# 2012 Survey Assessments and Analysis of Fish, Macroinvertebrates and Herpetofauna in the Otter Creek Coal Tracts Area of Powder River County

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# Executive Summary

We summarize the second year of baseline surveys for the Assessment of Fish, Macroinvertebrates, and Herpetofauna in the Otter Creek coal tracts area. Project goals remain the same: 1) to continue standardized surveys and collecting baseline information on the aquatic communities prior to coal development, 2) to seasonally assess aquatic community integrity and condition with key indicators recorded at the sites and comparing these against biotic thresholds of reference condition standards. These 2012 data represent the second year of pre-coal development (i.e. pre-impact, BACI design) conditions at the local reach scale.

Habitat assessments, herpetofauna, macroinvertebrate and fish surveys were performed during seasonally similar dates at the same sites visited in 2011: four mainstem Otter Creek reaches (control, impact {2} and downstream) and three tributaries. In total, we performed 16 surveys for fish during the visits: 12 at four mainstem Otter Creek reaches and four surveys in the tributary streams. Thirteen macroinvertebrate samples were collected during the visits; neither survey was conducted at Threemile Creek in any season due to lack of surface water present. All stream reaches were visually surveyed for amphibians or reptiles during all visits. Biological community integrity was calculated for 16 fish surveys using Fish Integrated Biotic Indices (IBI's) and Observed/Expected Models (O/E), while the 13 macroinvertebrate samples were assessed with Montana DEQ's multi-metric indices (MT MMI).

***Habitat Evaluations.*** Of the seven sampling reaches evaluated in the study area, we found three in Proper Functioning Condition (PFC) with a stable trend and four were Functional at Risk (FAR). Reasons that sites ranked FAR were likely due to anthropogenic habitat alteration by cattle (Home Creek {Otter_1A} and Threemile Creek {Otter_3m}) or stream manipulation (Otter Creek JT and Otter Creek #16). Highest site integrity scores using both the BLM Habitat and PFC Assessment methods were recorded at the Otter Creek sites #23 (Tenmile Creek) and #22 (control-Denson reach). Sites with lower habitat scores were structurally degraded by cattle use and had high associated CPI values (Home Creek, Threemile and Otter Creek #16-fall). Conductivity measurements recorded at all Otter Creek mainstem sites across most seasons were above the impairment threshold levels (>500μs, DEQ 2006), and the Home Creek site had visible signs of natural gas seepage from the sediments.

***Macroinvertebrate Communities***: Overall, 105 unique macroinvertebrate taxa were reported in 2012 from the 13 macroinvertebrate assessment samples. One mayfly species of concern (MTSOC), *Caenis youngi* was collected at the Otter Creek control site #22, which also reported the highest taxa richness (42 spp.) during the summer visit. Average macroinvertebrate richness per site was 29.8 taxa. The Montana DEQ multimetric index (MMI) ranked at least one sample of the five sites (9 of 13 samples) as non-impaired (good biological integrity), and scores were not significantly different than 2011 scores ($p > 0.4$). Three of the four samples that were ranked impaired were collected during the spring visit. Sites that maintained flowing water connectivity scored higher with the MMI than sites with interrupted pool areas. Overall, mainstem sites evaluated in the Otter Creek study scored significantly higher with MMI scores than those in the tributaries (ANOVA, $p < 0.01$). MMI's did not significantly differ between Otter Creek mainstem Pre-Impact Control, Impact or Downstream Sites (T-test, $p > 0.05$), despite fish communities reflecting a downstream decrease in biotic integrity.

***Fish Communities***. Overall, ten fish species (five native/five introduced) were identified from 19,440 individuals collected during 16 surveys. We added one introduced fish species, the golden shiner, in 2012. One potential species of concern (PSOC), the brassy minnow, was collected at five sites. Average total fish species per Otter Creek mainstem site across all seasons was 7.0 (± 0.5 SE), a slight increase from 2011 (6.5), while the tributary sites with water averaged 1.5 species. Brassy minnows had the highest site occupancy rate at 88% (14 of 16 visits) followed by fatheads, lake chubs and white suckers at 81% and 75% (13 and 12 of 16 visits), respectively. Fathead minnows continue to account for the highest proportion of total individuals collected at 34%. The most diverse fish sites in the study area were Otter Creek JT and Otter Creek #16 with nine species, while sites with the highest % of native species were Otter Creek #22 (four spp.) and Home Creek (two native spp.). Using Montana's Prairie Fish IBI, 10 of the 16 fish visits ranked non-impaired (good biological integrity), five were slightly-moderately impaired and one was ranked poor biotic integrity. As in 2011, fish biotic integrity decreased going downstream in the Otter Creek mainstem, and the Pre-Impact Control Site scored significantly higher than Downstream site (T-test, $p < 0.05$) but not the Impact sites ($p = 0.06$) this year. The O/E scores tracked the IBI ranks in most cases except in Otter impact site #2, where the O/E showed a slight impairment (0.73), but the IBI scores good integrity. Further evaluations into the relationship of the O/E to the IBI need to be addressed for non-natives.

***Amphibian and Reptile Incidentals.*** All fish presence sites also reported at least one species of amphibian. Eight herpetofauna species were observed or collected in conjunction with the assessment surveys. Of the four amphibian species; the Northern Leopard Frog (*Rana pipiens*) had the highest site occupancy, occurring at five of seven sites, followed by the Woodhouse's Toad (*Bufo woodhousii*) which was detected most often in 2011, and Boreal Chorus Frog (*Pseudacris maculata*) recorded at four and three sites, respectively. The Boreal Chorus Frog was detected vocally calling at two sites during the spring visits with tadpoles at the Tenmile Creek site and two adult incidental sightings during summer visits. We also recorded four reptile species (in order of site occurrence): Painted Turtle (*Chrysemys picta*), Western Rattlesnake (*Crotalus viridis*), Snapping Turtle (*Chelydra serpentina*) (MT SOC) and Terrestrial Garter Snake (*Thamnophis elegans*). We observed the presence of juvenile snapping turtles during the spring site visit at Trussler's (Otter_JT) indicating successful overwintering of 2011 hatchlings.

***Conclusions.*** Similar patterns of aquatic community species and biotic integrity were documented between the 2012 and 2011 surveys, despite significantly different flow regimes. Biotic integrity of mainstem Otter Creek (based on fish) in the upstream control reach remains higher and decreases as you proceed downstream with slight improvements in the IBI of the impact and downstream sites since 2011. Macroinvertebrates show no discernible pattern of integrity spatially, but temporally are showing higher integrity scores during the summer months. Fish communities have reassembled themselves since the 2011 high water with the addition of a new introduced species to three sites in 2012, likely from stock pond overflows, and sand shiners are no longer being collected at the Otter #2 impact site. The extraordinarily high density and large biomass of fish in the reach below Trusler's Ranch road crossing, essentially "stacking up" downstream of this barrier (20,000 fish per 300 m) has dispersed to other sections of Otter Creek and now averages about 3,000 fish per 300m with far fewer density dependent fish anomalies (lesions and parasites, i.e., yellow grub and anchorworm). The fish condition index at this site has improved tremendously since 2011.

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## Acknowledgements

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

# Introduction

The Otter Creek basin in southeast Montana is currently undergoing exploration for a large, open-pit coal mine. Baseline data on the condition of the ecosystem prior to coal mine development (pre-impact) is essential to determine what effects the coal extraction might have on the fish and wildlife in, and downstream of, the effected extraction area (post-impact). The initial mining rights transfer determined that no Federally Listed species under the ESA would be affected in the coal tracts area (BLM 2002). But this EA did not take into account the presence of Montana Species of Concern (MT SOC) or other ecologically sensitive native species assemblages. Despite numerous projects undertaken to document and monitor biological communities in the Powder and Tongue River watersheds (Confluence Consulting Inc. 2003, 2004; Stagliano 2006; Davis et al. 2009; Maxell 2009; Petersen et al. 2009; Senecal 2009, Stagliano 2011), large gaps still exist in basic baseline surveys for riparian macroinvertebrate, fish, and herpetofauna in the Otter Creek basin. Fish communities have been documented to be seasonally variable in prairie streams (Bramblett and Fausch 1991), thus sampling across all seasons is a good strategy to document baseline community differences. Since 2011 was an extremely "wet" year in the historic record for Otter Creek, seasonal sampling in 2012 will compliment that high discharge period with a "normal" water year, even though 2012 was still almost 2 times higher than the 35 year average of 4.7 cfs (USGS 2012).. Many small prairie streams that constitute the Great Plains Intermittent Prairie Stream ecological system (Stagliano 2005) are highly variable, and may have downstream connectivity early in the season for potential fish spawning and nursery areas (Smith and Hubert 1989, Bramblett 2000) or no fish colonization at all in dry years. By summer this stream system type often becomes a string of isolated pools that are important breeding and rearing areas for amphibians (Stagliano 2011). Identifying spatial and temporal baseline communities and conditions in streams of the coal tracts area (i.e., presence of fish, macroinvertebrate, and herpetofauna) prior to coal development is essential to understanding and potentially mitigating impacts to habitats and species during and after coal extraction.

