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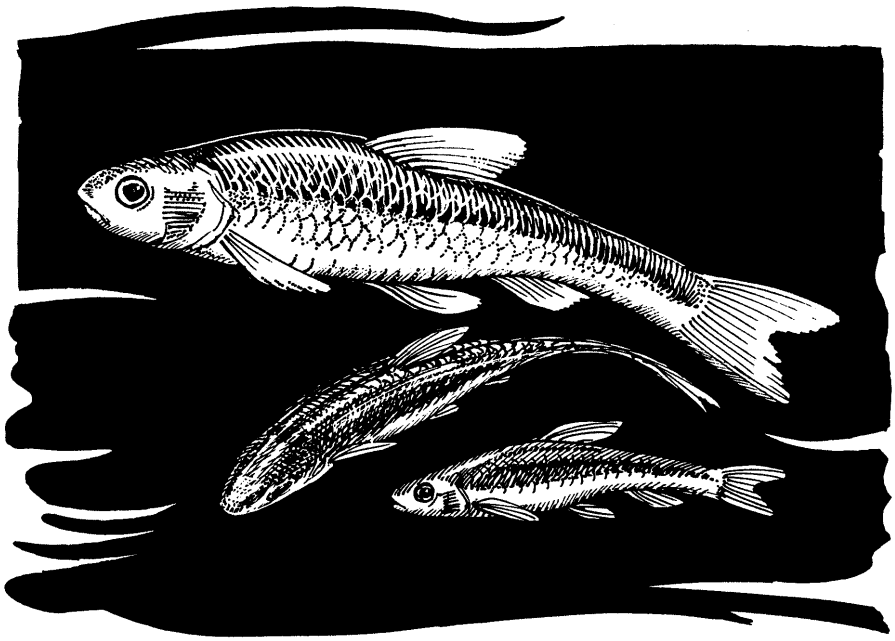
Cumulative Effects of Watershed Disturbances on Fish Communities in the Kakwa and Simonette Watersheds

The Northern Watershed Project

Study 3

Progress Report



Alberta Species at Risk Report No. 14

Alberta
SUSTAINABLE RESOURCE DEVELOPMENT

Cumulative Effects of Watershed Disturbances on Fish Communities in the Kakwa and Simonette Watersheds

The Northern Watershed Project

Study 3

Progress Report

Trevor Thera and Allan Wildeman

Alberta Species at Risk Report No. 14

March 2001

Project Partners:

Alberta SUSTAINABLE RESOURCE DEVELOPMENT

Alberta Conservation Association

ALBERTA PACIFIC FOREST INDUSTRIES INC

ALBERTA RESEARCH COUNCIL

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DMI DAISHOWA-MARUBENI INTERNATIONAL LTD.

MDFP MANNING DIVERSIFIED FOREST PRODUCTS LTD.

Publication No.: I/018
ISBN: 0-7785-1785-3 (Printed Edition)
ISBN: 0-7785-1786-1 (On-line Edition)
ISSN: 1496-7219 (Printed Edition)
ISSN: 1496-7146 (On-line Edition)

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Illustration: Brian Huffman

This publication may be cited as:

Thera, T. and A. Wildeman. 2001. Cumulative Effects of Watershed Disturbances on Fish Communities in the Kakwa and Simonette Watersheds Progress Report. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 14, Edmonton, AB.

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We gratefully acknowledge and appreciate the support, advice and contribution from the members of the Northern Watershed Stakeholders Committee.

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Sustainable Resource Development – Forestry	Dave Belyea
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Alberta Research Council	Garry Scrimgeour, Phil Lee
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EXECUTIVE SUMMARY

The Northern Watershed Project is a four-year, multi-stakeholder initiative consisting of three individual research sub-projects, they are:

1. Riparian – Upland Forest Communities –Project leader: **Phil Lee,** University of Alberta.

2. Relationships Between Landscape Characteristics and Fish Communities – Project leaders: **Trevor Thera,** Alberta Conservation Association ;
   Garry Scrimgeour, Alberta Research Council.

3. Modelling Cumulative Effects of Landscape Disturbances on Fish Communities in the Kakwa – Simonette Watersheds
   - Project leader: **Garry Scrimgeour,** Alberta Research Council.

