SAWTOOTH WILDERNESS HIGH LAKES MONITORING: AQUATIC AND WETLAND FLORA

by

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INTRODUCTION

The Idaho Conservation Data Center was contracted to collect baseline floristic data from aquatic and wetland habitats at selected high lakes in the Sawtooth Wilderness during 1995. This is an expansion of ongoing air and water quality monitoring on the Sawtooth National Forest to include these biotic factors: fish, amphibians, and plants. The Forest is targeting about 50 lakes in the Sawtooth Wilderness that will be used in the monitoring program. Beginning in 1995, 10-15 lakes will be sampled each year for baseline data. Following baseline data collection, the lakes will then be resurveyed on a similar five-year cycle to determine long-term trends of the various factors measured. The general goal of our portion of the project is to produce a floristic checklist, with some measure of relative abundance of the species, for each lake and associated wetland.

STUDY SITES

The ten lakes were chosen to be sampled in 1995 are described below. They are identified by an alpha-numeric code and listed by lake or drainage basin, more or less arranged from north to south. See also Table 1 in the Results section which contains additional data on the physical setting of the lakes.

Bench Lakes

50-3039 - The lowest of the Bench Lakes and the lowest elevation of the ten lakes studied this year. There is an extensive marginal wetland surrounding the entire lake. Forests occurring on gently undulating topography are adjacent the lake.

Finger of Fate

4C1-043 - This lake occupies an intermediate position in a string of lakes in the cirque north of the Finger of Fate in the Hell Roaring Creek drainage. It is surrounded by rocky slopes with just a few scattered subalpine fir and whitebark pine.

Hidden Lake

4C1-042-00-13 - This small lake sits in a high rocky basin at the headwaters of the South Fork Payette River above Hidden Lake. It is the highest elevation lake sampled, sitting in a steep, rocky cirque surrounded by very open whitebark pine stands.

16-3124 (Hidden Lake) - The largest lake sampled, Hidden Lake is surrounded by dense subalpine fir forests on moderate slopes. Most of the shoreline is vegetated.

"Upper McDonald Lakes"

17-313 - At the head of an unnamed drainage above McDonald and Yellow Belly lakes, this lake sits in a rocky cirque but is surrounded by relatively dense stands of subalpine fir and whitebark pine on steep-to-mostly moderate slopes. Most of the shoreline is vegetated.

4C1-044 - This lake sits in a steep-sided kettle with no surface inlet or outlet and a large drawdown during the summer. On September 6, the lake level was 15 feet below the high water mark. Consequently, there are very few wetland species and the one present have very low cover.

Flytrip Creek

4C1-058 - The northern and largest of two lakes sampled in upper Flytrip Creek. The lowest in a string of lakes, it is surrounded by dense forest on moderate slopes. The wetland vegetation is well developed and the extensive littoral zone supports a high cover of aquatic species.

4C1-047 - Surrounded by gentle, forested slopes, this is the smallest lake sampled. It is shallow throughout with an extensive littoral zone and completely surrounded by wetland vegetation.

Alpine Creek

4C1-048 - One of the numerous lakes in the Alpine Creek drainage, this one sits in a rocky cirque surrounded by steep slopes and cliffs, talus, and whitebark pine - subalpine fir parkland. Very little wetland vegetation occurs around the lake and no aquatic species were recorded.

38-358 - Similar to the other Alpine Creek lake, only with more cliffs and talus surrounding the lake and less wetland vegetation.

METHODS

The ten lakes were visited between August 23 and September 7, 1995. Because the spring and early summer of 1995 were abnormally cold and the snowpack in the Sawtooth Range was slow in melting, these dates coincided with peak flowering of most wetland species surrounding high lakes in the Sawtooth Wilderness. Even at this late date, however, some sedges still had immature flowers and *Epilobium angustifolium* was never observed flowering.