# Methods

***Study Sites***

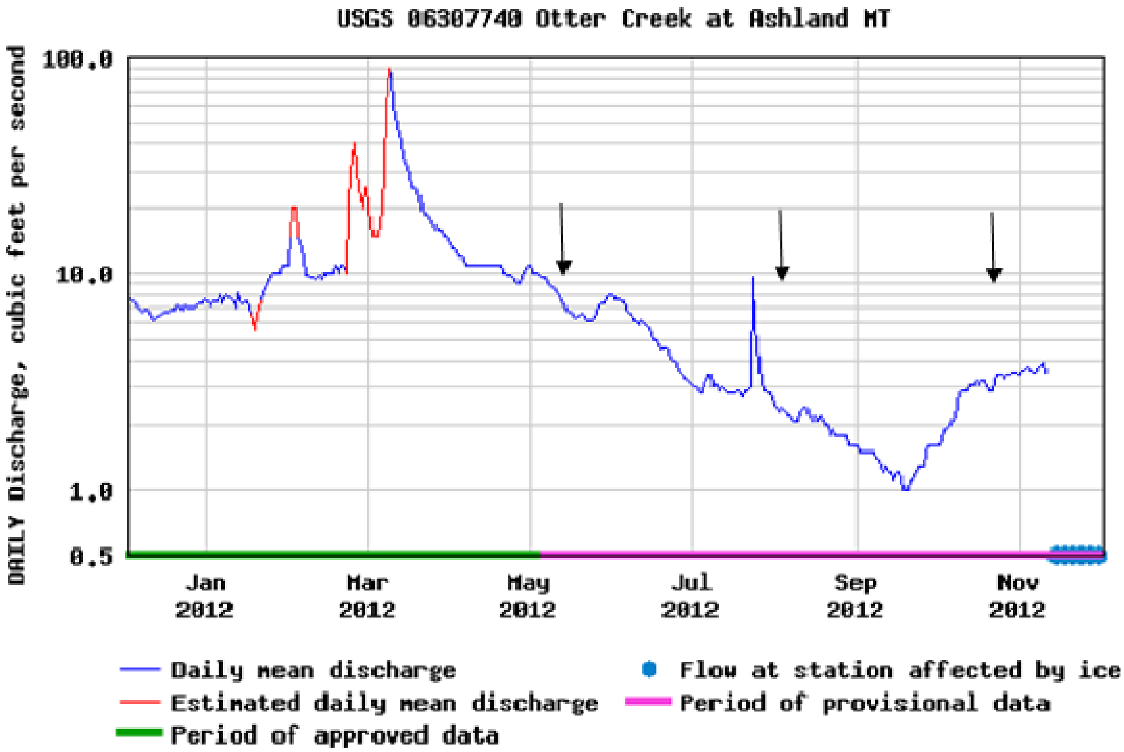
Pre-impact baseline sampling sites visited in 2012 were the same reaches designated in 2011 (Stagliano 2012). These sites are representative of the range of stream types found in the Otter Coal Tracts project area: Ephemeral, Intermittent and Perennial Prairie Streams. Four mainstem Otter Creek reaches (control, impact {2} and downstream) and three tributaries coinciding with established surface water quality stations were visited seasonally (May, July, October) (Table 1). Threemile Creek remained dry during all visits (see Site Photos). Seasonal site visits were timed with 2011 dates, and we coordinated sampling with baseflow discharge levels, which was easily accomplished in 2012, because the spring pulse arrived early and declined quickly (Figure 1).

**Table 1. Otter Creek Coal Study Site GPS Locations at the top (T) and bottom (B) of the assessment reach. Aquatic Ecological System (AES) code defined in text followed Stagliano (2005).**

| Site Code | Site Name | Type | AES code | Latitude | Longitude | Elev (m) | Comment |
|---|---|---|---|---|---|---|---|
| Otter_23 | Tenmile Creek (T) | Control | D005/E005 | 45.43409 | -106.13403 | 961 | Small pools below road during spring survey. Dry during July, Oct. visits |
| Otter_23 | Tenmile Creek (B) | Control | D005/E005 | 45.43465 | -106.13253 | 958 | |
| Otter_22 | Otter Creek 22 (T) | Control | D005/C005 | 45.43035 | -106.14428 | 951 | Top of reach ~60m below Tenmile Creek road, proceeded 300m downstream |
| Otter_22 | Otter Creek 22 (B) | Control | D005/C005 | 45.43274 | -106.14366 | 948 | |
| Otter_16 | Otter Creek 16 (T) | Impact | C005 | 45.48514 | -106.16487 | 938 | Top of reach began ~60m above the stream crossing and went 240m below |
| Otter_16 | Otter Creek 16 (B) | Impact | C005 | 45.48365 | -106.16725 | 937 | |
| Otter_3m | Threemile Creek (T) | Impact | E005 | 45.51054 | -106.16288 | 933 | Dry during all visits |
| Otter_3m | Threemile Creek (B) | Impact | E005 | 45.50955 | -106.16960 | 928 | |
| Otter_2 | Otter Creek 2 (T) | Impact | C005 | 45.50475 | -106.17493 | 929 | Site surveyed for fish during all visits, downstream of road crossing |
| Otter_2 | Otter Creek 2 (B) | Impact | C005 | 45.50561 | -106.17561 | 928 | |
| Otter_JT | Otter Creek JT (T) | Down | C005 | 45.55675 | -106.21798 | 910 | Top of reach began ~80m below the ranch road/impassable culvert, proceeded 300m down |
| Otter_JT | Otter Creek JT (B) | Down | C005 | 45.55782 | -106.21770 | 909 | |
| Otter_1A | Home Creek (B) | Down | D005/E005 | 45.54483 | -106.18717 | 952 | Bottom of reach began ~500m above the Otter Creek road crossing, proceeded 300m upstream |
| Otter_1A | Home Creek (T) | Down | D005/E005 | 45.54422 | -106.18947 | 950 | |

Average yearly discharge for 2012 was 8.6 cfs versus 14.9 cfs in 2011 and 3.96 cfs in 2010, which is still significantly higher than the 35 year average of 4.7 cfs (USGS 2012). Discharge during the 2012 May visit (7 cfs) was roughly 3x less than in 2011 (Figure 1), while the summer and fall visits were closer to baseflow at 2.5 and 3 cfs, respectively. Habitat assessments, herpotofauna, macroinvertebrate and fish surveys were performed during the same site visit. In total, we surveyed 16 reaches for fish during the visits: four mainstem Otter Creek reaches (12 surveys) and two tributary streams (4 surveys). Thirteen macroinvertebrate samples were collected during the visits; neither aquatic survey was conducted at Threemile Creek in any season due to lack of surface water present. Spring and fall macroinvertebrate samples were collected outside the range of the MTDEQ recommend sampling time frame (June 1$^{st}$-September 15$^{th}$) (MTDEQ 2006), but this time frame was largely derived for mountain streams, not the prairies. All stream reaches were visually and audibly surveyed for amphibians or reptiles during all visits.

**Figure 1.** Discharge reported at the USGS gage in Ashland, MT. Arrows indicate sampling visits.




***Habitat Assessments***

The stream assessment reach was divided into 10 equally spaced transects according to BLM and EMAP protocols (BLM 2008b; 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 300m (designated the assessment area or "AA") to the marked top of the reach. Parameters recorded at each transect were: wetted-width (WW), three channel depth measurements (¼, ½, ¾ ww distance), % large woody debris, substrate and riparian shading. On-site habitat assessments were conducted using the rapid assessment protocol developed for the BLM by the National Aquatic Assessment Team (scores 0-24) (BLM 2008). The process for determining Proper Functioning Condition followed Pritchard et al. (1993). Basic water parameters (temperature, TDS, pH, conductivity) were recorded prior to biological sampling using a Horiba H-10 water monitor, calibrated for the higher conductivity range. The Livestock Use Index ("Cowpie" CPI) was assessed by walking a randomly chosen 75m transect on both sides of the stream channel in the riparian area within the assessment area and counting all the old and new cowpies (higher CPI equals high cow usage). The goal of these evaluations is to characterize local reach geomorphology, riparian and in-stream habitat, and characteristics that influence aquatic community integrity. Sites ranking higher using these protocols are determined to have higher quality local reach-scale habitat.

### *Macroinvertebrate Communities*

Macroinvertebrate communities were sampled semi-quantitatively from each of the 10 transects within the 300m assessment reach using the EMAP Reach-Wide protocol (Lazorchak et al. 1998). Sampling started at the downstream transect (A) or #10 in the BLM protocol, and proceeded upstream alternating sampling with the 500-micron D-frame net to the left, right or center of the stream channel, so a random sampling of all habitats is achieved (Figure 2). The ten multi-habitat kicks/jabs were composited into a 20 liter bucket. All organisms and organic matter in the bucket were elutriated from the inorganic portion and washed onto a 500-micron sieve. The inorganic portion was washed and examined until no further organics or organisms were present and discarded. The organic portion on the sieve was transferred to one or two 1 liter Nalgene bottles (unless field sub-sampling was needed), labeled and preserved in 95% ethanol and brought to the MTNHP lab in Helena for processing (sorting, identification and data analysis) following protocols outlined by the BLM (2008a) and MTDEQ (2006). Macroinvertebrates were identified to the lowest taxonomic level (MTDEQ 2006), counted, imported into EDAS (Jessup 2006), and biological metrics were calculated from the data using the Montana Department of Environmental Quality's newest multimetric macroinvertebrate (MMI) protocols (Jessup et al. 2005, Feldman 2006). Metric results were scored using the MTDEQ bioassessment criteria and each sample categorized as nonimpaired or impaired according to threshold values (Table 2). The macroinvertebrate MMI score is based upon a series of metrics that measure attributes of benthic macroinvertebrate communities that are sensitive to condition changes in the stream (in the form of pollution or pollutants). 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 threshold set by MTDEQ is **37**

**Figure 2. Macroinvertebrate Sampling procedure Otter 1A.**

**Table 2. Impairment determination thresholds from the MTDEQ MMI and O/E (RIVPACS) models.**

| Ecoregion | RIVPACS | MMI | Impairment Determination |
|---|---|---|---|
| Mountain | ≥ 0.8 or ≤ 1.2 | ≥ 63 | Not impaired |
| | < 0.8 or > 1.2 | < 63 | Impaired |
| Low Valley | ≥ 0.8 or ≤ 1.2 | ≥ 48 | Not impaired |
| | < 0.8 or > 1.2 | < 48 | Impaired |
| Eastern Plains | ≥ 0.8 or ≤ 1.2 | ≥ 37 | Not impaired |
| | < 0.8 or > 1.2 | < 37 | Impaired |

for the Eastern Plains Stream Index, thus any scores above this threshold are considered unimpaired.

***Fish and Amphibian Surveys***

Fish sampling within the 300m stream assessment reach was conducted with 6 and 9 meter straight seines in 25-30m increments seining in a downstream direction toward the block seine (Figure 3, protocols outlined in Bramblett et al. 2005). Fish captured in a blocked section were transferred to holding buckets until the reach was completed, unless the reach was broken up by riffles, impassable or dry sections; in this case, fish were processed and released within the section of capture. Fish holding in the buckets were identified to species (Holton and Johnson 2003), enumerated, examined for external anomalies (e.g. deformities, eroded fins, lesions, and tumors), and then released. At least 10% of the individuals of a species were measured for total length in millimeters (TL mm) to obtain size structure data. Young-of-the-year fish less than 20 mm (TL) 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, and were preserved in 10% buffered formalin. These will be deposited with the Montana State University Collections. Adult amphibians or reptiles encountered while seining or walking the designated stream reach were counted and recorded even if they were not captured in the seine.

**Figure 3. Block seine set in Otter Creek JT Reach #2.**

Analysis of the sampled fish communities used Integrated Biotic Indices (IBI) designed for wadable prairie streams (Bramblett et. al 2005) and derived Observed/Expected (O/E) Fish Models (Stagliano 2011) to detect impairment in the biological integrity of the sites. The expected number of native fish species for a D005 classified reference stream is 2.5-3.75, while the expected number of fish for a C005 stream is 5.5-8.5 depending on watershed area; dividing the observed number of native fish species at a site by the expected number derives a percentage compared to reference condition (>0.8 or 80% = unimpaired) (Table 1). The IBI originally proposed by Karr (1981) involved the calculation of a series of 12 metrics evaluating different attributes of the fish community (i.e. species richness, tolerance to pollutants, trophic status) (Table 3). The 10 metrics used for the prairie streams were adjusted for watershed area to calculate an overall score between 0 and 100. Bramblett et al. (2005) did not propose threshold criteria for good, fair, and poor biological integrity for these scores. Therefore, we applied percentiles above the null criteria (no fish present score) at >30% indicates good to excellent biological integrity, 10-30% fair/good biological integrity, 0-10% indicated poor to fair biological integrity and scores below the null are indicative of poor biological integrity or severely impaired.

