Gobierno de España · Ministerio de Economía y Competitividad · INIA Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria · Junta de Castilla y León

# Stand composition and stocking management in Mediterranean Stone pine (*P. pinea* L. ) forests as an adaptive measure to climate change

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# INTRODUCTION

BACKGROUND

Mediterranean forests are among the most vulnerable ecosystems under climate change scenarios. Need to adapt these forests to low Precipitation and high Temperature.

In Mediterranean environments the main type of competition is for water.

The use of thinning to reduce stocking density and the promotion of mixed stands have been proposed as effective measures for adaptation.

Spatial distribution and use of resources.

- ✓In pure stands ALL space available is occupied by the species even if conditions are not the most favorable. Trees compete for resources in the same site and time.

- ✓In mixed stands the optimal spatial distribution of trees and species is assumed, each individual is expected to occupy the most favorable niche for growth. Trees may have different strategies to use resources.

# INTRODUCTION

AIMS

- To assess the effect of between and within species competition on radial growth of *Pinus pinea* in three  years with contrasting annual precipitation (dry *vs* wet years).

- Are the use of thinning to reduce stocking density and the promotion of mixed stands effective measures for adaptation to climate change?

HYPOTHESIS

1. The impact of between & within species competition is stronger in drier than in wet years.
2. The influence of  within species competition on the radial increment of *Pinus pinea* is stronger than the impact of the competition with other species. More prominent differences are expected in drier years.

# MATERIAL AND METHODS

## STUDY REGION

- ✓ Limestone plain areas located in the east of the province of Valladolid (Spain).
- ✓ Altitude: 800-850 m.
- ✓ Annual rainfall: 500-550mm.

- ✓ Approximately 50,000 ha occupied by *P. pinea* in Valladolid:16,000 ha are in limestone plains.
  - ➢ 12,000 ha are pure even-aged.
  - ➢ 4,000 ha of *P. pinea* are mixed with *Quercus ilex*, *Quercus faginea* and *Juniperus thuriphera*.

# INTRODUCTION


✓The preferred management objective of these stands is the production of pine nuts, timber production being a secondary objective.

# MATERIAL AND METHODS

EXPERIMENTAL TRIALS

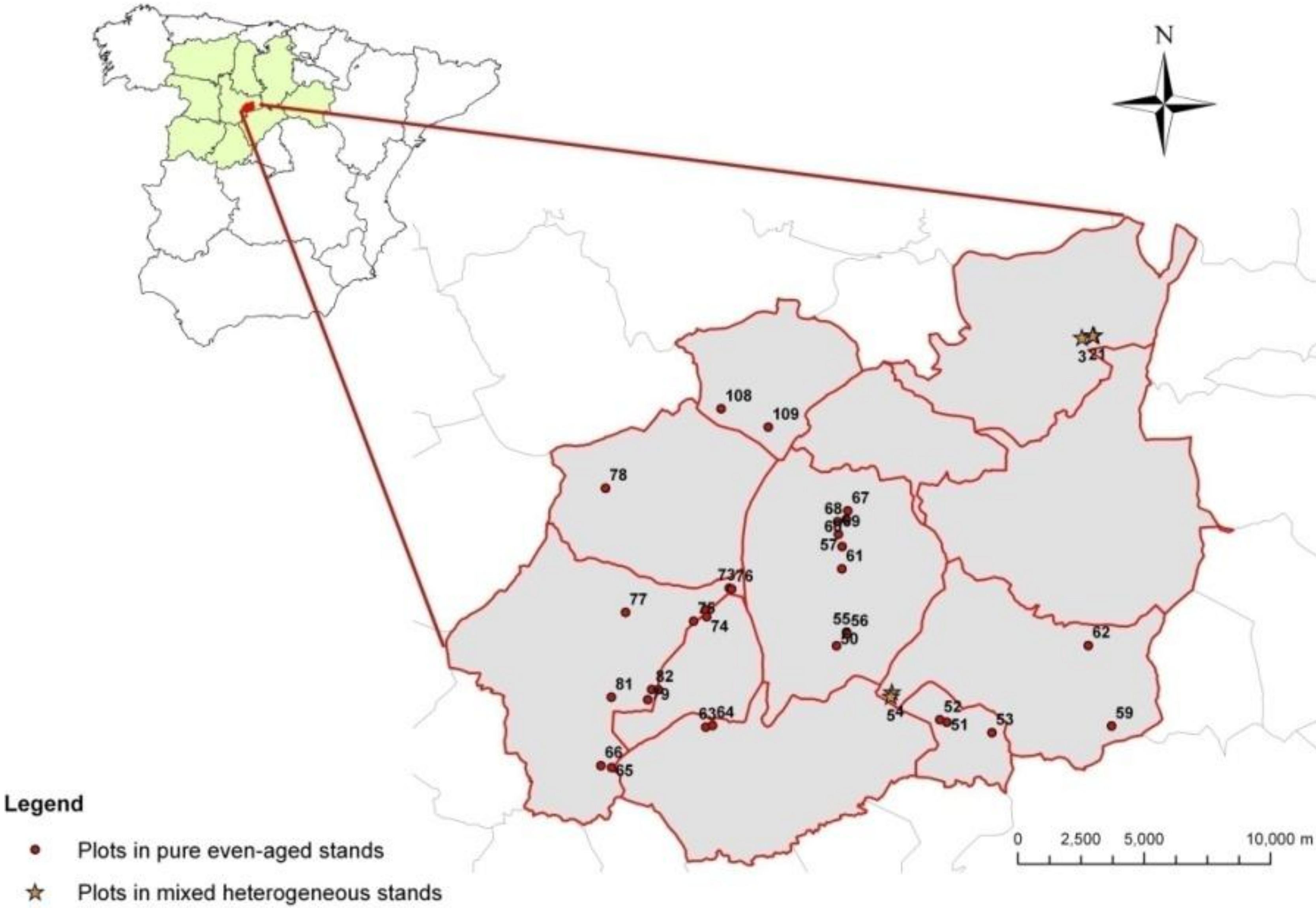
- ✓ Plots located in public forests covering the entire age range, stocking densities and site index available.

