Moving Giants: People, Physics and Cable Logging

DISCOVER FORESTRY NEW ZEALAND

How do you bring a tree weighing several tonnes off a steep hillside while protecting people, limiting soil disturbance and keeping the operation viable?

A working day on the hillside

The hauler's wire ropes draw a felled tree up the steep hillside towards the landing. The operator carefully controls its movement, lifting the stem where possible to reduce soil disturbance and damage to the wood. Each load requires judgement about the terrain, cable angles and weight of the tree.

A planned cable setup, secure anchors and an experienced operator guide the process, with adjustments made as the stem moves and the machine responds. The clip below, filmed in Oregon, demonstrates how a typical Swing Yarder operates. Cable extraction brings hazards from moving logs and tensioned wire ropes. The clip below, apparently filmed using a drone, helps viewers understand how the ropes and logs move on the hillside.



Planning before the first tree falls

"Before we get to the forest, there's been a harvest plan done," Warren explains. Roads and landings, also called skids, are prepared so the crew can position machinery, bring trees off the hillside, process the wood and load logs onto trucks.

The position of each landing shapes how the harvesting operation will work. Warren describes setting up the yarder near the edge of the landing, facing the trees to be extracted. The crew works along one cable line, recovering the felled trees beneath it, then moves the line across to reach the next area.

The terrain influences what is possible. The height of the hauler and the position of the anchor point across the hillside affect cable deflection and how much wood can be lifted. As Warren explains, some settings allow only one log to be brought in at a time; others allow several. These differences affect both the pace of work and the crew's ability to lift stems clear of the ground.

The previous hauler footage shows the recovery stage of this planned operation. Behind each moving stem are decisions about access, machine position and the route the wood will take to the landing. A harvest map connects those decisions with the terrain in the clip.

Harvest planning connects the terrain with access, landing locations and extraction routes before machinery arrives

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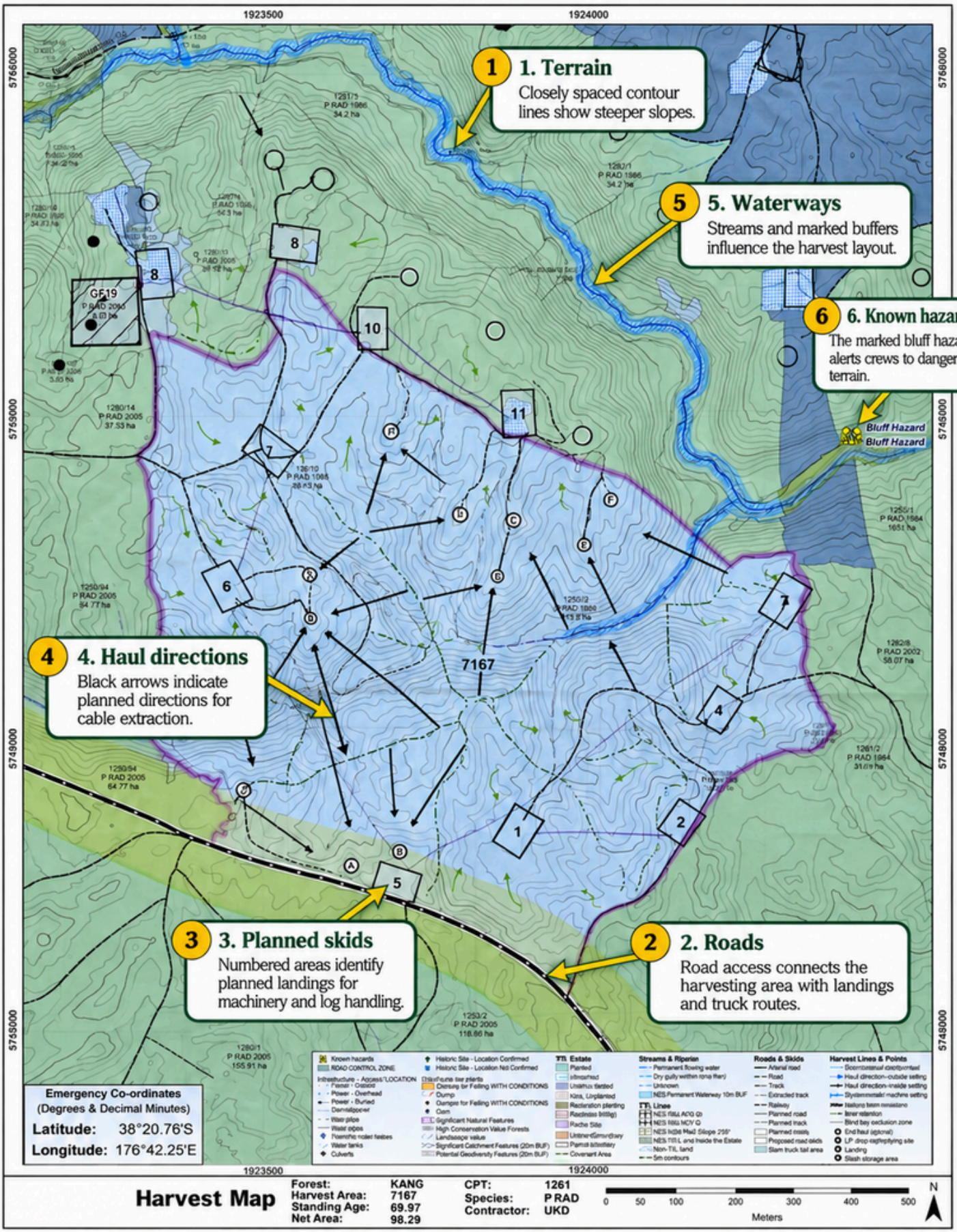
Planning Before the First Tree Falls

