# Climate-Based Seed Transfer

Greg O'Neill and Nicholas Ukrainetz

Research Branch, BC Ministry of Forests and Range
Kalamalka Forestry Centre, Vernon BC

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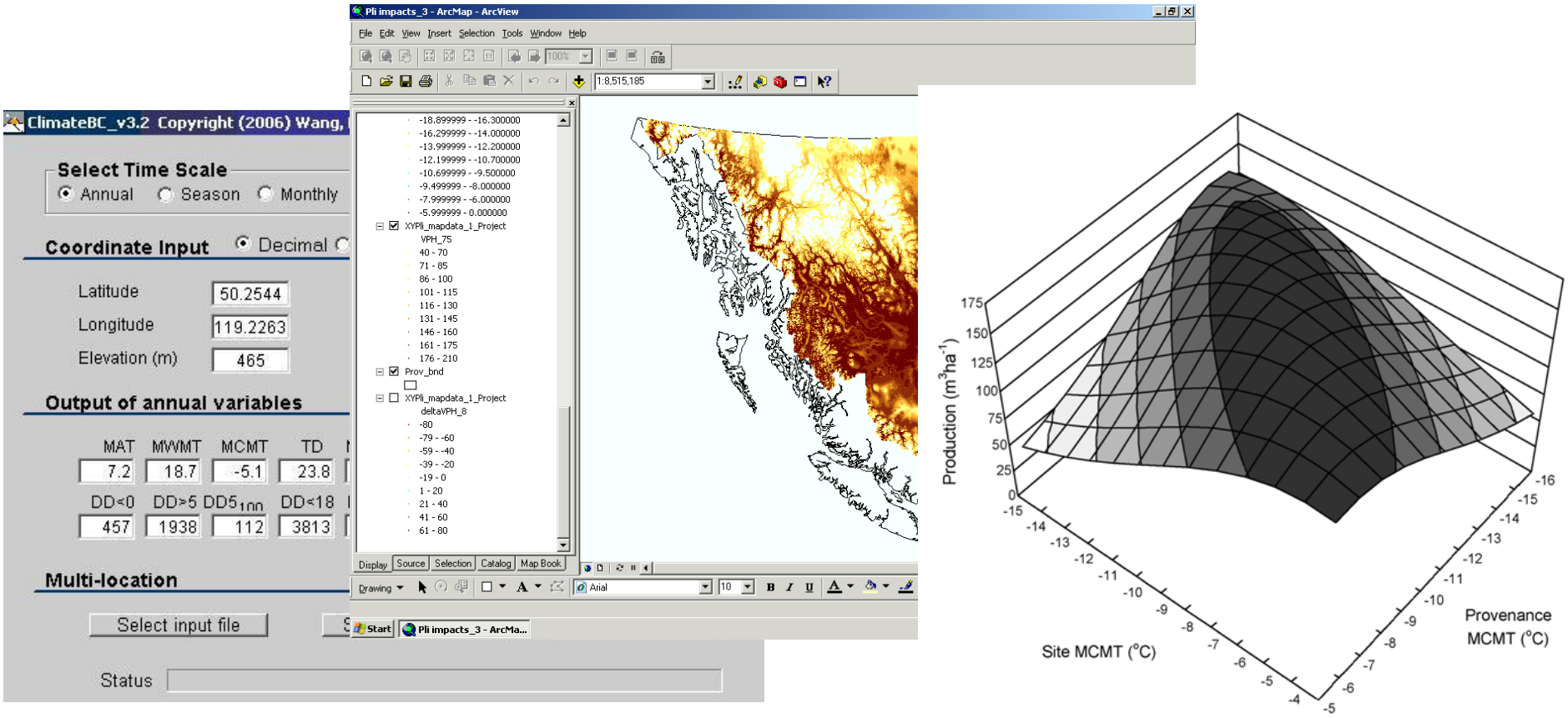
# Overview

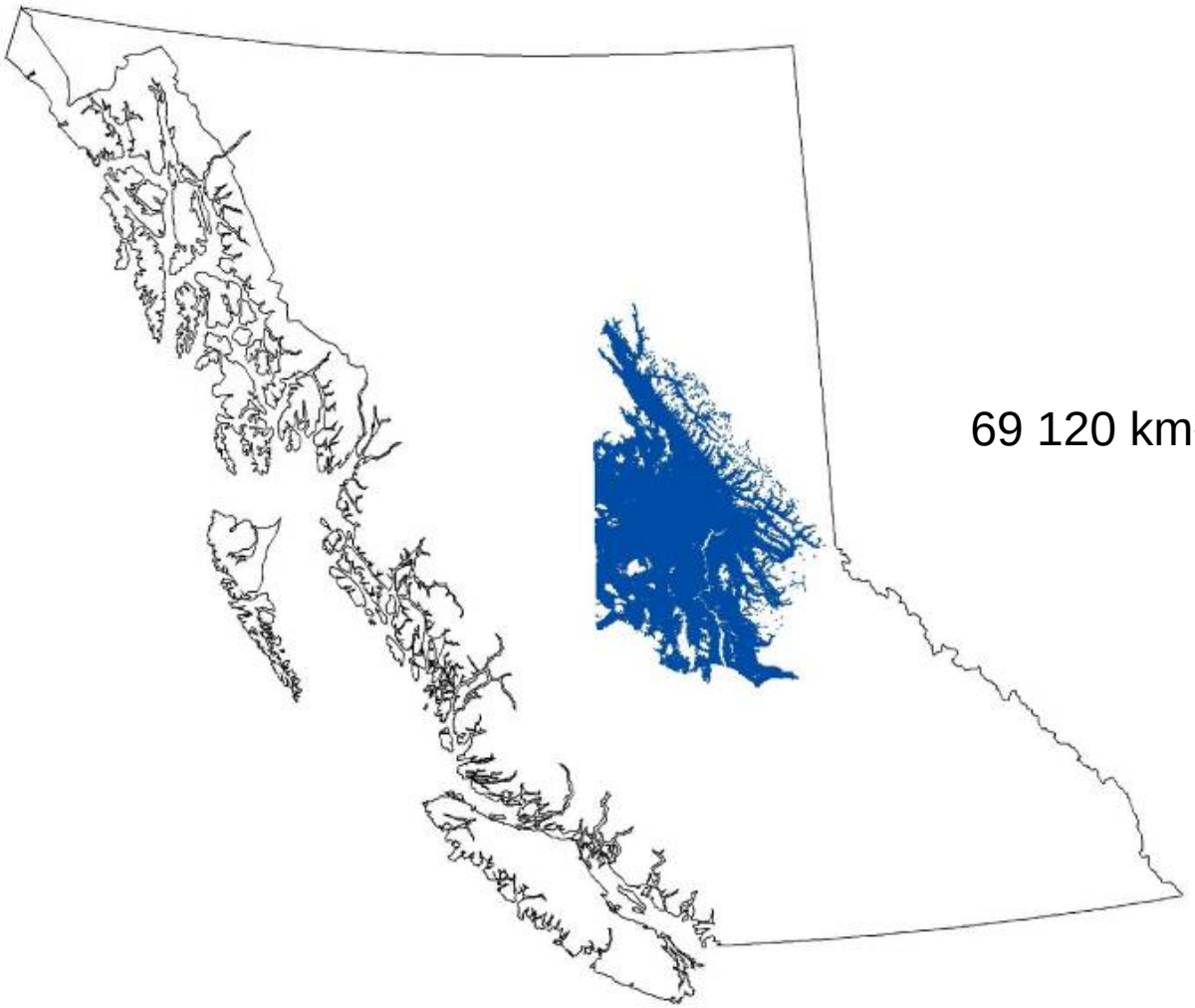
- Rationale
- Delineation methods
- Seed transfer systems
- Assisted migration

# Rationale

- The genecology revolution (Climate models, GIS, new statistical methods) allows for improvements to seed transfer systems.

