SMALLWOOD

- **Some background on Swedish Forestry**

Tomas Nordfjell Professor in Forest Technology

SLU, Swedish University of Agricultural Sciences

Project SMALLWOOD is supported under the umbrella of ERA-NET Cofund ForestValue by Formas, Swedish Energy Agency, Vinnova, Academy of Finland, Ministry of Education, Science and Sport (MIZS), Ministry of Economy, Industry and Competitiveness (MINECO). ForestValue has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 773324.

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- Some background on Swedish Forestry
- The development of mechanized thinning

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- The development of mechanized thinning
- Boom-corridor thinning

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This picture is from around 1955. The chain-saw operator is doing all the real work, but a special trained worker make the decisions about where to cross-cut the tree.

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Perhaps the most important change to do in forestry to be able to mechanize is to allow many operational decisions to be done directly of the worker instead of some kind of supervisor.

This picture is from around 1955. The chain-saw operator is doing all the real work, but a special trained worker make the decisions about where to cross-cut the tree.

The first step in mechanization was to remove the “supervisor” and train the chain-saw operator to make this kind of decisions.

Also the supervisor for marking trees in thinnings was removed

Photo: Tomas Ärlemo

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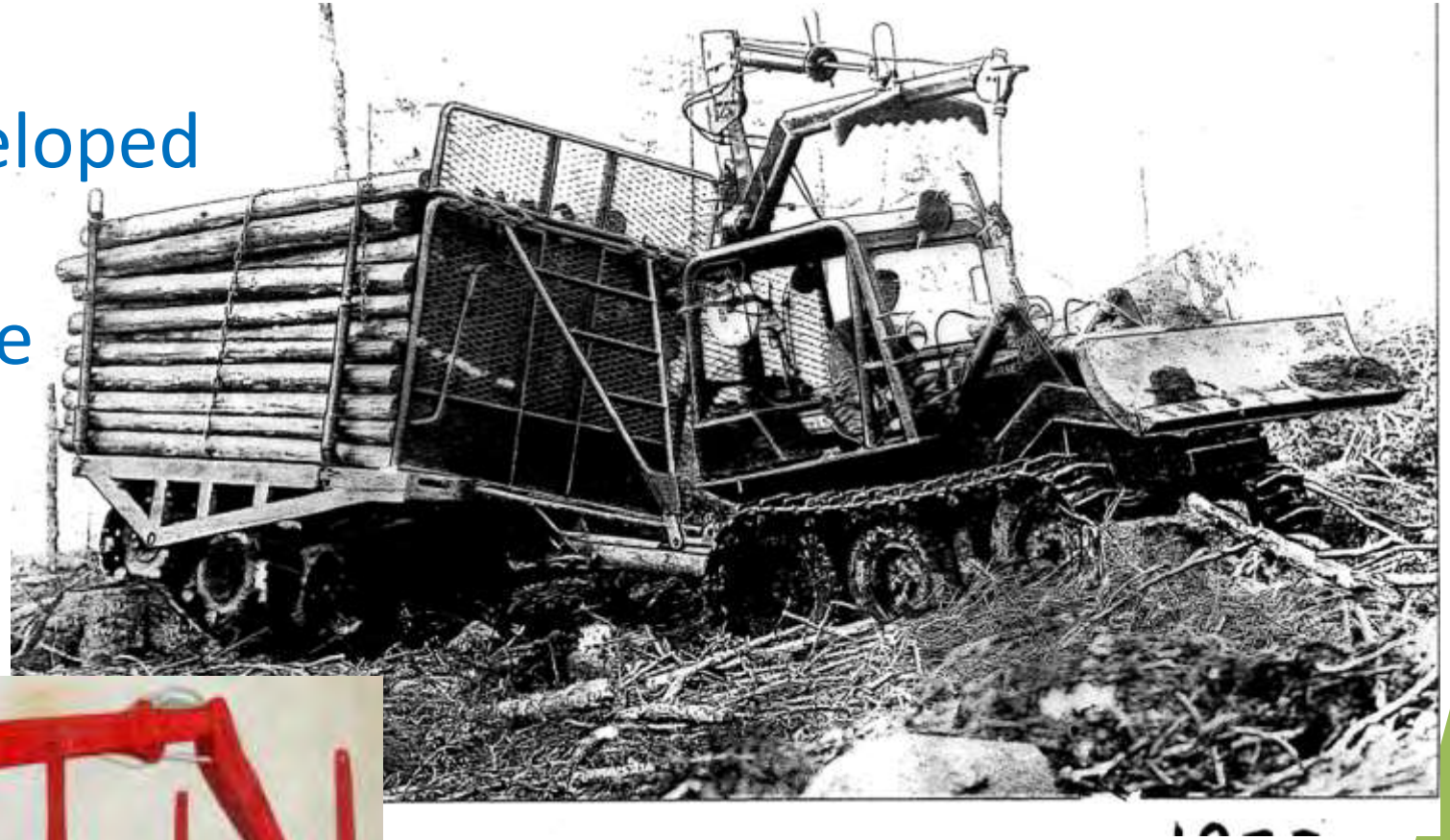
The forwarder was developed and become common 1960 – 1965, making the extraction mechanized



The felling and delimbing of trees in final felling was mechanized 1975 – 1980, and the two-grip harvester came soon thereafter

Final fellings fully mechanized around 1980, but what about thinnings then?

Thinnings were motor-manual done with chain saws and extracted with rather small forwarders, but it was expensive!

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It was also practiced a “forestry without thinning” of some companies during some time.

The single grip harvester 1984

Now the real mechanization of thinnings started !

The solution !

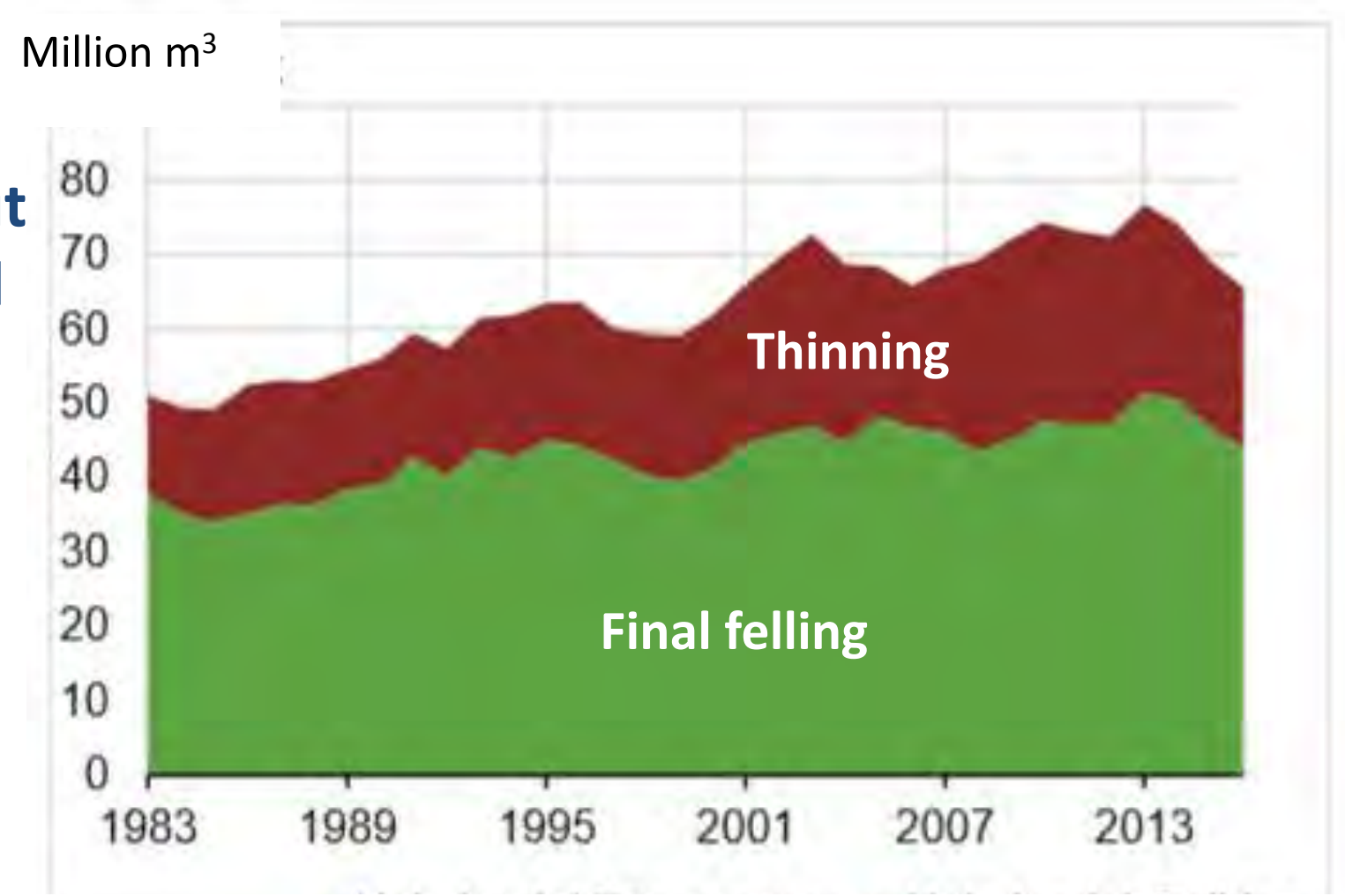
The single grip harvester 1984

Now the real mechanization of thinnings started !

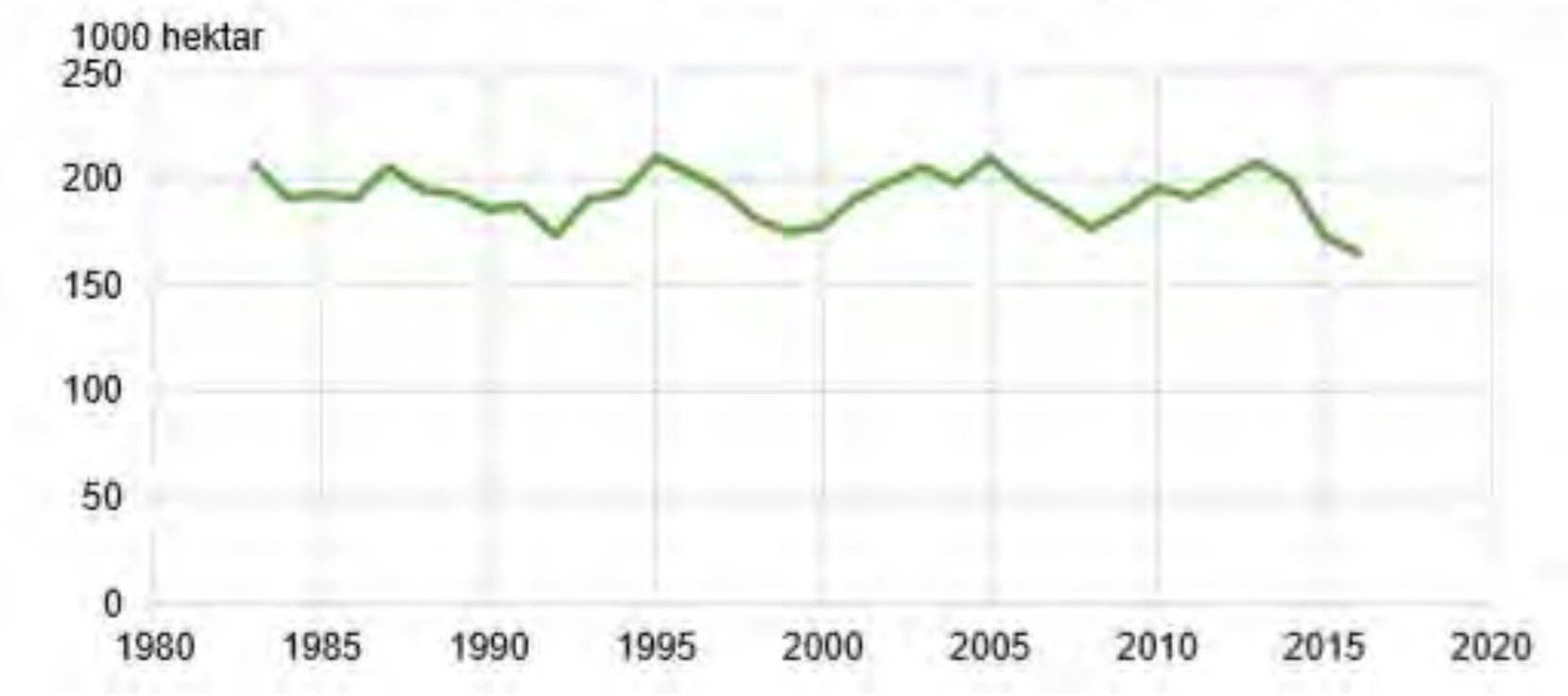
In year 1993 the single grip harvester was used for more than 90% of the volume in thinnings and more than 50% in final fellings.

