



Ground-Based Extraction



Ground-based Extraction

- Skidding
- Forwarding
- Shovel Logging



Ground-based Systems

- Produce the majority of wood harvested in eastern U.S.
- Are by far the most popular and most economical mechanized logging systems used throughout the world.
- Are sensitive to a variety of factors which can affect:
 - the safety,
 - productivity, and
 - cost of the operations.




Skidding and Forwarding

- All ground-based systems have at least one thing in common:
 - logs were moved from the stump to the landing by something:
 - on the ground, or
 - over the ground
- This movement is called:
 - skidding if logs are dragged on the ground, and
 - forwarding if logs are carried completely off the ground



Six Basic Means of Extraction

- Animals
- Crawler tractors
- Rubber-tired tractors (straight-frame)
- Rubber-tired, articulated skidders
- Track-laying skidders, and
- Forwarders (or prehaulers)



Capabilities of Extraction Methods

Source: Greene and Reisinger, 1999.

Method	Payload (cords)	Skidding Distance (feet)	Volume per Hour (cords)
Animal (draft horse)	0.30	500	1-2
Farm tractor (Log hog)	0.30	500	2-3
Rubber-tired skidder (JD 640)	1.0	1500	5-12
Forwarder (Gafner 5510)	3.0	2000	5-12



Rubber-tired, Articulated Skidders

- First developed in the late 1950's and became accepted in the 1960's.
- Are the today's standard ground skidding machines through North America and the world.
- Are/have:
 - 70 to 200 hp of engine power
 - 6 to 18 tons in weight, and
 - extremely good maneuverability



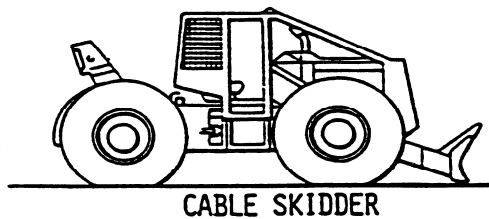
Skidder Types

Classified by the ways of holding logs as either:

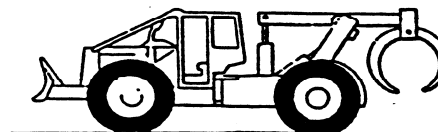
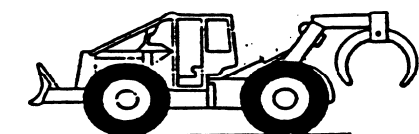
- Cable
- Grapple, or
- Clam-bunk



