Grapple Carriage Productivity Studies

Hunter Harrill
Cal Poly Humboldt
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Overview

- Grapple Carriage Types & Applications
- Fundamentals of Yarding Productivity
- Results from Recent Studies
- What Can we Learn From Research?

Grapple Carriage History

Mechanical & Motorized Grapple Carriages

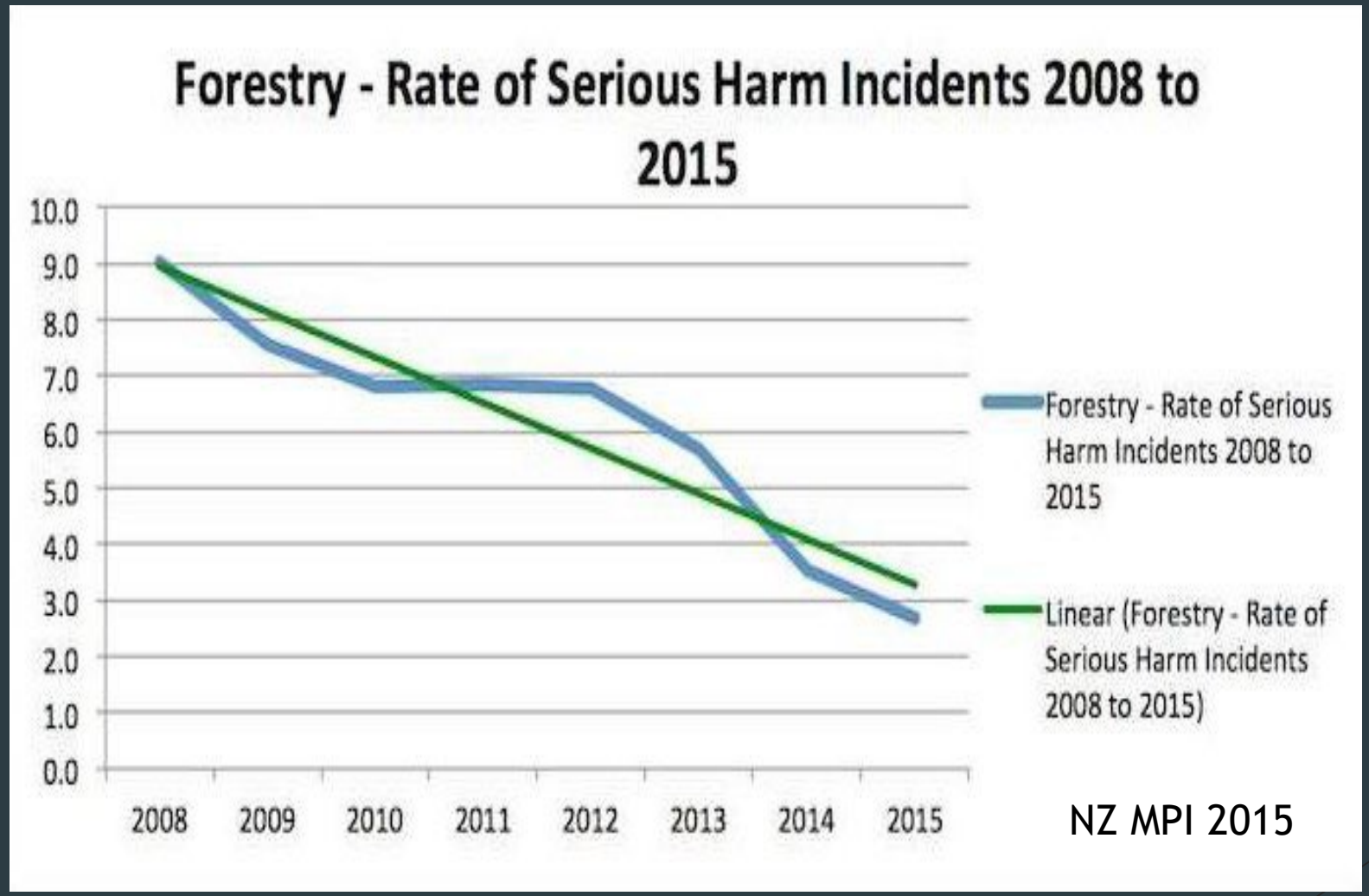
- Swing Yarder
- Excavator Yarder (3 drum)

