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Water Resources Program

Water Quality Monitoring

Environmental Stewards – Rutgers EcoComplex
June 6, 2007
Physical, Chemical, & Biological Monitoring
Physical Monitoring – Stream Visual Assessment

**Stream Visual Assessment Protocol**

- **Owner's Name**: Eimer Smith
- **Evaluator's Name**: Mary Scaifeh
- **Date**: 6-20-99
- **Stream Name**: Camp Creek
- **Waterbody ID Number**: 
- **Reach Location**: About 2,000 feet upstream of equipment shed
- **Ecoregion**: Drainage area 2,200 acres, Gradient 1.2% (map)
- **Applicable Reference Site**: Cherry Creek north of the Rte 310 bridge
- **Land Use within Drainage Area**: 40% row crop, 30% grazing, 20% forest, 10% residential
- **Past 2-6 days**: Clear
- **Active Channel Width**: 15 feet
- **Dominant Substrate**: Boulder, gravel, sand, silt, mud

![Site Diagram]

Physical Monitoring – Stream Visual Assessment Protocol

Assessment Scores

<table>
<thead>
<tr>
<th>Channel condition</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrologic alteration</td>
<td>10</td>
</tr>
<tr>
<td>Riparian zone</td>
<td>1</td>
</tr>
<tr>
<td>Bank stability</td>
<td>5</td>
</tr>
<tr>
<td>Water appearance</td>
<td>3</td>
</tr>
<tr>
<td>Nutrient enrichment</td>
<td>7</td>
</tr>
<tr>
<td>Barriers to fish movement</td>
<td>10</td>
</tr>
<tr>
<td>Instream fish cover</td>
<td>3</td>
</tr>
</tbody>
</table>

| Pools | 3 |
| Insutebrate habitat | 7 |

Score only if applicable

- Canopy cover | 3 |
- Mammal presence | 1 |
- Vertebrates | blank |
- Riffle embeddedness | 5 |
- Macroinvertebrates observed (optional) | 10 |

Overall score

| (Total divided by number scored) | 76/14 | 5.4 |

Assessment

| Poor | 0-6.0 |
| Fair | 6.1-7.4 |
| Good | 7.5-8.9 |
| Excellent | >8.0 |

Suspected causes of observed problems:

- This reach is typical of the reaches on the property. Severe degraded riparian zones lack brush, small trees. Some bank problems from livestock access.
- Channel may be widening due to high sediment load. Does not appear to be downcutting.

Recommendations:

- Install 391-Riparian Forest Buffer. Need to encourage livestock away from stream using water sources and shade or exclude livestock. Concentrated flows off fields need to be spread out in zone 3 of buffer. Relocate fallen trees if they deflect current into bank. Use stream barbs to deflect current to maintain channel.

Chemical Monitoring

Typically monitor for the following parameters:

**Nitrogen Series** - ammonia-N, nitrite-N, nitrate-N, total kjeldahl nitrogen

**Phosphorus Series** - total phosphorus, dissolved ortho-phosphate

**Bacteria** – fecal coliform, *E. coli*

**Additional Parameters** - total suspended solids, total dissolved solids, alkalinity, chlorophyll-a, pH, temperature, dissolved oxygen

*Values are then compared to the Surface Water Quality Standards.*
What is a Biological Assessment?

• Evaluation of the health of instream aquatic life

• Monitoring of indigenous aquatic biota (e.g., fish, benthic macroinvertebrates, algae)

• If an impairment is found, then additional chemical and physical testing can be done to:
  
  ► identify the causative agent(s),
  ► locate the source(s), and
  ► provide adequate information to formulate a mitigation plan.

• After mitigation, a biological assessment can provide an evaluation of the effectiveness of the control measures taken.
Part 1: Habitat Assessment

• Habitat quality is a major factor contributing to the results of a biological assessment.

• Habitat degradation (e.g., channelization, siltation, lack of shading, etc.) alone can account for biological impairment in a stream.

• Habitat parameters are examined and include an evaluation of substrate and instream cover, channel morphology, and riparian and bank structure.

