Queen Charlotte Islands Project

1981

Introduction

The Queen Charlotte Islands Fish-Forestry Interaction Program was an interdisciplinary study assessing the interactions between timber harvesting operations and mass wasting, and their effects on fish habitat.

The program began in 1981, after conflicts between forestry and fisheries resource interests escalated in the late 1970s following a series of winter rainstorms in 1978 that triggered hundreds of landslides throughout the Queen Charlotte Islands' forest land base. Logging practices on steep slopes were criticized for accelerating mass wasting events that delivered masses of debris and sediment to important salmon spawning streams, and these events brought forward public and private concerns regarding logging practices on the Islands. This led to the creation of the Fish-Forestry Interaction Program (FFIP) by federal and provincial agencies.

Figure 1: Government Creek watershed from the air and on the stream bank.

The general objectives of the FFIP were to:

- Survey and document the degree and severity of mass wasting events on the Islands, and evaluate the resulting effects on forest land and fish habitat
- Examine the feasibility of stream and forest site rehabilitation techniques to mitigate damage caused by landslides
- Investigate alternative silviculture practices to better maintain and improve slope stability
- Assess the feasibility of alternative logging practices on steep slopes

The program was funded by federal and provincial government agencies, including the Canadian Department of Fisheries and Oceans, the British Columbia (B.C.) Ministries of Forests and Environment, the Canadian Forestry Service, and the Forest Engineering Research Institute of Canada.

Findings of this program have been presented in peer-reviewed journals, at conferences, and in technical reports such as a series of Land Management Reports from the B.C. Ministry of Forests.

Figure 2.1: Queen Charlotte Islands satellite image (left).

Figure 2.2: Detail from inset showing the Government Creek area, indicated by the yellow dot (below).

Study Area

The Queen Charlotte Islands form an archipelago made up of two large main islands and roughly 148 smaller islands. The islands are located approximately 100 km west of the central British Columbia coast, extending through Hecate Strait, about 250 km north of Vancouver Island. The total land area of the islands is approximately 9940 km^2.

Much of the landscape of the Queen Charlotte Islands is naturally unstable, as many areas are characterized by steep slopes and highly erodible, weathered bedrock, as well as being subjected to frequent seismic activity. Mass wasting is the dominant geomorphic process, with debris slides, avalanches, flows, and torrents as well as slump-earth flows common in forested and harvested watersheds.

The Queen Charlotte Islands have valuable timber and fisheries resources. The mild climatic conditions and high annual rainfall result in rapid forest growth, and have created some of the most productive forestland in British Columbia. Old-growth timber is harvested on the islands, and includes the following species: Sitka spruce (*Picea sitchensis*), western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*) and yellow-cedar (*Chamaecyparis nootkatensis*).

Stream systems on the islands contribute to both commercial fish production and the sport fishing industry. Fish species found in Queen Charlotte Island streams include: pink (*Oncorhynchus gorbuscha*), chum (*O. keta*), and coho salmon (*O. kitsutch*); cutthroat (*O. clarki*) and steelhead trout (*O. mykiss*); and Dolly Varden char (*Salvelinus malma*). A small number of chinook salmon (*O. tshawytscha*) are present in some systems, along with runs of sockeye salmon (*O. nerka*).

Study Design

The Queen Charlotte Islands FFIP was accomplished in two 5-year phases between 1981 and 1994. An inventory of mass wasting events on the Queen Charlotte Islands was achieved during Phase 1. Other research examined hillslope and stream channel associations and processes. Phase 1 also included investigations of stream channel and forest site rehabilitation techniques to moderate the negative effects of landslides.

Output from Phase 1 included a set of policy recommendations for senior management in the B.C. Ministry of Forests, as well as many publications and reports. Phase 2 began in 1988 with new and continued research into hillslope and stream channel interactions. The second phase incorporated field demonstrations, and information sharing for resource managers and working foresters.