Reading a New Zealand harvest map



A yarder may be set up at a suitable landing. Its actual position and cable setup must be confirmed with the crew.

Educational annotations added to the supplied map photograph; not for operational navigation.

FROM HILLSIDE TO TRUCK

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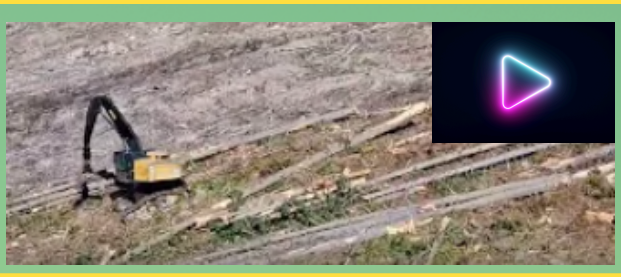
Moving a tree from a steep hillside to a logging truck involves several connected stages. Each machine has a different role, and the crew needs to coordinate the work so trees can be felled, recovered, processed and loaded safely.

The process begins with mechanised felling. A felling machine grips and cuts the tree, controlling its fall and positioning the stem for recovery. This clip shows a self-levelling machine working on sloping ground.

Warren explains that mechanisation has helped reduce the need for people to carry out some of the most hazardous tasks close to falling trees.



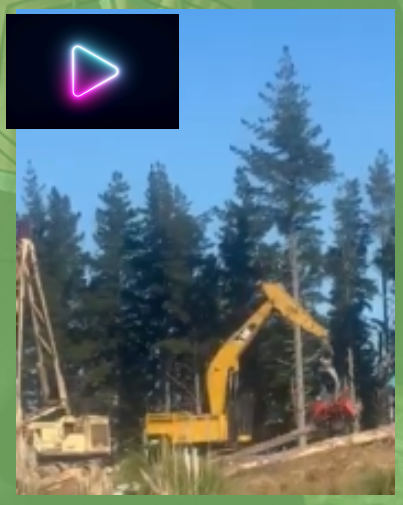
Next comes cable extraction. The hauler uses wire ropes and a grapple to recover the felled stems and bring them to the landing or skid site, the working area where wood is processed and loaded.