- ✓ 5 rectangular plots of 3.000 $m^2$ in mixed heterogeneous stands (*Pinus-Quercus-Juniperus).* 2011.

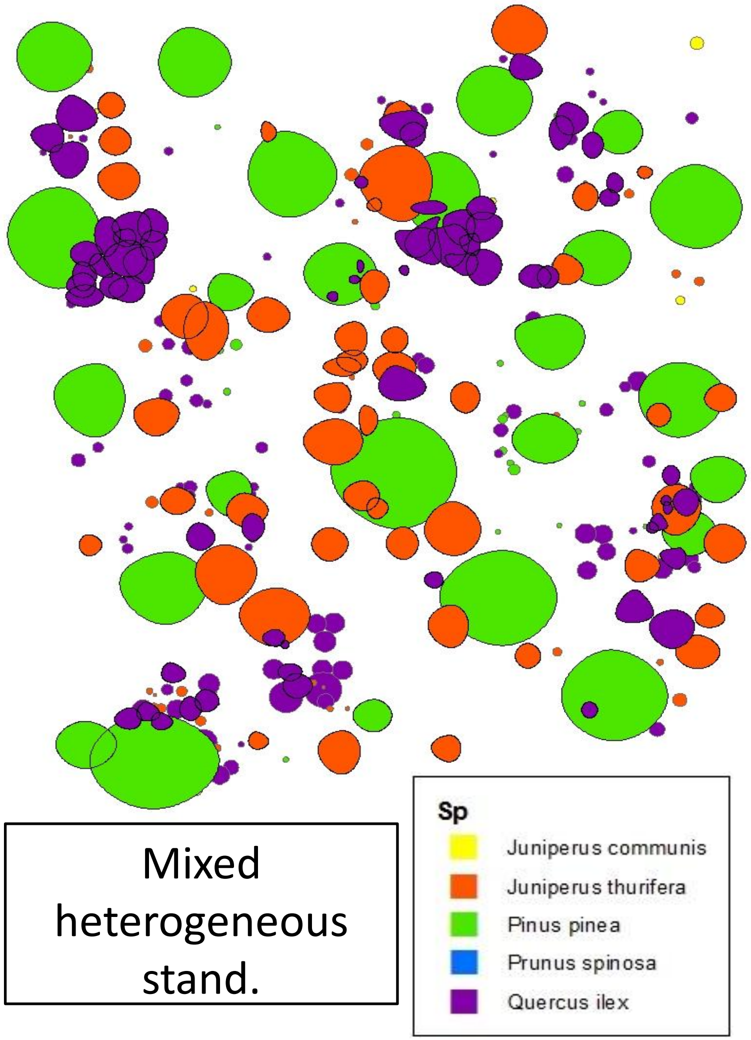
  33 circular plots of variable area including 20 trees in pure even-aged stands. 1996. Inventored since then.

