RESEARCH NEEDS: ENGINEERING, UTILIZATION
ECONOMICS, SOCIOECONOMICS, AND FIRE

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With few exceptions, management practices intended to reduce losses to mountain pine beetle, to recover mortality, or to condition stands to resist attack, involve removal of a portion or all of the stand. Harvesting is the principal management tool available to the manager to enhance stand development and avoid losses to insects, disease, and fire. Consequently, harvesting systems and practices, access, and utilization strategies are of paramount importance.

The issue most frequently at hand is one of economic feasibility; that is, covering the costs of stand treatment with the value of products removed. Compatibility with non-timber resource management and environmental considerations can also be critical issues. Much of the research to date and much of the research needed in utilization, engineering, and economics relate to: (1) reducing harvesting costs, (2) enhancing product values, and (3) developing compatible multi-resource management strategies. More efficient harvesting technology and expanded utilization alternatives can extend management to stands presently considered sub-economically.

STAND MANAGEMENT
AND
RESOURCE UTILIZATION CONSIDERATIONS

Harvesting system performance requirements and the economic feasibility of harvesting or cultural stand treatment are heavily influenced by stand character and condition. Some of the principal stand conditions in lodgepole pine influencing harvesting system development and economic feasibility include:

1. Old-growth, decadent stands, frequently containing large volumes of down, dead material.

Heavy concentrations of down, dead stems restrict the movement of personnel and certain kinds of ground-based equipment and also present a particular residue recovery opportunity.

2. Mature, green sawtimber stands, with a relatively clean forest floor, providing good access for personnel and equipment:
   a. With no significant understory.
   b. With a conifer understory that requires protection during harvesting operations.

3. Mature sawtimber stands with extensive recent mortality, usually without an excessive amount of down material:
   a. With no manageable understory.
   b. With a conifer understory to protect.

Such stands offer immediate salvage opportunities and may involve some urgency in recovering recently dead stems before they deteriorate.

4. Pole stands that may or may not be severely overstocked. Thinning in overstocked stands requires particular care to avoid damage to residual stems.

5. Stands of small, stagnated 2- to 5-inch (5-13 cm) stems, frequently in excess of 5,000 stems per acre (12,000 stems per ha).

Harvesting systems that can effectively deal with removing overstory sawtimber are likely to be different from systems designed to efficiently handle
several thousand small stems per acre. Anticipated stand conditions and treatment needs are important factors in establishing design criteria.

Harvesting prescriptions and utilization specifications are also significant determinants of system design. Major variations include:

- Clearcutting, in which all merchantable material is removed, typically without attempting to retain any understory. Clearcutting allows the greatest degree of freedom in system design and mode of operation.

- Partial cutting in mature or mixed age class stands, ranging from shelterwood to seed tree (even-aged management) and group to single tree selection (uneven-aged management). Partial cutting carries with it the constraints imposed by the need to protect the residual stand from damage, which is a significant concern for harvesting system design.

- Commercial thinning in pole stands, with a particular need to meet spacing guidelines and avoid damage, such as butt scarring, to the residual stand.

- Precommercial thinning, where the need to maintain spacing and avoid damage to residual stems is critical. Closer spacing also places particular constraints on the size and type of equipment that can be used. Recovery of small cut stems may also be considered essential to reduce fuel loading.

Within any silvicultural prescription, the level of desired or required utilization affects harvesting system productivity and influences system makeup. Intensive levels of prescribed utilization of normally submerchantable material may dictate whole-tree recovery systems and in-woods sorting and processing capability.

Product opportunities and product potential are a third determinant of harvesting and utilization system design. A system must be appropriate for intended product recovery objectives; e.g., an in-woods chipping system is inappropriate for recovery of roundwood products. Product considerations in lodgepole pine include:

- Posts, fencing, rails, small roundwood products.
- House logs (frequently the product of highest value).
- Sawn lumber, principally dimension stock and studs.
- Chip and fiber products, ranging from clean pulp chips to whole-tree chips for fuel.

