# Upper Pack River Stressor Identification

Task Order 26
Contract 68-C-02-111

*Prepared for:*

U.S. Environmental Protection Agency
Region X
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and

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## Table of Contents



## Table of Tables



## Table of Figures

## SUMMARY

TerraGraphics Environmental Engineering, Inc. (TerraGraphics) identified seven potential stressors or causes for fish, macroinvertebrate or habitat scores to be significantly different from established reference sites. The stressors include:

- Low nutrients resulting in low fish and macroinvertebrate abundance;
- Increased flood frequency and maximum stream flows with a concomitant decrease in base flows;
- Increased sediment delivery and percent fines;
- Reduction in riparian cover, shift in riparian plant species, lower quality shade;
- Increased metal concentrations;
- Increased nutrients; and
- Ineffective sampling or inappropriate reference stream reaches for comparison.

Increased nutrients and high metal concentrations were eliminated as potential stressors based on available information from investigation of current and historic land use practices. We determined that the likely stressor was excessive sediment.

We recommend the development of a sediment Total Maximum Daily Load (TMDL) for the lower portion of the Upper Pack River watershed.

## SECTION 1.0 SCOPE OF THE INVESTIGATION

The Upper Pack River drainage contains 19,264 acres used primarily for forestry with a small area of rural residential. Approximately 46% of the area is forest covered. Land ownership is distributed among industrial timber companies, the Idaho Panhandle National Forest, the Idaho Department of Lands (IDL), and small private owners (USGS).

Elevation ranges from 2,230 feet at Hellroaring Creek to 7,550 feet at the headwaters, with an average elevation of 4,650 feet. The average slope throughout the drainage is 34%. Over 54% of the area contains slopes greater than 30% and 11.7% of the drainage contains slope greater than 30% and facing North (USGS). The Upper Pack River watershed is underlain by Cretaceous granitics of the Kaniksu Batholith. In the very lower portion of the drainage, near the mouth of the creek, there are deposits of Pleistocene unconsolidated glacial debris and coarse alluvial materials (IDL 2003a).