A provincial stakeholder committee (Northern Watershed Project Stakeholder Committee) represented by members from government and non-government organisations, forest and oil and gas industries, and Alberta Research Council provide funding support and direction to the research program.

The goal of the Northern Watershed Project is to develop predictive models relating the cumulative ecological effects of a suite of watershed disturbances to fish community structure. Establishing linkages and associated levels of risks allows managers to address immediate resource development concerns as well as aid in long-term planning.

1.0 INTRODUCTION

During the last several decades the boreal forest natural regions of Alberta have undergone significant changes with the development and continued expansion of forestry, oil and gas, agriculture, mining and human-related infrastructure (e.g., towns, roads, electrical). These anthropogenic disturbances combined with natural disturbances of fire, flooding, wind events, and pest outbreaks dramatically alter the landscape and the biotic communities that it supports. The specific objective of Component 3 of the Northern Watersheds Project is to determine the effects of watershed disturbances on fish communities in the Kakwa and Simonette basins.

1.1 Modelling Cumulative Effects of Landscape Disturbances on Fish Communities in the Kakwa and Simonette Watersheds.

Management of Alberta's forests within disturbance-based models requires an understanding of how the suite of anthropogenic disturbances affects aquatic communities. Empirical relationships between fish communities and watershed disturbances are being evaluated in the Kakwa and Simonette basins. These basins were chosen because of gradients of anthropogenic disturbance within and among watersheds and the availability of fisheries inventory data and watershed attribute databases (e.g., AVI and Phase III). Establishing linkages between fish community structure and watershed disturbances requires the acquisition of three database types:

a. Fish communities
b. Stream habitat attributes
c. Watershed attributes

This document provides a summary of activities completed within Component 3 of the Northern Watershed Project (NWP) for the period 1 April 2000 – 31 March 2001. It describes tasks completed as part of:

1) Sample site selection and protocol development.
2) Field sampling and data management.
3) GIS data acquisition and management.
4) Criteria evaluation and planned statistical analyses.
5) Communications
6) Planning for 2001-2002

2.0 STUDY AREA

The study area consists of two drainage basins, the Kakwa and Simonette Rivers. They are located approximately 90 kilometers south of the city of Grande Prairie and both are major tributaries to the Smoky River (Figure 1). The lower portions of these drainages, within the study area, are generally located in Upper and Lower Boreal-Cordilleran ecoregions. The headwaters lie in Subalpine and to a lesser extent Alpine ecoregions. Industrial activity within the study area consists of seismographic exploration, hydrocarbon extraction, timber harvesting and coal mining. While the impact of

industrial activity does exist and is projected to intensify, much of the study area is currently relatively pristine compared to many foothill regions in the province.

