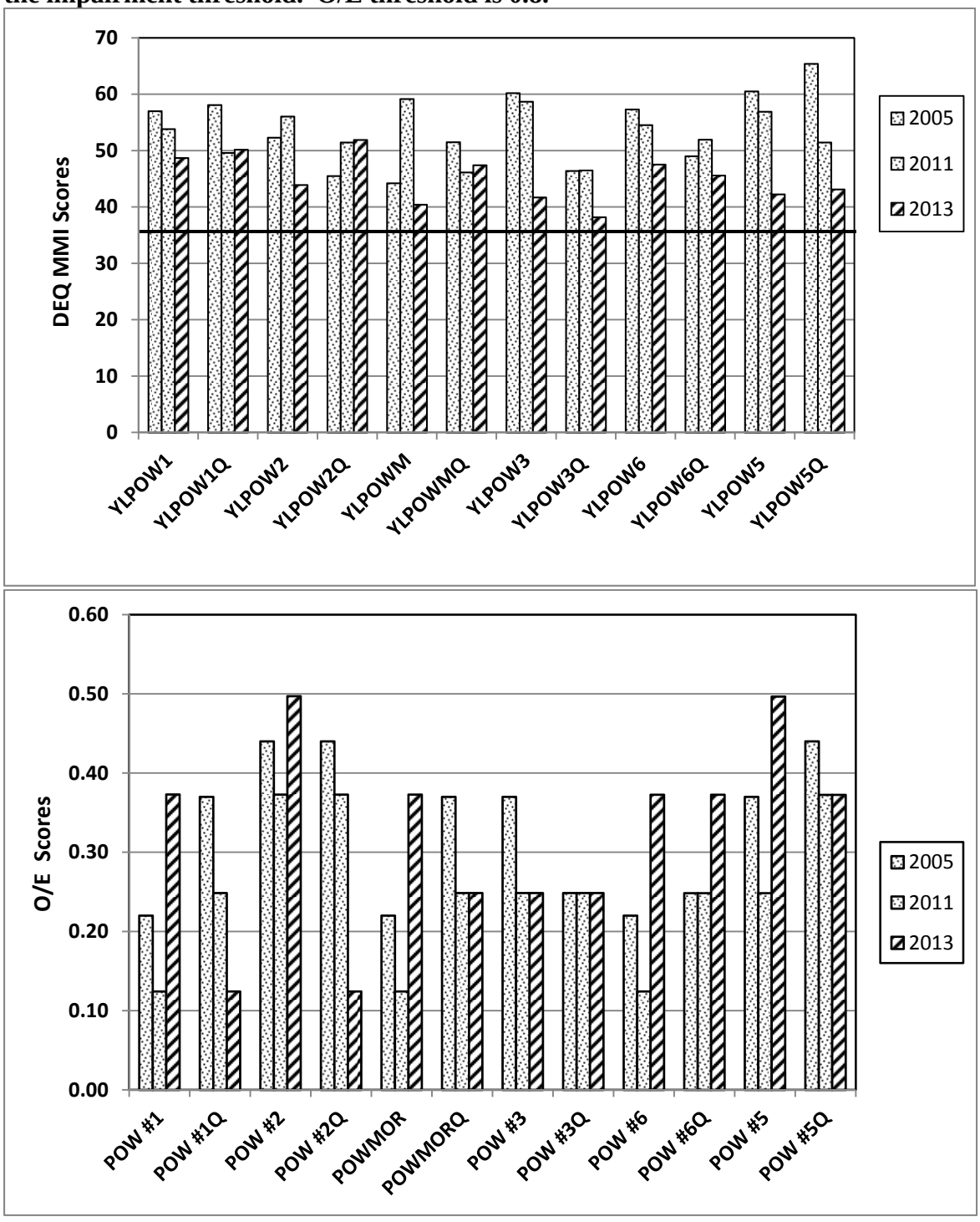
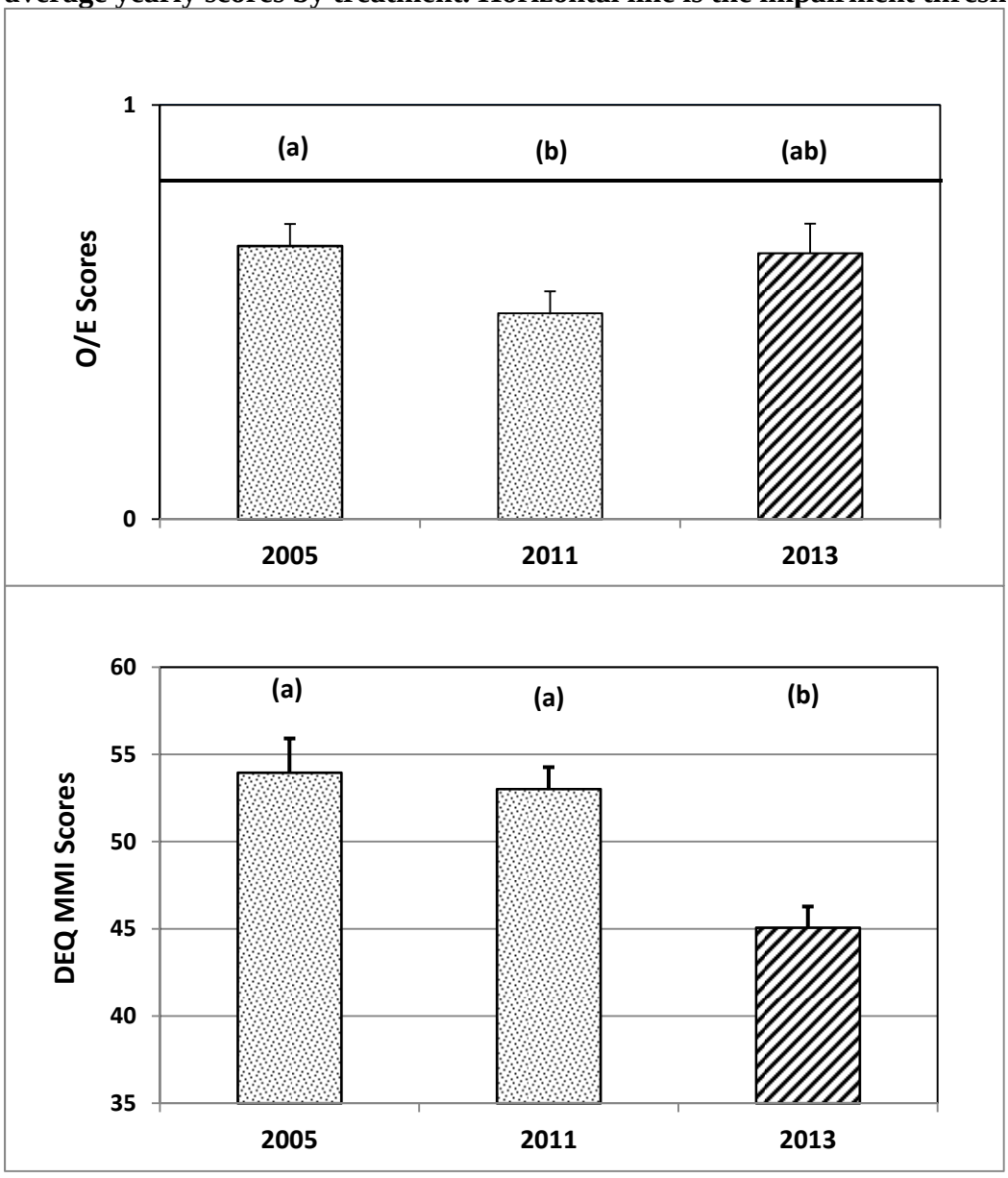


**Figure 8. Powder River study reach macroinvertebrate O/E (top) and DEQ MMI (bottom) average yearly scores by treatment. Horizontal line is the impairment threshold.**



***Community Integrity.*** Multiple lines of evidence (fish and macroinvertebrates) indicate significant declines in the biological integrity of this reach of the Powder River since CBNG development in Wyoming (surveys after 2003). This was particularly noted in declines of fish and SOC mayfly species between the Wyoming border and Moorhead Bridge (~12.8 rkm). Since 2011, the fish community integrity has rebounded to levels seen pre-CBNG development, but macroinvertebrate communities have not experienced a similar recovery. Concurrent studies have found that the maximum concentrations of alkalinity in the Powder River also occurred in this reach (Petersen et al. 2011), potentially implicating cumulative effects from coalbed natural gas extraction-related outflows derived from upstream in Wyoming as a likely contributor to this biological condition. Community Integrity results from the 2012 and 2013 fish and macroinvertebrate surveys combined to rank the Powder River reach at the Moorhead Bridge Site as the most biologically intact, followed by Powder River Site #5 upstream of Rough Creek (POW#5). In 2005, the Powder River reach at the Wyoming border (POW#1) and POW#5 had the highest fish biotic integrity (IBI). Powder River Site #5 was also the only site where we collected Sturgeon Chubs (MT SOC) in 2005. We failed to collect any during the 2011 or 2012 sampling events, but detected them again in 2013.