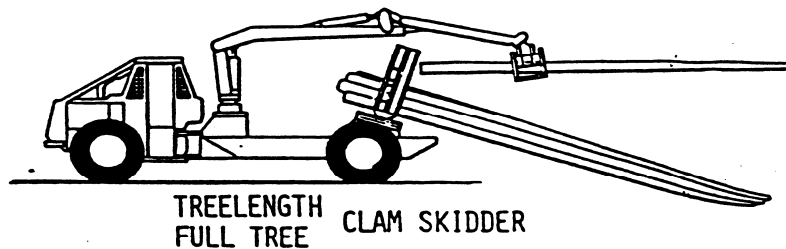
Skidder Types



CABLE SKIDDER



Grapple Skidder

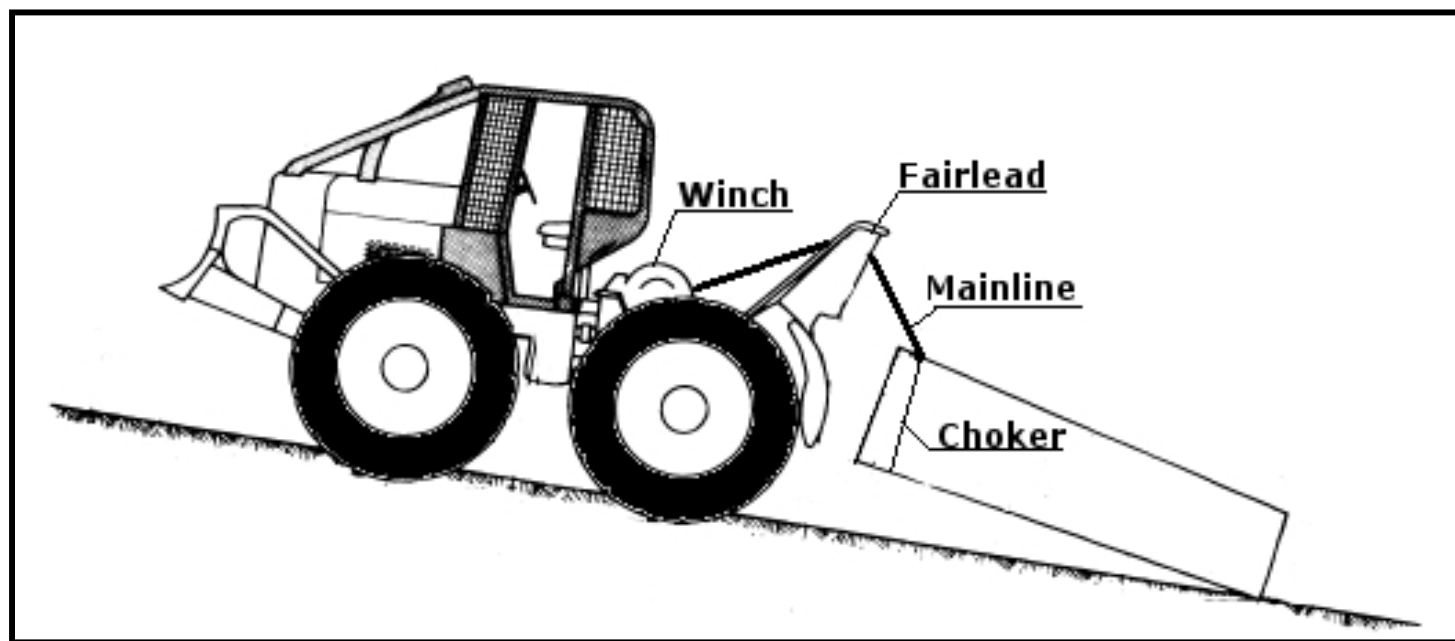


TREELNGTH FULL TREE CLAM SKIDDER

Source: Greene and Reisinger, 1999.



Cable Skidder



- ◆ Uses a powerful **winch, mainline cable, wire rope chokers** to assemble and hold logs during skidding.
- ◆ The operator attaches chokers to the logs, the logs are then winched up to the skid plate, and skidding begins.
- ◆ At the landing, the logs are then unhooked.



Cable Skidder





Cable Skidders

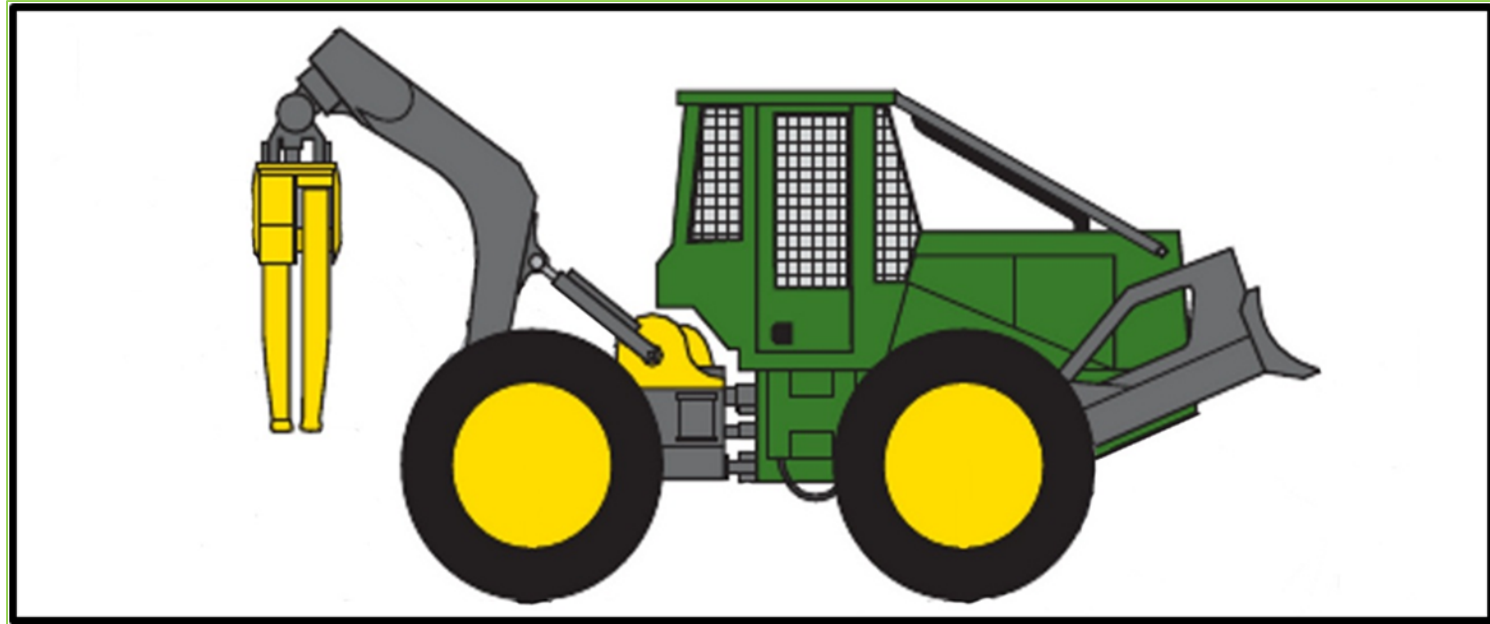
- Are the **least expensive** machines to own and operate.
- Can be **highly productive** when skidding larger timber.
- Also **work better** than most skidders on adverse slope or in wet areas.