Warren compares the rope drums to fishing reels on a much larger scale. The operator controls the load, working within the limits of the equipment and the cable setup. Lifting as much of the stem as possible helps limit soil disturbance and reduces the risk of breaking the wood.

At the landing, a processing machine turns the recovered stems into logs. Its processing head grips the stem, feeds it through rollers, removes branches and cuts it into specified lengths.

The processing-head clip introduces the equipment used at this stage. Warren emphasises the value of recovering a tree in one piece: broken stems mean additional work to retrieve the remaining wood.





Finally, a loader lifts the processed logs onto a logging truck for transport. The landing must provide room for machinery, sorted logs and truck access.

The crew coordinates these movements so each stage supports the next, while keeping people clear of moving wood and equipment.

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FROM HILLSIDE TO TRUCK

Four connected stages of a harvesting operation

1. MECHANISED FELLING

Felling machine

Grips and cuts the tree, then positions the stem for recovery.



2. CABLE EXTRACTION

Hauler • wire ropes • grapple

Brings felled stems from the hillside to the landing.



3. PROCESSING

Processing machine and head

Grips the stem, removes branches and cuts logs to specified lengths.



4. LOADING

Log loader and logging truck

Lifts processed logs onto a truck for transport.



LANDING: The working area where recovered stems are processed and logs are loaded.

Crew coordination connects every stage: planning • communication • safe machine movements

Simplified process overview

Inside the cab: controlling the ropes

From inside the hauler cab, the operator controls the movement of the grapple and the wood through a coordinated system of wire ropes. In the accompanying clips, the operator introduces the front main, rear main and tail main, showing the controls used to manage the system.

Winding rope in and letting it out allows the operator to position the grapple, recover a stem and bring it towards the landing. These movements require careful coordination as the load travels across uneven ground.

Cameras help the operator see what is happening beyond the cab. Warren explains that a camera on the grapple allows the operator to locate individual logs and guide the grapple into position. This technology reduces the need for someone to work beside the wood on the ground during recovery.

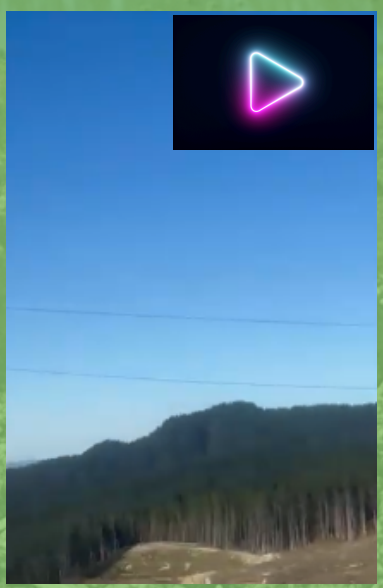
When hauling wood, the operator combines this visual information with experience and knowledge of the equipment's limits. The operator will adjust the payload to suit the available cable deflection: some settings allow only one log at a time, while others allow several. Clutches, brakes and machine safety features also help manage the forces involved.





Deflection - the belly in the rope

Deflection is the sag of a cable below the straight line between its supports. Warren explained that greater deflection can allow the crew to lift a larger payload.
A flatter cable needs much higher tension to support the same weight.



Dylan Ewart gives an on-site explanation explaining the "belly" or sag in the rope between its supports and how it helps lift felled stems clear of the ground.

The hillside provides a practical example of the challenges crews face when balancing lift, cable tension, stem protection and soil disturbance.