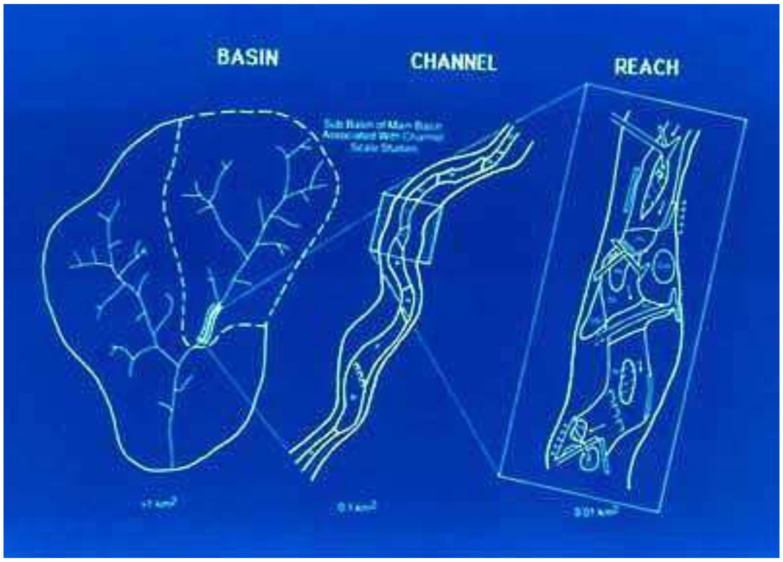


Figure 3: Phase 2 continued research into hillslope and stream channel interactions.

The primary study design used in the Queen Charlotte Islands FFIP was the 'extensive post-treatment' approach involving comparative studies in forested and previously logged watersheds, although multiple basin case studies and opportunity-based prescriptive projects were also carried out. Study sites were located throughout the islands and ranged from the northern tip of Graham Island to southern Moresby Island (see map). A range of spatial scales were also used in the study.

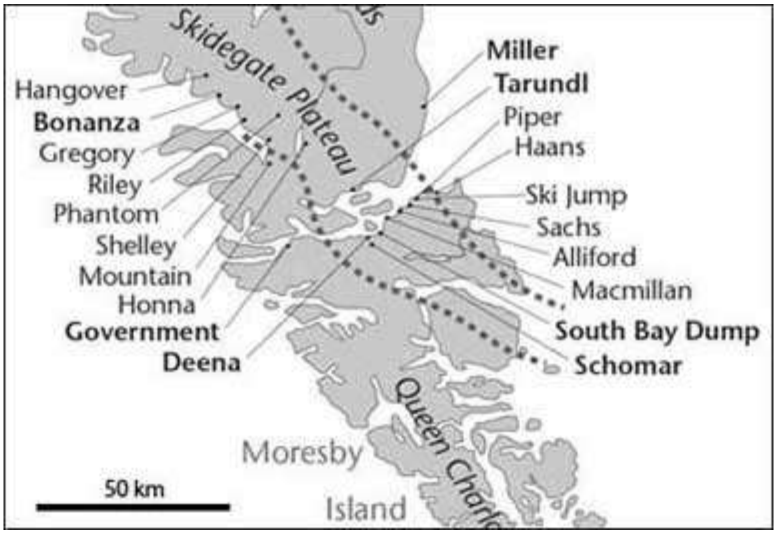


Figure 4: Location of streams sampled in the FFIP synoptic suspended sediment sampling program, and of streams (named in bold type) studied for environments of fine deposits.

Summary of Main Findings

Components in the Queen Charlotte Islands FFIP have included assessments of:

- The location, extent, and severity of landslides
- The effects of landslides on stream channels, forest productivity, and fish and fish habitat
- The role of gullies in unstable terrain
- Similarity measures for watersheds
- Stream restoration and rehabilitation techniques
- Logging and silvicultural techniques

Some of the key findings of the FFIP are listed below:

- Logging activities accelerated the frequency and yield of mass wasting on steep slopes. Mass wasting events occurring in clear-cut and road cut areas resulted in a greater volume of material entering streams, compared to those that occur in forested terrain. (Rood 1984).


