Aquatic Studies at Kensington Mine, 2012
Presented by Kate Kanouse (ADF&G)
Aquatic Studies Program

- Purpose
- Study area
- Aquatic studies required
- Other studies
- 2012 results
- TTF algal bloom
- Take-home messages
- Recommendations for 2013
Purpose

To document the condition of aquatic biological communities and sediments near mine development and operations.
Study Area
Aquatic studies required

2012 studies required by:
- Plan of Operations (2005 - ongoing)
- APDES Permit (2011 - ongoing)
Plan of Operations annual studies include:

- Adult salmon counts (July – Nov)
- Photographs of anadromous fish habitat (year-round)

Aquatic studies required

Habitat biologist
Gordon Willson-Naranjo
Aquatic studies required

APDES annual studies include:

- Pink salmon spawning substrate quality (July)
- Fine sediment composition, [metals, Se, As], and toxicity (July)
- Dolly Varden char whole body [metals, Se] (August)
- Resident fish population & condition (August)
- Aquatic insect density & richness (May)
- Periphyton biomass and chlorophyll-type (July)
Aquatic studies required

- Periphyton biomass and chlorophyll-type

Habitat biologist Tess Quinn
Aquatic studies required

- Aquatic insect density and community composition

Habitat biologist Greg Albrecht

EPT taxa

Ephemeroptera (mayflies)

Plecoptera (stoneflies)

Trichoptera (caddisflies)
Aquatic studies required

- Resident fish populations and fish condition
- Juvenile fish whole body [metals, Se]:
  - Ag
  - Al
  - Cd
  - Cr
  - Cu
  - Hg
  - Ni
  - Pb
  - Se
  - Zn
Aquatic studies required

- Pink salmon spawning substrate quality

Habitat biologist Greg Albrecht

Habitat biologist Gordon Willson-Naranjo
Aquatic studies required

- Fine sediment composition, [metals, Se, As], and toxicity

Habitat biologist Kate Kanouse
Other Aquatic Studies: Slate Cove, 7/7/11

Photo by CF Haines AMB Randy Bachman
Other Aquatic Studies: TTF algal bloom 7/28/11
Other Aquatic Studies: TTF algal bloom 7/2/12
Upper Slate Lake, 9/13/12
2012 Results

Sherman Creek
East Fork Slate Creek MDD during the month of July, 2012.
Slate Creek

(# sample sites in parentheses)

- Periphyton (4)
- Aquatic insects (4)
- Resident fish (2)
- Resident fish [metals] (3)
- Sediment [metals, Se, As] and toxicity (3)
- Adult salmon counts (1)
- Pink salmon spawning sub. (1)
Lower Slate Creek - periphyton
East Fork Slate Creek - periphyton

Chlorophyll a (mg/m²)

Periphyton Biomass

chlor-a  chlor-b  chlor-c
West Fork Slate Creek - periphyton

Chlorophyll a (mg/m²)

- 7/29/11
- 7/25/12

Periphyton Biomass

- chlor-a
- chlor-b
- chlor-c
Upper Slate Creek - periphyton

Chlorophyll a (mg/m²)

Periphyton Biomass

- chlor-a
- chlor-b
- chlor-c
Slate Creek - aquatic insects
Lower Slate Creek - aquatic insects

Number of taxa:

<table>
<thead>
<tr>
<th></th>
<th>May 2011</th>
<th>Feb 2012</th>
<th>May 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other</td>
<td>14%</td>
<td>38%</td>
<td>38%</td>
</tr>
<tr>
<td>Aquatic Diptera</td>
<td>29</td>
<td>30</td>
<td>32</td>
</tr>
<tr>
<td>Trichoptera</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Plecoptera</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Ephemeroptera</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>
East Fork Slate Creek - aquatic insects

Mean Benthic Macroinvertebrates / m²

Number of taxa:

- May 2011: 27 taxa (19%)
- Feb 2012: 33 taxa (22%)
- April 2012: 33 taxa (23%)

Categories:
- Other
- Aquatic Diptera
- Trichoptera
- Plecoptera
- Ephemeroptera
West Fork Slate Creek - aquatic insects

Habitat biologist Ben Brewster

Number of taxa:

- May 2011: 21 taxa, 80%
- May 2012: 31 taxa, 80%

Mean Benthic Macroinvertebrates / m²

- Other
- Aquatic Diptera
- Trichoptera
- Plecoptera
- Ephemeroptera

Graph showing the distribution of taxa and their abundance over two years.
Upper Slate Creek - aquatic insects

