

Patterns of Genetic Diversity in Wild Populations of American Ginseng in the Southeastern U.S.

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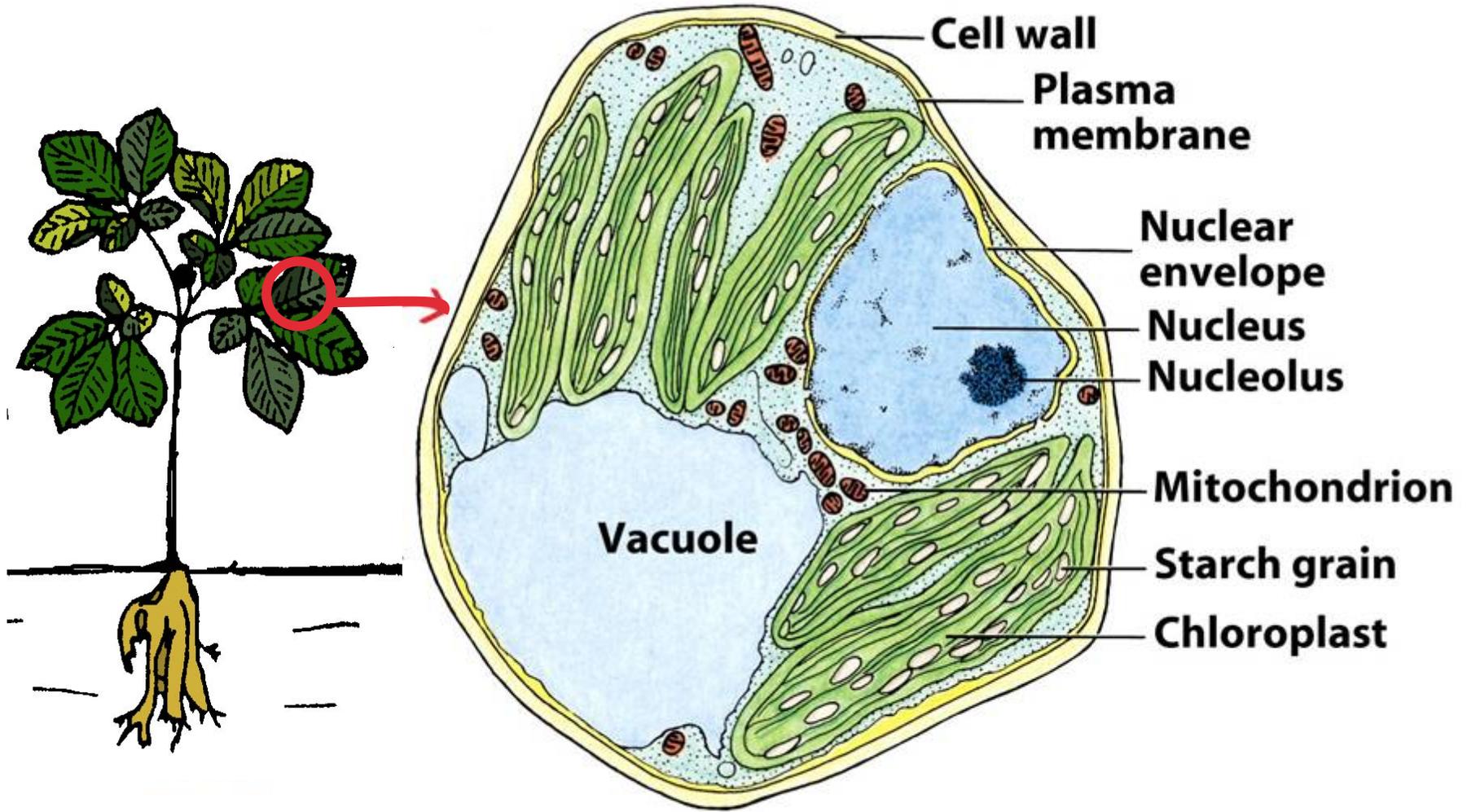
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American Ginseng

Panax quinquefolius

- **Araliaceae**
- **Perennial herb**
- **Flowers: May-July**
- **Fruits: July-October**
- **Pollinators:**
generalist insects



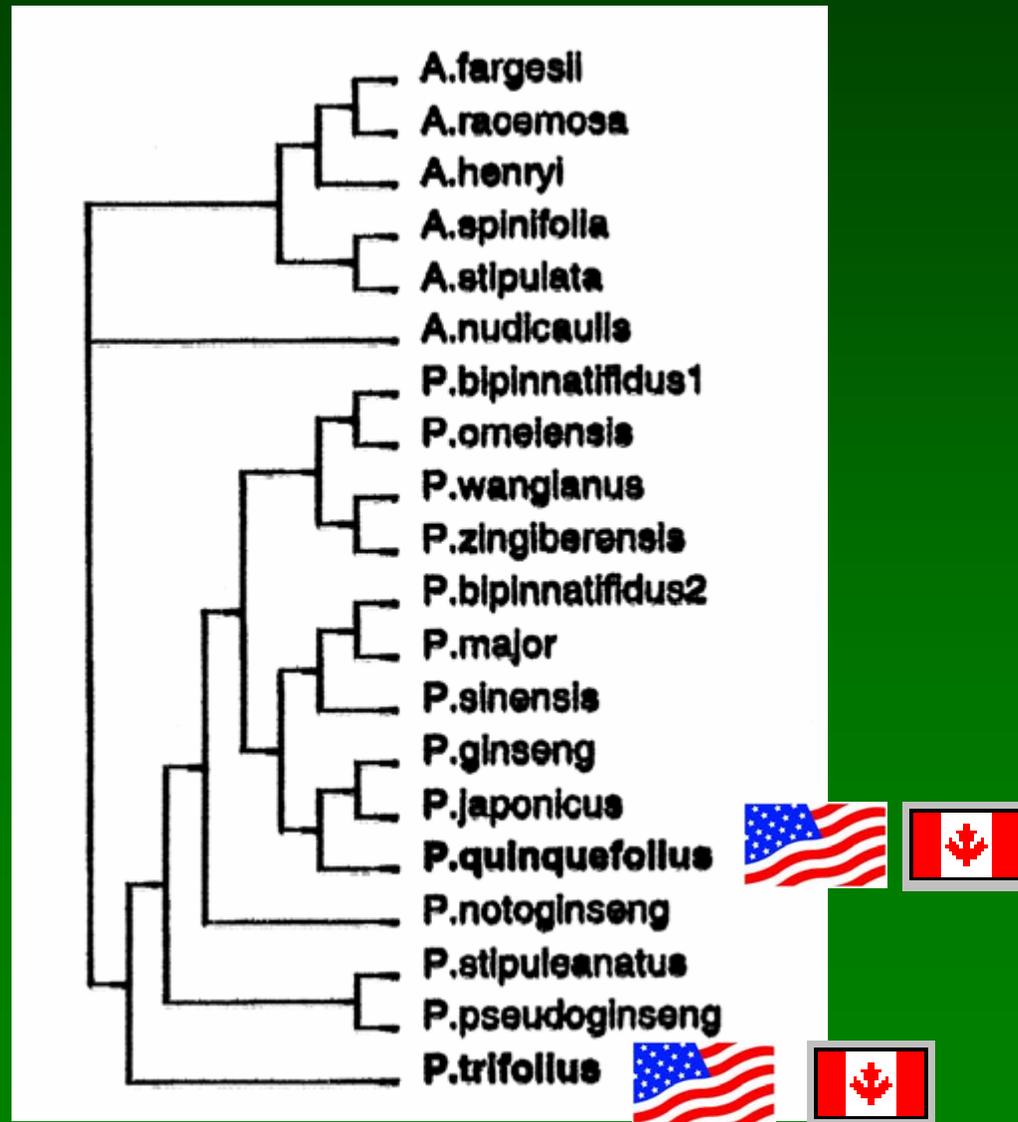
Adapted from
Biology of Plants, Seventh Edition