**Table 3. Fish metrics and classification of fishes captured during the Otter Creek Study (2012).**

| Species | Scientific Name | Trophic * | Feeding Habitat† | Repro Guild‡ | General Tolerance ** | Origin †† | Total Length 3 years |
|---|---|---|---|---|---|---|---|
| **Catostomidae** | | | | | | | |
| White sucker | *Catostomus commersoni* | OM | BE | LO | TOL | N | 229 |
| **Cyprinidae** | | | | | | | |
| Common Carp | *Cyprinus carpio* | OM | BE | | TOL | I | 381 |
| Brassy minnow | *Hybognathus hankinsoni* | HB | BE | | MOD | N | 81 |
| Fathead Minnow | *Pimephales promelas* | OM | GE | TOL§ | TOL | N | 76 |
| Golden Shiner | *Notemigonus crysoleucas* | OM | WC | | MOD | I | 102 |
| Lake Chub | *Couesius plumbeus* | OM | GE | | MOD | N | 140 |
| Sand Shiner | *Notropis stramineus* | OM | GE | LO | MOD | N | 61 |
| **Centrarchidae** | | | | | | | |
| Green Sunfish | *Lepomis cyanellus* | IC | GE | TOL§ | TOL | I | 102 |
| Pumpkinseed | *Lepomis gibbosus* | IC | GE | TOL§ | MOD | I | 89 |
| **Ictaluridae** | | | | | | | |
| Black Bullhead | *Ameiurus melas* | IC | BE | TOL§ | TOL | I | 152 |

*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)
‡ LO=Litho-obligate Reproductive Guild; 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)

# Results

We evaluated seven stream reaches in the study area: four Otter Creek mainstem sites that were classified as Perennial Prairie Stream types (C005), and the three tributaries were Great Plains Intermittent Prairie Stream systems (D005, E005) (Table 1). Proper classification is important when determining biological integrity (Hawkins and Norris 2000) and expected species richness. The Intermittent Prairie Stream (E005) in Montana is naturally fishless 80% of the time; therefore, absence of fish, in itself, should not be viewed as a biological impairment (e.g. Threemile and Tenmile Creek). Likewise, stream reaches of Otter Creek have become dry in previous years (Stagliano, personal observation. 2005-2008), thus placing certain stream sections within the D005 classification. We have identified and characterized reference condition indicator assemblages for these ecosystem types previously (Stagliano 2005), and were used here to compare to our site-specific observed species.

***Habitat Evaluations.*** Of the seven sampling reaches evaluated within the study area, we found three in Proper Functioning Condition (PFC) with a stable trend and four were Functional at Risk (FAR) (Table 7). Reasons that sites ranked FAR were due to structural habitat alteration by cattle with associated high CPI values (Home Creek {Otter_1A}, Threemile Creek {Otter_3m} and Otter #16-fall) (Figure 4) or anthropogenic stream manipulation (Otter Creek JT-Trussler and Otter Creek #16). Highest site integrity scores using both the BLM Habitat and PFC Assessment methods were recorded at the Tenmile Creek (Otter_23) and Otter Creek #22 (control-Denson reach) (Table 7). Point conductivity measurements recorded at all Otter Creek mainstem sites and tributaries across all seasons were above the threshold for impairment levels (>500µs, DEQ 2006), and Home Creek site had visible signs of natural gas seepage from the sediments.

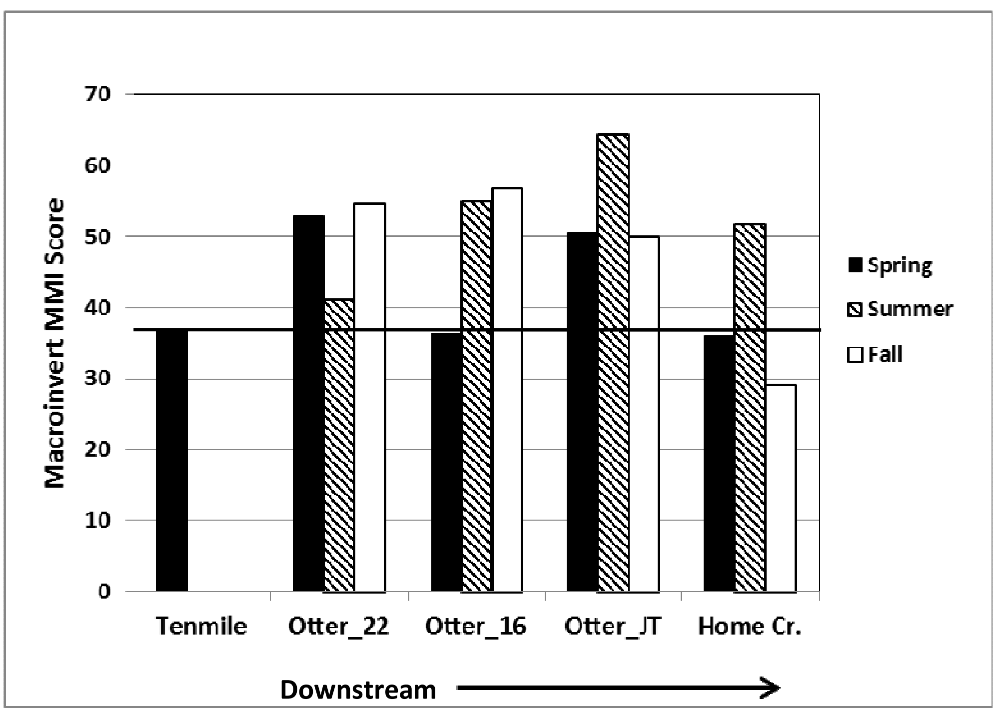
**Figure 4. Structurally cattle damaged reach-Home Creek**

***Macroinvertebrate Communities***: Overall, 105 unique macroinvertebrate taxa were reported from the 13 macroinvertebrate assessment samples (Appendix B). One known MT species of concern (SOC), the mayfly, *Caenis youngi* was collected at the control site, Otter Creek #22. Stoneflies (P) were not present at any sites, so the EPT taxa per site usually consisted of two species of tolerant mayflies (E), and one or two species of caddisfly (T); the highest EPT richness at any site was five species at the Otter 16 site summer (Table 4, Appendix B). Average macroinvertebrate taxa richness per site was 29.8 and the highest taxa richness was 42 taxa reported at the Otter Creek 22 control site. Using the MTDEQ multimetric index (MMI), four of the five sites (9 of 13 samples) were ranked non-impaired (good to excellent biological integrity), while two samples from Home Creek and one each from Tenmile and Otter #16 were ranked impaired (Table 4, Figure 5).

**Table 4**. Macroinvertebrate sample characteristics and various metrics used for the DEQ MMI.

| Site ID | CollDate | Total Ind. ID'ed | Total Sample | Total Taxa | Plains MMI Index | EPT Tax | % EPT | HBI | % Non Insect |
|---|---|---|---|---|---|---|---|---|---|
| OTTER_23t | 5/19/2012 | 405 | 810 | 12 | 36.4 | 0.0 | 0.0 | 7.8 | 6.9 |
| OTTER_22t | 5/19/2012 | 581 | 4,648 | 31 | 52.9 | 3.0 | 13.6 | 7.5 | 55.9 |
| OTTER_22ts | 7/31/2012 | 521 | 16,672 | 23 | 41.1 | 1.0 | 5.8 | 7.6 | 53.9 |
| OTTER_22tf | 10/16/2012 | 535 | 2,274 | 42 | 54.6 | 4.0 | 8.6 | 7.7 | 61.5 |
| OTTER_16t | 5/19/2012 | 511 | 1,022 | 33 | 36.3 | 4.0 | 19.2 | 7.0 | 19.4 |
| OTTER_16ts | 7/30/2012 | 594 | 1,931 | 31 | 55.0 | 3.0 | 17.3 | 7.3 | 35.0 |
| OTTER_16tf | 10/15/2012 | 554 | 1,108 | 33 | 56.8 | 5.0 | 23.5 | 6.9 | 21.3 |
| OTTER_JTt | 5/19/2012 | 481 | 1,924 | 31 | 50.6 | 3.0 | 1.5 | 7.0 | 25.4 |
| OTTER_JTts | 7/30/2012 | 573 | 2,292 | 33 | 64.4 | 2.0 | 3.3 | 7.3 | 8.9 |
| OTTER_JTtf | 10/15/2012 | 592 | 2,368 | 37 | 50.0 | 4.0 | 7.8 | 7.3 | 6.8 |
| OTTER_1At | 5/20/2012 | 558 | 3,488 | 24 | 35.9 | 1.0 | 0.2 | 7.0 | 9.1 |
| OTTER_1Ats | 7/30/2012 | 520 | 4,160 | 31 | 51.8 | 0.0 | 0.0 | 7.6 | 61.5 |
| OTTER_1Atf | 10/15/2012 | 517 | 3,231 | 26 | 29.0 | 1.0 | 0.2 | 7.5 | 38.7 |

**Figure 5.** DEQ MMI scores across sites and seasons. Line is the impairment threshold at 37.



Stream sites that maintained flowing, connected water scored higher with the MMI than sites with interrupted pools. Overall, Otter Creek mainstem sites received significantly higher macroinvertebrate MMI scores than those in the tributaries (ANOVA, p <0.01) (Figure 5). Macroinvertebrate MMI's did not significantly differ between Otter Creek mainstem Pre-Impact Control, Impact or Downstream Sites or years (T-test, p >0.05) (Figures 6 and 7), despite the fish communities reflecting a downstream decrease in biotic integrity. No site had consistently high MMI scores across all seasons and summer visits tended toward higher scores (Figure 5).