## CONCLUSIONS & RECOMMENDATIONS

1. In contrast to the 2011 fish community results, IBI and O/E scores from surveys in 2012 and 2013 show a significant improvement in the biological integrity of most sites from the Wyoming border to Broadus. Using a BAI design, significant differences in O/E scores were detected Pre vs. Active-CBNG, Active vs. Post-CBNG and Active vs. Pre + Post-CNBG. Sturgeon chub occupancy and numbers of individuals collected have significantly increased throughout the study reach and even 15 river miles upstream into Wyoming where they haven't been reported since 2002. We conclude that the fish community integrity documented in 2012 and 2013 has significantly rebounded from the active CBNG survey period since the high water year of 2011, and has maintained this integrity level near or above pre-CBNG historical levels. Since the Powder River experienced low summer flows

in 2012 more similar to drought levels of the early to mid-2000's, these sustained fish integrity improvements documented in both 2012 and 2013 can be causally linked to a decrease in the production of CBNG wells across large portions of the structural basin in Wyoming.

**2.** In 2013, all sites in our Powder River study section ranked as unimpaired with the fish IBI, O/E and MDEQ MMI scores, but were all considered biologically impaired with the macroinvertebrate $O/E_{p>0.5}$. Individual sensitive macroinvertebrate species responses also provide evidence for impaired benthic biological integrity. Therefore, we conclude that the macroinvertebrate communities have not shown a recovery corresponding to the fish community. Community integrity results from the 2012 and 2013 fish and macroinvertebrate surveys combined to rank the Powder River reach at the Moorhead Bridge Site as the most biologically intact, followed by Powder River Site 5 upstream of Rough Creek.

**3.** Impairment thresholds for DEQ MMI metrics appear to be too low to detect a substantial reduction in total taxa and sensitive taxa. The O/E models, on the other hand, reflect the documented impairment of a declining macroinvertebrate community losing taxa. Therefore, we recommend using the O/E model scores as the indication of the macroinvertebrate community integrity for the Powder River.

**4.** Surveys conducted in 2013 continued to document absences or declines in the numbers of many of these rare, sensitive mayfly species.

**5.** Mussel populations, essentially fatmuckets, in the Powder River are scarce and presence is linked to large tributaries contributing "fresh" water such as Clear Creek. Fatmuckets in the upper Tongue River are more evenly distributed and attain densities similar to other Yellowstone River tributaries without CBNG. Since there is no difference in mussel presence or densities upstream or downstream from Tongue River tributaries with CBNG outflows, no relationship between mussel presence and CBNG activities can be inferred from this survey effort, but we now have improved baseline population distribution.

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# APPENDIX A

# Global/State Rank Definitions

# Heritage Program Ranks

The international network of Natural Heritage Programs employs a standardized ranking system to denote global (range-wide) and state status. Species are assigned numeric ranks ranging from 1 to 5, reflecting the relative degree to which they are "at-risk". Rank definitions are given below. A number of factors are considered in assigning ranks — the number, size and distribution of known "occurrences" or populations, population trends (if known), habitat sensitivity, and threat. Factors in a species' life history that make it especially vulnerable are also considered (e.g., dependence on a specific pollinator).

## Global Rank Definitions (NatureServe 2003)

| | |
|---|---|
| G1 | Critically imperiled because of extreme rarity and/or other factors making it highly vulnerable to extinction |
| G2 | Imperiled because of rarity and/or other factors making it vulnerable to extinction |
| G3 | Vulnerable because of rarity or restricted range and/or other factors, even though it may be abundant at some of its locations |
| G4 | Apparently secure, though it may be quite rare in parts of its range, especially at the periphery |
| G5 | Demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery |
| T1-5 | **Infraspecific Taxon** (trinomial) —The status of infraspecific taxa (subspecies or varieties) are indicated by a "T-rank" following the species' global rank |

## State Rank Definitions

| | |
|---|---|
| S1 | At high risk because of extremely limited and potentially declining numbers, extent and/or habitat, making it highly vulnerable to extirpation in the state |
| S2 | At risk because of very limited and potentially declining numbers, extent and/or habitat, making it vulnerable to extirpation in the state |
| S3 | Potentially at risk because of limited and potentially declining numbers, extent and/or habitat, even though it may be abundant in some areas |
| S4 | Uncommon but not rare (although it may be rare in parts of its range), and usually widespread. Apparently not vulnerable in most of its range, but possibly cause for long-term concern |
| S5 | Common, widespread, and abundant (although it may be rare in parts of its range). Not vulnerable in most of its range |

### Combination Ranks

G#G# or S#S# **Range Rank**—A numeric range rank (e.g., G2G3) used to indicate uncertainty about the exact status of a taxon

## Qualifiers

NR Not ranked

Q **Questionable taxonomy that may reduce conservation priority**—Distinctiveness of this entity as a taxon at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, or inclusion of this taxon in another taxon, with the resulting taxon having a lower-priority (numerically higher) conservation status rank

X **Presumed Extinct**—Species believed to be extinct throughout its range. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered

H **Possibly Extinct**—Species known from only historical occurrences, but may never-the-less still be extant; further searching needed

U **Unrankable**—Species currently unrankable due to lack of information or due to substantially conflicting information about status or trends

HYB **Hybrid**—Entity not ranked because it represents an interspecific hybrid and not a species

? **Inexact Numeric Rank**—Denotes inexact numeric rank

C **Captive or Cultivated Only**—Species at present is extant only in captivity or cultivation, or as a reintroduced population not yet established

A **Accidental**—Species is accidental or casual in Montana, in other words, infrequent and outside usual range. Includes species (usually birds or butterflies) recorded once or only a few times at a location. A few of these species may have bred on the one or two occasions they were recorded

Z **Zero Occurrences**—Species is present but lacking practical conservation concern in Montana because there are no definable occurrences, although the taxon is native and appears regularly in Montana

P **Potential**—Potential that species occurs in Montana but no extant or historic occurrences are accepted

R **Reported**—Species reported in Montana but without a basis for either accepting or rejecting the report, or the report not yet reviewed locally. Some of these are very recent discoveries for which the program has not yet received first-hand information; others are old, obscure reports

SYN **Synonym**—Species reported as occurring in Montana, but the Montana Natural Heritage Program does not recognize the taxon; therefore the species is not assigned a rank

* A rank has been assigned and is under review. Contact the Montana Natural Heritage Program for assigned rank