Species Checklist

A thorough list of wetland and aquatic plant species was made at each lake. For wetland species, only those that occurred in the marginal wetlands around the lake were included. These are areas that are tied hydrologically to the lake and will be of greatest indicator value to monitoring change in water chemistry of the lake. Excluded were species occurring in wetlands that extended upslope from the lake and were irrigated by water sources above the lake.

Vascular plant nomenclature follows Hitchcock and Cronquist (1973), except for *Salix,* which follows Brunsfeld and Johnson (1985), and *Carex utriculata* (previously referred to as *C. rostrata*), which follows Reznicek (1985). Mosses follow Lawton (1971), except for *Sphagnum*, which follows Andrus and Layser (1976). Liverworts follow Won (1976) and lichens follow McCune and Goward (1995).

Voucher Specimens

At least one specimen of nearly all species was collected as a voucher. Exceptions are *Epilobium angustifolium, Hieracium gracile*, and *Polytrichum* sp., for which I saw no fertile plants, and the four tree species, *Abies lasiocarpa, Pinus albicaulis, P. contorta,* and *Picea engelmannii*. The primary set of vouchers are deposited at the University of Idaho Herbarium (ID), Moscow, with duplicates also deposited at the Sawtooth National Recreation Area herbarium at the Stanley Ranger Station.

Species Abundance

Ideally, ecological sampling using plots would have been the best method of quantitatively documenting the structure and composition of wetland and aquatic communities at the lakes. Methods similar to those used by Moseley *et al.* (1994) in the Sawtooth Valley peatlands are the most accurate way to record baseline conditions useful for long-term ecological monitoring. For two reasons, however, this was not done: (1) the fine-scale mosaic of community patterns at the high lakes would require a large number of plots, and (2) the funding level for this project constrained the amount of time that could be spent at each lake.

To save time but still record the abundance of wetland species at the lake, I devised a method that used the entire vegetated portion of the lake shore as the "plot." I estimated the abundance for wetland species on a 1 to 5 scale, based on the cover of the species in the vegetated portion of the shoreline. The cover values for the five classes are as follows: 1 = 1-20%; 2 = 20-40%; 3 = 40-60%; 4 = 60-80%; 5 = 80-100%. These are rather broad classes, but with a "plot" as large as the entire wetland around a lake, any smaller classes would have been hard to estimate with accuracy. The abundance estimate of aquatic species was also on a 1-5 scale, but was based on relative abundance and not on cover, which is difficult to estimate on a water surface, especially in a large lake.

Physical Attributes

Eight physical attributes were recorded for each lake (described below). These attributes or characteristics create a biophysical environment that affect the distribution of plants in the marginal wetlands and in the lake (for aquatic species). They were used in exploring the floristic relationships of the ten lakes using direct gradient analysis (see next section).

Elevation - Recorded in feet using the USGS topographic maps. This attribute is related to temperature and probably also precipitation.

Cirque Aspect - The general aspect of the cirque, recorded degrees (with 18.5° E declination). Cirque aspect is related to solar input (heat) and possibly also differential snowloading; for example, easterly-facing cirques are in the lee of the prevailing winds and may have greatest snow accumulations.

Lake Position - The position of the lake in the cirque, relative to other lakes. Recorded as a 1-3 scalar, with 1 being the highest lake in the cirque, generally occurring at the headwall, and 3 being the lowest lake in the chain; lakes occupying intermediate positions are 2. This attribute relates to the age of the lake following glacial retreat and to organic and sediment inputs, with the lowest lakes (3) having greater amounts of each.

Shoreline Vegetation - Recorded as the percent of lake shoreline having vegetation. Barren rock surfaces occupy the remainder. This attribute affects species richness (the larger the area, generally the greater the number of species).

Shoreline Gradient - Recorded in degrees of inclination and represents an average of ten readings of the slope gradient at the lake margin taken as I circumnavigated the lake. This attribute is an indirect measure of the extent of the littoral zone of the lake, an important characteristic that affects the distribution and abundance of aquatic species. Bottom profiles would be a better measure, but were not available to me. Shoreline gradient also affects the width of the wetland vegetation along the lake.