The annual harvest in Sweden 1983-2016

In modern time about 33% of the harvested volume in Sweden comes from thinning



The yearly final felling area in Sweden



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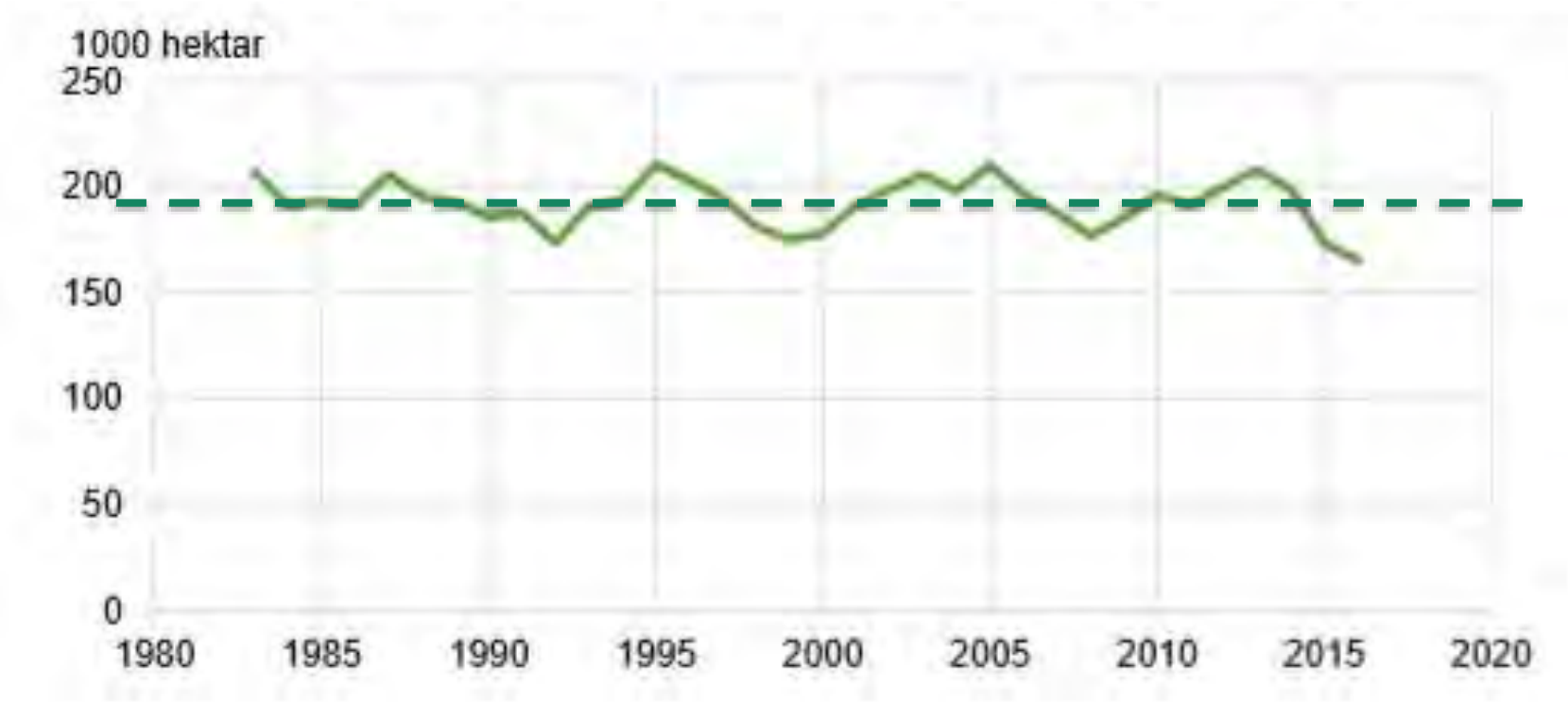
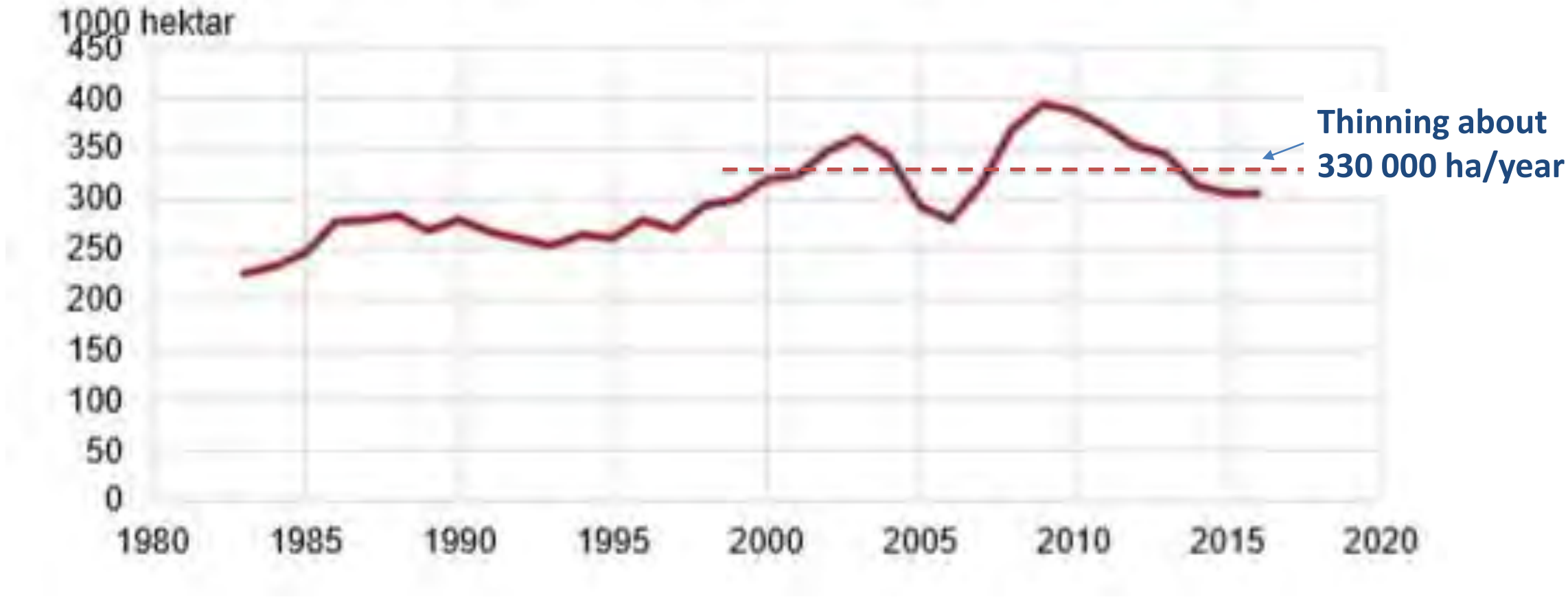


About
190 000 ha/year
in average

The yearly thinning area is larger than the final felling area



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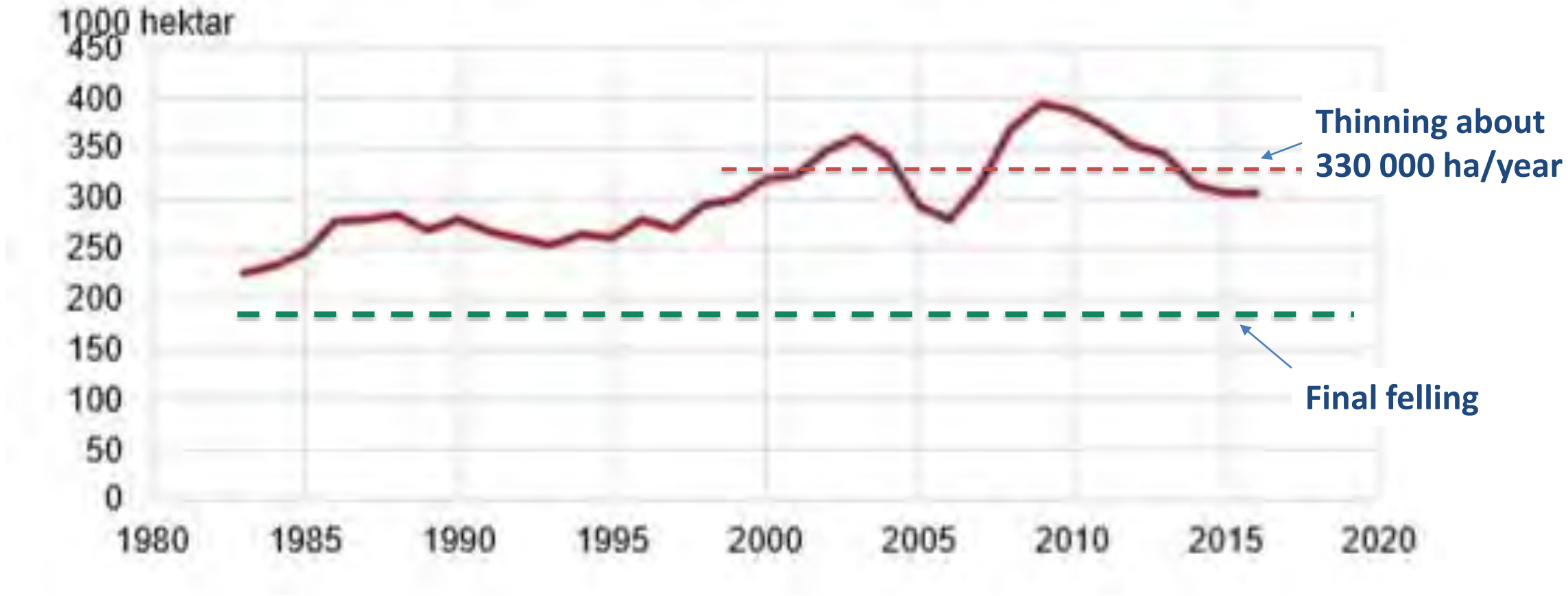

Average harvest in Sweden

Final felling: average 259 m3/ha (variation 150 – 400 m3/ha)