THE GEOMETRY BEHIND THE LIFT

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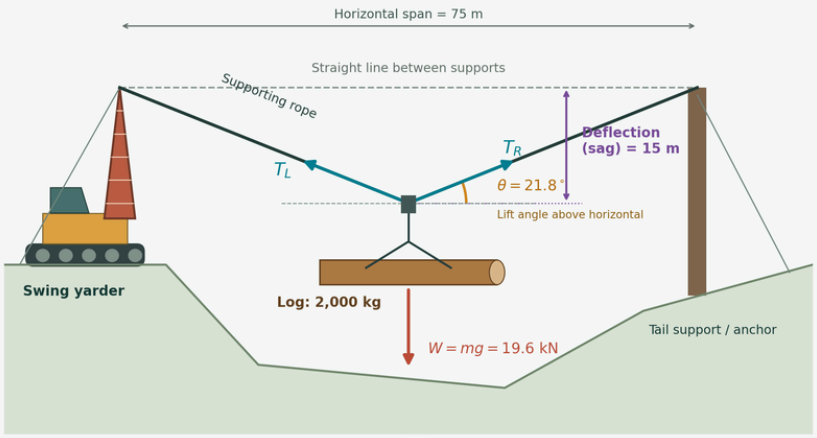
Cable geometry helps explain the challenge of maintaining clearance while managing the load.

SWING YARDER: DEFLECTION & ROPE TENSION

A suspended log pulls the supporting rope down; the rope pulls up on the load.



FORCE BALANCE AT THE LOAD

$$2T\sin\theta = W \quad \Rightarrow \quad T = \frac{W}{2\sin\theta}$$

Here: T = 19.6 ÷ (2 × sin 21.8°) = 26.4 kN

T is the tension in EACH supporting rope segment.

LESS DEFLECTION → HIGHER TENSION

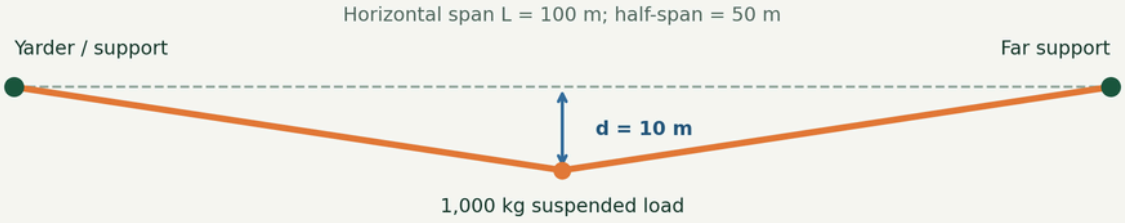
Same 2,000 kg log; equal lift angles on both sides:

20° lift angle: 28.7 kN in each segment

10° lift angle: 56.5 kN in each segment

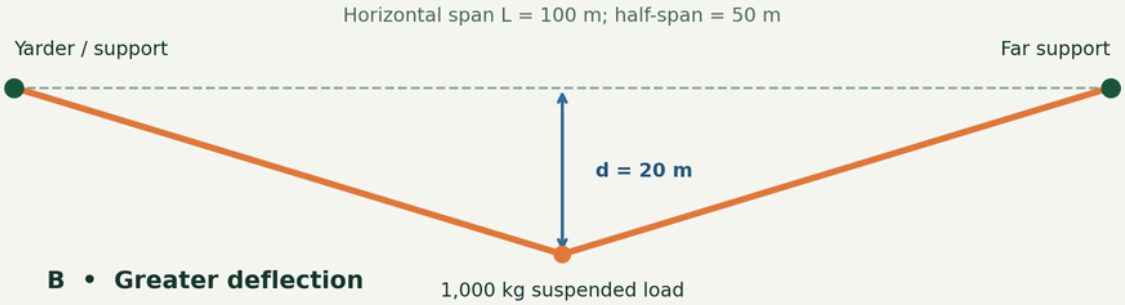
Simplified static teaching model: equal-height supports, centred load, weightless rope and no movement.
One supporting rope shown; other working ropes omitted. Real yarder forces depend on rigging, rope weight and motion.