FFE 2022

- Tower Yarder
- Swing Yarder
- Excavator Yarder
- Yoader

Skurdahl 2020

Mechanization → Safety & Productivity

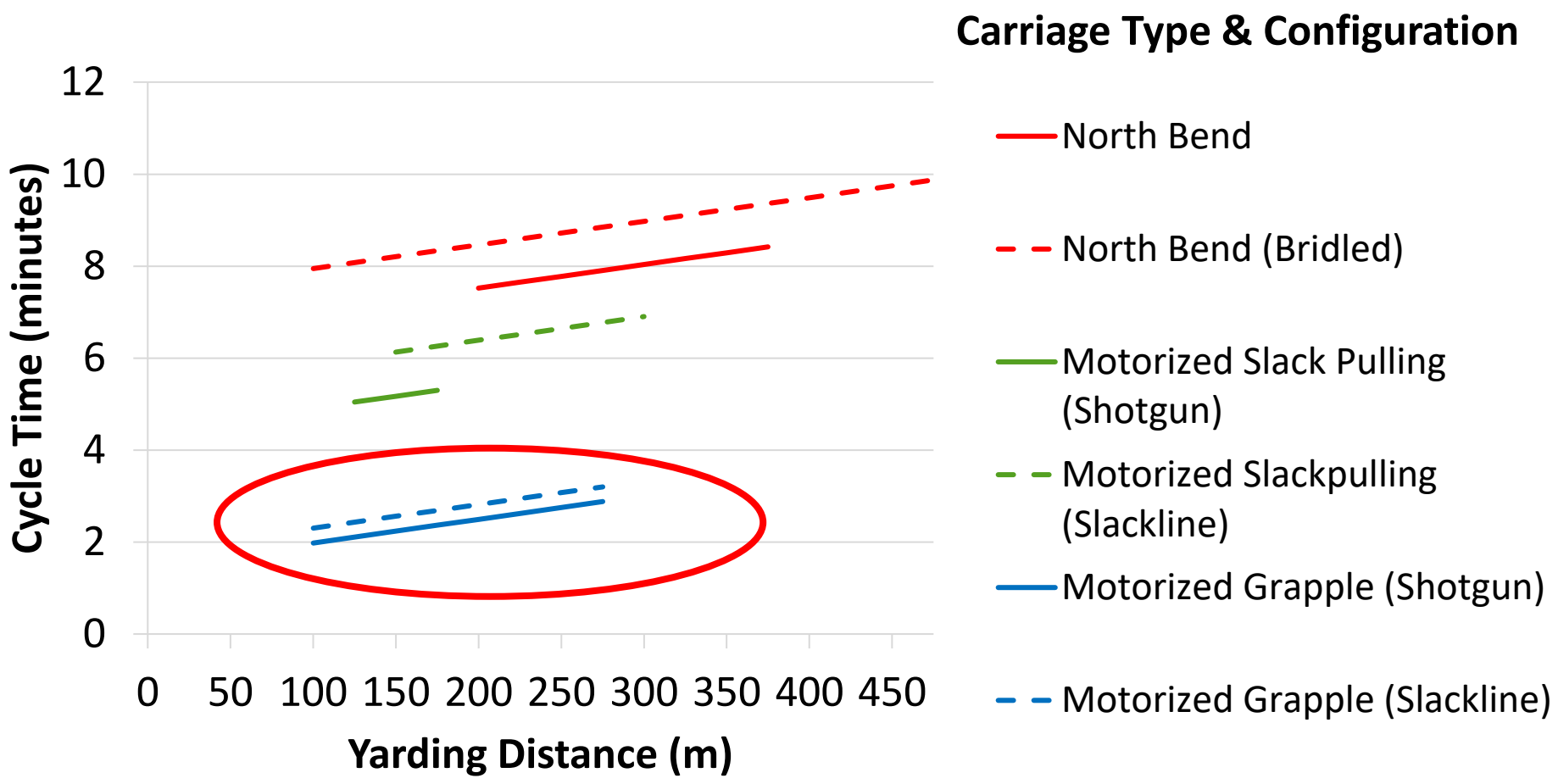


NZ MPI 2015

A New Zealand Example:

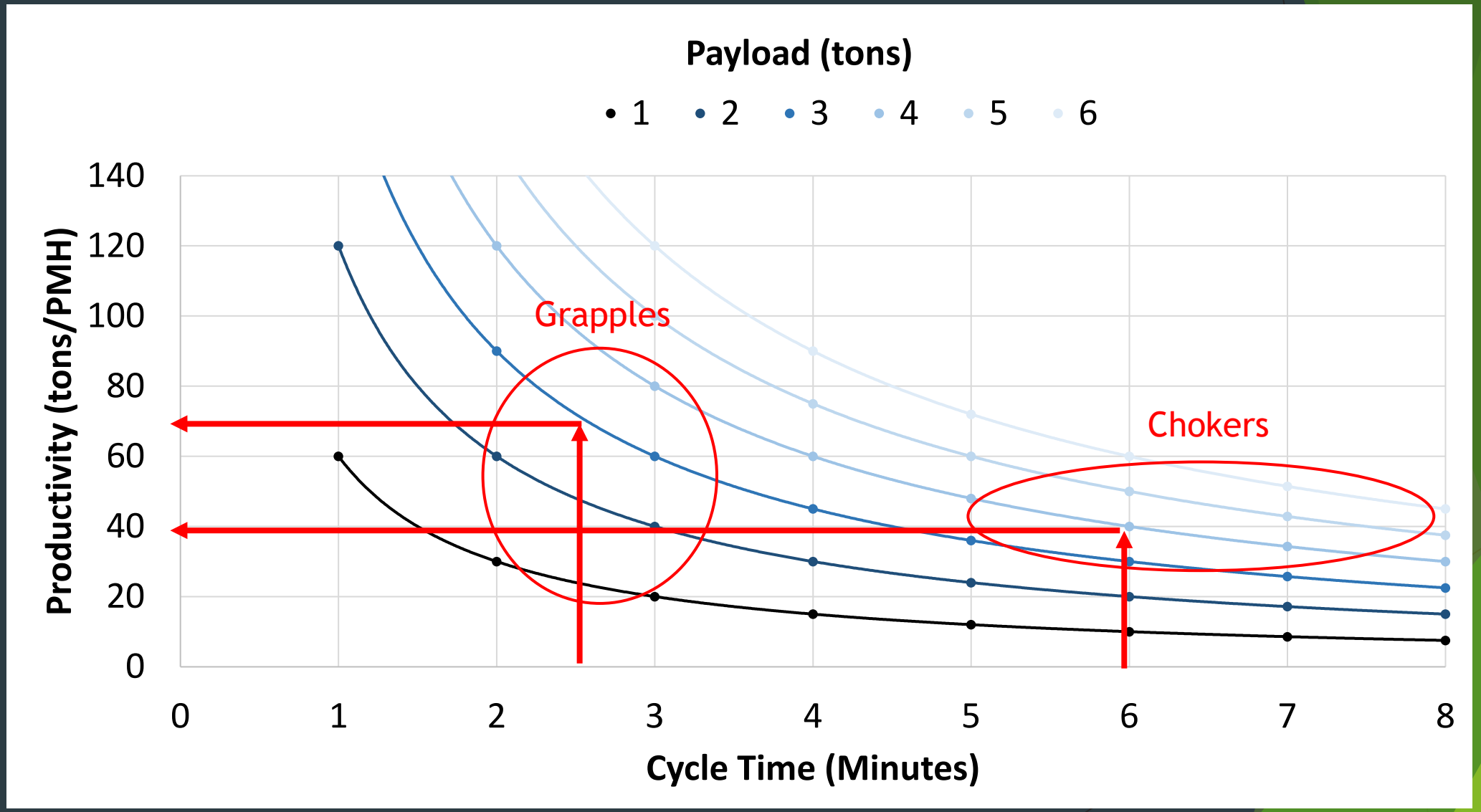
- 60% reduction in serious injury
- 30% increase in cable yarding productivity
- $6/ton reduction in cable yarding cost
- In 2022 >50% of cable yarding crews are fully mechanized