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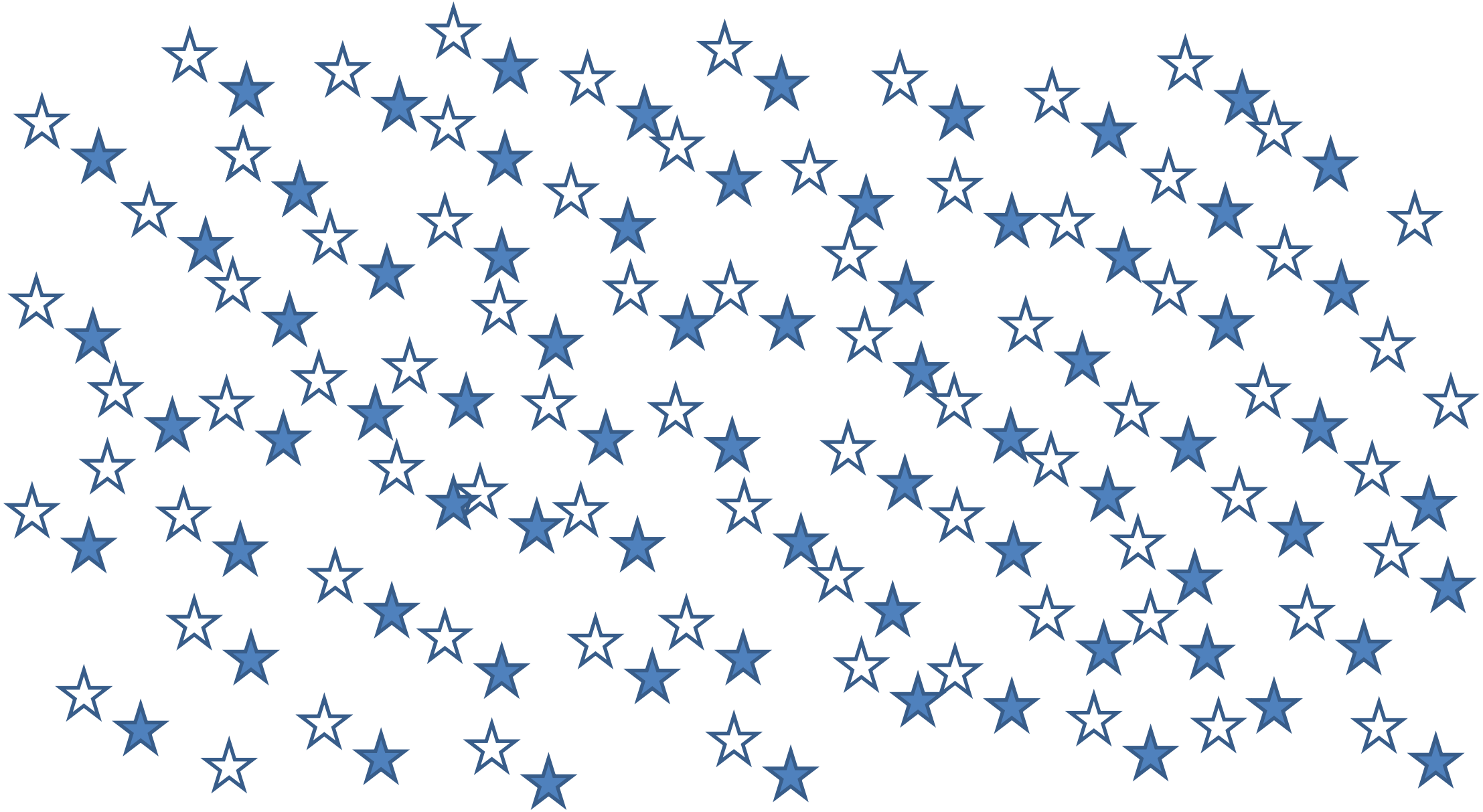
Thinning: average 72 m3/ha

A first thinning: 25 – 45 m3/ha

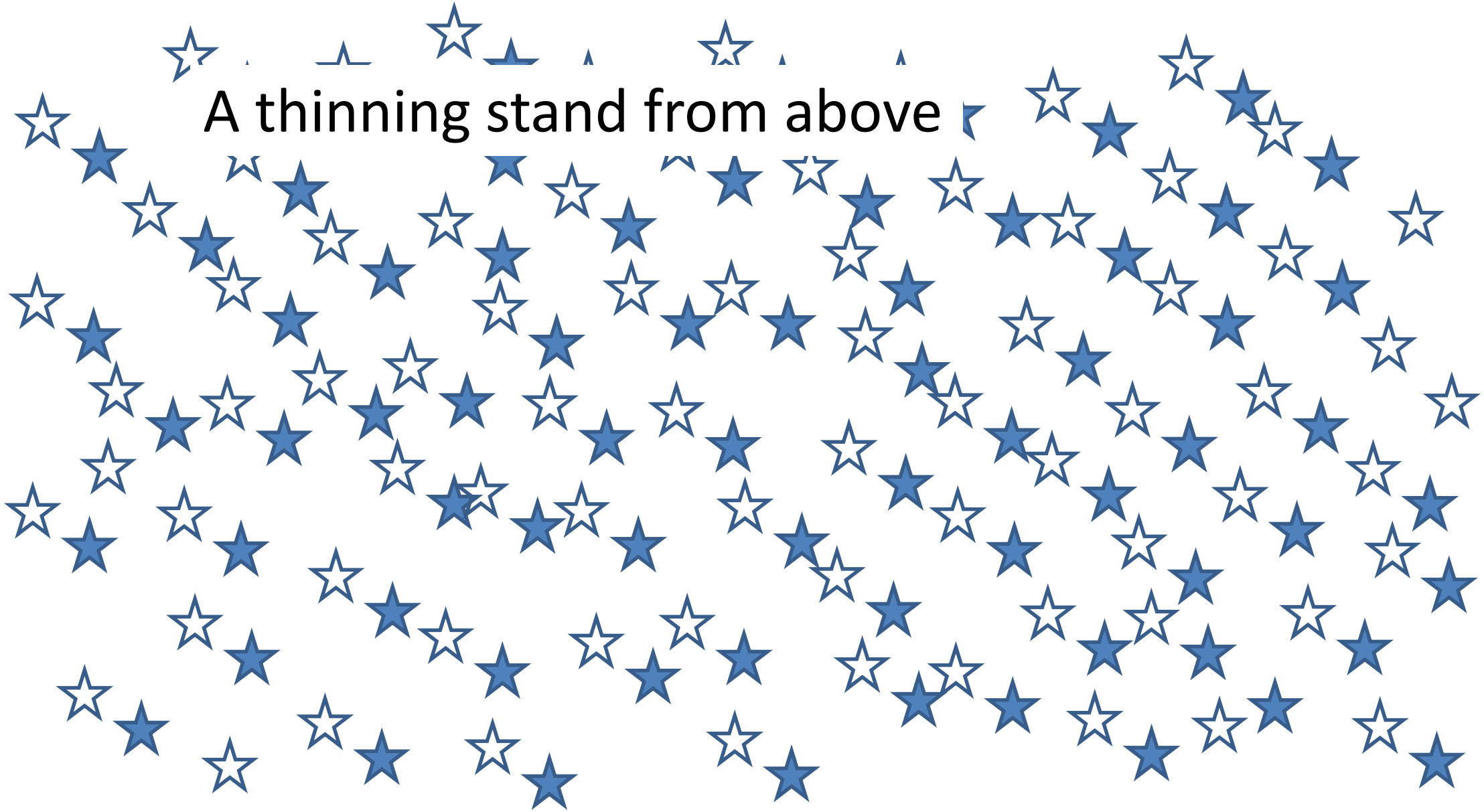
Later thinning: 60 – 120 m3/ha

How is an ordinary fully mechanized first thinning with a harvester and forwarder done in reality?

Normally 4 m wide strip-roads with a distance of 20 m.