Number of taxa:
33 39

Mean Benthic Macroinvertebrates / m²

- Other
- Aquatic Diptera
- Trichoptera
- Plecoptera
- Ephemeroptera

63% 68%
Slate Creek – DV populations
East Fork Slate Creek – DV population

Fish condition (g/mm³):
1.11
1.08

Population Estimate

<table>
<thead>
<tr>
<th>Year</th>
<th>Riffles</th>
<th>Pools</th>
<th>Glides</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>12</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>2012</td>
<td>24</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>
Upper Slate Creek– DV population

Fish condition (g/mm³):
1.05 0.99
Lower Slate Creek – DV [silver]

(pink data points are the 2011 values)
Lower Slate Creek – DV [aluminum]

(pink data points are the 2011 values)
Lower Slate Creek – DV [cadmium]

(pink data points are the 2011 values)
Lower Slate Creek – DV [chromium]

(pink data points are the 2011 values)
Lower Slate Creek – DV [copper]

(pink data points are the 2011 values)
Lower Slate Creek – DV [mercury]

(pink data points are the 2011 values)
Lower Slate Creek – DV [nickel]

[pink data points are the 2011 values]
Lower Slate Creek – DV [lead]

(pink data points are the 2011 values)
Lower Slate Creek – DV [selenium]

(pink data points are the 2011 values)
Lower Slate Creek – DV [zinc]

(pink data points are the 2011 values)
Lower Slate Creek – sediment [metals, Se, As]

2011
- Aluminum: 13,600,000
- Zinc: 220,000
- Silver: 0.134
- Selenium: 0.720
- Nickel: 47.400
- Mercury: 0.050
- Lead: 7.790
- Other: 379.854

2012
- Aluminum: 13,600
- Zinc: 200
- Silver: 0.145
- Selenium: ND
- Nickel: 43.2
- Mercury: 0.0994
- Copper: 50.7
- Lead: 8.45
- Other: 345.12
- Arsenic: 9.31
- Cadmium: 1.22
- Chromium: 32.0
East Fork Slate Creek – sediment [metals, Se, As]

2011
- Aluminum 20,100,000
- Other 1,682,012
- Zinc 1,360,000
- Silver 0.233
- Selenium 1.410
- Nickel 143,000
- Arsenic 30.000
- Cadmium 20.900
- Chromium 29.500
- Lead 8.500
- Copper 88.400
- Mercury 0.069

2012
- Aluminum 15,300
- Other 1,904.07
- Zinc 1,490
- Silver 0.513
- Selenium 0.934
- Nickel 153
- Arsenic 24.0
- Cadmium 23.2
- Chromium 38.9
- Lead 14.2
- Copper 159
- Mercury 0.327
Upper Slate Creek – sediment [metals, Se, As]

2011
- Aluminum: 22,500,000
- Other: 420.821
- Lead: 3.370
- Copper: 53.400
- Nickel: 87.500
- Chromium: 127.000
- Zinc: 130.000
- Silver: 0.120
- Selenium: 0.809
- Arsenic: 17.900
- Cadmium: 0.722

2012
- Aluminum: 20,300
- Other: 412.827
- Lead: 4.05
- Copper: 55.4
- Nickel: 78.4
- Chromium: 125
- Zinc: 134
- Silver: 0.132
- Selenium: 0.606
- Arsenic: 14.4
- Cadmium: 0.776
Slate Creek – 2012 sediment [metals, Se, As]

East Fork Slate Creek

Lower Slate Creek

Upper Slate Creek

Habitat Biologist
Ben Brewster
Slate Creek – sediment toxicity

Short-term toxicity testing results for all three sites sampled:

No significant difference in growth or survival of either organism compared to the control.
Lower Slate Creek – Pink salmon spawning substrate quality

Geometric Mean Particle Size (mm)

<table>
<thead>
<tr>
<th>Sample Point 1</th>
<th>Sample Point 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>2012</td>
</tr>
<tr>
<td>10.1</td>
<td>10.9</td>
</tr>
<tr>
<td>10.6</td>
<td>10.9</td>
</tr>
</tbody>
</table>
Lower Slate Creek – adult salmon counts

Pink salmon return estimate = 3,636
Chum salmon return estimate = 1
Coho salmon return estimate = 0
2011 algal bloom in TTF
2011 aquatic vegetation in Slate Creek
TTF water quality results

Chlorophyll a

Total Nitrogen

Control  TTF  TTF 2011  Effluent  EFSC


Total Nitrogen (mg/L)
TTF water quality results

Phosphorus

Potassium

Control TTF Effluent EFSC

Phosphorus (mg/L)

Potassium (mg/L)

Control TTF Effluent EFSC
TTF water quality results

<table>
<thead>
<tr>
<th></th>
<th>Sulfur (mg/L)</th>
<th>Total Organic Carbon (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TTF</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Effluent</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>EFSC</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Graph showing Sulfur and Total Organic Carbon levels](image)
Continuing studies in 2013

