MONTANA STATE UNIVERSITY

The Relationships of wood debris to juvenile salmonid production and microhabitat selection in small southeast Alaska streams
by Charles Andrew Dolloff

A thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Biological Sciences
Montana State University
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Abstract:
Many small streams in Southeast Alaska contain both wood debris deposited by natural causes and/or logging and populations of juvenile salmonlds. Resource managers have assumed that large amounts of wood debris were detrimental to fish populations and have recommended debris removal. This study was initiated to describe the effects of wood debris and debris removal on populations of Juvenile coho salmon and Dolly Varden in four tributary streams of Staney Creek, Prince of Wales Island, Alaska during the summers of 1979-1981. Three streams were located in clearcuts and had debris removed from selected subsections by manual labor.

A fourth stream was located in an uncut forest stand and provided information on fish populations under natural conditions. Population densities and production of both species were typically higher in subsections having debris accumulations intact. Production during the June-September period for age 0+ and age 1+ coho combined ranged from 0.464-2.496 g/square meter. Dolly Varden production ranged from 0.106-0.879 g/square meter. For coho, debris provided visual isolation, permitting larger numbers of fish to live together without excessive territorial interactions.

Greater Dolly Varden numbers were related to increased cover provided by debris. There was little apparent competition between the species. An examination of microhabitat preferences showed that each of two coho and three Dolly Varden age classes was found in distinct areas. Coho occupied midwater positions that they defended from other fish. Dolly Varden were found on the stream bottom in dense cover. Analysis of stomach contents showed that coho selected most dietary items from the drift whereas Dolly Varden primarily exploited benthic prey.

Discriminant analysis showed that depth of focal point, depth of water, distance to nearest fish and distance to nearest cover were the most important variables accounting for separation of the five species-age class groups. Discriminant analysis using species as groups and incorporating the proportion of diet from terrestrial sources as an independent variable revealed that dietary differences also contributed to group separation. Stream cleaning in streams similar to those studied will likely be detrimental to anadromous Juvenile fish populations.

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APPROVAL

of a thesis submitted by

Charles Andrew Dolloff

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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## ABSTRACT

Many small streams in Southeast Alaska contain both wood debris deposited by natural causes and/or logging and populations of juvenile salmonids. Resource managers have assumed that large amounts of wood debris were detrimental to fish populations and have recommended debris removal. This study was initiated to describe the effects of wood debris and debris removal on populations of juvenile coho salmon and Dolly Varden in four tributary streams of Staney Creek, Prince of Wales Island, Alaska during the summers of 1979-1981. Three streams were located in clearcuts and had debris removed from selected subsections by manual labor. A fourth stream was located in an uncut forest stand and provided information on fish populations under natural conditions. Population densities and production of both species were typically higher in subsections having debris accumulations intact. Production during the June-September period for age 0+ and age 1+ coho combined ranged from 0.464-2.496 g/square meter. Dolly Varden production ranged from 0.106-0.879 g/square meter. For coho, debris provided visual isolation, permitting larger numbers of fish to live together without excessive territorial interactions. Greater Dolly Varden numbers were related to increased cover provided by debris. There was little apparent competition between the species. An examination of microhabitat preferences showed that each of two coho and three Dolly Varden age classes was found in distinct areas. Coho occupied midwater positions that they defended from other fish. Dolly Varden were found on the stream bottom in dense cover. Analysis of stomach contents showed that coho selected most dietary items from the drift whereas Dolly Varden primarily exploited benthic prey. Discriminant analysis showed that depth of focal point, depth of water, distance to nearest fish and distance to nearest cover were the most important variables accounting for separation of the five species-age class groups. Discriminant analysis using species as groups and incorporating the proportion of diet from terrestrial sources as an independent variable revealed that dietary differences also contributed to group separation. Stream cleaning in streams similar to those studied will likely be detrimental to anadromous juvenile fish populations.