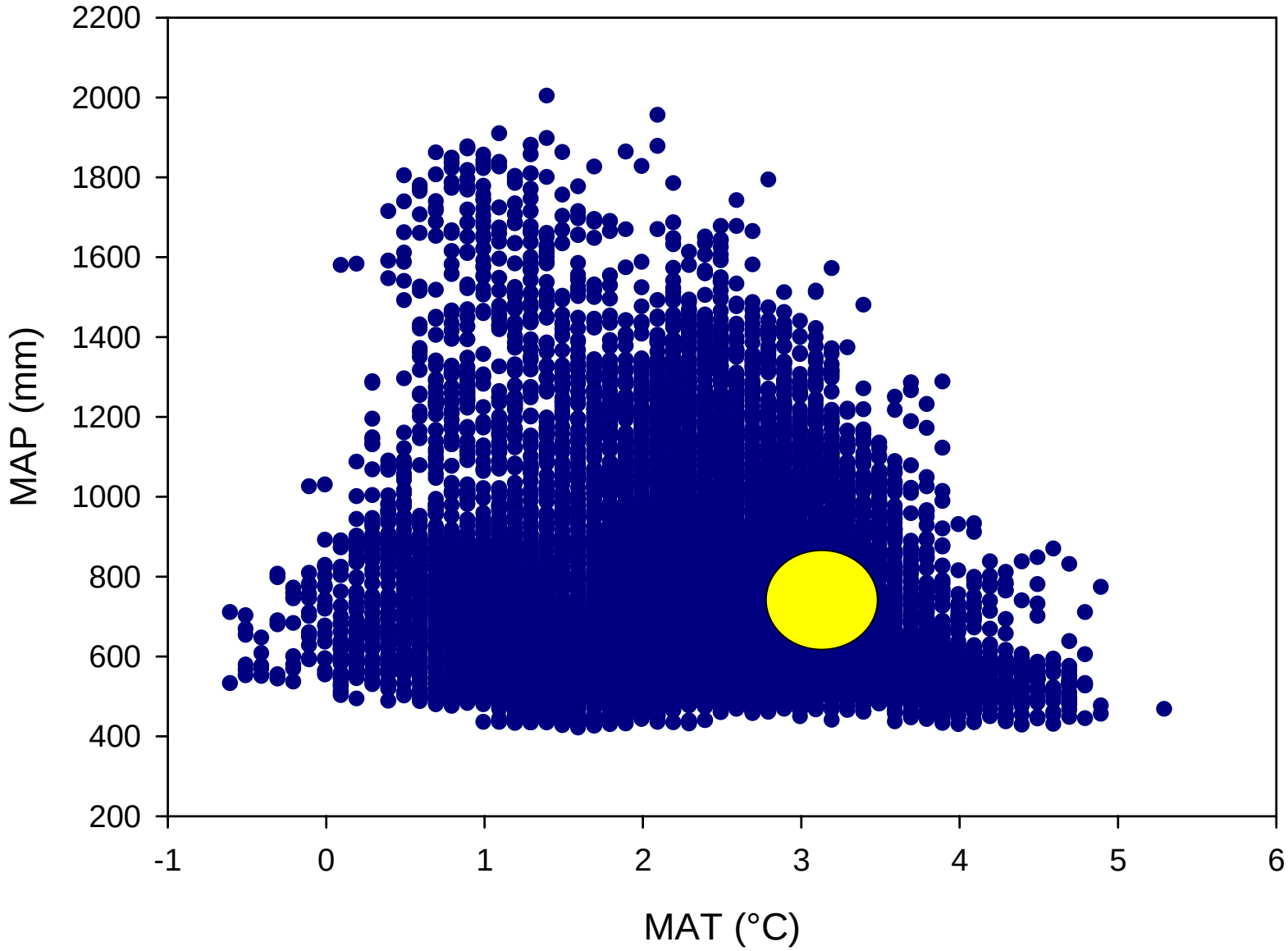


# Geographic-based deployment zone for Sx PG Low

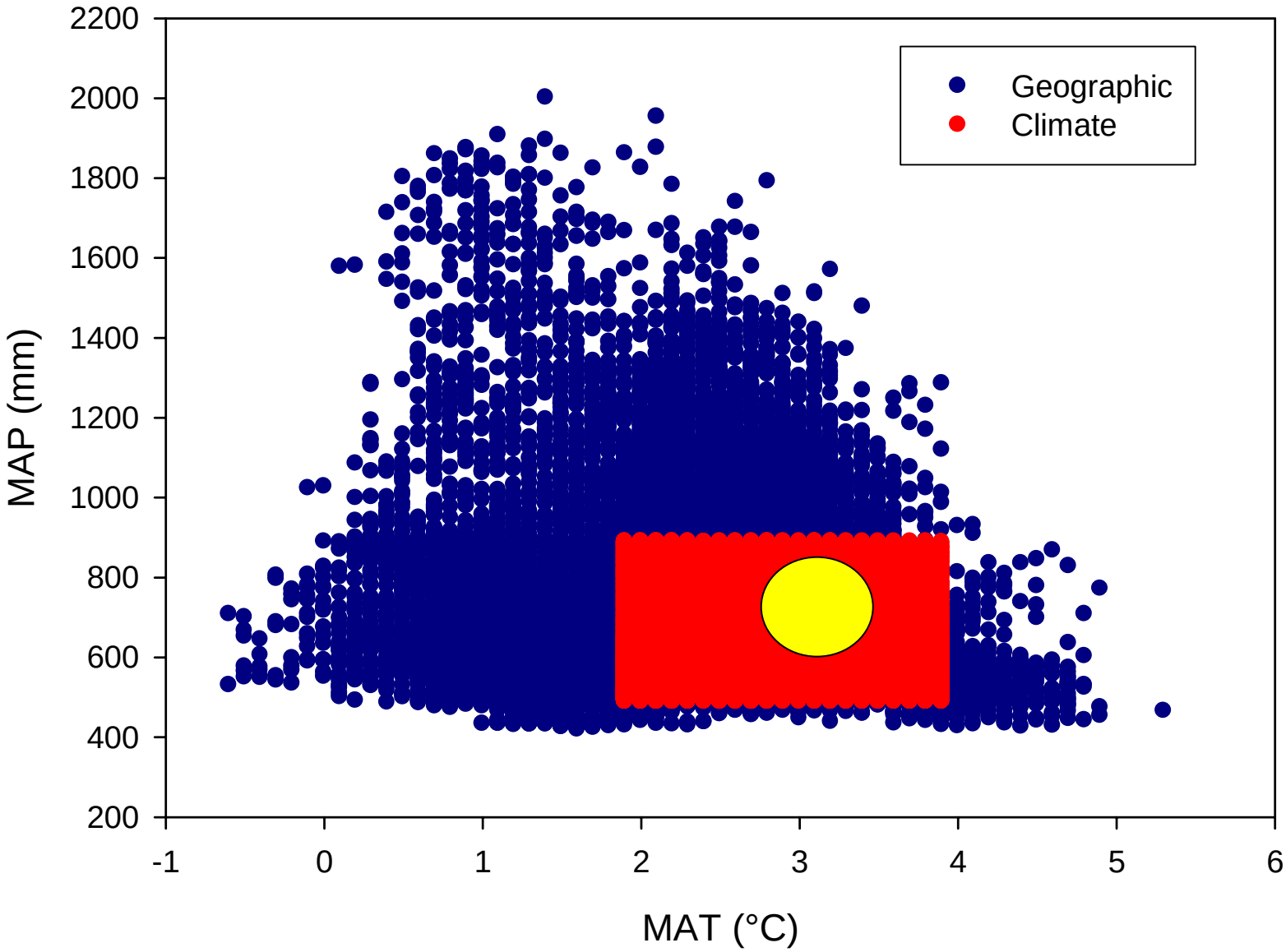


69 120 km$^2$

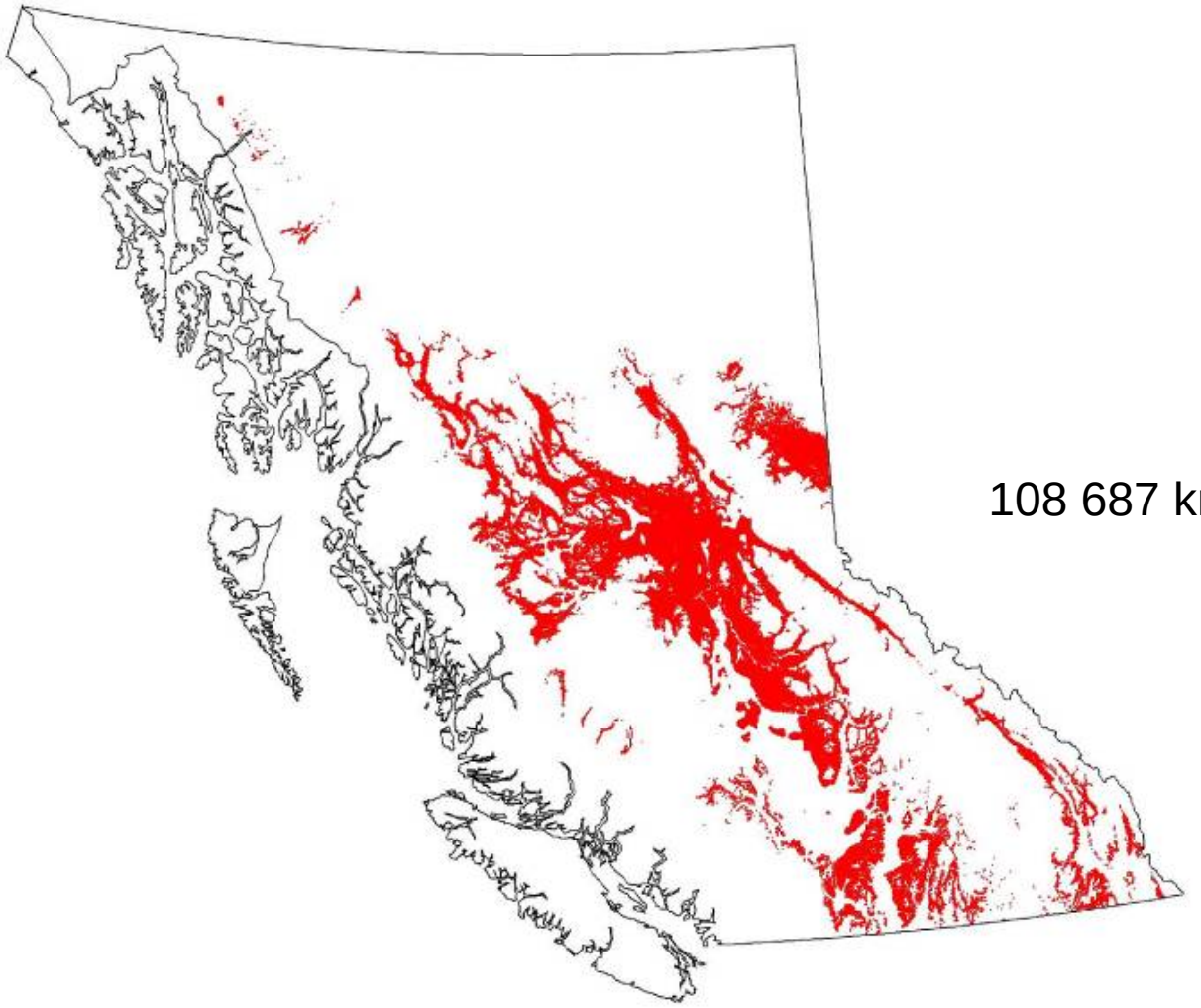
# Geographic-based deployment zone for Sx PG Low



# Geographic and climate-based deployment zone for PG Sx Low



# Climate-based deployment zone for Sx PG Low



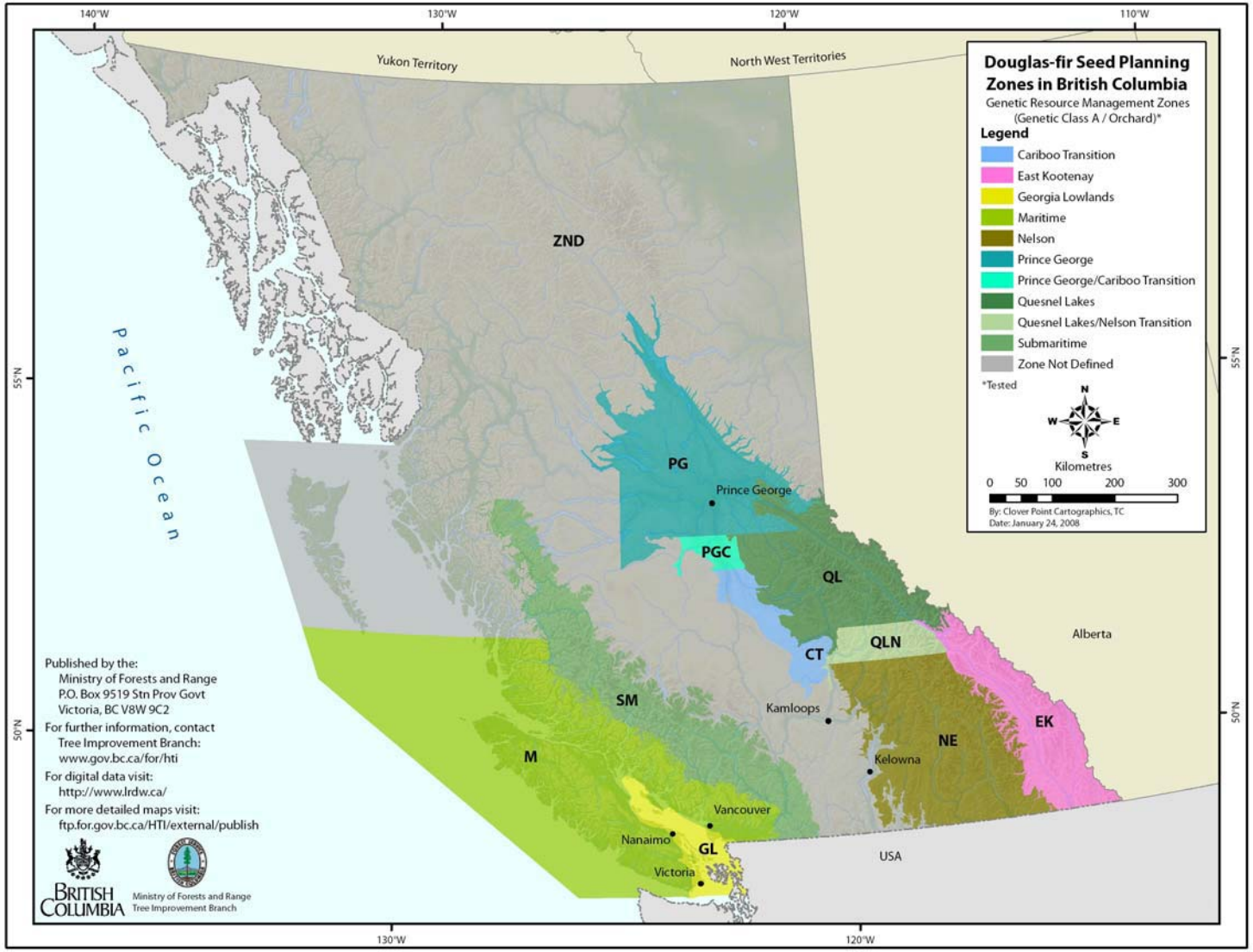
108 687 km$^2$

- Rationale
  - The  genecology revolution (Climate models, GIS, new statistical methods) allows for improvements to seed transfer systems.
  - Assisted migration requires a climate-based seed transfer system.