Yarding Cycle Time



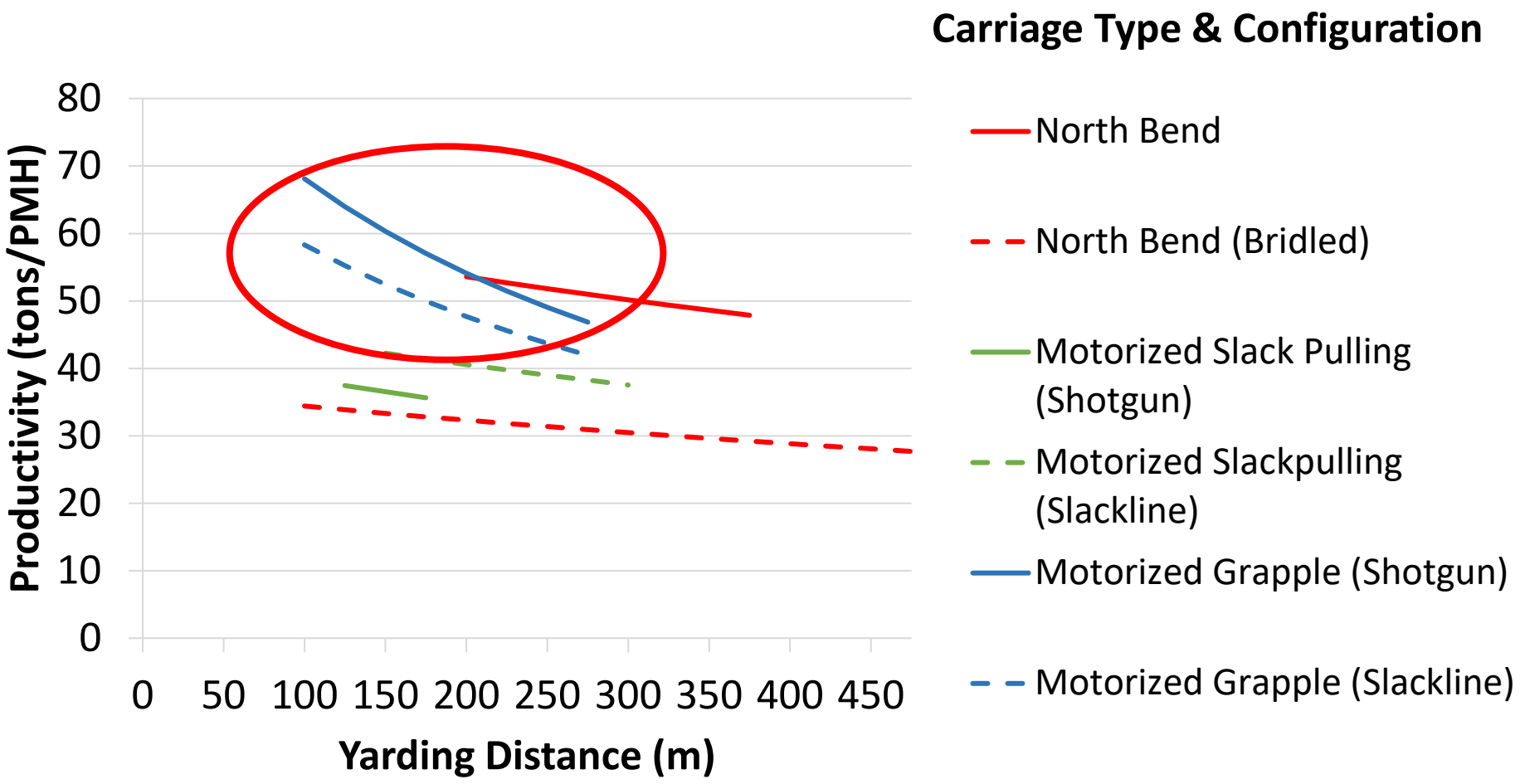
- Fast cycle times!
- 2-4 minutes

$$Productivity = \frac{Payload}{Cycle\ Time\ (hrs)}$$



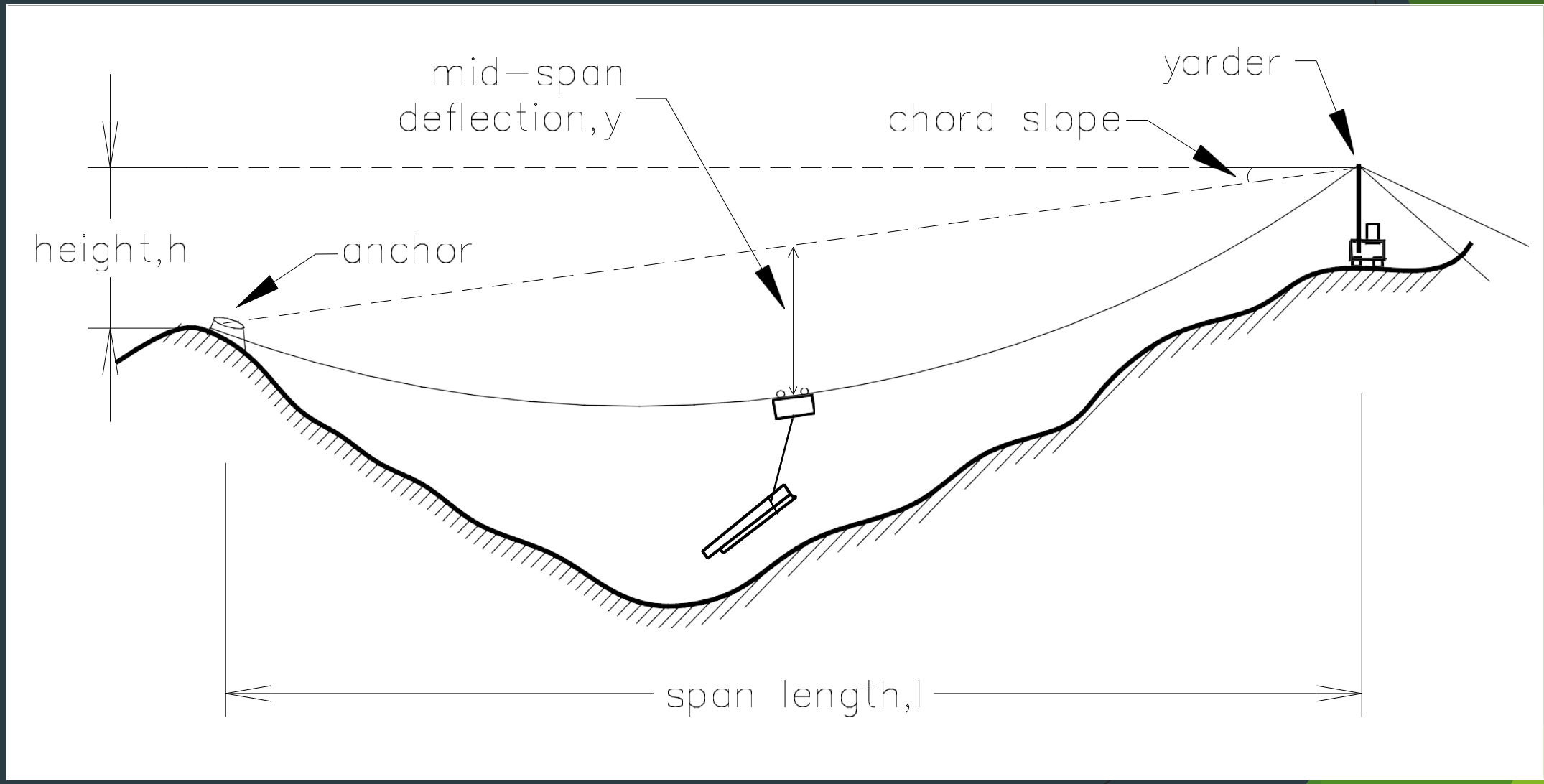
Note: PMH= Productive Machine Hours (no delays)