Genetic Diversity Studies

- **DNA sequences**
- **Chloroplast markers**

- **Allozymes**
- **Microsatellites**
- **AFLP and RAPD markers**

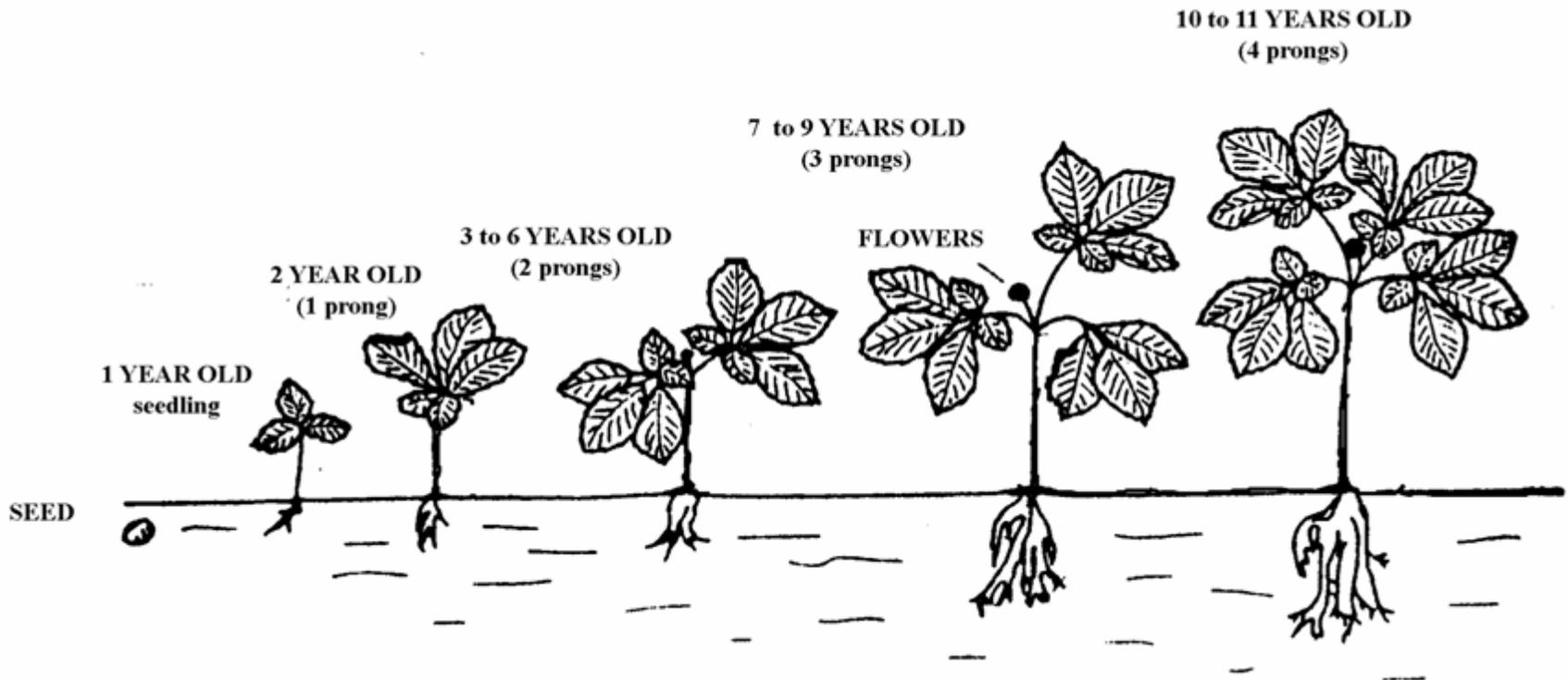
DNA sequence comparison: History of *Panax* sp. dispersal



Wen and Zimmer, 1996

Patterns of Genetic Variation in Plants

- **Low** genetic variation in **small** populations
(Barrett and Kohn, 1991; Ellstrand and Elam, 1993)
- Genetic **diversity** and rarity or commonness
of a plant species are **unrelated** (Stebbins, 1980)
- Genetic diversity in rare **southeastern**
species is **higher** than that in other endemics
(Godt and Hamrick, 2001)



Anderson et al., 1993

Population Biology

- **Genetic diversity
within and among
populations**
- **Relationships
among plants
within populations**

Management concerns

- Increase in numbers of harvested wild roots
- Root size decreasing
- What are the impacts of harvest on genetic diversity?



