Tracking the Spread of Pampas Grass: Which Cultivar Does Not Matter

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Pampas Grass (*Cortaderia selloana*)

- Non-native invasive
- Horticultural Origin

Pampas Grass

- Gynodioecious (female & hermaphrodite)

  or

  Dioecious (female & male)

- Most cultivars are vegetatively propagated.

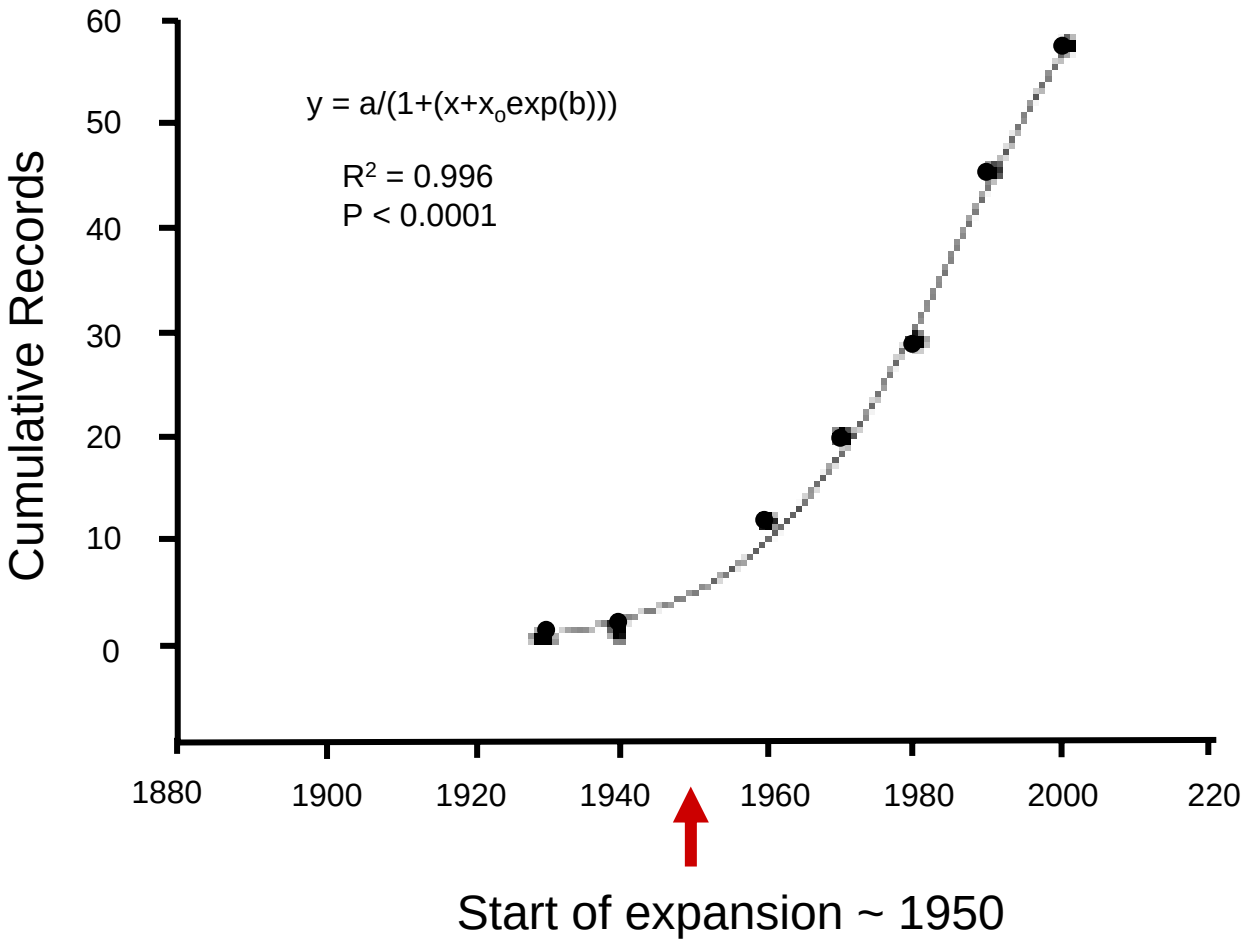
  ↓

  female- or male-only cultivars

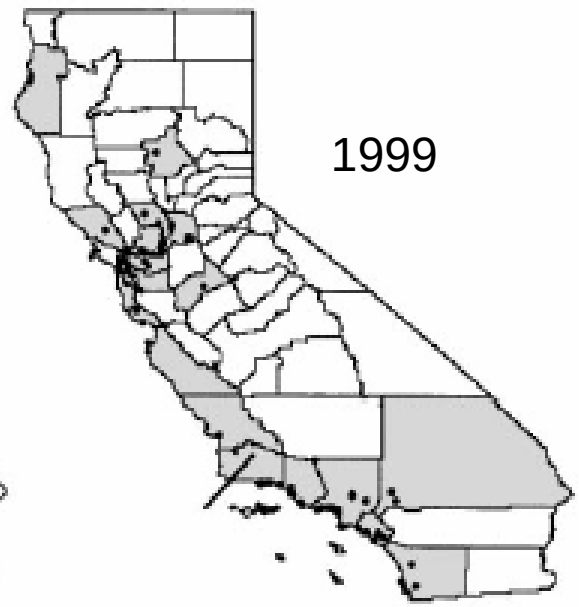
Pampas Grass in California

Introduction	**Date**
Horticultural	mid-1800s - **TODAY**
Cut-plume industry	~1875-1900
Forage & erosion control trials	1940's-1950's

