AIR QUALITY IMPACTS
FRANK CHURCH-RIVER OF NO RETURN WILDERNESS

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LAKE SAMPLING

Lake sampling started in 1985 with the Environmental Protection Agency (EPA) conducting Phase One (Western Lake Survey) of a five-year National Water Survey for acid rain effects. Rain and other precipitation are naturally acidic. The acid rain cycle begins with emissions from sulfur dioxide, coal burning power plants and nitrogen oxide, from vehicles and fossil-fuel power plants into the atmosphere. These two gasses when combined with moisture in the atmosphere produce sulfuric acid and nitric acid, which is then deposited on the earth as "acid rain" (deposition). Within the Wilderness, on the Salmon-Challis National Forest, six lakes were sampled as part of the EPA program for cations, anions, ANC, pH and other measurements. Four lakes are located on granite, one on volcanics and one on quartzite parent material. The results showed that some lakes were extremely sensitive to acid rain "deposition" based on their low, acid neutralizing capacity (ANC), and those were located in granitic watersheds. Lake sampling results showed that parent material (geology) is directly related to the ANC, with volcanics generally having higher ANC and pH. Only two of the EPA tested lakes are influenced by volcanics that are Falconberry and Marble northwest. Only Dome Lake watershed consists of the Yellowjacket Formation of metagraywacke and schist parent material. With the increase in elevation and rainfall, some sites that are of quartzite and granite have low ANC and pH. Calcium and magnesium is generally the most important element found in the soil for neutralizing the acid rain effects, such as found in rain and snow. The lower the calcium / magnesium content in the soil, the higher the potential impact of acid rain effects to the ecosystem, such as found in some granite and quartzite watersheds. Since some lakes showed low ANC, a detailed lake sampling program was started in 1989 and has been an on-going project.

Besides the six wilderness lakes listed in this report that were sampled in 1985 as part of the Phase One, EPA-Western Lakes Survey, and extensive lake monitoring program within the wilderness was started in 1989 on the Challis portion of the forest and in 1994 it included the Salmon portion of the forest. Twenty-nine new lakes were added on the Salmon portion and thirty-five new lakes on the Challis portion of the forest.

The latest major drought started around May 1985 and was terminated the winter of 1994-1995. The following are the nine EPA lakes sampled in 1985: Golden Trout, Harbor, Skyhigh, Dome, Marble (northwest) and Falconberry. Four of the above lakes have been re-sampled: Golden Trout (1994, 1995, 1996, 1998), Harbor (1994-1998), Skyhigh (1994, 1996, 1997, 1998) and Marble (1990). Results show very close similarity to the 1985 Western Lake Survey data. Due to the drought starting in 1985, which produced very low amounts of moisture, the ANC and pH in some of the lakes might be higher than normal years, depending on the geology. During the first spring snowmelt, the runoff is more acidic for a very short time, then after some time, the ANC and pH increases, probably in response to biotic uptake of Nitrogen and Sulfur and due to increased weathering, as flow rates decline and water-mineral contact time increases.

Acid Neutralizing Capacity (ANC) is measured in microequivalents per liter per liter (ueq/l).

EPA Lakes Re-sampled

			ANC	pH
Golden Trout Lake:	September	1985	75	7.1
	July	1994	81	6.8
	July	1995	78	6.2
	September	1996	73	6.1
	August	1998	73	6.6
Harbor Lake:	September	1985	42	6.9
	July	1994	38	6.5
	September	1994	37	6.1
	July	1995	25	5.6
	September	1995	35	6.1
	July	1996	42	6.1
	September	1996	37	6.2
	July	1997	44	6.3
	August	1997	40	6.2
	October	1997	36	6.3
	August	1998	36	6.2
Skyhigh Lake:	September	1985	86	7.1
	July	1994	96	6.8
	August	1996	73	6.0
	October	1997	90	6.8
	August	1998	83	6.7
Falconberry Lake:	October	1985	430	7.9
	August	1990	422	7.7
Marble Northwest:	October	1985	454	7.7
	September	1990	478	7.8

EPA Lake Not Re-sampled

Dome Lake:	September	1985	372	7.8

With less snowpack in 1994, Harbor Lake during July snowmelt showed ANC was 38 microequivalents per liter and in 1995 with higher snowpack the ANC in July was 25 microequivalents per liter. This data suggests that under certain conditions, that the spring snowpack and snowmelt has a direct effect to high elevation granitic lakes, by lowering the

ANC. When we compare the September 1985 ANC for Harbor Lake of 42 microequivalents per liter with September 1995 of 35 microequivalents per liter we find that over a ten-year period the ANC is lower, which might be due to the drought conditions. This decrease was also noticed in Golden Trout Lake with a ANC of 78 microequivalents per liter in 1985 and 73 microequivalents per liter in 1996.

Two lakes, Falconberry and Marble northwest are influenced by volcanics and Dome Lake is of quartzite parent material, which all show high ANC and pH of 7.7. Re-sampling of Falconberry and Marble northeast showed that the lakes did not change over time. Dome Lake was not re-sampled due to the non-sensitive nature of the lake. This data shows that these types of lakes are not affected by acid deposition because of the high amounts of buffering materials like calcium and magnesium. Dome Lake contained 241 microequivalents per liter per liter of calcium and 88 microequivalents per liter of magnesium.