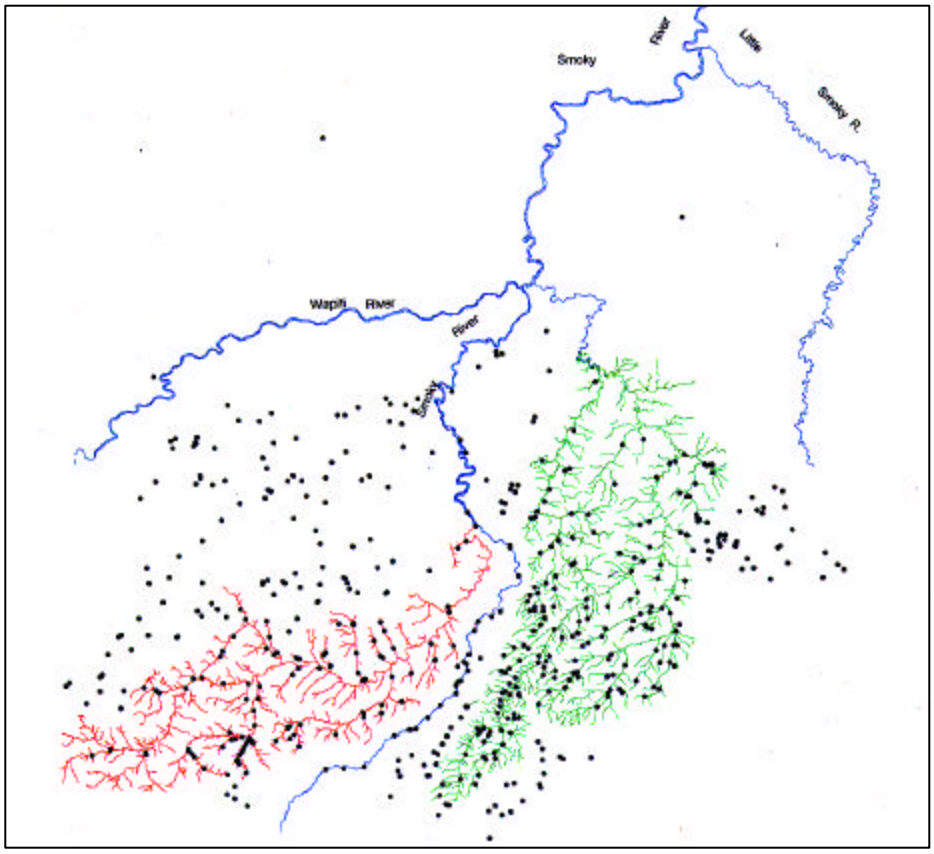

Figure 1. Location of fisheries sampling sites in the Kakwa (left) and Simonette (right) basins in north-west Alberta.

3.0 METHODS & RESULTS

3.1 Field sampling and data management

Successful completion of Component 3 requires databases of fish community structure, stream habitat and watershed attributes for the Kakwa and Simonette watersheds. Watershed attributes include linear and non-linear disturbances. Prior to 2000-2001, fisheries databases for the Kakwa and Simonette consisted of information gathered during 1994-97 data collection seasons as part of the Co-operative Fisheries Inventory Program (CFIP; Hvenegaard 1998), and a historical database collected prior to 1994. Combining the data sets provides fish community data totalling 207 sites in the Kakwa and 366 sites in the Simonette drainage. Preliminary analysis of all data in 1999-2000 indicated that more sampling was needed to accomplish the project objectives. A field program was developed for the collection of well-defined fish and habitat information for summer 2000 (Table 1).

Table 1. Fish and stream habitat variables sampled at each site during the 2000-2001 field season. With the exception of sampling of woody debris, field methods follow that described by Hvenegaard (1998).

	Variable	Sampling Method
Fish	Species Number Length	➢ Fish were collected using a single pass electroshocking technique completed by either backpack or boat mounted system. When possible, the upper end of each reach was blocked with nets. ➢ Shocking effort was quantified as time shocked and distance shocked. ➢ Sport and non-sport fish were identified to species and enumerated. Fish not captured but identified to species with confidence were recorded and included in fish estimates.
Habitat	Habitat Type Bankfull width (m) Wetted width (m) Depth (m)	➢ Each reach was divided into operation reaches and habitats recorded as riffle, run or pool. ➢ Three transects were established across the reach at equal intervals. Bankfull width and the wetted width were measured at each transect point. Wetted depth was measured at 3 points along each transect.
	Substrate Composition	➢ Substrate composition was estimated at 3 points along each transect as relative proportions of fines (<2mm), small gravel (2-16mm), large gravel (17-64mm), cobble (65-256mm), and boulder (>256mm) within a 1 meter diameter circle. Proportions must sum to 100%.
	% Canopy Cover	➢ Canopy cover was measured for each of the zones in between the transects as the percentage of each bank covered by overhanging vegetation, where overhanging means vegetation actually extended out over the water. The estimate for both banks within a zone must equal 100%.
	Large Woody Debris	➢ For each of the zones, the number of large woody debris was counted, where LWD is defined as a piece of wood at least 1-m long and 10 cm in diameter. The estimate included all pieces of LWD found at or below bankfull width. ➢ For each piece of LWD, up to a total of 20-30, the total length and diameter of top and bole (bottom) were measured to allow woody volume to be estimated. Stability was assessed for these same pieces according to the following scoring system: stability score of 1-no ends buried, 2-one end buried, 3-two ends buried, 4-one side buried. ➢ In the event of a debris dam, the height, width and length of the dam were measured, and the fraction of LWD and the mean diameter of LWD in the dam visually estimated.
	% Unstable Bank	➢ For each zone, the percentage of the left and right bank that was highly unstable was estimated, where unstable banks are indicated by massive bank slumping and large deposits of silt.
	% Undercut	➢ For each zone, the percentage of each bank that was undercut was estimated, where undercuts are indicated by lateral scouring.

