

A Guide for Management of Landslide-Prone Terrain in the Pacific Northwest

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A Guide for Management of Landslide-Prone Terrain in the Pacific Northwest

Second Edition

by

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FISH/FORESTRY INTERACTION PROGRAM

This study was undertaken as part of the Fish/Forestry Interaction Program (FFIP), a multidisciplinary research study initiated in 1981. The program was started following a series of major winter storms in 1978 that triggered landslides over much of the Queen Charlotte Islands forest land base. Originating on steep slopes, many slides deposited tonnes of debris in streams and on valley flats. The events raised private and public concerns over logging practices on the Islands and prompted the establishment of the 5-year program. Overall objectives of FFIP were:

- to study the extent and severity of mass wasting and to assess its impacts on fish habitat and forest sites.
- to investigate the feasibility of rehabilitating stream and forest sites damaged by landslides.
- to assess alternative silvicultural treatments for maintaining and improving slope stability.
- to investigate the feasibility and success of using alternative logging methods, including skylines and helicopters, and by logging planning to reduce logging-related failures.

The program is jointly funded by direct appropriations from the Canada Department of Fisheries and Oceans, the B.C. Ministry of Forests (Research Branch), and the B.C. Ministry of Environment (Fisheries Branch). Participating agencies include Forestry Canada (Pacific Forestry Centre), and the Forest Engineering Research Institute of Canada (FERIC), Vancouver, B.C.

Program results are published through the B.C. Ministry of Forests, Land Management Report series, as well as in papers presented at symposiums, conferences, and through technical journals.

For information about the program contact Ministry of Forests, Research Branch, 31 Bastion Square, Victoria, B.C. V8W 3E7.

PREFACE TO THE SECOND EDITION

A decision was made to reissue Land Management Handbook Number 18 - A Guide for Management of Landslide-Prone Terrain in the Pacific Northwest, due to the considerable demand for copies. It is not the intent of this second edition to reflect substantial revision of the contents of Handbook Number 18; however, some minor changes reflect suggestions expressed by users. These have been incorporated into this edition. Changes have been made to Chapters 1, 2, 3 and 4, along with the addition of three new appendices following Chapter 2.

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INTRODUCTION

A Guide for Management of Landslide-Prone Terrain in the Pacific Northwest has been prepared for agency and industry personnel who are operating in areas with existing or potential stability problems. The document is intended for use in the coastal areas of the Pacific Northwest, even though the principles may be applicable to other locations in North America. The guide addresses four topics:

- Slope movement processes and characteristics.
- An office/field technique for recognizing landslide-prone terrain.
- Measures to manage unstable terrain during forestry activities.
- Road deactivation and revegetation of unstable terrain.

The guide is designed to be carried in field staff vehicles. A "condensed" version of the book will be available in the form of field cards that can be more easily carried in field note books. They will provide some of the basic information contained in this larger document.

Physical Setting

The region referred to as the Pacific Northwest extends from southern Alaska to northern California, and includes the province of British Columbia, and the states of Washington and Oregon. It is an area of high relief and varied bedrock comprised of several mountain systems fronting the Pacific Ocean.