B **Breeding**—Rank refers to the breeding population of the species in Montana

# APPENDIX B

# Raw fish data and IBI metric calculation from 2012 and 2013 Powder River sites.

**Appendix B. Raw data and IBI metric calculation from fish data collected from Powder River 2013 Sites**

| | Powder River #1 | Powder River #2 | Powder River #3 | Powder River #4 | Powder River #6 | Powder River #5 | Powder Moor | Powder Broadus |
|---|---|---|---|---|---|---|---|---|
| Channel Catfish | 24.0 | 12.0 | 27.0 | 4.0 | 12.0 | 17.0 | 18.0 | 43.0 |
| Common Carp | 1.0 | 1.0 | 1.0 | 0.0 | 0.0 | 2.0 | 0.0 | 0.0 |
| Emerald Shiner | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 |
| Green Sunfish | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Plains Killifish | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Flathead Chub | 130.0 | 100.0 | 105.0 | 88.0 | 175.0 | 133.0 | 206.0 | 324.0 |
| Goldeye | 0.0 | 0.0 | 4.0 | 2.0 | 2.0 | 1.0 | 6.0 | 1.0 |
| Lake Chub | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Longnose Dace BI | 1.0 | 1.0 | 3.0 | 4.0 | 2.0 | 2.0 | 4.0 | 1.0 |
| Plains Minnow | 0 | 2.0 | 5.0 | 8.0 | 42.0 | 15.0 | 18.0 | 17.0 |
| River Carpsucker | 2.0 | 3.0 | 5.0 | 4.0 | 2.0 | 1.0 | 1.0 | 8.0 |
| Sand Shiner | 42.0 | 32.0 | 126.0 | 96.0 | 163.0 | 380.0 | 114.0 | 174.0 |
| Sauger | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Shorthead Redhorse BI | 14.0 | 0.0 | 2.0 | 2.0 | 5.0 | 5.0 | 2.0 | 10.0 |
| Smallmouth Bass | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Sturgeon Chub BI | 0.0 | 2.0 | 0.0 | 2.0 | 12.0 | 4.0 | 0.0 | 23.0 |
| Shovelnose Sturgeon | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Stonecat BI | 4.0 | 7.0 | 5.0 | 4.0 | 2.0 | 1.0 | 4.0 | 1.0 |
| White Sucker (LOSU) | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Western Silvery Minnow | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total # species | 9.0 | 9.0 | 10.0 | 11.0 | 10.0 | 12.0 | 9.0 | 10.0 |
| Native Species | 8.0 | 8.0 | 9.0 | 11.0 | 10.0 | 10.0 | 9.0 | 10.0 |
| Native Families | 3.0 | 3.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| Total Individuals | 220.0 | 160.0 | 283.0 | 215.0 | 417.0 | 562.0 | 373.0 | 602.0 |
| # Minnow Species Thrive | 4.0 | 4.0 | 2.0 | 2.0 | 4.0 | 4.0 | 5.0 | 5.0 |
| Proportion of tolerant individuals | 1.36 | 0.63 | 0.35 | 0.00 | 0.00 | 0.53 | 0.00 | 0.00 |
| # Sucker + Catfish Species | 5.0 | 3.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| % Insectivorous Minnows | 59.5 | 64.4 | 38.2 | 43.7 | 45.3 | 24.9 | 56.3 | 57.8 |
| # Benthic Invertivore Species | 3.0 | 3.0 | 3.0 | 4.0 | 4.0 | 4.0 | 3.0 | 4.0 |
| % Litholphilic Spawners | 29.5 | 28.1 | 51.2 | 53.0 | 45.1 | 70.1 | 35.1 | 36.2 |
| % Parental Care | 10.91 | 7.50 | 9.54 | 1.86 | 2.88 | 3.02 | 4.83 | 7.14 |
| % Native to Montana | 99.5 | 99.4 | 99.6 | 100.0 | 100.0 | 99.5 | 100.0 | 100.0 |
| # Long Lived Species | 7.0 | 5.0 | 7.0 | 9.0 | 8.0 | 8.0 | 8.0 | 6.0 |

| **Table 1. Powder River Sites 2013** | **Powder River #1** | | **Powder River #2** | | **Powder River #3** | | **Powder River #4** | | **Powder River #6** | | **Powder River #5** | | **Powder Moor** | | **Powder Broadus** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metrics | Adjust Value | Score | Adjust Value | Score | Adjust Value | Score | Adjust Value | Score | Adjust Value | Score | Adjust Value | Score | Adjust Value | Score | Adjust Value | Score |
| Number of Native Fish Species to Montana | 6.9 | 38.1 | 6.9 | 38.1 | 7.9 | 43.7 | 9.9 | 54.8 | 8.9 | 49.2 | 8.9 | 49.2 | 7.9 | 43.7 | 8.6 | 48.0 |
| Number of Native Fish Families to Montana | 2.8 | 52.1 | 2.8 | 52.1 | 3.8 | 70.6 | 3.8 | 70.6 | 3.8 | 70.6 | 3.8 | 70.6 | 3.8 | 70.6 | 3.8 | 70.6 |
| Proportion of tolerant individuals | 1.4 | 98.6 | 0.6 | 99.3 | 0.4 | 99.6 | 0.0 | 100.0 | 0.0 | 100.0 | 0.5 | 99.4 | 0.0 | 100.0 | 0.0 | 100.0 |
| Number of Sucker and Catfish Species | 4.4 | 48.1 | 2.4 | 26.4 | 3.4 | 37.2 | 3.4 | 37.2 | 3.4 | 37.2 | 3.4 | 37.2 | 3.4 | 37.2 | 3.4 | 37.2 |
| Proportion out of the Total Number of Fish That Were Insect eating Minnows | 59.5 | 81.8 | 64.4 | 88.4 | 38.2 | 52.4 | 43.7 | 60.0 | 45.3 | 62.2 | 24.9 | 34.2 | 56.3 | 77.3 | 57.8 | 79.4 |
| Total Number of Species That Prefer to Eat Insects That Live on the Stream Bottom | 2.6 | 43.4 | 2.6 | 43.4 | 2.6 | 43.4 | 3.6 | 60.4 | 3.6 | 60.4 | 3.6 | 60.4 | 2.6 | 43.4 | 3.6 | 60.4 |
| Proportion of the Total Number of Fish That Require Rocks to Lay Eggs | 29.5 | 35.6 | 28.1 | 33.9 | 51.2 | 61.8 | 53.0 | 63.9 | 45.1 | 54.4 | 70.1 | 84.5 | 35.1 | 42.3 | 36.2 | 43.7 |
| Proportion of the Total Number of Individuals That Do Not Require Rocks, But Have Parental Care of Eggs | 10.9 | 87.6 | 7.5 | 91.5 | 9.5 | 89.1 | 1.9 | 97.9 | 2.9 | 96.7 | 3.0 | 96.6 | 4.8 | 94.5 | 7.1 | 91.9 |
| Proportion of the Total Number of Fish Sampled That Were Native to Montana | 99.5 | 99.6 | 99.4 | 99.4 | 99.6 | 99.7 | 100.0 | 100.0 | 100.0 | 100.0 | 99.5 | 99.5 | 100.0 | 100.0 | 100.0 | 100.0 |
| Number of Long-Lived Native Species | 6.3 | 64.6 | 4.3 | 44.2 | 6.3 | 64.6 | 8.3 | 85.1 | 7.3 | 74.9 | 7.3 | 74.9 | 7.3 | 74.9 | 5.3 | 54.4 |
| | | 649.6 | | 616.7 | | 662.2 | | 730.0 | | 705.7 | | 706.6 | | 684.0 | | 685.6 |
| **IBI Score** | | **64.96** | | **61.67** | | **66.22** | | **73.00** | | **70.57** | | **70.66** | | **68.40** | | **68.56** |

# APPENDIX C

## Macroinvertebrate taxa lists, abundance and metrics for EMAP Targeted Riffle (TR) and Reach-wide (RW) samples for MMI calculations.