Yarding Productivity

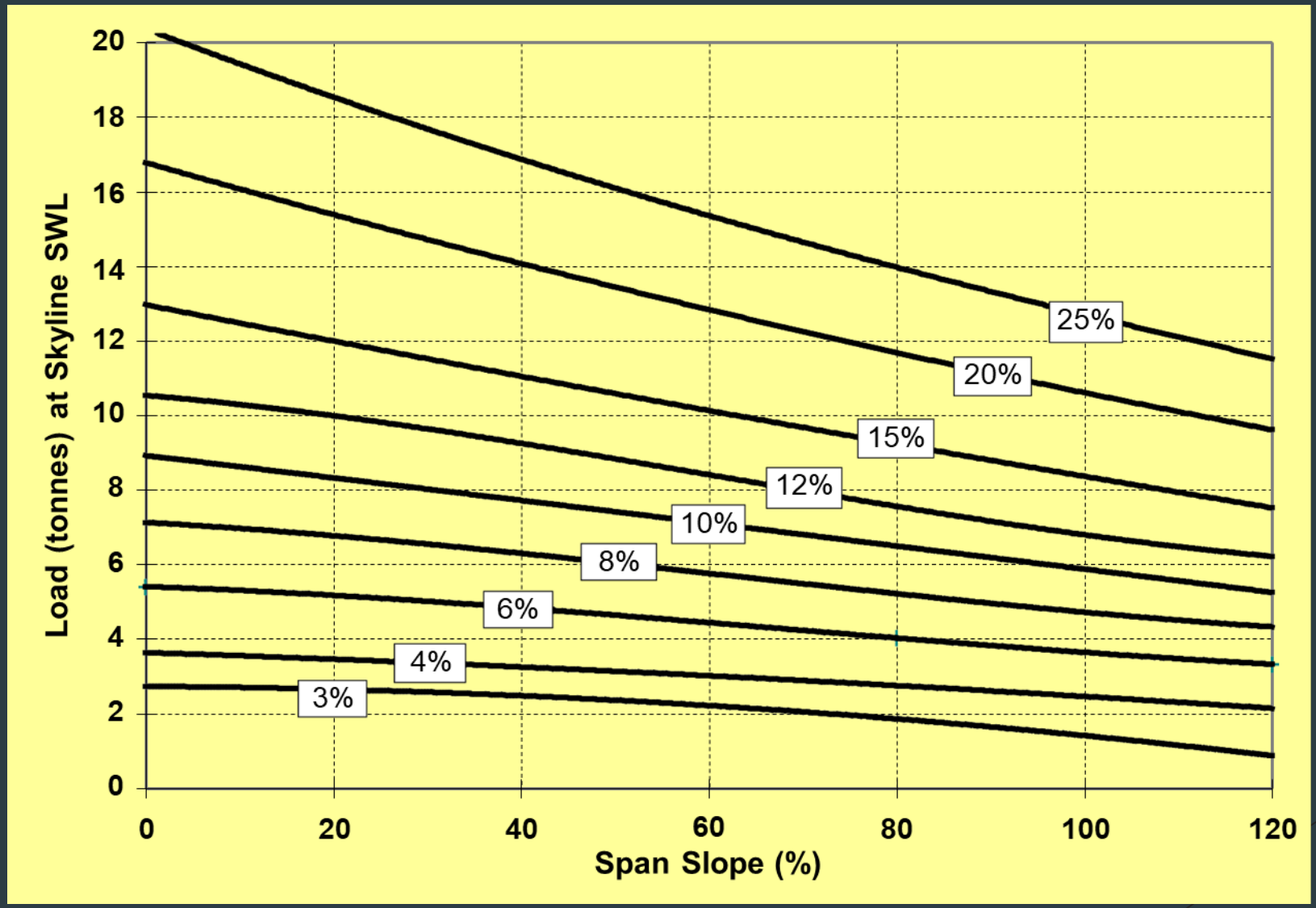


- Grapple carriages most effective <200 m (650 ft)
- Need to ensure infrastructure supports yarding distance