- ✓ Variables measured for trees taller than 1.30m: dbh, diameter at stump height, tree coordinates (XY), total height, height to crown base, crown diameter.

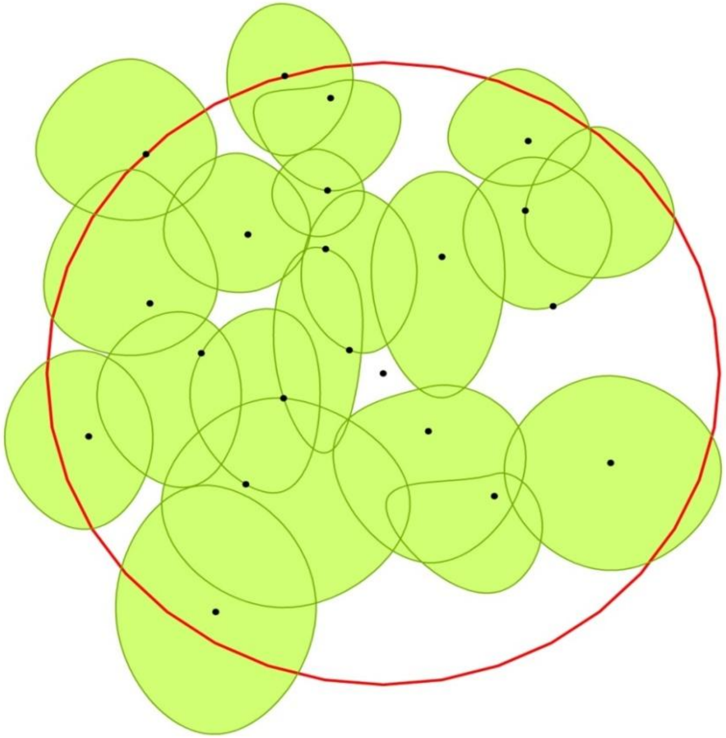
# MATERIAL AND METHODS



# MATERIAL AND METHODS




Mixed heterogeneous stand.



Pure even-aged stand.