Grapple Skidder

- Uses a hydraulically operated grapple to assemble and hold logs during skidding.
- Eliminate the operator from dismounting the machine to choke individual logs.
- Drags can be assembled faster and the work environment is safer.
- While the grapple adds both weight and expense to the machine, it often pays itself through higher production.

Grapple Skidder





Grapple Skidder



Ground-based
Extraction Methods



Grapple Skidders

- If trees have been felled and bunched by a feller-buncher, grapple skidders are much more productive than cable skidders.
- For large timber which has been manually felled, the productivities of cable and grapple skidders are nearly equal.
- Once small trees could be bunched to take advantages of the grapple capabilities, system using both feller-bunchers and grapple skidders would be the best option.



Clam-bunk Skidder

- Uses an inverted grapple located at the rear of the machine to hold large load of wood while skidding.
- The grapple is loaded using a small hydraulic loader attached to the clam-bunk machine.
- Allows to:
 - drag larger payloads (3-5 cords)
 - skid longer distance economically





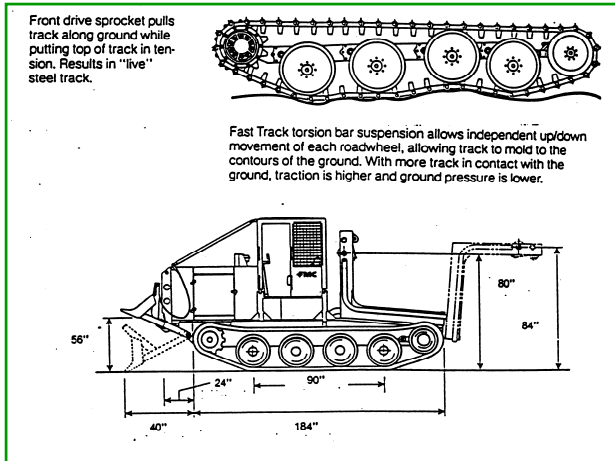
Clam-bunk Skidders

- Are used less frequently than cable or grapple skidders.
- Are frequently employed in large un-roaded areas where road building costs are high.





Track-laying Systems



- ◆ Permit higher speed and better traction
- ◆ Reduce site damage
- ◆ Are often used on sites with environmental concerns or poor trafficability.



Track-laying Skidders

- Are expensive to purchase and maintain.
- Can skid large payloads in steep slopes or wet areas.
- Are also made in:
 - cable,
 - grapple, and
 - calm-bunk versions.



