Harvesting Systems and Equipment in British Columbia
The handbook does not attempt to define a single “best” system for any site. Instead, it presumes that readers need to be aware of the key factors that influence the probability of achieving success with any given combination of equipment and site characteristics. Readers will then use their own judgement to evaluate the merits of the various options. The information in the handbook should be considered only as part of an overall process for equipment selection which will vary from company to company.
Abstract

This handbook describes the various types of equipment and systems used for harvesting timber in British Columbia. Falling, primary transport (ground, cable, and aerial), processing, and loading phases are described in terms of common and distinguishing features and their relationship to operational and environmental considerations. The handbook also discusses the effects of operating techniques, site characteristics, and external requirements from the same operational and environmental perspectives.

Primary operating conditions for the various machine types are outlined in summary tables. A series of flowcharts based on a risk-analysis system is used to rank the probability of conducting successful operations with different equipment on various sites.

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Disclaimer

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Harvesting Systems and Equipment

Part One

EQUIPMENT SELECTION

The handbook does not attempt to define a single “best” system for any site. Instead, it presumes that readers need to be aware of the key factors that influence the probability of achieving success with any given combination of equipment and site characteristics. Readers will then use their own judgement to evaluate the merits of the various options. The information in the handbook should be considered only as part of an overall process for equipment selection which will vary from company to company.
INTRODUCTION

Many different harvesting systems and equipment are available for today’s logger. Options range from small skidders to large skylines to helicopters, with a wide variety in between. Two of the most important tasks faced by the logger are to select the best harvesting system and equipment for a given site, and to use the selected equipment in the best way possible. Each system can operate successfully under a wide range of conditions, and the conditions suitable to each system can overlap considerably. On many sites, several systems could be used successfully, yet the conditions on other sites may favour a single harvesting system.

Sometimes the choice between harvesting systems and equipment may result from personal or corporate preferences, especially if the options are similar. In other cases, the same equipment can be used on different sites, but the operating techniques must be changed to achieve the desired results. Regardless of the selection process, understanding both the economic and environmental ramifications of choosing a particular type of equipment for use on any given site is necessary.

In addition to economic, corporate, and environmental considerations, harvest-system selections can have legal implications. Depending on the jurisdiction, planners may choose equipment that meets criteria or achieves results in certain site conditions as required by various regulations.

With so many factors to consider, how does a person decide which harvesting equipment and system is best suited for a particular site? While there are as many different ways to arrive at a decision as there are loggers, planners, and equipment owners, each decision should be based on a thorough understanding of the implications of selecting the different equipment types. Better understanding will lead to better decisions, and the objective of this handbook is to help improve that understanding.

The handbook describes the various harvesting systems and equipment commonly used in British Columbia. It describes various site characteristics, operating techniques, and external requirements, and their effect on different types of harvesting equipment. The information contained herein can help the logger or planner make better choices. However, the handbook is not meant to be used as a rigid guide — its role is mainly for reference.

About This Handbook

Background
The British Columbia Ministry of Forests approached FERIC in 1995 to prepare an educational resource about harvesting systems and equipment. The new Forest Practices Code of British Columbia Act required licensees to identify harvesting systems in logging plans, and ministry personnel to review the intended use of those systems and equipment. However, information was lacking — no common descriptions existed of what equipment was available for timber harvesting in British Columbia, and what the capabilities were of that equipment. This handbook resulted from those discussions.

While this handbook grew out of a requirement of the Forest Practices Code of British Columbia Act, FERIC’s advisory committee was apprehensive about its possible role regarding harvest planning and the Forest Practices Code. The committee wanted to ensure that the handbook could not be misinterpreted as providing a “cookbook” formula to determine the “correct” equipment to use for any particular harvesting site. In
addition, it was recognized that this handbook would likely serve a wider audience than British Columbia; such an audience may not be interested in the legal requirements for timber harvesting in British Columbia. Lastly, it was recognized that legislation is subject to change, and that linking the handbook closely with the requirements of the Forest Practices Code might limit its usefulness if the requirements of the Forest Practices Code were to change.

As a result of these concerns, the handbook provides information about the capabilities of the various systems and equipment, but does not link them directly to the requirements of the Forest Practices Code. That task is left to the reader as a separate exercise.

**Organization**

The handbook is divided into two parts.

Part 1 reviews the context of equipment selection, summarizes the primary characteristics of various types of equipment, and lists the key factors to consider when matching harvesting equipment to sites. It also includes several examples of using the handbook to select candidate harvesting systems for specific site conditions.

Part 2 provides more detailed reference information about the various types of equipment and working conditions. It describes the harvesting phases, operating techniques, site characteristics, and external requirements, and their effect on the suitability of the different equipment types to various sites. The phases are primary transport, falling, processing, and loading. Primary transport is presented first, even though it occurs after falling, because it is commonly used to describe and classify harvesting systems.