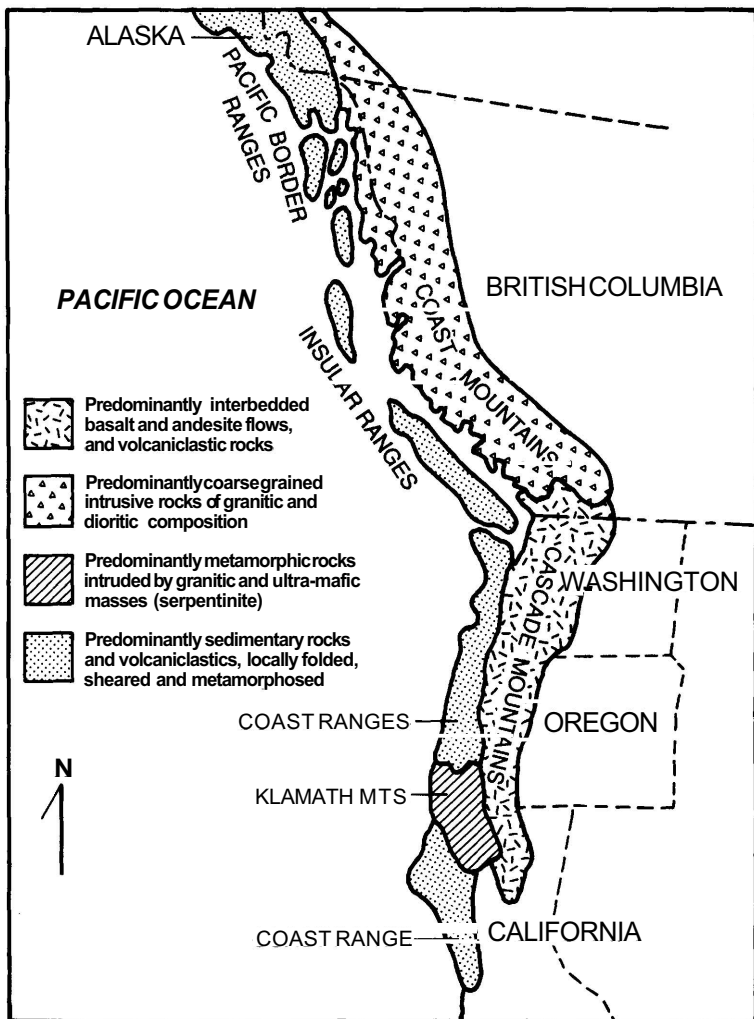
Region	Mountain system	Dominant bedrock
Alaska	Pacific Border Ranges	Sedimentary+volcaniclastic rocks
British Columbia	Insular Mountains	Sedimentary+volcaniclastic rocks
	Coast Mountains	Granitic and dioritic intrusives
Washington/Oregon	Coast Ranges	Sedimentary+volcaniclastic rocks
	Cascade Range	Volcanic flow and clastic rocks
	Klamath Mountains	Metamorphic with intrusions
Northern California	Klamath Mountains	Metamorphic with intrusions
	Cascade Range	Volcanic flow and clastic rocks
	Coast Ranges	Sedimentary+volcaniclastic rocks

The present-day landscape of the Pacific Northwest has been shaped by a variety of geological processes during the past 10 million years:

- uplift
- glaciation
- fluvial dissection
- mass wastage

It is therefore a region of diverse geology, topography and climate.

The high relief of the various mountain ranges is a product of recent geologic uplift that began about 10 million years ago. The Coast Mountains of British Columbia, for example, have risen 2-3 km in the last 10 million years. During the last 1 million years, the mountain ranges extending from northern Washington to Alaska have been extensively modified and sculptured by repeated glaciations during the Pleistocene (1 million to 10 000



Mountain ranges of the coastal Pacific Northwest - dominant bedrock types

years ago). The topography of these regions is characterized by rugged, glacier-clad mountains, fiords carved by glaciers, and steep mountain slopes with rounded ridgetops overtopped by glacier ice. Valley profiles are typically U-shaped and have glacially oversteepened sideslopes.

During this glacial interval, the southern Washington, Oregon and northern California landscape was modified by fluvial erosion. This resulted in the incision of valleys and the creation of rugged, mountainous topography. These southern mountain ranges are typically deeply dissected, characterized by incised rivers, steep slopes and narrow sinuous ridgetops. Valley profiles are V-shaped.

The coastal Pacific Northwest is characterized by a temperate rainy climate with warm to cool summers (maritime west coast climate – Alaska and British Columbia) or warm to hot summers (Mediterranean climate – Washington, Oregon, and northern California). Average precipitation ranges from 100 to more than 500 cm per year; most of the rainfall occurs during winter storms between October and April.

Tectonic activity, intense precipitation (especially during the winter months), and steep slopes all combine to make the Pacific Northwest a landscape where denudation of slopes is dominated by **mass movement processes**. These processes and their impacts, in turn, have been altered by human activities such as forest harvesting and construction of resource roads. Minimizing the effects of mass movements in such landslide-prone terrain – or preventing them altogether – requires the consolidated effort of all resource managers.