# Overview

- Rationale
- Delineation methods
- Seed transfer systems
- Assisted migration

Seed Planning Zones
BB
BLK
BSH
CHL
CP
CT
DK
EK
FIN
FN
GL
HH
M
MGR
MIC
MRB
NCH
NST
QL
SA
SM
TOA
TOD
WK


Douglas-fir Seed Planning Zones in British Columbia
Genetic Resource Management Zones (Genetic Class A / Orchard)*
Legend
Cariboo Transition
East Kootenay
Georgia Lowlands
Maritime
Nelson
Prince George
Prince George/Cariboo Transition
Quesnel Lakes
Quesnel Lakes/Nelson Transition
Submaritime
Zone Not Defined
*Tested
N
W
E
S
Kilometres
0 50 100 200 300
By: Clover Point Cartographics, TC
Date: January 24, 2008
Yukon Territory
North West Territories
Alberta
USA
Pacific Ocean
ZND
PG
Prince George
PGC
QL
QLN
CT
SM
M
Kamloops
EK
NE
Kelowna
Vancouver
Nanaimo
GL
Victoria
140°W
130°W
120°W
110°W
55°N
50°N
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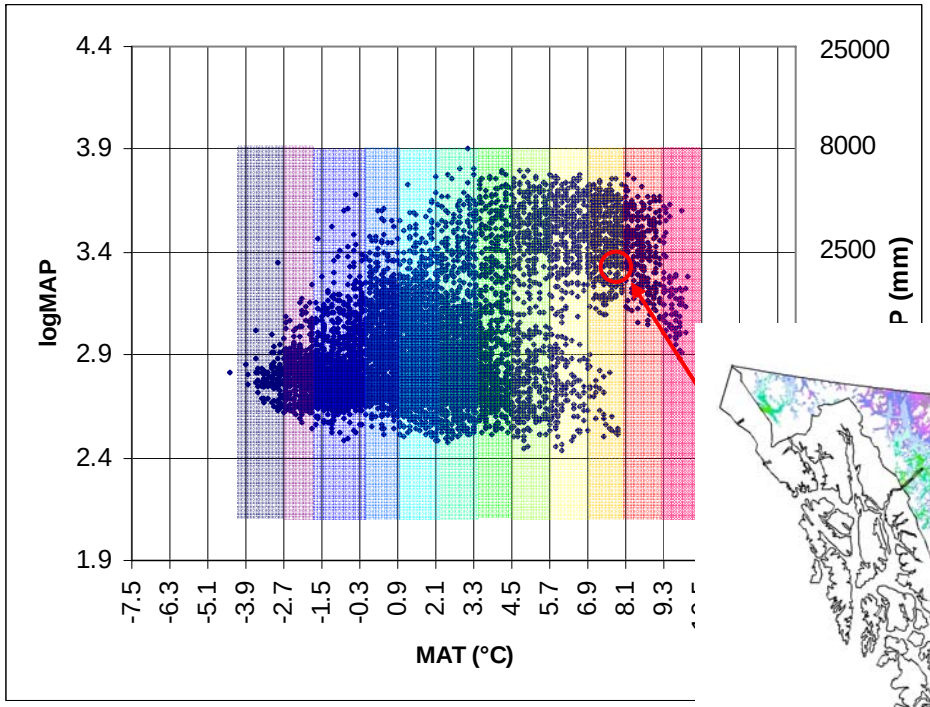
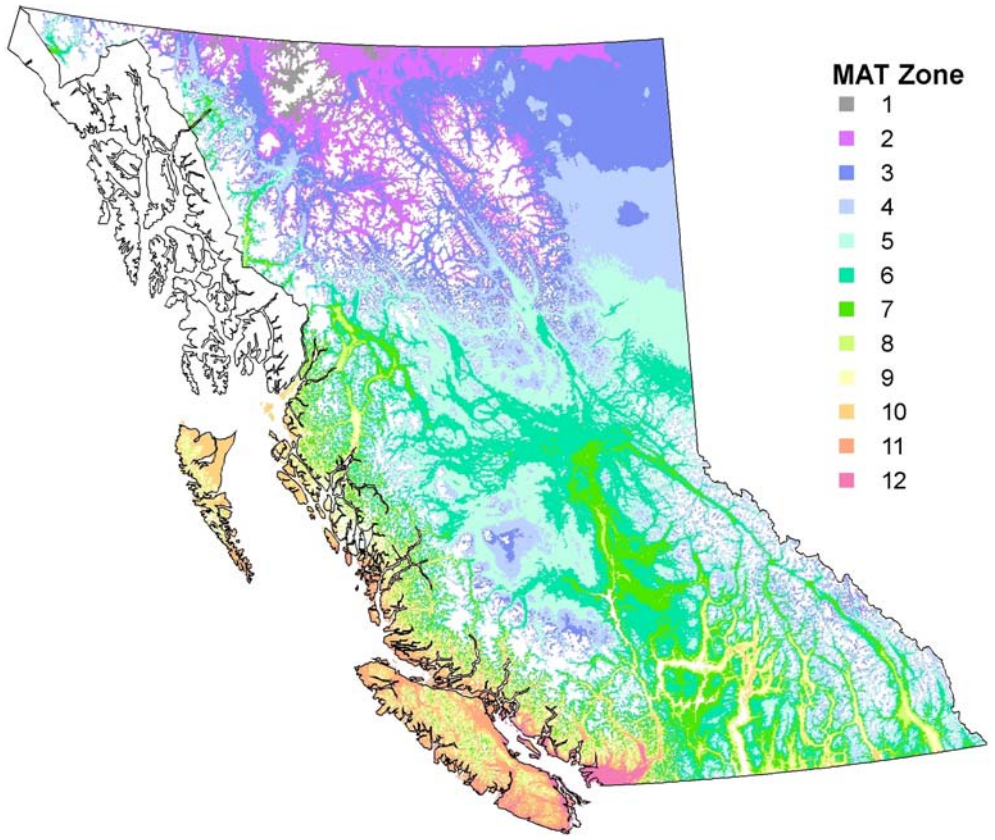
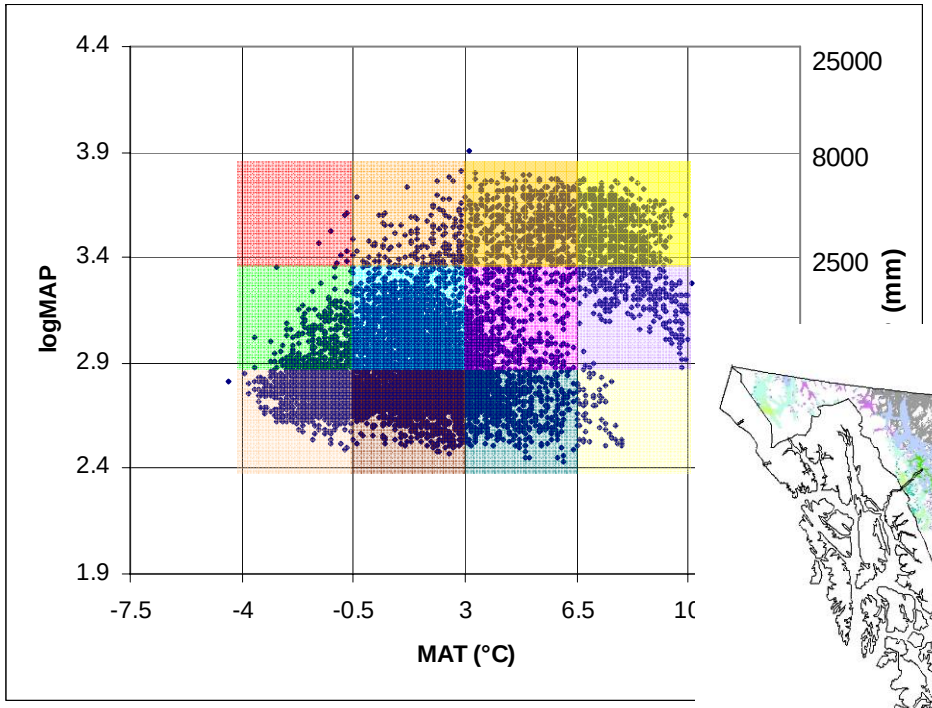
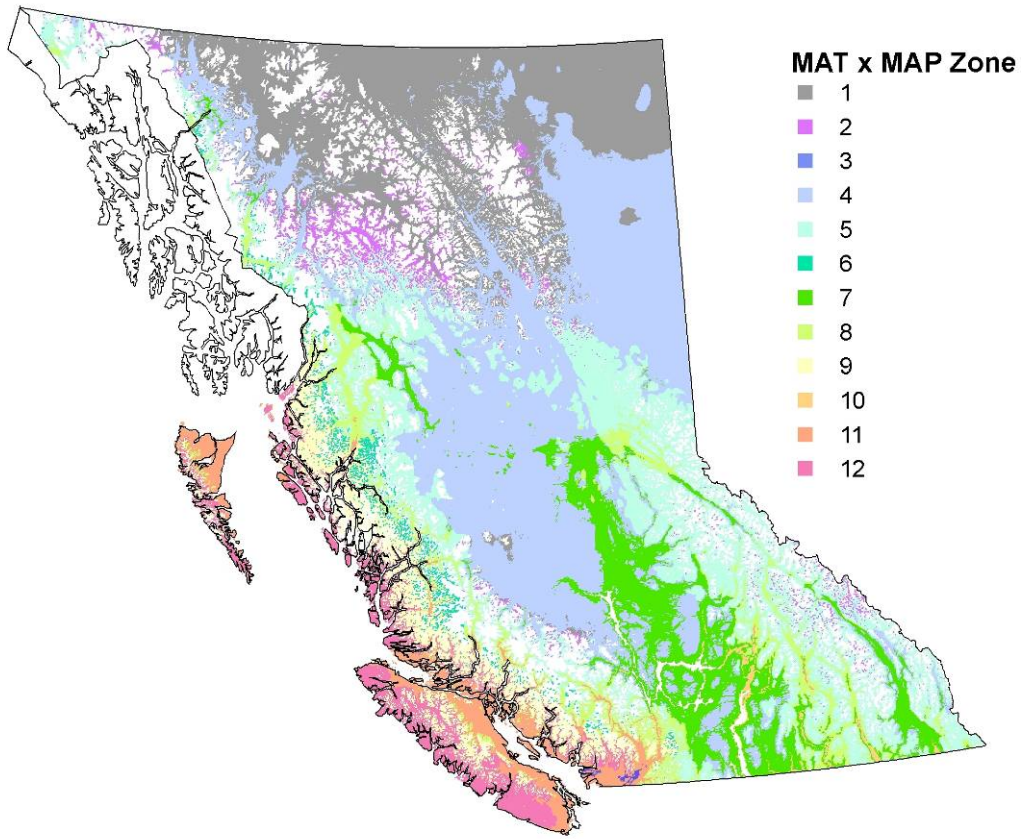
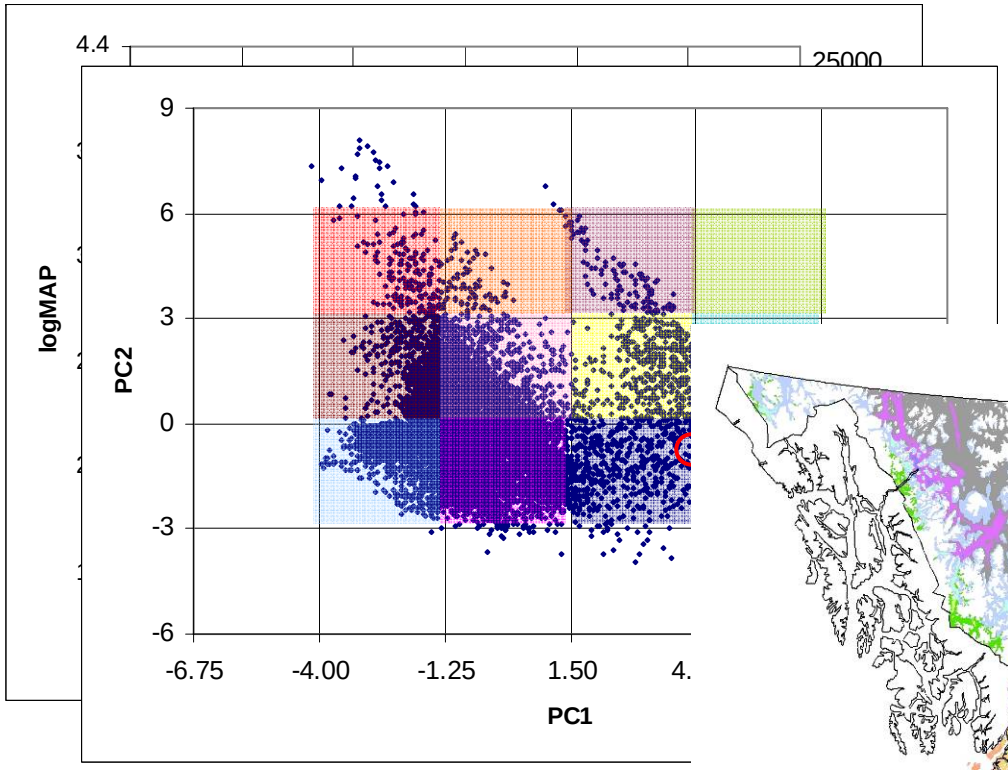
Victoria, BC V8W 9C2
For further information, contact
Tree Improvement Branch:
www.gov.bc.ca/for/hti
For digital data visit:
http://www.lrdw.ca/
For more detailed maps visit:
ftp.for.gov.bc.ca/HTI/external/publish
BRITISH COLUMBIA
Ministry of Forests and Range
Tree Improvement Branch

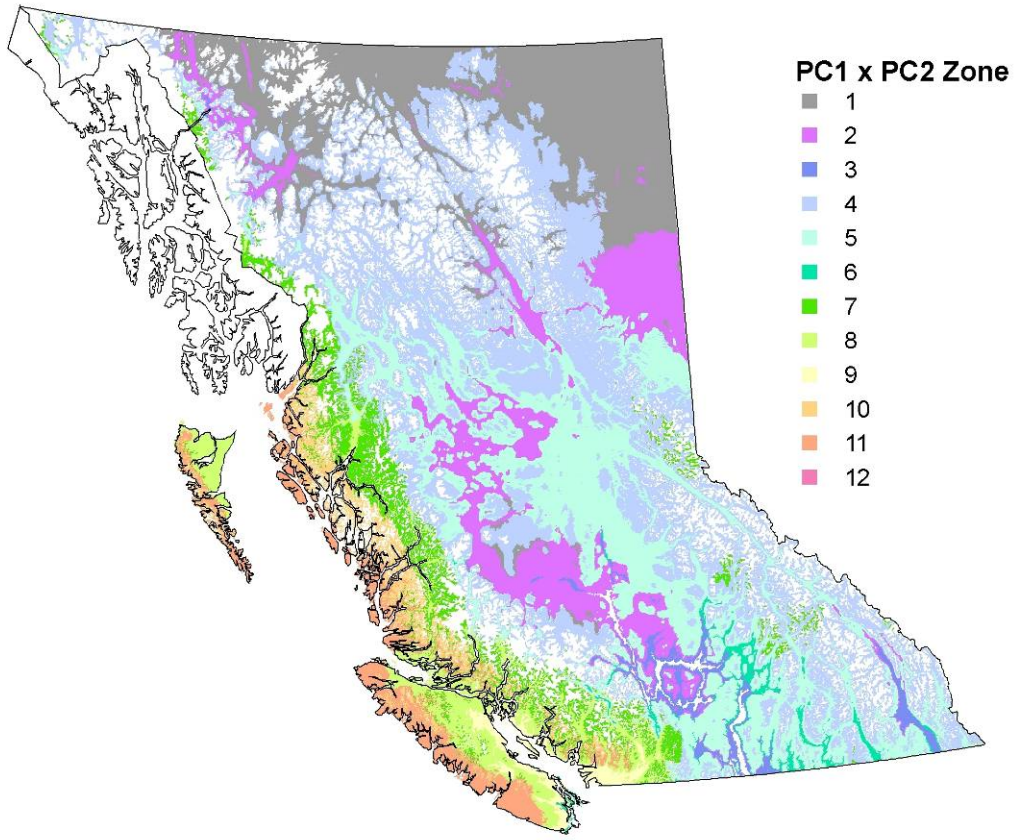

4.4
3.9
3.4
2.9
2.4
1.9
logMAP
25000
8000
2500
P (mm)
-7.5
-6.3
-5.1
-3.9
-2.7
-1.5
-0.3
0.9
2.1
3.3
4.5
5.7
6.9
8.1
9.3
MAT (°C)