Spread of Pampas Grass
(Lambrinos 2001)



Two Foci of Spread
(Lambrinos 2001)



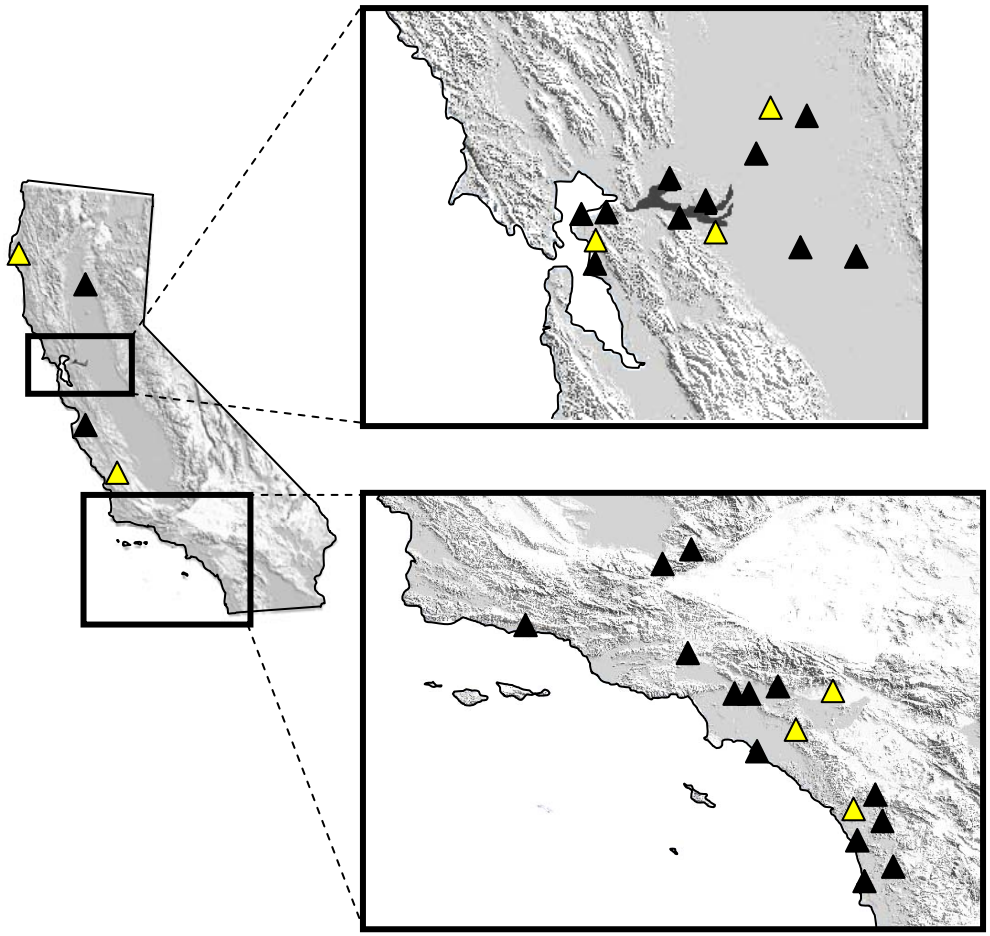
Objectives

1. How has pampas grass spread?

2. Which cultivar(s) escaped plantings?

Materials and Methods

- Sampling
  - ⇨ 33 populations
  - ⇨ 9 small populations ($n \leq 10$)

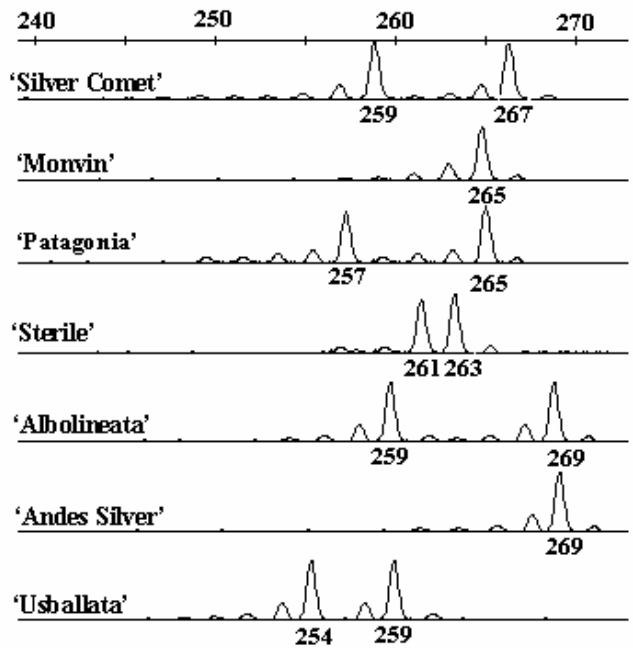


Materials and Methods

- Sampling
  - ⇨ 169 cultivated plants
    - 17 named cultivars + 4 selections (~90 % of pampas grass cultivars) [58]
    - plants sold as "*C. selloana*" [9]
    - 18 plantings in California [83]
    - 5 plantings outside California [19]