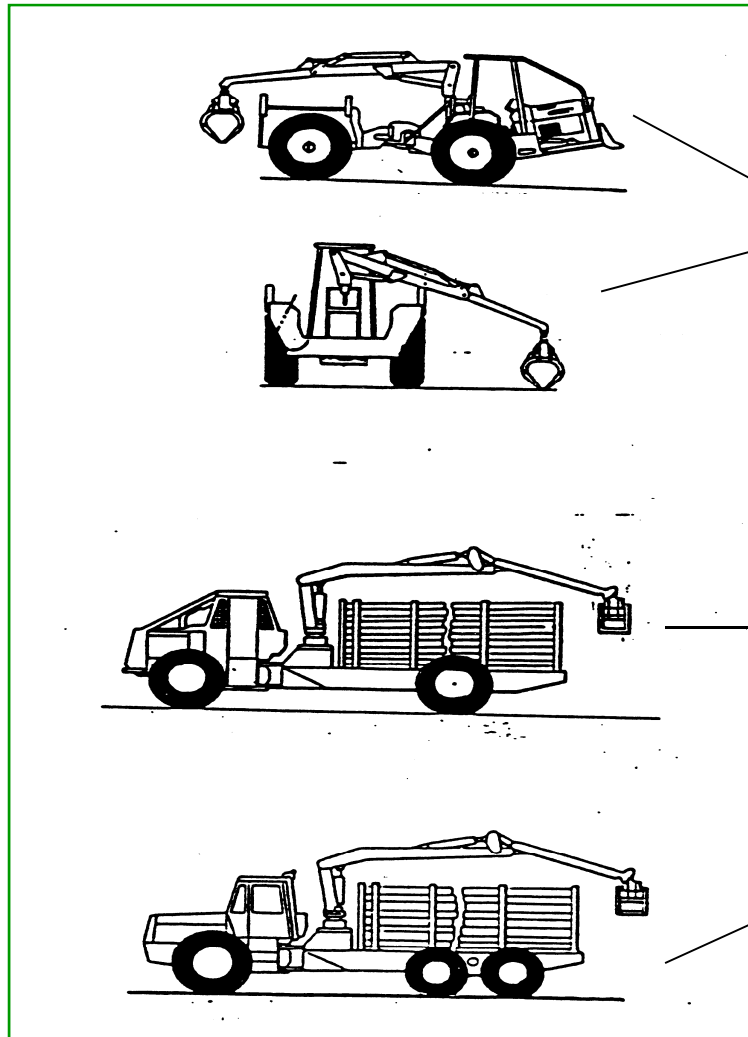
Forwarders

- Forwarders (or prehaulers) differ from skidders:
 - their payloads are carried entirely off the ground
- Assembling loads with a self-contained knuckleboom loader.
- Productivity is higher when loading roughly piled logs after bucking.
- Can economically move wood long distances, and often compete directly with clam-bunk skidders.



Source: Greene and Reisinger, 1999.

Forwarders



Articulated frame forwarder

Single-axle forwarder

Double-axle forwarder



Forwarder





Forwarders

- Either unload logs at roadside onto ground or directly onto a truck or setout trailer.
- Most forwarders used in the United States **simply move wood and do no processing.**
- Are often widely used for thinning or partial cuts of timber.



Forwarder

- When used in conjunction with harvester,
 - can travel over a thick mat of branches left in the corridor,
 - provides additional support for heavy loads, and
 - prevents rutting of the corridor