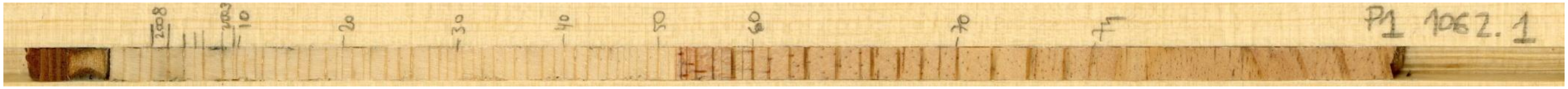
# MATERIAL AND METHODS

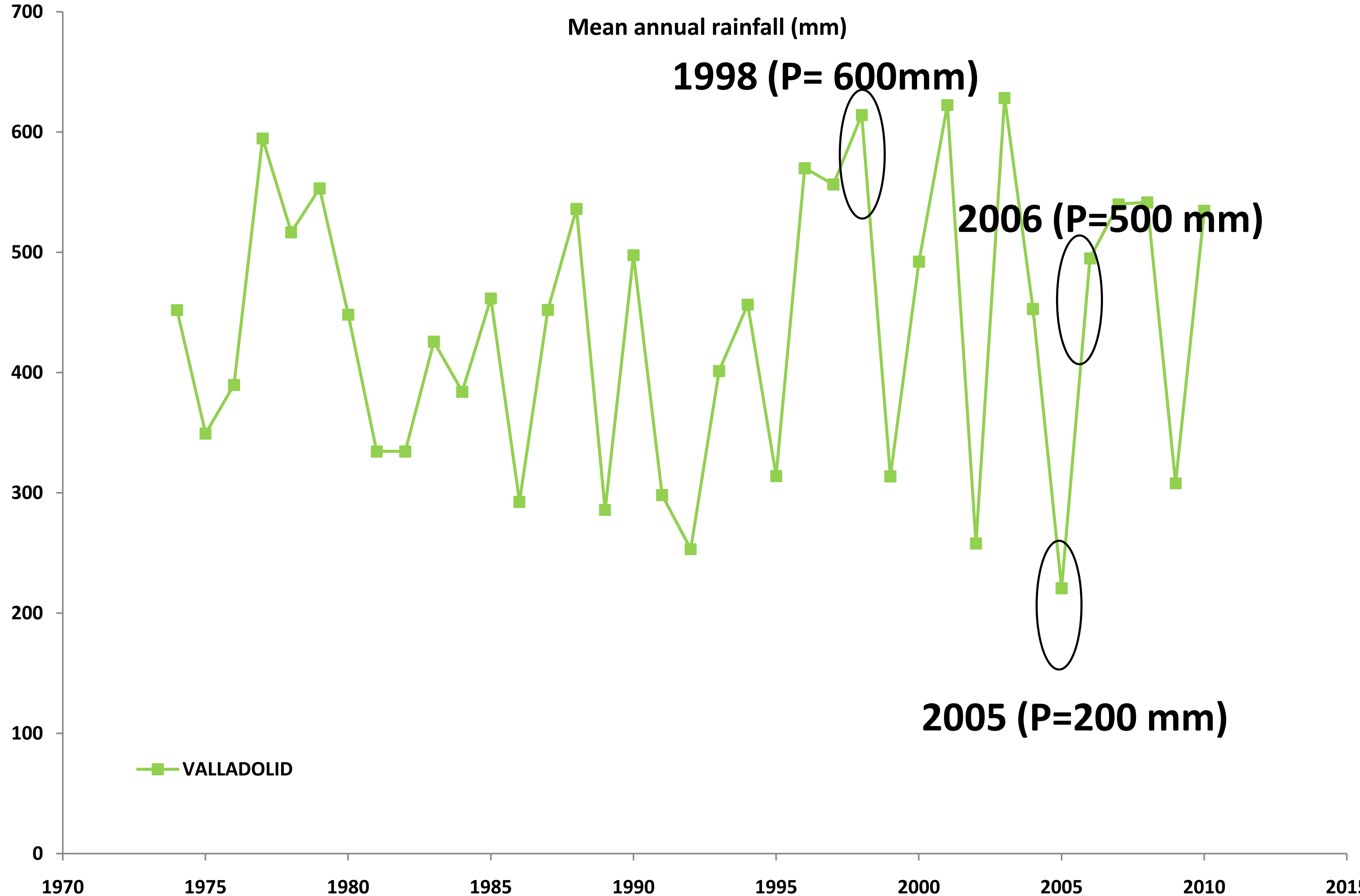
✓ <u>Radial increment cores and cross section slices</u>

- *Pinus pinea*
  - In mixed stands 23-30 trees per plot. 2 cores per tree.
  - In pure even-aged stands 5 trees per plot. 2 cores per tree.
- *Juniperus thurifera* and *Quercus faginea* 10 trees per plot. 1 core per tree.
- *Quercus ilex*. 10 trees in total (cross section slices).

✓ Analysis of cores and cross section slices.

Cores and cross section slices were scanned and visually dated with Lignovision 1.37 software and TSAPWin Professional 0.55.




Studied variable: annual radial increment of *P. pinea* in 1998, 2005 and 2006.

# MATERIAL AND METHODS

## METHODS

- ✓ DBH reconstruction of all trees in years T: 1998 (wet), 2005 (dry), 2006 (year after dry year).

$$DI_{T-2011} = a + b(DBH_{2011})$$

- ✓ Distance dependent competition index: Area overlap index (AOI). Bella 1971.

$$AOI_i = \sum_{j=1}^{n} \left[ \frac{ZO_{ij}}{ZA_i} \times \left( \frac{D_j}{D_i} \right)^{EX} \right]$$

Calculated for all *P. pinea* cored trees for the three years studied.