Materials and Methods

1. Microsatellite Markers
   - ⇨ 10 loci
   - ⇨ Each plant genotyped

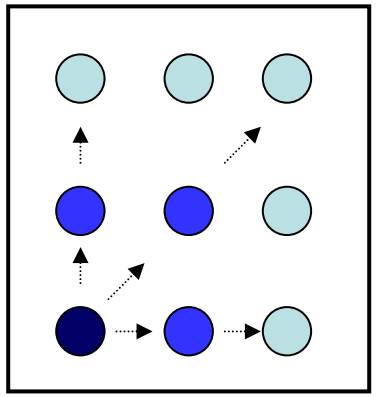


Objective 1:
How have they spread?
(Dispersal and Introduction Pattern)

1. Small steps or long jumps?
2. How much dispersal among populations?
3. How many introductions in CA?

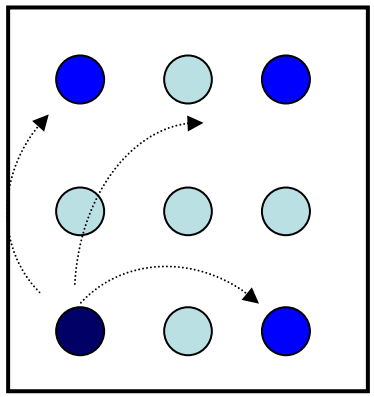
Geographic Pattern of Genetic Variation

1. Small steps

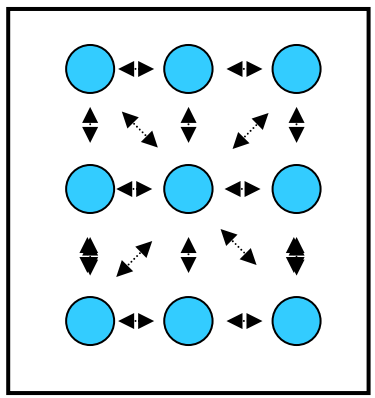


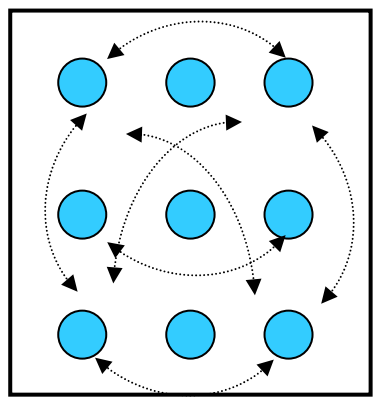
2. Long jumps

   Multiple introductions



3. A lot of dispersal





Results

- F_{ST}: measure of population differentiation

$$F_{ST} = 0.204 \quad (p < 0.001)$$

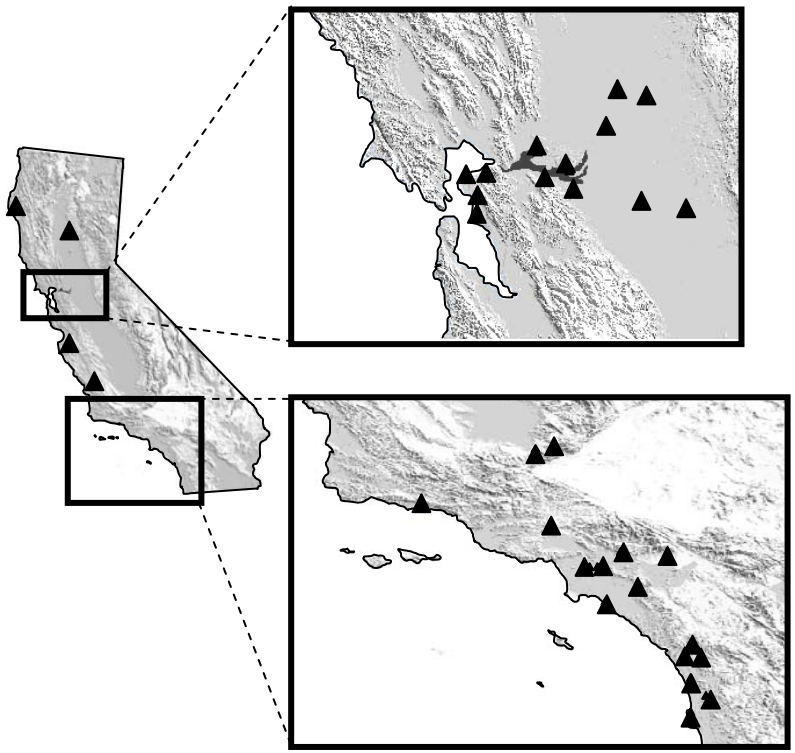
Differentiation	F_{ST}
Little	0-0.05
Moderate	0.05-0.15
Great	0.15-0.25
Very great	> 0.25

- Conclude: Dispersal is not high enough to homogenize populations.

❖Test for correlation between genetic and geographic distance.