**Figure 6.** Average MMI scores by site type. (a) = no baseline differences between treatments.

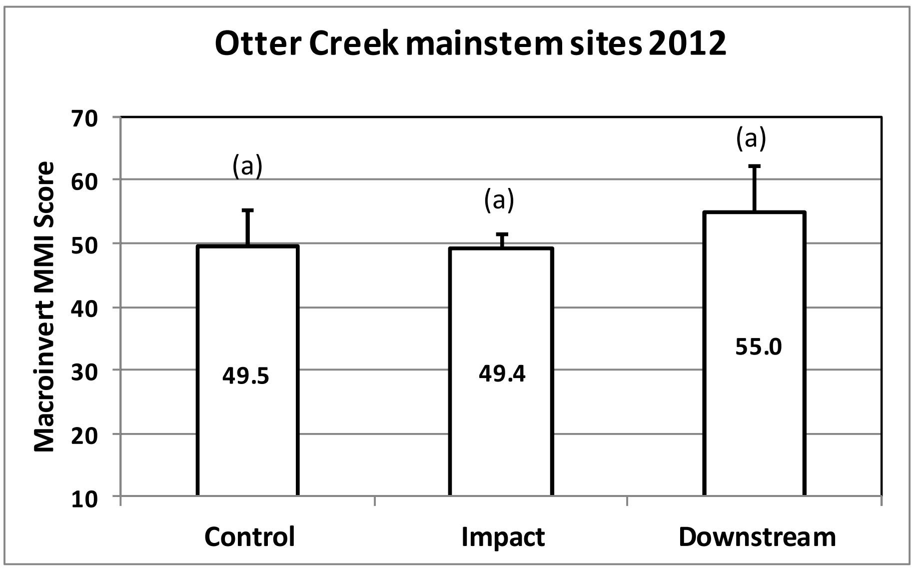
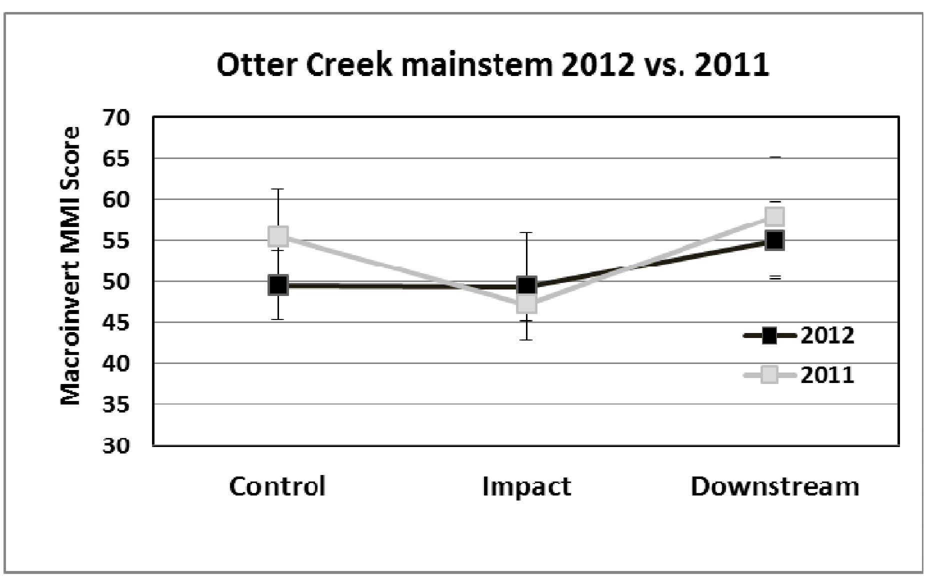



**Figure 7.** Average macroinvertebrate MMI scores by year. Error bars are standard error (SE).



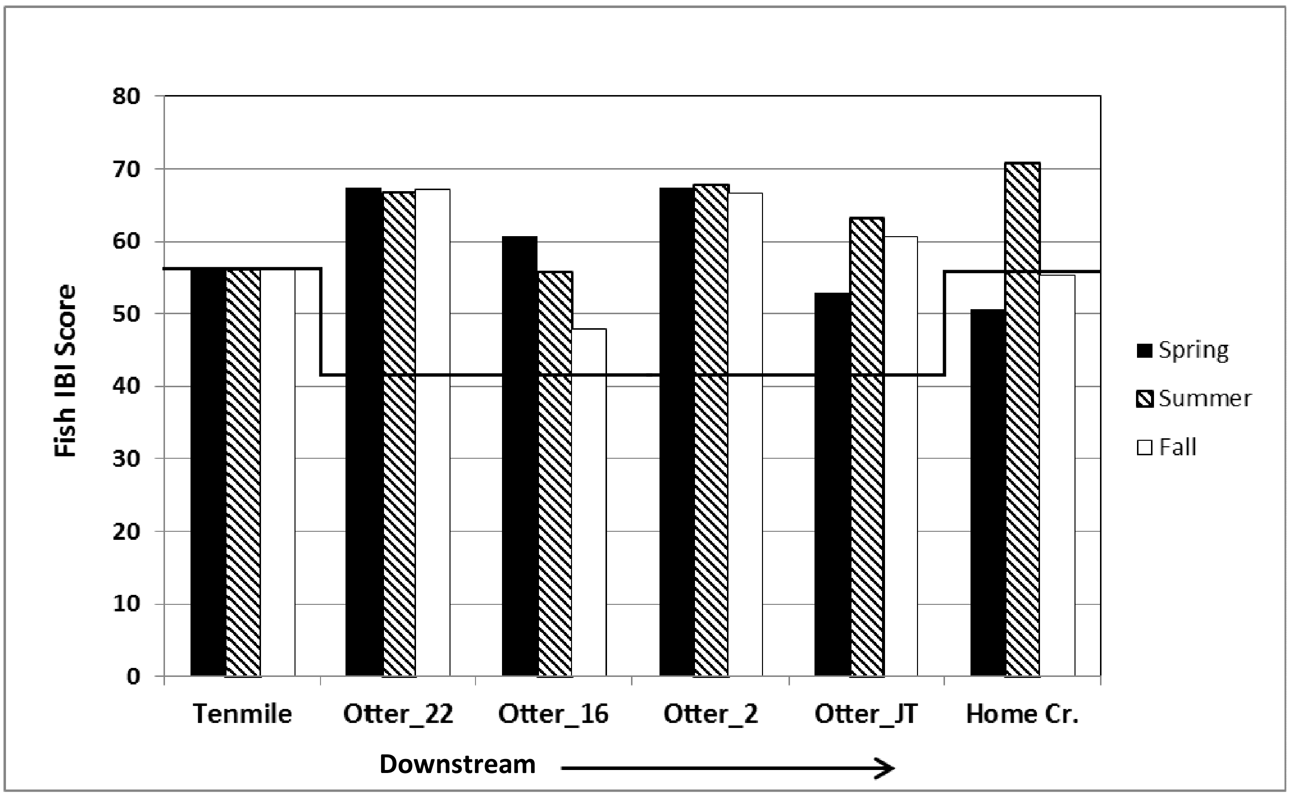
***Fish Communities.*** Overall, ten fish species (five native/five introduced) were identified from 19,440 individuals collected during 16 surveys (Table 5). We added one introduced fish species in 2012, the golden shiner. One potential species of concern (PSOC), the brassy minnow, was collected at five sites and in very high numbers at the control site, Otter 22. Dominance by brassy minnows and lake chubs at the upstream sites shifts to a tolerant fathead minnow and sand shiner dominated community at the downstream site, Otter JT (Table 5). Otter Creek site 16 was heavily infested by introduced species during the summer and fall visits representing 41% and 93% of the fish sampled, respectively. Average total fish species per Otter Creek mainstem site across all seasons was 7.0 (± 0.5 SE), a slight increase from 2011 (6.5), while the tributary sites with water averaged 1.5 species. Brassy minnows had the highest site occupancy rate at 88% (14 of 16 visits) followed by fatheads, lake chubs and white suckers at 81% and 75% (13 and 12 visits), respectively. Fathead minnows continue to be the highest proportion of total individuals collected at 34%. The most diverse fish sites in the study area were Otter Creek JT and Otter Creek 16 with nine species, while the sites with the highest % of native species were Otter Creek #22 (four spp.) and Home Creek (two native spp.). Fish communities have reassembled themselves since the 2011 high water with an addition of a new introduced species to three sites in 2012, likely from stock pond overflows, and sand shiners are no longer being collected at the Otter #2 impact site. The high density and large biomass of fish reported in the reach below Trusler's Ranch road crossing in fall of 2011, essentially "stacking up" downstream of this barrier (20,000 fish per 300 m) has dispersed to other sections of Otter Creek and now averages about 3,000 fish per 300m with significantly fewer density dependent fish anomalies (lesions and parasites, i.e., yellow grub and anchorworm). The qualitative fish condition index at this site has improved tremendously since 2011.

**Table 5.** Fish abundance, IBI's and O/E results for the 6 sites that have reported fish. ns = not seined during visit (dry). Underlined values are fish communities that ranked biologically unimpaired. * = introduced species.

| | OTTER_23 | | | OTTER_22 | | | OTTER_16 | | | OTTER_2 | | | OTTER_JT | | | OTTER_1A | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **May** | **Jul** | **Oct** | **May** | **Jul** | **Oct** | **May** | **Jul** | **Oct** | **May** | **Jul** | **Oct** | **May** | **Jul** | **Oct** | **May** | **Jul** | **Oct** | **Total** |
| **Black Bullhead*** | 0 | ns | ns | 0 | 5 | 20 | 16 | 27 | 123 | 7 | 21 | 0 | 8 | 0 | 3 | 0 | 0 | 0 | 230 |
| **Brassy Minnow** | 0 | ns | ns | 234 | 55 | 940 | 1604 | 90 | 3 | 98 | 49 | 154 | 10 | 15 | 5 | 2 | 0 | 5 | 3,264 |
| **Common Carp*** | 0 | ns | ns | 0 | 0 | 0 | 492 | 54 | 9 | 0 | 14 | 7 | 12 | 23 | 18 | 0 | 0 | 0 | 629 |
| **Fathead Minnow** | 0 | ns | ns | 0 | 0 | 0 | 620 | 189 | 45 | 35 | 63 | 7 | 3290 | 1085 | 1245 | 10 | 10 | 10 | 6,609 |
| **Lake Chub** | 0 | ns | ns | 870 | 300 | 1500 | 746 | 198 | 6 | 308 | 441 | 77 | 40 | 75 | 15 | 0 | 20 | 0 | 4,596 |
| **Green Sunfish*** | 0 | ns | ns | 0 | 5 | 75 | 44 | 9 | 42 | 0 | 0 | 0 | 14 | 0 | 3 | 0 | 0 | 0 | 192 |
| **Golden Shiner*** | 0 | ns | ns | 0 | 5 | 0 | 96 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 108 |
| **Pumpkinseed*** | 0 | ns | ns | 18 | 30 | 5 | 224 | 201 | 129 | 7 | 0 | 0 | 5 | 0 | 3 | 0 | 0 | 0 | 622 |
| **Sand Shiner** | 0 | ns | ns | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 906 | 900 | 763 | 0 | 0 | 0 | 2,569 |
| **White Sucker** | 0 | ns | ns | 40 | 150 | 80 | 24 | 45 | 66 | 28 | 14 | 7 | 24 | 98 | 45 | 0 | 0 | 0 | 621 |
| **Total # species** | 0 | 0 | 0 | 4 | 7 | 6 | 9 | 8 | 8 | 7 | 6 | 5 | 9 | 6 | 9 | 2 | 2 | 2 | 10 |
| **Native Species** | 0 | 0 | 0 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 2 | 2 | 2 | 5 |
| **Total Individuals** | 0 | 0 | 0 | 1162 | 550 | 2620 | 3866 | 813 | 423 | 490 | 602 | 252 | 4309 | 2196 | 2100 | 12 | 30 | 15 | 19,440 |
| **IBI** | 56.1 | 56.1 | 56.1 | 67.5 | 66.8 | 67.2 | 60.8 | 55.8 | 47.9 | 67.5 | 67.8 | 66.6 | 52.9 | 63.3 | 60.6 | 51.7 | 70.8 | 55.4 | |
| **O/E** | 0 | 0 | 0 | 0.80 | 0.80 | 0.80 | 0.73 | 0.73 | 0.73 | 0.73 | 0.73 | 0.73 | 0.67 | 0.67 | 0.67 | 0.82 | 0.82 | 0.82 | |
| **O/E %** | 0 | 0 | 0 | 80.0 | 80.0 | 80.0 | 72.7 | 72.7 | 72.7 | 72.7 | 72.7 | 72.7 | 66.7 | 66.7 | 66.7 | 81.6 | 81.6 | 81.6 | |