Bottom Substrate - Two classes were recorded, based on the predominant substrate of the portion of the lake bottom that was visible from the shore: gyttja and rock. Gyttja refers to the organic muck, usually in a colloidal state, on the bottom of a lake or slow-moving stream. This attribute affects the distribution of aquatic species, which rarely root on rock substrates.

Lake Size - Derived from planimeter measurement of USGS topo maps and recorded in acres. Lake size and the next attribute, shoreline distance, can affect the extent of wetland and aquatic habitat.

Shoreline Distance - Also derived from a planimeter, the distance is recorded in feet.

Gradient Analysis

I used direct gradient analysis to show the relationship of the ten lakes to each other, based on the species present and their abundance, and to determine which environmental gradients, represented by the physical attributes, most affect species distributions. Species abundance data for each lake were used to ordinate the ten lakes along environmental gradients with canonical correspondence analysis (CCA), a multivariate direct gradient analysis technique (Ter Braak 1991). The axes extracted by CCA represent those directions of variation in species composition and abundance at the lakes that are related to supplied external variables (Ter Braak 1987) - in this case, the physical attributes.

Literature Search

Although considerable research has been conducted on the water chemistry/quality indicator value of aquatic plants, much of the research has been conducted in the eastern and midwestern portions of North America on widespread, lowland species. While some of the species occur in Idaho, apparently none occur at high elevations. Most of the species documented at the Sawtooth high lakes are typical of high elevations of the mountain ranges of western North America (discussed in the next section) but are not found elsewhere. Because of this, no comprehensive discussion of research relating to the indicator value of the species is included in the Results section. Of special note, however, is a forthcoming book on the riparian plants of the Great Basin (Elzinga *et al*. 1995) that contains a few of the species that occur at the Sawtooth high lakes. Although water chemistry relationships are not mentioned, they do have excellent discussions of their autecology and management.

RESULTS

Flora

Ninety-two vascular, moss, liverwort, and lichen species were documented from the ten lakes studied in 1995 (Table 1). As expected, *Carex* was the most prominent genus in terms of both richness (14 species) and cover. No other genus had more than three species. The flora can best be characterized as typically cordilleran, being comprised of species which are restricted to the mountain ranges of western North America. Very few boreal elements occur in the flora. This phytogeographic pattern was also observed by Bursik (1990) and Bursik and Henderson (1995) in their study of the flora of lowland and subalpine peatlands in Idaho.

Most species occur in wetland habitats on the lake shore. Only eight species (9% of the flora) were rooted in the lakes, either as floating-leaved plants or as emergents: *Isoetes bolanderi, Sparganium minimum, Carex utriculata (rostrata), C. aquatilis, C. saxatilis, Nuphar polysepalum, Menyanthes trifoliata,* and *Potamogeton natans*. The latter three species, typically found in lowland lakes and streams, only occur at lower Bench Lake (50-3039), the lowest lake sampled. *Sparganium minimum* and the submerged pteridophyte *Isoetes bolanderi*

are the most widespread aquatic species but only occur in lakes with at least some gyttja substrate (Table 1).

Bench Lake (50-3039) has the most species with 48, followed closely by the Finger of Fate (4C1-043), Hidden Lake (16-3124), and the larger Flytrip Lake (4C1-058, each having 40 or more species. All these lakes occupy lower (3) or intermediate (2) positions in their basins. The lower of the Upper McDonald Lakes (4C1-044) has the fewest species with three. As explained in the Study Sites section, this lake is in a kettle with no surface inlet or outlet and a summer drawdown of at least 15 feet, a difficult habitat for subalpine species to persist in. The southern Alpine Creek lake (4C1-048) has only four species due to the very small area of wetland vegetation along its shore. Most of the shoreline is cliffs or talus.