# Montana Bioassessment Report

**Waterbody Name:** Powder River@WYBorder
**Benthic Sample ID:** 18115
**Station ID:** YLPOW1t2b
**Rep. Num** 0
**Reference Status:**
**STORET Activity ID:** P1-R500-M
**Site Classification:**
**Collection Date:** 07/22/2013
**Latitude:**
**Collection Method:** MAC-T-500
**Longitude:**
**Total Number of Individuals in Sample:** 768

## Sample Taxa List

| *Order:* | *OTU name:* | *FinalID:* | *Individuals* | *Tol Val:* | *FFG:* | *Habit:* |
|---|---|---|---|---|---|---|
| Coleoptera | Dubiraphia | Dubiraphia | 6 | 6 | SC/CG | "CN/50%, BU/50%" |
| Coleoptera | Microcylloepus | Microcylloepus pusillus | 44 | 5 | CG | "CN/50%, BU/50%" |
| Coleoptera | Stenelmis | Stenelmis | 90 | 5 | SC/CG | "CN/50%, BU/50%" |
| Diptera | Chironominae | Cryptochironomus | 2 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Chironominae | Polypedilum | 4 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Chironominae | Tanytarsus | 6 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Hemerodromia | Hemerodromia | 2 | 6 | PR | SP |
| Diptera | Orthocladiinae | Cricotopus bicinctus | 2 | | CG/SC | SP/BU |
| Diptera | Simuliidae | Simulium | 2 | 6 | CF | CN |
| Ephemeropte | Cercobrachys | Cercobrachys | 60 | | CG | "SP/75%, CM/90%" |
| Ephemeropte | Ephoron | Ephoron album | 14 | 2 | CG | BU |
| Ephemeropte | Fallceon | Fallceon quilleri | 6 | 5 | CG | "SW/10%, CN/90%" |
| Ephemeropte | Isonychia | Isonychia campestris | 2 | 2 | CF | SW/CN |
| Ephemeropte | Neochoroterpes | Neochoroterpes oklahoma | 46 | 2 | CG | CN/SP |
| Ephemeropte | Pseudocloeon | Pseudocloeon | 4 | 4 | CG | "SW/10%, CN/90%" |
| Ephemeropte | Traverella | Traverella albertana | 14 | 2 | CF | CN |
| Ephemeropte | Tricorythodes | Tricorythodes minutus | 40 | 4 | CG | CN/SP |
| Haplotaxida | Oligochaeta | Tubificidae | 8 | 8 | CG | BU |
| Lepidoptera | Lepidoptera | Petrophila | 4 | 7 | SH | CM |
| Odonata | Gomphidae | Ophiogomphus severus | 6 | 2 | PR | BU |
| Plecoptera | Acroneuria | Acroneuria abnormis | 4 | 0 | PR | CN |
| Trichoptera | Brachycentrus | Brachycentrus occidentalis | 4 | 1 | CF | CN |
| Trichoptera | Cheumatopsyche | Cheumatopsyche | 324 | 5 | CF | CN |
| Trichoptera | Hydropsyche_Cera | Hydropsyche | 20 | 5 | CF | CN |
| Trichoptera | Hydropsyche_Cera | Hydropsyche morosa gr. | 18 | 5 | CF | CN |
| Trichoptera | Mayatrichia | Mayatrichia | 20 | 1 | SC | CN |
| Trichoptera | Nectopsyche | Nectopsyche gracilis | 4 | 2 | SH | CM/SP/CN |
| Trichoptera | Oecetis | Oecetis | 6 | 8 | PR | CN/SP |
| Veneroida | Pisidiidae | Sphaerium simile | 6 | 8 | CF | BU |

# Montana Bioassessment Report

**Waterbody Name:** Powder River@WYBorder
**Benthic Sample ID:** 18116
**Station ID:** YLPOW1t2Qb
**Rep. Num** 0
**Reference Status:**
**STORET Activity ID:** P1-Q500-M
**Site Classification:**
**Collection Date:** 07/22/2013
**Latitude:**
**Collection Method:** MAC-R-500
**Longitude:**
**Total Number of Individuals in Sample:** 554

## Sample Taxa List

| *Order:* | *OTU name:* | *FinalID:* | *Individuals* | *Tol Val:* | *FFG:* | *Habit:* |
|---|---|---|---|---|---|---|
| | | Anepeorus rusticus | 2 | | | |
| | | Melaniodes | 1 | | | |
| Coleoptera | Microcylloepus | Microcylloepus pusillus | 17 | 5 | CG | "CN/50%, BU/50%" |
| Coleoptera | Stenelmis | Stenelmis | 24 | 5 | SC/CG | "CN/50%, BU/50%" |
| Diptera | Chironominae | Cryptochironomus | 2 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Chironominae | Polypedilum | 2 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Hemerodromia | Hemerodromia | 2 | 6 | PR | SP |
| Diptera | Simuliidae | Simulium | 176 | 6 | CF | CN |
| Ephemeropte | Acentrella | Acentrella turbida | 2 | 4 | CG | "SW/10%, CN/90%" |
| Ephemeropte | Baetis | Baetis tricaudatus | 3 | 5 | CG | "SW/10%, CN/90%" |
| Ephemeropte | Camelobaetidius | Camelobaetidius warreni | 1 | 4 | CG | "SW/10%, CN/90%" |
| Ephemeropte | Cercobrachys | Cercobrachys | 5 | | CG | "SP/75%, CM/90%" |
| Ephemeropte | Ephoron | Ephoron album | 1 | 2 | CG | BU |
| Ephemeropte | Fallceon | Fallceon quilleri | 14 | 5 | CG | "SW/10%, CN/90%" |
| Ephemeropte | Isonychia | Isonychia campestris | 4 | 2 | CF | SW/CN |
| Ephemeropte | Leucrocuta | Leucrocuta | 7 | 1 | SC | CN |
| Ephemeropte | Traverella | Traverella albertana | 150 | 2 | CF | CN |
| Ephemeropte | Tricorythodes | Tricorythodes minutus | 40 | 4 | CG | CN/SP |
| Odonata | Gomphidae | Ophiogomphus severus | 3 | 2 | PR | BU |
| Plecoptera | Acroneuria | Acroneuria abnormis | 15 | 0 | PR | CN |
| Trichoptera | Brachycentrus | Brachycentrus occidentalis | 3 | 1 | CF | CN |
| Trichoptera | Cheumatopsyche | Cheumatopsyche | 55 | 5 | CF | CN |
| Trichoptera | Hydropsyche_Cera | Hydropsyche | 15 | 5 | CF | CN |
| Trichoptera | Hydropsyche_Cera | Hydropsyche morosa gr. | 3 | 5 | CF | CN |
| Trichoptera | Mayatrichia | Mayatrichia | 2 | 1 | SC | CN |
| Trichoptera | Nectopsyche | Nectopsyche gracilis | 5 | 2 | SH | CM/SP/CN |

# Montana Bioassessment Report

**Waterbody Name:** Powder River@drycreek
**Benthic Sample ID:** 18117
**Station ID:** YLPOW2t2b
**Rep. Num** 0
**Reference Status:**
**STORET Activity ID:** P2-R500-M
**Site Classification:**
**Collection Date:** 07/22/2013
**Latitude:**
**Collection Method:** MAC-T-500
**Longitude:**
**Total Number of Individuals in Sample:** 515

## Sample Taxa List

| *Order:* | *OTU name:* | *FinalID:* | *Individuals* | *Tol Val:* | *FFG:* | *Habit:* |
|---|---|---|---|---|---|---|
| Coleoptera | Dubiraphia | Dubiraphia | 2 | 6 | SC/CG | "CN/50%, BU/50%" |
| Coleoptera | Microcylloepus | Microcylloepus pusillus | 10 | 5 | CG | "CN/50%, BU/50%" |
| Coleoptera | Stenelmis | Stenelmis | 22 | 5 | SC/CG | "CN/50%, BU/50%" |
| Diptera | Chironominae | Polypedilum | 6 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Chironominae | Robackia | 10 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Chironominae | Stempellinella | 4 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Chironominae | Tanytarsus | 6 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Orthocladiinae | Cricotopus bicinctus | 8 | | CG/SC | SP/BU |
| Diptera | Simuliidae | Simulium | 6 | 6 | CF | CN |
| Ephemeropte | Cercobrachys | Cercobrachys | 14 | | CG | "SP/75%, CM/90%" |
| Ephemeropte | Ephoron | Ephoron album | 22 | 2 | CG | BU |
| Ephemeropte | Fallceon | Fallceon quilleri | 14 | 5 | CG | "SW/10%, CN/90%" |
| Ephemeropte | Leucrocuta | Leucrocuta | 4 | 1 | SC | CN |
| Ephemeropte | Neochoroterpes | Neochoroterpes oklahoma | 18 | 2 | CG | CN/SP |
| Ephemeropte | Pseudocloeon | Pseudocloeon | 4 | 4 | CG | "SW/10%, CN/90%" |
| Ephemeropte | Traverella | Traverella albertana | 66 | 2 | CF | CN |
| Ephemeropte | Tricorythodes | Tricorythodes minutus | 30 | 4 | CG | CN/SP |
| Haplotaxida | Oligochaeta | Tubificidae | 2 | 8 | CG | BU |
| Lepidoptera | Lepidoptera | Petrophila | 4 | 7 | SH | CM |
| Odonata | Gomphidae | Gomphus externus | 2 | 2 | PR | BU |
| Plecoptera | Acroneuria | Acroneuria abnormis | 1 | 0 | PR | CN |
| Trichoptera | Cheumatopsyche | Cheumatopsyche | 220 | 5 | CF | CN |
| Trichoptera | Hydropsyche_Cera | Hydropsyche confusa | 6 | 5 | CF | CN |
| Trichoptera | Hydropsyche_Cera | Hydropsyche morosa gr. | 6 | 5 | CF | CN |
| Trichoptera | Mayatrichia | Mayatrichia | 14 | 1 | SC | CN |
| Trichoptera | Nectopsyche | Nectopsyche gracilis | 2 | 2 | SH | CM/SP/CN |
| Trichoptera | Oecetis | Oecetis | 6 | 8 | PR | CN/SP |
| Veneroida | Pisidiidae | Sphaerium simile | 6 | 8 | CF | BU |