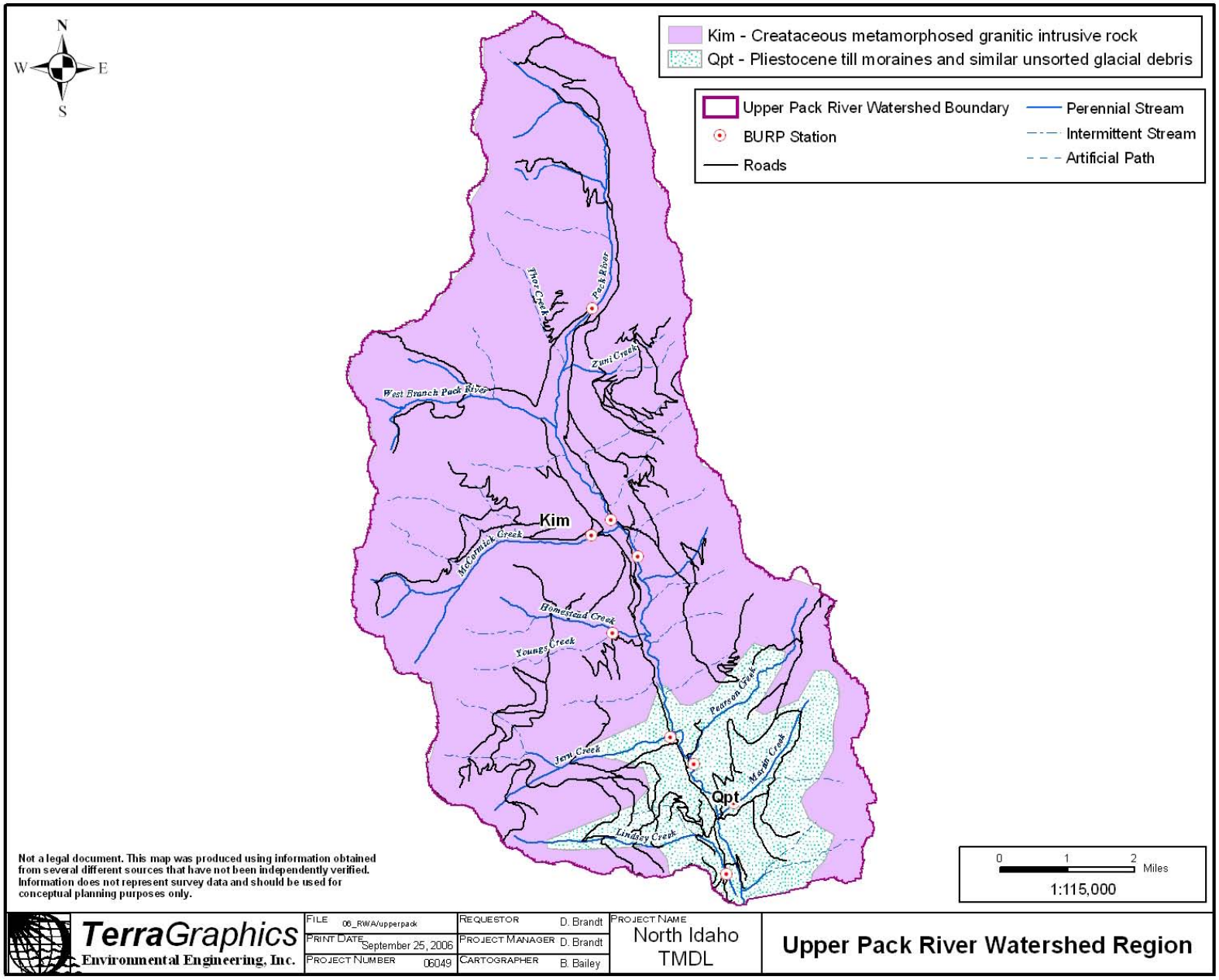
Cool, dry summers and moderately cold winters characterize the area (IDL 2003a). Average annual precipitation is 40.2 inches (USGS). The majority of precipitation occurs as winter snowfall and spring rain. High-volume runoff occurs during spring snowmelt and major rain-on-snow events (IDL 2003a).

Vegetation varies with elevation, aspect, and landform. Lower elevations generally support Cedar-Hemlock habitat types. Uplands support a mixed conifer forest of Douglas fir, grand fir, red cedar, larch, hemlock, ponderosa pine, lodgepole pine, and western white pine with the more xeric species dominating south to west facing aspects. Higher elevation sites include subalpine fir, and spruce. Very wet areas especially along riparian zones support alder, willow, and other water loving species (IDL 2003a).

The Stressor Identification was completed using existing biological data, water chemistry data, aerial photos, field notes from previous investigations, Idaho Department of Environmental Quality (IDEQ) BURP database and Pend Oreille Sub-basin TMDL, U.S. Forest Service (USFS) reports, interviews, and Geographic Information Systems (GIS) coverages (land use, geology).

A map of the drainage with some distinguishing features can be found in Figure 1.

**Figure 1 Upper Pack River Site Location Map**



## SECTION 2.0 DESCRIPTION OF THE IMPAIRMENT

In 1998 and 2003, the Coeur d'Alene office of IDEQ conducted rapid bioassessment surveys of the Upper Pack River second order tributaries. The data were analyzed according to the Ecological Assessment Framework (Grafe 2002a) and the Water Body Assessment Guidance (WBAG) document (Grafe et al 2002b). A status report was created in 2002 for the 1998 data. The Index Scores for Upper Pack River tributaries are located in Table 1. Only one of the four sites was determined to be not supporting its beneficial uses. The Stream Macroinvertebrate Index (SMI) and the Stream Fish Index (SFI) for Martin Creek were lower than expected for a stream within the Northern Rockies Ecoregion (Table 2). The Stream Habitat Index (SHI) for Martin Creek was consistent with habitat conditions found in reference streams. The Pack River and Youngs Creek were supporting their beneficial uses. Lindsey Creek was dry at the time of the survey and was therefore not assessed.