Using the Prairie Fish IBI, 10 of the 16 fish sites were ranked non-impaired (good biological integrity), two were slightly impaired (moderate integrity), three were moderately impaired (poor biotic integrity) and the Home Creek spring survey was ranked severely impaired (Figure 8). Although, this Home Creek rank was due to low capture numbers, as the O/E has this site ranked as an almost intact community (Table 5, Figure 8). The O/E models tracked the IBI scores quite well in most cases (13 of 16), except where the O/E ranked the site as slightly impaired and the IBI ranked the sites as non-impaired (Figure 9).

**Figure 8.** Fish IBI scores across sites and seasons. Line is the null IBI threshold (fish absent).




Fish IBI's decreased going downstream on Otter Creek, and the Pre-Impact Control Site scored significantly higher than Downstream sites (T-test, $p < 0.05$), but not the Impact sites during this year (Figure 10). The O/E scores tracked the IBI ranks in most cases except in Otter impact site #2, where the O/E shows slight impairment (0.73), but the IBI scores good integrity. Further evaluations into the relationship of the O/E to the IBI need to be addressed for non-natives.

**Figure 9.** 2012 Fish IBI compared to O/E model (%) scores across sites and seasons.

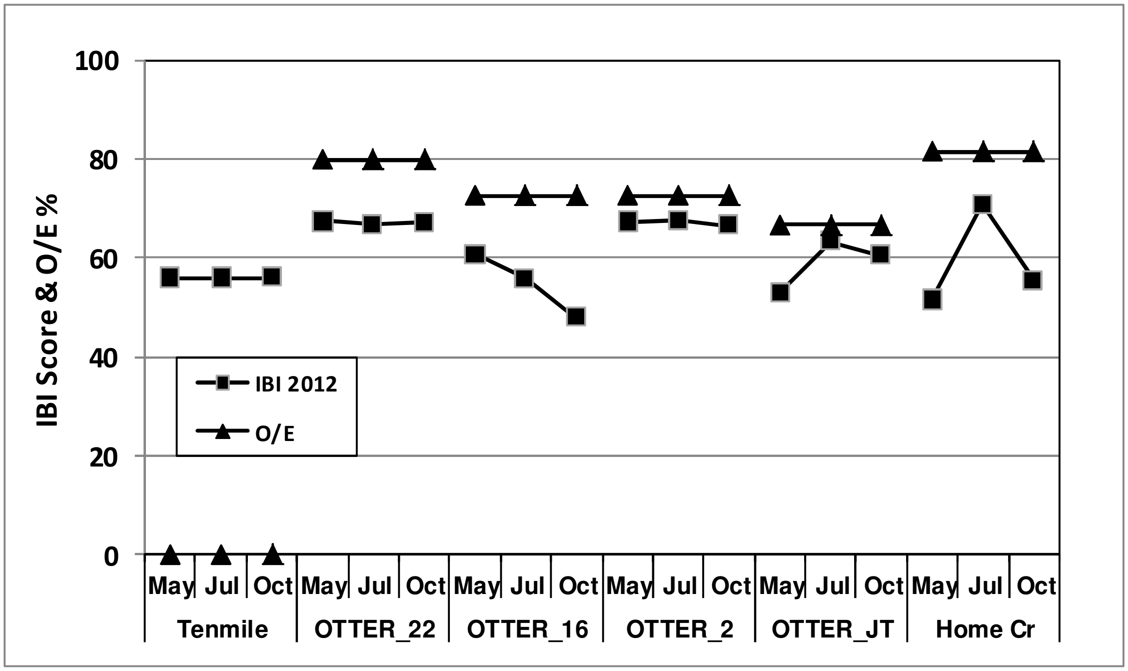
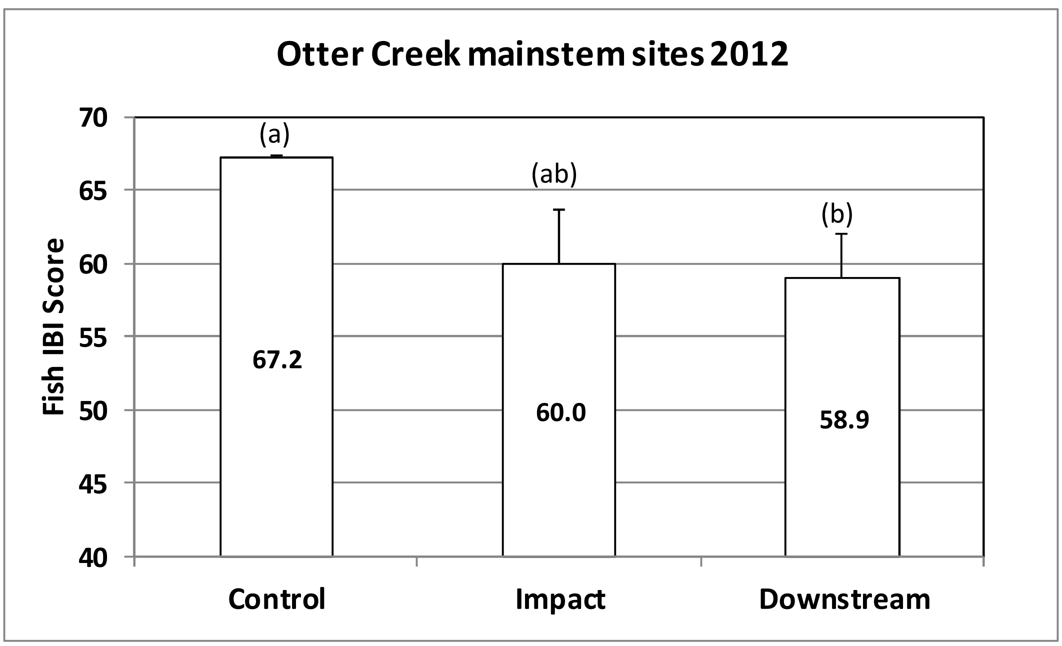



**Figure 10.** Average fish IBI scores by site type. (a) = no baseline differences between treatments.




Fish IBI scores in 2012 showed similar seasonal patterns as in 2011, except at the Otter JT site which reported a significantly higher IBI scores during all visits in 2012 (T-Test- $p<0.01$)(Figure 11). Otter Creek site 16 exhibited decreasing seasonal trends in the Fish IBI during both years (Figure 11) and this was significantly correlated with the percentage of native fish individuals collected during that visit (Figure 12). All mainstem Otter Creek sites reported introduced species present (Table 5), but native fish species still dominated the percentage of individuals of the communities except at site 16 (Figure 12).

**Figure 11.** Comparison of 2012 and 2011 Fish IBI scores across sites and seasons.

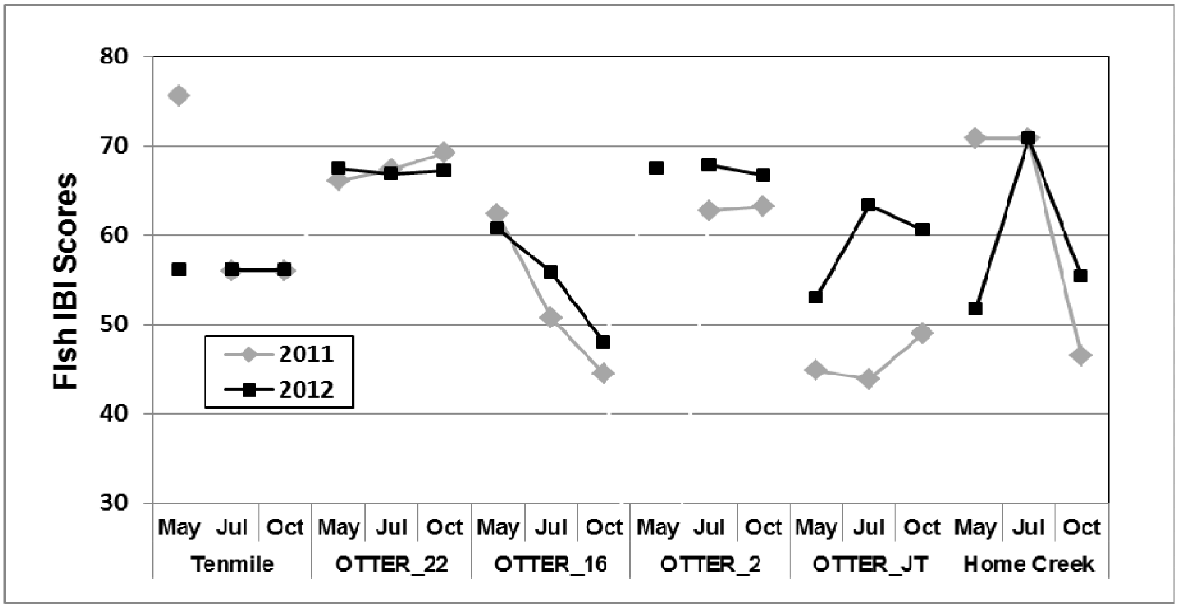
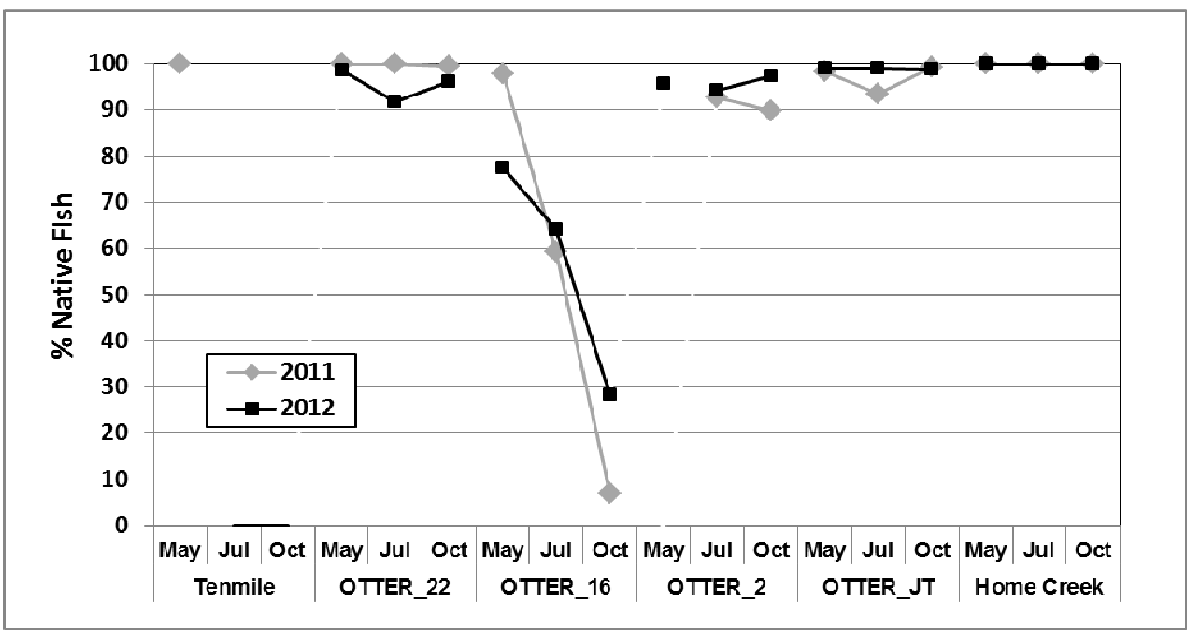