# Montana Bioassessment Report

**Waterbody Name:** Powder River@drycreek
**Benthic Sample ID:** 18118
**Station ID:** YLPOW2t2Qb
**Rep. Num** 0
**Reference Status:**
**STORET Activity ID:** P2-Q500-M
**Site Classification:**
**Collection Date:** 07/22/2013
**Latitude:**
**Collection Method:** MAC-R-500
**Longitude:**
**Total Number of Individuals in Sample:** 646

## Sample Taxa List

| *Order:* | *OTU name:* | *FinalID:* | *Individuals* | *Tol Val:* | *FFG:* | *Habit:* |
|---|---|---|---|---|---|---|
| Coleoptera | Microcylloepus | Microcylloepus pusillus | 10 | 5 | CG | "CN/50%, BU/50%" |
| Coleoptera | Stenelmis | Stenelmis | 4 | 5 | SC/CG | "CN/50%, BU/50%" |
| Diptera | Chironominae | Cryptochironomus | 40 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Chironominae | Polypedilum | 12 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Chironominae | Robackia | 4 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Hemerodromia | Hemerodromia | 6 | 6 | PR | SP |
| Diptera | Simuliidae | Simulium | 268 | 6 | CF | CN |
| Ephemeropte | Acentrella | Acentrella turbida | 2 | 4 | CG | "SW/10%, CN/90%" |
| Ephemeropte | Cercobrachys | Cercobrachys | 6 | | CG | "SP/75%, CM/90%" |
| Ephemeropte | Ephoron | Ephoron album | 18 | 2 | CG | BU |
| Ephemeropte | Fallceon | Fallceon quilleri | 16 | 5 | CG | "SW/10%, CN/90%" |
| Ephemeropte | Isonychia | Isonychia campestris | 6 | 2 | CF | SW/CN |
| Ephemeropte | Leucrocuta | Leucrocuta | 5 | 1 | SC | CN |
| Ephemeropte | Traverella | Traverella albertana | 70 | 2 | CF | CN |
| Ephemeropte | Tricorythodes | Tricorythodes minutus | 18 | 4 | CG | CN/SP |
| Odonata | Gomphidae | Ophiogomphus severus | 4 | 2 | PR | BU |
| Plecoptera | Acroneuria | Acroneuria abnormis | 10 | 0 | PR | CN |
| Trichoptera | Brachycentrus | Brachycentrus occidentalis | 2 | 1 | CF | CN |
| Trichoptera | Cheumatopsyche | Cheumatopsyche | 114 | 5 | CF | CN |
| Trichoptera | Hydropsyche_Cera | Hydropsyche confusa | 4 | 5 | CF | CN |
| Trichoptera | Hydropsyche_Cera | Hydropsyche morosa gr. | 4 | 5 | CF | CN |
| Trichoptera | Nectopsyche | Nectopsyche gracilis | 19 | 2 | SH | CM/SP/CN |
| Trichoptera | Oecetis | Oecetis | 4 | 8 | PR | CN/SP |

# Montana Bioassessment Report

**Waterbody Name:** Powder River@Jenkins
**Benthic Sample ID:** 18119
**Station ID:** YLPOW3t2b
**Rep. Num** 0
**Reference Status:**
**STORET Activity ID:** P3-T500-M
**Site Classification:**
**Collection Date:** 07/23/2013
**Latitude:**
**Collection Method:** MAC-T-500
**Longitude:**
**Total Number of Individuals in Sample:** 780

## Sample Taxa List

| *Order:* | *OTU name:* | *FinalID:* | *Individuals* | *Tol Val:* | *FFG:* | *Habit:* |
|---|---|---|---|---|---|---|
| Coleoptera | Microcylloepus | Microcylloepus pusillus | 6 | 5 | CG | "CN/50%, BU/50%" |
| Coleoptera | Stenelmis | Stenelmis | 14 | 5 | SC/CG | "CN/50%, BU/50%" |
| Diptera | Chironominae | Cryptochironomus | 2 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Chironominae | Polypedilum | 6 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Chironominae | Robackia | 4 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Hemerodromia | Hemerodromia | 2 | 6 | PR | SP |
| Diptera | Simuliidae | Simulium | 148 | 6 | CF | CN |
| Ephemeropte | Cercobrachys | Cercobrachys | 30 | | CG | "SP/75%, CM/90%" |
| Ephemeropte | Ephoron | Ephoron album | 14 | 2 | CG | BU |
| Ephemeropte | Fallceon | Fallceon quilleri | 6 | 5 | CG | "SW/10%, CN/90%" |
| Ephemeropte | Isonychia | Isonychia campestris | 2 | 2 | CF | SW/CN |
| Ephemeropte | Leucrocuta | Leucrocuta | 4 | 1 | SC | CN |
| Ephemeropte | Traverella | Traverella albertana | 390 | 2 | CF | CN |
| Haplotaxida | Oligochaeta | Tubificidae | 4 | 8 | CG | BU |
| Plecoptera | Acroneuria | Acroneuria abnormis | 2 | 0 | PR | CN |
| Trichoptera | Cheumatopsyche | Cheumatopsyche | 110 | 5 | CF | CN |
| Trichoptera | Hydropsyche_Cera | Hydropsyche | 24 | 5 | CF | CN |
| Trichoptera | Hydropsyche_Cera | Hydropsyche morosa gr. | 2 | 5 | CF | CN |
| Trichoptera | Mayatrichia | Mayatrichia | 2 | 1 | SC | CN |
| Trichoptera | Nectopsyche | Nectopsyche gracilis | 6 | 2 | SH | CM/SP/CN |
| Trichoptera | Oecetis | Oecetis | 2 | 8 | PR | CN/SP |

# Montana Bioassessment Report

**Waterbody Name:** Powder River@Jenkins
**Benthic Sample ID:** 18120
**Station ID:** YLPOW3t2Qb
**Rep. Num** 0
**Reference Status:**
**STORET Activity ID:** P3-Q500-M
**Site Classification:**
**Collection Date:** 07/23/2013
**Latitude:**
**Collection Method:** MAC-R-500
**Longitude:**
**Total Number of Individuals in Sample:** 410