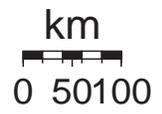
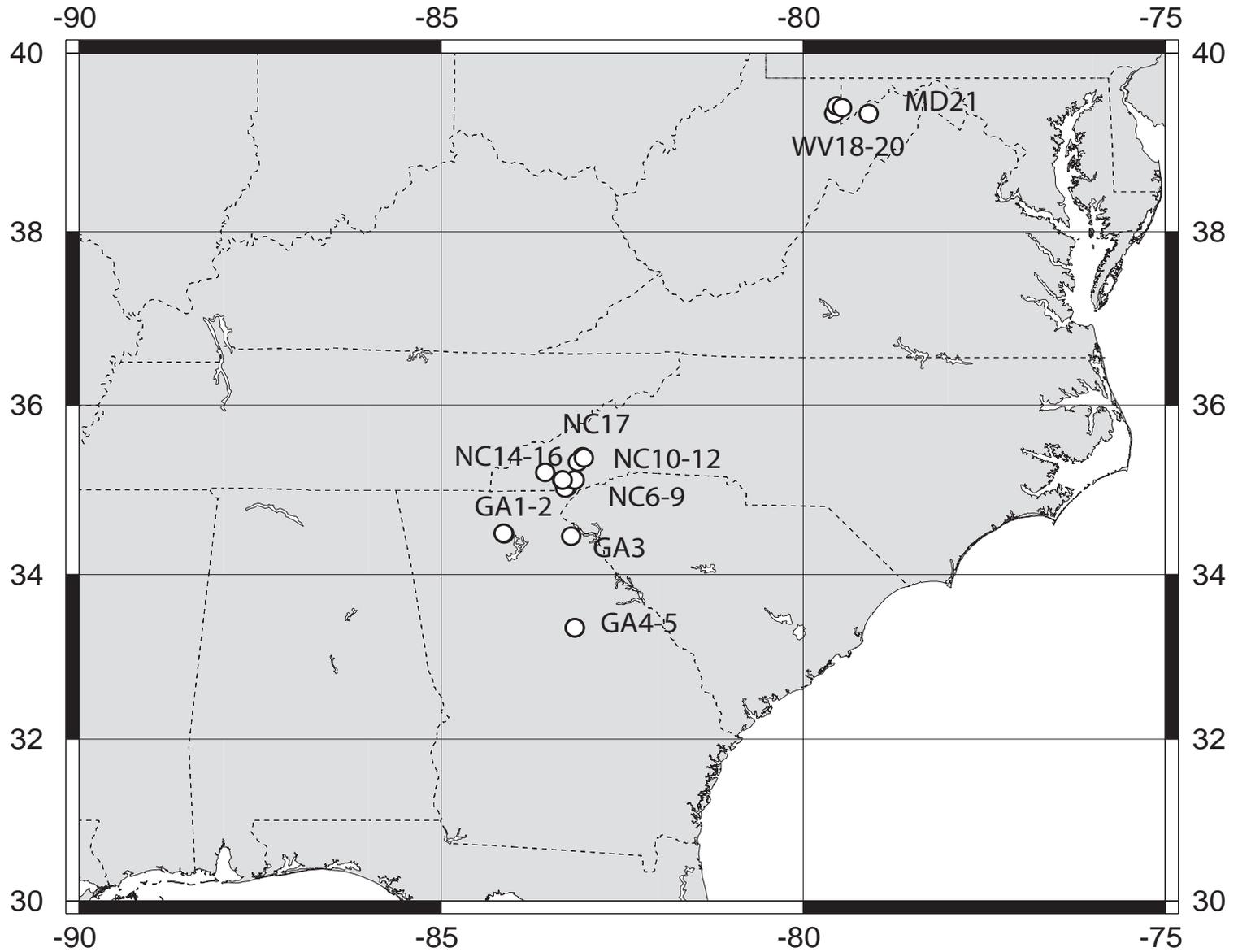
Genetic diversity within populations in the Southeast?

21 populations (1317 plants) from Georgia, North Carolina, West Virginia, and Maryland

- 13 unprotected sites
- 8 protected populations

Methods

- Number of leaves and presence of flowers and fruits were recorded
- 16 allozyme loci (10 polymorphic)
- Protected populations: 32 – 120 plants
- Unprotected populations: 15 – 104 plants





Set 2: Gel 11 TPI 4/21/02

[The text in this section is extremely faint and illegible, appearing as a series of dark, blurry shapes.]

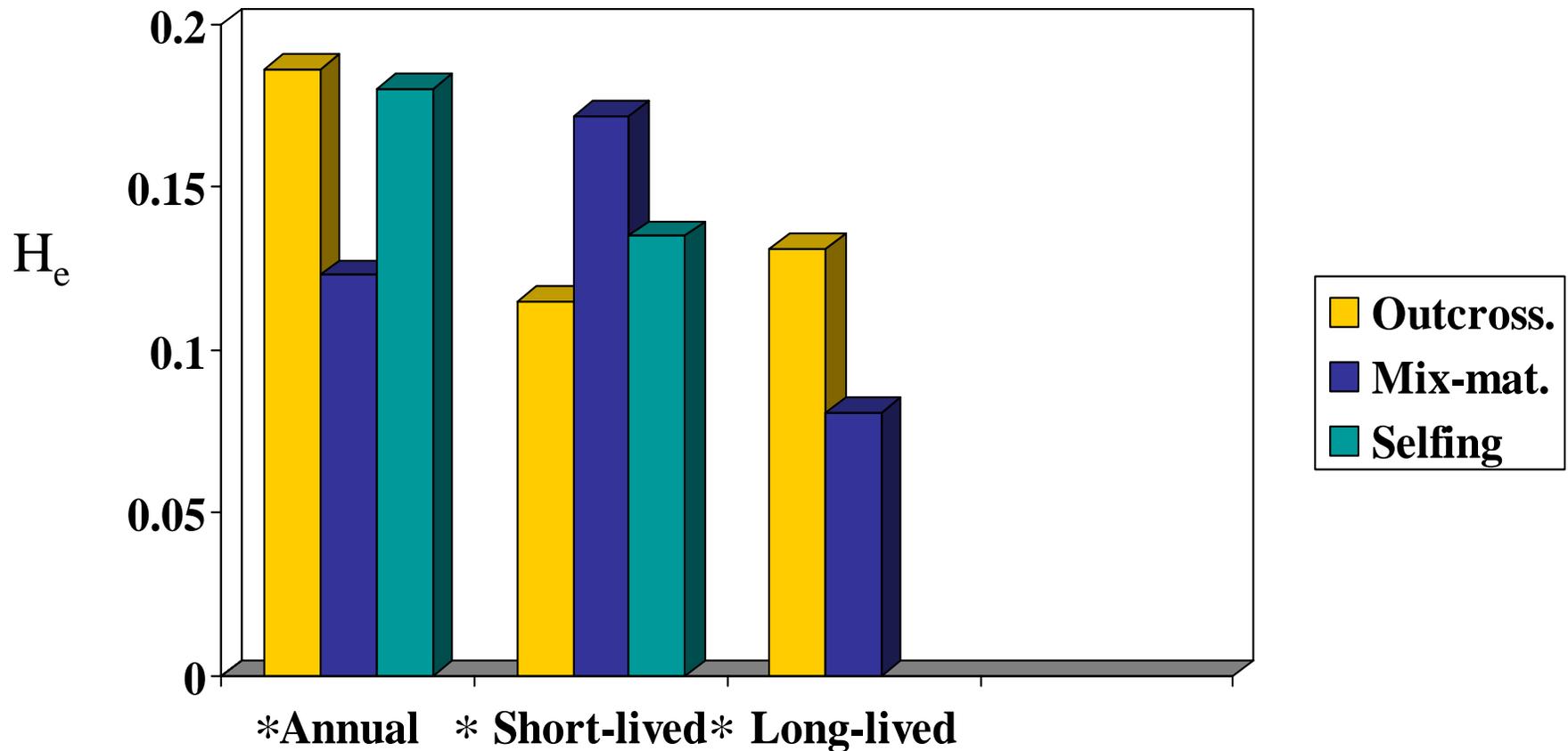
Genetic Diversity and Structure

	P	AP	A_e	H_e	G_{ST}
Species	62.5	2.70	1.26	0.159	0.493
Population	27.3	2.23	1.33	0.072	-