**Figure 12.** Comparison of 2012 and 2011 Native Fish Percentage (%) across sites and seasons.



***Amphibian and Reptile Observations.*** Overall, eight herpetofauna species were observed, collected in dipnets/seines or incidentally recorded in conjunction with the 2012 surveys. Otter Creek #22 and #16 were the most diverse sites reporting five herpetofuana species cumulatively across all seasons. We reported four amphibian species, of which, Northern Leopard Frog (*Rana pipiens*) had the highest site detection, occurring at five of seven sites, followed by the Woodhouse's Toad *(Bufo woodhousii),* which was highest in 2011, and Boreal Chorus Frog (*Pseudacris maculata*) recorded at four and three sites, respectively (Table 6). The Woodhouse's Toad contributed the highest percent of individuals because of the pool of tadpoles (~100) detected at Tenmile Creek. The Boreal Chorus Frog was detected vocally calling at two sites during the spring visits with tadpoles detected during the same visit at Tenmile Creek site and two incidental sightings during summer visits. We also recorded four reptile species (in order of site occurrence): Painted Turtle (*Chrysemys picta*) (Figure 10), Western Rattlesnake, (*Crotalus viridis*) and Snapping Turtle (*Chelydra serpentina*)(MT SOC) and Terrestrial Garter Snake, (*Thamnophis elegans*) (Table 6).

Table 6. Vertebrates (Species Code) recorded during the 2012 Otter Creek Surveys. Frequency of Occurrence (FO) was calculated from the # of site visits detected / # of visits capable for detection: Herps (n=21) and Fish (n=16). Porportion of individuals out of total. * = Introduced Species

| Herpetofauna | Visits Det | FO | % of total ind. |
|---|---|---|---|
| Northern Leopard Frog (RAPI) | 7 | 0.33 | 0.18 |
| Woodhouse's Toad (BUWO) | 6 | 0.29 | 0.42 |
| Boreal Chorus Frog (PSMA) | 4 | 0.19 | 0.30 |
| Painted Turtle (CHPI) | 4 | 0.19 | 0.04 |
| Tiger Salamander (AMTI) | 3 | 0.14 | 0.02 |
| Western Rattlesnake (CRVI) | 2 | 0.10 | 0.01 |
| Snapping Turtle (CHSE) | 2 | 0.10 | 0.02 |
| Terrestrial Gartersnake (THEL) | 2 | 0.10 | 0.01 |
| **Fish** | | | |
| Brassy Minnow (BRMI) | 14 | 0.88 | 0.17 |
| Lake Chub (LACH) | 13 | 0.81 | 0.24 |
| Fathead Minnow (FAMI) | 12 | 0.75 | 0.34 |
| White Sucker (WHSU) | 12 | 0.75 | 0.03 |
| Black Bullhead* (BLBU) | 9 | 0.56 | 0.01 |
| Pumpkinseed* (PUMP) | 9 | 0.56 | 0.03 |
| Common Carp* (CARP) | 8 | 0.50 | 0.03 |
| Green Sunfish* (GRSU) | 7 | 0.44 | 0.01 |
| Golden Shiner*(GOSH) | 3 | 0.19 | 0.01 |
| Sand Shiner (SASH) | 3 | 0.19 | 0.13 |

**Figure 13.** Snapping Turtle (yearling) (left) and Painted Turtle adult (right) from Otter Creek JT.

## Conclusions

The 2012 aquatic community sampling baseline data represents some significant deviations from 2011 data. Seasonal baseflows this year were 2x lower than in 2012, but still were above the 35 year average. Spring 2012 visits to Tenmile Creek revealed small isolated pools, where in 2011, there were seineable pools with fish. Threemile Creek remained dry during all seasons and provided no biological data. Despite this being an unusually high water year for the region, stream communities that we sampled across the seasons encompassed the range of expected species to occur in these stream types, and fish and macroinvertebrate community assessment scores were similar to biological assessments performed in previous years (Table 7).

Biotic integrity of the upstream control reaches of Otter Creek remained higher than the lower Otter Creek reaches during this second year but was not significantly different from the Impact Reaches. Otter Creek site #16 continued to exhibit decreasing seasonal trends in the Fish IBI during both years and increasing numbers of introduced fish in the community. A reason for this accumulation of introduced fish at site 16 and not at other sites may be related to the graveled road crossing acting as a barrier to fish movement during low water periods, but this is largely unexplained. The extraordinarily high density and large biomass of fish in the reach below Trusler's Ranch road crossing, essentially "stacking up" downstream of this barrier (20,000 fish per 300 m) has dispersed to other sections of Otter Creek and now averages about 3,000 fish per 300m with far fewer density dependent fish anomalies (lesions and parasites, i.e., yellow grub and anchorworm). The fish condition index at this site has improved tremendously since 2011.

Outside of coal extraction, manageable threats to this stream system include grazing and livestock use around the riparian areas. Moderate occurrences in these basins can have strong local effects resulting in sedimentation, stream widening at cattle crossings and loss of functional channel hydrology. Introductions of game (green sunfish, bullheads or pumpkinseeds) or forage fish (golden shiners) in stock ponds anywhere in the watershed can pose potential problems for native fish as these introduced fish become permanent residents, outcompete or prey upon the native fish and contribute to overall community degradation. Diverse aquatic communities with high biological integrity are usually correlated with good riparian condition and habitat quality (Allen et al. 1997). Thus, effective riparian zone management in cattle grazing would contribute to intact vegetation buffers and less sediment in the aquatic environment (George et al. 2002). During both years of the study, macroinvertebrate communities assessed by the MMI ranked few sites as impaired, even those with an obvious impaired riparian condition and in-stream habitat limitations. The effectiveness of macroinvertebrate communities in assessing prairie stream impairment, especially for sediment, is still under debate in Montana. Community results from the habitat, fish and macroinvertebrate surveys combined to rank the following sites from highest biological integrity to lowest within their aquatic ecological classification codes:

**Northwestern Great Plains Perennial Prairie Stream** (AES code C005)-1) Otter Creek #22, 2) Otter Creek #2, 3) Otter Creek #16, 4) Otter Creek –J Trusler site

## Site Photos

**Otter Creek #22 (control) during spring 2012 visit: pools (left) and manipulated riffle (right)**

**Otter Creek #2 (impact): fall visit 2011 looking downstream to block net (left) and upstream summer 2012 (right).**

## Site Photos

**Otter Creek #16 (impact) spring visit: pool (left) and shallow stream crossing (right).**


**Otter Creek #16 (impact) during summer visit: downstream pool (left) and drill trucks using the stream crossing (right).**

## Site Photos

**Otter Creek JT (downstream): summer visit looking downstream (left) and upstream (right)**

**Northwestern Great Plains Intermittent Prairie Stream**-(AES code D005)-1) Home Creek 1A, 2) Tenmile Creek,

**Home Creek (Otter 1A) during the Spring (left) and Summer (right) Visits**

## Site Photos

**Tenmile Creek (Otter_23) in the Spring (left) and Summer (right)**


**Great Plains Intermittent Fishless Prairie Stream** (AES code E005)-1) Threemile Creek

**Site Photos: Threemile Creek (Otter 3m) during the spring (left) and summer (right) Visits**

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**Appendix A. Raw data and IBI metric calculation from fish data collected from Otter Creek Coal Tract Sites**