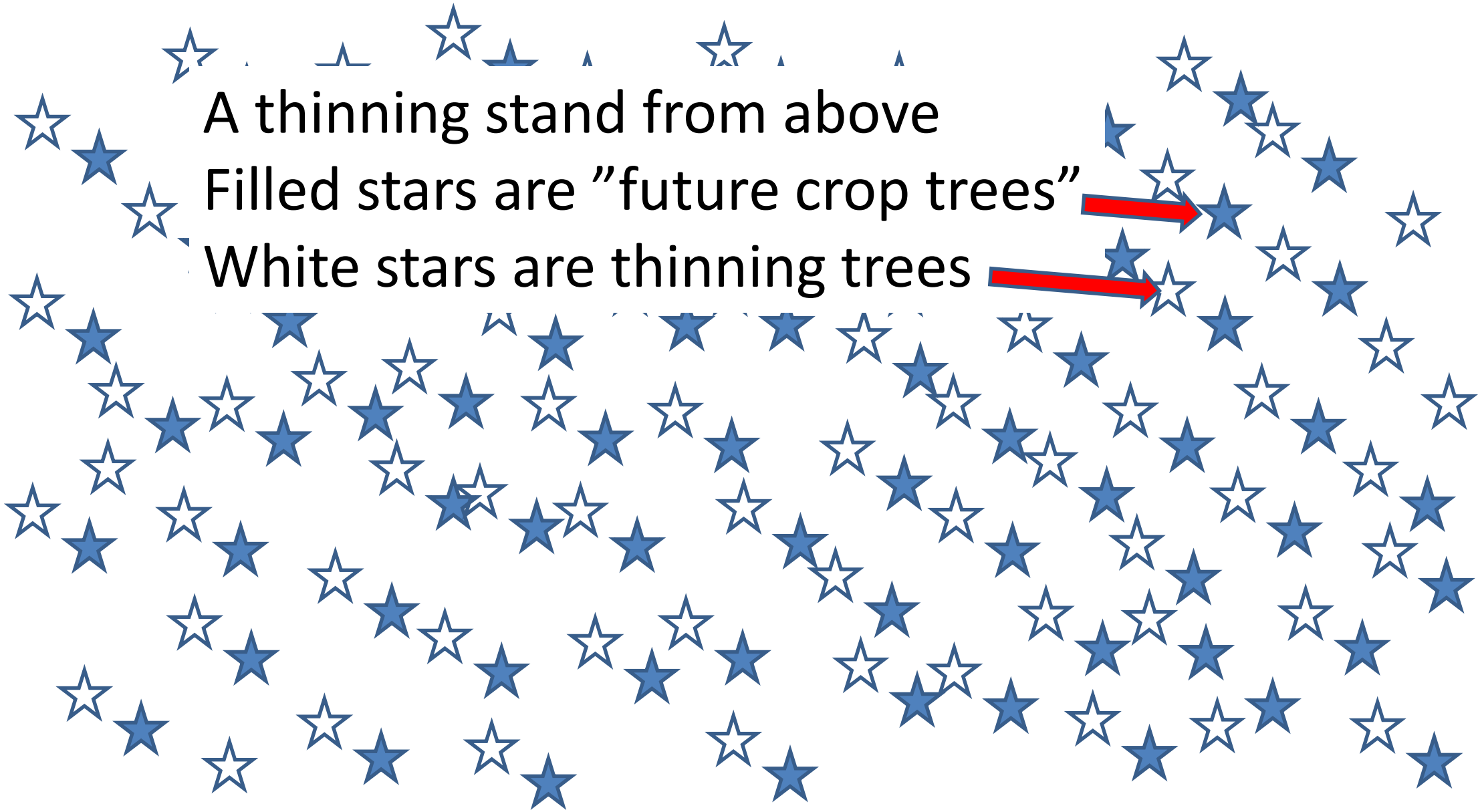


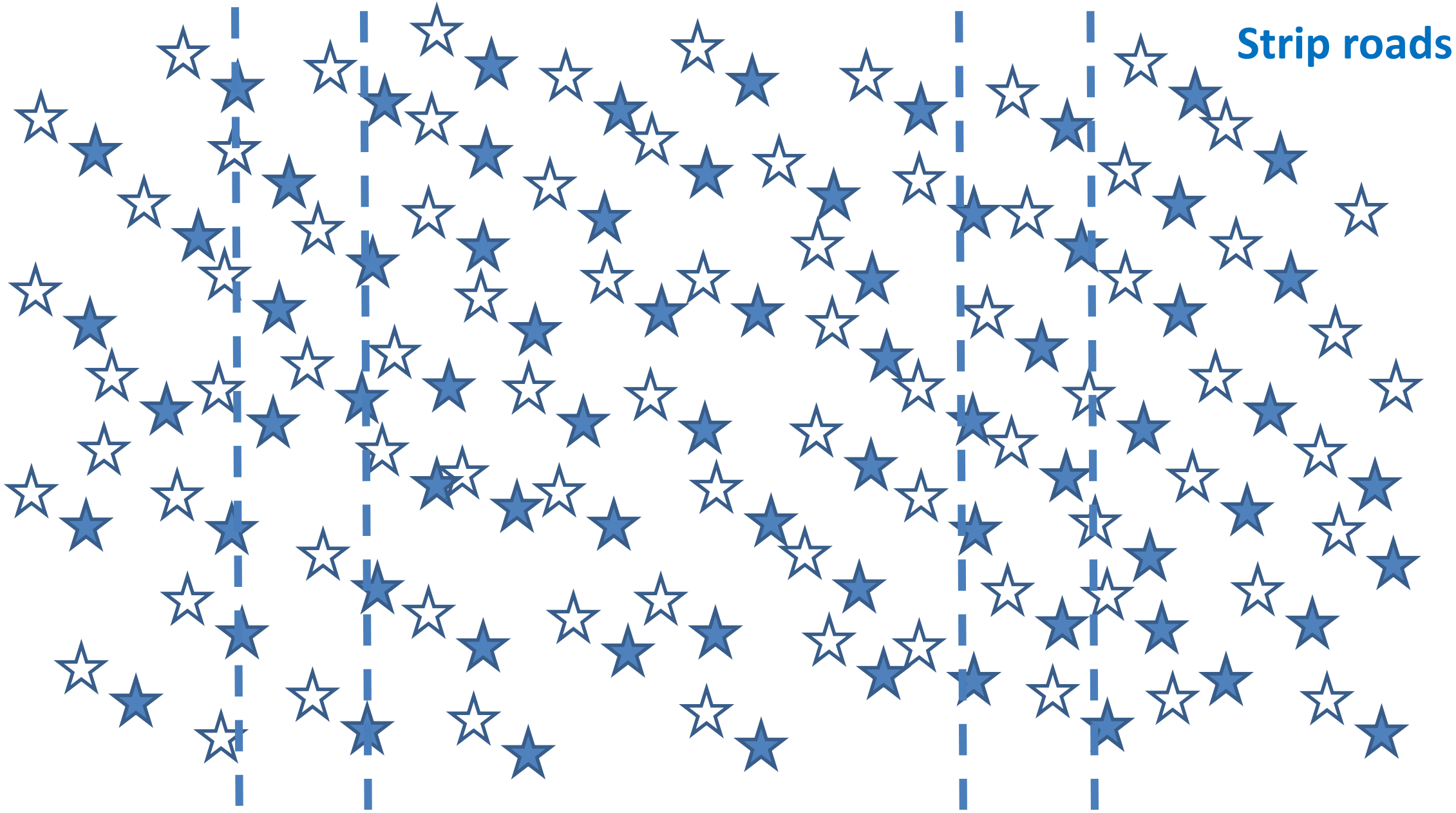
A thinning stand from above

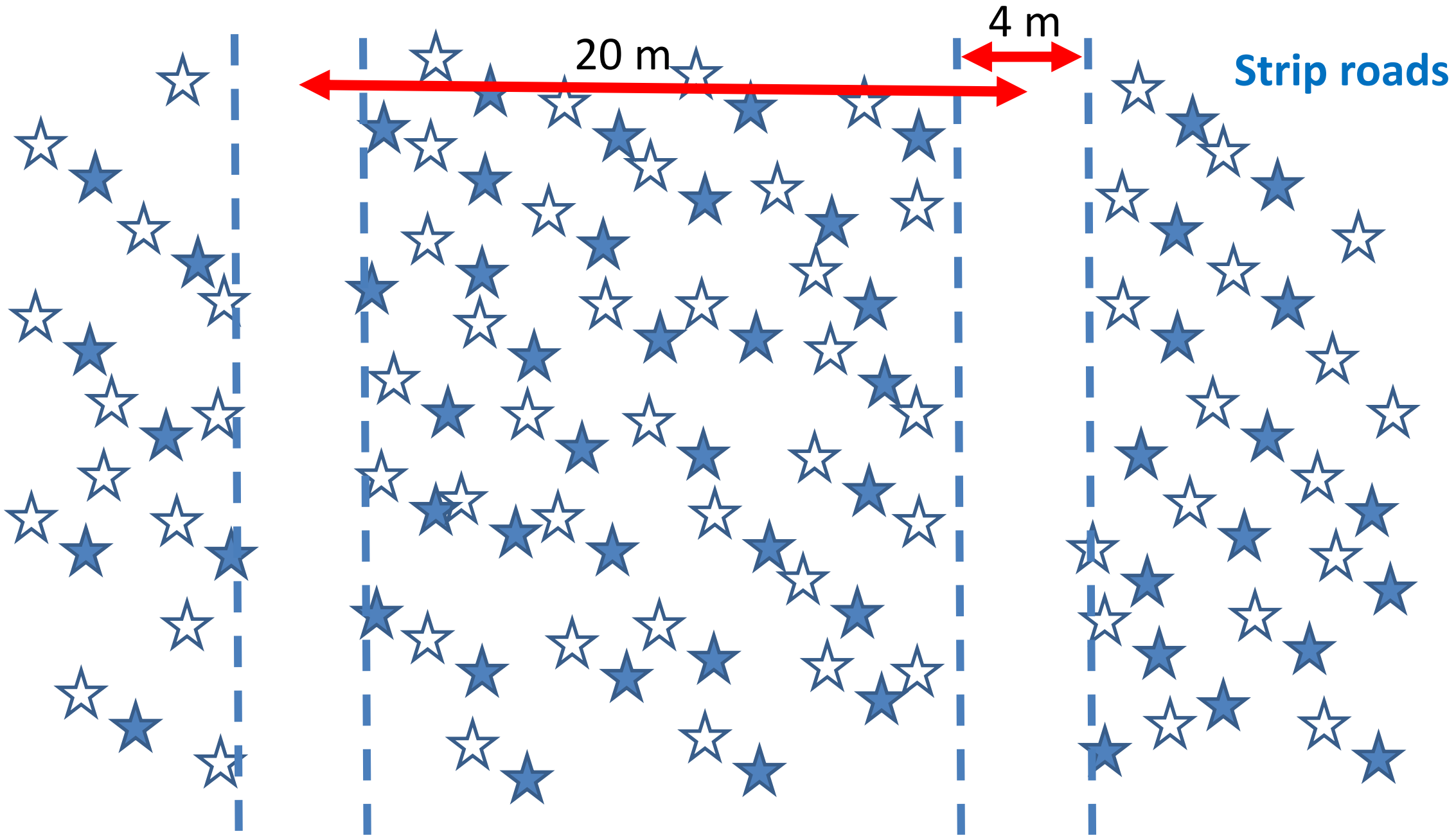


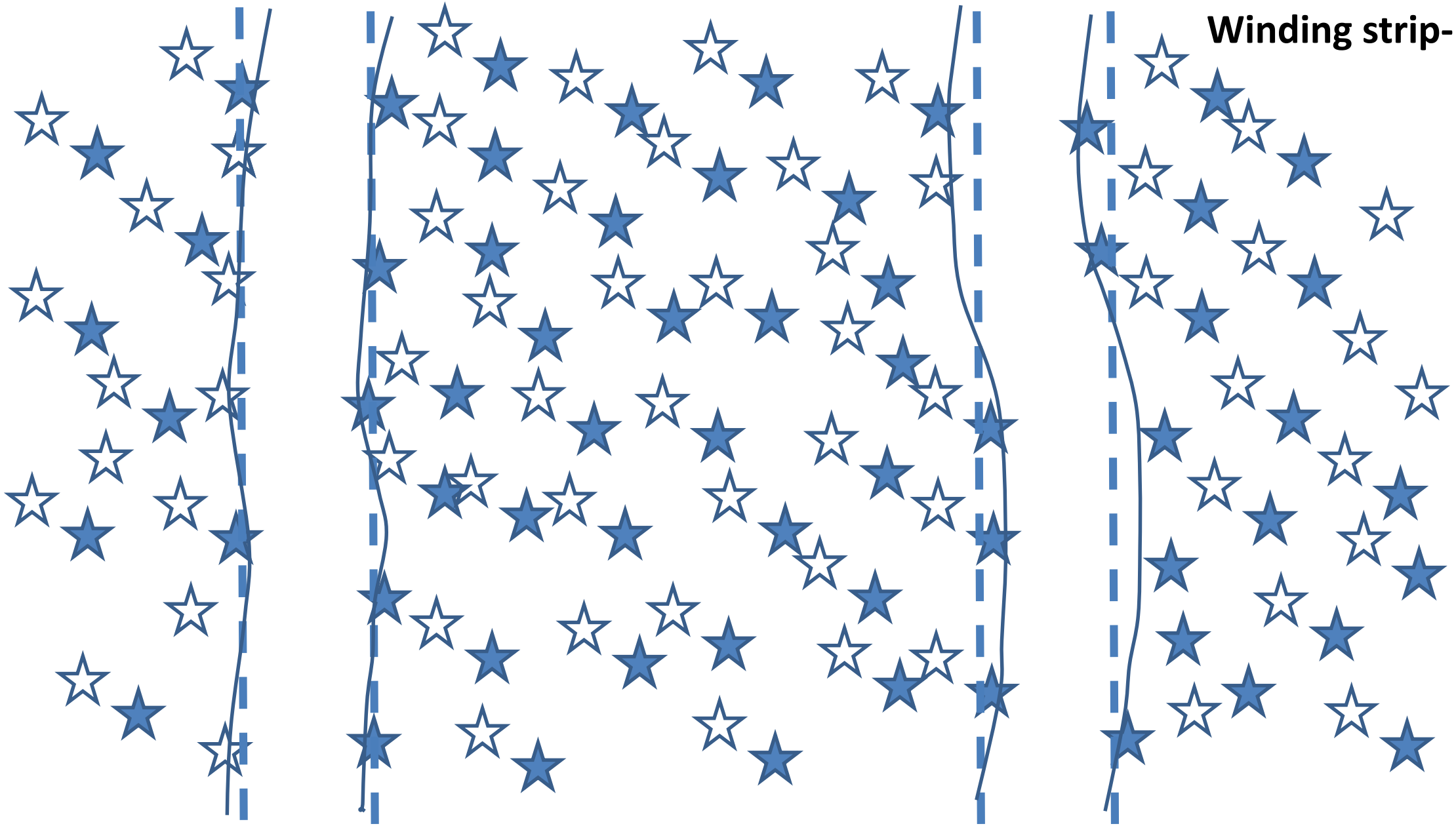
A thinning stand from above

Filled stars are ”future crop trees”


A thinning stand from above
Filled stars are ”future crop trees”
White stars are thinning trees