- Quarterly periphyton sampling
- Monthly water quality (nutrient) testing
Aquatic insects (1)
Sediment [metals] and tox. (1)
Adult salmon counts (1)
Lower Johnson Creek - sediment [metals, Se, As]

2011
- Aluminum 13,100.000
- Nickel 27.300
- Lead 9.760
- Silver 0.164
- Zinc 93.300
- Copper 73.100
- Arsenic 16.200
- Cadmium 0.238
- Chromium 31.500

2012
- Aluminum 13,100
- Nickel 23.4
- Lead 9.45
- Silver 0.342
- Zinc 97.3
- Copper 76.8
- Arsenic 12.8
- Cadmium 0.250
- Chromium 35.5
Lower Johnson Creek – sediment toxicity

*Chironomus dilutus* (midge)

*Hyalella azteca* (crustacean)

**Short-term toxicity testing results:**
No significant difference in growth or survival of either organism compared to the control.
Lower Johnson Creek - adult salmon counts

Pink salmon return estimate = 6,267
Chum salmon return estimate = 248
Coho salmon return estimate = 90*
Upper Johnson Creek – aquatic insects

Habitat biologists Ben Brewster & Matt Kern

Mean Benthic Macroinvertebrates / m²

Number of taxa:

- May 2011: 24 (55%)
- April 2012: 28 (64%)

- Other
- Aquatic Diptera
- Trichoptera
- Plecoptera
- Ephemeroptera
Sherman Creek

(# sample sites in parentheses)

- Periphyton (2)
- Aquatic insects (2)
- Sediment [metals] and tox. (1)
- Adult salmon counts (1)
Lower Sherman Creek SP1 - periphyton

[Graph showing Chlorophyll a (mg/m²) for 7/28/11 and 7/26/12]

[Bar graph showing Periphyton Biomass for 7/28/11 and 7/26/12]
Lower Sherman Creek SP2 - periphyton

Chlorophyll a (mg/m²)

Periphyton Biomass

7/28/11 7/26/12
Lower Sherman Creek SP1 – aquatic insects

Habitat biologist Matt Kern

Number of taxa:
- May 2011: 26 taxa
- April 2012: 31 taxa

- Other: 32%
- Aquatic Diptera: 66%
- Trichoptera
- Plecoptera
- Ephemeroptera
Lower Sherman Creek SP2 – aquatic insects

Habitat biologist Matt Kern

Number of taxa:
- May 2011: 30 taxa (76%)
- April 2012: 37 taxa (79%)

- Other
- Aquatic Diptera
- Trichoptera
- Plecoptera
- Ephemeroptera
Lower Sherman Creek – sediment [metals, Se, As]

**2011**
- Aluminum: 18,200,000
- Other: 332,226
- Nickel: 45,900
- Lead: 6,700
- Zinc: 110,000
- Copper: 94,000
- Arsenic: 28,900
- Cadmium: 0.389
- Chromium: 46,200

**2012**
- Aluminum: 17,900
- Other: 332,365
- Nickel: 40,2
- Lead: 8,430
- Zinc: 128
- Copper: 79.1
- Arsenic: 24.3
- Cadmium: 0.578
- Chromium: 51.4
Lower Sherman Creek – sediment toxicity

*Chironomus dilutus* (midge)

*Hyalella azteca* (crustacean)

**Short-term toxicity testing results:**

No significant difference in growth or survival of either organism compared to the control.
Lower Sherman Creek – adult salmon counts

Pink salmon return estimate = 804
Take-Home Messages:

- We observed change at several trophic levels in 2012
- Consider weather and stream flow data when interpreting results
- Several new data sets began in 2011 with little pre-mining data to compare
  - More important to compare between years than between sites
  - Whole body juvenile fish [metals] variable
- East Fork Slate Creek sediments generally greatest in [metals, Se, As]
Recommendations for 2013

- Sample second reach in Lower Slate Creek for aquatic insects
- Sample sediment in West Fork Slate Creek for [metals, Se, As]
- Sample sediment in Upper Sherman Creek for [metals, Se, As]
- Same DV in West Fork Slate Creek for [metals, Se]
- Investigate relationship between P and tails deposition in TTF
- Investigate overwintering fish habitat and DV use in East Fork Slate Creek
- Continue to investigate juvenile coho salmon presence in Lower Slate Creek
Thank you

Coeur Alaska, Inc. for funding, the opportunity, and logistical and field assistance,

ADF&G Habitat Biologists for data collection, sample analyses, and technical review, and

ADF&G Dan Reed for biometric review.
Thank you!
Questions?