• Each parameter is scored and summed to produce a total score which is assigned a habitat quality category of optimal (excellent), suboptimal (good), marginal (fair), or poor.
Part 1: Habitat Assessment

1. Epifaunal Substrate/Available Cover-Low Gradient

   Optimal Range
   Poor Range
Part 1: Habitat Assessment

2. Pool Substrate Characterization—Low Gradient

Optimal Range

Poor Range

(Mary Kay Corazalla, U. of Minn.)
Part 1: Habitat Assessment

3. Pool Variability--Low Gradient

Optimal Range

Poor Range

(Peggy Morgan, FL DEP)

(William Taft, IN DEM)
Part 1: Habitat Assessment

4. Sediment Deposition -- Low Gradient

Optimal Range

Poor Range

(arrows pointing to sediment deposition)
Part 1: Habitat Assessment

5. Channel Flow Status--Low Gradient

Optimal Range

Poor Range

(James Stahl, IN DEM)
Part 1: Habitat Assessment

6. Channel Alteration--Low Gradient

Optimal Range

Poor Range

(John Maxted, DE DNREC)
Part 1: Habitat Assessment

7. Channel Sinuosity--Low Gradient

Optimal Range

Poor Range
Part 1: Habitat Assessment

8. Bank Stability (condition of banks) -- Low Gradient

Optimal Range

Poor Range

(Peggy Morgan, FL DEP)
Part 1: Habitat Assessment

9. Bank Vegetative Protection--Low Gradient

Optimal Range  Poor Range

(Peggy Morgan, FL DEP)  (MD Save Our Streams)
Part 1: Habitat Assessment

10. Riparian Vegetative Zone Width--Low Gradient

Optimal Range

Poor Range
Part 2: Biosurvey

Advantages of Using Benthic Macroinvertebrates as Indicators of Water Quality:

• Benthic macroinvertebrates are an important part of the community of life found in and around a stream.
  ► They are normally abundant in most natural surface waters.
  ► They serve as the primary food source for many recreationally and commercially important fish species.

• Benthic macroinvertebrates differ in their sensitivity to water pollution.
  ► They are sensitive to both point and non-point sources of pollution.
  ► They can be used to assess non-chemical impacts to the benthic habitat, such as thermal pollution or excessive siltation from sediment loading.
Part 2: Biosurvey

Advantages of Using Benthic Macroinvertebrates as Indicators of Water Quality:

• Benthic macroinvertebrates provide information about the quality of a stream over long periods of time.

  ► They are good indicators of localized conditions of water quality due to their limited mobility. They can’t swim away like fish!
Part 2: Biosurvey

Advantages of Using Benthic Macroinvertebrates as Indicators of Water Quality:

• Benthic macroinvertebrates are relatively easy to collect.
Part 2: Biosurvey

Multihabitat approach to benthic sampling:

- **Cobble (hard substrate)** - Cobble will be prevalent in the riffles (and runs), which are a common feature throughout most mountain and piedmont streams. In many high-gradient streams, this habitat type will be dominant. However, riffles are not a common feature of most coastal or other low-gradient streams. Sample shallow areas with coarse (mixed gravel, cobble or larger) substrates by holding the bottom of the dip net against the substrate and dislodging organisms by kicking the substrate for 0.5 m upstream of the net.

- **Snags** - Snags and other woody debris that have been submerged for a relatively long period (not recent deadfall) provide excellent colonization habitat. Sample submerged woody debris by jabbing in medium-sized snag material (sticks and branches). The snag habitat may be kicked first to help dislodge organisms, but only after placing the net downstream of the snag. Accumulated woody material in pool areas are considered snag habitat. Large logs should be avoided because they are generally difficult to sample adequately.
Part 2: Biosurvey

Multihabitat approach to benthic sampling:

- **Vegetated banks** - When lower banks are submerged and have roots and emergent plants associated with them, they are sampled in a fashion similar to snags. Submerged areas of undercut banks are good habitats to sample. Sample banks with protruding roots and plants by jabbing into the habitat. Bank habitat can be kicked first to help dislodge organisms, but only after placing the net downstream.

- **Sand (and other fine sediment)** - Usually the least productive macroinvertebrate habitat in streams, this habitat may be the most prevalent in some streams. Sample banks of unvegetated or soft soil by bumping the net along the surface of the substrate rather than dragging the net through soft substrates; this reduces the amount of debris in the sample.
Part 2: Biosurvey

Multihabitat approach to benthic sampling:

- **Submerged macrophytes** - Submerged macrophytes are seasonal in their occurrence and may not be a common feature of many streams, particularly those that are high-gradient. Sample aquatic plants that are rooted on the bottom of the stream in deep water by drawing the net through the vegetation from the bottom to the surface of the water (maximum of 0.5 m each jab). In shallow water, sample by bumping or jabbing the net along the bottom in the rooted area, avoiding sediments where possible.
Macroinvertebrates Sensitive to Pollution

Found in good quality water:
Macroinvertebrates Somewhat Sensitive to Pollution

Found in good to fair quality water:
Macroinvertebrates Tolerant of Pollution

Found in any quality water:

[Images of various macroinvertebrates]
Several community measures or biometrics are used to evaluate biological condition:

**Taxa Richness** – How many families?

*A reduction in taxa richness typically indicates pollution.*

**EPT** (Ephemeroptera, Plecoptera, Trichoptera) Index – How well are the mayflies, stoneflies, and caddisflies represented?