Strip roads


20 m
4 m
Strip roads


Winding strip-roads

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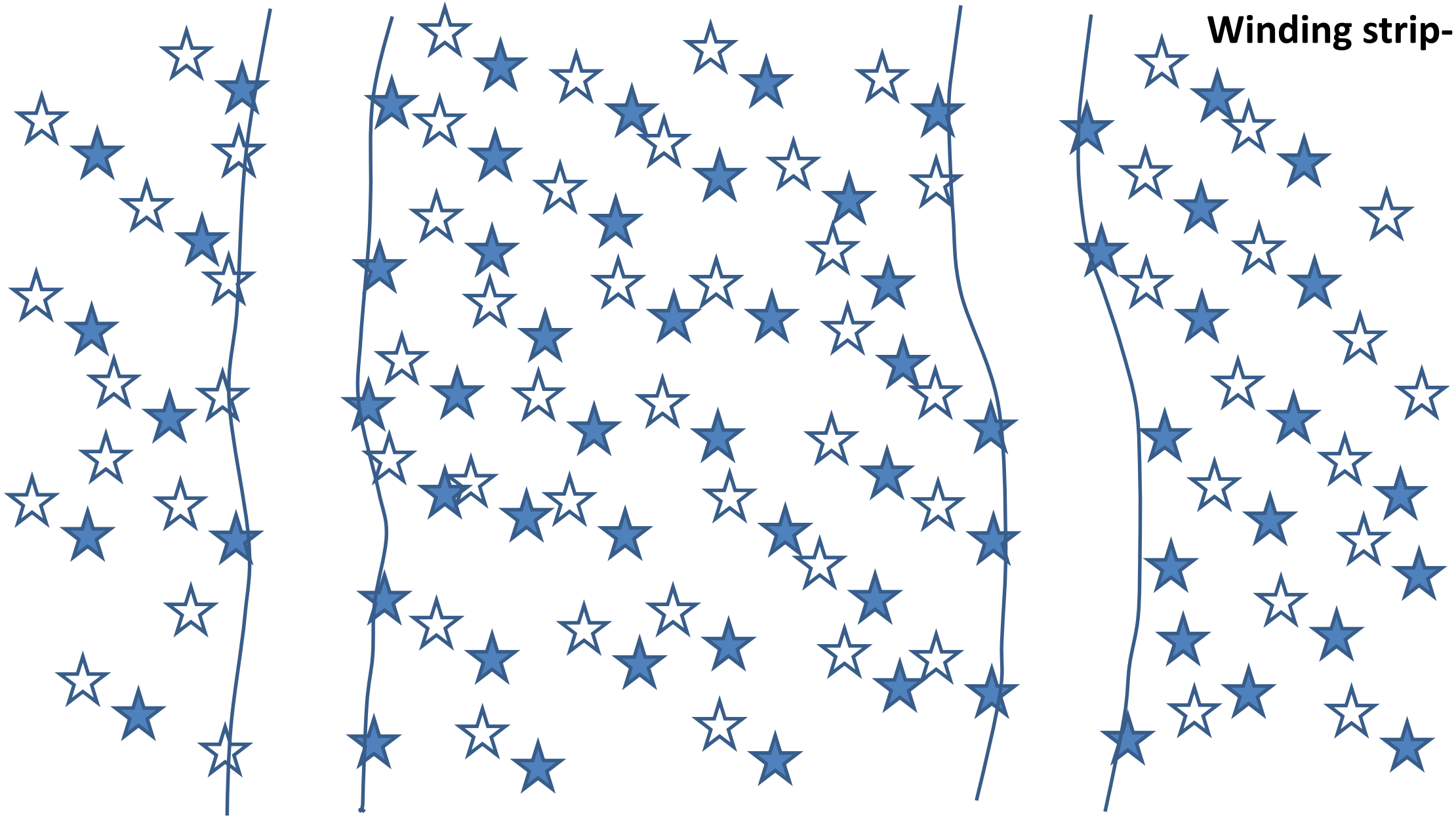