G_{ST} Proportion of the total diversity among populations = $(H_T - H_s) / H_T$
H_e expected genetic diversity = $1 - \sum p_i^2$ (polymorphic loci)

Species Level Genetic Diversity

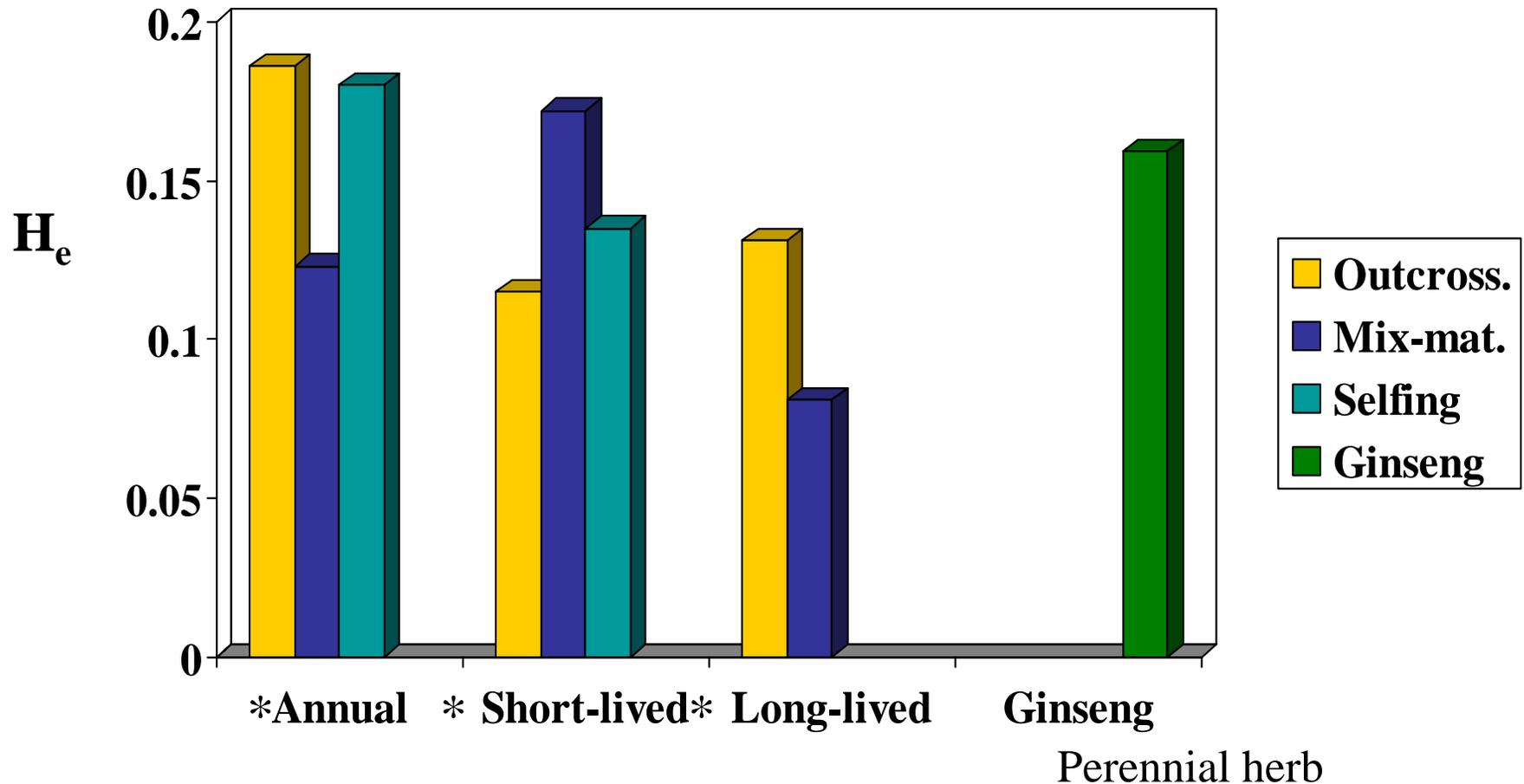
Plant Life Form and Breeding System



*From Hamrick and Godt, 1997

Species Level Genetic Diversity

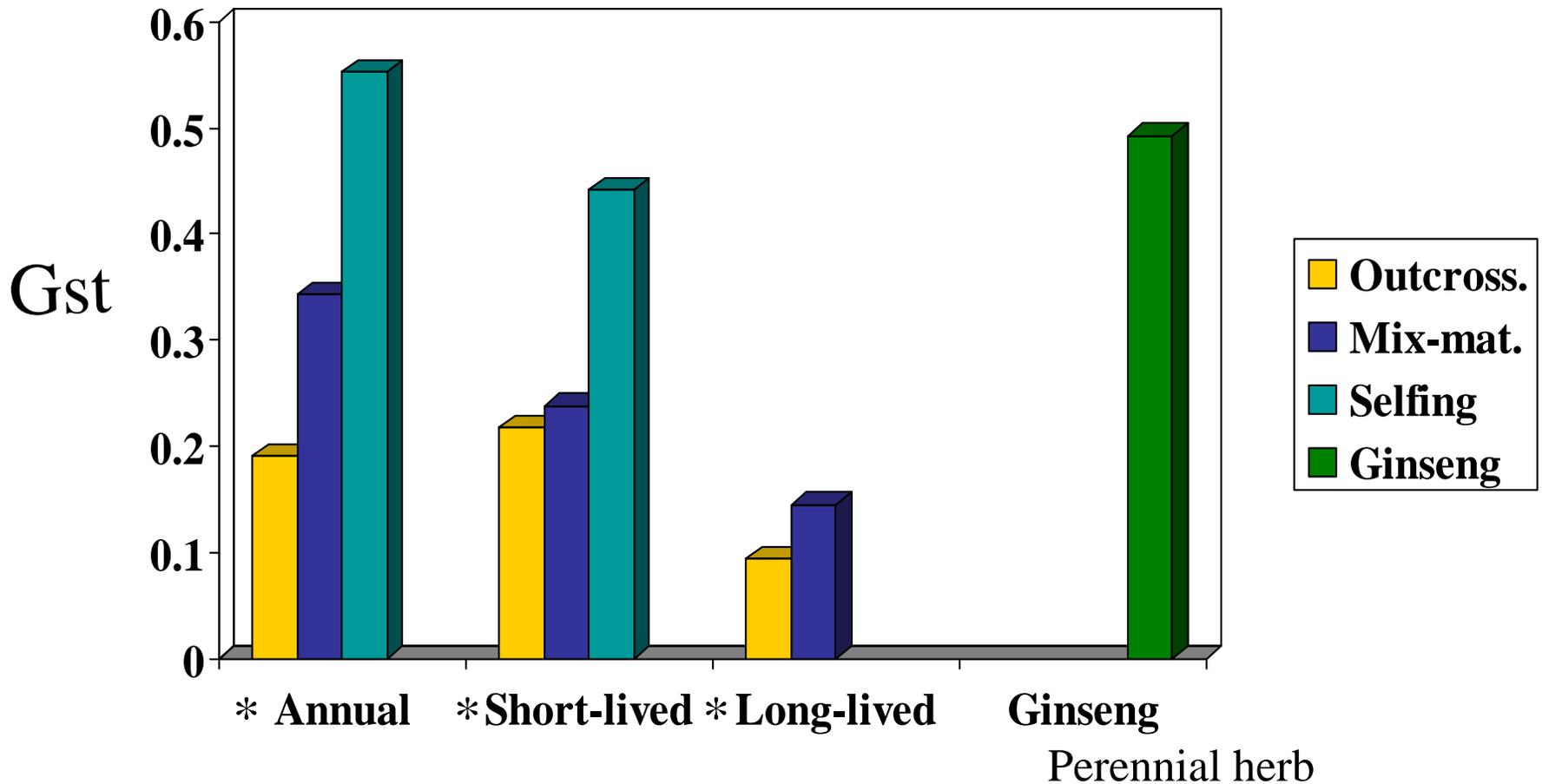
Plant Life Form and Breeding System



*From Hamrick and Godt, 1997

Genetic Structure