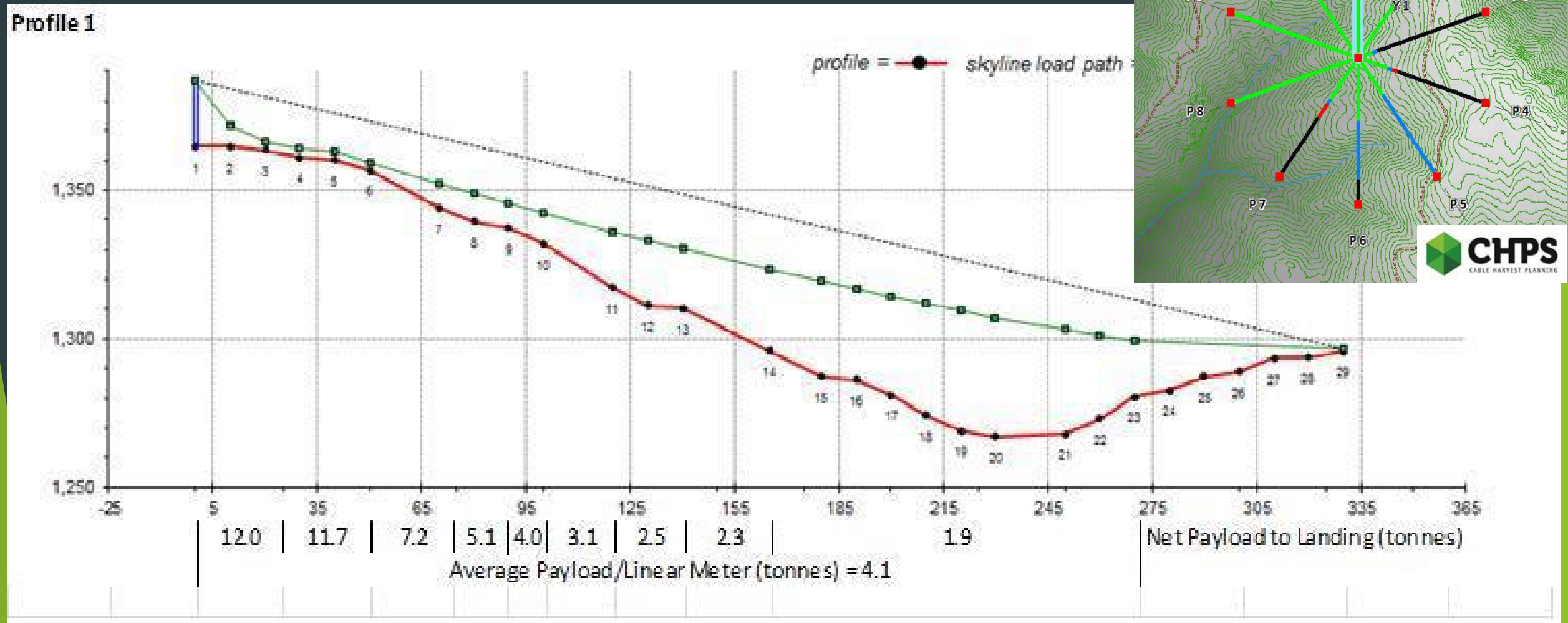
Importance of Deflection (Minimum=6%)