	Variable	Sampling Method
	Discharge	➢ Discharge was measured at a constricted section of stream. Wetted width was measured along with a series of depths and flow measurements taken at 0.4 times the depth above the stream bottom using a flow meter.
	Water temperature Conductivity Dissolved oxygen pH Turbidity	➢ Water chemistry variables were measured using hand held field instruments.
	Location	➢ UTM co-ordinates for each site were measured with hand held GARMIN™ GPS units, and the location of the sample site in relation to its location in the longitudinal profile (stream order) recorded using 1:20 000 topographic maps.

In the absence of forest cover and other watershed physiographic attributes, the objective of the 2000-2001 field program was to increase representation of 1st to 6th order stream sites (i.e., sites were stratified by stream order). Using field practices described previously (NWP 2000), fish and habitat surveys were completed at 62 sites in the Kakwa and 78 sites in the Simonette watersheds (Table 2). High stream water levels, inability to access small streams and discrepancies between predicted stream hydrography and actual stream networking resulting in reduced sampling compared with that initially planned (Table 2).

Table 2. Summary of fish and stream habitat surveys sites completed in the Kakwa and Simonette watersheds in 2001-2002. Data are numbers of sampling sites located in first to sixth order streams.

	Kakwa watershed		**Simonette watershed**	
Stream order	**Planned**	**Actual**	**Planned**	**Actual**
1st	30	7	15	8
2nd	12	13	10	12
3rd	16	20	14	23
4th	12	20	34	23
5th	0	20	10	9
6th	0	2	8	3
Total	70	62	91	78

Fish community and instream habitat variables have been uploaded into the Provincial Governments' Fisheries Management Information System (FMIS; Project ID# 1814), and when combined with other data sources comprise a moderately large dataset (Table 3) to evaluate linkages between fish communities (Table 4) and watershed attributes.

Table 3. Summary of the individual sample sites included in the Fisheries Management Information System (FMIS) database for the Kakwa and Simonette watersheds.

Data source	Kakwa	Simonette
Historical	117	48
Co-operative Fisheries Inventory Program	90	318
Northern Watershed Project – 2000	62	78
Total	268	444

Table 4. Summary of fish species assemblage in the Kakwa and Simonette watersheds.

		Watersheds		
Common Name	**General Status**	**Simonette**	**Kakwa**	**Total**
Arctic Grayling	Sensitive	334	326	660
Brook Stickleback	Not at Risk	1217	0	1217
Bull Trout	Sensitive	286	667	953
Burbot	Not at Risk	36	0	36
Emerald Shiner	Not at Risk	16	0	16
Finescale Dace	Status Undetermined	308	0	308
Flathead Chub	Not at Risk	203	0	203
Lake Chub	Not at Risk	4944	1	4945
Largescale sucker	Sensitive	5	0	5
Longnose Dace	Not at Risk	325	1	326
Longnosed Sucker	Not at Risk	668	14	682
Mountain Whitefish	Not at Risk	491	389	880
Northern Pike	Not at Risk	3	0	3
Northern Redbelly Dace	Sensitive	6616	0	6616
Pearl Dace	Status Undetermined	1305	0	1305
Rainbow Trout	Not at Risk	0	240	240
Redside Shiner	Not at Risk	289	5	294
Slimy Sculpin	Not at Risk	6027	1891	7918
Spoonhead Sculpin	May be at Risk	1	0	1
Trout-perch	Not at Risk	176	0	176
Walleye	Not at Risk	8	0	8
White Sucker	Not at Risk	2366	10	2376
	Totals	25624	3544	**29168**

3.2 GIS data acquisition and management

Establishing linkages between fish communities and watershed disturbances requires accurate information on watershed physiography including stream hydrography, forest cover, and watershed disturbances. The majority of these data are obtained by analysing

geographic information systems (GIS) databases held by Alberta Sustainable Resource Development and those provided by Weyerhaeuser and Canadian Forest Products. The first step in this process was to acquire databases from partners followed by a file screening process to ensure that data retrieval did not result in transcription errors. These data sets were then compiled and are stored in a restricted-access folder at Alberta Sustainable Resource Development, Peace River office.