Shovel Logging



Shovel Logging





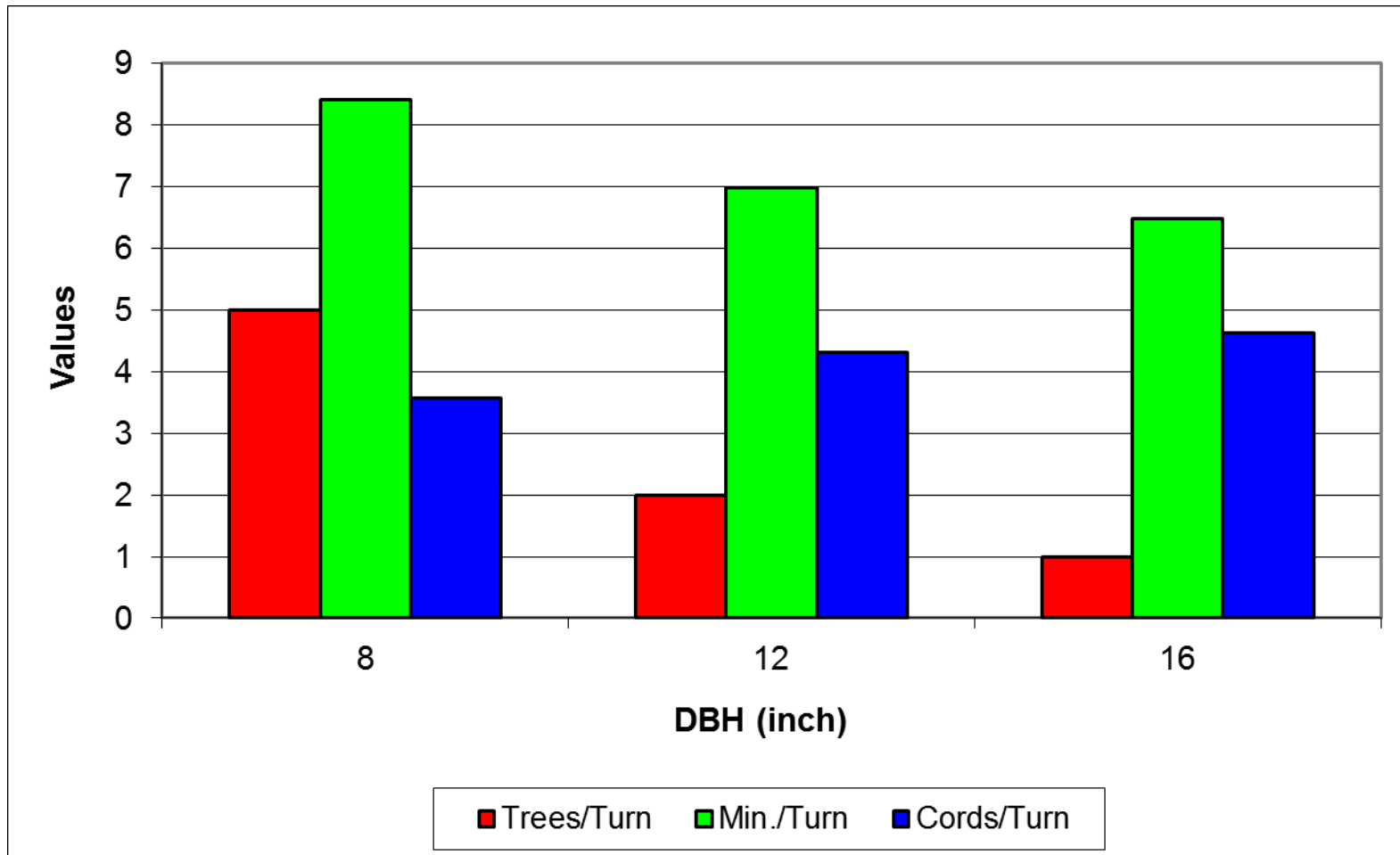
Factors Affecting Productivity and Costs

Several factors affect the productivity and cost of ground-based systems:

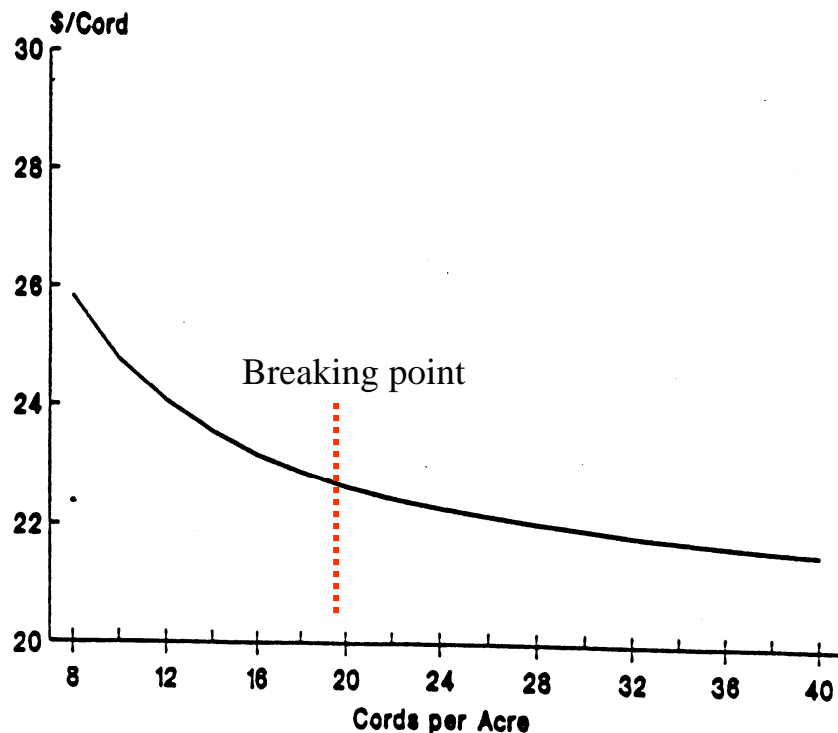
- Average tree size (DBH)
- Stand volume per acre
- Extraction distance
- Extraction payload
- Type of harvests (thinning or clearcut)
- Species harvested



Average Tree Size



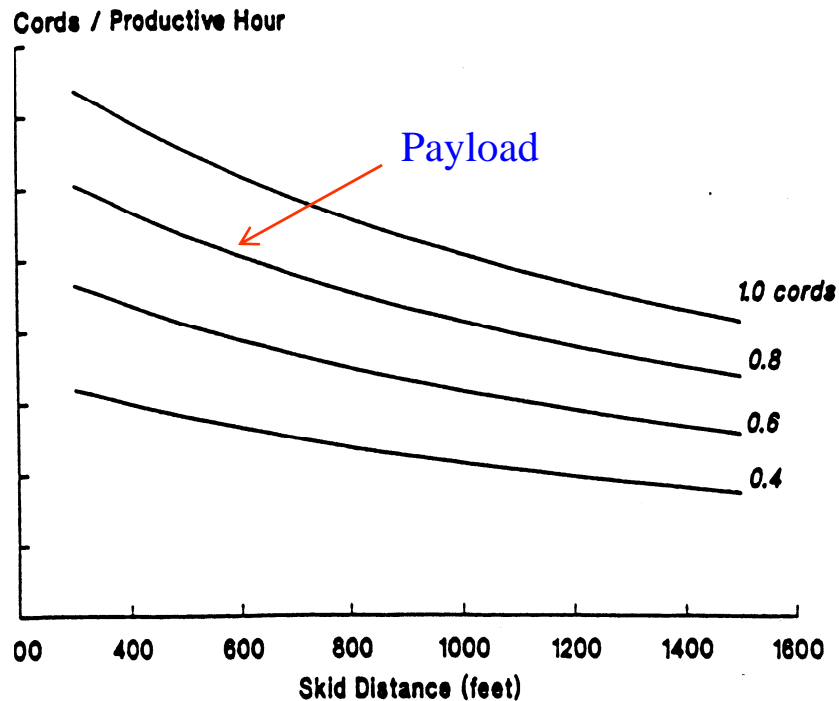
Stand Volume Per Acre



- In dense stands, Vol/Ac has a greater effect on system productivity and cost than individual tree size.
- For highly mechanized systems using FB and SD, the effect diminishes once vol/ac exceeds 20 cords per acre.

Source: Greene and Reisinger, 1999.

Extraction Distance and Payload



- Affect system productivity and cost most.
- Can be controlled by planning and layout of logging operations.
- The number and locations of landings determine the average extraction distance.
- Payload is determined by type and size of timber harvested, and the method of felling and extraction.

Naturally, a logger seeks to move the largest payload over the shortest possible distance.

Source: Greene and Reisinger, 1999.