Plant Life Form and Breeding System

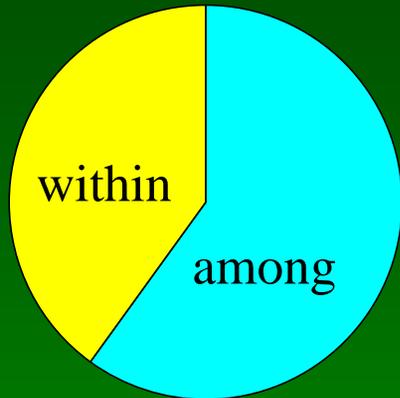


*From Hamrick and Godt, 1997

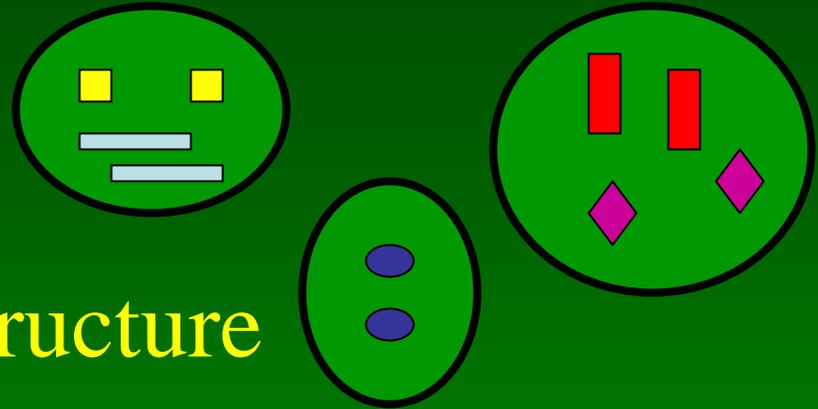
Genetic Diversity within Species



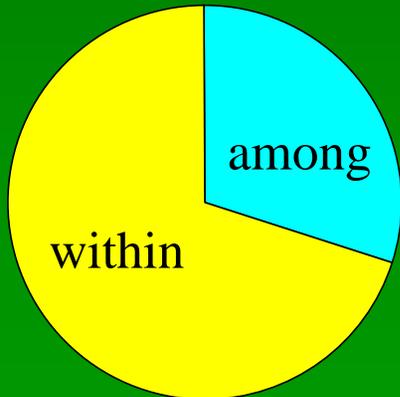
Genetic Structure



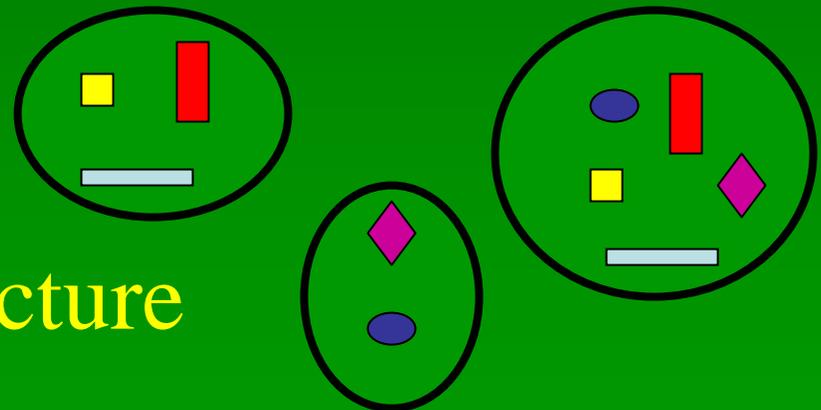
High structure



Total diversity



Low structure



Higher Diversity in Protected Populations

	P	AP	A_e	H_e	G_{ST}
Protected	28.0	2.23	1.13	0.076 *	0.167
Unprotected	27.5	2.22	1.13	0.070	0.491