## Sample Taxa List

| *Order:* | *OTU name:* | *FinalID:* | *Individuals* | *Tol Val:* | *FFG:* | *Habit:* |
|---|---|---|---|---|---|---|
| Coleoptera | Stenelmis | Stenelmis | 7 | 5 | SC/CG | "CN/50%, BU/50%" |
| Diptera | Chironominae | Cryptochironomus | 5 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Hemerodromia | Hemerodromia | 11 | 6 | PR | SP |
| Diptera | Orthocladiinae | Orthocladius | 3 | | CG/SC | SP/BU |
| Diptera | Orthocladiinae | Parakiefferiella | 4 | | CG/SC | SP/BU |
| Diptera | Simuliidae | Simulium | 127 | 6 | CF | CN |
| Ephemeropte | Camelobaetidius | Camelobaetidius warreni | 2 | 4 | CG | "SW/10%, CN/90%" |
| Ephemeropte | Ephoron | Ephoron album | 14 | 2 | CG | BU |
| Ephemeropte | Fallceon | Fallceon quilleri | 16 | 5 | CG | "SW/10%, CN/90%" |
| Ephemeropte | Isonychia | Isonychia campestris | 2 | 2 | CF | SW/CN |
| Ephemeropte | Leucrocuta | Leucrocuta | 4 | 1 | SC | CN |
| Ephemeropte | Plauditus | Plauditus punctiventris | 3 | 5 | SC | "SW/10%, CN/90%" |
| Ephemeropte | Traverella | Traverella albertana | 99 | 2 | CF | CN |
| Ephemeropte | Tricorythodes | Tricorythodes minutus | 26 | 4 | CG | CN/SP |
| Odonata | Gomphidae | Ophiogomphus severus | 1 | 2 | PR | BU |
| Plecoptera | Acroneuria | Acroneuria abnormis | 8 | 0 | PR | CN |
| Trichoptera | Brachycentrus | Brachycentrus occidentalis | 4 | 1 | CF | CN |
| Trichoptera | Cheumatopsyche | Cheumatopsyche | 52 | 5 | CF | CN |
| Trichoptera | Hydropsyche_Cera | Hydropsyche | 1 | 5 | CF | CN |
| Trichoptera | Nectopsyche | Nectopsyche gracilis | 21 | 2 | SH | CM/SP/CN |

# Montana Bioassessment Report

**Waterbody Name:** Powder River@RoughCreek
**Benthic Sample ID:** 18121
**Station ID:** YLPOW5t2b
**Rep. Num** 0
**Reference Status:**
**STORET Activity ID:** P5-T500-M
**Site Classification:**
**Collection Date:** 07/24/2013
**Latitude:**
**Collection Method:** MAC-T-500
**Longitude:**
**Total Number of Individuals in Sample:** 776

## Sample Taxa List

| *Order:* | *OTU name:* | *FinalID:* | *Individuals* | *Tol Val:* | *FFG:* | *Habit:* |
|---|---|---|---|---|---|---|
| Coleoptera | Microcylloepus | Microcylloepus pusillus | 2 | 5 | CG | "CN/50%, BU/50%" |
| Coleoptera | Stenelmis | Stenelmis | 10 | 5 | SC/CG | "CN/50%, BU/50%" |
| Diptera | Chironominae | Polypedilum | 8 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Chironominae | Robackia | 16 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Chironominae | Tanytarsus | 4 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Hemerodromia | Hemerodromia | 2 | 6 | PR | SP |
| Diptera | Orthocladiinae | Cricotopus bicinctus | 18 | | CG/SC | SP/BU |
| Diptera | Simuliidae | Simulium | 140 | 6 | CF | CN |
| Diptera | Tanypodinae | Thienemannimyia Gr. | 2 | | PR | SP/BU |
| Ephemeropte | Cercobrachys | Cercobrachys | 70 | | CG | "SP/75%, CM/90%" |
| Ephemeropte | Ephoron | Ephoron album | 18 | 2 | CG | BU |
| Ephemeropte | Fallceon | Fallceon quilleri | 24 | 5 | CG | "SW/10%, CN/90%" |
| Ephemeropte | Isonychia | Isonychia campestris | 2 | 2 | CF | SW/CN |
| Ephemeropte | Leucrocuta | Leucrocuta | 4 | 1 | SC | CN |
| Ephemeropte | Traverella | Traverella albertana | 178 | 2 | CF | CN |
| Ephemeropte | Tricorythodes | Tricorythodes minutus | 36 | 4 | CG | CN/SP |
| Haplotaxida | Oligochaeta | Tubificidae | 4 | 8 | CG | BU |
| Plecoptera | Acroneuria | Acroneuria abnormis | 28 | 0 | PR | CN |
| Trichoptera | Cheumatopsyche | Cheumatopsyche | 168 | 5 | CF | CN |
| Trichoptera | Hydropsyche_Cera | Hydropsyche | 6 | 5 | CF | CN |
| Trichoptera | Hydropsyche_Cera | Hydropsyche morosa gr. | 4 | 5 | CF | CN |
| Trichoptera | Mayatrichia | Mayatrichia | 2 | 1 | SC | CN |
| Trichoptera | Nectopsyche | Nectopsyche gracilis | 24 | 2 | SH | CM/SP/CN |
| Trichoptera | Oecetis | Oecetis | 6 | 8 | PR | CN/SP |

# Montana Bioassessment Report

**Waterbody Name:** Powder River@RoughCreek
**Benthic Sample ID:** 18122
**Station ID:** YLPOW5t2Qb
**Rep. Num** 0
**Reference Status:**
**STORET Activity ID:** P5-Q500-M
**Site Classification:**
**Collection Date:** 07/24/2013
**Latitude:**
**Collection Method:** MAC-R-500
**Longitude:**
**Total Number of Individuals in Sample:** 391

## Sample Taxa List

| *Order:* | *OTU name:* | *FinalID:* | *Individuals* | *Tol Val:* | *FFG:* | *Habit:* |
|---|---|---|---|---|---|---|
| Basommatop | Physa_Physella | Physella acuta | 1 | 8 | CG | CN |
| Coleoptera | Stenelmis | Stenelmis | 4 | 5 | SC/CG | "CN/50%, BU/50%" |
| Diptera | Chironominae | Cryptochironomus | 2 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Chironominae | Polypedilum | 4 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Hemerodromia | Hemerodromia | 4 | 6 | PR | SP |
| Diptera | Orthocladiinae | Parakiefferiella | 2 | | CG/SC | SP/BU |
| Diptera | Simuliidae | Simulium | 24 | 6 | CF | CN |
| Ephemeropte | Cercobrachys | Cercobrachys | 22 | | CG | "SP/75%, CM/90%" |
| Ephemeropte | Ephoron | Ephoron album | 10 | 2 | CG | BU |
| Ephemeropte | Fallceon | Fallceon quilleri | 3 | 5 | CG | "SW/10%, CN/90%" |
| Ephemeropte | Isonychia | Isonychia campestris | 5 | 2 | CF | SW/CN |
| Ephemeropte | Leucrocuta | Leucrocuta | 2 | 1 | SC | CN |
| Ephemeropte | Traverella | Traverella albertana | 180 | 2 | CF | CN |
| Ephemeropte | Tricorythodes | Tricorythodes minutus | 12 | 4 | CG | CN/SP |
| Odonata | Gomphidae | Ophiogomphus severus | 4 | 2 | PR | BU |
| Plecoptera | Acroneuria | Acroneuria abnormis | 14 | 0 | PR | CN |
| Trichoptera | Cheumatopsyche | Cheumatopsyche | 86 | 5 | CF | CN |
| Trichoptera | Hydropsyche_Cera | Hydropsyche | 2 | 5 | CF | CN |
| Trichoptera | Mayatrichia | Mayatrichia | 1 | 1 | SC | CN |
| Trichoptera | Nectopsyche | Nectopsyche gracilis | 8 | 2 | SH | CM/SP/CN |
| Veneroida | Pisidiidae | Sphaerium | 1 | 8 | CF | BU |

# Montana Bioassessment Report

**Waterbody Name:** Powder River@buttermilk
**Benthic Sample ID:** 18123
**Station ID:** YLPOW6t2b
**Rep. Num** 0
**Reference Status:**
**STORET Activity ID:** P6-T500-M
**Site Classification:**
**Collection Date:** 07/23/2013
**Latitude:**
**Collection Method:** MAC-T-500
**Longitude:**
**Total Number of Individuals in Sample:** 592