The assessment resulted in the determination that all of the second order tributaries of the Upper Pack River were not supporting their beneficial uses of cold water aquatic life and salmonid spawning. The pollutants identified as causing the impairment were "thermal modifications" and "unknown." This stressor identification process will address the "unknown" pollutant but will not attempt to verify the validity of the "thermal modification" determination.

**Table 1 Index Scores for the Upper Pack River Watershed**

| Assessment Unit | Stream | BURP ID | Stream Macroinvertebrate Index (SMI) | Steam Fish Index (SFI) | Stream Habitat Index (SHI) |
|---|---|---|---|---|---|
| ID17010214PN041_02 | Youngs Creek | 1998SCDAB027 | 61.736 | 81.624 | 83 |
| ID17010214PN041_02 | Martin Creek | 1998SCDAB028 | 10.296 | 30.000 | 69 |
| ID17010214PN041_02 | Pack River | 2003SCDAA019 | 68.984 | N/A | 78 |

**Table 2 Index Scoring Criteria**

| Condition Category | SMI (Northern Mountains) | SFI (Forest) | SHI (Northern Rockies) | Condition Rating |
|---|---|---|---|---|
| Above 25$^{th}$ percentile of reference condition | ≥65 | ≥81 | ≥66 | 3 |
| 10$^{th}$ to 25$^{th}$ percentile of reference condition | 57-64 | 67-80 | 58-65 | 2 |
| Minimum to 10$^{th}$ percentile of reference condition | 39-56 | 34-66 | <58 | 1 |
| Below minimum of reference condition | <39 | <34 | N/A | Minimum threshold |

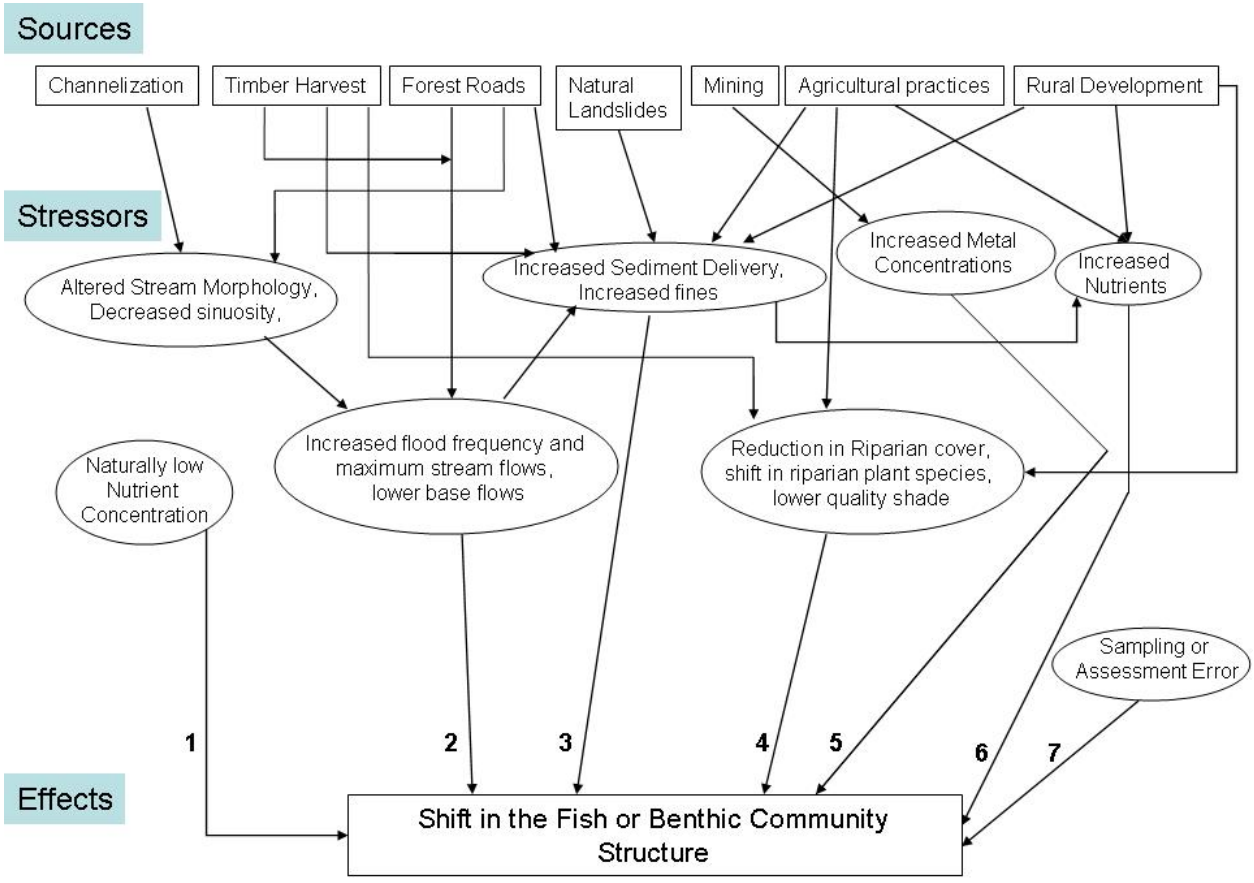
Note: N/A – Not available. SHI does not have a minimum threshold condition rating.