Figure 5 & 6.

- Debris torrents delivering organic material to streams reduced the quality and quantity of juvenile salmonid rearing habitat in first- and second-order streams, especially those below 7% gradient. In torrented streams, pool depth and area decreased, as did the amount of cover provided by undercut banks and large organic debris (Tripp and Poulin 1986a).
- Streams in watersheds that were either logged to the channel banks by older methods, or logged by modern methods and debris-torrented, exhibited differences in pool and riffle characteristics when compared to unlogged streams and those logged by modern methods but not torrented. In older logged and torrented channels, stored sediment volume increased, reducing pool size and creating larger riffles. The size distribution and orientation of large organic debris were altered in older logged and torrented streams, resulting in decreased fish habitat value. No significant morphological differences were observed in unlogged watersheds compared to those logged by modern methods and not torrented (Hogan 1986).



Figure 7, 8 & 9.

- Landslides delivered sediment and debris to streams in an episodic manner but logging on steep slopes was found to accelerate their occurrence. This increased the number of in-stream debris jams and influenced the frequency and magnitude of sediment wedges in receiving streams. Debris jams had specific effects on channel morphology and negative impacts on fish habitat. Streams with recently formed debris jams exhibited shallow pools, extensive riffle sections, reduced sediment texture variability, decreased bar stability, deep scour and fill, and an increase in the occurrence of de-watered channel. Stream morphology and fish habitat were drastically transformed during the first 10 years subsequent to landslides, but most began to resemble undisturbed conditions after ~ 30–35 years (Hogan 1989; Hogan and Schwab 1991b; Hogan et al. 1998).

Figure 10.

- Logging and mass wasting events increased fine sediment levels in streams. This decreased the quality of salmonid spawning gravel, resulting in a decline in egg-to-fry survival rates. Streams affected by logging and mass wasting exhibited an increase in gravel scour, and an associated increase in egg losses (Tripp and Poulin 1986b).

Figure 11, 12 & 13.

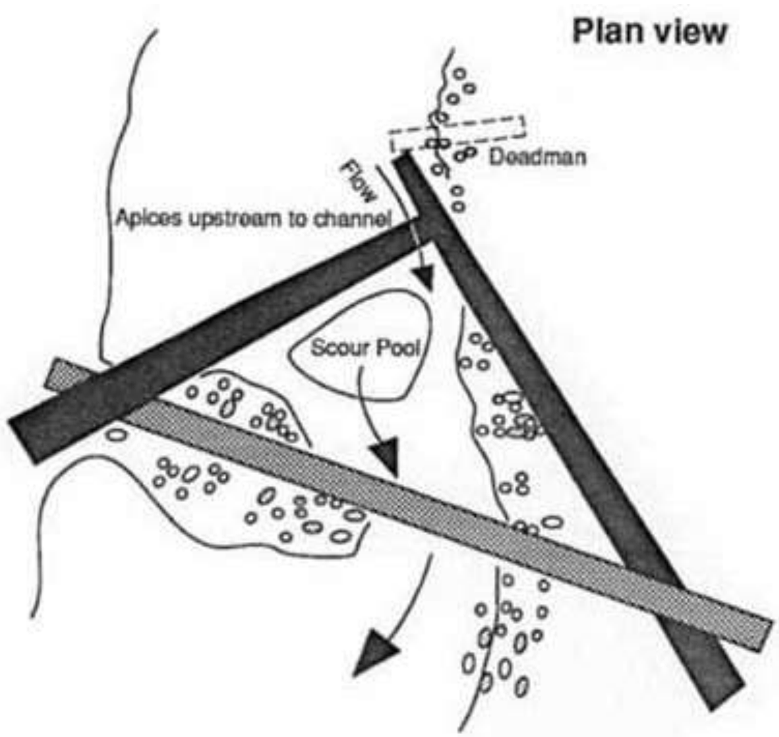
- Unlogged reaches had more undercut bank cover than logged reaches. Reaches subject to logging and mass wasting contained less undercut bank cover, fewer and shallower pools, fewer glides, less large organic debris, and a lesser wetted width relative to channel width. In mass-wasted streams, fish benefited from faster growth rates, and attained larger size. Gains in fish production were cancelled out by poor egg-to-fry and overwinter survival rates due to excess gravel scour and loss of overwintering habitat. Overall, mass wasting events had negative effects on salmonid populations through declining overwinter survival rates and smolt yields (Tripp and Poulin 1992).
- Logging operations increased hillslope sediment yield, and have altered the supply and characteristics of woody debris input to stream channels. The total number of large woody debris pieces found in logged and unlogged stream basins did not differ. In logged areas, the size of woody debris delivered to channels was smaller and more transportable when compared to forested areas. Logged stream channels displayed different woody debris arrangements, resulting in less channel complexity, decreased pool area, more homogeneous channel depth and width, and more sediment texture variability. Forested streams had greater channel stability than logged channels, due to the more uniform distribution of stored sediment along the length of the stream (Hogan 1984; Chatwin and Hogan 1990).

