GLACIER PAGE 2003

North Cascades National Park Glacier Monitoring Program

The National Park Service began monitoring glaciers in North Cascades National Park in 1993 and Mount Rainier glaciers in 2002 (see the Mount Rainier Glacier Page). Goals for this program and additional data can be found at North Cascades National Park home page at http:/www.nps.gov/noca/massbalance.htm or contact Jon_Riedel@nps.gov or Rob_Burrows@nps.gov.

The four glaciers monitored are located at the headwaters of four watersheds, each with large hydroelectric operations (Figure 1). The glaciers represent a range in elevation from 8800 to 5600 feet, and a range in climatic conditions from maritime to continental. Methods include three visits annually to each glacier to measure winter accumulation and summer melt. Measurements are taken at a series of points down the centerline of each glacier (Table 1), then integrated across the entire glacier surface to determine mass balance for the entire glacier. Glaciers east of the hydrologic crest of the park (Silver and Sandalee) have recently had more positive mass balances than the west-side glaciers (Noisy, North Klawatti, South Cascade) due to their higher elevations, and north aspects (Figure 2). In addition to the accumulation and ablation measurements each glacier was remapped in 2002 to quantify terminus and surface elevation changes. A 10-year data summary will be published this year.

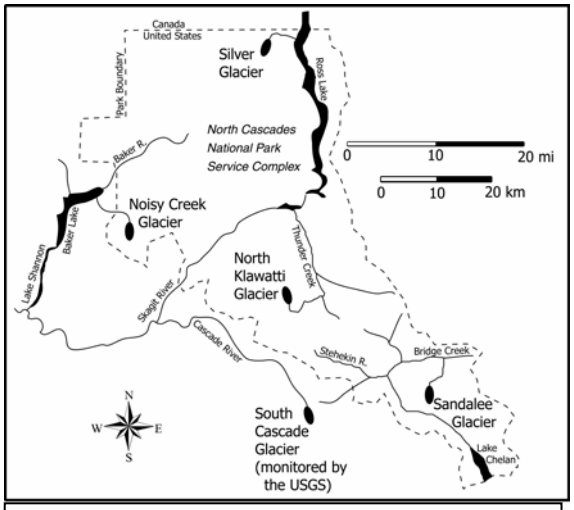

Figure 1. Glaciers monitored in North Cascades N.P.S. Complex.

Table 1. Glacier:	Elevation (feet)	Average Accumulation (inches W.E.)	2003 Accumulation (inches W.E.)	2003 Percent of Average
Noisy Creek Density= 0.50 @ 5900 ft 5/13/03	**Entire Glacier**	**129**	**119**	**93**
	6061	132	143	108
	6038	135	130	96
	5900	125	109	87
	5760	116	103	89
	5630	116	104	90
Silver Density= 0.41 @ 7544 ft 5/13/03	**Entire Glacier**	**97**	**73**	**76**
	8550	120	90*	75*
	8050	103	72	70
	7544	121	74*	61*
	7050	65	61	94
N.Klawatti Density= 0.47@7700 0.51@6080 5/19/03	**Entire Glacier**	**120**	**100**	**83**
	7665	125	103	83
	7300	127	104	82
	6900	127	103	81
	6390	109	91	84
	6080	99	88	88
Sandalee Density= 0.45 @ 7157 ft 5/15/03	**Entire Glacier**	**125**	**91**	**73**
	7360	117	86	73
	7157	131	88	67
	6900	118	88	75
	6780	139	97	70

Table 1 presents this spring's provisional winter accumulation data, along with average values and percent of the 11-year average. The 2003 snow depths were measured between May 9 and 19 on the four glaciers. Ice layers and cold temperatures within the snowpack made probing difficult on the upper Silver Glacier. These data are extremely tentative (marked with *) and will be revised after a July visit. We measured snow densities at the midpoint of three glaciers and at the top and bottom of N. Klawatti. Densities are in fraction of water density.