## SECTION 3.0 CANDIDATE CAUSES

A conceptual model of candidate causes has been created for the Upper Pack River Watershed (Figure 2). The conceptual model indicates seven potential causes for the low SMI and SFI scores within the Upper Pack River Watershed. These seven causes include:

1. **Low nutrients resulting in low fish and macroinvertebrate abundance**. If low nutrients are the cause, one would expect low macroinvertebrate abundance and low species diversity due to limited periphyton biomass for the grazer and scraper guilds, low levels of detritus for shredder guilds and insufficient biomass to support macroinvertebrate predators. The low biomass of macroinvertebrates would result in low food for the fish community, resulting in low fish abundance.
2. **Increased flood frequency and maximum stream flows with a concomitant decrease in base flows.** If these were the causes, the stream flows during the time in which the Beneficial Use Reconnaissance Program (BURP) data were collected would be too low to support a viable aquatic community.
3. **Increased sediment delivery and percent fines.** Increased percent fines decreases both the amount of interstitial space for emerging fish fry as well as intergravel dissolved oxygen. This would result in a decreased survival rate of young of the year fish and a resultant reduction in the total fish abundance within the system. The higher percent fines would also result in a shift in the taxa of macroinvertebrates present in the stream. The sediment intolerant species would be suppressed and the sediment tolerant taxa would have higher abundance.
4. **Reduction in riparian cover, shift in riparian plant species, lower quality shade.** The loss of riparian cover and/or a shift to a lower shade canopy would result in increased stream temperatures. This would cause a shift in the aquatic macroinvertebrate community and the fish community. Fish species that require cold water, particularly for spawning and rearing areas, would have increased year class mortality and lower biomass than areas with more or higher quality shade.
5. **Increased metal concentrations.** Increased metal concentrations would result in a reduction in biomass and taxa richness.
6. **Increased nutrients.** Excessive nutrients would result in nuisance levels of periphyton, and lower scores on the Hillsenhoff Biotic Index (HBI).
7. **Ineffective sampling or inappropriate reference stream reaches for comparison.** The BURP protocol and the WBAG II were developed to assess beneficial use support conditions for a wide variety of streams. There is a sub-set of streams that are outside of the range of conditions used to develop the field protocols and the assessment model. These conditions could include things such as too little water, too large of stream, too large of substrate, or too steep of gradient. The result of applying the field techniques and assessment protocol to those streams outside the range of experience of the model would result in an erroneous assessment of not full support.