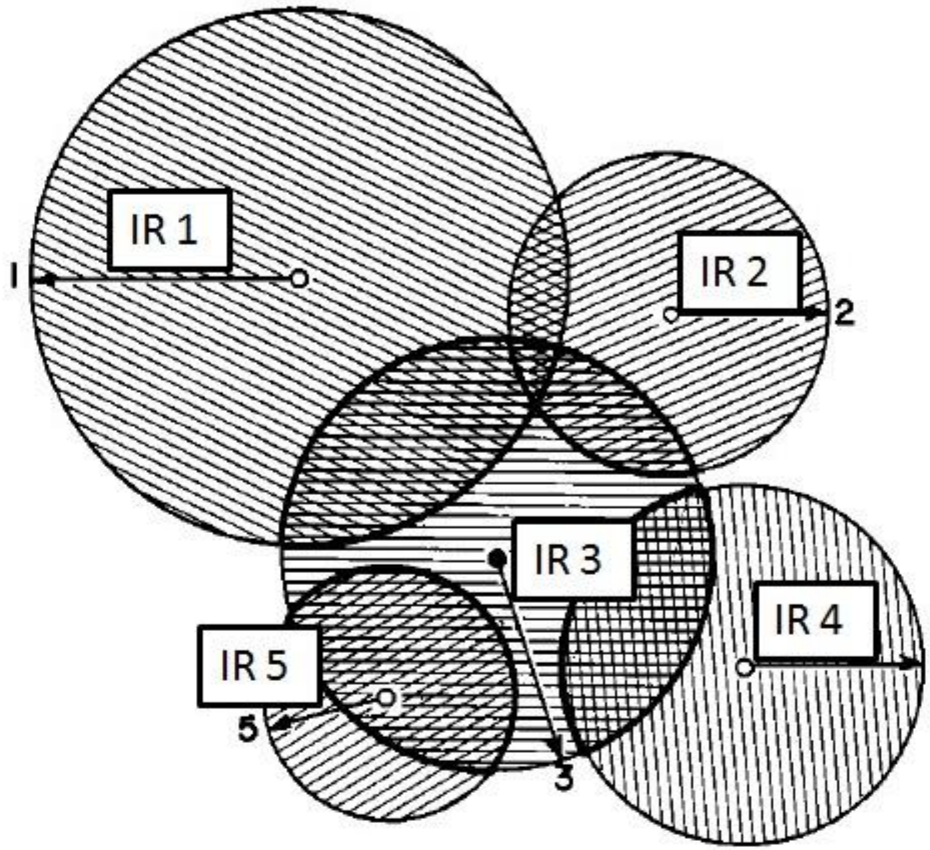
$AOI_i$: Area overlap index for subject tree i.
n: Number of competitors whose zone intersects that of the subject tree.
$ZO_{ij}$: Area of zone overlap between subject tree i and competitor j.
$ZA_i$: Influence zone area of the subject tree i= $\pi \times IR^2$ [IR: Influence zone-Radius based on DBH factors(1, 1.5, 2, 2.5, 3, 4 times DBH, in m)]
$D_i$: Diameter of the subject tree, in cm.
$D_j$: Diameter of the competitor tree, in cm.
EX: 0, 1, 2, or 3.

# MATERIAL AND METHODS

✓<u>Selection of Influence zone Radius (IR) and Exponent (ex) best correlated with Ln($ri_T$).</u> Pearson correlation.

✓<u>Radial increment (ri) models for years T</u>

$$Ln(ri_T) = a + b \times AOI_{Pp} + c \times AOI_{rest} + e$$



# RESULTS AND DISCUSSION

Influence radius = 2.5

Exponents $[(Dj/Di)^{Ex}]$

$$\begin{cases} AOI_{Pp} = 1 \\ AOI_{rest} = 0 \end{cases}$$

| | a | b | | c | |
|---|---|---|---|---|---|
| $Ln\,(ri_{1998})$ = | 5.80180 | - 0.04540 | x $AOI_{Pp}$ | - 0.01319 | x $AOI_{rest}$ +e |
| $Ln\,(ri_{2005})$ = | 4.64703 | - 0.11461 | x $AOI_{Pp}$ | - 0.03365 | x $AOI_{rest}$ +e |
| $Ln\,(ri_{2006})$ = | 5.20154 | - 0.09862 | x $AOI_{Pp}$ | - 0.02919 | x $AOI_{rest}$ +e |