Cable deflection: why the lift angle changes rope tension



A • Small deflection

θ = arctan(10/50) = 11.3° | T = 9.81 / (2 sin θ) = 24.6 kN per side



B • Greater deflection

θ = arctan(20/50) = 21.8° | T = 9.81 / (2 sin θ) = 13.2 kN per side

Teaching model: level supports, centred point load, two straight rope segments, static equilibrium. Real yarding needs engineered checks for moving loads, rope weight, geometry and equipment limits.

Keeping the system stable

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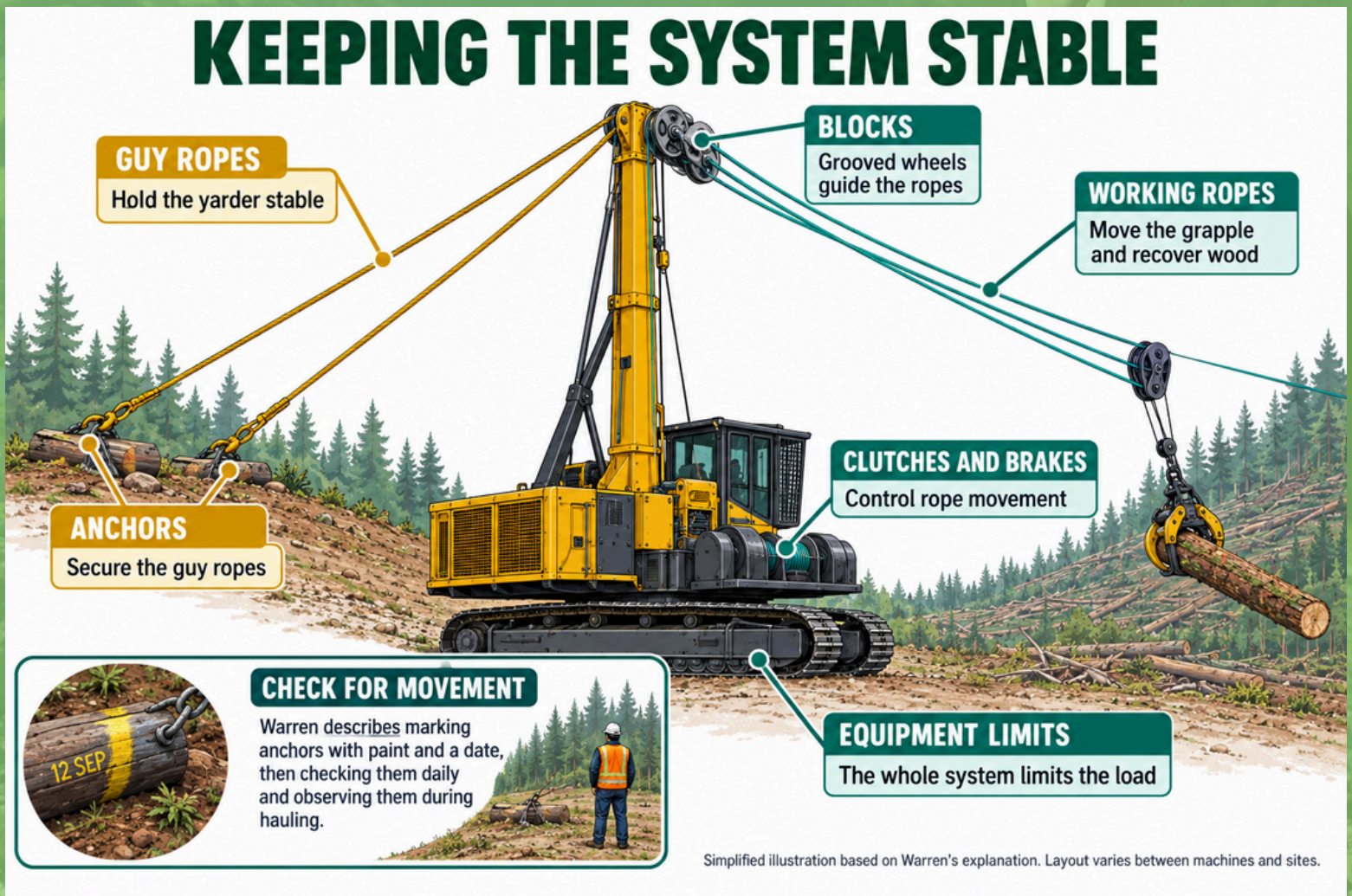
Pulling heavy stems across a hillside places large forces on the ropes and the yarder. Warren explains that keeping the machine stable begins with its setup: guy ropes extend from the tower to secure anchors, helping resist the pull of the working ropes.