MAT Zone
1
2
3
4
5
6
7
8
9
10
11
12

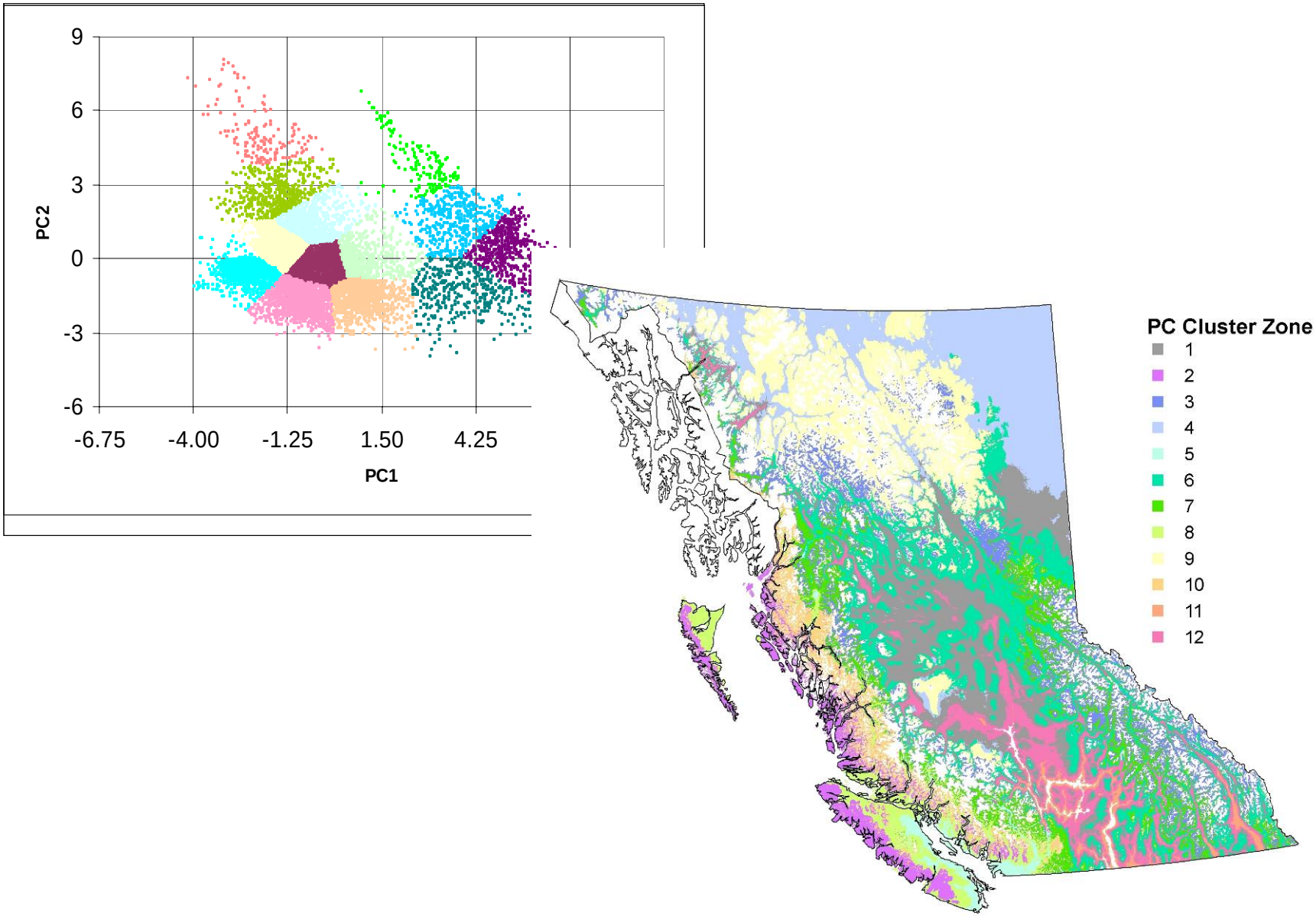

4.4
3.9
3.4
2.9
2.4
1.9
logMAP
25000
8000
2500
(mm)
-7.5
-4
-0.5
3
6.5
MAT (°C)

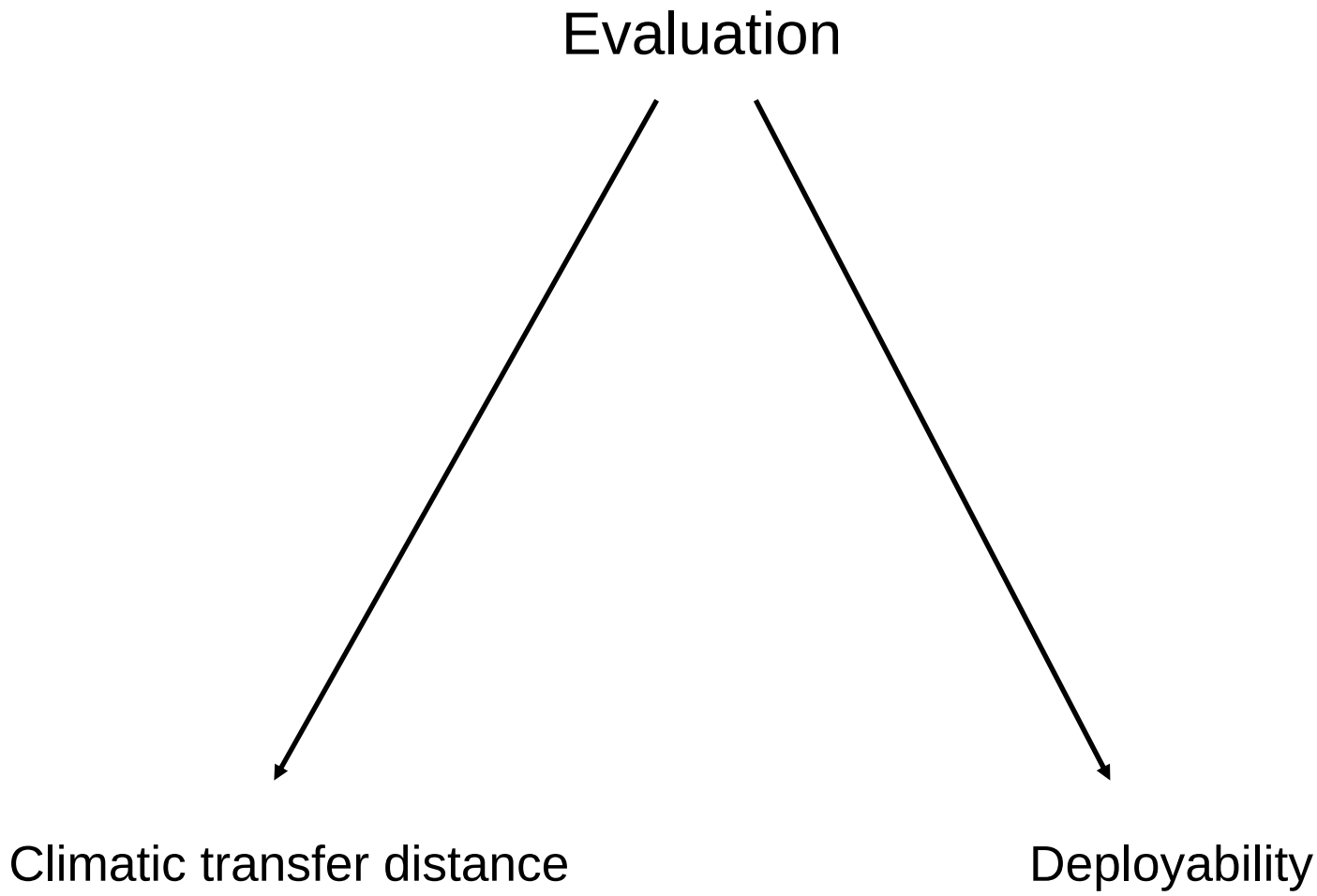

MAT x MAP Zone
1
2
3
4
5
6
7
8
9
10
11
12

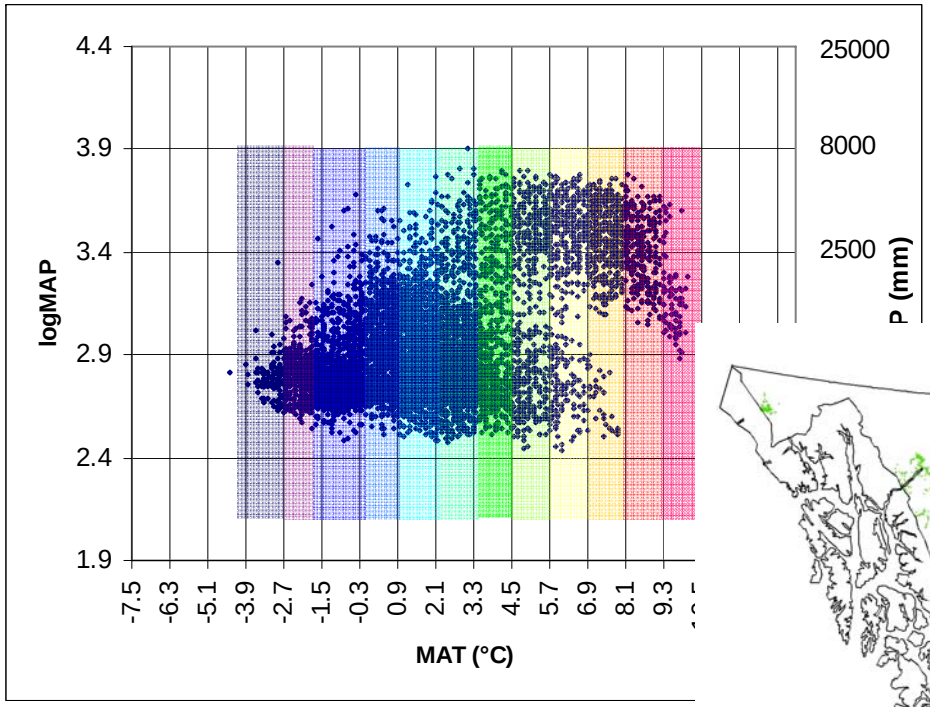


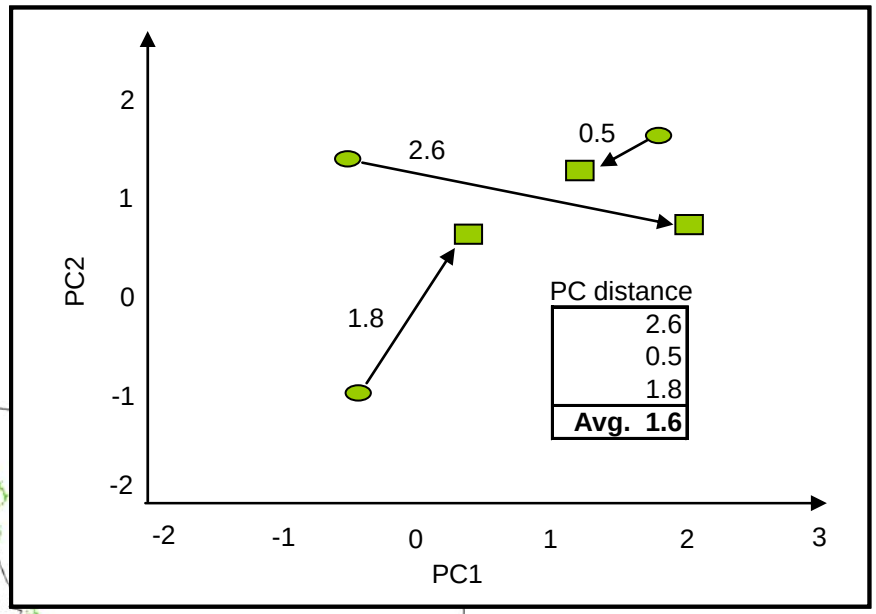



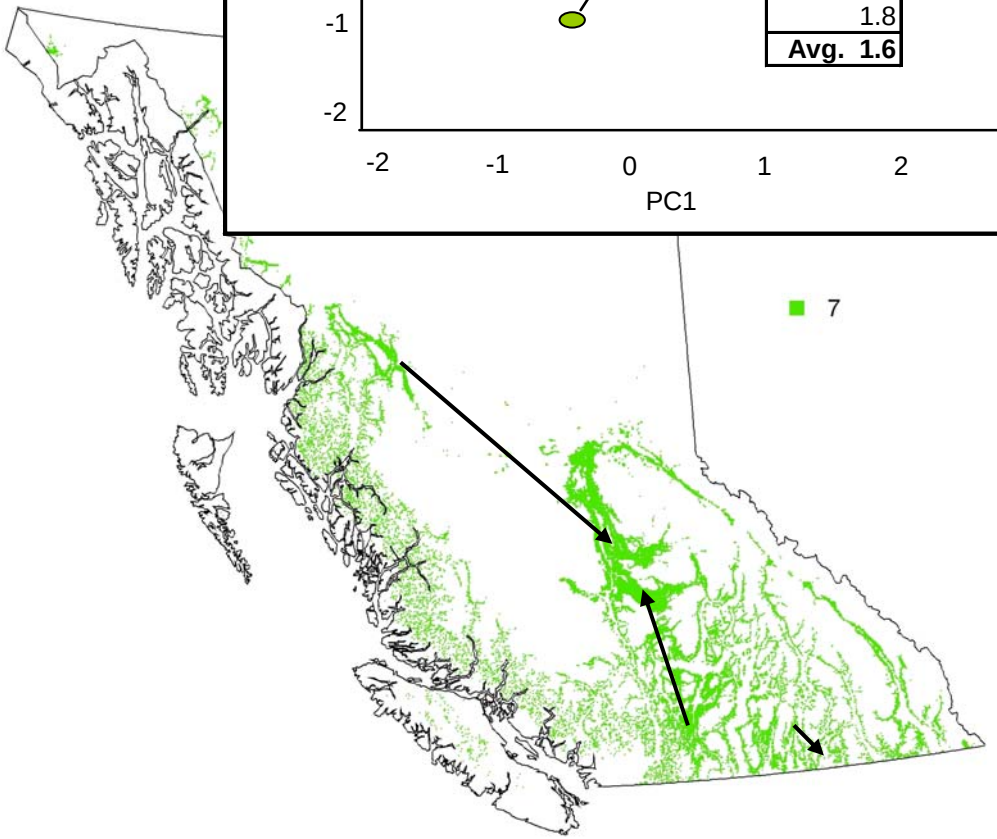

Mean Annual Temp
Mean Annual Precip
Mean Cold Month Temp
Continentality
Degree Days > 5 °C
Mean Summer Precip
Annual Drought Index
Summer Drought Index


9
6
3
0
-3
-6
PC2
-6.75
-4.00
-1.25
1.50
4.25
PC1
PC Cluster Zone
1
2
3
4
5
6
7
8
9
10
11
12