**Spring 2012**

| | Otter23 | | Otter22 | | Otter16 | | Otter2 | | OtterJT | | Otter1A | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Black Bullhead | 0.0 | | 0.0 | | 16.0 | | 21.0 | | 8.0 | | 0.0 | |
| Brassy Minnow | 0.0 | | 234.0 | | 1604.0 | | 49.0 | | 10.0 | | 2.0 | |
| Common Carp | 0.0 | | 0.0 | | 492.0 | | 14.0 | | 12.0 | | 0.0 | |
| Fathead Minnow | 0.0 | | 0.0 | | 620.0 | | 63.0 | | 3290.0 | | 10.0 | |
| Lake Chub | 0.0 | | 870.0 | | 746.0 | | 441.0 | | 40.0 | | 0.0 | |
| Green Sunfish | 0.0 | | 0.0 | | 44.0 | | 0.0 | | 14.0 | | 0.0 | |
| Golden Shiner | 0.0 | | 0.0 | | 96.0 | | 0.0 | | 0.0 | | 0.0 | |
| Pumpkinseed Sunfish | 0.0 | | 18.0 | | 224.0 | | 0.0 | | 5.0 | | 0.0 | |
| Sand Shiner | 0.0 | | 0.0 | | 0.0 | | 0.0 | | 906.0 | | 0.0 | |
| White Sucker | 0.0 | | 40.0 | | 24.0 | | 14.0 | | 24.0 | | 0.0 | |
| Total # species | 0.0 | | 4.0 | | 9.0 | | 6.0 | | 9.0 | | 2.0 | |
| Native Species | 0.0 | | 3.0 | | 4.0 | | 4.0 | | 5.0 | | 2.0 | |
| Native Families | 0.0 | | 2.0 | | 2.0 | | 2.0 | | 2.0 | | 1.0 | |
| Total Individuals | 0.0 | | 1162.0 | | 3866.0 | | 602.0 | | 4309.0 | | 12.0 | |
| # Minnow Species Thrive | 0.0 | | 2.0 | | 3.0 | | 3.0 | | 4.0 | | 2.0 | |
| Proportion of tolerant individuals | 0.00 | | 3.44 | | 33.42 | | 18.60 | | 77.70 | | 83.33 | |
| # Sucker + Catfish Species | 0.0 | | 1.0 | | 2.0 | | 2.0 | | 2.0 | | 0.0 | |
| % Insectivorous Minnows | 0.0 | | 74.9 | | 19.3 | | 73.3 | | 22.0 | | 0.0 | |
| # Benthic Invertivore Species | 0.0 | | 0.0 | | 1.0 | | 1.0 | | 1.0 | | 0.0 | |
| % Litholphilic Spawners | 0.0 | | 3.4 | | 0.6 | | 2.3 | | 21.6 | | 0.0 | |
| % Parental Care | 0.00 | | 0.00 | | 16.45 | | 13.95 | | 76.54 | | 83.33 | |
| % Native to Montana | 0.0 | | 98.5 | | 77.4 | | 94.2 | | 99.1 | | 100.0 | |
| # Long Lived Species | 0.0 | | 4.0 | | 5.0 | | 1.0 | | 4.0 | | 2.0 | |
| | **Otter23** | | **Otter22** | | **Otter16** | | **Otter2** | | **OtterJT** | | **Otter1A** | |
| Metrics | Adjust Value | Score | Adjust Value | Score | Adjust Value | Score | Adjust Value | | Adjust Value | Score | Adjust Value | Score |
| Number of Native Fish Species to Montana | 11.6 | 64.7 | 9.3 | 51.8 | 10.1 | 56.0 | 10.0 | 55.3 | 10.8 | 59.9 | 13.3 | 73.7 |
| Number of Native Fish Families to Montana | 2.1 | 39.5 | 3.2 | 58.7 | 3.1 | 57.8 | 3.1 | 57.4 | 3.1 | 56.8 | 3.1 | 56.7 |
| Proportion of tolerant individuals | 0.0 | 100.0 | 3.4 | 96.4 | 33.4 | 64.6 | 18.6 | 80.3 | 77.7 | 17.8 | 83.3 | 11.8 |
| Number of Sucker and Catfish Species | 7.1 | 77.1 | 4.9 | 53.3 | 5.8 | 62.6 | 5.7 | 61.8 | 5.6 | 60.7 | 6.9 | 74.7 |
| Proportion out of the Total Number of Fish That Were Insect eating Minnows | 0.0 | 0.0 | 74.9 | 102.8 | 19.3 | 26.5 | 73.3 | 100.6 | 22.0 | 30.2 | 0.0 | 0.0 |
| Total Number of Species That Prefer to Eat Insects That Live on the Stream Bottom | 5.5 | 93.1 | 3.0 | 51.3 | 4.9 | 83.3 | 4.8 | 82.4 | 4.8 | 81.0 | 5.3 | 90.2 |
| Proportion of the Total Number of Fish That Require Rocks to Lay Eggs | 0.0 | 0.0 | 3.4 | 4.2 | 0.6 | 0.7 | 2.3 | 2.8 | 21.6 | 26.0 | 0.0 | 0.0 |
| Proportion of the Total Number of Individuals That Do Not Require Rocks, But Have Parental Care of Eggs | 0.0 | 100.0 | 0.0 | 100.0 | 16.5 | 81.3 | 14.0 | 84.1 | 76.5 | 13.0 | 83.3 | 5.2 |
| Proportion of the Total Number of Fish Sampled That Were Native to Montana | 0.0 | 0.0 | 98.5 | 98.5 | 77.4 | 77.5 | 94.2 | 94.2 | 99.1 | 99.1 | 100.0 | 100.0 |
| Number of Long-Lived Native Species | 8.5 | 86.9 | 5.7 | 58.1 | 9.5 | 97.3 | 5.4 | 55.4 | 8.3 | 84.9 | 10.2 | 104.7 |
| | | 561.4 | | 675.1 | | 607.6 | | 674.5 | | 529.4 | | 517.3 |
| **IBI Score** | | **56.14** | | **67.51** | | **60.76** | | **67.45** | | **52.94** | | **51.73** |

**Appendix A.** Raw data and IBI metric calculation from fish data collected from Otter Creek Coal Tract Sites

| | Summer 2012 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Otter23** | | **Otter22** | | **Otter16** | | **Otter2** | | **OtterJT** | | **Otter1A** | |
| Black Bullhead | 0.0 | | 5.0 | | 27.0 | | 21.0 | | 0.0 | | 0.0 | |
| Brassy Minnow | 0.0 | | 55.0 | | 90.0 | | 49.0 | | 15.0 | | 0.0 | |
| Common Carp | 0.0 | | 0.0 | | 54.0 | | 14.0 | | 23.0 | | 0.0 | |
| Fathead Minnow | 0.0 | | 0.0 | | 189.0 | | 63.0 | | 1085.0 | | 10.0 | |
| Lake Chub | 0.0 | | 300.0 | | 198.0 | | 441.0 | | 75.0 | | 20.0 | |
| Green Sunfish | 0.0 | | 5.0 | | 9.0 | | 0.0 | | 0.0 | | 0.0 | |
| Golden Shiner | 0.0 | | 5.0 | | 0.0 | | 0.0 | | 0.0 | | 0.0 | |
| Pumpkinseed Sunfish | 0.0 | | 30.0 | | 201.0 | | 0.0 | | 0.0 | | 0.0 | |
| Sand Shiner | 0.0 | | 0.0 | | 0.0 | | 0.0 | | 900.0 | | 0.0 | |
| White Sucker | 0.0 | | 150.0 | | 45.0 | | 14.0 | | 98.0 | | 0.0 | |
| Total # species | 0.0 | | 7.0 | | 8.0 | | 6.0 | | 6.0 | | 2.0 | |
| Native Species | 0.0 | | 3.0 | | 4.0 | | 4.0 | | 5.0 | | 2.0 | |
| Native Families | 0.0 | | 2.0 | | 2.0 | | 2.0 | | 2.0 | | 1.0 | |
| Total Individuals | 0.0 | | 550.0 | | 813.0 | | 602.0 | | 2196.0 | | 30.0 | |
| # Minnow Species Thrive | 0.0 | | 2.0 | | 3.0 | | 3.0 | | 4.0 | | 2.0 | |
| Proportion of tolerant individuals | 0.00 | | 30.00 | | 39.85 | | 18.60 | | 54.92 | | 33.33 | |
| # Sucker + Catfish Species | 0.0 | | 2.0 | | 2.0 | | 2.0 | | 1.0 | | 0.0 | |
| % Insectivorous Minnows | 0.0 | | 54.5 | | 24.4 | | 73.3 | | 44.4 | | 66.7 | |
| # Benthic Invertivore Species | 0.0 | | 1.0 | | 1.0 | | 1.0 | | 0.0 | | 0.0 | |
| % Litholphilic Spawners | 0.0 | | 27.3 | | 5.5 | | 2.3 | | 45.4 | | 0.0 | |
| % Parental Care | 0.00 | | 0.91 | | 26.57 | | 13.95 | | 49.41 | | 33.33 | |
| % Native to Montana | 0.0 | | 91.8 | | 64.2 | | 94.2 | | 99.0 | | 100.0 | |
| # Long Lived Species | 0.0 | | 1.0 | | 2.0 | | 1.0 | | 4.0 | | 1.0 | |
| | **Otter23** | | **Otter22** | | **Otter16** | | **Otter2** | | **OtterJT** | | **Otter1A** | |
| Metrics | Adjust Value | | Adjust Value | | Adjust Value | | Adjust Value | | Adjust Value | | Adjust Value | Score |
| Number of Native Fish Species to Montana | 11.6 | 64.7 | 9.3 | 51.8 | 10.1 | 56.0 | 10.1 | 56.0 | 10.8 | 59.9 | 13.3 | 73.7 |
| Number of Native Fish Families to Montana | 2.1 | 39.5 | 3.2 | 58.7 | 3.1 | 57.8 | 3.1 | 57.8 | 3.1 | 56.8 | 3.1 | 56.7 |
| Proportion of tolerant individuals | 0.0 | 100.0 | 30.0 | 68.3 | 39.9 | 57.8 | 18.6 | 80.3 | 54.9 | 41.9 | 33.3 | 64.7 |
| Number of Sucker and Catfish Species | 7.1 | 77.1 | 5.9 | 64.2 | 5.8 | 62.6 | 5.8 | 62.6 | 4.6 | 49.8 | 6.9 | 74.7 |
| Proportion out of the Total Number of Fish That Were Insect eating Minnows | 0.0 | 0.0 | 54.5 | 74.9 | 24.4 | 33.4 | 73.3 | 100.6 | 44.4 | 61.0 | 66.7 | 91.6 |
| Total Number of Species That Prefer to Eat Insects That Live on the Stream Bottom | 5.5 | 93.1 | 4.0 | 68.3 | 4.9 | 83.3 | 4.9 | 83.3 | 4.8 | 81.0 | 5.3 | 90.2 |
| Proportion of the Total Number of Fish That Require Rocks to Lay Eggs | 0.0 | 0.0 | 27.3 | 32.9 | 5.5 | 6.7 | 2.3 | 2.8 | 45.4 | 54.8 | 0.0 | 0.0 |
| Proportion of the Total Number of Individuals That Do Not Require Rocks, But Have Parental Care of Eggs | 0.0 | 100.0 | 0.9 | 99.0 | 26.6 | 69.8 | 14.0 | 84.1 | 49.4 | 43.8 | 33.3 | 62.1 |
| Proportion of the Total Number of Fish Sampled That Were Native to Montana | 0.0 | 0.0 | 91.8 | 91.9 | 64.2 | 64.2 | 94.2 | 94.2 | 99.0 | 99.0 | 100.0 | 100.0 |
| Number of Long-Lived Native Species | 8.5 | 86.9 | 5.7 | 58.1 | 6.5 | 66.5 | 5.5 | 56.3 | 8.3 | 84.9 | 9.2 | 94.5 |
| | | 561.4 | | 668.0 | | 558.2 | | 678.1 | | 632.9 | | 708.4 |
| **IBI Score** | | **56.14** | | **66.80** | | **55.82** | | **67.81** | | **63.29** | | **70.84** |