These ropes have different jobs. Working ropes move the grapple and recover the wood; guy ropes stabilise the machine. Warren describes using stronger ropes for the guying system and positioning anchors far enough behind the yarder to provide effective support. The arrangement depends on the machine and the terrain.

Blocks, grooved wheels through which ropes run, guide the ropes, while clutches and brakes control their movement. The operator must work within the limits of the complete system. A rope's strength alone does not determine how much wood can safely be hauled: the machine, anchors and cable geometry also matter.

Stability is checked throughout the work. "We mark them with paint and put a date on it," Warren explains, describing the crew's anchor checks. They inspect the anchors daily and watch for movement while wood is being pulled. These reference marks help the crew identify changes that need attention.
The illustration shows how the components work together. Safe recovery depends on both a secure setup and people checking how that setup responds under load.



Protecting the ground and recovering the wood

Bringing a heavy stem across uneven terrain requires careful control. The crew aims to lift as much of the tree as the cable setup allows, but maintaining clearance along its whole length can be difficult. Warren explains that limited deflection restricts what can be lifted, so parts of the stem may remain in contact with the hillside.

That contact matters on Tairāwhiti's erodible soils. Warren describes how dragging wood can create trenches that channel water and contribute to erosion. Lifting more of the stem helps reduce ground disturbance, although the terrain and available lift constrain what the operator can achieve.

Keeping the wood intact matters too. A stem that catches on the ground can break, leaving pieces that require another recovery cycle. As Warren explains, bringing a tree to the landing in one piece reduces the work needed to retrieve it. This connects environmental protection with efficient harvesting: less dragging can mean less soil disturbance and less damage to the wood.

Cable deflection affects the lift available during extraction. This helps explain why keeping stems clear of the hillside can be difficult, and why operators adjust the load to suit the setting.



People, technology and safety

"You're a human … the softest thing in the forest," Warren explains. Mechanised felling, grapples and cameras reduce the need for people to work beside falling trees and moving stems. Safetree recognises these benefits while emphasising that machinery brings risks requiring careful management.

Dan's cab demonstration shows the controls and camera view used to guide the grapple. Operators still need concentration and judgement to interpret what they see, coordinate movements and work within equipment limits. Warren describes developing these skills through practical experience and regular training.

Another crew member, with years of logging experience, stresses proper training, problem-solving and awareness of fatigue. He also advocates repeating radio messages back: if someone says they are approaching on the right, the operator confirms that direction. "You're not just assuming somebody heard you."

That shared understanding is essential. WorkSafe requires hauling to stop when communication is unclear. Technology supports safety, alongside skilled people who communicate clearly and remain alert to changing conditions.