**Figure 2 Upper Pack River Conceptual Model of Candidate Causes**



## SECTION 4.0 EXISTING DATA

### 4.1 Physical Habitat Data

Table 3 summarizes the habitat data collected during the BURP sampling events. The Upper Pack River had very low percent fines but both Youngs and Martin Creek had high percent fines within the stream channel.

**Table 3 Summary of Selected BURP Habitat Data for Upper Pack River**

| BURP ID | Bank Cover Percentage | Bank Stability Percentage | Percent Canopy | Percent Fines* | Embedded Score | Channel Shape Score | Pool/Riffle Ratio | Average Wet Depth (m) | Average Wet Width (m) | Width/Depth Ratio (wetted) | Discharge (cfs) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1998SCDAB027 (Youngs Creek) | 100 | 100 | 64.5 | 48 | 18 | 8 | 0.135 | 0.25 | 2.43 | 28.55 | 0.0 |
| 1998SCDAB028 (Martin Creek) | 100 | 100 | 60.5 | 37 | 14 | 5 | 0.325 | 0.23 | 3.37 | 42.98 | 1.8 |
| 2003SCDAA019 (Pack River) | 100 | 100 | 29 | 6.7 | 20 | 5 | 0.190 | 0.23 | 7.77 | 101.30 | 2.9 |

* Percent Fines were calculated from BURP field forms. Values in the database were not consistent with the field forms.

IDL conducted Cumulative Watershed Effects (CWE) surveys on several streams within the Upper Pack River Watershed (IDL 2003b, 2003c, 2003d). Tables 4 and 5 contain the index scores and summary evaluations of the watershed. The CWE surveys indicate that there are moderate and low risks of mass failure and total sediment delivery. The primary contributors to this assessment are the mean watershed gradient and the soil type.

**Table 4 Upper Pack River CWE Assessment Results**

| CWE Watersheds | Results | Channel Stability | Canopy Removal | Roads | Mass Failure | Total Sediment Delivery | Hydrologic Risk |
|---|---|---|---|---|---|---|---|
| **Homestead Creek (Crew 1)** | *Score* | 54 | 0.64 | 32.2 | 39.8 | 76 | |
| Acres: 2335 FPA Acres: 2335 | *Rating* | Moderate | | Moderate | Moderate | Moderate | High |
| **Homestead Creek (Crew 2)** | *Score* | 52 | 0.3 | 32.6 | 39.8 | 76.5 | |
| Acres: 2335 FPA Acres: 2335 | *Rating* | Moderate | | Moderate | Moderate | Moderate | Moderate |
| **Lindsey Creek (Crew 1)** | *Score* | 59 | 0.19 | 16.7 | 9 | 31.7 | |
| Acres: 2404 FPA Acres: 2402 | *Rating* | High | | Low | Low | Low | Low |
| **Lindsey Creek (Crew 2)** | *Score* | 42 | 0.3 | 29.2 | 9 | 44.2 | |
| Acres: 2404 FPA Acres: 2401 | *Rating* | Moderate | | Low | Low | Low | Moderate |
| **Martin Creek** | *Score* | 32 | 0.03 | 13 | 38.9 | 53.9 | |
| Acres: 2314 FPA Acres: 2314 | *Rating* | Low | | Low | Moderate | Low | Low |

Notes: FPA=Forest Practices Act
Canopy Removal is expressed only as a score.
Hydrologic Risk is expressed only as a rating.