The information in Part 1 is presented as a series of tables outlining the equipment characteristics, and charts outlining the key factors to consider for equipment selection. The reference sections in Part 2 are organized around common characteristics and distinguishing characteristics for the various equipment types. The common characteristics are those that define a particular type of equipment — they make a machine what it is. On the other hand, the distinguishing characteristics separate the various makes and models of equipment from similar machines within the same type.

These characteristics, the basis of the equipment-selection process, are also the factors that make one machine suitable for use on a particular site while rendering another machine unsuitable.

The descriptions in Part 2 explain the effects of each factor from operational and environmental perspectives. The operational perspectives include machine productivity, log quality, safety, and others, while the environmental items include soil disturbance, water quality, and long-term forest productivity.

**Intended audience**

This handbook is intended for two different audiences. The first group consists of people interested in timber-harvesting processes, but who may have only a rudimentary understanding of harvesting systems and equipment. Resource agency officers or other government officials who deal with timber harvesting only incidentally may find pertinent information in the handbook that can help with their job functions. Inexperienced foresters can also use the handbook to broaden their exposure to harvesting systems and equipment. The second group is people such as equipment operators and planners who are more experienced in timber harvesting in their own locale, but who
want to learn about systems used in other regions of the province. The handbook may provide them with new information that can be taken from one region and applied to their local operations.

The handbook can be used in various ways depending on the reader's objectives. The reader can follow the charts from Part 1 to rank the relative risk of using different machine types under various conditions, and then seek specific information about the equipment in Part 2. Alternatively, reading through each section in Part 2 will provide the reader with a more complete overview of the capabilities and limitations of the various equipment types.

The handbook is intended to provide a broad overview of the capabilities and limitations of the various equipment types. After browsing the handbook, the reader will have a basic introduction to the capabilities of the harvesting equipment commonly used in British Columbia.

**Background to Equipment Selection**

**Context for equipment selection**

This section provides a very brief overview of the issues involved with equipment selection. It is intended for readers who may be inexperienced with equipment selection, but who are required to specify equipment to use for a particular cutblock. It will focus the reader's attention on those factors that are most important for that cutblock.

However, this handbook does not intend to suggest that any particular make, model, or type of equipment must be used on a specific site. That decision must rest with the various planners and owners responsible for managing the area.

**Why is equipment selection important?**

Each cutblock has a set of management objectives that likely include aspects of safety, profitability, forest health, water quality, and environmental concerns. If the equipment and system chosen for a cutblock are mismatched to the site and stand conditions, then it may be impossible to achieve any or all of these objectives. The ramifications of improper equipment selection may range from unsafe working conditions to unacceptable costs to charges under the applicable forest-practices legislation. Making sound choices aims to reduce the risk of those events happening.

**Who selects the equipment and when?**

Many people make decisions about equipment selection at different times. These include:

- Equipment owner or corporate financial officer — matches the equipment fleet to the long-term expected site conditions to ensure that the equipment is profitable to operate over the long term. Decisions made when buying the equipment.

- Layout personnel — ensures that the road and cutblock boundary locations are suitable to the type of equipment that will be used for harvesting. Decisions made at layout time.

- Planner and woodlands manager — ensures a balance between equipment availability and number of cutblocks laid out for particular equipment types. Decisions made periodically (e.g., monthly or annually).
• Woodlands supervisor or contractor — assigns specific machines to work on specific sites. Fine-tunes the layout and operating techniques to match the site characteristics. Decisions made at harvest time.

What factors affect equipment selection?

**Terrain**  The factors to consider include slope, ground profile, streams and wetlands, gullies, and roughness. These factors affect the ability of the equipment to travel over the ground to reach the operating sites. Driving access is required to all parts of the cutblock for ground-based equipment, while cable and aerial systems allow for remote access. Ground-based systems may cause more soil disturbance than cable or aerial systems, especially on steep slopes or rough ground. The ground profile is critical to the success of cable systems — the layout must be engineered with adequate deflection and ground clearance to support the intended payload. In general, ground-based systems are less expensive to own and operate than cable systems, which are less expensive than aerial. Sensitive areas must be considered carefully to ensure that soil disturbance or other environmental damage does not occur.

**Soil**  Soil characteristics to consider during equipment selection include texture, moisture content, and seasonal impact. These factors affect the bearing strength of the soil, and its ability to withstand machine traffic without degradation. Fine-textured soils and moist soils are more sensitive to machine traffic than coarse-textured or dry soils. Frozen or deep-snow conditions allow ground-based machines to access ground that may not support traffic during non-frozen conditions.