Estimates of glacial contribution to runoff for three watersheds are based on the mass balance measurements and GIS analyses to determine glacier area within 165 ft elevation bands (Table 2). Glaciers reduce the variation of flow in these watersheds by providing meltwater from ice in dry/warm years, and by storing water in wet/cool years. Glacial contribution to streamflow in these watersheds varies by as much as 100% annually. Magnitude of glacial contribution to streamflow is large, but varies by the amount of glacial cover in each watershed. Thunder Creek is 13% glacierized, while Baker River and Stehekin River are 6% and 3% glacierized, respectively (Post and others, 1971; Granshaw, 2002).

Relative importance of glacial contribution to streamflow increases from west to east. For example, glaciers annually contribute a higher percentage of meltwater to streamflow in the Stehekin watershed than in the Baker, despite the fact that the Baker is more glaciated. This is due to lower snowfall east of the hydrologic crest of the North Cascades. In this below average accumulation year we anticipate that glacier contribution to summer runoff will be above average, particularly because of below average snowpack at elevations below the glaciers.

	Mean Glacial Runoff	Range of Glacial Runoff		Percent Glacial Runoff to Total Summer Runoff	
		Minimum	Maximum	Minimum	Maximum
Noisy Creek Glacier	1.4	1.1	1.9	---	---
Baker River Watershed	66	48	94	5	12
North Klawatti Glacier	3.9	2.8	4.8	---	---
Thunder Creek Watershed	105	76	159	22	45
Sandalee Glacier	0.5	0.4	0.6	---	---
Stehekin River Watershed	70	50	106	6	16
Silver Glacier	0.9	0.7	1.0	---	---
Ross Lake Watershed	64	46	96	N/A	N/A

Table 2. Glacial contribution to summer stream flow (May 1 to Sept. 30) for three watersheds. Runoff units are thousands of acre-feet. Data from 1993-2002 except the Sandalee Glacier and Stehekin River Watershed (1995-2002).

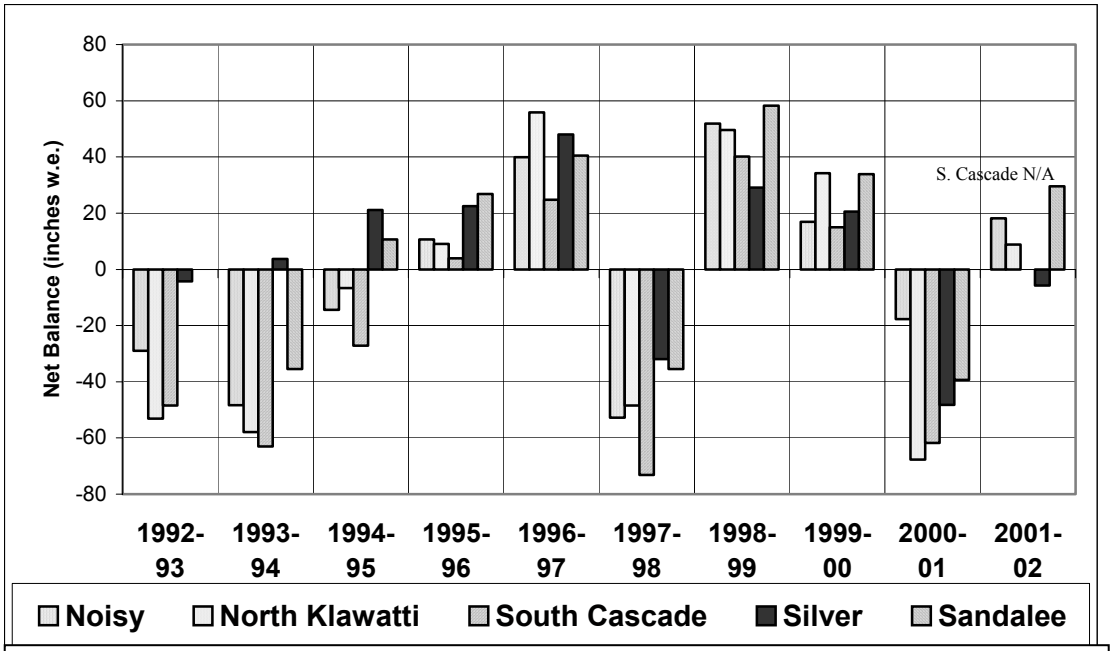

Figure2. Net annual mass balance for the five glaciers monitored in the North Cascades

