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Effect of planting method on the survival of *Alnus glutinosa* and *Quercus petraea* saplings in compacted coal-mine spoils, South Wales.

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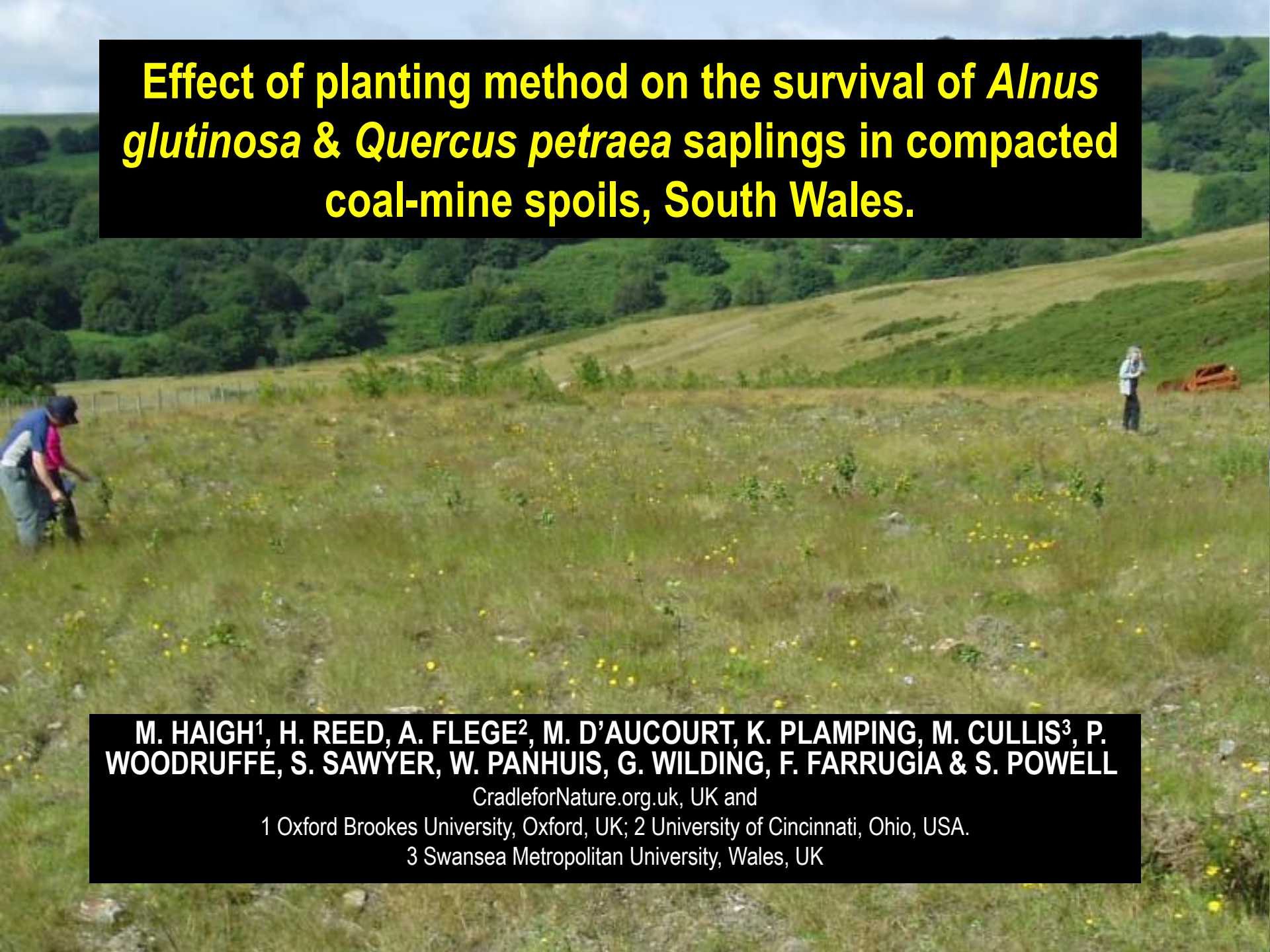