Increased product opportunities are facilitated by the development of harvesting systems oriented toward whole-tree recovery, leaving maximum product options open.

The enhancement of end-product values is also a valid research concern. Lodgepole pine exhibits some excellent stem form and wood quality features—straight stems, little taper, small knots, slow growth, uniform texture, and superior machine-ability. Although the species has historically been utilized for relatively low value kinds of products, the opportunity exists to develop end uses and markets that could substantially increase recovered product values.

Harvesting systems research, utilization strategies, and products research must be approached with a view to developing total systems that integrate stand management objectives, maximization of product potential, and economic efficiency. A major current research need is for the development of well-defined “management systems” for lodgepole pine that consider short- and long-term management objectives. Comprehensive management systems can set the parameters for harvesting and utilization system design. At present, there is a lack of consensus on the management needs that harvesting systems must satisfy and on the specific operational and economic criteria that system design should be addressing.

TECHNOLOGICAL ACCESS
AND
HARVESTING SYSTEM CONSIDERATIONS

Given the decision to harvest or treat a stand, the first technological problem is getting there—creating access to the site. Much of the lodgepole pine in the Northern Rocky Mountains is either under-accessed or totally unaccessed. Thus, road design
and construction is a significant problem and a major contributor to economic infeasibility. Research is needed to develop acceptable alternatives to expensive system road design and construction practices. Alternatives need to consider both economic and environmental concerns and be directed toward developing cost-effective, lower standard access systems that can still satisfy performance and environmental protection requirements.

Once on the site, the technical question is one of equipment and practices to achieve maximum harvesting efficiency. On gentle terrain, the options are somewhat more numerous and less costly than for steep terrain. For example, feller-bunchers provide an efficient option for facilitating whole-tree recovery and for accomplishing bunching prior to skidding. Research to date demonstrates the importance of bunching as a subfunction in small stem harvesting systems and the general need for systems designed to handle multiple, rather than single stems. Following bunching, grapple skidders can move stems in whole-tree form to landings for further processing. One such procedure that offers promise is to employ any of several whole-tree processors that delimb and buck material to desired lengths. Logs may be recovered tree-length or to specified lengths; limbs and cull portions can then be chipped on the landing for fuel. Additional research in system makeup, operating strategy, and in-woods practices is needed to improve the economic efficiency of such systems.

Stands on gentle terrain may also allow consideration of more frequent entries into “tended” stands (i.e., intensively managed stands), following the European style of management. The development of permanently dedicated forwarding trails and the use of various kinds of fast-forwarding equipment can provide a systematized means of removing material at frequent (10- to 20-year) intervals.

In steep terrain, the technological problem is somewhat more difficult and usually more costly. Basic system design considerations include developing reduced dependence on roads, achieving means of bunching small stems prior to yarding, and resolving anchoring needs for cable systems. One bunching concept currently under study uses a self-powered skyline bunching carriage. Bunched material can then be grapple-yarded in multiple stem turns. Anchoring needs, a major concern in small-stem stands, require the development of artificial anchoring methods for cable systems.

Where timber values allow, multispans cable systems offer potential for resolving difficult harvesting problems posed by limited access in steep, irregular terrain. Such systems are comparatively insensitive to road location and density. Smaller, low-capital investment skyline systems are also badly needed. A significant research opportunity exists for development of low-capital investment systems that retain running skyline capabilities and afford reasonable reach capability.

Alternatives to conventional cable systems are also possibilities. One concept currently under study proposes a steep slope ground vehicle, operating in conjunction with small, portable skyline towers and powered by cable. Permanent forwarding corridors are established, along which the cable-powered forwarding vehicle moves. This concept allows significantly reduced dependence on roads, facilitating operation at some distance from roads on irregular terrain.

To guide future harvesting systems development, a particular research need is for broad economic analyses of alternative harvesting system access system combinations. Trade-offs between systems that require a relatively dense road network and the development of no-road harvesting technology need to be viewed in terms of economic consequences for both short- and long-run stand management. The issue of future road spacing has not been sufficiently addressed, yet it forms a critical basis for the direction of research efforts in harvesting methodology.