Evaluation
Climatic transfer distance
Deployability



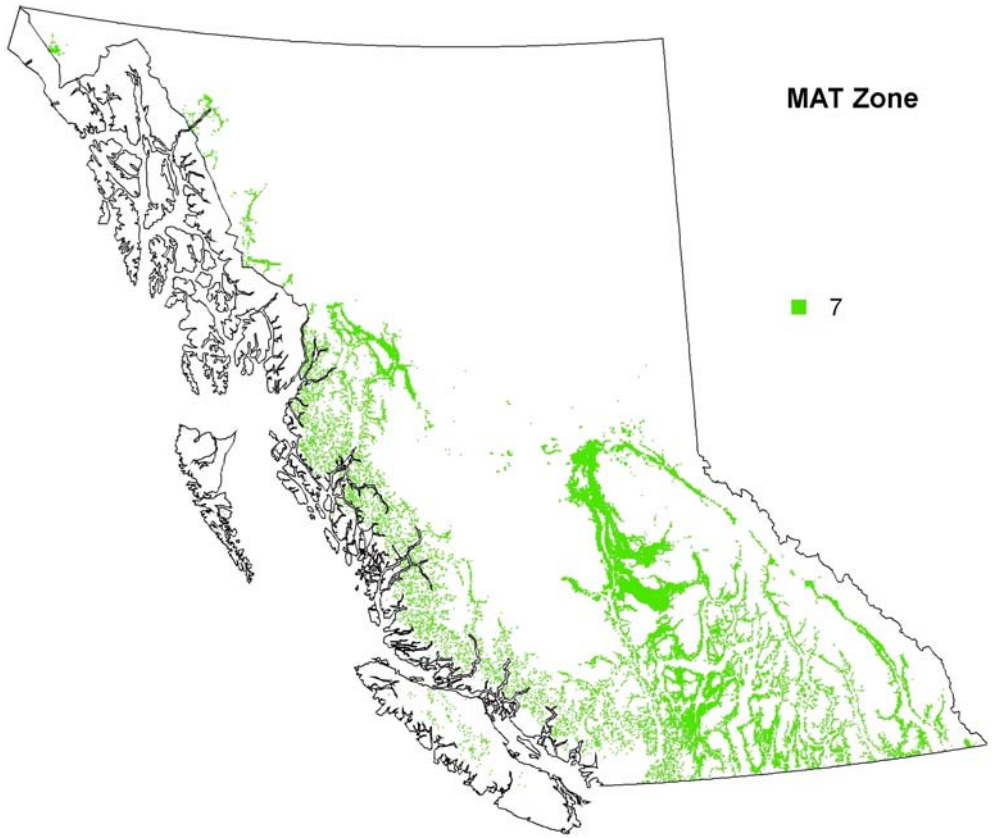



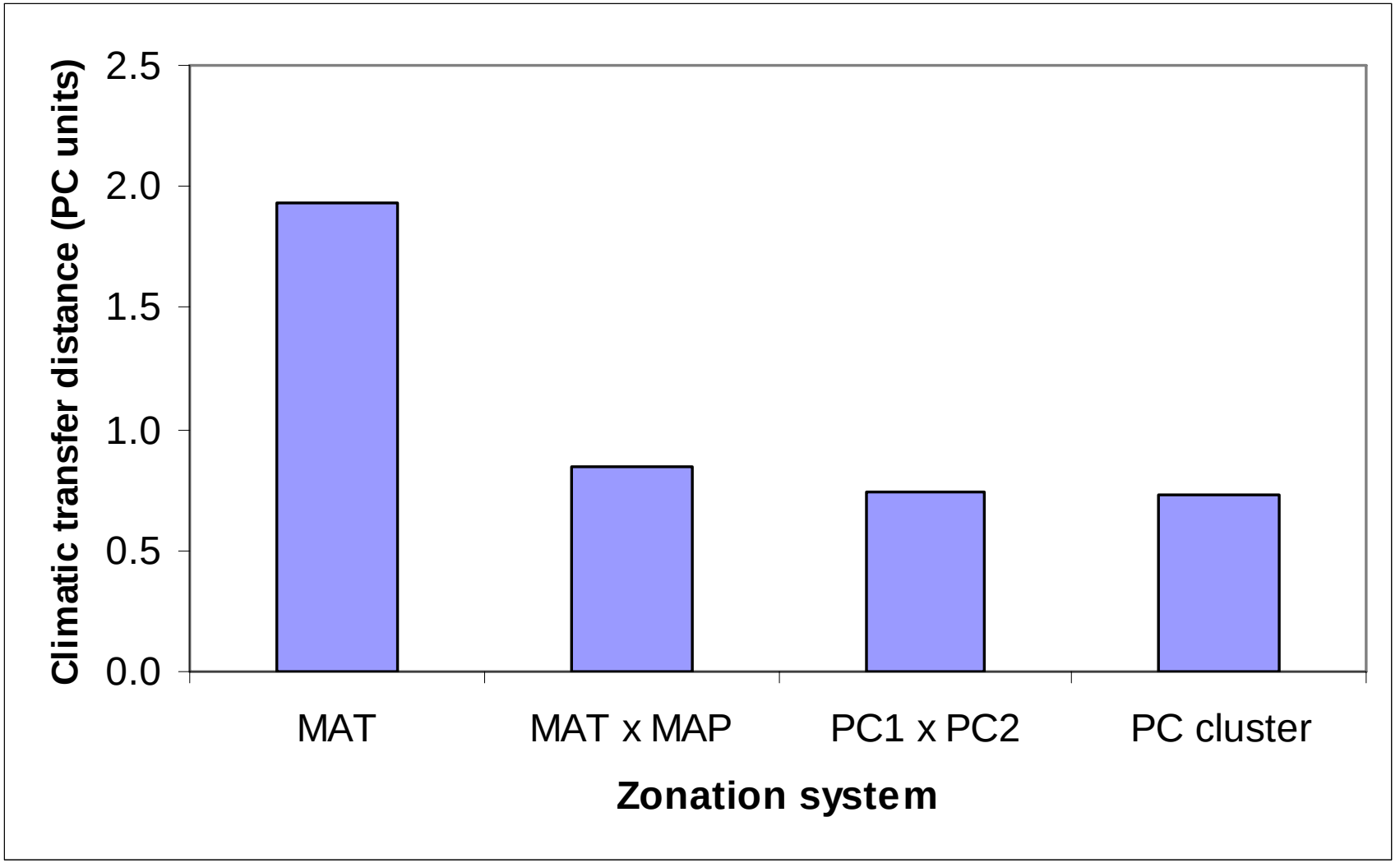



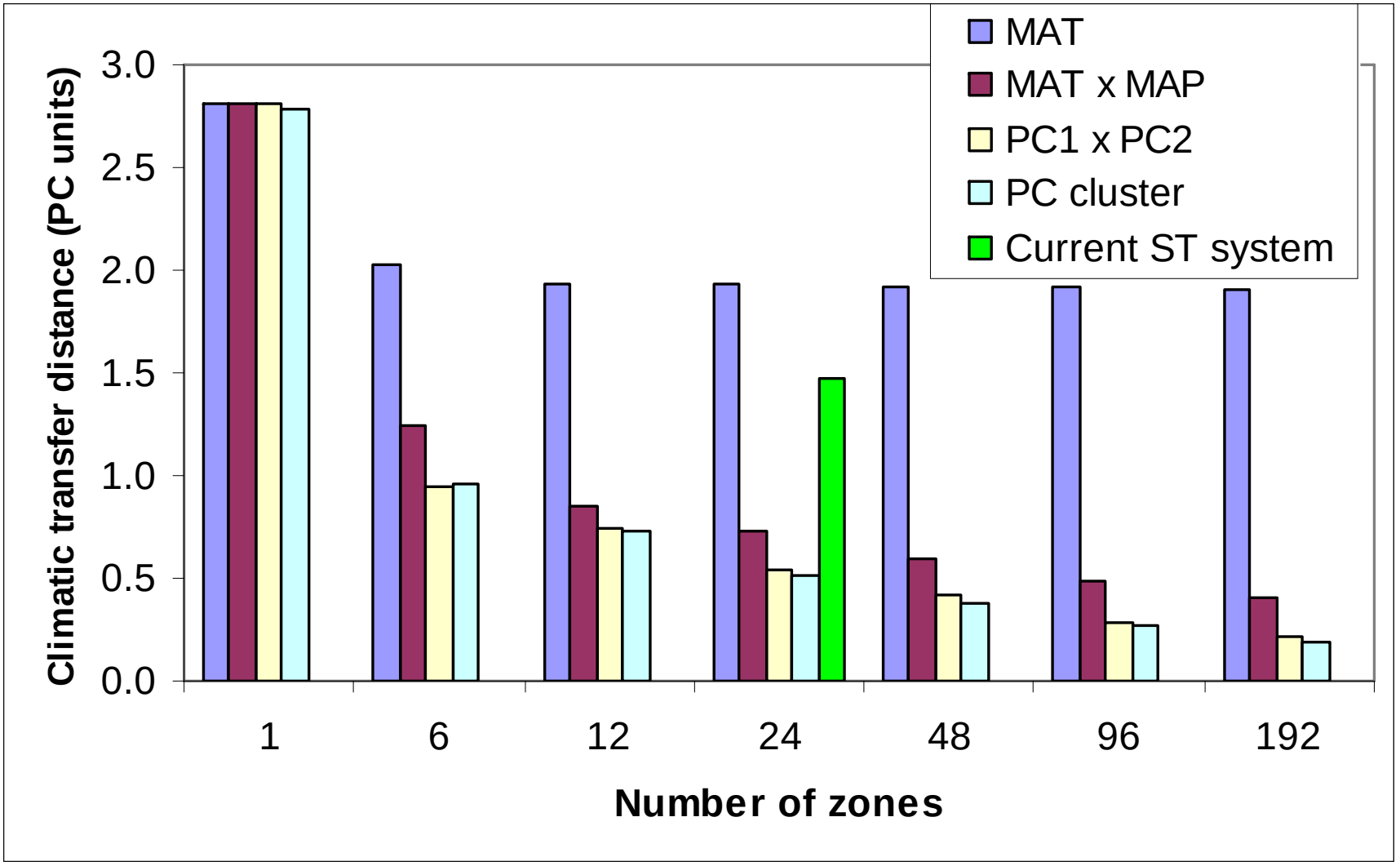

Climatic transfer distance

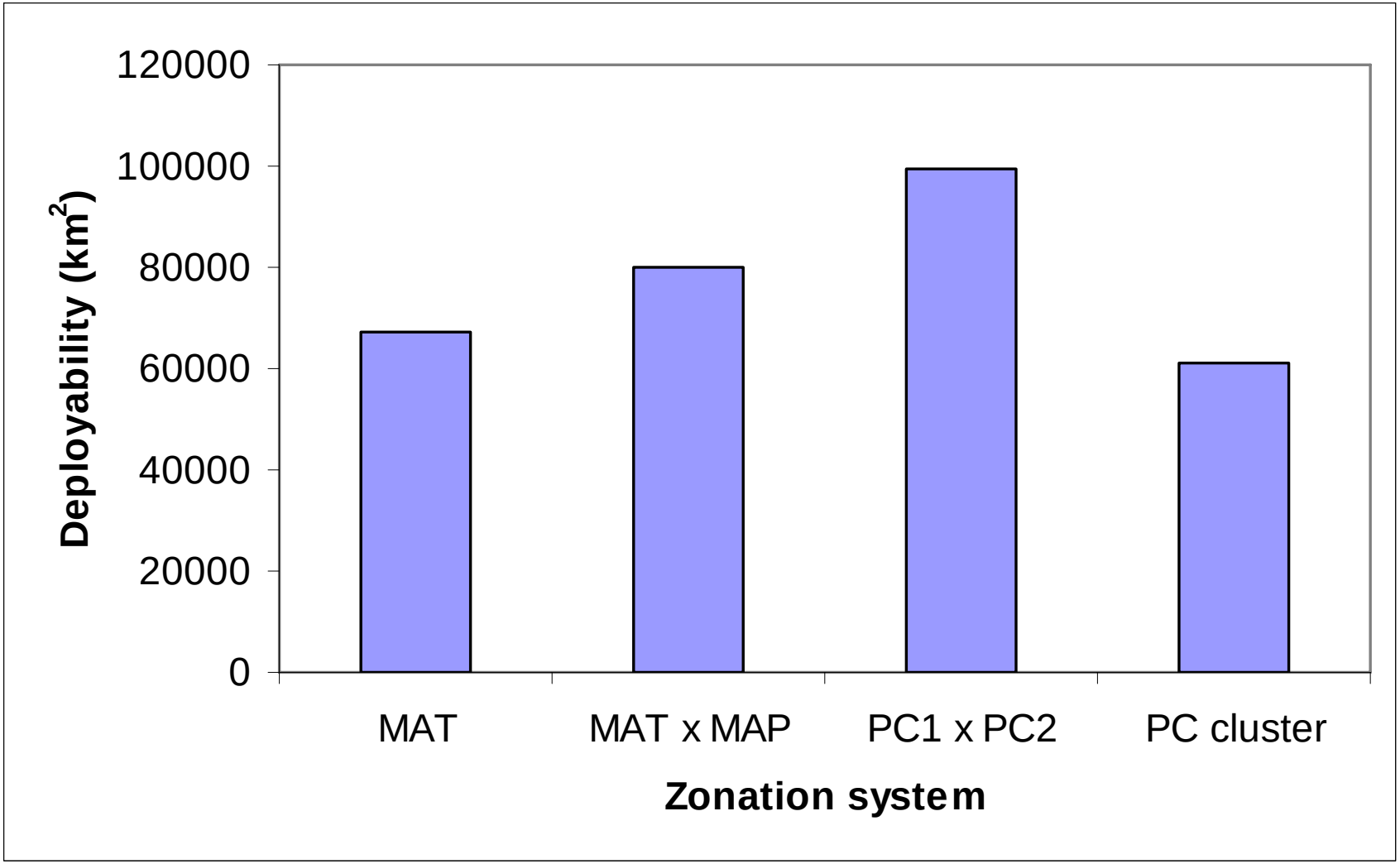
# Deployability

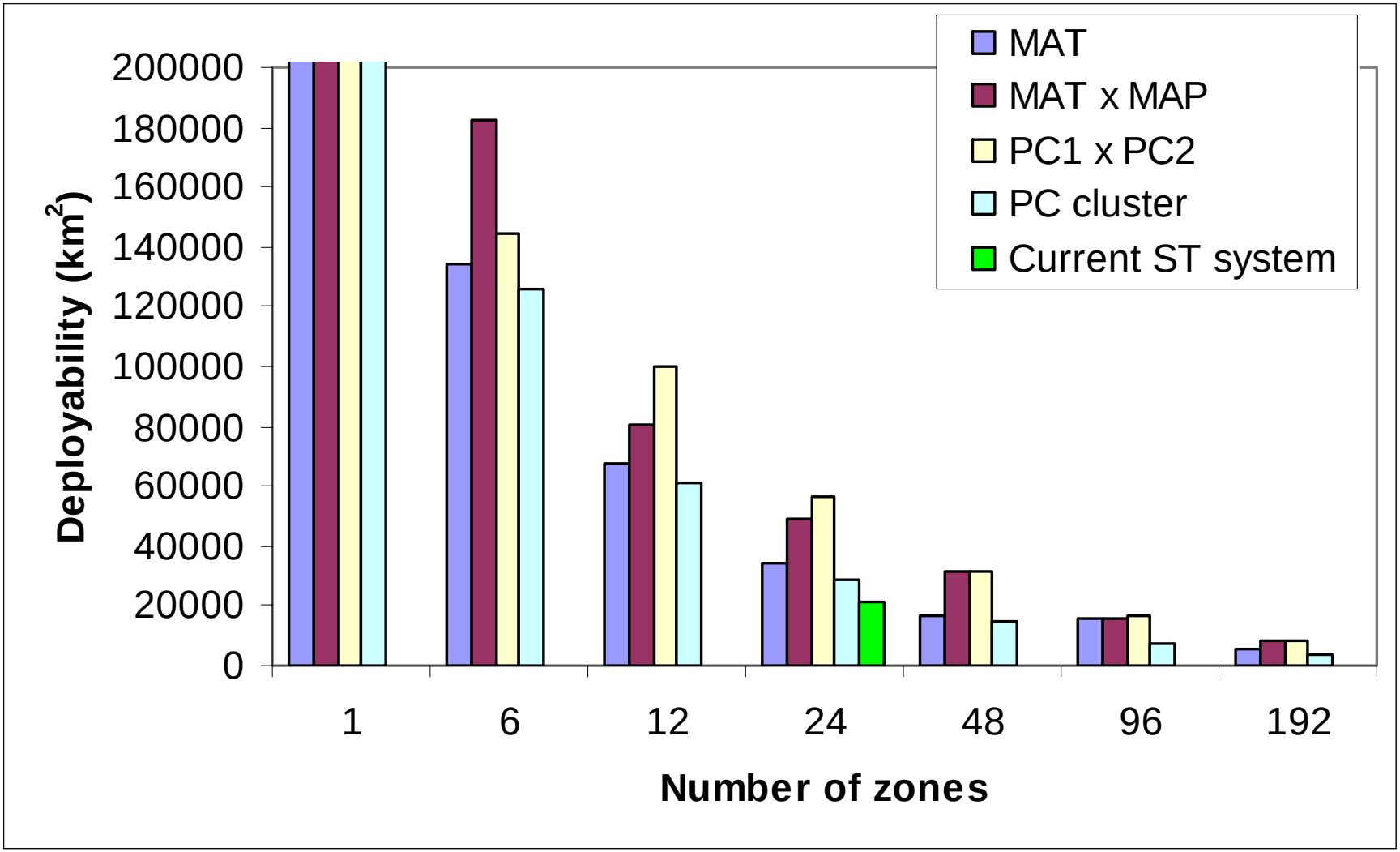
| MAT zone | Area (km2) |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| 11 | |
| 12 | |
| **Average** | |




Climatic transfer distance (PC units)
2.5
2.0
1.5
1.0
0.5
0.0
MAT
MAT x MAP
PC1 x PC2
PC cluster