MOUNT RAINIER GLACIER PAGE 2003

This year the National Park Service continues to collect data and develop methods for monitoring mass balance annually on Mount Rainier glaciers. This program is a cooperative venture between Mount Rainier National Park, the US Geological Survey, and North Cascades National Park. The program includes field measurements on Nisqually Glacier and Emmons Glacier, annual air photography, and 10-year remapping of the glaciers below 10,000 feet.

Between April 1 and May 1 we measured bulk density of the snowpack, probed snow depths, and placed ablation stakes on the lower Nisqually (April 22 & 23) and Emmons (April 1, May 1) glaciers below 10,000 feet. Accumulation on the south side of the mountain (Muir Snowfield and Nisqually Glacier) shows an increasing trend with elevation to ~7400 feet and decreasing trend above (Table 1). A similar trend may exist on the Emmons this year but data gaps prevent definite conclusions. Maximum accumulation most likely occurred in mid/late May, later than the measurement dates. Nearby SNOTEL sites (Morse Lake, Corral Pass, and Paradise) indicate that snow water equivalent increased by 3-7 inches during this interim period, perhaps slightly more on the glaciers. Ablation stakes were placed at 7400 and 6150 feet on Nisqually Glacier, at 9920 and 9170 feet on the Muir Snowfield, and at 9450, 8990, 6360, and 5750 feet on Emmons Glacier. We will return in mid June to check ablation and place an additional stake near the terminus of each glacier. In addition we will probe snow depth higher on the mountain. On a fall visit (late September/early October) we will record final ablation measurements from the stakes. Last year over 23 feet (275 inches) water equivalent of surface melt occurred on the lower glaciers!

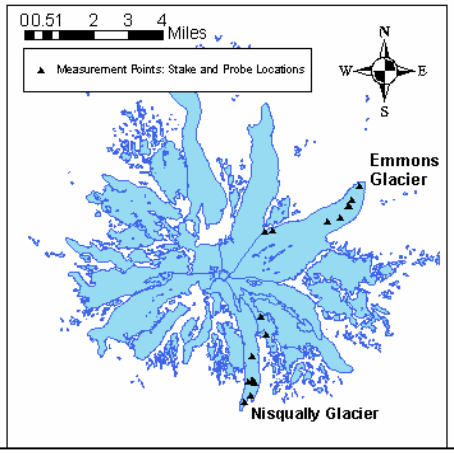

Figure 1. Glacier cover of Mount Rainier, monitored glaciers, and measurement locations on Muir Snowfield, Emmons, and Nisqually Glaciers

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Table 1	Elevation feet	Accumulation inches w.e.	Std Dev. inches w.e.	N
Emmons Glacier	9450	56	14	11
	8990	53	7	13
	6360	63	11	11
	6050	60	12	11
	5820	50	18	11
	5750	59	7	11
	5610	52	31	10
	5050	24	10	8
Muir Snowfield and Nisqually Glacier	9920	71	2	10
	9170	90	8	4
	7400	125	13	9
	6190	108	6	9
	6185	115	14	10
	6150	106	8	11
	6150	100	12	10
	5740	109	24	11
	5180	68	22	12
	5120	59	Paradise SNOTEL	

Table 1. Accumulation on Mount Rainier Glaciers, Spring 2003. Determined from probing snow depth on each elevation contour at "N" points. Standard deviation represents the variation in snow depths from changes in the underlying ice surface topography and wind drifting.

Table 2 Glacier	Snow Density	Altitude (ft)	Snow Depth (inches)	Date
Emmons	0.45	6360	63	4/1/03
Emmons	0.35	9450	56	5/1/03
Nisqually	0.46	7380	125	4/22/03

Table 2. Snow density was measured at three different points at three different times on Mt. Rainier this spring. Although the density was measured a month apart on the upper and lower Emmons Glacier we believe this represents the density at near maximum snow accumulation at each point.