M. HAIGH[1], H. REED, A. FLEGE[2], M. D'AUCOURT, K. PLAMPING, M. CULLIS[3], P. WOODRUFFE, S. SAWYER, W. PANHUIS, G. WILDING, F. FARRUGIA & S. POWELL

CradleforNature.org.uk, UK and

1 Oxford Brookes University, Oxford, UK; 2 University of Cincinnati, Ohio, USA.

3 Swansea Metropolitan University, Wales, UK

Degradation of Reclaimed Coal-lands

- Lands that have become degraded following ineffective reclamation from surface coal mining are common in S. Wales but the problem is not recognised officially.
- BUT many such lands are classed as “suitable for environmental improvement”.
- Recent interest in “Carbon Sequestration” has improved attitudes towards the forestation of these unproductive wastelands.

Cradle for Nature

The aim is research & development towards a reliable method for the community-based reforestation of degraded former opencast coal-lands in South Wales.

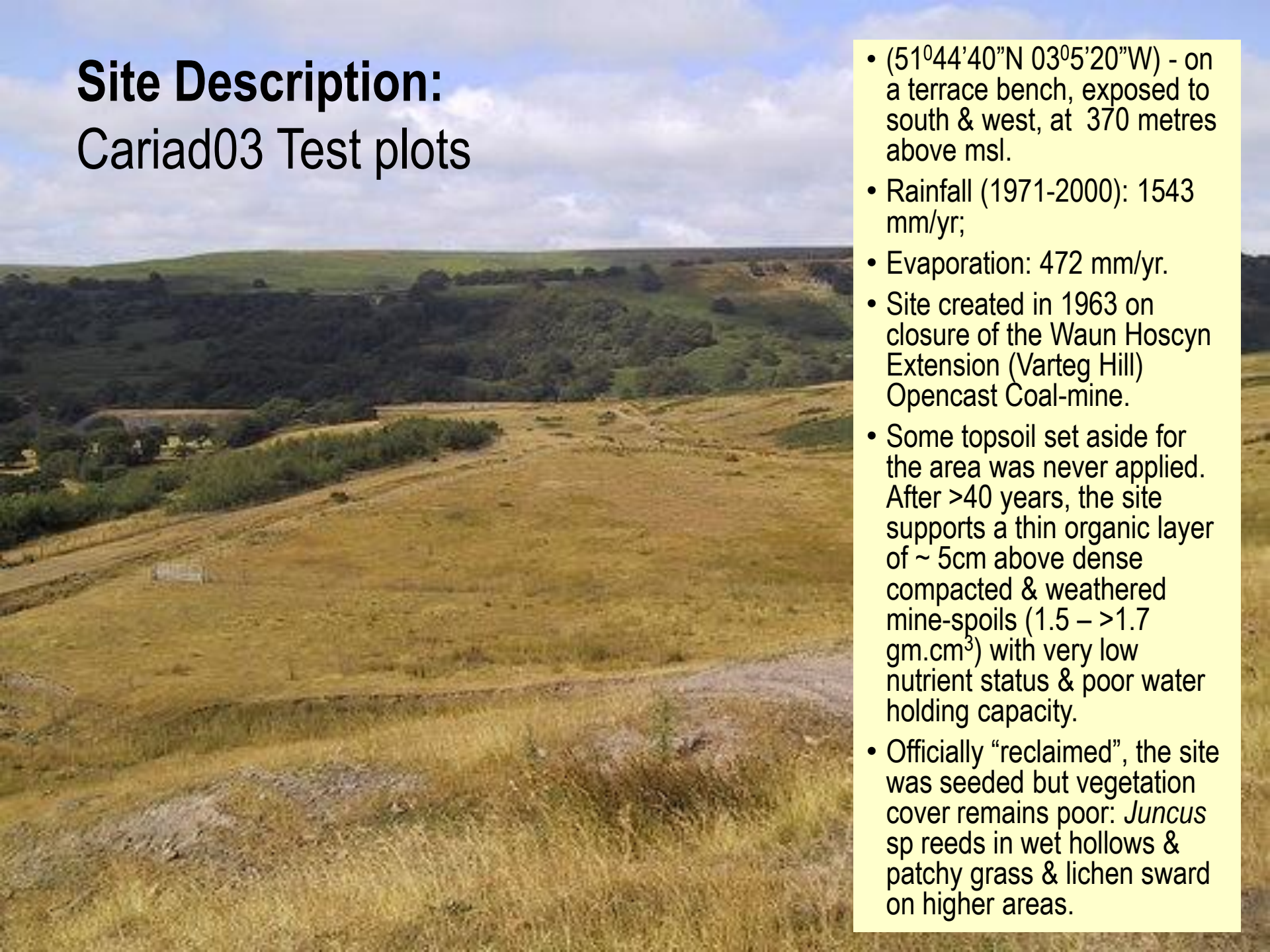
Since funds for community works tend to be ‘one-off’. This requires a technique that can achieve a ‘natural’, self-sustaining outcome, even in the absence of regular investment or maintenance.