NONTIMBER RESOURCE MANAGEMENT
AND
PROTECTION CONSIDERATIONS

Timber harvesting and utilization practices dramatically affect other resources and use opportunities on an area. The effects can be beneficial—in fact, necessary—to achieving management objectives; they may also be viewed as detrimental to certain objectives. To the extent that alternative practices affect the opportunities, activities, and potential well-being of the public, they become socioeconomic issues. The real or perceived effects of alternative systems and practices on other resources and on people significantly influence the whole approach to timber access, harvesting, and utilization. Harvesting and utilization alternatives should be compatible with
and facilitate meeting total resource management objectives and public expectations.

Specific resource management concerns with which harvesting and utilization systems and practices must interact include:

1. Adequate and timely regeneration.

2. Wildlife habitat effects (a concern that may often be reflected as a primary purpose of treatment).


4. Site quality: effects on nutrient capital, soils, and microbiology.

5. Esthetic quality: how it looks and how it is expected to change over time.


Research is needed to more explicitly define the consequences of alternative harvesting and utilization practices for these and other resources and management concerns.

Residue management problems are a socioeconomic concern, as a question of aesthetics, and a physical and economic concern in terms of fuels, fire management, and the high cost of residue treatment. The use of prescribed fire is frequently the chosen means of residue reduction and site preparation. Research is needed to develop a better basis for prescription to achieve desired effects and to better define the total consequences of fire on the ecosystem and on vegetative succession. Because lodgepole pine is favored by the appropriate use of fire, fire is likely to be included in any management strategy proposed for the species.

Fire—including fuels management, use of fire, and smoke management—is frequently an issue of public concern. A strengthened scientific basis for prescription and use of fire is essential to the acceptance of management practices that include fire.

Finally, the effects of alternative harvesting and utilization practices on local and regional economies is an issue. Particularly needed is research to define the probable effects of major changes in policy or practice on both large and small industry. Because lodgepole pine is frequently the major species in the area of interest, management direction for lodgepole pine is critical to the stability of the timber-dependent industry.

RESEARCH NEEDS:
A SUMMARY

The foregoing discussion elaborates on a few research needs believed to be most critical to improvement of management opportunities in lodgepole pine stands. For convenience, the following tabulation summarizes those, as well as other research needs that relate to harvesting, utilization, economics, socioeconomics, and fire.

1. Resource Management
   - Improved resource inventory information.
   - Research in "Management Systems" for lodgepole pine (management direction and treatment needs).
   - Improved criteria for systems development.

2. Products and Processes
   - Improved multiproduct recovery systems.
   - Enhanced product values.
   - Specific product-process systems for small timber.
   - Concentration yard and merchandizing systems.

   a. Harvesting Systems
      - Systems for bunching, fast forwarding.
      - Efficient systems for whole-tree processing, small stems.
      - Reduced capital investment requirements.
- Anchoring systems (for cable operations).
- Reduced dependence on roads.
- Reduced sensitivity to road location.
- Labor and energy efficiency.

b. Access

- Development of lower cost access alternatives.
- Effective integration of access and harvest systems.
- Development of more efficient "large area" access and harvesting planning.
- Research in cost-effective alternatives for meeting both performance and environmental objectives with forest roads.

4. Economic and Socioeconomic Issues

a. Economic-Financial

- Methodology for multiresource cost-benefit analysis: marginal costs and values.
- Investment analysis for alternative stand management strategies.
- Effects of significant timber utilization changes on regional, local economies.

b. Socioeconomic

- Research defining influences of alternative harvesting practices on:
  - Esthetic and recreation values.
  - Wildlife, range.
  - Watershed management.
  - Future resource values.
  - Protection concerns.
- Research investigating public preferences for management of lodgepole pine timberlands.

5. Fire Management

- Research defining influences of fire on lodgepole pine ecosystems and succession.
- Development of prescription guidelines for use of fire to achieve management objectives.
- Refinement of beetle fuel-buildup fire relationships: fuels modeling over time.