Review of the Provincial Government's Base Features GIS layer for the Kakwa and Simonette watersheds indicated that the existing Digital Elevation Models were of low quality and that hydrologically corrected DEM's needed to be created for both basins to produce accurate stream hydrography layers. GISmo Solutions Ltd. subsequently developed hydrologically corrected DEM's for both watersheds.

3.3 Criteria evaluation and planned statistical analyses

A broad suite of predictor variables and statistical tests (i.e., univariate, multivariate, parametric and non-parametric) will be used to evaluate linkages between fish and watershed attributes (Table 5). Analyses will commence in late fall 2001 (see Plans for 2001-2002).

Table 5. Potential population and community-level attributes of fish communities to be related with disturbance attributes in the Kakwa and Simonette watersheds. Non-disturbance indicators are generally used to as covariates within models or in variance partitioning procedures.

A) Fish population and community attributes to be predicted	
1. Total faunal density 2. Density of individual fish species 3. Relative abundance of individual fish species 4. Presence-absence of individual fish species	5. Fish community types 6. Community richness 7. Community diversity metrics
B) Disturbance indicators	
1. Seismic density and arial coverage. 2. Road density arial coverage. 3. Pipeline right-of-ways density and arial coverage. 4. Harvest blocks arial extent and age. 5. Harvest block adjacency. 6. Well site density and arial coverage.	7. Oil and gas facility density and arial coverage. 8. Stream crossing density and arial coverage. 9. Transmission right-of ways density and arial coverage. 10. Railway line density and arial coverage 11. Mean stand age of area forested

C) Non-disturbance indicators	
1. Watershed and stream order 2. Watershed area (total, contributing) 3. Watershed slope 4. Stream slope estimates 5. Stand type 6. Dominant tree species 7. Elevation	8. Site proximity 9. Site longitude and latitude 10. Stand type 11. Dominant tree species 12. Age of dominant tree species 13. Percent wetlands within watershed 14. Percent lake within watershed

4.0 MANAGEMENT IMPLICATIONS AND FUTURE DIRECTIONS

The sustainable management of Alberta's boreal forests requires an understanding of how all watershed disturbances arising from oil and gas, and forestry operations affect fish communities. This study contributes to sustainable forest management by describing the impacts of types, and interactions of watershed activities. These results will provide industry and government with pragmatic criteria through which they can evaluate the cumulative effects of existing and proposed industrial activities. The information obtained in this study will be able to provide resource managers with methods of quantifying the risks associated with land use activities on aquatic species currently at risk within the watersheds.

During 2000-2001, ten presentations on the NWP Cumulative Effects component were delivered to the NWP Science team, NWPSC members and other interested audiences (i.e., Canadian Association of Petroleum Producers, ACA's Partners in Conservation). In 2000-2001 three quarterly reports and four funding proposals were distributed to the NWPSC and NWP partners, respectively.

Researchers involved in the Fish Component also contributed to the development of the first NWP newsletter. This letter is scheduled for distribution by 15 March, 2001 and is part of the larger objective to develop a communications plan for the project.

4.1 Planning for 2001-2002

The draft final report describing results and management implications of work completed as part of the NWP Cumulative Effects Component will be completed by 15 March 2003. This length of time is required to:

1) Collect additional information on fish communities in both study watersheds.
2) Enter and subsequently retrieve relevant fisheries data from the Provincial Governments' Fisheries Management Information System (FMIS).
3) Complete a draft final report for Component 2.

Pending approval from the NWPSC, activities in 2001-2002 will comprise:

1) Fish habitat surveys in the Kakwa and Simonette basins.
2) Inventory of stream crossings in the Simonette and if funds are sufficient, the Kakwa watershed.
3) Review of other studies whose objective was to evaluate the cumulative effects of watershed disturbances on fish communities.

In 2001-2002, selection of field sites will be based on a data gap analysis. The data gap analysis comprises:
1) Collation of the fish database.
2) Completion of GIS queries to attribute sampling sites and their watersheds.
4) Statistical analyses of the two data sources to quantify spatial coverage.

GIS attributing will be completed by Brian Fairless (LFS; Peace River), with input from other members of the research team. Given our understanding of existing data gaps, such as the absence of fish surveys in the northern region of the Simonette watershed, an additional field season will be required. Thus, statistical analyses and interpretation will likely commence in winter 2001.

5.0 LITERATURE CITED

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