Type of Harvest

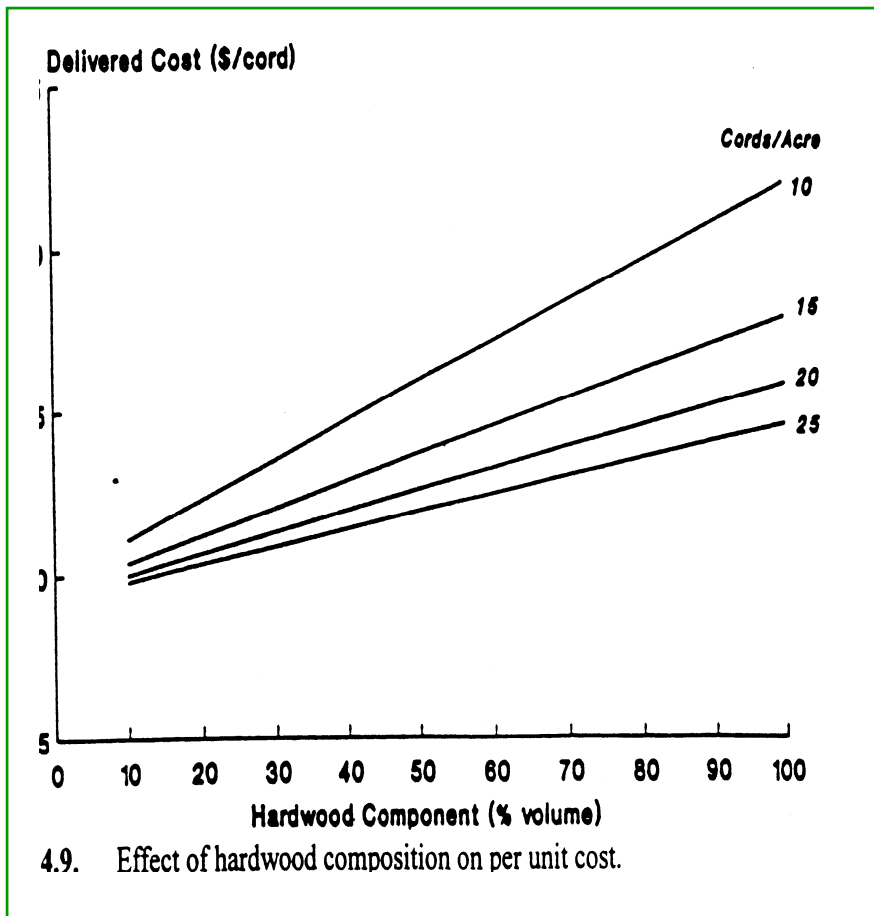
- Clearcut presents fewer constraints to a harvesting system than thinning or partial cut.
- Thinning often requires smaller equipment or different operating strategies than clearcut.
- Residual trees not only represent an obstacle to be avoided, they must be protected.
- Thinnings and partial cuts increase operating costs due to:
 - Smaller payloads
 - Longer extraction distance



Species Composition

- From a harvesting standpoint, softwood species are the preferred timber type because many of the harvesting functions can be mechanized.
- Harvesting of hardwood species are generally more difficult to mechanize due to several factors.

Species Composition



- Hardwoods often occupy **difficult sites**.
- Are **heavier and poorly formed**, and making large payloads more difficult.
- **Large heavy crowns** reduce mechanical felling productivity.

(These factors combined together make harvesting hardwoods more expensive than harvesting softwood species.)