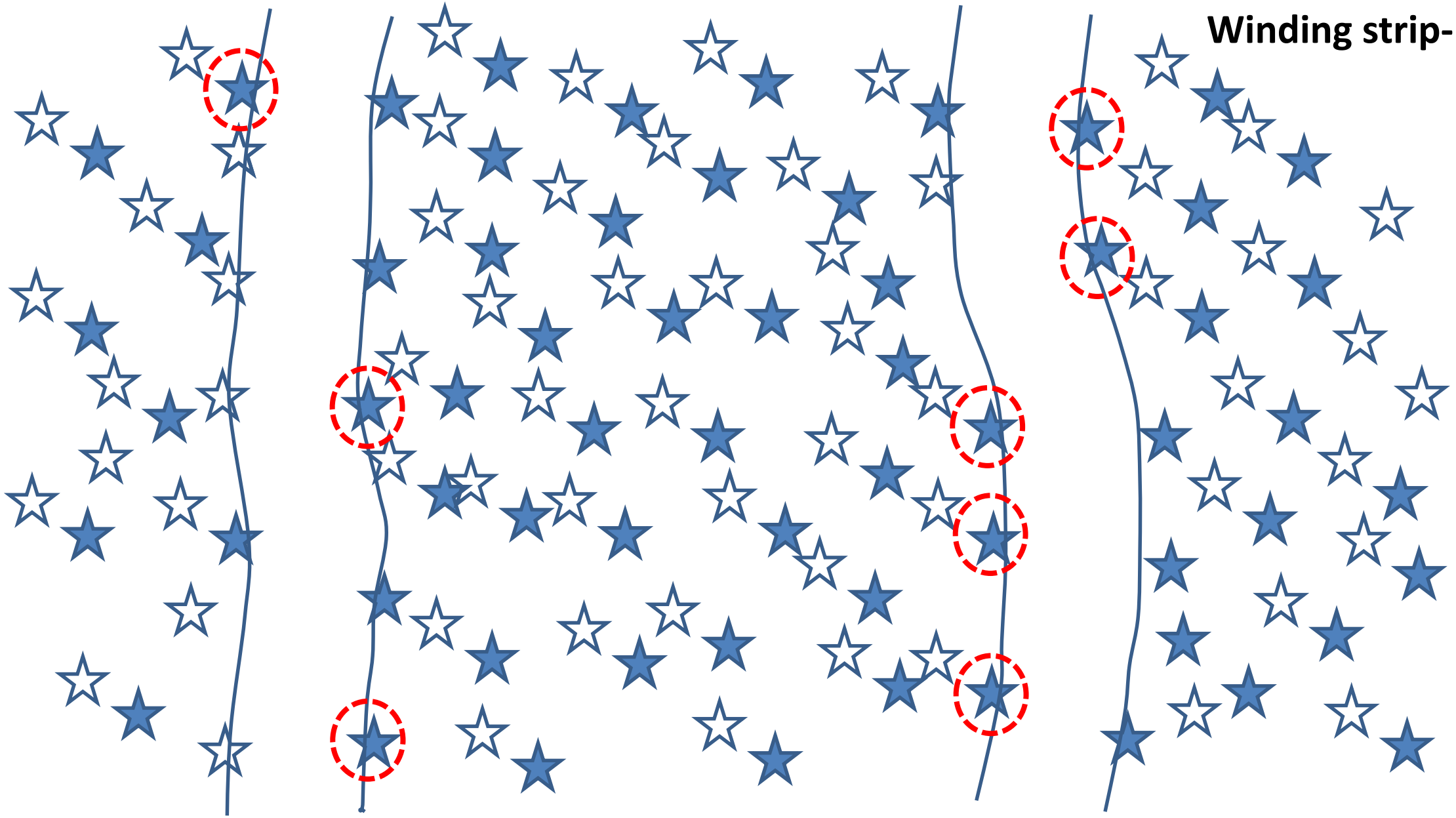
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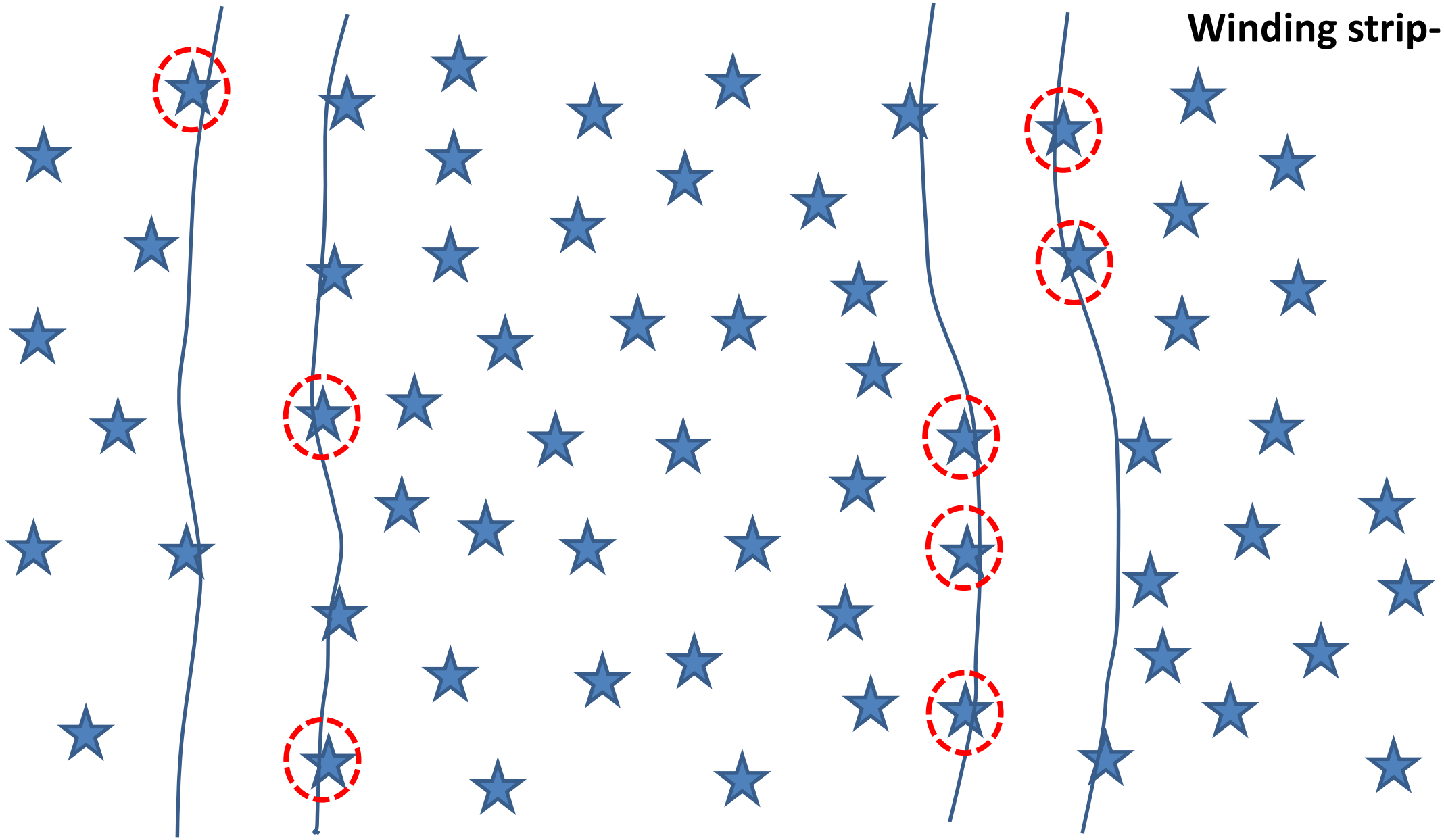
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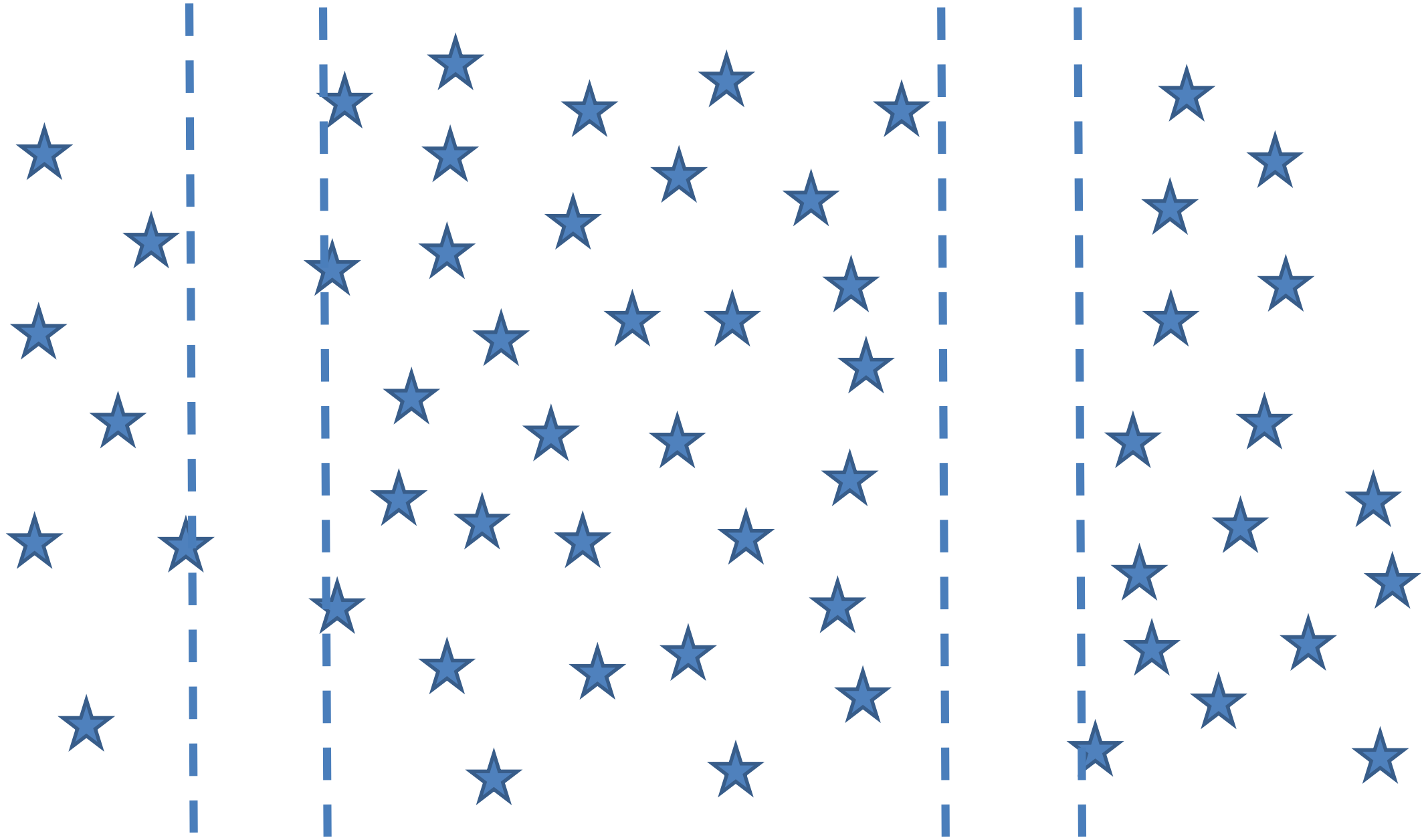
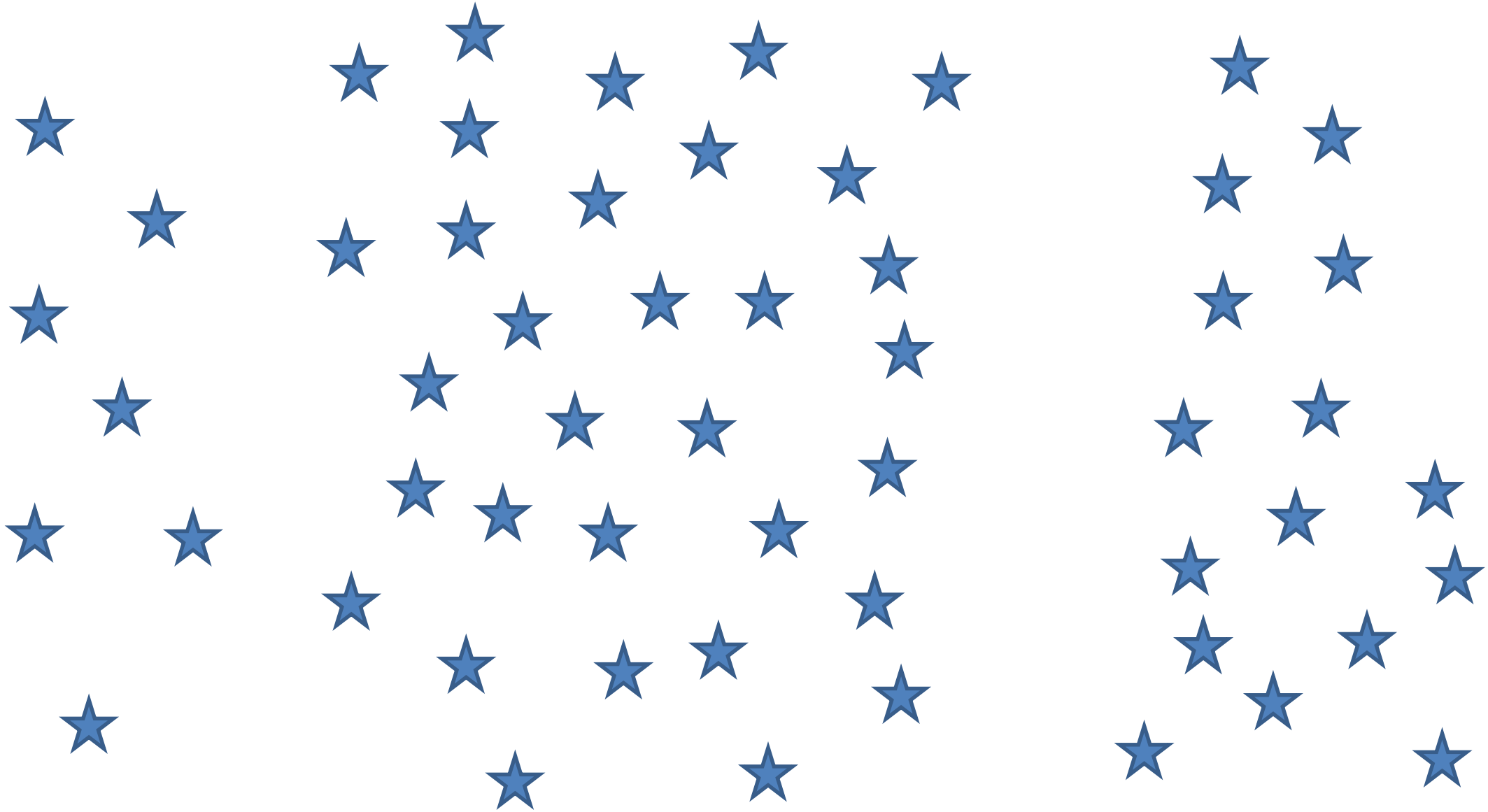
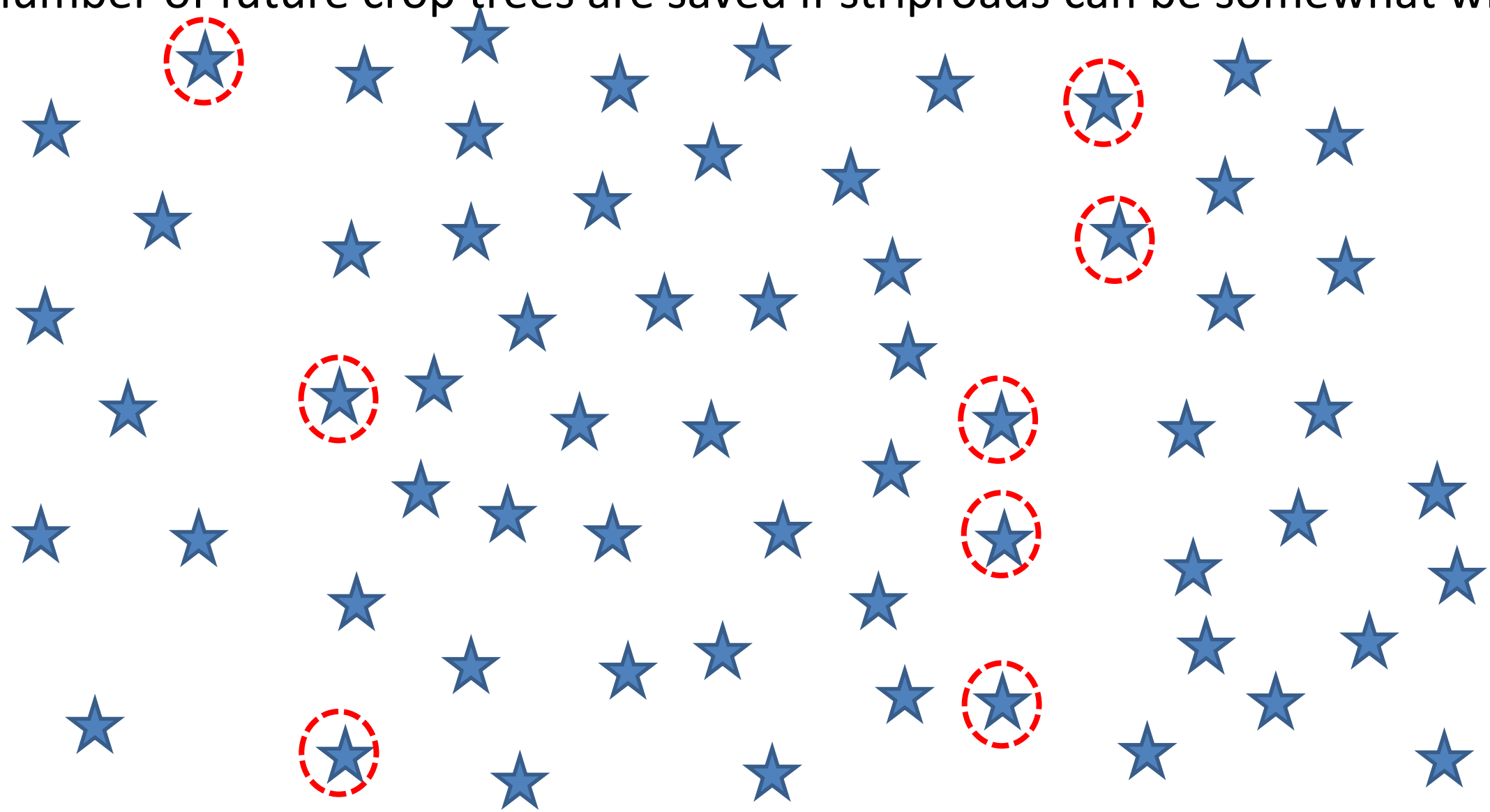