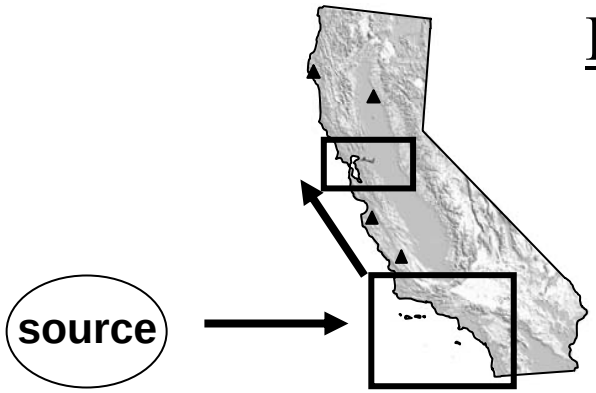
- No significant correlation

= long jumps or multiple introduction



Genetic Differentiation Within & Across Regions

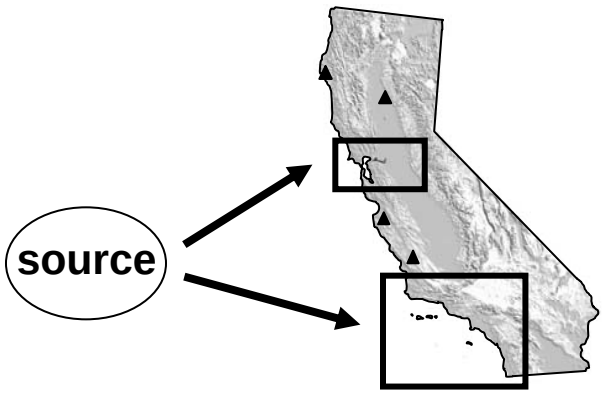
❖ Single Introduction



F_{ST} within regions: high; high

F_{ST} across regions: **high**

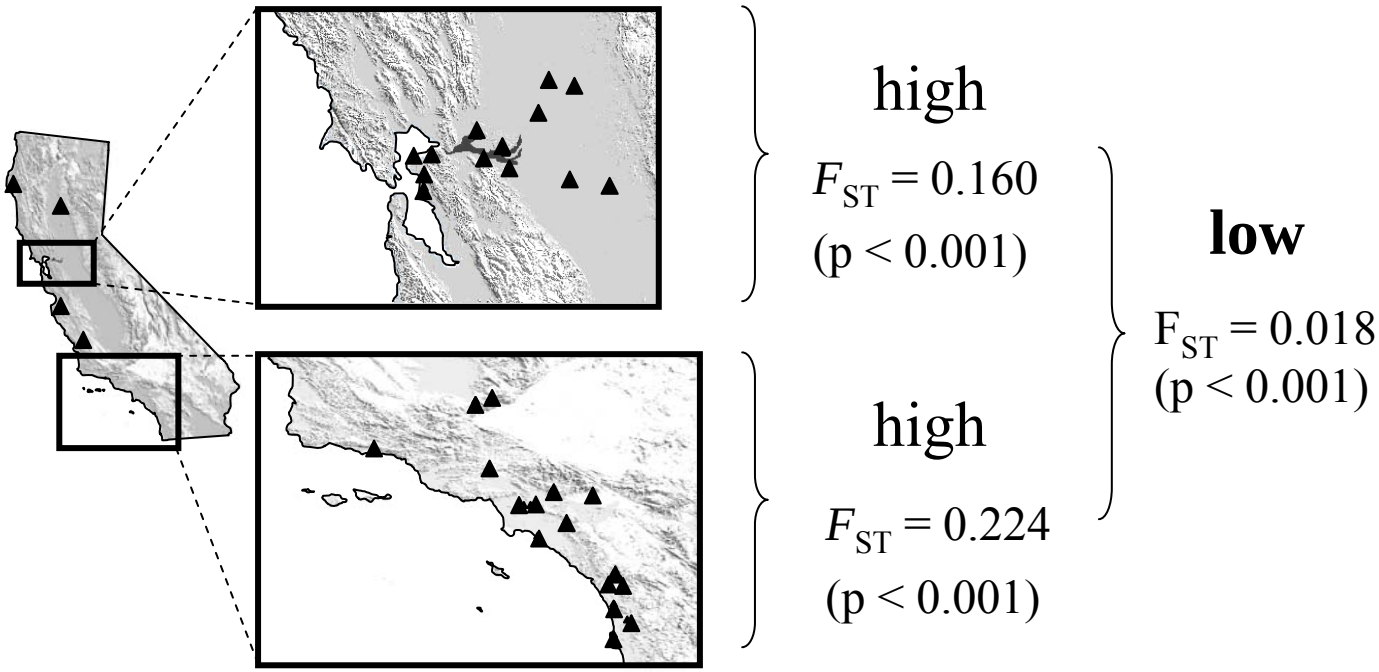
❖ Independent Introductions



F_{ST} within regions: high; high

F_{ST} across regions: **low**

❖ Compare Differentiation Within vs. Between Regions

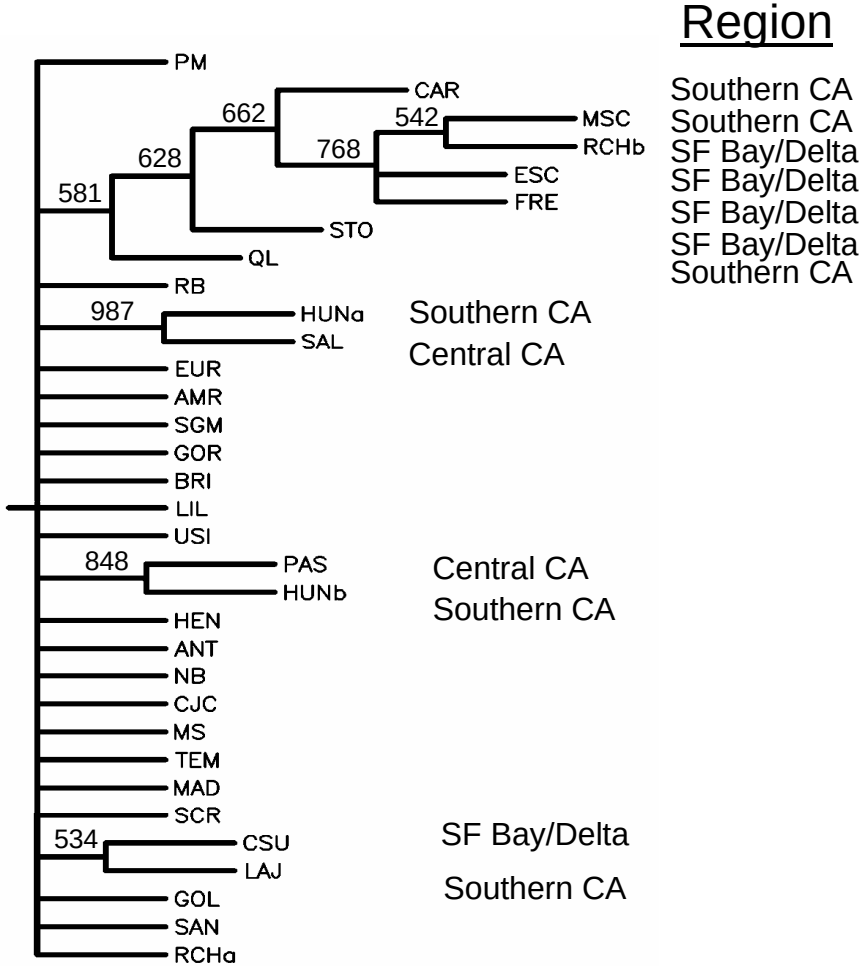


❖ Conclude: Shared source between regions

❖Pattern of Genetic Similarity Among Populations

Dendrogram:

- Nei's Standard Genetic Distance
- Neighbor-joining
- 1000 bootstrap reps



❖Conclude: At least 4 different sources are repeatedly introduced

Summary of Introduction Pattern

- Multiple sources introduced in CA
- Repeated introductions across regions
- Limited dispersal among populations

Objective 1:
How have they spread?
(Local Colonization Pattern)

- Within population structure
- Pattern of genetic variation among populations

Observation 1:

F_{IS} correlated to allelic richness across populations (population subdivision ↑, alleles found ↑)

Hypothesis:

Multiple immigration events per population

Observation 2:

Population genetic parameters are very similar between small vs. large populations.

H_E: Expected heterozygosity (measure of genetic diversity)

F_{ST}: Measure of population differentiation

Small vs. Large Populations

1. Small ⇨ recruitment ⇨ Large

	Small vs. Large
H_E	>
F_{ST}	<

2. Large ⇨ decline ⇨ Small

	Small vs. Large
H_E	<
F_{ST}	>

Small vs. Large Populations

3. Large ⇨dispersal ⇨ Small

	Small vs. Large
H_E	=
F_{ST}	>

4. Source ⇨dispersal ⇨ Small and Large

	Small vs. Large
H_E	=
F_{ST}	=

Hypothesis: Population growth through immigration from source

Summary of Colonization Pattern

Hypotheses:

1. Multiple immigration events per population

2. Population growth by immigration

- Propagule pressure from plantings may be important.

Objectives 2

Which cultivar(s) escaped plantings?

❖ Comparison of Cultivated & Naturalized Pampas Grass

- 169 cultivated individuals
  - 114 alleles found

- 698 naturalized plants
  - 84 alleles found
  - 6 alleles not in cultivated
    - 4 were found only once
    - 2 had 7 and 9 copies

❖Conclusion: Naturalized pampas grass is a subset of the cultivated material

Genetic Variation in Cultivated Pampas Grass

- No cultivar specific alleles

❖Try to look for groups of genetically similar cultivars

❖Which cultivar group escaped plantings?