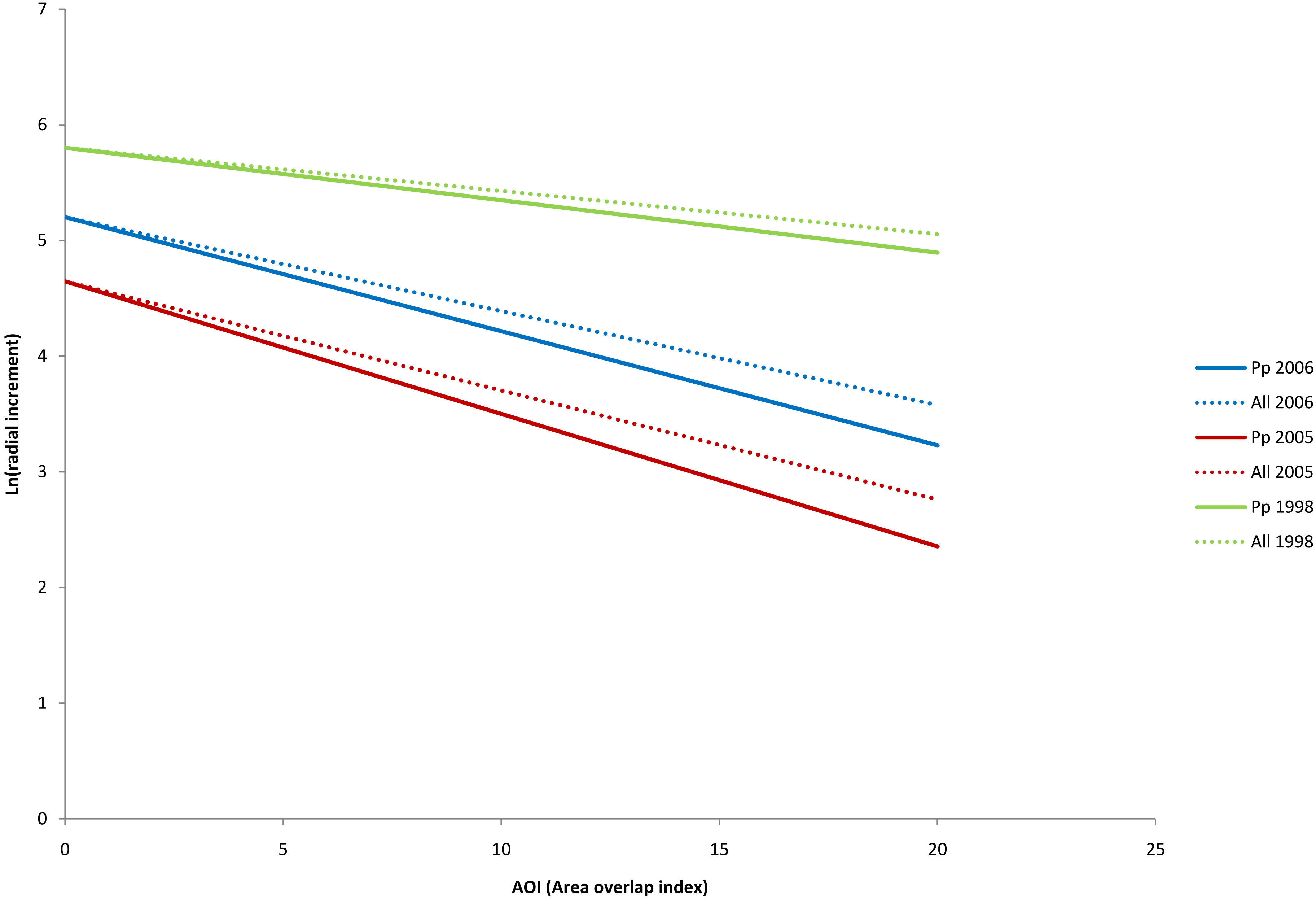
$$\begin{cases} a_{dry} < a_{wet} \\ |b_{dry\ year}| > |b_{wet\ years}| \\ |c_{dry\ year}| > |c_{wet\ year}| \end{cases}$$

Hypothesis 1 validation → Competition is greater in drier years.

Assuming in all cases Di=Dj:

$$\begin{cases} |b_{dry\ year}| > |c_{dry\ year}| \\ |b_{wet\ years}| > |c_{wet\ years}| \end{cases}$$

$b \approx 3c$ → Hypothesis 2 validation → Competition within pines is much greater than competition between pines and other species in all years studied.



7
6
5
4
3
2
1
0
Ln(radial increment)
0
5
10
15
20
25
AOI (Area overlap index)
Pp 2006
All 2006
Pp 2005
All 2005
Pp 1998
All 1998

# CONCLUSIONS

- Composition and Competition have a great effect on growth, especially in drier years.
- Optimal growth conditions for *P. pinea* would be either the presence of trees of other species as competitors, or smaller *P. pinea* trees, within its area of influence.
- Trees in low dense mixed stands are expected to show a better response in growth than trees growing in pure high stocking stands, especially in years when drought is a limiting factor.

Promotion of mixed stands with thinnings would be a good adaptive measure to climate change.

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THANK YOU VERY MUCH!