$p < 0.001$

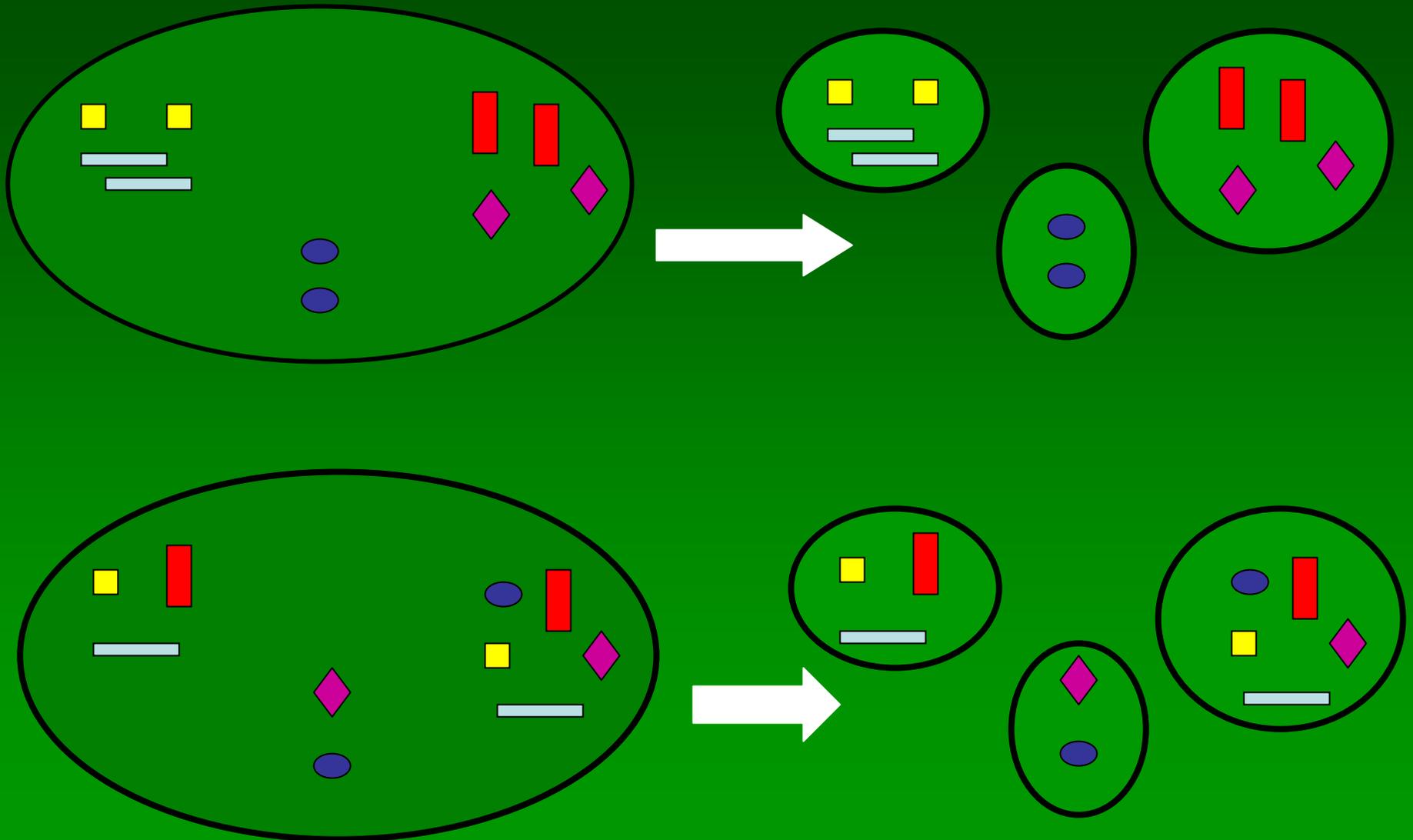
Genetic Diversity and Structure

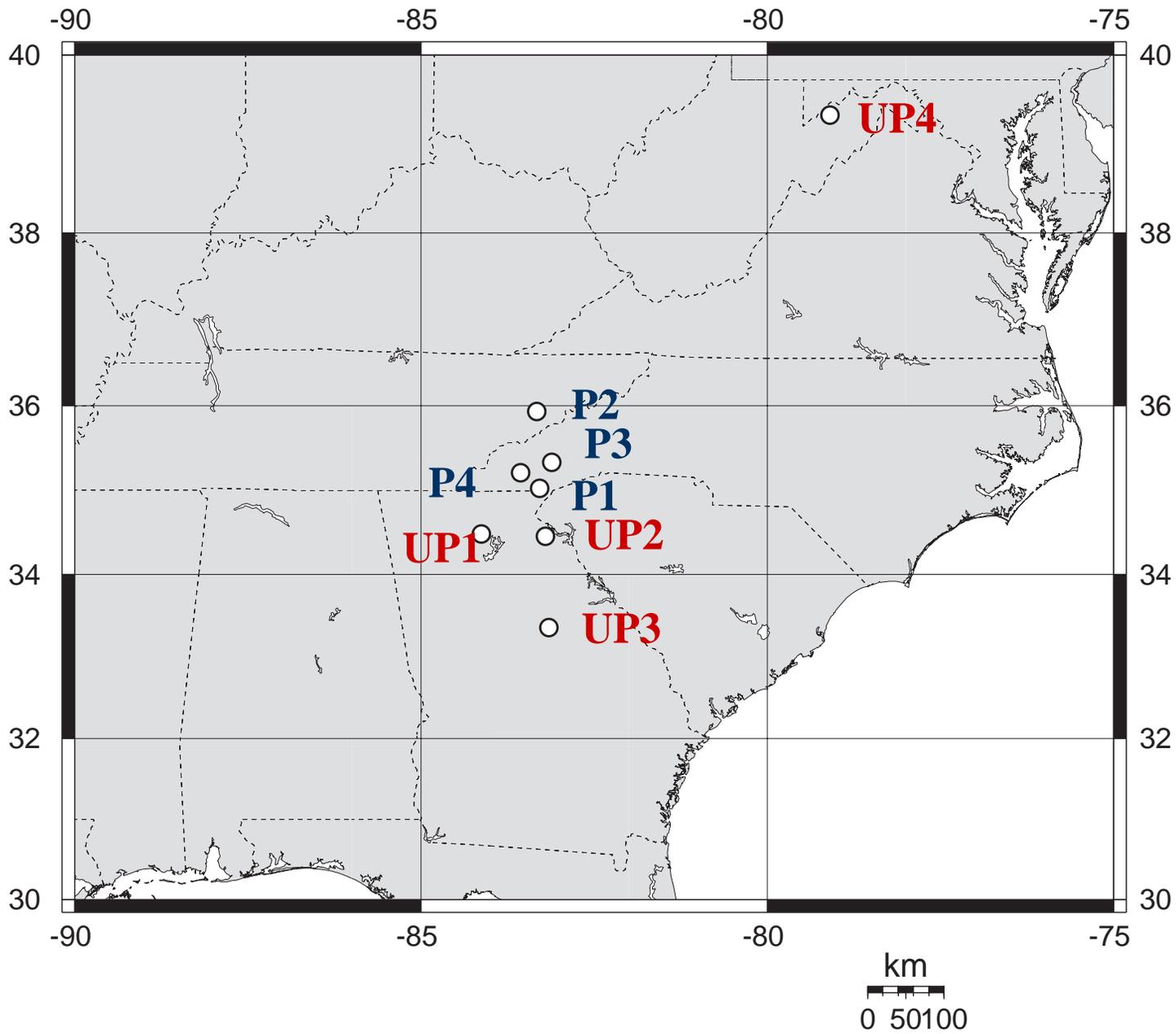
- Comparable diversity to similar plants
- Higher diversity in protected populations
- High structure among unprotected populations

Why examine fine-scale genetic diversity within populations?