Keeping the crew working



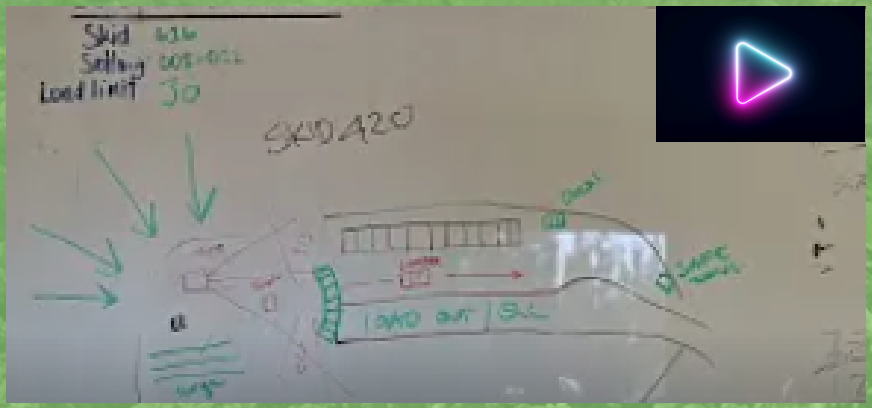


Behind the harvesting machinery is the less visible work that keeps an operation running. The mobile workshop and office bring space for repairs, maintenance, planning and administration to a workplace that may be hours from town. Looking after equipment and organising the work are part of keeping the crew productive and safe.

Experience is equally important. Warren began by breaking out on the hillside in his uncle's crew, learning from experienced workers alongside regular training. He progressed to operating machinery, building his understanding of the whole harvesting system.

The most demanding cable logging takes years to master. Warren estimates that developing the expertise to lead difficult work with large towers can take at least 15 years. He compares setting one up to putting together "a huge crane on a goat track … on the side of a cliff".

Keeping the crew working therefore means maintaining both equipment and expertise: making repairs, planning ahead and helping newer workers develop the judgement that experienced people bring to the job.



Why would a crew working far from town need repair facilities on site?

What happens to the rest of the operation when one machine stops?

The challenge ahead

For Warren, the challenge extends beyond getting today's wood to the landing. He believes recovering mature trees from the region's most difficult country will require experienced crews working over many years, alongside decisions about which areas should remain in forestry and which should transition to another land use.

Meeting this challenge means investing in people, equipment and long-term planning. Viable contracting businesses can maintain machinery, retain experienced workers and train new crew members.

As Warren's story shows, expertise takes years to develop. Creating pathways for younger workers to learn alongside experienced crews will help forestry carry out this demanding work safely and effectively.

Suggested secondary curriculum connections

Learning area or subject	Connection to the case study	Possible learning applications
Science / Physics	Gravity, tension, friction, balanced forces, motion and energy transfer.	Draw force diagrams for a suspended stem; explain how cable angle affects tension and how ground contact changes the forces.
Mathematics and Statistics	Measurement, scale, geometry, trigonometry, formulae and mathematical modelling.	Read a harvest map scale; calculate cable angles and tension using the simplified model; identify its assumptions and limitations.
Technology	Mechanical systems, controls, cameras and technological responses to practical problems.	Explain how the felling machine, hauler and processor work together; evaluate how mechanisation changes tasks and risks.
Social Sciences / Geography	Terrain, erosion, land use, resource management and relationships between industry and communities.	Interpret contours and waterways; evaluate harvesting choices on steep, erodible land and discuss future land use.
Agricultural and Horticultural Science	Plantation forestry as a production system; soil management, harvesting and sustainable resource use.	Investigate how terrain and soil conditions affect harvesting methods and long-term management.
Economics / Business Studies	Productivity, operating costs, investment, workforce skills and business viability.	Examine how broken stems, maintenance, training and additional recovery cycles affect costs and productivity.
English	Technical vocabulary, oral communication, explanation and evidence-based argument.	Analyse the interviews; explain a process for a non-specialist audience; develop an argument supported by case-study evidence.

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WIDE TRUST

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FOREST GROWERS LEVY TRUST (FGLT)

The Forest Growers' Levy Trust collects the commodity levy paid on harvested wood material from forest growers and acts as the custodian of those funds. The Trust ensures the levy is invested in research, development, biosecurity, promotion and other industry-good activities that benefit New Zealand's plantation forest sector.