

## THESIS APPROVAL

The abstract and thesis of Frank D. Granshaw for the Master of Science in Geology were presented December 7, 2001, and accepted by the thesis committee and the department.

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## ABSTRACT

An abstract of the thesis of Frank D. Granshaw for the Master of Science in Geology presented December 7, 2001.

Title: Glacier Change in the North Cascades National Park Complex, Washington State USA, 1958 to 1998

The North Cascades National Park Complex contains 25% of the glaciers of the contiguous United States. In addition to their ecological and scenic value, these glaciers are a major water resource for northwestern Washington. Despite their importance, little information about glacier change in the complex exists. To address this problem an inventory of all glaciers in the complex was constructed for 1958 and for 1998. Data from this inventory, regional climate data, and streamflows for selected watersheds were used to determine the extent of glacier change, the causes of that change, and the impact of glacier change on regional water resources.

From 1958 to 1998 the glacier population of the complex dropped from 321 to 316 and combined glacier area decreased by 7.0%. Total glacier volume loss is estimated at  $-0.8 \pm 0.1 \text{ km}^3$ . This reduction resulted from the disappearance of five small glaciers and mass loss from 80% of the remaining glaciers. This change was due to a warming, drying trend in regional climate, particularly during the period 1977-1997. Rates of change for individual glaciers were primarily influenced by area, but unaffected by other topographic characteristics. During the period 1958-1998, glacier mass loss contributed less than  $1.0 \text{ km}^3$  to the total stream flow of the Skagit, Nooksak, and Stehekin Rivers. Though this contribution may seem insignificant, average annual glacier mass loss accounts for 0.1 to 6.0% of the runoff during the two driest months of the year, August and September. Alternately, average mass loss augments precipitation by as much as 16%.

A comparison of the topographic characteristics of five regularly monitored or “index” glaciers to the regional database revealed that only one of these glaciers, Sandalee Glacier, is representative of the typical glacier in the complex. The changes in the index glaciers to area / volume changes in the bulk of the glaciers show that index glaciers can not be used to accurately infer the magnitude of the regional change in glacier cover. However, the index glaciers can be used to infer the rate of change over time.

GLACIER CHANGE IN THE NORTH CASCADES NATIONAL  
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1958 TO 1998

by  
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