Only two rare species were encountered. A small population of *Carex livida* was discovered near the outlet of the lowest of the Bench Lakes. This plant is usually found in valley peatlands, with only two mountain locations known (both from the Sawtooth Wilderness). At Bench Lakes it occurs on peat (organic) substrates and is a very small population, occupying only a few square feet. A small patch of *Scirpus caespitosus* was found at the lake below the Finger of Fate (4C1-044). Known in Idaho only from the Sawtooth Valley and Sawtooth Mountains, this species is also more commonly found in lower-elevation peatlands. For additional information on the distribution and conservation status of these species in Idaho, refer to Moseley *et al.* (1994).

Unlike the wetland vegetation of the Sawtooth Valley, the high-elevation wetlands in the Sawtooth Range have not been thoroughly classified. Two cursory vegetation descriptions have been done, however, that describe community patterns in the area (Lewis and Riegelhuth 1964; Schlatterer 1972). The *Carex nigricans-Agrostis humilis* (black alpine sedge/alpine bentgrass) community described in both studies is the most common community in wetlands at the lakes. *Carex nigricans* occurs as a dense turf on peat, with scattered plants of the tiny *Agrostis humilis* and other species having low cover. The *Phyllodoce empetriformis-Ledum glandulosum* community also occurs on hummocks on wetlands surrounding the lakes. This community is only described by Schlatterer (1972). Small areas along the lake shores are sometimes occupied by the *Pinus contorta/Vaccinium occidentale* (lodgepole pine/western blueberry) community described by Tuhy and Jensen (1982) from the Sawtooth Valley. The aquatic communities in the Sawtooths have not been classified and described.

Table 1. Plant species abundance at ten lakes studied in the Sawtooth Wilderness in 1995. Abundances are on a 1 (lowest) to 5 (highest) scale. Blank columns indicate that the species was not collected, or observed at that lake. The number in parentheses in some columns refers to my voucher collection number for that lake. All other occurrences are observations. See text for definitions of the abundance classes and an explanation of voucher specimen documentation.

	Bench Lks	Finger	Upper McDonald		Hidden Lake		Flytrip Creek		Alpine Creek	
	50-3039	4C1-043	17-3131	4C1-044	4C1-042	16-3124	4C1-058	4C1-047	4C1-048	38-358
PHYSICAL ATTRIBUTES										
Elevation (feet)	7750	8940	8840	8500	9090	8563	8562	8580	9050	8980
Crique Aspect (°)	60	130	86	93	190	188	245	265	154	34
Lake Position	3	2	2	3	1	2	3	3	1	1
Shoreline Vegetation (%)	100	60	80	10	30	80	85	100	10	1
Shoreline Gradient (°)	<2	21	15	24	20	22	16	17	>30	>30
Bottom Substrate	gyttja	rock	gyttja	rock	rock	gyttja	gyttja	gyttja	rock	rock
Lake Size (acres)	4.5	4.5	6.1	8.1	4.7	38.3	13.1	2.8	16.7	8.2
Shoreline Distance (feet)	2133	1847	3007	2795	2305	7927	3472	1679	3515	2274
SPECIES										
TREES										
Abies lasiocarpa		1				1	1	2		
Pinus albicaulis		1	1							
Pinus contorta	3			1		1		1		
Picea engelmannii	1		1			1	1	1		
SHRUBS										
Cassiope mertensiana		1	1		2 (2966)	1	1			
Gaultheria humifusa		1			1		1	1	1 (2954)	
Kalmia microphylla	4 (2904)	2	3			3	3	2		
Ledum glandulosum	5 (2902)	3	4			4	3	3		
Lonicera caerulea	2 (2906)									
Phyllodoce empetriformis		2	1		1 (2965)	1	2	2		
Salix drummondii	1 (2902)									
Salix boothii	1 (2921)									
Spiraea densiflora	1						2	2 (3010)		
Vaccinium occidentale	5 (2903)	2	4			1	1	1		
Vaccinium scoparium			2			1 (2989)		1		

Table 1. Continued.