A number of future crop trees are saved if striproads can be somewhat winding



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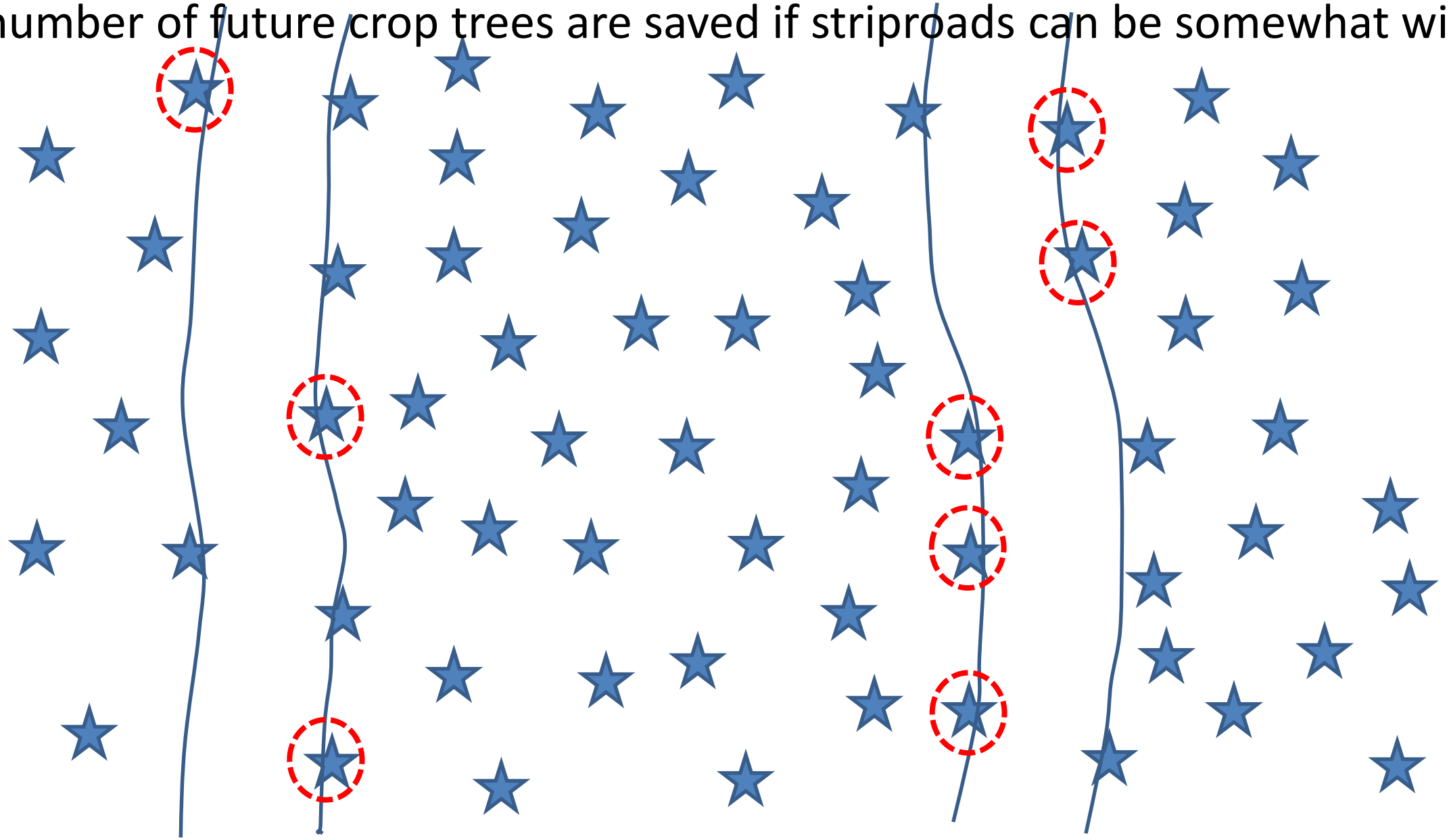


Lesson 1 learned during the development of mechanized thinning

Let the harvester operator decide on trees to be thinned based on instructions like:

- Thinning from below
- Remove XX% of the standing volume
- Favor a specific species composition
- Etc.

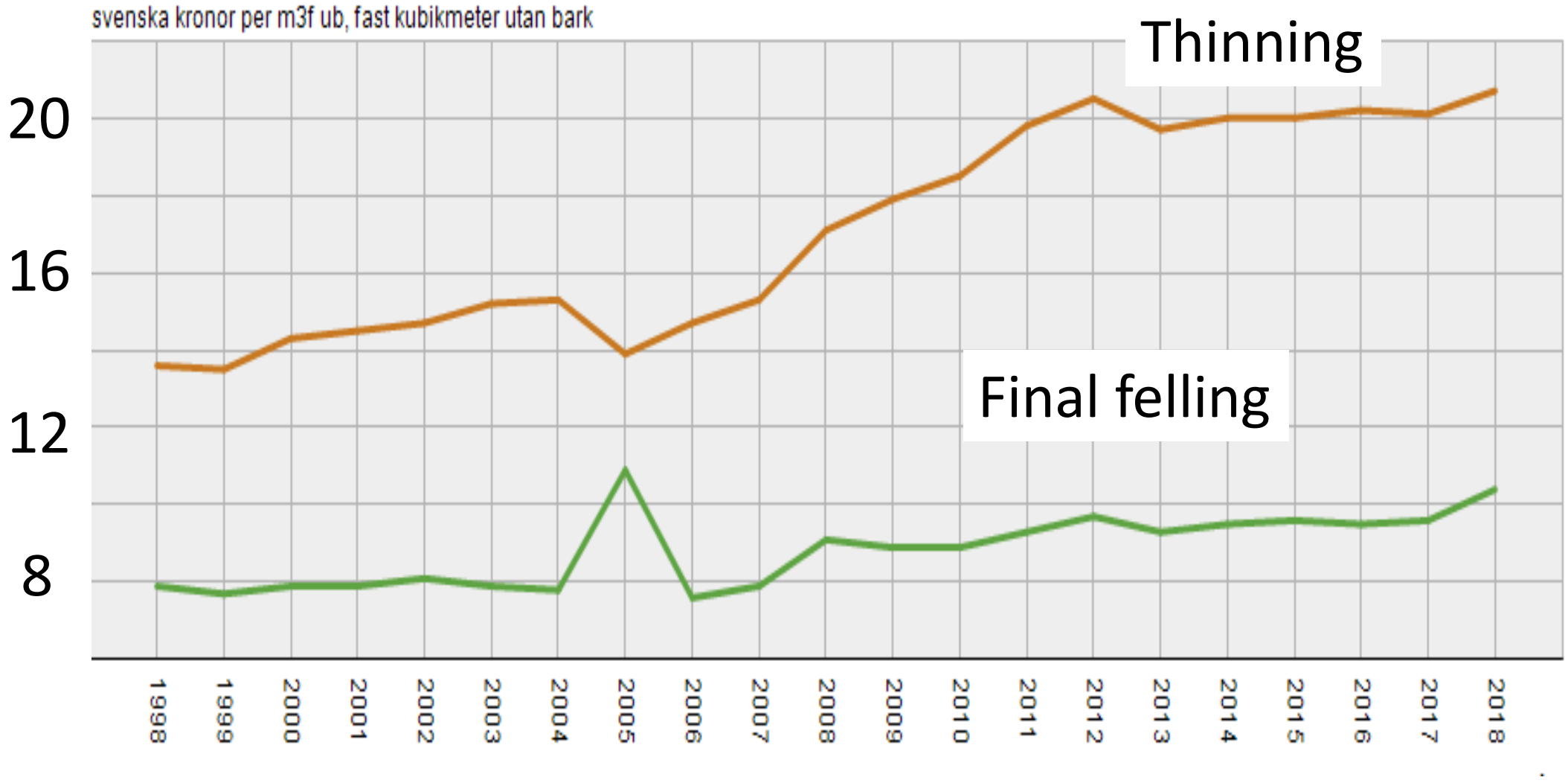
Lesson 2 learned during the development of mechanized thinning

Let the strip roads be somewhat winding to minimize the thinning of the good future crop trees. This will mean:

- The distance between striproads might vary between 15 and 25 m, but in average about 20 m.

The cost for harvesting and forwarding in Sweden years 1998-2018

Euro/m3



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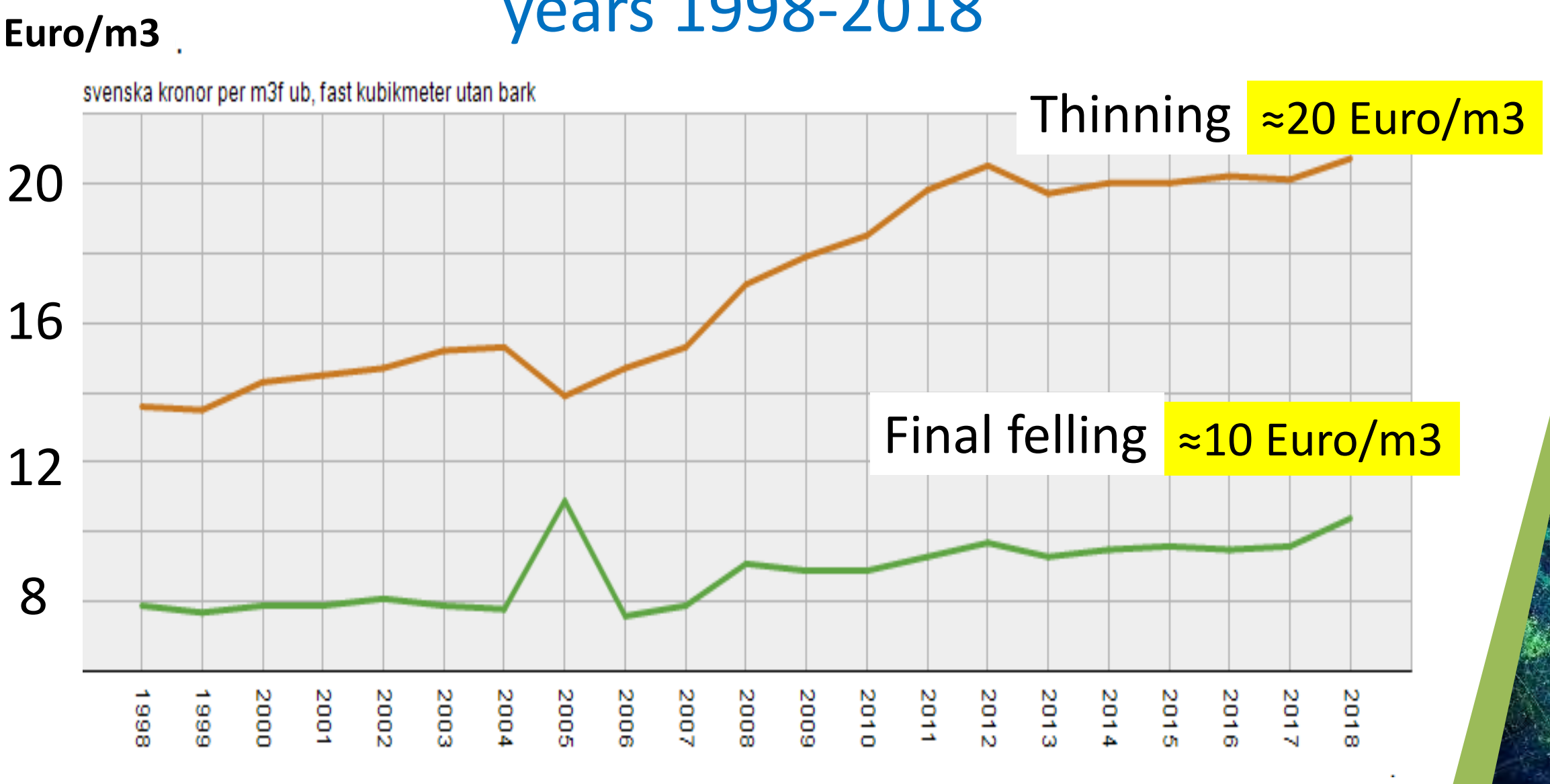

So, we do know how to handle ordinary first thinning stands !

But, what about really dense thinning stands with most trees to small for ordinary pulp-wood logs?