**Appendix A. Raw data and IBI metric calculation from fish data collected from Otter Creek Coal Tract Sites**

| | Fall 2012 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Otter23 | | Otter22 | | Otter16 | | Otter2 | | OtterJT | | Otter1A | |
| Black Bullhead | 0.0 | | 20.0 | | 123.0 | | 0.0 | | 3.0 | | 0.0 | |
| Brassy Minnow | 0.0 | | 940.0 | | 3.0 | | 154.0 | | 5.0 | | 5.0 | |
| Common Carp | 0.0 | | 0.0 | | 9.0 | | 7.0 | | 17.0 | | 0.0 | |
| Fathead Minnow | 0.0 | | 0.0 | | 45.0 | | 7.0 | | 1245.0 | | 10.0 | |
| Lake Chub | 0.0 | | 1500.0 | | 6.0 | | 77.0 | | 15.0 | | 0.0 | |
| Green Sunfish | 0.0 | | 75.0 | | 42.0 | | 0.0 | | 3.0 | | 0.0 | |
| Golden Shiner | 0.0 | | 0.0 | | 0.0 | | 0.0 | | 0.0 | | 0.0 | |
| Pumpkinseed Sunfish | 0.0 | | 5.0 | | 129.0 | | 0.0 | | 3.0 | | 0.0 | |
| Sand Shiner | 0.0 | | 0.0 | | 0.0 | | 0.0 | | 763.0 | | 0.0 | |
| White Sucker | 0.0 | | 80.0 | | 66.0 | | 7.0 | | 45.0 | | 0.0 | |
| Total # species | 0.0 | | 6.0 | | 8.0 | | 5.0 | | 9.0 | | 2.0 | |
| Native Species | 0.0 | | 3.0 | | 4.0 | | 4.0 | | 5.0 | | 2.0 | |
| Native Families | 0.0 | | 2.0 | | 2.0 | | 2.0 | | 2.0 | | 1.0 | |
| Total Individuals | 0.0 | | 2620.0 | | 423.0 | | 252.0 | | 2099.0 | | 15.0 | |
| # Minnow Species Thrive | 0.0 | | 2.0 | | 3.0 | | 3.0 | | 4.0 | | 2.0 | |
| Proportion of tolerant individuals | 0.00 | | 6.68 | | 67.38 | | 8.33 | | 62.55 | | 66.67 | |
| # Sucker + Catfish Species | 0.0 | | 2.0 | | 2.0 | | 1.0 | | 2.0 | | 0.0 | |
| % Insectivorous Minnows | 0.0 | | 57.3 | | 1.4 | | 30.6 | | 37.1 | | 0.0 | |
| # Benthic Invertivore Species | 0.0 | | 1.0 | | 1.0 | | 0.0 | | 1.0 | | 0.0 | |
| % Litholphilic Spawners | 0.0 | | 3.1 | | 15.6 | | 2.8 | | 38.5 | | 0.0 | |
| % Parental Care | 0.00 | | 0.76 | | 39.72 | | 2.78 | | 59.46 | | 66.67 | |
| % Native to Montana | 0.0 | | 96.2 | | 28.4 | | 97.2 | | 98.8 | | 100.0 | |
| # Long Lived Species | 0.0 | | 4.0 | | 4.0 | | 4.0 | | 4.0 | | 2.0 | |
| | Otter23 | | Otter22 | | Otter16 | | Otter2 | | OtterJT | | Otter1A | |
| Metrics | Adjust Value | | Adjust Value | | Adjust Value | | Adjust Value | | Adjust Value | | Adjust Value | Score |
| | | | | | | | | | | | | |
| Number of Native Fish Species to Montana | 11.6 | 64.7 | 9.3 | 51.8 | 10.1 | 56.0 | 10.1 | 56.0 | 10.8 | 59.9 | 13.3 | 73.7 |
| Number of Native Fish Families to Montana | 2.1 | 39.5 | 3.2 | 58.7 | 3.1 | 57.8 | 3.1 | 57.8 | 3.1 | 56.8 | 3.1 | 56.7 |
| Proportion of tolerant individuals | 0.0 | 100.0 | 6.7 | 92.9 | 67.4 | 28.7 | 8.3 | 91.2 | 62.6 | 33.8 | 66.7 | 29.5 |
| Number of Sucker and Catfish Species | 7.1 | 77.1 | 5.9 | 64.2 | 5.8 | 62.6 | 4.8 | 51.7 | 5.6 | 60.7 | 6.9 | 74.7 |
| Proportion out of the Total Number of Fish That Were Insect eating Minnows | 0.0 | 0.0 | 57.3 | 78.6 | 1.4 | 1.9 | 30.6 | 42.0 | 37.1 | 50.9 | 0.0 | 0.0 |
| Total Number of Species That Prefer to Eat Insects That Live on the Stream Bottom | 5.5 | 93.1 | 4.0 | 68.3 | 4.9 | 83.3 | 4.9 | 83.3 | 4.8 | 81.0 | 5.3 | 90.2 |
| Proportion of the Total Number of Fish That Require Rocks to Lay Eggs | 0.0 | 0.0 | 3.1 | 3.7 | 15.6 | 18.8 | 2.8 | 3.3 | 38.5 | 46.4 | 0.0 | 0.0 |
| Proportion of the Total Number of Individuals That Do Not Require Rocks, But Have Parental Care of Eggs | 0.0 | 100.0 | 0.8 | 99.1 | 39.7 | 54.8 | 2.8 | 96.8 | 59.5 | 32.4 | 66.7 | 24.2 |
| Proportion of the Total Number of Fish Sampled That Were Native to Montana | 0.0 | 0.0 | 96.2 | 96.2 | 28.4 | 28.4 | 97.2 | 97.3 | 98.8 | 98.8 | 100.0 | 100.0 |
| Number of Long-Lived Native Species | 8.5 | 86.9 | 5.7 | 58.1 | 8.5 | 87.0 | 8.5 | 87.0 | 8.3 | 84.9 | 10.2 | 104.7 |
| | | 561.4 | | 671.7 | | 479.4 | | 666.4 | | 605.6 | | 553.9 |
| **IBI Score** | | **56.14** | | **67.17** | | **47.94** | | **66.64** | | **60.56** | | **55.39** |

**Appendix C** . Stream Habitat and Water Quality Parameters measured for the Otter Creek sites visited. na = not visited or sampled during this visit, dry.

| 2012 | OTTER_23 | | | OTTER_22 | | | OTTER_16 | | | OTTER_3m | | | OTTER_2 | | | OTTER_JT | | | OTTER_1A | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | May | Jul | Oct | May | Jul | Oct | May | Jul | Oct | May | Jul | Oct | May | Jul | Oct | May | Jul | Oct | May | Jul | Oct |
| Water Temp © | 11.8 | na | na | 14 | 22.5 | 8.2 | 17.8 | 29.5 | 10.1 | na | na | na | 17.9 | 30.4 | 9.3 | 13.1 | 25 | 10.7 | 11.8 | 27.8 | 10.8 |
| TDS (ppm) | >2,000 | >2,000 | na | 1820 | 1824 | 1266 | 1970 | >2,000 | 1456 | na | na | na | 2000 | >2,000 | 1410 | 1860 | 1668 | 1750 | >2,000 | >2,000 | 1844 |
| Conductivity (µs/cm) | >4,000 | >4,000 | na | 3646 | 3658 | 2528 | 3915 | >4,000 | 2741 | na | na | na | 3950 | >4,000 | 2730 | 3760 | 3339 | 3540 | >4,000 | >4,000 | 3325 |
| pH | 7.8 | 8.4 | na | 8.3 | 8.4 | 8.4 | 8.5 | 8.5 | 8.5 | na | na | na | 8.44 | 8.6 | 8.6 | 8.1 | 8.4 | 8.1 | 8.05 | 8.5 | 8.2 |
| PFC | FAR | FAR | FAR | PFC | PFC | PFC | PFC | PFC | FAR | FAR | FAR | FAR | FAR | FAR | FAR | PFC | PFC | PFC | FARd | FARd | FARd |
| BLM HBI | 16 | 17 | 17 | 22 | 22 | 22 | 20 | 19 | 18 | 16 | 18 | 18 | 17 | 17 | 17 | 19 | 19 | 19 | 11 | 12 | 13 |
| Avg wetted width (m) | 0.4 | 0.2 | 0.0 | 7.0 | 6.2 | 5.7 | 10.3 | 10.3 | 9.5 | 0.0 | na | na | 1.8 | 1.5 | 1.2 | 5.0 | 4.7 | 4.6 | 2.2 | 2.1 | 2.0 |
| Avg Left CHD (cm) | 10 | 2 | 0 | 51 | 67 | 35 | 88 | 80 | 78 | 0 | na | na | 25 | 30 | 22 | 53 | 28 | 23 | 22 | 25 | 26 |
| Avg Center CHD (cm) | 12 | 3 | 0 | 52 | 97 | 47 | 107 | 100 | 96 | 0 | na | na | 35 | 42 | 30 | 54 | 44 | 28 | 30 | 27 | 35 |
| Avg Right CHD (cm) | 10 | 2 | 0 | 46 | 66 | 32 | 87 | 75 | 76 | 0 | na | na | 20 | 25 | 20 | 55 | 41 | 27 | 18 | 15 | 15 |
| % Fines in Reach | 90 | 100 | 100 | 95 | 84 | 92 | 90 | 91 | 88 | 100 | 100 | 100 | 30 | 50 | 60 | 70 | 67 | 63 | 99 | 99 | 97 |
| % Gravel Reach | 5 | 0 | 0 | 2 | 8 | 4 | 6 | 5 | 7 | 0 | 0 | 0 | 40 | 35 | 30 | 20 | 26 | 34 | 1 | 1 | 3 |
| % Cobble Reach | 5 | 0 | 0 | 3 | 9 | 5 | 4 | 4 | 5 | 0 | 0 | 0 | 30 | 15 | 10 | 11 | 8 | 3 | 0 | 0 | 0 |
| Livestock Use (CPI) | 63 | 11 | 60 | 30 | 36 | 13 | 90 | 7 | 46 | 30 | 44 | 24 | 5 | 12 | 5 | 18 | 22 | 19 | 55 | 36 | 28 |
| Avg. Riparian Shade | 0 | 5 | 0 | 0 | 10 | 0 | 5 | 10 | 10 | 20 | 40 | 20 | 10 | 10 | 10 | 10 | 20 | 10 | 10 | 30 | 20 |