Some lakes pH were lower in July and slightly higher in late summer, showing that some of the lakes are able to maintain the ability to buffer acid rain deposition. Overall, all of the lakes were consistance over the years sampled, with a very slight variation in pH possibly due to specific snow chemistry from climate conditions. The Harbor Lake 4 year early summer average pH was 6.12 while the mid to late summer average was 6.18, thus showing that the lake can maintain the ability to buffer acid rain deposition. Skyhigh Lake in July of 1994 showed a pH of 6.8 and in September 1985 it was 7.1. All of the 1985 pH readings are between 0.2 to 0.4 units higher than the readings from 1994 through 1998 and those 4 years averages are also less than the 1985 readings.

Lake pH

			pH
Harbor Lake:	July	1995	5.6
	September	1995	6.1
Skyhigh Lake:	September	1985	7.1
	July	1994	6.8

NITRATE

Most of the lakes that were tested for nitrates are exhibiting the watershed characteristic of absorbing most of the nitrate before it reaches the lake. The nitrates that do reach the lake are quickly assimilated by the plankton. Five lakes sampled in 1995 show **above** detection limits for nitrate. The same lakes were re-sampled in 1996 and two lakes read 0.00, one was dry and three showed a decrease in nitrates.

	1995	1996
Barking Fox Lake	1.47 microequivalents per liter	0.00
Sergent Lake # 220	2.68	0.00
Sergent Lake # 221	8.71	Dry
Crimson Lake # 31	2.54	1.13
Crimson Lake # 32	5.64	4.50
Crimson Lake # 36	1.28	3.66

On the date sampled, generally mid to late summer, these lakes would not be expected to have nitrates above detection limits. Alpine lakes in Colorado recently have shown to be in a stage of nitrogen saturation of the watershed. The first indicator that nitrogen saturation is taking place is the occurrence of nitrate levels above detection limits, such as the above listed lakes, throughout the growing season. A recent published report from NADP shows that nitrates have been increasing in our area and to a lesser extent sulfates for the period 1985-1993. For the U.S. the trend of increasing nitrates is quite widespread, whereas, the sulfates are generally decreasing throughout the nation. Long-term projections for the western U.S. indicate an increase of nitrates for the next 20-30 years. Due to the high nitrates in the above listed lakes, they will be re-sampled in 1996 to verify the nitrate level. From the results of lake sampling in 1996, the following Crimson Lakes # 31, 32 and 36 should be re-sampled over a 5 to 10 year period for long-term monitoring to determine amount of nitrate deposition.

LAKE SENSITIVE TO ACID DEPOSITION

As of December 1998, on the Salmon-Challis National Forest, 68 lakes that have been sampled since 1989 for acid deposition, approximately 16 show Low Sensitivity; 23 are Ultra Sensitive; 8 are Very Sensitive, 9 are Sensitive and 12 are Non-Sensitive. No lakes were listed as acidic. Golden Trout Lake is listed in two different sensitive groups, due to the difference of sampling data being below 75 ANC and above 75 ANC. Golden Trout Lake should be re-sampled over a 5 to 10 year period for long-term monitoring to determine which sensitive group it best fits. Due to the granitic geology, amount of snow pack and local microclimate conditions, it might still fall between the Very Sensitive and Ultra Sensitive groups.

NON-SENSITIVE	**>200 ANC (acid neutralizing capacity-ueq/l)**
SENSITIVE	**<200 ANC**
VERY SENSITIVE	**75-100 ANC**
ULTRA SENSITIVE	**<75 ANC**
LOW	**<50 ANC**
ACIDIC	**<0 ANC**

LAKE SENSITIVITY

LOW SENSITIVITY: <50 ANC

Crimson # 31, 32, 35, 36, 37, 38, 39.
Knapp # 11, 13
Harbor
Wilson
Tango # 30, 42
Tiptop-Upper
Gooseneck
Crater

ULTRA SENSITIVITY: <75 ANC

Knapp # 9, 10, 12, 14, 16, 17, 18, 19, 25
Glacier
Shoban
Sheepeater
Echo
Ship Island
Fawn
Turquoise
Birdbill (67 & 71)
Heart
Skyhigh
Big Clear
Golden Trout (2 yrs. are in this group- both 73.0)
Gentian
Cathedral- Upper

VERY SENSITIVITY: 75-100 ANC

Golden Trout (2 yrs. are in this group- 78 & 81)
Airplane
Twin Cove- Upper
Twin Cove
Skyhigh

VERY SENSITIVITY: 75-100 ANC (cont)

Deer
Mirror
Un-named # 154

SENSITIVE: <200 ANC

Ramshorn- Lower
Upper Terrace

Knapp # 3
Barking fox
Welcome
Goat
Mystery # 60
Doe
Cache Creek # 201

NON SENSITIVE: > 200 ANC

Sergent # 139
Sergent # 220
Sergent # 221
Master Sergent # 138
Tech Sergent # 140
Yellowjacket
Cache Creek # 211
Cache Creek # 212
Dome
Falconberry
Marble (NW)
Mystery # 59

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