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At the same time, those stands have a large biomass content, and this is an interesting potential for bioenergy and in the future also for biorefineries producing chemicals a liquid fuel

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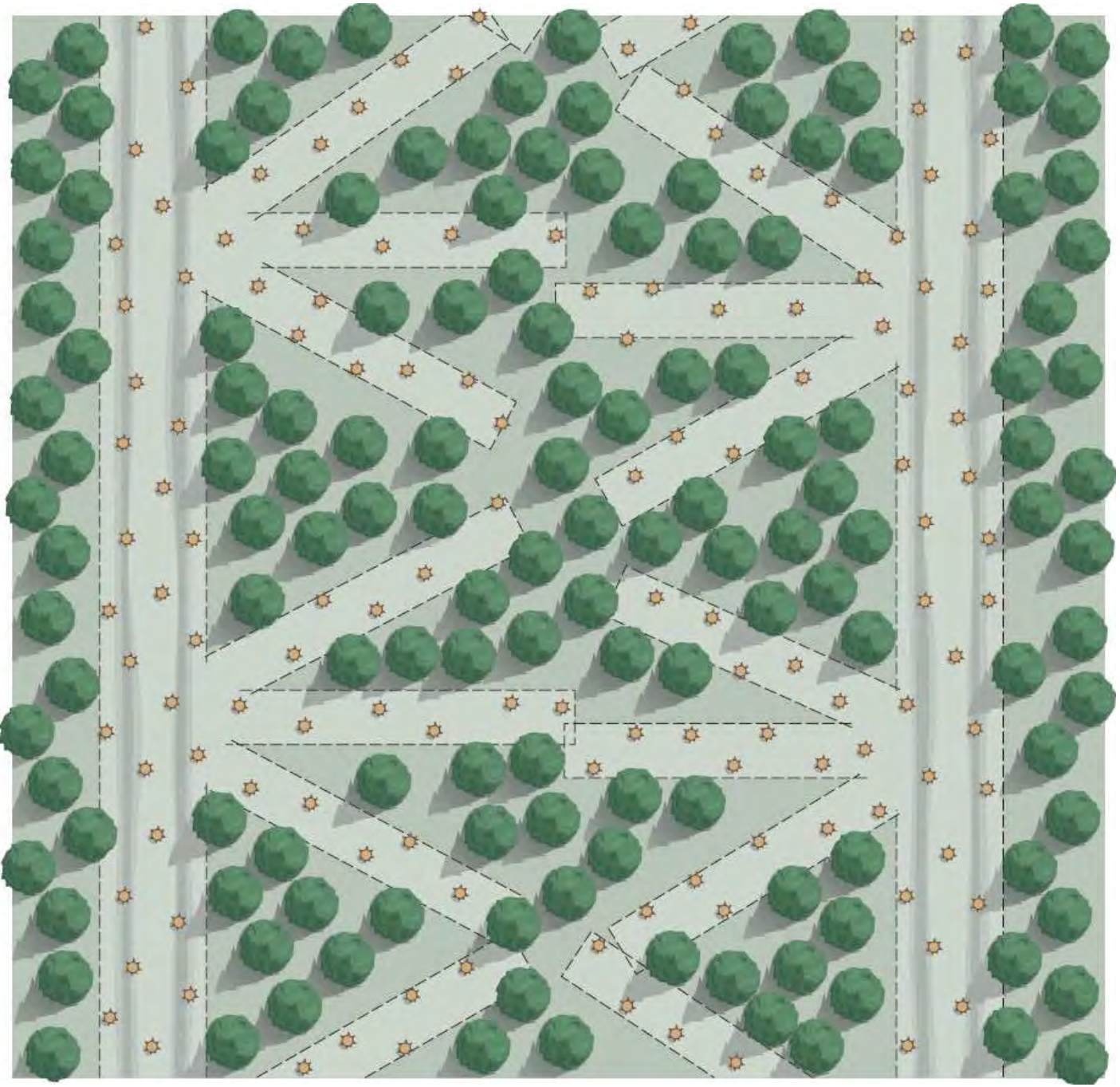
Such stands should be thinned for future development, but this is very expensive with ordinary thinning technique

The solution is to thin somewhat more geometric with a felling head that can handle many trees at a time

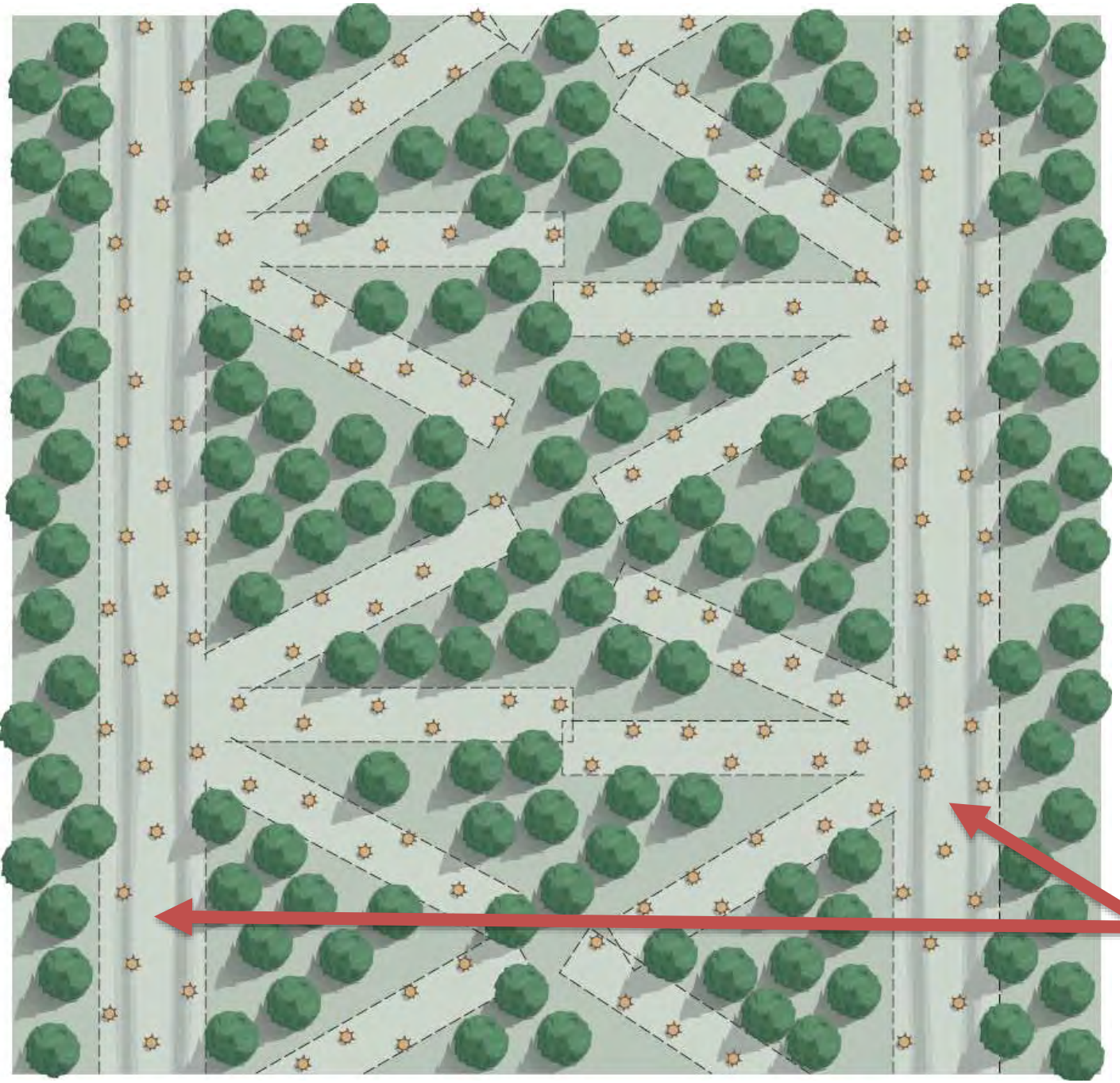
An experimental prototype from 2008

Many trees must be handled in the same boom movement to give a high productivity



And, this is the working method for this kind of thinning

Boom corridor thinning



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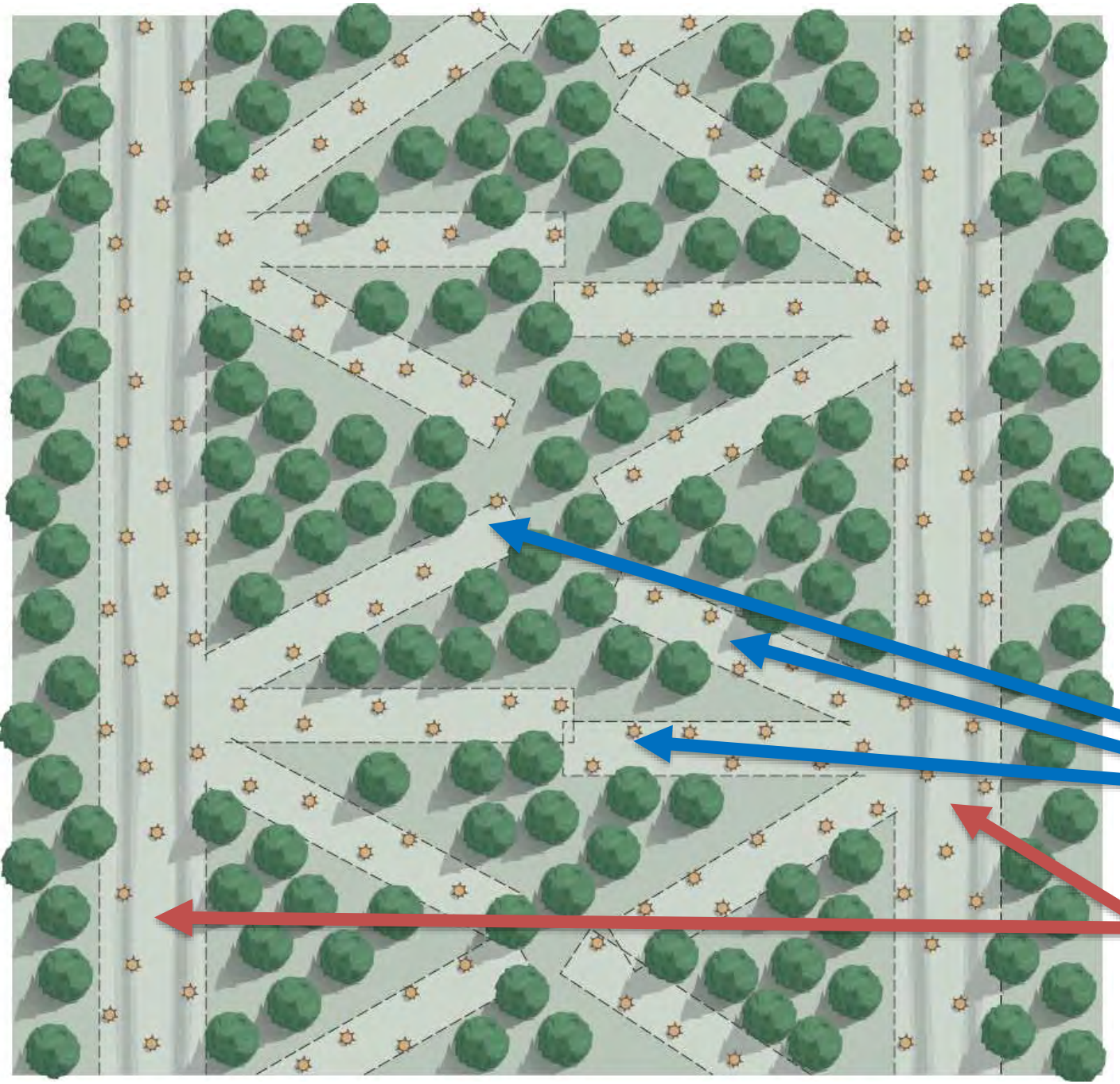
Boom corridor thinning

Ordinary striproads



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Boom corridor thinning

Boom corridors

Ordinary striproads

Our research aim for principle solutions that machine manufacturers then can develop to commercial products

Bracke Forest company have a product that fulfil many of the important characteristics needed to do a boom corridor thinning. It is not perfect, but the best felling head on the market for this work. It has also been further developed in the SMALLWOOD project

Swedish trial

Comparison of selective thinning and boom-corridor thinning in a young dense stand.

Swedish trial

Comparison of selective thinning and boom-corridor thinning in a young dense stand.

In both cases the same machine was used, with the same felling head and the same operator

Swedish trial

- Pine dominated stand with spruce, birch and other broadleaves

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- Average 5000 stems / ha (> 30 mm at DBH), variation 2000-9000 st/ha
- Average height 10.2 m

Swedish trial

- Pine dominated stand with spruce, birch and other broadleaves
- Average 5000 stems / ha (> 30 mm at DBH), variation 2000-9000 st/ha
- Average height 10.2 m
- Standing volume 186 m3 biomass/ha (93 ton dry biomass/ha). Estimated with biomass functions

Swedish results then?

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All results are based on scaled biomass. The results are solid!

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- Average harvest 89 m3 solid biomass/ha (44.5 ton dry biomass/ha)

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- Average harvest 89 m3 solid biomass/ha (44.5 ton dry biomass/ha)
- Average productivity 11.4 m3 solid biomass/G_0 hour

  (5.7 ton dry biomass/ha)