Zonation system


MAT
MAT x MAP
PC1 x PC2
PC cluster
Current ST system
Climatic transfer distance (PC units)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1
6
12
24
48
96
192
Number of zones

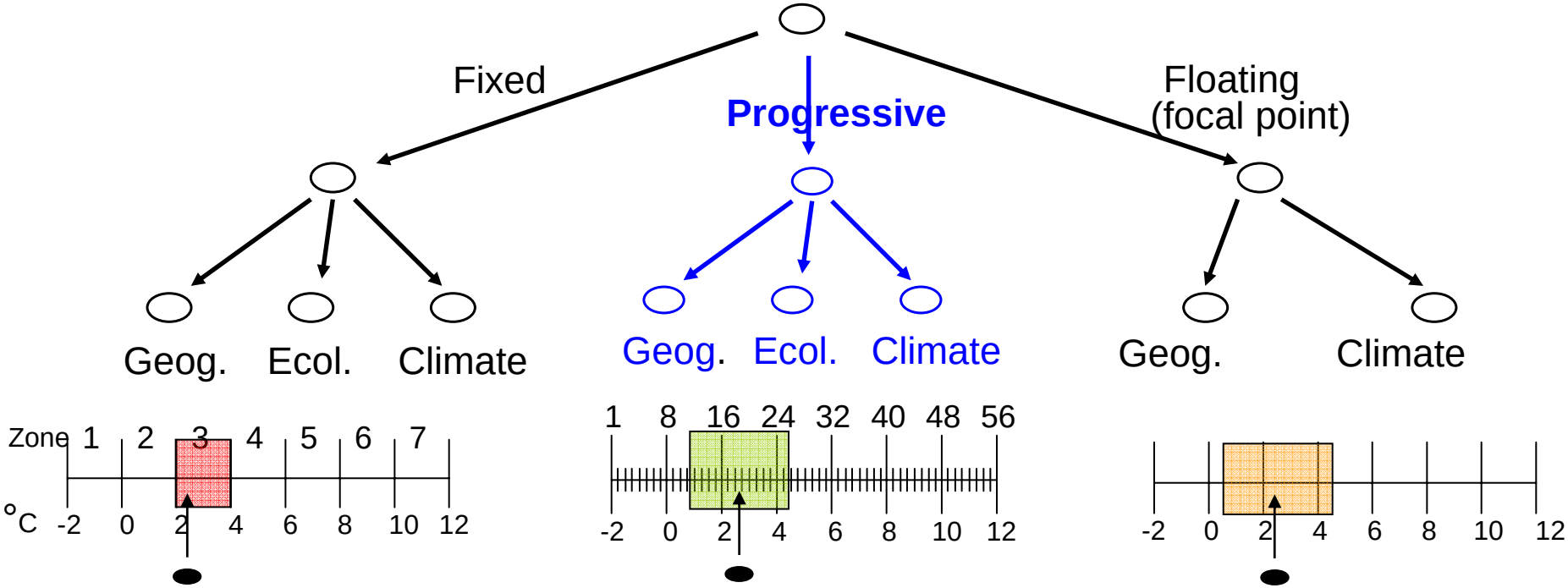

120000
100000
80000
60000
40000
20000
0
Deployability (km2)
MAT
MAT x MAP
PC1 x PC2
PC cluster
Zonation system


MAT
MAT x MAP
PC1 x PC2
PC cluster
Current ST system
200000
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
Deployability (km2)
1
6
12
24
48
96
192
Number of zones