# INTRODUCTION

The forests of Southeast Alaska contain many small streams that provide important spawning areas and rearing space for juvenile anadromous fishes. These streams typically contain large amounts of wood debris deposited by natural processes. In addition, logging operations frequently result in the additional deposition of slash and unmerchantable timber. When this occurs, resource management policies call for stream cleaning. While the intent of these policies is to restore affected streams to prelogging conditions, little is known about the role of wood debris in the structure of fish habitats and the consequences of stream cleaning on fish populations.

Stream cleaning operations in the United States have been conducted for over 100 years (Sedell and Luchessa 1982). In the past, it was generally assumed that large amounts of wood debris were detrimental to fish populations and the efficacy of stream cleaning operations was rarely questioned. Early studies were largely based on the belief that debris negatively affected fish populations and generally advocated drastic clearance of logs and debris from stream channels (Merrell 1951). One of California's first major stream clearance programs "...was deemed beneficial, although no satisfactory method was devised to evaluate results." (Holman and Evans 1964). Narver (1971)

reviewed the environmental requirements of eight salmonid species and concluded that accumulations of logging debris could have serious negative consequences on their production in small streams. Au (1972) recommended a vigorous cleanup of Oregon streams to maintain coho salmon (Oncorhynchus kisutch) populations within normal ranges.

In recent years, however, some researchers have become more critical of the effects of stream cleaning. Wood debris accumulates naturally in forest streams where it strongly influences channel morphology and biological processes (Swanson et al. 1976). Many fishes have evolved in its presence; salmonids in particular have demonstrated a broad range of tolerance, if not adaptation, to varying amounts of debris (Sedell and Luchessa 1982). Recognizing these facts, Hall and Baker (1975) concluded that debris in stream systems could have positive as well as detrimental effects depending upon the particular stream and the extent of debris loading. Bustard and Narver (1975) suggested that overzealous stream cleaning may result in the loss of overwintering habitat and decreased survival in coho salmon and steelhead (Salmo gairdneri) populations. In Southeast Alaska, Elliott and Hubartt (1975) documented decreased Dolly Varden (Salvelinus malma) populations following debris removal.

The present study was undertaken to determine the relationships between wood debris and associated habitat

features and salmonid populations in small southeast Alaska streams. The effects of stream cleaning on distributions, numbers, and the production of coho salmon and Dolly Varden were examined during the June-September field seasons from 1979 through 1981. Microhabitat use and resource partitioning were examined to account for interactions among the various age classes and species and habitat characteristics present. The findings of the study will be used to evaluate and develop management practices dealing with salmonid rearing habitat in Alaska.

## DESCRIPTION OF STUDY AREA

The Staney Creek Drainage lies in the Tongass National Forest on the west side of Prince of Wales Island in Southeast Alaska (Figure 1). The Tongass is part of the Northwestern Pacific needle-leaf forest -- an environment characterized by cool, cloudy weather and dense stands of old growth coniferous trees. The mean annual temperature recorded at the U.S. Forest Service station at Ketchikan, approximately 135 kilometers (km) southeast of Staney Creek, is 8.0 Celsius (C) and annual precipitation ranges from 225 to over 500 centimeters (cm) (Louis Bartos, personnal communication). Western hemlock (Tsuga heterophylla) and Sitka spruce (Picea sitchensis) are the principal codominant tree species with mountain hemlock (Chamaecyparis nootkatensis) and western redcedar (Thuja plicata) present on many sites. Red alder (Alnus rubra) is common along stream margins and on disturbed soils.

Logging in the drainage has produced a mosaic of clearcuts interspersed with virgin timber stands. Clearcuts ranged in size from 10 to over 1,000 hectares (ha). Revegetation in clearcuts occured in dense patches with Sitka spruce and western hemlock dominating shrub communities variously composed of salal (Gaultheria shallon), salmonberry (Rubus spectabilis), blueberry (Vaccinium spp.), and currant (Ribes spp.).