**Timber characteristics**  The following timber characteristics can influence equipment selection: tree size, volume per hectare, and timber quality. There are two primary concerns: (1) the physical ability of the equipment to handle the trees without causing unsafe working conditions or causing damage to the equipment, site, or timber; and (2) harvesting economics for both per-tree and per-cutblock costs. Small trees are less economical to harvest than large trees, and small cutblocks are less economical than large cutblocks. Fixed costs such as road construction must be amortized over the volume harvested from the cutblock, and lower volumes per hectare result in smaller cutblock volumes and higher costs. Harvesting systems with high mobilization costs, such as cable or aerial systems, are especially susceptible to the effects of low volumes per hectare. The timber quality affects the timber value, and thus the harvesting economics. Large trees may be too heavy for some equipment to handle, and small trees may be damaged by large equipment.

**Business requirements**  The timber must be harvested safely and economically for the licensee and its contractors to ensure worker safety and to remain in business. All costs, including ownership, operating, and maintenance costs, must be considered.

Business requirements, as opposed to site characteristics, may impose conditions on the harvesting operations. These business requirements may include the operating season, timber flow, mill's log specifications, amount of work available, unique operating methods, labour availability, and equipment availability, service, and transportation.

Each company chooses harvesting equipment and methods that it feels best meets its corporate objectives, and different corporate objectives can be reflected in the equipment selection. For example, the mill may be equipped to accept a certain wood form as input (e.g., whole stems, logs, short logs); therefore, the harvesting system must be
geared to produce that wood form. This choice can have ramifications throughout all phases of harvesting.

**Weather and climate**  Inclement weather such as rain or wind can affect the severity of soil disturbance or can cause more hazardous working conditions. Saturated soils are more susceptible than dry soils to damage from machine traffic. Wind is especially problematic for hand-fallers. Deep snow can provide a protective ground covering for machines to travel upon, although it can also impair machines' mobility. Snow on steep terrain creates a safety hazard for on-the-ground workers because of slippery footing.

**Silvicultural system**  The silvicultural system is significant for equipment selection because some machines can maneuver better than others between the standing trees and extract logs from a partial cut without damaging the residual stand or affecting future growth potential. Machine size and maneuverability are important issues to consider in relation to silvicultural systems.

**Legislation, regulations, or permit requirements**  Some of the operating parameters in the cutblocks result from legislative requirements or permit conditions required by government. For example, utilization standards may include acceptable limits for stump heights and levels of breakage. Soil disturbance guidelines can limit the number of roads, trails, and other access structures that are allowed to be constructed on various sites, and thus affect the range of candidate equipment.

**Planning horizon for equipment selection**  Selecting the equipment for a particular site must be made within the current corporate and regulatory environment. Some typical questions to ask might be: What equipment is available? What is the long- and short-term budgeted production? What are the log quality requirements for the mill? What capital is available? What special environmental factors must be considered? Sometimes, different equipment can be selected upon short notice, but more often the equipment available for any specific site is limited by budgets or by other long-term commitments. Therefore, harvesting equipment selection must be considered over both the long term and the short term.

Over the long term, the general site and timber characteristics that are expected must be examined, and the equipment fleet selected to suit those conditions. The time horizon, which is related to budget and capital amortization, is generally three to five years or longer for major capital purchases.

Contractual and corporate obligations mean there is less flexibility to choose different equipment in the short term, and the equipment selection question is reversed. The site and stand characteristics remain important, but instead of asking “What equipment is suited to this site?” the question becomes “What site is available to use this equipment?” The process of matching equipment to sites becomes a matter of ensuring an adequate number of suitable sites for the available equipment.

These long- and short-term considerations apply not only to large companies, but also to independent contractors and planners with the Ministry of Forests Small Business Forest Enterprise Program. The difference between them is a matter of degree, especially regarding the control over each planning level. Large companies that incorporate both planning and operational functions control their long- and short-term planning — to a large extent, they control their own destiny within their corporate structure. On the other hand, long- and short-term plans are provided to contractors — their equipment selection decisions are based on the information contained in the plans provided to them.
Planners for the Ministry of Forests Small Business Forest Enterprise Program do not purchase equipment themselves, but they do influence the choices made by logging contractors by way of their future timber sale opportunities and the conditions placed on specific timber sales.

**What constitutes successful harvesting operations?**

The success of a particular harvesting system can be measured against operational and environmental criteria. The operational criteria include such factors as safety, profitability, and log quality, while the environmental criteria include water quality, soil disturbance, and residual stand protection. These objectives will change in importance depending on the site and the outlook of the observer. For example, the contractor may rank profitability before residual stand protection, while the forester may reverse their importance. However, both operational and environmental criteria must be considered to harvest timber successfully in today’s corporate and environmental climate.