# Overview

- Rationale
- Delineation methods
- Seed transfer systems
- Assisted migration

# Seed Transfer Systems



# Overview

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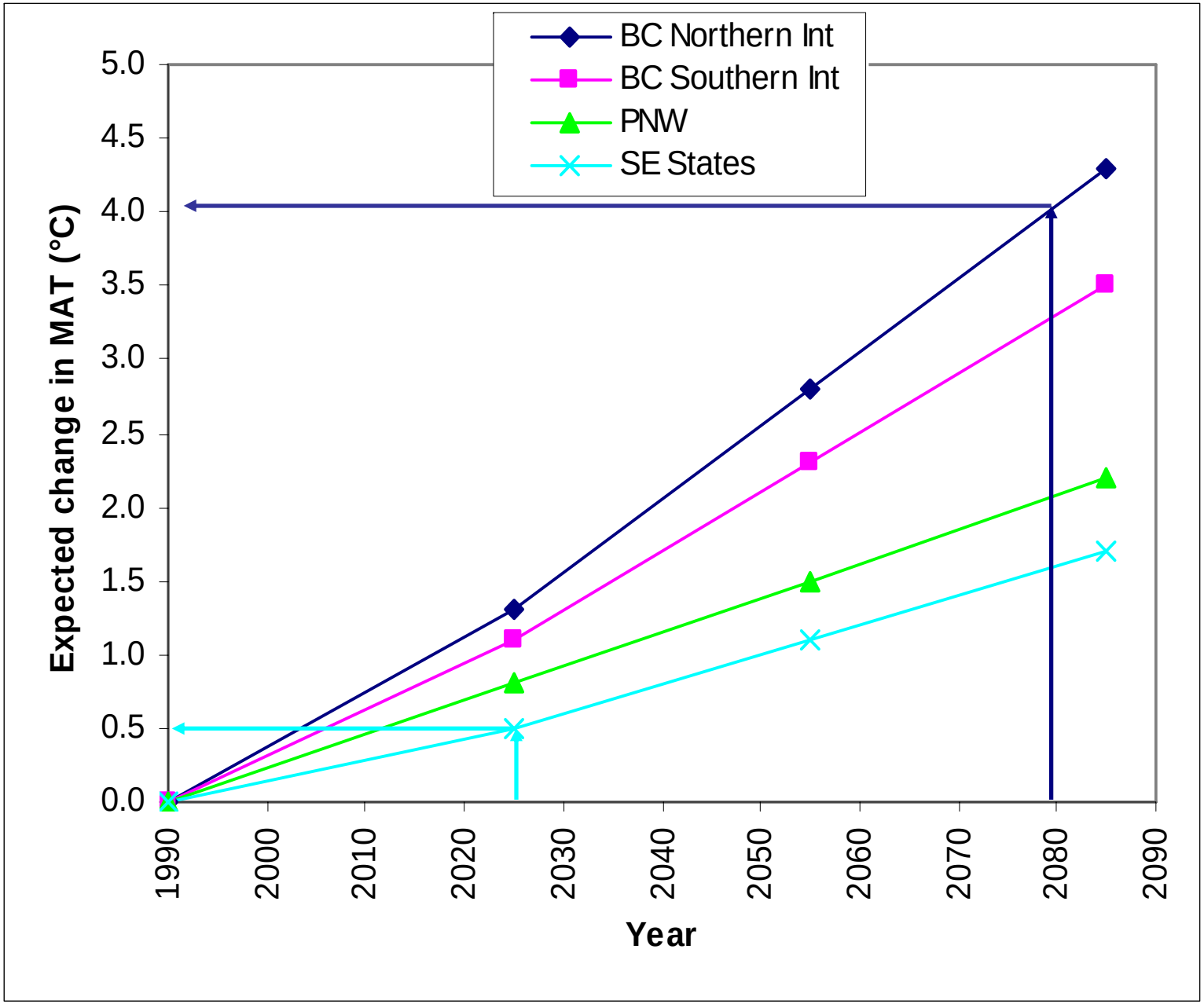
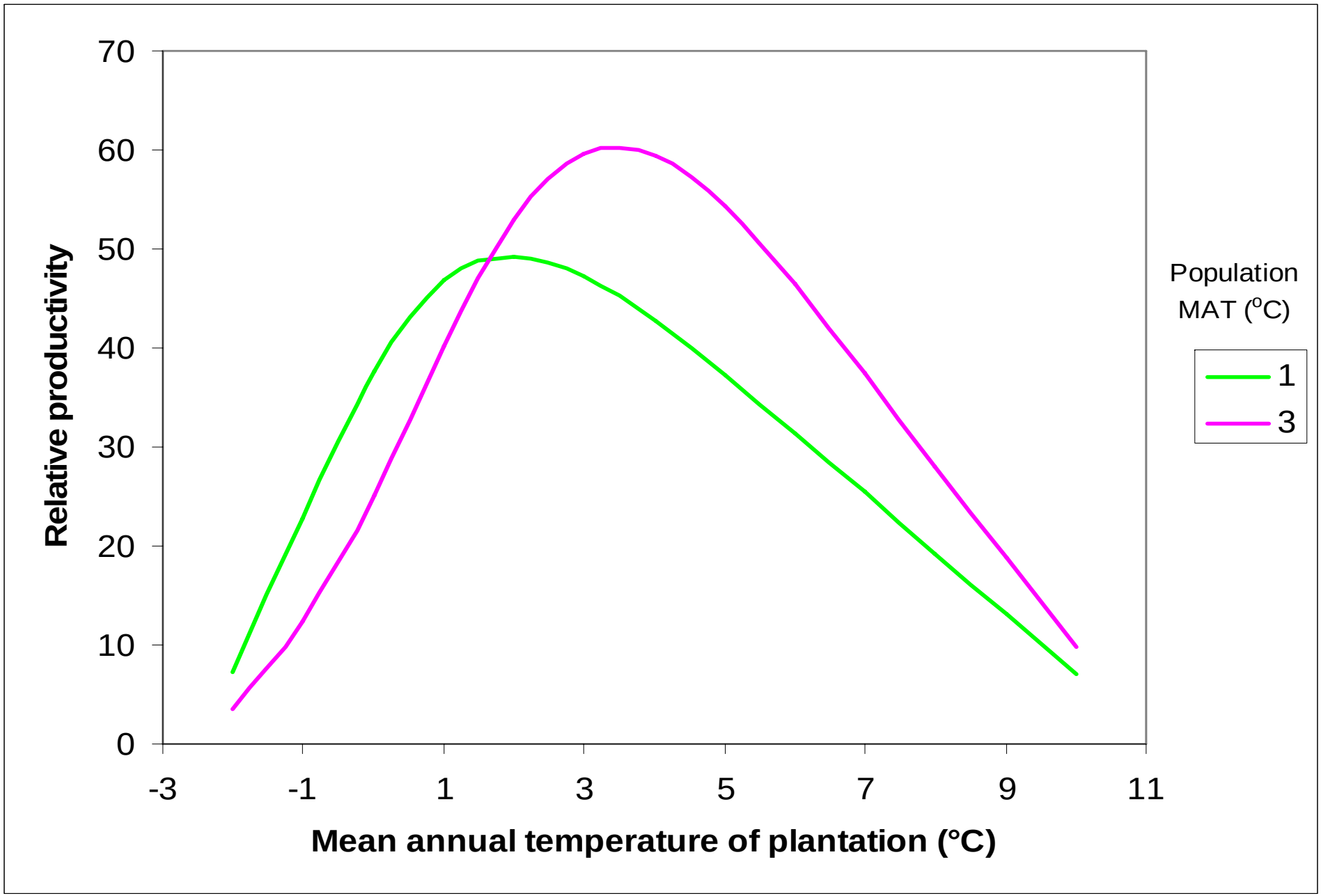
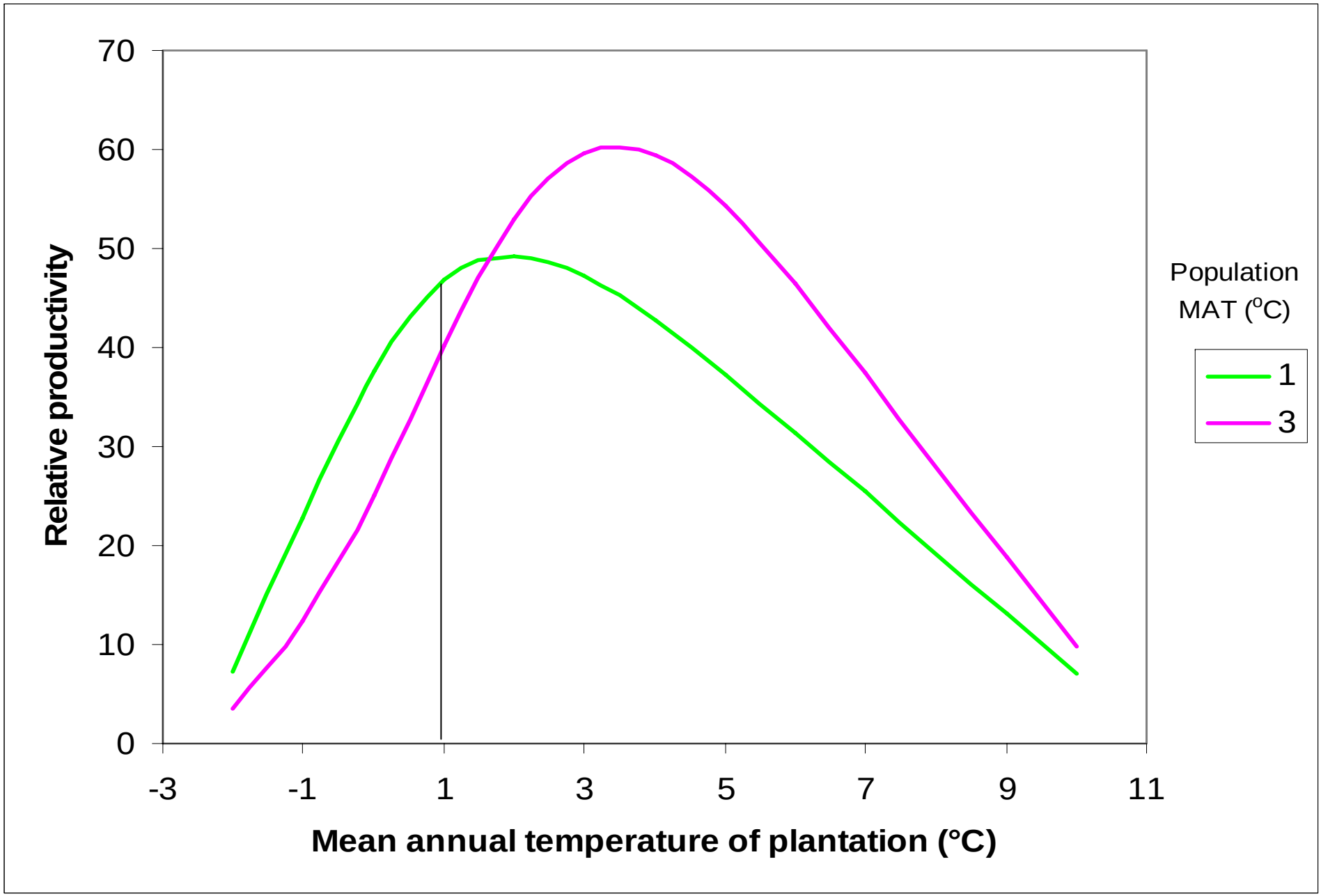
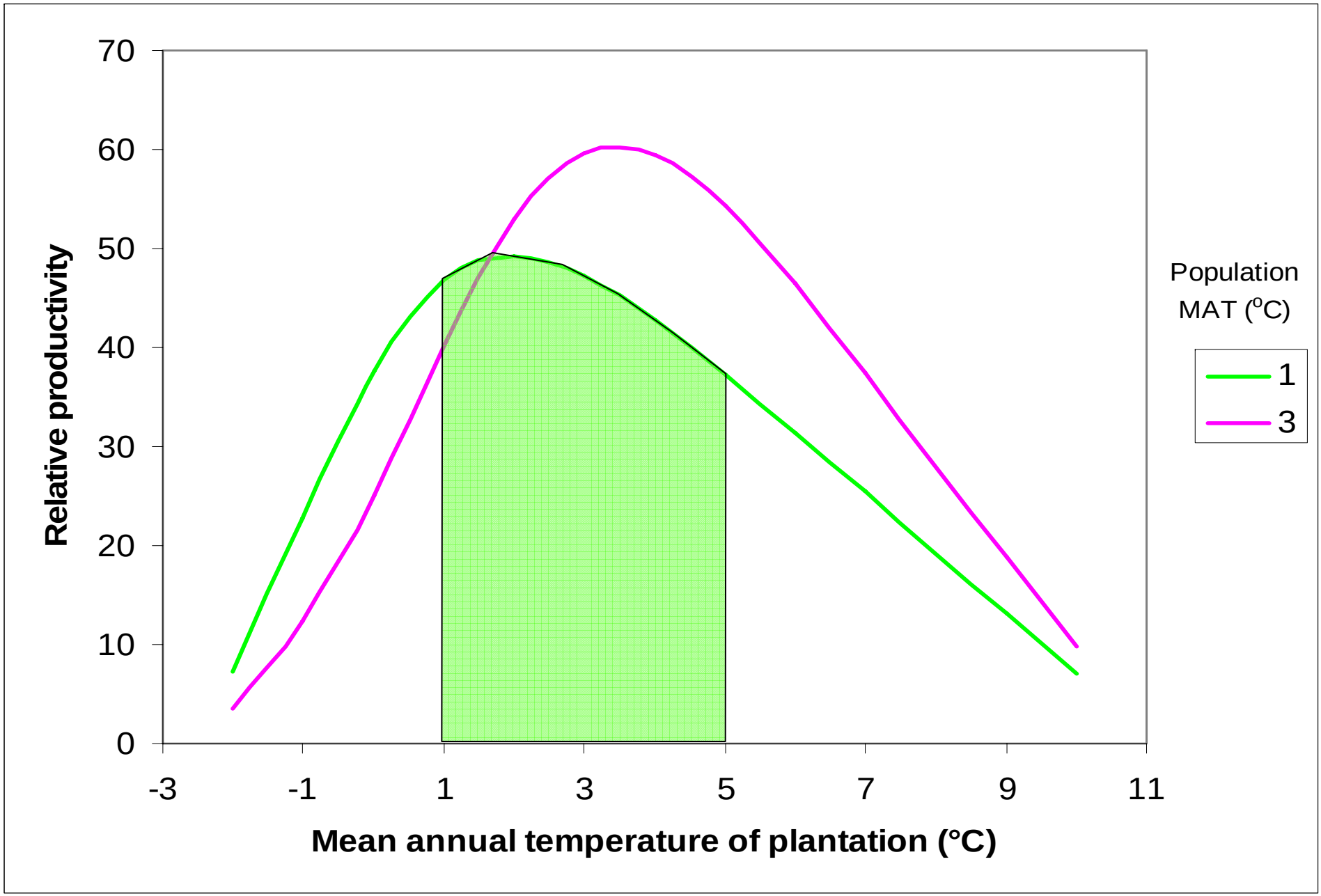
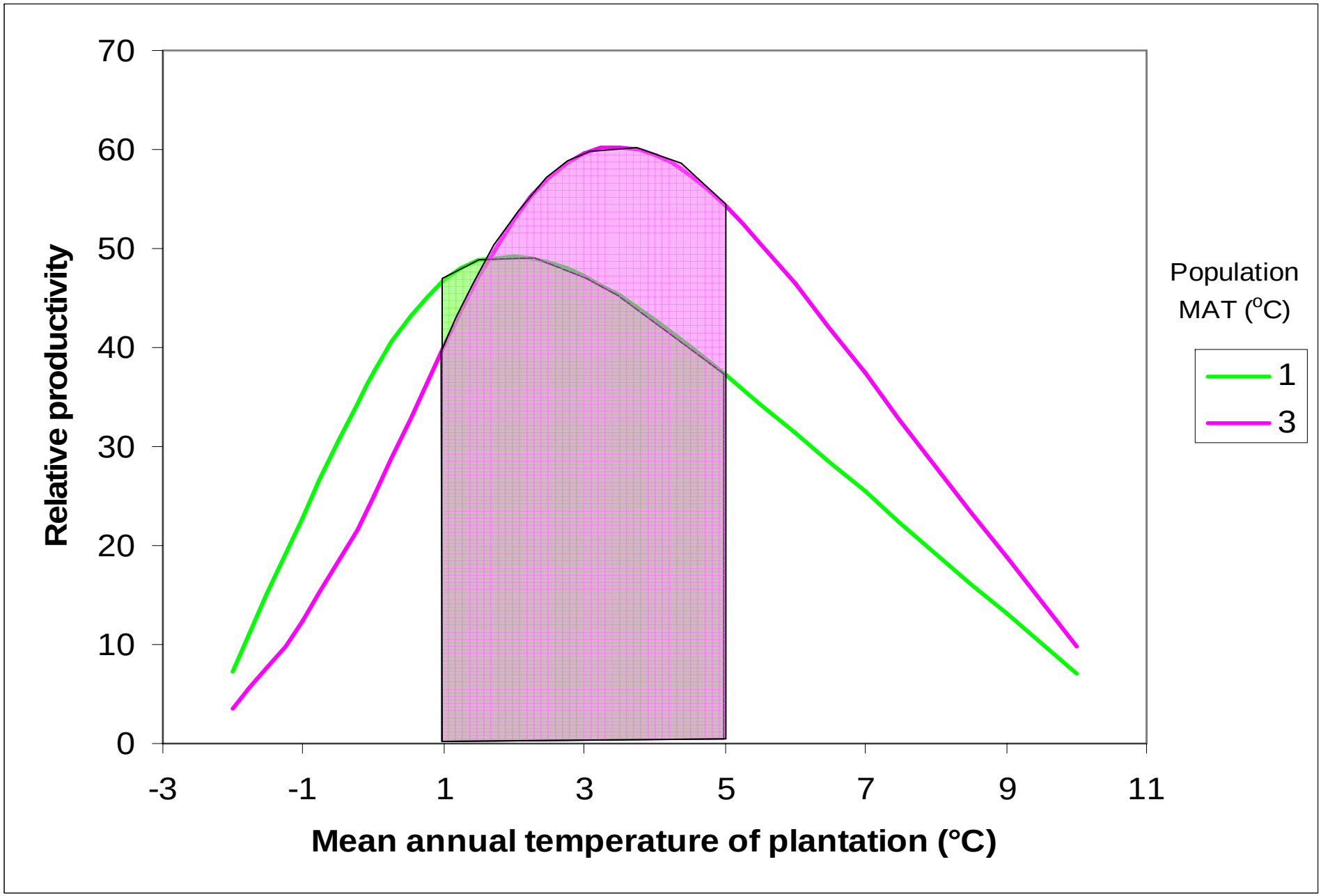
- Assisted migration

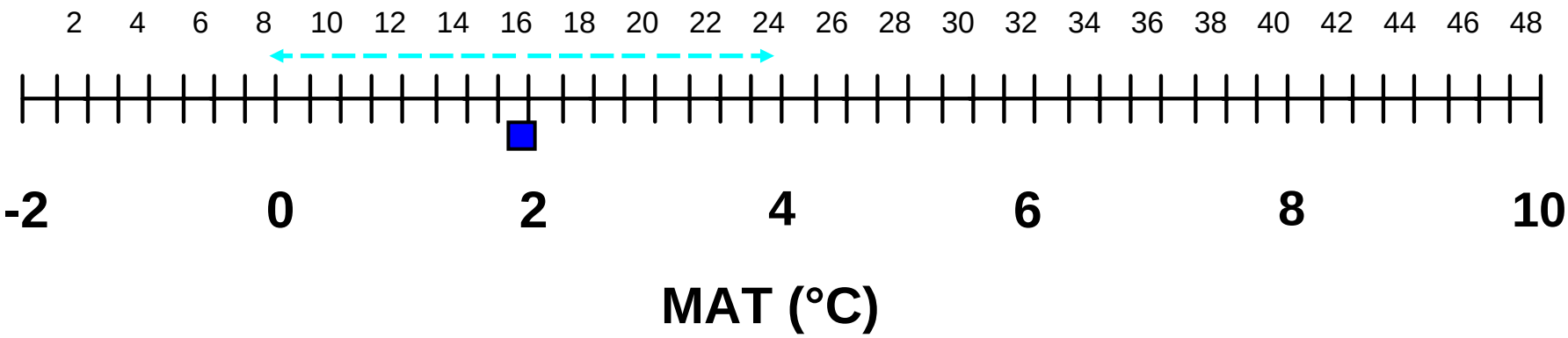

BC Northern Int
BC Southern Int
PNW
SE States
Expected change in MAT (°C)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1990
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
Year