Bench Lks	Finger	Upper McDonald	Hidden Lake		Flytrip Creek		Alpine Creek			
	50-3039	4C1-043	17-3131	4C1-044	4C1-042	16-3124	4C1-058	4C1-047	4C1-048	38-358
FORBS										
Antennaria alpina		1	1		2 (2968)					
Antennaria corymbosa	1 (2911)									
Antennaria lanata						1 (2976)	1	1		
Arnica latifolia					1 (2961)		1			
Arnica mollis		1 (2990)	1				1			
Aster occidentalis	3 (2912)									
Castilleja cusickii						1 (2980)				
Dodecatheon jefferyi	1 (2914)	1			1	2	1	2	1 (2950)	1
Epilobium alpinum		1			1 (2962)		1			
Epilobium angustifolium		1								
Epilobium glandulosum	1 (2908)		1							
Erigeron peregrinus		1	2		1	2	2	1	1 (2947)	
Gentiana calycosa		2	2		1	1 (2987)	2	1	1	1
Hieracium gracile		1	1							
Hypericum anagalloides	1 (2916)	1					1			
Isoetes bolanderi	5 (2910)	1	4 (3003)			5 (2978)	4	5		
Lewisia pygmaea					1 (2958)					
Ligusticum tenuifolium		3	2		1	2	2	1	1 (2949)	
Menyanthes trifoliata	3 (2905)									
Nuphar polysepalum	3 (2924)									
Pedicularis grpenlandica		1				1 (2977)	1			
Polygonum bistortoides						2	1		2 (2953)	
Polygonum polygaloides	3 (2909)									
Potamogeton natans	3 (2922)									
Potentilla flabellifolia		2	2		1	2	2	2	1 (2951)	
Ranunculus eschscholtzii					1 (2960)					
Rorippa curvisiliqua	1 (2915)									
Senecio cymbalarioides		3	2			3 (2988)	2			
Senecio triangularis		1 (2995)					1			
Stellaria umbellata						1 (2982)				
Sibbaldia procumbens		1	1		1 (2957)	1	1			
Spiranthes romanzoffiana	2 (2907)	1								
Sparganium minimum	2 (2923)		1 (3004)			4 (2979)	4	1		

Table 1. Continued.

Bench Lks	Finger	Upper McDonald		Hidden Lake		Flytrip Creek		Alpine Creek		
	50-3039	4C1-043	17-3131	4C1-044	4C1-042	16-3124	4C1-058	4C1-047	4C1-048	38-358
Tofieldia glutinosa		2 (2991)					1			
Veronica wormskjoldii		1			1	1	1		1 (2952)	
Viola adunca				1					1 (2948)	
Viola mackloskeyi		2 (2919)	1 (3002)							
GRAMINOID										
Agrostis humilis		1 (2992)	1		1 (2971)		1			
Agrostis scabra	3 (2938)									
Calamagrostis canadensis	5 (2937)		1			1		1		
Carex aurea		1 (2994)								
Carex aquatilis	5 (2944)		2 (3005)			4 (2984)				
Carex canescens	1 (2942)									
Carex illota		3 (2997)	2			4 (2985)		1		
Carex lenticularis	2 (2941)						4 (3007)	4		
Carex leporinella	3 (2946)							1 (3009)		
Carex livida	1 (2917)									
Carex luzulina	3 (2939)	4	2			1	1	1		
Carex muricata	4 (2943)									
Carex nigricans		3	3		5 (2963)	3	1	1		1 (2955)
Carex paysonis		3 (2998)			2 (2964)	4 (2986)				
Carex saxatilis	3 (2945)					1 (2972)	2 (3008)	1		
Carex scopulorum		4 (2999)	4 (3006)		1 (2956)	2 (2982)	4	4		
Carex utriculata (rostrata)	4 (2925)		2							
Danthonia intermedia		1 (3001)					1	1		
Deschampsia cespitosa	3 (2936)	3	2	5	2	4	3	1	1	
Eleocharis bella	2 (2913)									
Eleocharis pauciflora	1 (2918)	1				2 (2975)		1		
Juncus ensifolius	2 (2934)	1								
Juncus longistylis	3 (2935)	1	2		1	1 (2983)	1	1	1	1
Juncus parryi		1 (2993)	1		3	1	1	1		
Luzula campestris	1 (2940)									
Luzula parviflora					1 (2970)					
Phleum alpinum					1 (2967)	1				
Scirpus caespitosus		1 (2996)								