*These organisms are very sensitive to pollution.*

**%EPT** – How abundant are the mayflies, stoneflies, and caddisflies?

*Decreases in %EPT have been noted for relatively minimal increases in organic and/or toxic pollutants.*

**%CDF** – How balanced is the community?

*A healthy community is characterized by a diverse number of taxa that have abundances somewhat proportional to each other.*

**Family Biotic Index** – Measure of pollution tolerance.
Three Categories of Biological Condition for New Jersey Streams:

**Non-impaired:** A non-impaired site has a benthic community comparable to other undisturbed streams within the region.
- high # of species/taxa
- individuals are evenly distributed among the taxa
- sensitive species are well represented

**Moderately Impaired:** Moderately impaired sites are characterized by reduced taxa richness, in particular the EPT taxa.
- ↓ in EPT
- less sensitive species are more dominant

**Severely Impaired:** A severely impaired site is one in which the benthic community has undergone a dramatic change.
- low # of species/taxa
- #'s can be high (dominance) or low (paucity of organisms)
- dominated by pollution tolerant species
Causes of Impairment

1. Degraded habitat
   a. lack of stable and varied substrate
   b. lack of bank vegetation/canopy (= poor bank stability, lack of shade)
   c. excessive sedimentation (= poor substrate and water clarity)
   d. lack of streamflow (= low water level, low dissolved oxygen, possible sedimentation, undesirable vegetation)

2. Eutrophication (= excessive nutrients promoting undesirable vegetation or algal blooms, and increased turbidity)

3. Domestic (organic) waste (promotes hypoxia, turbidity, eutrophication)

4. Physiochemical water quality factors which, alone or in combination, can have adverse effects
   a. higher than normal temperature
   b. excessive turbidity
   c. lack of dissolved oxygen
   d. presence of toxicants (in various chemical forms)
Causes of Impairment

Inter-related human activities or practices, land uses, and natural features or events contributing to degraded stream quality:

1. Deforestation/development/construction (largely via runoff from non-point sources)
2. Urbanization/industrialization (largely via runoff from non-point sources)
3. Agricultural operations (largely via runoff from non-point sources)
4. Municipal or industrial wastewater discharge (from point source)
5. Artificial channelization or habitat alteration
6. Upstream impoundment, lake or pond
7. Drought conditions
AMNET – Lower Delaware Water Region

Source: NJDEP, 2003, Ambient Biomonitoring Network Lower Delaware Region 2000-2001 Benthic Macroinvertebrate Data
AMNET – Lower Delaware Water Region

Source: NJDEP, 2003,
Ambient Biomonitoring Network
Lower Delaware Region 2000-
2001 Benthic Macroinvertebrate
Data
AMNET – Watershed Management Area 18

Pennsauken Creek, Cooper River, Big Timber, Mantua, & Racoon Creeks Watersheds

Source: NJDEP, 2003, Ambient Biomonitoring Network Lower Delaware Region 2000-2001 Benthic Macroinvertebrate Data
AMNET – Watershed Management Area 18

Watershed Management Area 18
1993/1996 Bioassessment Results
(53 total sites)

- Severely impaired: 34.0%
- Moderately impaired: 64.1%
- Non-impaired: 1.9%

Watershed Management Area 18
2001 Bioassessment Results
(52 total sites)

- Severely impaired: 26.9%
- Moderately impaired: 71.2%
- Non-impaired: 1.9%

Source: NJDEP, 2003, Ambient Biomonitoring Network Lower Delaware Region 2000-2001 Benthic Macroinvertebrate Data
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<tbody>
<tr>
<td>Non-Impaired</td>
<td>1</td>
<td>1</td>
<td>Optimal</td>
<td>9</td>
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<tr>
<td></td>
<td>1.9%</td>
<td>1.9%</td>
<td></td>
<td>17.3%</td>
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<tr>
<td>Moderate</td>
<td>34</td>
<td>37</td>
<td>Suboptimal</td>
<td>32</td>
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<td></td>
<td>64.1%</td>
<td>71.2%</td>
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<td>61.5%</td>
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<tr>
<td>Severe</td>
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<td>14</td>
<td>Marginal</td>
<td>11</td>
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<tr>
<td></td>
<td>34.0%</td>
<td>26.9%</td>
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<td>21.2%</td>
</tr>
<tr>
<td>Poor</td>
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Source: NJDEP, 2003, Ambient Biomonitoring Network Lower Delaware Region 2000-2001 Benthic Macroinvertebrate Data
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