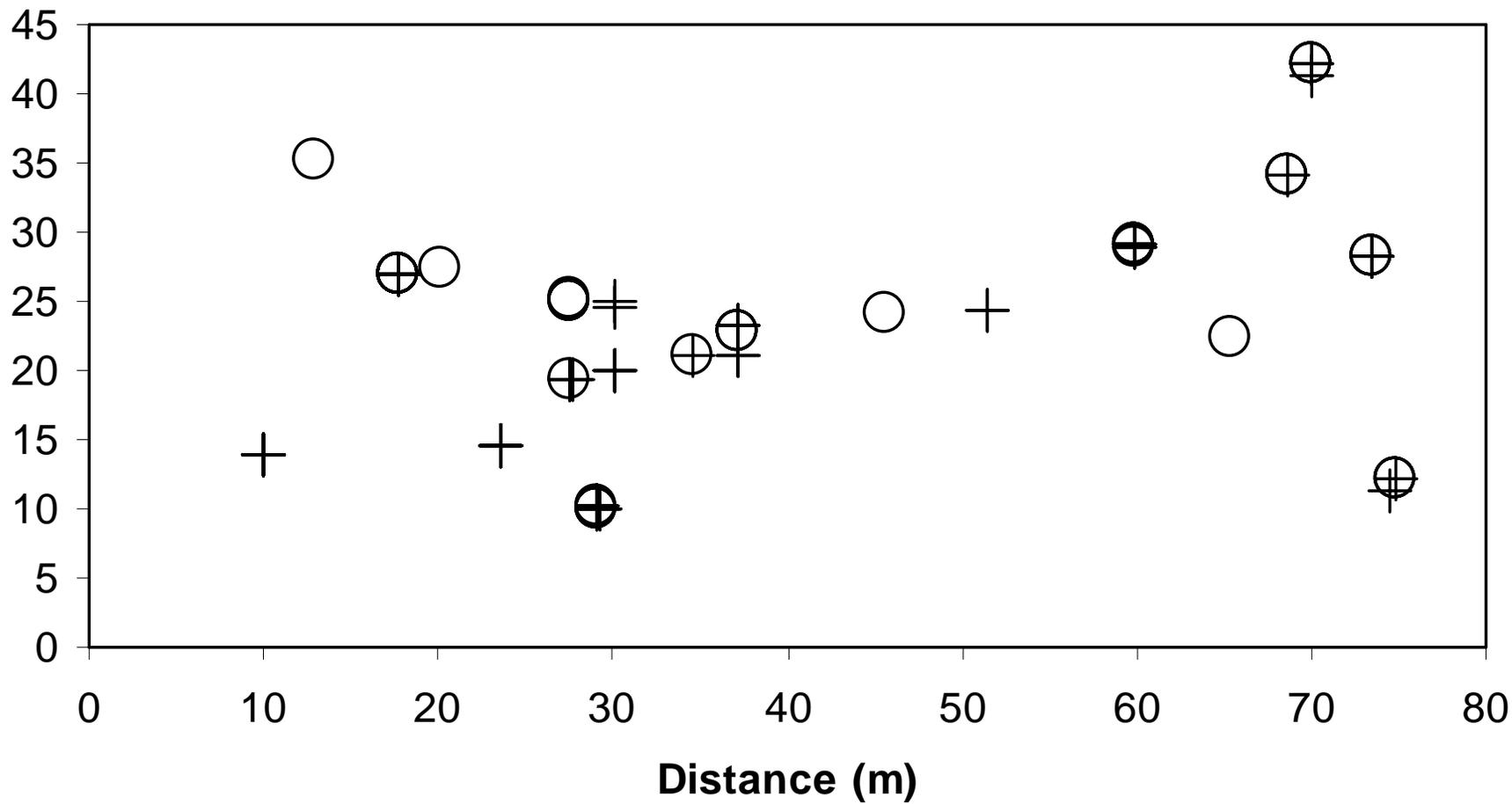
- Mixed mating system
- Seeds gravity-dispersed
- Genetically subdivided populations
- Locally adapted genotypes
- Family structure

Genetic Structure

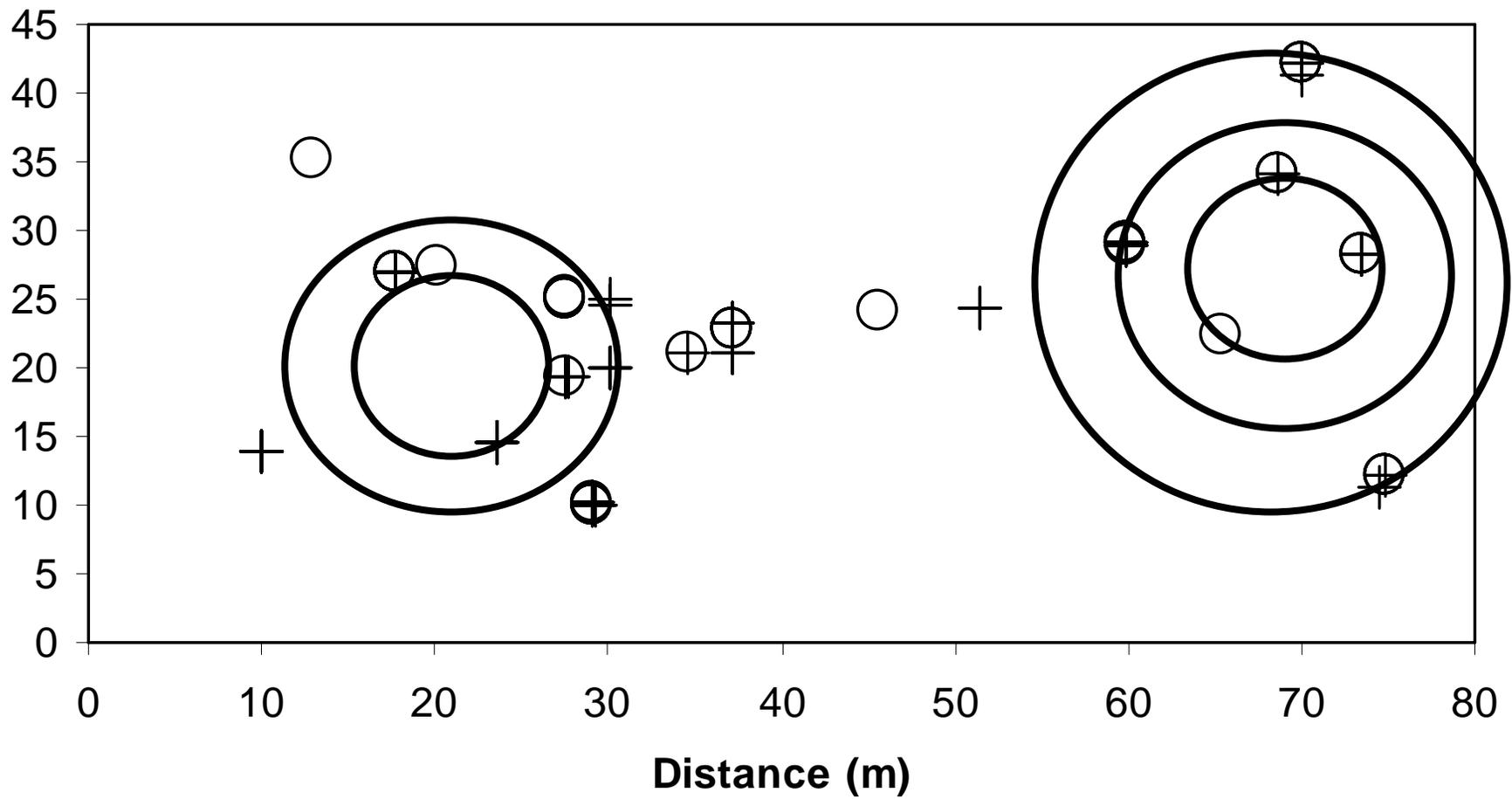




NC17



NC17



Spatial Genetic Structure

	Ripley	All plants	Juvenile	Adult
UP1	6m	6m	6m	none
UP2	All	4m	2m	2, 10m
UP3	All	2m	2m	10m
UP4	All	none	6m (-16m)	none
P5	14m	4m	none	4m
P6	All	2m	2,12	none
P7	All	2m	2,8m (-12,14m)	none
P8	All	none	none	none