Figure 14 & 15.

- Comparisons of logjam sites in logged and unlogged stream channels showed more variability in fish habitat above and below the jams than between the jams. Patterns and rates of change were comparable between unlogged and logged reaches. Increasing the intricacy of logjams depended upon the continued recruitment of woody debris. New debris was not as readily available in logged systems as it is at forested sites. Fish habitat in debris-torrented zones lacking logjams was more homogeneous (Tripp 1998).
- The number of juvenile steelhead trout did not decline subsequent to streamside logging. In logged stream reaches, densities of age-0 and age-1 steelhead were higher than in unlogged sections. This increase was not observed in older fish (Hartman et al. 1998).

- Large organic debris (LOD) was placed in a small debris-torrented stream in an attempt to restore fish habitat. In the experimental stream section the number of pools, pool types, and pool area increased, as did the amount of LOD cover. In the first year following restoration, coho overwintering survival and smolt production increased in the experimental section when compared to a control section (Tripp 1986).
- Stream rehabilitation with large organic debris structures and ponds created with explosives in off-channel areas improved fish habitat. Salmonid habitat was enhanced at LOD placement sites by increasing total cover, winter cover, and the number, size, and depth of pools. Juvenile salmonid densities increased following the installation of LOD structures and creation of blast pools. Assessments of LOD structures following the first winter indicated that single log placements were the most successful structures tested (Poulin and Associates 1991).

Figure 16: Aerial view of LOD structure in Macmillian Creek (below).



- Stream rehabilitation using large organic debris resulted in greater channel definition and a reduction in wetted area. Although the amount of overhanging vegetative cover was greatly reduced, habitat diversity more than doubled after rehabilitation, and available critical overwinter rearing habitat tripled. The total pool number and area more than doubled, and the number of types of pools increased. Following large winter flood events, most log structures remained in place, but 50% of them had been underscoured, which reduced pool depths and added to overall habitat diversity (Klassen 1991).

- Gabion weirs were successful in rehabilitating salmon spawning habitat in downstream, low-gradient (less than 2%) channels in landslide-damaged streams (Klassen 1984).

Figure 17.

Conclusions

The results of the Queen Charlotte Islands FFIP provide valuable data on the interactions between logging operations and mass wasting, and the response of stream channels, fish, and fish habitat to these events.

The program produced scientific data on how logging practices on steep slopes can accelerate mass wasting events, and have deleterious effects on salmonid populations. The Queen Charlotte Islands FFIP complements other British Columbia fish-forestry research initiatives investigating the effects of logging on fish habitat, including the Carnation Creek and Slim-Tumuch Creek projects. The research adds significantly to our understanding of the impacts of timber harvesting on hillslopes, watersheds, and fish in the Pacific coast region.

The information gained through this project has contributed to the development of better forest management guidelines, regulations, and practices in British Columbia.