## Sample Taxa List

| *Order:* | *OTU name:* | *FinalID:* | *Individuals* | *Tol Val:* | *FFG:* | *Habit:* |
|---|---|---|---|---|---|---|
| Coleoptera | Microcylloepus | Microcylloepus pusillus | 2 | 5 | CG | "CN/50%, BU/50%" |
| Coleoptera | Stenelmis | Stenelmis | 12 | 5 | SC/CG | "CN/50%, BU/50%" |
| Diptera | Chironominae | Polypedilum | 4 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Chironominae | Robackia | 18 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Chironominae | Tanytarsus | 2 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Orthocladiinae | Cricotopus bicinctus | 2 | | CG/SC | SP/BU |
| Diptera | Simuliidae | Simulium | 74 | 6 | CF | CN |
| Diptera | Tanypodinae | Thienemannimyia Gr. | 2 | | PR | SP/BU |
| Ephemeropte | Cercobrachys | Cercobrachys | 14 | | CG | "SP/75%, CM/90%" |
| Ephemeropte | Ephoron | Ephoron album | 18 | 2 | CG | BU |
| Ephemeropte | Fallceon | Fallceon quilleri | 10 | 5 | CG | "SW/10%, CN/90%" |
| Ephemeropte | Isonychia | Isonychia campestris | 2 | 2 | CF | SW/CN |
| Ephemeropte | Leucrocuta | Leucrocuta | 10 | 1 | SC | CN |
| Ephemeropte | Oligoneuriidae | Homoeoneuria alleni | 12 | 2 | unk | CN/BU |
| Ephemeropte | Traverella | Traverella albertana | 190 | 2 | CF | CN |
| Ephemeropte | Tricorythodes | Tricorythodes minutus | 14 | 4 | CG | CN/SP |
| Plecoptera | Acroneuria | Acroneuria abnormis | 2 | 0 | PR | CN |
| Trichoptera | Cheumatopsyche | Cheumatopsyche | 166 | 5 | CF | CN |
| Trichoptera | Hydropsyche_Cera | Hydropsyche | 12 | 5 | CF | CN |
| Trichoptera | Hydropsyche_Cera | Hydropsyche morosa gr. | 6 | 5 | CF | CN |
| Trichoptera | Mayatrichia | Mayatrichia | 2 | 1 | SC | CN |
| Trichoptera | Nectopsyche | Nectopsyche gracilis | 16 | 2 | SH | CM/SP/CN |
| Trichoptera | Oecetis | Oecetis | 2 | 8 | PR | CN/SP |

# Montana Bioassessment Report

**Waterbody Name:** Powder River@buttermilk
**Benthic Sample ID:** 18124
**Station ID:** YLPOW6t2Qb
**Rep. Num** 0
**Reference Status:**
**STORET Activity ID:** P6-Q500-M
**Site Classification:**
**Collection Date:** 07/23/2013
**Latitude:**
**Collection Method:** MAC-R-500
**Longitude:**
**Total Number of Individuals in Sample:** 508

## Sample Taxa List

| *Order:* | *OTU name:* | *FinalID:* | *Individuals* | *Tol Val:* | *FFG:* | *Habit:* |
|---|---|---|---|---|---|---|
| Coleoptera | Microcylloepus | Microcylloepus pusillus | 1 | 5 | CG | "CN/50%, BU/50%" |
| Coleoptera | Stenelmis | Stenelmis | 4 | 5 | SC/CG | "CN/50%, BU/50%" |
| Diptera | Chironominae | Cladotanytarsus | 1 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Chironominae | Cryptochironomus | 7 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Chironominae | Polypedilum | 12 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Chironominae | Robackia | 11 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Hemerodromia | Hemerodromia | 7 | 6 | PR | SP |
| Diptera | Orthocladiinae | Parakiefferiella | 7 | | CG/SC | SP/BU |
| Diptera | Simuliidae | Simulium | 75 | 6 | CF | CN |
| Ephemeropte | Camelobaetidius | Camelobaetidius warreni | 3 | 4 | CG | "SW/10%, CN/90%" |
| Ephemeropte | Cercobrachys | Cercobrachys | 14 | | CG | "SP/75%, CM/90%" |
| Ephemeropte | Ephoron | Ephoron album | 22 | 2 | CG | BU |
| Ephemeropte | Fallceon | Fallceon quilleri | 27 | 5 | CG | "SW/10%, CN/90%" |
| Ephemeropte | Isonychia | Isonychia campestris | 4 | 2 | CF | SW/CN |
| Ephemeropte | Leucrocuta | Leucrocuta | 3 | 1 | SC | CN |
| Ephemeropte | Oligoneuriidae | Homoeoneuria alleni | 7 | 2 | unk | CN/BU |
| Ephemeropte | Traverella | Traverella albertana | 178 | 2 | CF | CN |
| Ephemeropte | Tricorythodes | Tricorythodes minutus | 25 | 4 | CG | CN/SP |
| Haplotaxida | Oligochaeta | Tubificidae | 2 | 8 | CG | BU |
| Odonata | Gomphidae | Ophiogomphus severus | 3 | 2 | PR | BU |
| Plecoptera | Acroneuria | Acroneuria abnormis | 5 | 0 | PR | CN |
| Trichoptera | Cheumatopsyche | Cheumatopsyche | 68 | 5 | CF | CN |
| Trichoptera | Hydropsyche_Cera | Hydropsyche | 10 | 5 | CF | CN |
| Trichoptera | Nectopsyche | Nectopsyche gracilis | 12 | 2 | SH | CM/SP/CN |

# Montana Bioassessment Report

**Waterbody Name:** Powder River@MooreheadBridge
**Benthic Sample ID:** 18125
**Station ID:** YLPOWMt2b
**Rep. Num** 0
**Reference Status:**
**STORET Activity ID:** PM-T500-M
**Site Classification:**
**Collection Date:** 07/23/2013
**Latitude:**
**Collection Method:** MAC-T-500
**Longitude:**
**Total Number of Individuals in Sample:** 866

## Sample Taxa List

| *Order:* | *OTU name:* | *FinalID:* | *Individuals* | *Tol Val:* | *FFG:* | *Habit:* |
|---|---|---|---|---|---|---|
| Coleoptera | Dubiraphia | Dubiraphia | 2 | 6 | SC/CG | "CN/50%, BU/50%" |
| Coleoptera | Microcylloepus | Microcylloepus pusillus | 12 | 5 | CG | "CN/50%, BU/50%" |
| Coleoptera | Stenelmis | Stenelmis | 16 | 5 | SC/CG | "CN/50%, BU/50%" |
| Diptera | Chironominae | Cryptochironomus | 2 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Chironominae | Polypedilum | 12 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Chironominae | Robackia | 4 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Chironominae | Stempellinella | 8 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Chironominae | Tanytarsus | 2 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Hemerodromia | Hemerodromia | 2 | 6 | PR | SP |
| Diptera | Orthocladiinae | Cricotopus bicinctus | 8 | | CG/SC | SP/BU |
| Diptera | Simuliidae | Simulium | 40 | 6 | CF | CN |
| Ephemeropte | Camelobaetidius | Camelobaetidius warreni | 2 | 4 | CG | "SW/10%, CN/90%" |
| Ephemeropte | Cercobrachys | Cercobrachys | 8 | | CG | "SP/75%, CM/90%" |
| Ephemeropte | Ephoron | Ephoron album | 20 | 2 | CG | BU |
| Ephemeropte | Fallceon | Fallceon quilleri | 12 | 5 | CG | "SW/10%, CN/90%" |
| Ephemeropte | Isonychia | Isonychia campestris | 2 | 2 | CF | SW/CN |
| Ephemeropte | Traverella | Traverella albertana | 318 | 2 | CF | CN |
| Lepidoptera | Lepidoptera | Petrophila | 2 | 7 | SH | CM |
| Odonata | Gomphidae | Ophiogomphus severus | 2 | 2 | PR | BU |
| Plecoptera | Acroneuria | Acroneuria abnormis | 4 | 0 | PR | CN |
| Trichoptera | Brachycentrus | Brachycentrus occidentalis | 2 | 1 | CF | CN |
| Trichoptera | Cheumatopsyche | Cheumatopsyche | 298 | 5 | CF | CN |
| Trichoptera | Hydropsyche_Cera | Hydropsyche | 60 | 5 | CF | CN |
| Trichoptera | Hydropsyche_Cera | Hydropsyche morosa gr. | 14 | 5 | CF | CN |
| Trichoptera | Mayatrichia | Mayatrichia | 4 | 1 | SC | CN |
| Trichoptera | Nectopsyche | Nectopsyche gracilis | 2 | 2 | SH | CM/SP/CN |
| Trichoptera | Oecetis | Oecetis | 6 | 8 | PR | CN/SP |
| Veneroida | Pisidiidae | Sphaerium simile | 2 | 8 | CF | BU |

