A mayfly captured at Greens Creek Site 48 in 2012.
Aquatic Biomonitoring Program

- Purpose
- Location and monitoring schedule
- Program components
- 2012 results
- Comparisons among sites
- Trends in the data
- Recommendations
Purpose of the program

To document the condition of aquatic biological communities in Greens Creek and Tributary Creek near mine development and operations.
Program Components

- Juvenile fish whole body metals concentrations
- Juvenile fish populations
- Aquatic insect density and community composition
- Periphyton biomass and chlorophyll-type
Program components

- Periphyton biomass and chlorophyll-type
Program components

- Aquatic insect density and community composition

Rick Hoffman (ADF&G Habitat Intern) sampling aquatic insects

EPT taxa

- Ephemeroptera (mayflies)
- Plecoptera (stoneflies)
- Trichoptera (caddisflies)
Program components

- Juvenile fish populations
- Juvenile fish whole body metals:
  - Ag
  - Cd
  - Cu
  - Hg
  - Pb
  - Se
  - Zn
2012 sample sites

GC Site 48

GC Site 54

TC Site 9
2012 Stream Flow

Greens Creek Mean Daily Discharge (ft³/s)
2001-2012 Stream flow
NRCS Alaska Snowpack Map
Greens Creek Site 48
GC Site 48 – Periphyton biomass

![Chlorophyll a (mg/m²) over time](chart.png)
GC Site 48 – Periphyton chlorophylls

![Bar chart showing periphyton biomass from 2001 to 2012 for chlor-a, chlor-b, and chlor-c. The chart demonstrates the percentage distribution of chlorophylls across the years.]
GC Site 48 – Aquatic insect density and number of taxa

![Graph showing aquatic insect density and number of taxa over time.](image-url)
GC Site 48 – Aquatic insect community
GC Site 48 – Juvenile fish populations

[Graph showing Juvenile Fish Population Estimate from 2001 to 2012 for Dolly Varden char]
GC Site 48 – Juvenile fish metals concentrations

- **Ag (mg/kg)**
  - 0.00
  - 0.03
  - 0.06
  - 0.09
  - 0.12
  - ND

- **Pb (mg/kg)**
  - 0
  - 1
  - 2
  - 3
  - 4

- **Cd (mg/kg)**
  - 0
  - 10
  - 20
  - 30
  - 40
  - 50
  - 60
  - 70
  - 80
  - 90
  - 100

- **Cu (mg/kg)**
  - 0.00
  - 0.04
  - 0.08
  - 0.12
  - 0.16
  - 0.20

- **Hg (mg/kg)**
  - 0
  - 100
  - 200
  - 300
  - 400

- **Se (mg/kg)**
  - Cu 5/6
  - Pb 1/6
  - Cd 2/6
GC Site 48 – 2012 Summary

- Upstream of mine development and operations
- 2012 periphyton mean density lowest observed since 2001
- Aquatic insect density and richness within range observed since 2001
- EPT remains ~90%
- Fish population within range observed since 2001
- High values of Cd, Cu, and Pb in whole body juvenile DV suggest contamination
Greens Creek Site 54
GC Site 54 – Periphyton biomass
GC Site 54 – Periphyton chlorophylls

Periphyton Biomass

 chlor-a
 chlor-b
 chlor-c

GC Site 54 – Aquatic insect density and number of taxa
GC Site 54 – Aquatic insect community

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**Graph Description:**

- **Y-axis:** Benthic Macroinvertebrates / m²
- **X-axis:** Years 2001 to 2012
- **Legend:**
  - Ephemeroptera
  - Plecoptera
  - Trichoptera
  - Aq. Diptera
  - Other

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**Data Analysis:**

- The graph shows the percentage of different aquatic insect communities over the years from 2001 to 2012.
- Ephemeroptera and Plecoptera consistently contribute the highest proportion, with Trichoptera, Aq. Diptera, and Other categories following suit.
- No specific trend or decline is evident from the years displayed.
GC Site 54 – Juvenile fish populations

Dolly Varden char  Coho salmon

<table>
<thead>
<tr>
<th>Year</th>
<th>Dolly Varden char</th>
<th>Coho salmon</th>
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<td>2007</td>
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<tr>
<td>2008</td>
<td>4</td>
<td>1</td>
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<tr>
<td>2009</td>
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</tr>
<tr>
<td>2010</td>
<td>5</td>
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<tr>
<td>2011</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td></td>
<td></td>
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</tbody>
</table>
In 2010, a brown bear destroyed 8/29 (28%) minnow traps during third pass.

In 2011, we extended the 28m reach to 50m.