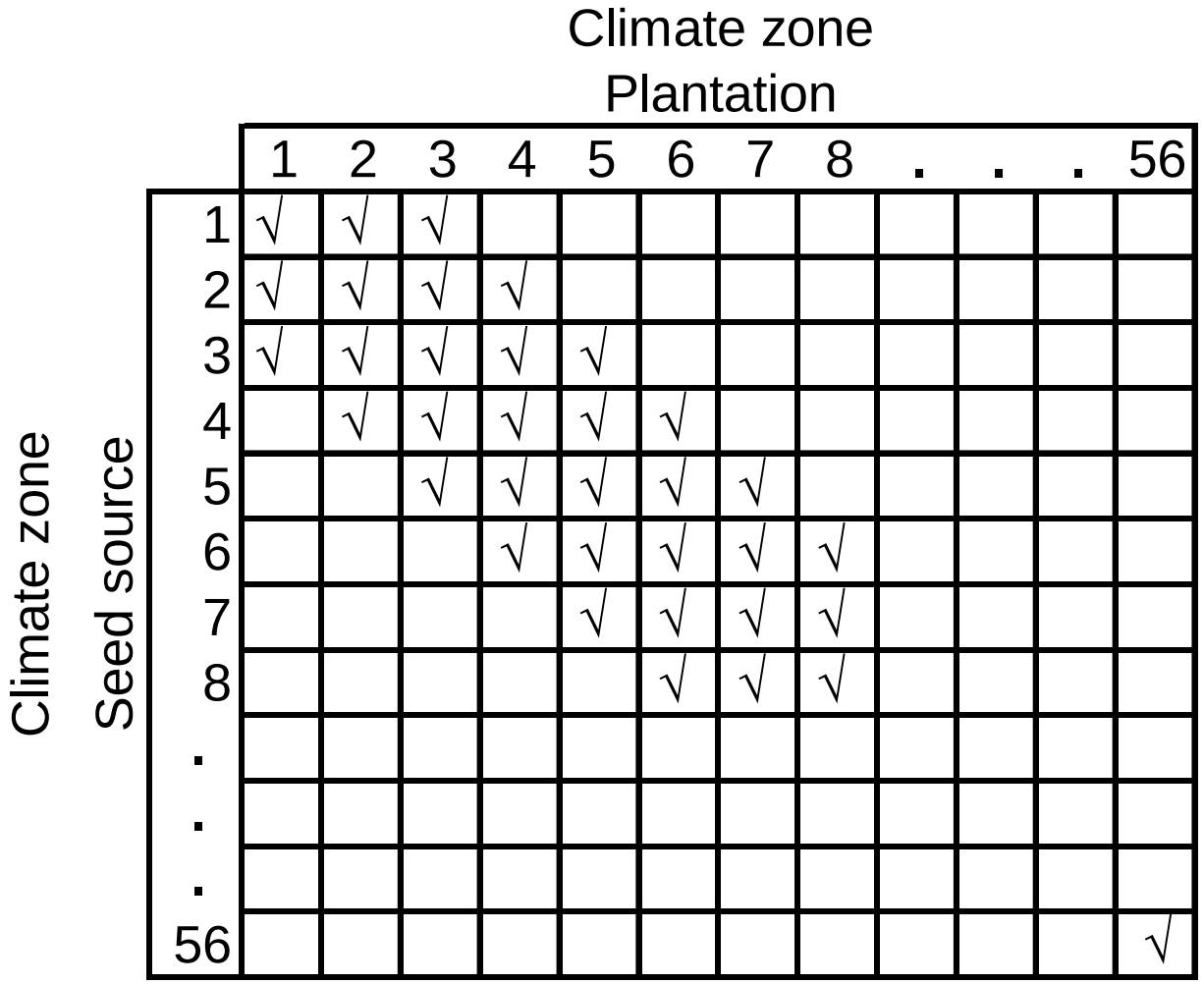

70
60
50
40
30
20
10
0
Relative productivity
-3
-1
1
3
5
7
9
11
Mean annual temperature of plantation (°C)
Population
MAT (°C)
1
3


70
60
50
40
30
20
10
0
Relative productivity
-3
-1
1
3
5
7
9
11
Mean annual temperature of plantation (°C)
Population
MAT (°C)
1
3

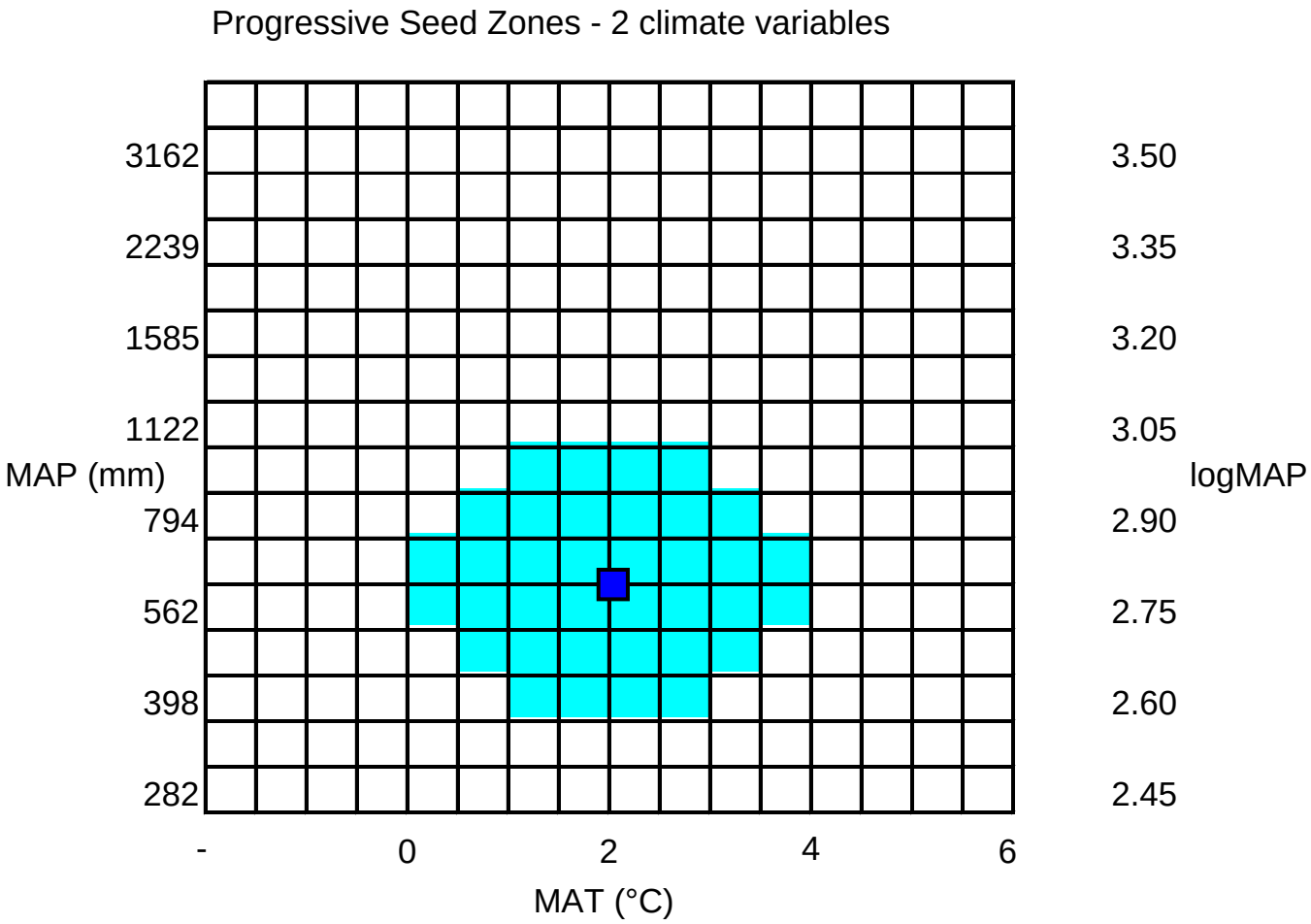

70
60
50
40
30
20
10
0
Relative productivity
-3
-1
1
3
5
7
9
11
Mean annual temperature of plantation (°C)
Population
MAT (°C)
1
3

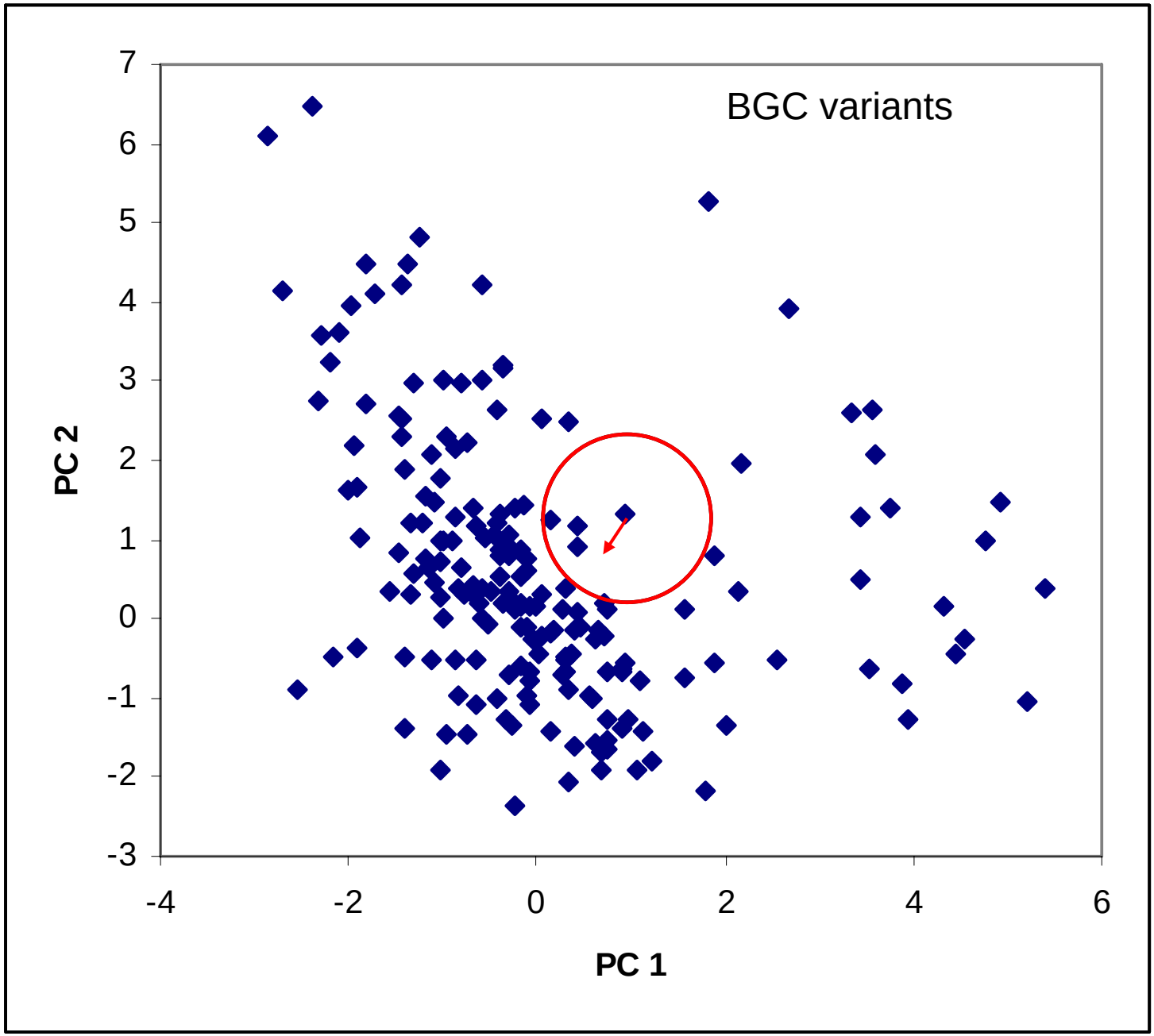

70
60
50
40
30
20
10
0
Relative productivity
-3
-1
1
3
5
7
9
11
Mean annual temperature of plantation (°C)
Population
MAT (°C)
1
3


2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48
-2 0 2 4 6 8 10
MAT (°C)



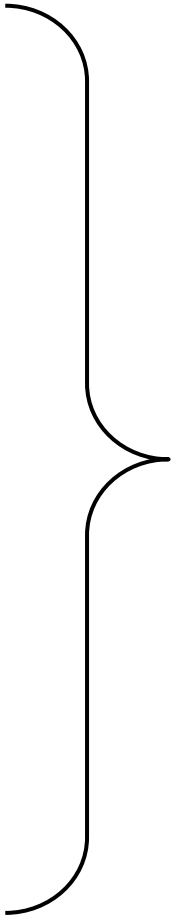

√ = acceptable deployment


Progressive Seed Zones - 2 climate variables
3162
2239
1585
1122
794
562
398
282
MAP (mm)
3.50
3.35
3.20
3.05
2.90
2.75
2.60
2.45
logMAP
-
0
2
4
6
MAT (°C)


BGC variants
PC 2
PC 1
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-2
0
2
4
6

# Seed transfer variables

- Species
- SPZ
- SPU
- Class A/B/B+
- BEC zone
- Latitude
- Longitude
- Elevation
- Overlap zones
- QCI (Ss, Hw)
- > 1100 m (Yc)
- North of 56 (Pli)
- North of 52 and EK SPZ (Fdi)



- Species
- BEC variant
- Latitude

- Conclusions regarding CBST
  - Climate transfer distance halved
  - Deployability doubled
  - Low cost
  - Rapid implementation
  - Progressive ST system combines merits of fixed and focal ST
  - Assisted migration easily accommodated
  - Operationally simple

- Next
  - BEC vs climate-based ST system
  - Number of zones to optimize adaptation *vs* deployability

# Acknowledgements

- **Data**
  - Doug Ashbee
  - Andreas Hamann
  - Barry Jaquish
- **Analysis**
  - Frank van Thienen
- **Discussions**
  - Sally Aitken
  - Andreas Hamann
  - Jerry Rehfeldt
  - Tongli Wang
  - Jack Woods
  - Alvin Yanchuk