Deflection & Payload for 1&1/8” Skyline



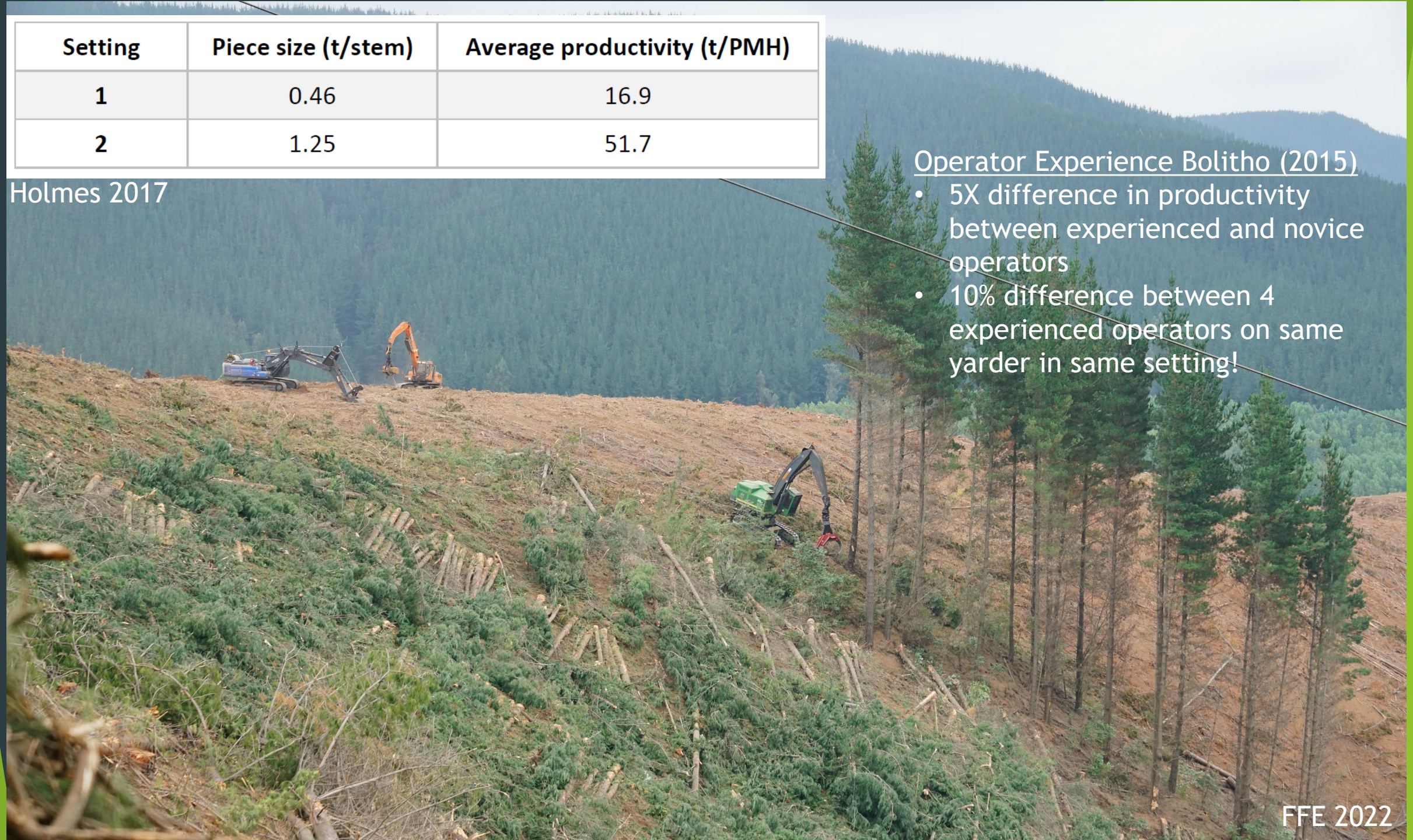
Payload Analysis is Essential



Holmes 2017

Setting	Piece size (t/stem)	Average productivity (t/PMH)
1	0.46	16.9
2	1.25	51.7

Holmes 2017



Operator Experience Bolitho (2015)

- 5X difference in productivity between experienced and novice operators
- 10% difference between 4 experienced operators on same yarder in same setting!

Stem Presentation	Observed Cycles (#)	Average Time (minutes)	Average Payload (tonnes)
Fed	341	0.41	1.7
Mechanically felled	252	0.65	2.3
Surge pile	114	0.75	2.5
Bunched	220	1.14	2.8
Manually felled	101	0.76	1.7
Choked	24	3.11	1.8

Taylor 2021

Grapple Time

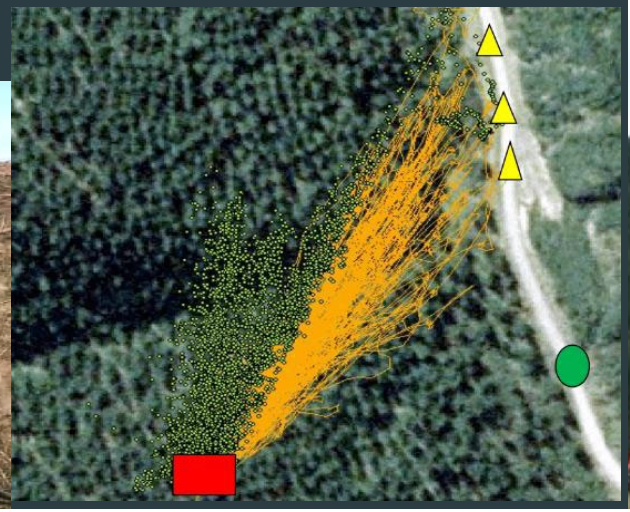
Table 3. Stem presentation and yarding cycle time and average productivity for the yarders studied.