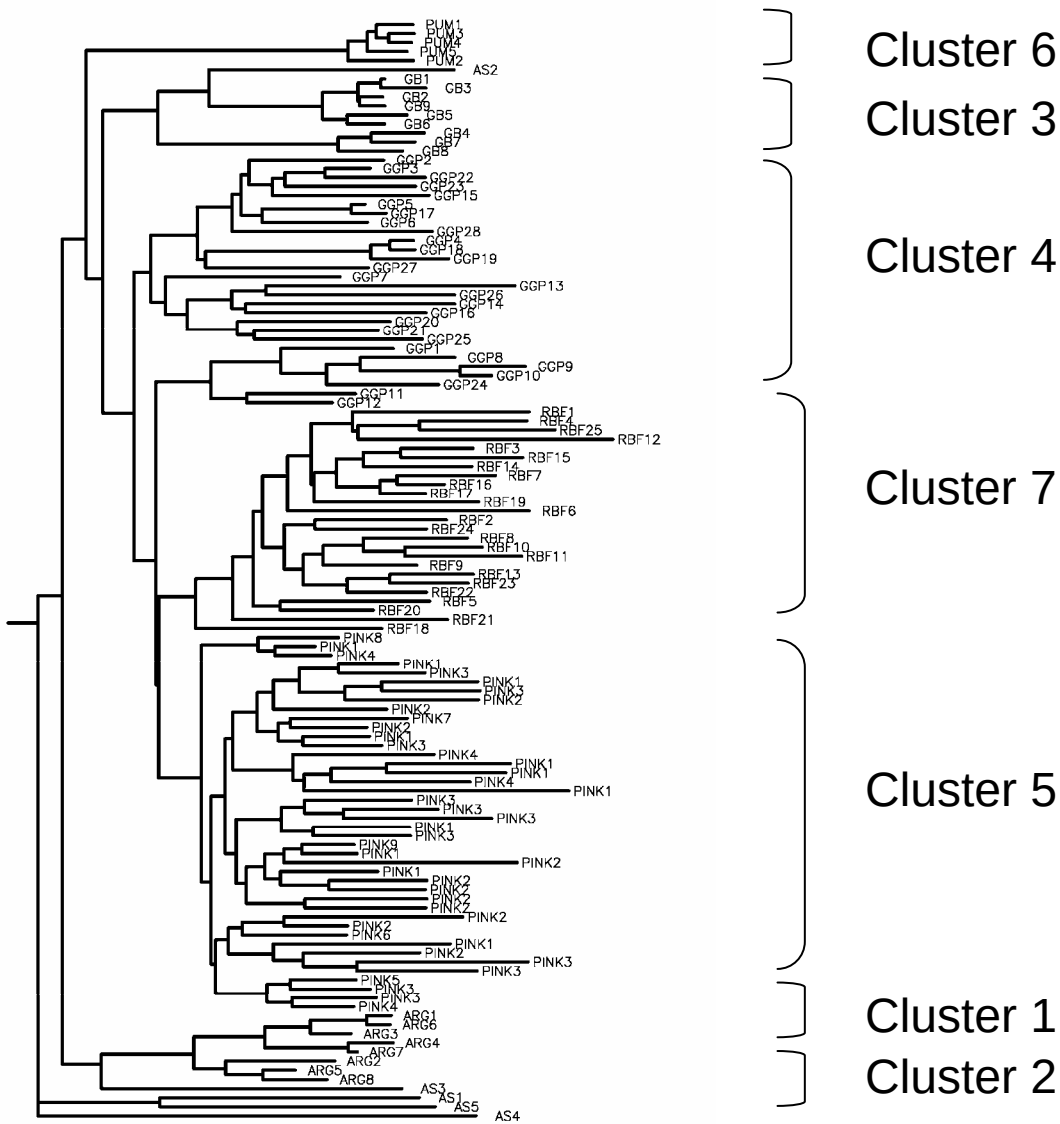
Model-based Bayesian Clustering Method
(Pritchard et al. 2000)

- Finds clusters of similar individuals
- Assigns individuals to the clusters
- Identify ancestry in hybrids