**Table 5 Upper Pack River Adverse Conditions**

| CWE Watersheds | Temperature Adverse Condition | Nutrient Adverse Condition | Fine Sediment Adverse Condition | Hydrologic Adverse Condition |
|---|---|---|---|---|
| Homestead Creek (Crew 1) | Yes | N/A | Yes | Yes |
| Homestead Creek (Crew 2) | Yes | N/A | Yes | No |
| Lindsey Creek (Crew 1) | Yes | N/A | N/A | No |
| Lindsey Creek (Crew 2) | Yes | N/A | N/A | No |
| Martin Creek | Yes | N/A | N/A | No |

## 4.2 Biological Data

Table 6 summarizes the individual metric scores that are components to the SMI used in the WBAG process. Figure 3 is a graphical representation of the individual metric scores plotted with the average metric scores of streams assessed to be full support within the Pend Oreille Sub-basin. The scores presented are not the raw metric scores but a conversion of the raw scores to a similar scale and scoring for this ecoregion. The full explanation of how these scores are derived can be found in the WBAG II document (Grafe et al 2002b). Youngs Creek and the Upper Pack River site have metric scores similar to those found in full support streams within the basin. The individual metric scores for Martin Creek are significantly lower than similar streams. Martin Creek is dominated by Chironmidae, Oligocheata, and Diptera. These taxa are all sediment tolerant taxa. There are only two taxa in the sample that are moderately intolerant to fine sediment. Youngs Creek and the Upper Pack River have more diverse fauna with a mixture of sediment tolerant and intolerant taxa.

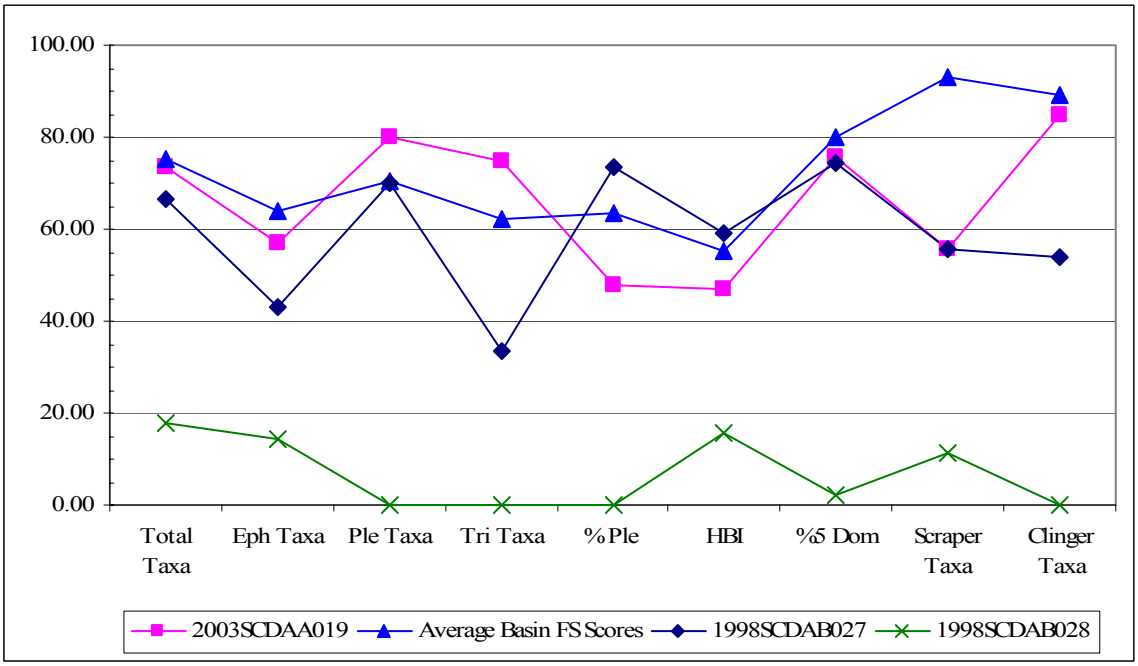
The BURP crew captured Rainbow trout in Martin Creek and Cutthroat trout in Youngs Creek and the Upper Pack River.