Swing yarder	Stem presentation	Number of yarding cycles #	Mean yarding distance (m)	Mean grapple time (min)	Total cycle time (min)	Mean payload per cycle (tonnes)	Mean Productivity (t/PMH)
T-Mar 650	Bunched	144	188	1.35	3.94	3.1	51.3
	Mechanically felled	32	65	0.76	2.22	1.7	48.9
T-Mar 550	Choked	24	279	3.11	9.17	1.8	12.2
	Manually felled	101	161	0.76	2.35	1.7	63.3
Madill 124	Bunched	76	300	0.76	3.62	3.0	50.5
	Mechanically felled	220	251	0.63	2.51	2.2	54.9
	Surge piled	114	254	0.75	2.70	2.5	59.8
Overall	Bunched	220	258	1.15	3.83	3.0	51.0
	Choked	24	279	3.11	9.17	1.8	12.2
	Manually felled	101	161	0.76	2.35	1.7	63.3
	Mechanically felled	252	227	0.65	2.47	2.1	54.2
	Surge piled	114	254	0.75	2.70	2.5	59.8

Bunched – stems are laid out under the ropes by the felling machine in piles of two or three; **Surge piled** - picked from a surge pile; **Mechanically felled** - grappled from stems with butt ends all in the same direction and in some cases laid perpendicular to the ropes throughout cutover; **Manually felled** - chainsaw felled with varying laid-out pattern; **Choked** – stems were hauled using chokers.

Visser et al. 2023

NZ: Excavator Yarder & Motorized Grapple (Abeyratne 2021)



	Mosgiel	Rotorua	Opotiki
Machine used	Sumitomo SH460 HD	Doosan DX380 LC	Komatsu PC400 LC
Average extraction distance (m)	105	96	181
Cycle time	1.35 min	1.4 min	2.45 min
Piece size (t)	2.0	1.9	2.3
Productivity (t/PMH)	86	77	58
Carriage out velocity (m/s)	4.0	3.8	4.0
Carriage in velocity (m/s)	3.8	3.0	2.8

CA: Swing Yarder & Mechanical Grapple

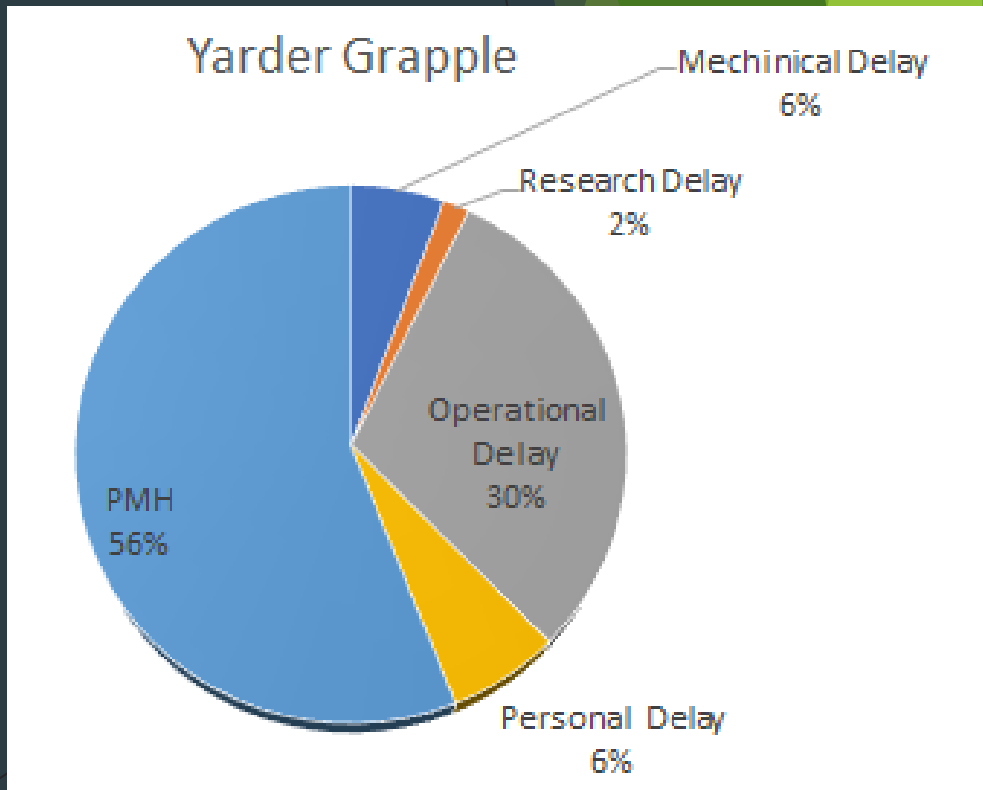
(Trozera et al. 2021)

Wright 2021

CA Study 2021

Average Cycle Time
4.3 min (Chokers)
2.7 min (Grapple)

Approx. 215 m (700 ft)
1.45 ton payload
32 tons/PMH
(or about 7mbf/PMH)



How to Improve Grapple Yarding Productivity?

- Reduce Cycle Time (appropriate yarding distance & stem presentation, camera & control systems)
- Increase Payload (good deflection, payload analysis, tethered felling & bunching)
- Reduce Delays (Systems Perspective & Planning)
  - 5B's of mechanized logging (OSU 1987):

    Bottlenecks, Balance, Buffers, Breakdowns & Blunders

Thank You!

Questions?