# Montana Bioassessment Report

**Waterbody Name:** Powder River@MooreheadBridge
**Benthic Sample ID:** 18126
**Station ID:** YLPOWMt2Qb
**Rep. Num** 0
**Reference Status:**
**STORET Activity ID:** PM-Q500-M
**Site Classification:**
**Collection Date:** 07/23/2013
**Latitude:**
**Collection Method:** MAC-R-500
**Longitude:**
**Total Number of Individuals in Sample:** 615

## Sample Taxa List

| *Order:* | *OTU name:* | *FinalID:* | *Individuals* | *Tol Val:* | *FFG:* | *Habit:* |
|---|---|---|---|---|---|---|
| Coleoptera | Dubiraphia | Dubiraphia | 2 | 6 | SC/CG | "CN/50%, BU/50%" |
| Coleoptera | Stenelmis | Stenelmis | 12 | 5 | SC/CG | "CN/50%, BU/50%" |
| Diptera | Chironominae | Cryptochironomus | 3 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Chironominae | Polypedilum | 6 | 7 | CG/CF/PR | BU/CN/SP |
| Diptera | Hemerodromia | Hemerodromia | 4 | 6 | PR | SP |
| Diptera | Orthocladiinae | Orthocladius | 1 | | CG/SC | SP/BU |
| Diptera | Simuliidae | Simulium | 211 | 6 | CF | CN |
| Diptera | Tanypodinae | Thienemannimyia Gr. | 2 | | PR | SP/BU |
| Ephemeropte | Ephoron | Ephoron album | 26 | 2 | CG | BU |
| Ephemeropte | Fallceon | Fallceon quilleri | 11 | 5 | CG | "SW/10%, CN/90%" |
| Ephemeropte | Isonychia | Isonychia campestris | 6 | 2 | CF | SW/CN |
| Ephemeropte | Leucrocuta | Leucrocuta | 3 | 1 | SC | CN |
| Ephemeropte | Plauditus | Plauditus punctiventris | 3 | 5 | SC | "SW/10%, CN/90%" |
| Ephemeropte | Traverella | Traverella albertana | 122 | 2 | CF | CN |
| Ephemeropte | Tricorythodes | Tricorythodes minutus | 24 | 4 | CG | CN/SP |
| Odonata | Gomphidae | Ophiogomphus severus | 2 | 2 | PR | BU |
| Plecoptera | Acroneuria | Acroneuria abnormis | 6 | 0 | PR | CN |
| Trichoptera | Brachycentrus | Brachycentrus occidentalis | 2 | 1 | CF | CN |
| Trichoptera | Cheumatopsyche | Cheumatopsyche | 133 | 5 | CF | CN |
| Trichoptera | Hydropsyche_Cera | Hydropsyche | 22 | 5 | CF | CN |
| Trichoptera | Hydropsyche_Cera | Hydropsyche morosa gr. | 1 | 5 | CF | CN |
| Trichoptera | Mayatrichia | Mayatrichia | 1 | 1 | SC | CN |
| Trichoptera | Nectopsyche | Nectopsyche gracilis | 12 | 2 | SH | CM/SP/CN |

# APPENDIX D

# Site Photographs

Photo 1. Powder River Site #1 located near the Wyoming Border.

Photo 2. Powder River #1 Shovelnose sturgeon (40 inches) captured in 2012.

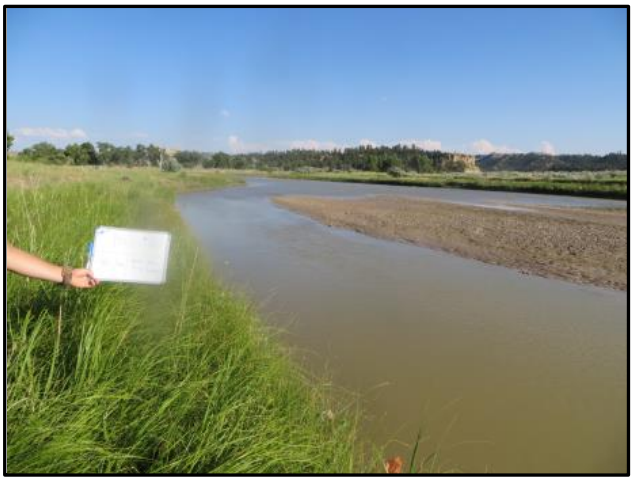

Photo 3. Powder River Site #2 located near Dry Creek.

Photo 4. Powder River Moorhead Bridge Site located U/S of the USGS gauge.

Photo 5. Powder River Site #3 located near Jenkins Creek.

Photo 6. Powder River Site #6 located near Buttermilk Creek.

Photo 7. Powder River Site #6 bluff pool located near Buttermilk Creek.

Photo 8. Powder River Site #5 located upstream of Rough Creek.

Photo 9. Powder River Site #5 located upstream of Rough Creek.

Photo 10. Powder River Broadus Bridge Site.

Photo 11. Channel Catfish from Broadus Bridge site.

Photo 12. Powder River Site #18 in Wyoming.

Photo 13. Tongue River mussel site above the reservoir.

Photo 14. Tongue River Site at Wyoming RT 338 bridge.

Photo 15. Fatmucket (FAMU) from Tongue River at Wyoming RT 338 bridge.

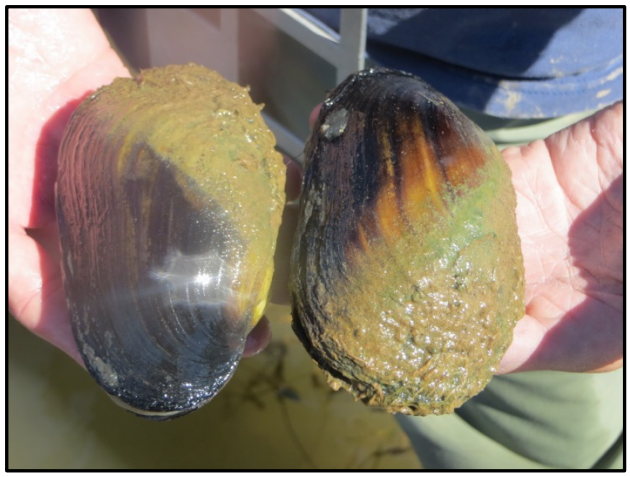

Photo 16. Fatmuckets (FAMU) from Tongue River #4.

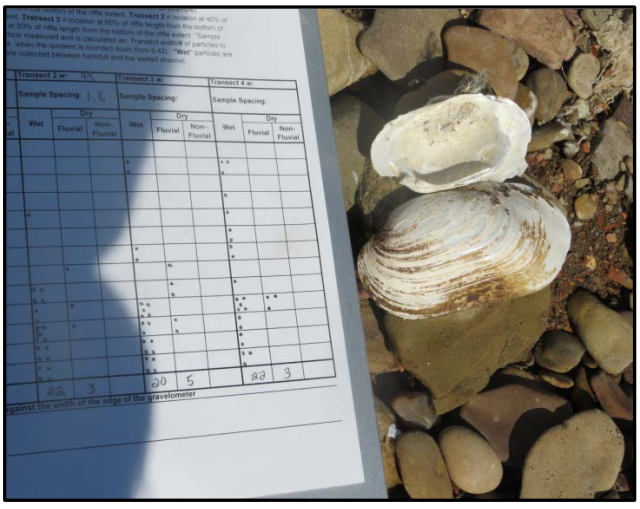

Photo 17. Fatmucket (FAMU) shells from Tongue River #5

Photo 18. Western Hognose Snake at Powder River Site #1