**Table 6 Summary of Individual Metric Scores for Upper Pack River**

| BURPID | Total Taxa | Ephemeroptera Taxa | Plecoptera Taxa | Trichoptera Taxa | % Plecoptera | HBI | % Dominance of top 5 taxa | Scraper Taxa | Clinger Taxa | SMI |
|---|---|---|---|---|---|---|---|---|---|---|
| 1998SCDAB027 (Youngs Creek) | 66.67 | 42.86 | 70.00 | 33.33 | 73.34 | 59.17 | 74.18 | 55.56 | 53.85 | 58.77 |
| 1998SCDAB028 (Martin Creek) | 17.78 | 14.29 | 0.00 | 0.00 | 0.00 | 15.61 | 2.16 | 11.11 | 0.00 | 6.77 |
| 2003SCDAA019 (Pack River) | 73.33 | 57.14 | 80.00 | 75.00 | 47.81 | 47.15 | 75.81 | 55.56 | 84.62 | 66.27 |
| Average Basin Scores for Full Support Sites | 75.4 | 63.8 | 70.6 | 62.0 | 63.4 | 55.1 | 79.9 | 93.1 | 89.2 | 72.5 |

Note: The scores range from 0 to 100 and are compared to reference streams within the Bioregion. They are not the raw metric scores.

**Figure 3 Individual Metric Scores of Upper Pack River Compared to the Average Score of BURP sites with SMI scores >2 for the Pend Oreille Sub-basin**



### 4.3 Water Chemistry

Total Phosphorus and Total Nitrogen concentrations were measured from the Upper Pack River near Martin Creek in August 2006. The water chemistry and field data from this monitoring effort can be found in Table 7. The water chemistry data do not indicate that excessive nutrients are a problem within Upper Pack River. The nutrient levels are low for Upper Pack River. Phosphorus concentrations were found to be 4 µg/L and total nitrogen less than 0.1 mg/L. Specific conductance, another measure of anthropogenic impacts to a watershed, was extremely low and indicative of an unimpacted system. We were unable to locate any nutrient data for Martin or Youngs Creek.

**Table 7 Water Chemistry and Field Parameter Results from August 2006**

| Date | Temperature ($^{o}$C) | pH | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% Saturation) | Specific Conductance (µs) | Total Nitrogen (mg/L) | Total Phosphorus (mg/L) |
|---|---|---|---|---|---|---|---|
| 8/9/2006 | 22.47 | 6.84 | 7.38 | 92.5 | 21 | <0.1 | 0.004 |
| 8/23/2006 | 18.65 | 7.14 | 7.98 | 93.8 | 23 | <0.1 | 0.004 |

A review of the mine inventory for Upper Pack River does not indicate a history of mining activity within the watershed; therefore, it is unlikely that metal loading is a concern.

## SECTION 5.0 ANALYSIS

This section investigates each potential cause to determine which ones are supported by the evidence found within the watershed and the current understanding of aquatic ecosystem function.

### 5.1 Stressor Refinement

Of the seven candidate stressors identified in Section 3.0, we have found sufficient evidence to remove excessive nutrients and high metal concentrations from the list of potential stressors. This decision was based on the extremely low nutrient concentrations found during the 2006 sample events as well as the lack of evidence of historical mining operations within the watershed.

### 5.2 Candidate Cause Elimination

**Low nutrients resulting in low fish and macroinvertebrate abundance**.

The nutrient values found in the Upper Pack River are extremely low. The phosphorus concentrations would classify this stream as ultra-oligotrophic. It is likely that the nutrient levels found within the Upper Pack River are limiting primary production and subsequent secondary production which could result in low macroinvertebrate and fish densities. Since the SMI is very sensitive to changes in abundance and taxa richness, low productivity could result in low abundance. This did not appear to be the case in the Upper Pack River or Youngs Creek. There is low abundance in Martin Creek but the taxa composition does not point to low nutrient concentrations as a potential stressor.