Table 1. Continued.

Bench Lks	Finger	Upper McDonald		Hidden Lake		Flytrip Creek		Alpine Creek		
	50-3039	4C1-043	17-3131	4C1-044	4C1-042	16-3124	4C1-058	4C1-047	4C1-048	38-358
MOSSES										
Sphagnum angustifolium	1 (2929)						4	5		
Sphagnum centrale	1 (2928)					3				
Polytrichum sp.					2	3	2	2		
Moss	4 (2930)	4	3					1		
Moss	1 (2931)									
Moss	1 (2932)									
Moss	2 (2933)									
Moss				1 (2959)						
Moss					2 (2973)					
Moss					1 (2974)					
LIVERWORT										
Riccia sp.	1 (2927)									
LICHEN										
Cladonia chlorophaea?	1 (2926)									
TOTAL SPECIES	48	43	32	3	25	41	40	34	11	4

Gradient Analysis

Figure 1 displays the ordination diagram of the ten lakes and the physical variables along the first two axes extracted by CCA. The lakes are arranged in the ordination space based on species composition. The main direction of change for each of the external variables is illustrated by the line with the length of the line corresponding to the relative importance of that variable in explaining floristic change. The first two axes account for 78% of the variance in species ordination scores with respect to the physical variables. The eigenvalue and species-environment correlation for axis 1 are lambda=0.504, r= 0.99, respectively, while lambda=0.28, r=0.97 for axis 2.

The physical variables, lake position, elevation, cirque aspect, and shoreline gradient explain most of the floristic variation along axis 1. Bench Lake (50-3039) lies at one extreme of this axis, occupying a lower basin position and having the greatest wetland and aquatic vegetation development, while the high elevation lakes occupying the upper basin positions below cirque headwalls lie at the other extreme: northern Alpine Creek (4C1-048) and upper Hidden Lake (4C1-042). The lake size and shoreline distance variables accounted for little of the floristic variation along axis 1 (the distance variable is not labeled in Figure 1, but mirrors the size line).

The lakes are relatively clumped along axes 1 but are more widely dispersed along axis 2, where substrate and shoreline vegetation explain most of the variation. The lower Upper McDonald Lake is an outlier along this axis having a rock substrate, little vegetation cover, and few species, as well as having a high cover of *Deschampsia cespitosa*, which is a unique condition at the ten lakes studied. The other three lakes at this end of axis 2, southern (38-358) and northern (4C1-048) Alpine Creek and upper Hidden Lake (4C1-042) all have low vegetation cover and rock substrates. With the exception of Finger of Fate Lake (4C1-043), which has a rock substrate, all lakes at the lower end of axis 2 have gyttja substrate and high vegetation cover along the shoreline.

CONCLUSIONS

The methods used to assess community composition and structure in 1995 will give only general trends in ecosystem change that will probably only be detectable over a long period of time. A much more precise method, where change would probably be detectable over shorter time periods, is to establish permanent plots in the different wetland community types found near the lakes. These plot data would also enable the CDC to better assess wetland community diversity at high elevations in the Sawtooth Range, which is currently a gap in our understanding of wetlands ecosystems in Idaho.

Figure 1. CCA ordination of the ten lakes (numbered) with eight physical variables (labeled; the distance variable is not labeled, but mirrors the size line). Lines associated with the physical variables denote main direction of change and relative importance of each variable.

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