This means building a ‘cradle for nature’ , a habitat where natural processes gain sufficient strength to restore the depleted biological systems on these degraded lands & set in process a benevolent cycle of environmental improvement.

Test Hypothesis: planting method plays a major role in the survival of forest species on compacted opencast coal spoils.

- The Cariad03 experiment tests a hypothesis suggested by two decades of forestation action research on the same site.
- The test concerns 3 types of planting method.
  - 1. forestry industry style 'notch planting ', where the ground is opened & a young tree is heeled directly into the slot;
  - 2. 'parks and gardens' style 'pit' planting, where the sapling is planted into a 30-cm diameter by 30-cm deep soil pit along with the inverted topsoil;
  - 3. contour trench planting, where the sapling is planted into a trench, ca. 50 cm wide by 40 cm deep, which has been back-filled with the inverted soil profile.
- This reports findings from a formal, 5-year, trial of 900 trees divided between two species, alder (*Alnus glutinosa (L.) Gaertn.*), which is commonly used on Welsh opencast sites, (used as nursemaid for) Durmast Oak (*Quercus petraea (Matt.)* (*Liebl.*), a dominant species in pre-opencast woodland locally.

Site Description:
Cariad03 Test plots



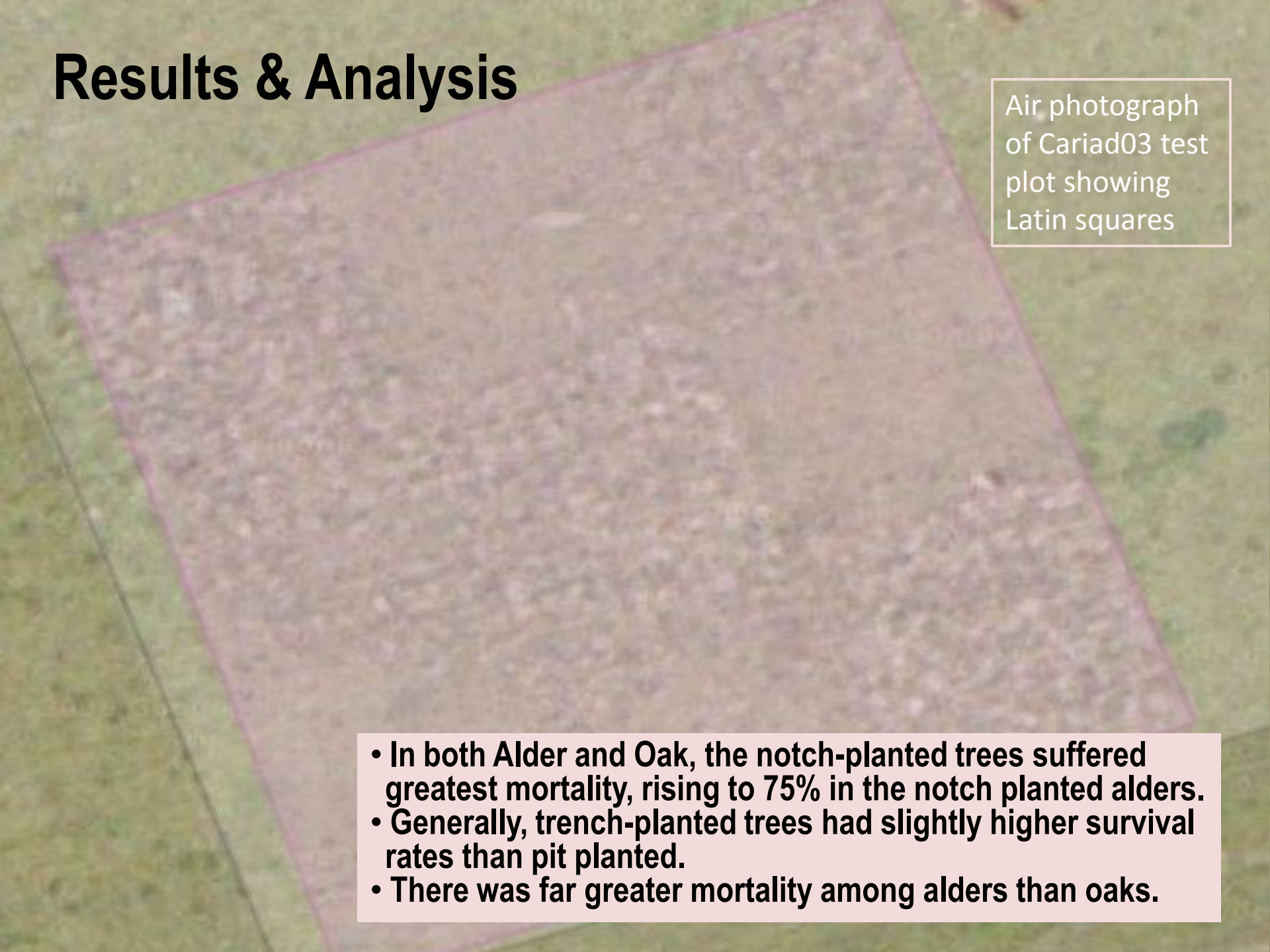
- (51^{0}44’40”N 03^{0}5’20”W) - on a terrace bench, exposed to south & west, at 370 metres above msl.
- Rainfall (1971-2000): 1543 mm/yr;
- Evaporation: 472 mm/yr.
- Site created in 1963 on closure of the Waun Hoscyn Extension (Varteg Hill) Opencast Coal-mine.
- Some topsoil set aside for the area was never applied. After >40 years, the site supports a thin organic layer of ~ 5cm above dense compacted & weathered mine-spoils (1.5 – >1.7 gm.cm^{3}) with very low nutrient status & poor water holding capacity.
- Officially “reclaimed”, the site was seeded but vegetation cover remains poor: *Juncus* sp reeds in wet hollows & patchy grass & lichen sward on higher areas.

Method

1: Notch	2: Pit	3: Trench
2: Pit	3: Trench	1: Notch
3: Trench	1: Notch	2: Pit

- The experiment (Cariad03) was set out as a Latin Square. There are 9 plots, 3 each of notch planted, pit-planted & trench planted trees.
- Trees were planted as root trainers. Random number tables were used to locate 281 oak trees in a matrix of 675 alders.