**Increased flood frequency and maximum stream flows with a concomitant decrease in base flows.**

In 1988, a paper was published in Northwest Science that looked at the hydrologic conditions before and after the 1967 Sundance fire (Campbell and Morris 1988). The paper concluded that there was no change in the overall runoff from the watershed but that there appeared to be a shift in the timing of peak flows to occur five days earlier on average than pre-fire; however, the difference was not statistically significant. Based on this study, it seems unlikely that the impairment of the use is due to a large change in the hydrology of the system.

**Increased sediment delivery and percent fines.**

The Upper Pack River had relatively few fines within the stream channel. One would not expect the levels found within the Upper Pack River to impact the aquatic community. The level of fines found in both Youngs and Martin Creeks are at levels expected to impair the beneficial uses. Many researchers have concluded that values in excess of 25% to be the point where the aquatic community becomes impaired (Relyea, personal communication, 2004). The fact that

Youngs Creek had an acceptable aquatic community but Martin Creek did not is difficult to reconcile with the percent fines in found in both streams.

TerraGraphics has determined that excess fine sediment is a likely stressor to Martin Creek and is also stressing Youngs Creek even though the aquatic community does not exhibit the typical response. We do not believe excess sediment is impairing the Upper Pack River.

**Reduction in riparian cover, shift in riparian plant species, lower quality shade.**

TerraGraphics was unable to locate historical information regarding the riparian shade within the Youngs Creek or Martin Creek watersheds; however we know that both of these watersheds were impacted by the Sundance fire of 1967 and subsequent logging operations. The BURP data indicate that the canopy closure was between 60 and 65%.

The Upper Pack River was assessed in 2003 by Golder Associates. They found that the area around the Upper Pack River BURP site is a western red cedar community. The range was 88% to 22% Cedar followed by willow and Sitka Spruce. Late seral stages ranged from 88% to 24%. Seventy-five percent of the reaches in the Upper Pack had late Seral vegetation in excess of 60%. This indicates that the riparian community is well established.

The information we have indicates that the Upper Pack is not significantly impacted by increased stream temperatures. It is possible that the fire and logging operations within Youngs and Martin Creeks have increased stream temperature but no data exist to support that contention and the riparian canopy closure is similar to values seen in streams that support their beneficial uses.

TerraGraphics does not believe that loss of riparian vegetation is the primary stressor on the aquatic community in this assessment unit.

**Ineffective sampling or inappropriate reference stream reaches for comparison.**

The BURP protocol and the WBAG scoring systems were derived to deal with the most common stream types within Idaho. These are typically streams with gradients of 1-4% and with a gravel/cobble substrate. Upper Pack River, Youngs Creek and Martin Creek are characteristic of the types of streams that BURP and WBAG were developed to assess.

Based on the conditions within this assessment unit, we have determined that the application of the BURP sampling protocol and the WBAG process was appropriate.

## SECTION 6.0 CONCLUSIONS

Based on the analysis of existing biological, chemical, habitat, and watershed conditions, we have determined that the most likely candidate for the low SMI and SFI scores for Martin Creek is excessive sediment. Even though Youngs Creek aquatic community does not exhibit impairment, we believe that it is receiving excessive sediment based on the large amount of fine material in the stream bed. The Upper Pack River appears to be in good condition and does not require additional sediment reduction.

Based on our analysis, we believe that the development of a TMDL for sediment is appropriate for the lower portion of assessment unit 17010214PN41_02. This would include the Martin, Youngs, Lindsey, Pearson and Homestead watersheds. The Northern boundary would be near the northern extent of the Sundance Fire.

## SECTION 7.0 REFERENCES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