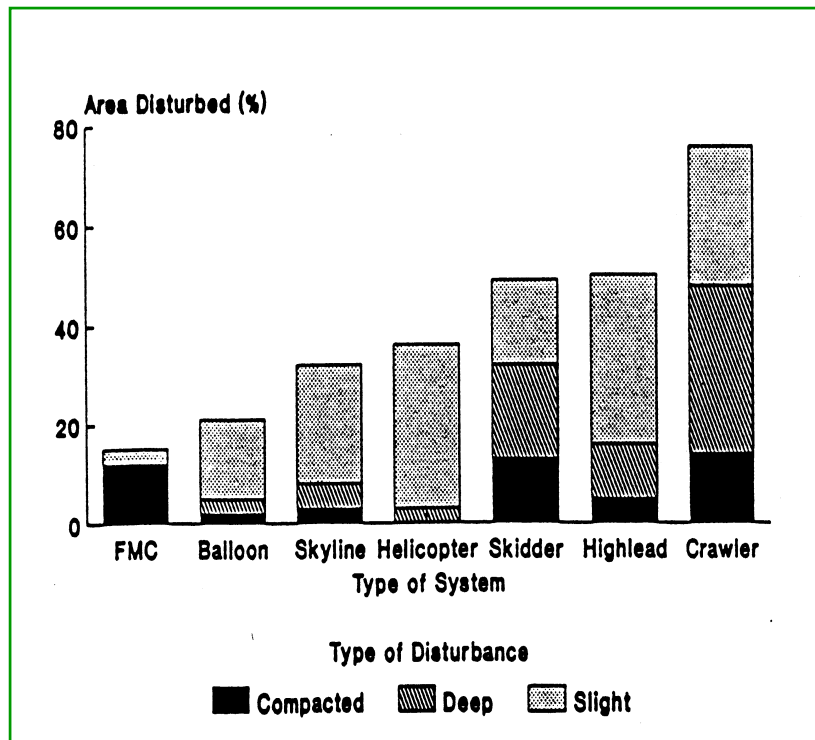
Source: Greene and Reisinger, 1999.



Site Damage

- Regardless of the type of logging system used, some site damage can occur due to:
 - passage of equipment and
 - movement of felled trees across the site
- Several factors influence the amount and type of damage:
 - Type of machine used
 - Type of product skidded
 - Soil condition, terrain, and
 - Sale layout

Site Damage

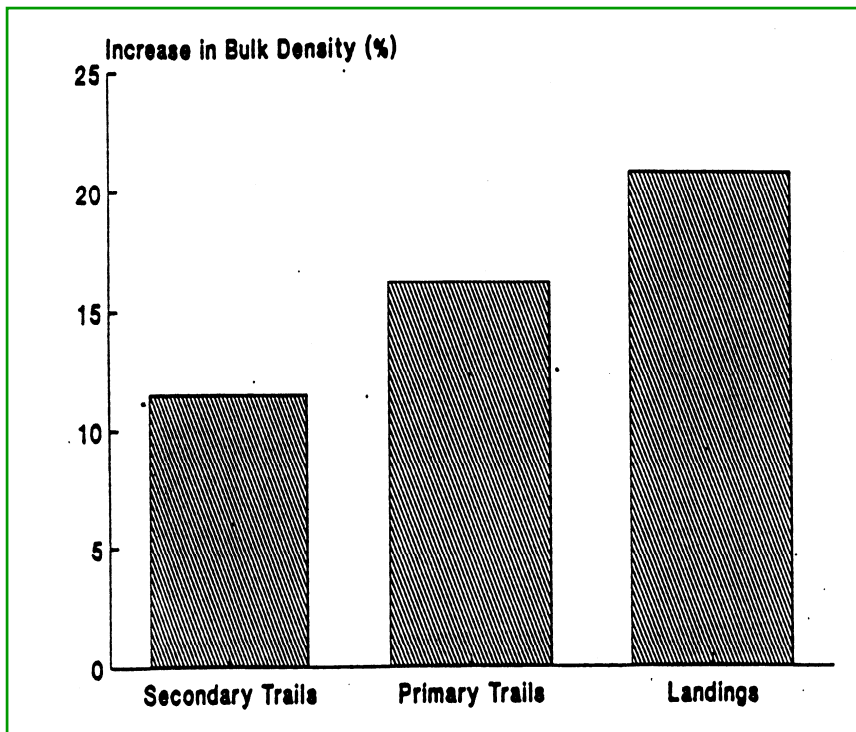


- Cable and aerial systems generally disturb a smaller percentage of the harvested site.
- Track-laying skidder (FMC) causes the most amount of compaction.
- Rubber-tired skidder or crawler disturbs a significantly higher percentage of the area.

Source: Greene and Reisinger, 1999.



Site Compaction



- Compaction is measured as an increase in soil bulk density.
- High level compaction is not desirable.
- Compaction can occur quickly with just few passes of a heavy machine across the site.
- Designated skid trails are recommended to use.

Source: Greene and Reisinger, 1999.