Significant Fine-Scale Genetic Structure

- Significant spatial clumping
- Juvenile plants clustered around adults
- Spatial genetic structure at 2m
- Dispersal into microhabitats, limited seed dispersal

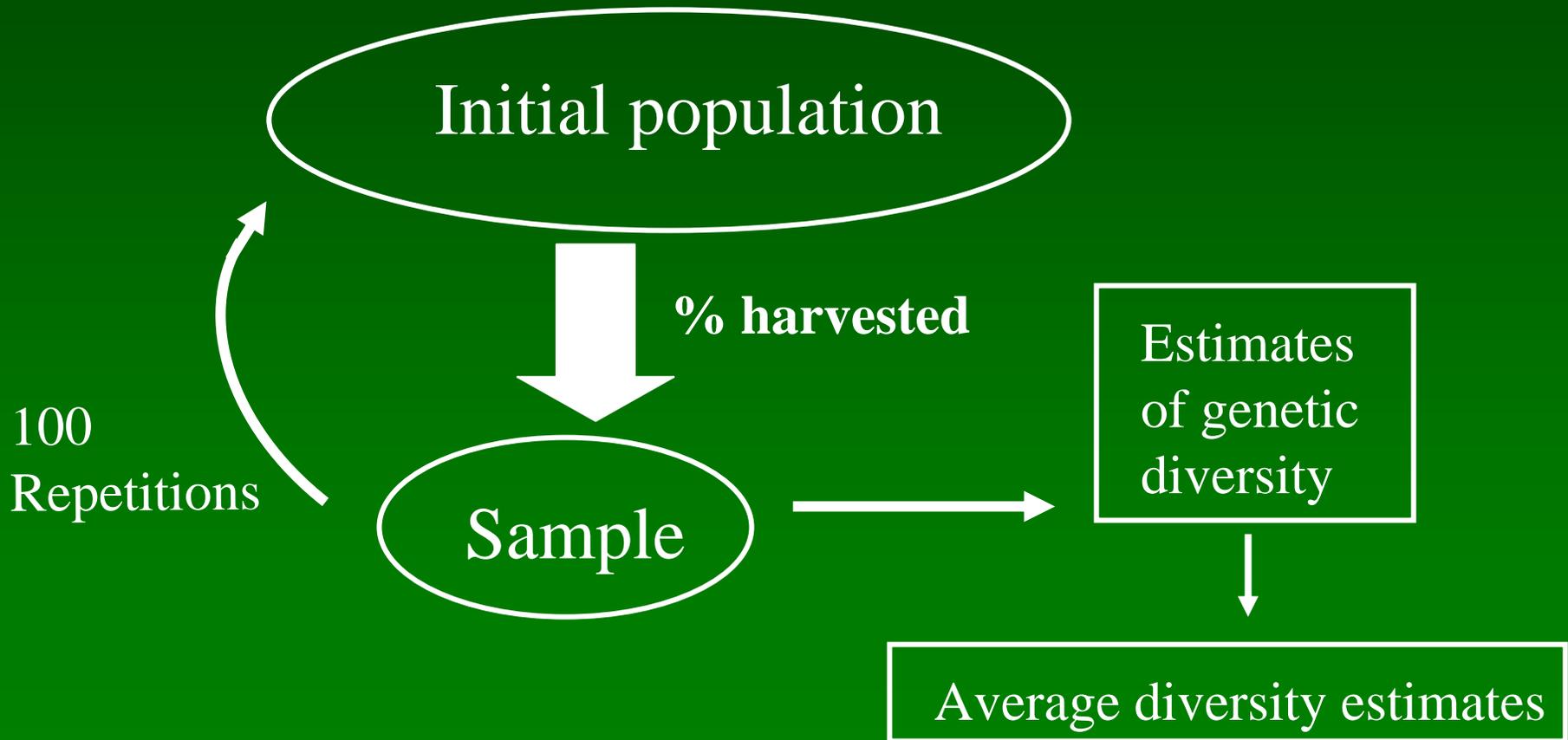


Patterns of Harvest

- Experienced harvesters collect all large plants (Lewis 1984)
- Choosy harvesters: fewer, larger plants
- Busy harvesters: many, smaller plants
- Sustainable harvest 0 – 16% (Charron and Gagnon 1991)
- 30% harvest every 5 years results in population decline (Nantel et al. 1996)
- Herbivory (McGraw and Furedi, 2005)

ID	STATUS	N	% HARVESTED
NC6	P	43	50
NC7	P	52	10
NC14	P	87	10
NC15	P	106	10
NC17	P	96	30
G1	U	61	20
G2	U	48	10
G3	U	66	50
G4	U	104	50
NC10	U	27	40
NC12	U	34	40
NC13	U	39	30
NC18	U	64	20
WV19	U	100	20
MD21	U	94	20

Simulated Random Harvest for One Generation



Significant Loss in Diversity with Simulated Harvest

Average within population estimates

	N	P	He	Allelic richness
Initial	15	30 ^a	0.075 ^a	22 ^a
Random harvest	15	28 ^a	0.061 ^c	21 ^b
Adult Harvest	15	27 ^b	0.072 ^b	21 ^b

Conservation Implications

- Populations in **protected** areas had **higher** genetic diversity
- Random culling **reduced genetic diversity** and **increased variation** in expected diversity
- Harvest less than the proportion of mature plants in population

Conservation Implications

- Harvesting affects the **structure** of genetic diversity among populations
- **Many different populations** must be protected to maintain the majority of genetic diversity within the species
- High genetic structure; difficult to predict diversity in any one population

Future Studies

- **Demography** and reproduction within natural populations
- Impact of **habitat quality** on populations
- **Relationships** among plants across the species range



Acknowledgements

- Georgia Natural Heritage Program
 - Tom Patrick
 - Regina Malcolm
 - Jon Ambrose
 - Jim McGraw
 - John Nason
 - Daniel Gagnon
- Great Smoky Mountain National Park
 - Janet Rock
 - Keith Langdon
- National Forest Service
 - Gary Kauffman
 - Cindy Wentworth

Acknowledgements

Hoyt Bonds
Mark Crawford
George Hoover
Tony Hayes
Arlie McCaleb
Earl Raburn
James Sullivan
John Tate
Charles White
Malcom Wright



State Botanical Garden of Georgia
National Council of State Garden Clubs
Plant Biology Department Small Grant