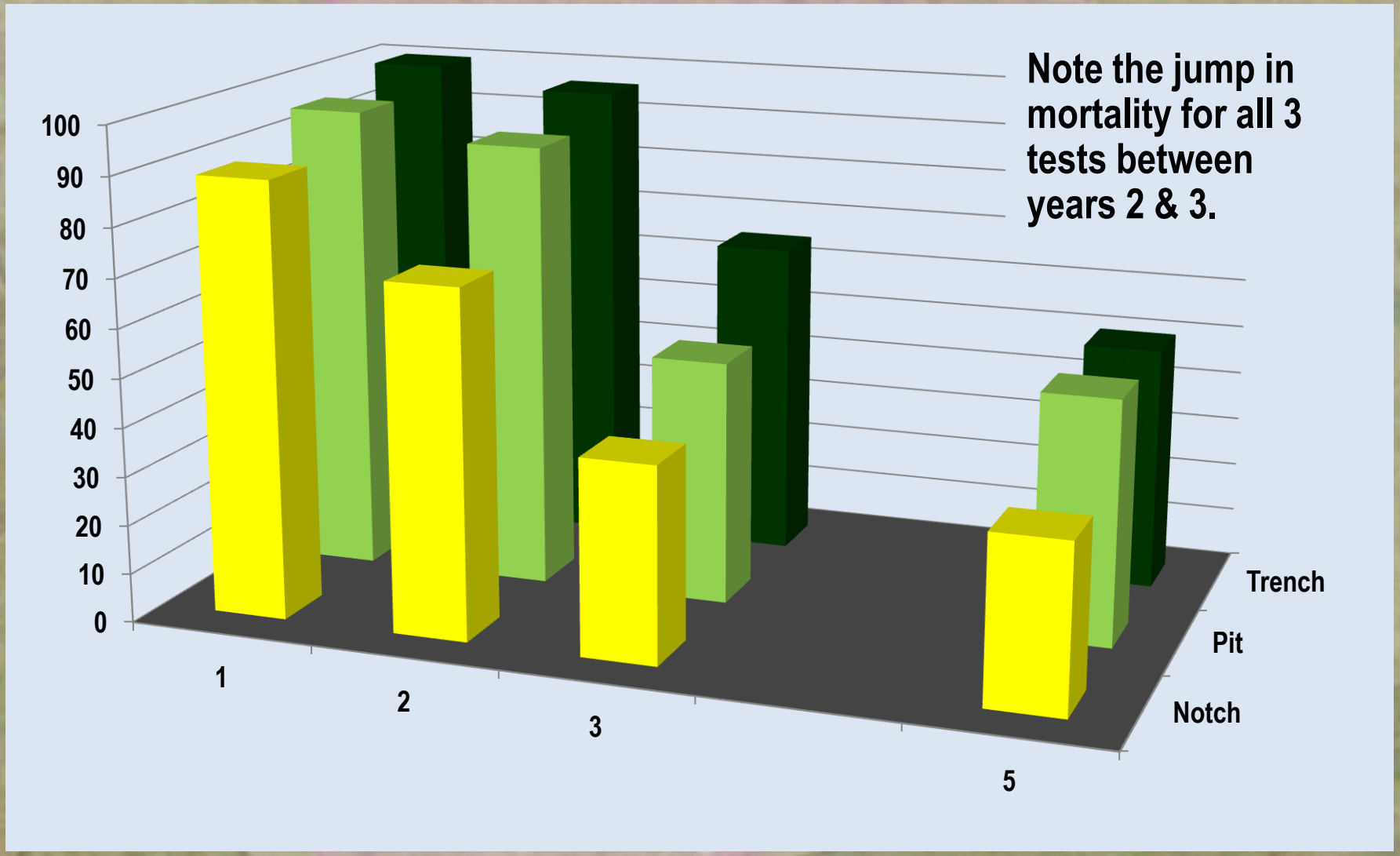
Results & Analysis



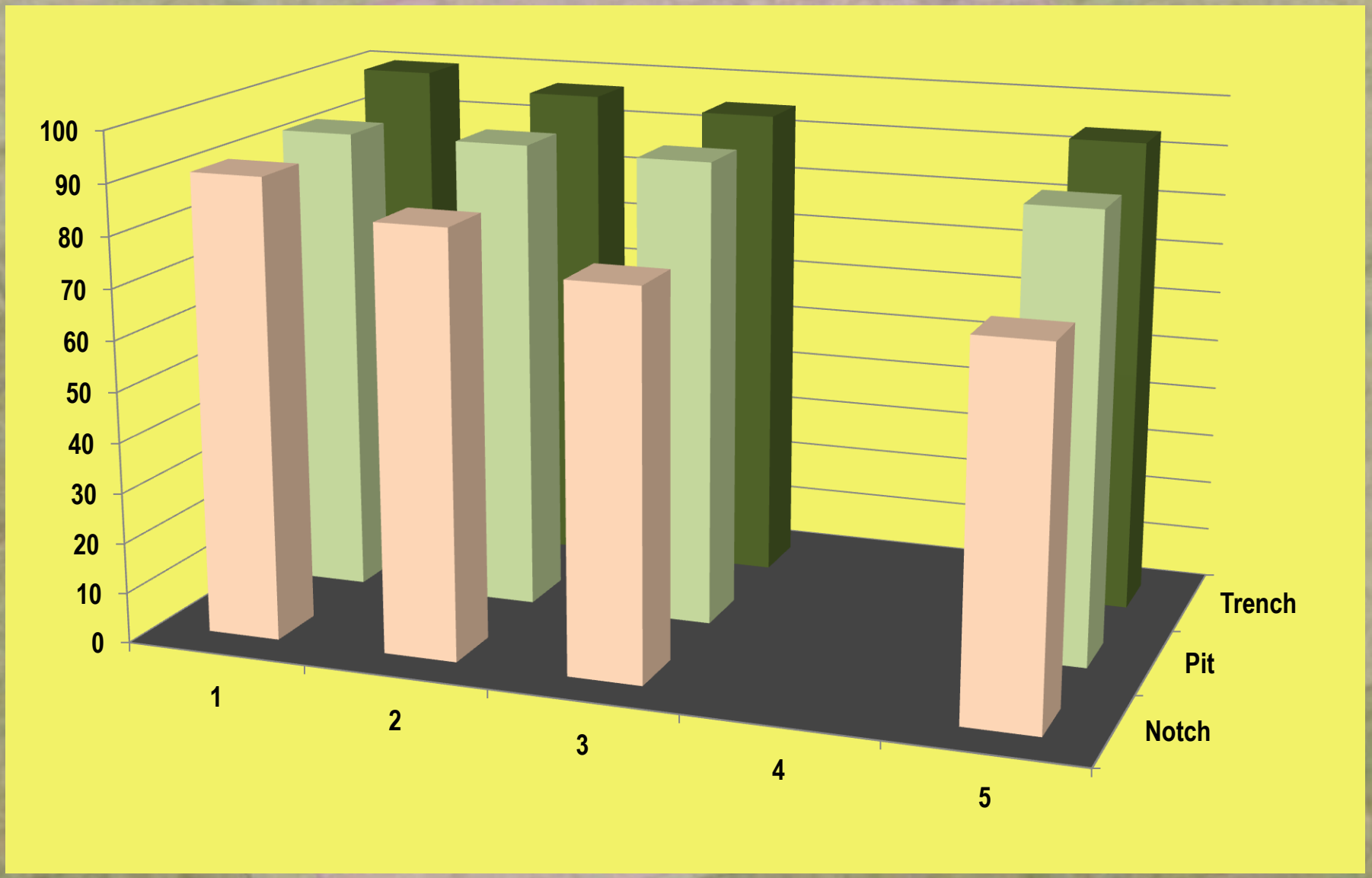
Air photograph of Cariad03 test plot showing Latin squares

- In both Alder and Oak, the notch-planted trees suffered greatest mortality, rising to 75% in the notch planted alders.
- Generally, trench-planted trees had slightly higher survival rates than pit planted.
- There was far greater mortality among alders than oaks.