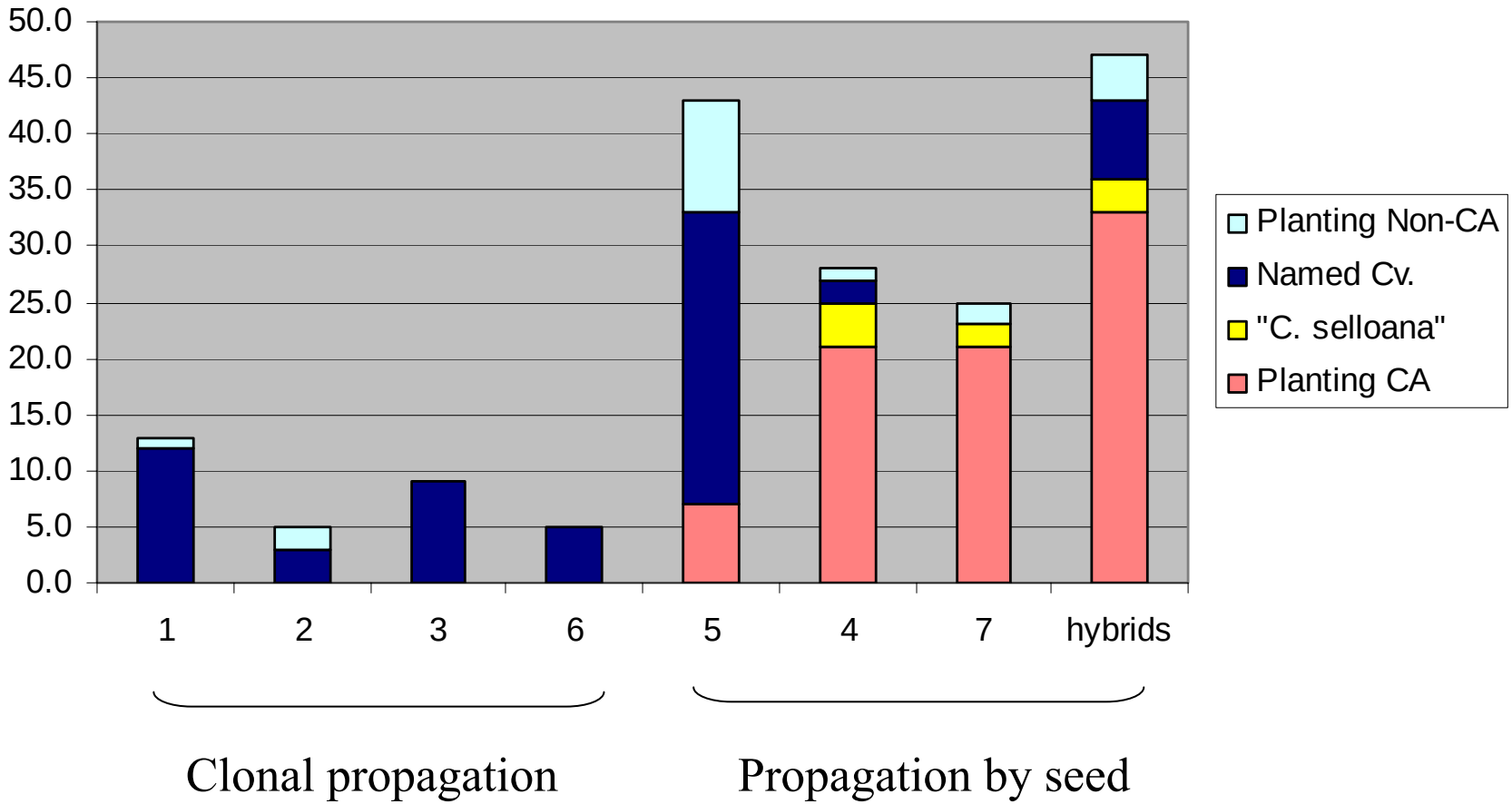
Results

- 7 clusters found in cultivated pampas grass
- 47 cultivated individuals are hybrids. (27.8 %)

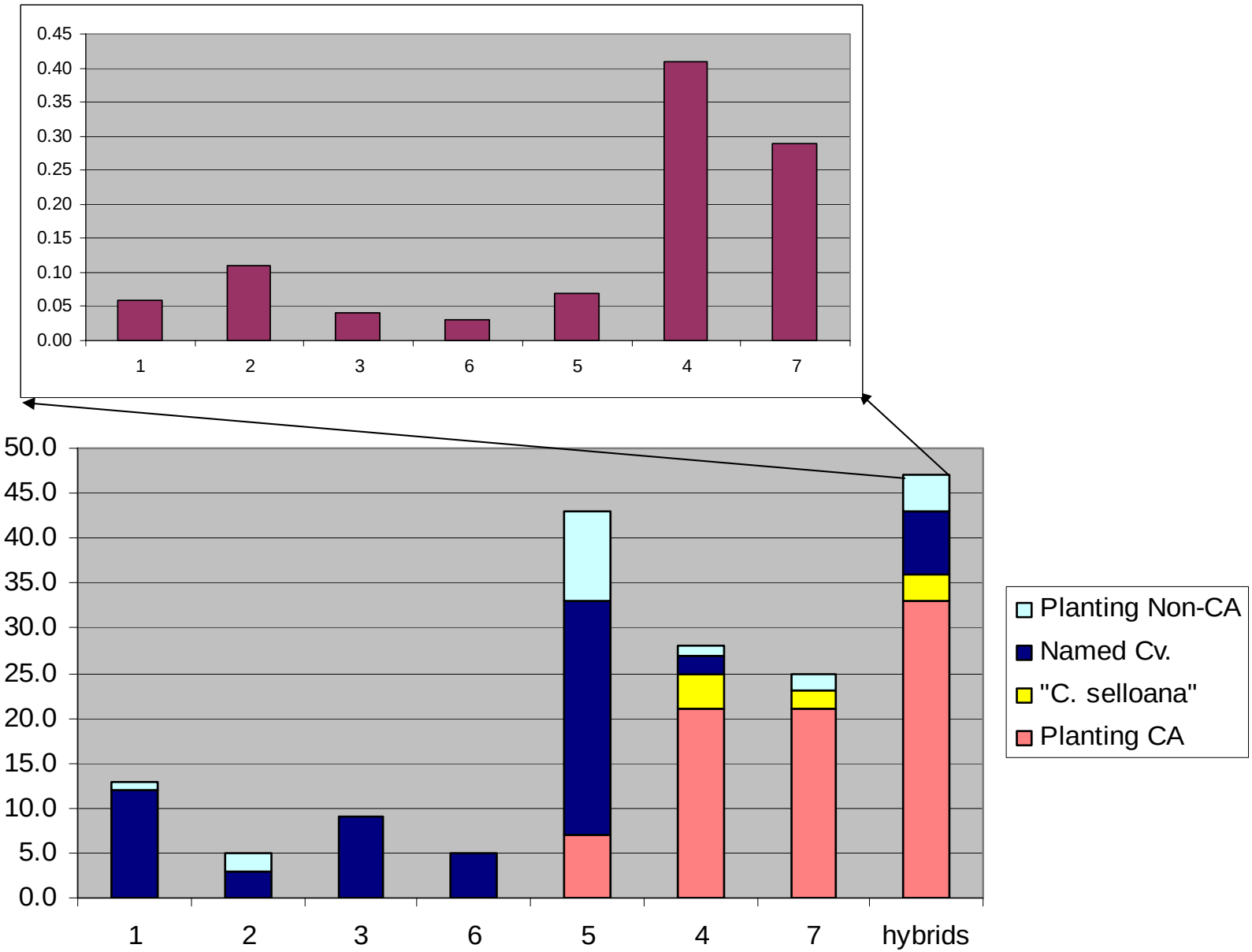
Seven Clusters within Cultivated Pampas Grass