In 2012, we sampled the same reach as 2011.
GC Site 54 – Juvenile fish metals concentrations

- Ag (mg/kg): ND, 0.03, 0.06, 0.09, 0.12
- Cu (mg/kg): 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0
- Cd (mg/kg): 0, 10, 20, 30, 40, 50
- Pb (mg/kg): 0.00, 0.03, 0.06, 0.09, 0.12, 0.15
- Hg (mg/kg): 0, 100, 200, 300, 400
- Zn (mg/kg): 0, 3, 6, 9, 12
- Se (mg/kg): Cu 2/6, Cd 2/6, Se 1/6
GC Site 54 – 2012 Summary

- Downstream of portal development and operations
- 2012 periphyton mean density low, within range
- Aquatic insect density low, richness high
- EPT remains ~90%
- DV populations greater in 2011 and 2012*
- High values of Cd, Cu, and Se in whole body juvenile DV suggest contamination
Tributary Creek Site 9
New beaver activity upstream of Site 9
TC Site 9 – Periphyton biomass
TC Site 9 – Periphyton chlorophylls

The diagram shows the percentage of periphyton biomass attributed to different chlorophyll types (chlor-a, chlor-b, chlor-c) for each year from 2001 to 2012. The y-axis represents the percentage of periphyton biomass, ranging from 0% to 100%, while the x-axis represents the years from 2001 to 2012.
TC Site 9 – Aquatic insect density and number of taxa
TC Site 9 – Aquatic insect community
TC Site 9 – Aquatic insect community

The chart shows the mean benthic macroinvertebrates per square meter from 2001 to 2012. The categories include Ephemeroptera, Plecoptera, Trichoptera, Aquatic Diptera, Other, and Taxa. The graph indicates a peak in the number of taxa in 2003.
TC Site 9 – Juvenile fish populations

Juvenile Fish Population Estimate

- Dolly Varden char
- Coho salmon
TC Site 9 – Juvenile fish metals concentrations

- Cu concentrations:
  - 4/6

- Metal concentrations (mg/kg):
  - Ag: 0.0 - 1.0
  - Cd: 0 - 75
  - Cu: 0 - 4
  - Hg: 0 - 300
  - Pb: 0 - 5
  - Se: 0 - 12
  - Zn: 0 - 400
TC Site 9 – 2012 Summary

- Downstream of tailing storage facility
- 2012 periphyton mean density similar to values observed since 2006
- Aquatic insect density and richness similar to values observed in all years, except 2003
- EPT ~53% (ranged 50-80% 2001-2011)
- Fish populations similar to previous years
- High values of Cu in whole body juvenile DV suggest contamination
Comparisons among Greens Creek sites
Samples from both sites contained about 90% chlor-a, nearly 0% chlor-b, and about 10% chlor-c.
Greens Creek aquatic insect densities
Greens Creek aquatic insect taxa
Greens Creek DV populations
NEW IN 2012
Juvenile fish condition, ALL SITES

Several factors influence fish health:
- Age
- Sex
- Season
- Diet
- Fat reserve, etc...

Site 48 DV = 1.03 g/mm³
Site 54 DV = 1.08 g/mm³
Site 9 DV = 1.00 g/mm³
Site 9 CO = 1.14 g/mm³
Three trophic (productivity) levels

Finally, juvenile fish metals concentrations
Juvenile fish median whole body [Ag]
Juvenile fish median whole body [Cd]
Juvenile fish median whole body [Cu]
Juvenile fish median whole body [Hg]
Juvenile fish median whole body [Pb]
Juvenile fish median whole body [Se]

![Graph showing Se (mg/kg) from 2001 to 2012 for Site 48, Site 54, and Site 9. The graph illustrates the variation in Se levels across different sites and years.]
Juvenile fish median whole body [Zn]
Trends among the data

- In Greens Creek, differences between years are generally greater than between sites.
- High flows prior to sampling appear to affect periphyton densities more than aquatic insect densities.
- Some adult coho transit the fishpass.
- Tributary Creek fish populations more variable than periphyton density, or aquatic insect density and richness.
2011 Recommendations

- Compare water quality data with biological abundance and composition data, and
- Compare water quality data with whole body fish metals concentrations data.
Greens Creek Site 48 WQ and fish [metals]

\[ p = 0.0092 \]
Greens Creek Site 54 WQ and fish [metals]
Tributary Creek Site 9 WQ and fish [metals]
2012 Recommendations

- Compare water quality data with periphyton density data and with aquatic insect density & composition data
- Measure sediment metals concentrations
- Test for significant positive correlations between juvenile fish metals concentrations and years
Thank you

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ADF&G Dan Reed for biometric review.
Questions?