Alder: Mortality by Year



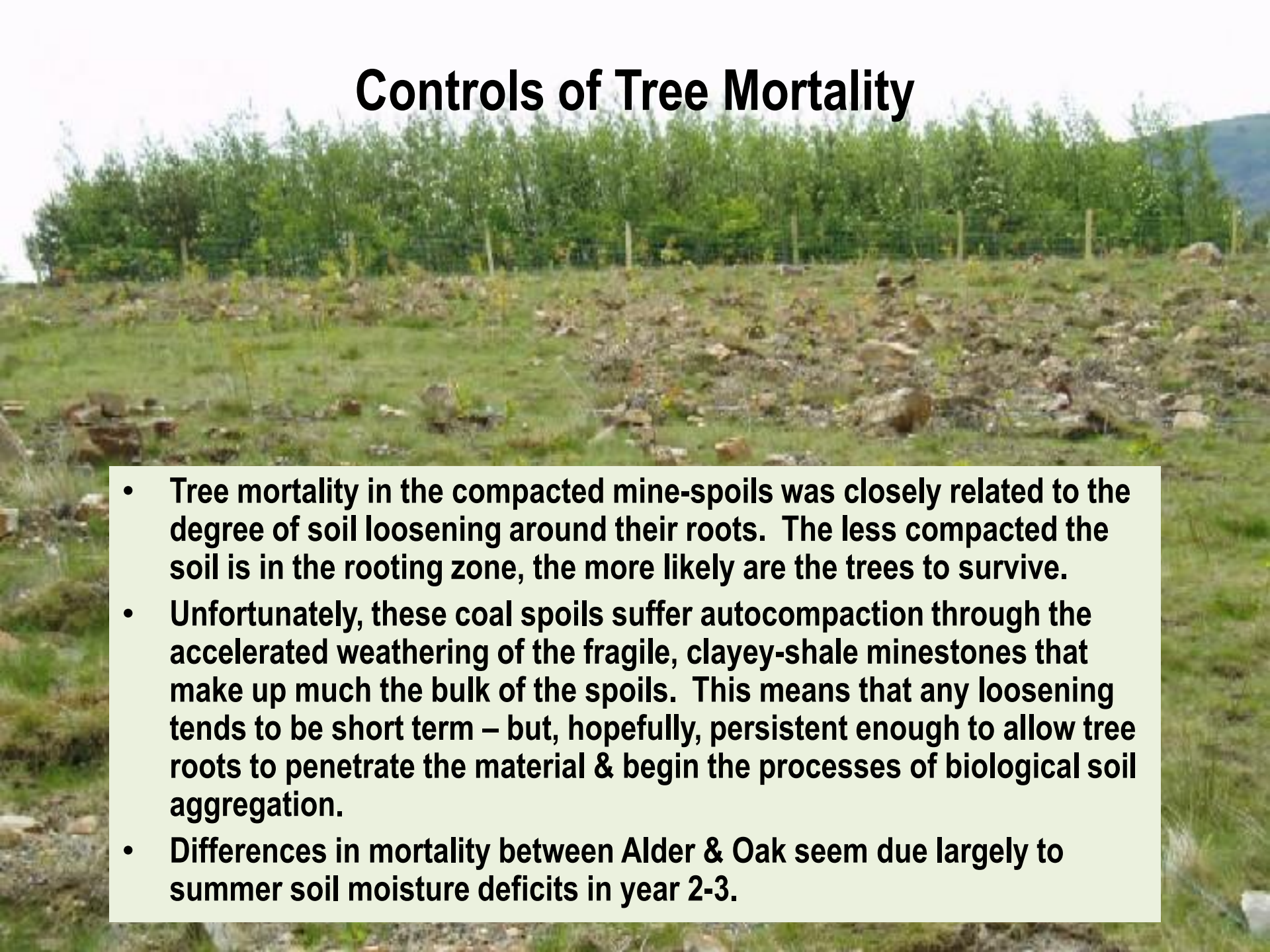
Oak: Mortality by Year



Statistical Analysis (Fisher Exact Test).

- Both species show significantly ($p < 0.005$) better survival rates from trench & pit planting versus notch planting.
- In Alder (*Alnus glutinosa*), early differences in survival rates between pit & trench planted trees disappear by year 2.
- In Oak (*Quercus petraea*), the relative survival of trench versus notch planting increases progressively through the 5 years of observation BUT, in Alder, these benefits decline after Year 2.

Controls of Tree Mortality



- Tree mortality in the compacted mine-spoils was closely related to the degree of soil loosening around their roots. The less compacted the soil is in the rooting zone, the more likely are the trees to survive.
- Unfortunately, these coal spoils suffer autocompaction through the accelerated weathering of the fragile, clayey-shale minestones that make up much the bulk of the spoils. This means that any loosening tends to be short term – but, hopefully, persistent enough to allow tree roots to penetrate the material & begin the processes of biological soil aggregation.
- Differences in mortality between Alder & Oak seem due largely to summer soil moisture deficits in year 2-3.

Conclusion

- The aim is to re-establish a self-sustaining ecological system on land where reclamation after surface coal-mining has not been successful.
- This explores 3 planting methods suitable for the community-based afforestation of degraded lands with very high soil densities.
- It uses 2 common land reclamation species, alder (*Alnus glutinosa*) & Welsh oak (*Quercus petraea*) in a formal Latin-square trial of 3 planting methods: notch planting, pit planting & trench planting.
- Mortality records, collected 1, 2, 3 & 5 years after planting, show that survival rates start and remain significantly lower for notch-planted trees, while those that are pit-planted & trench planted are much better.
- Survival rates tend to be higher for trench-planted than pit-planted trees but the difference is not significant for either species after the year 1.
- However, the conclusion is that providing a loosened, lower density rooting substrate significantly improves the survival rates of trees planted in compacted Welsh surface coal-mine spoils.

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