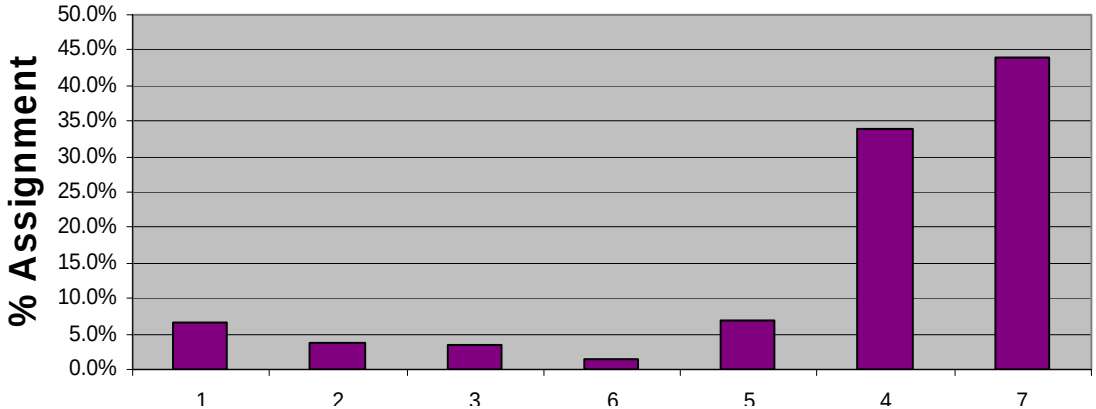
7 Clusters of Cultivated of Pampas Grass

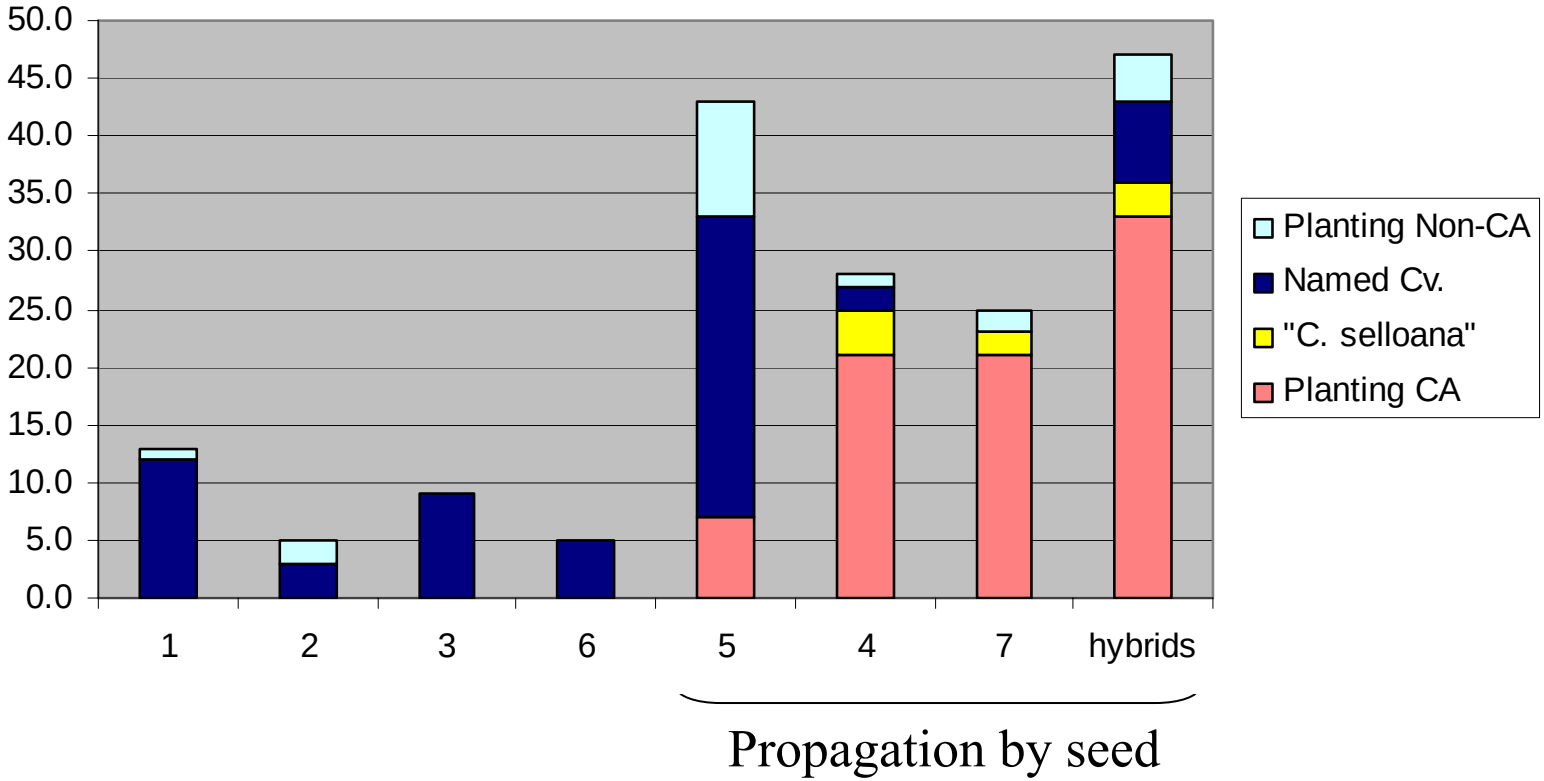


Genetic Composition of the Hybrid Group



Assignment of 698 naturalized pampas grass to 7 clusters





Summary of Cultivated vs. Naturalized Comparison

1. Cultivated pampas grass was grouped into 7 clusters by genetic similarity

2. The two clusters to which naturalized plants highly assign were:
   - Propagated by seed (both sexes in the plantings)
   - Found most often in CA plantings

Conclusion

Range Expansion in pampas grass appears to be driven by:

- Multiple introductions
- Dispersal from plantings

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Royal Botanic Garden Edinburgh, Scotland

Sir Harold Hillier Gardens, England

Strybing Botanic Garden, California

University of California Botanical Garden at Berkeley, California

University of Oxford Botanic Garden, England