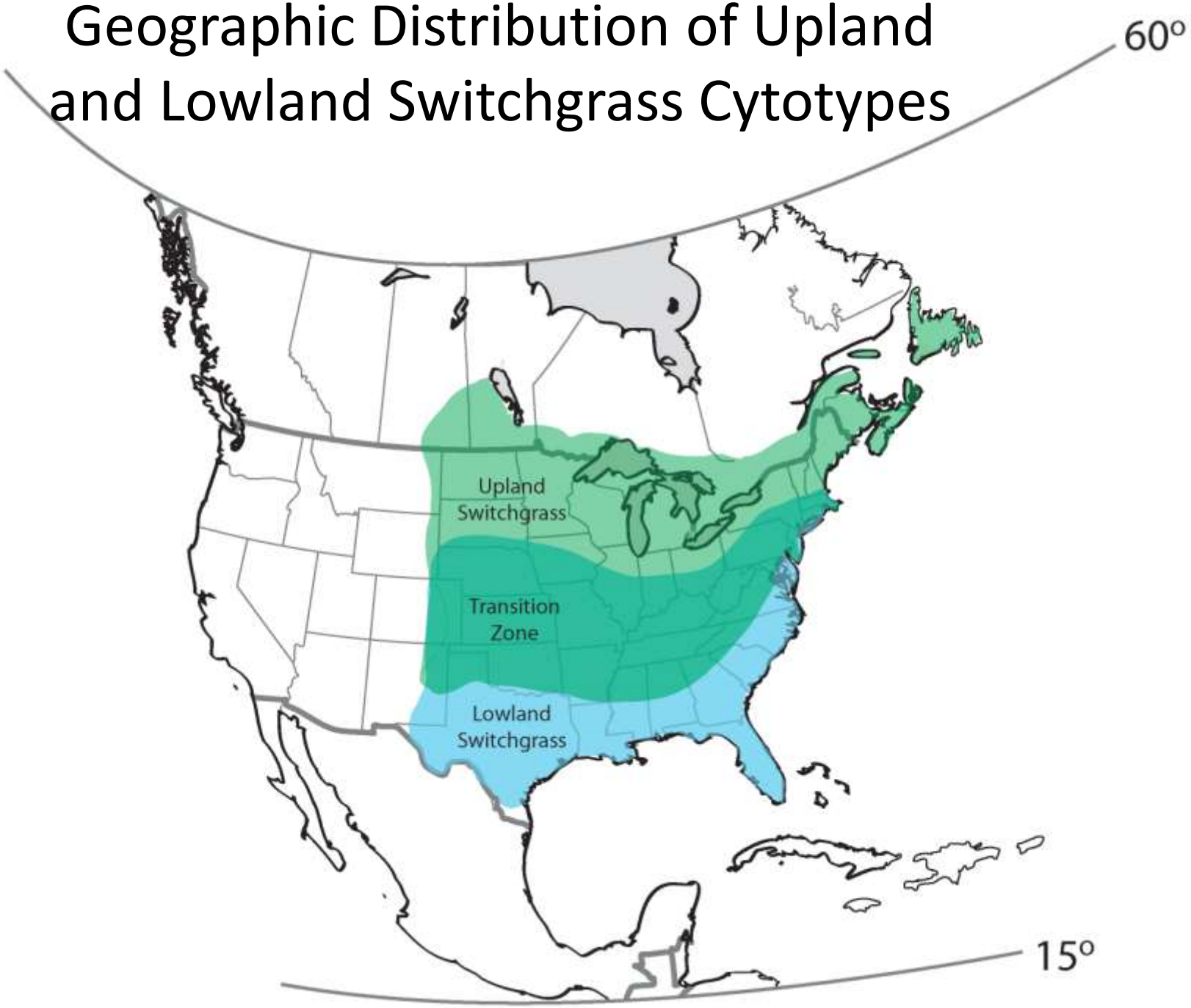
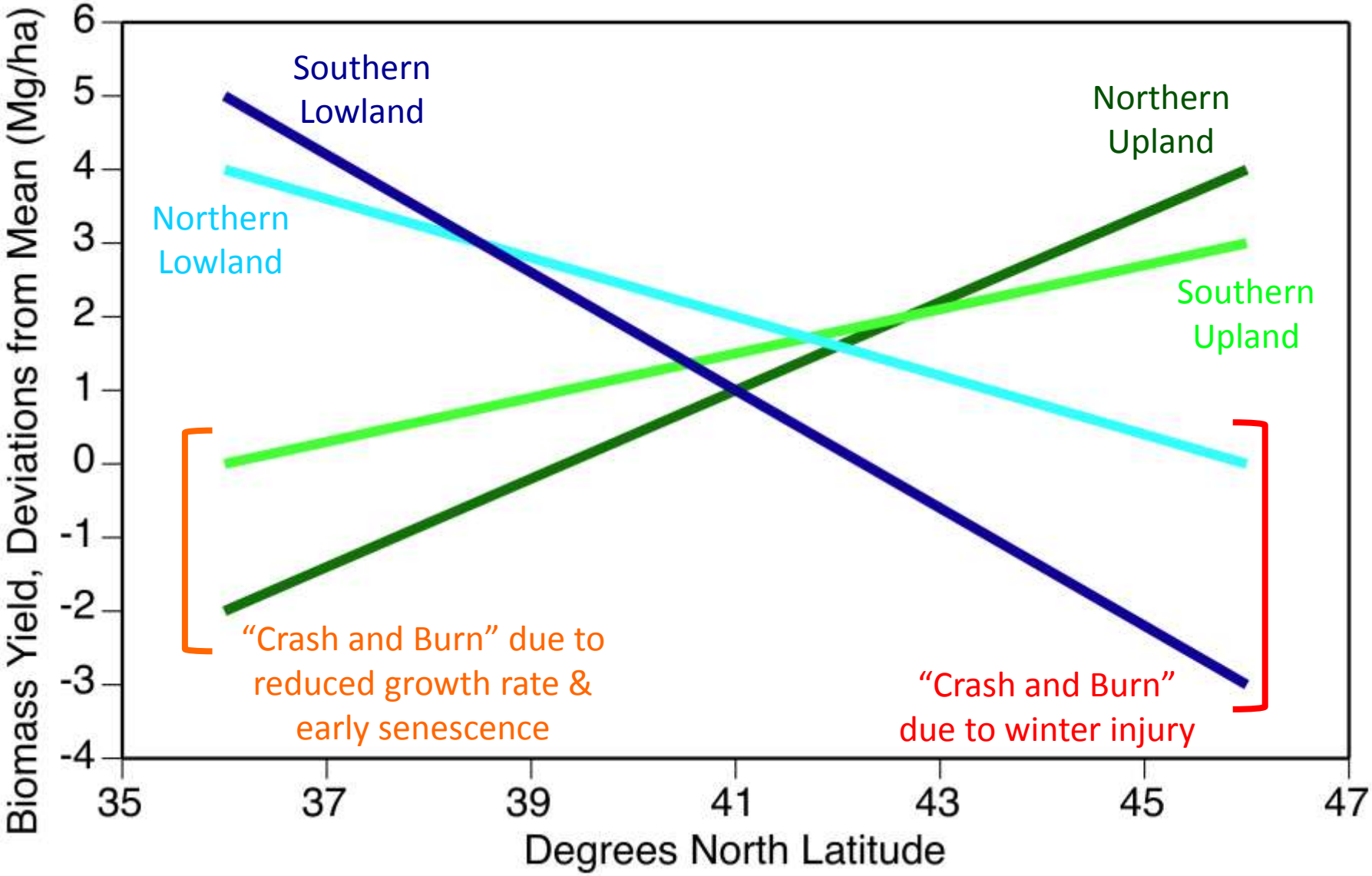
Origins, Adaptive Radiation, and Evolution of Switchgrass

Michael Casler
U.S. Dairy Forage Research Center
USDA-ARS, Madison, WI
& University of Wisconsin

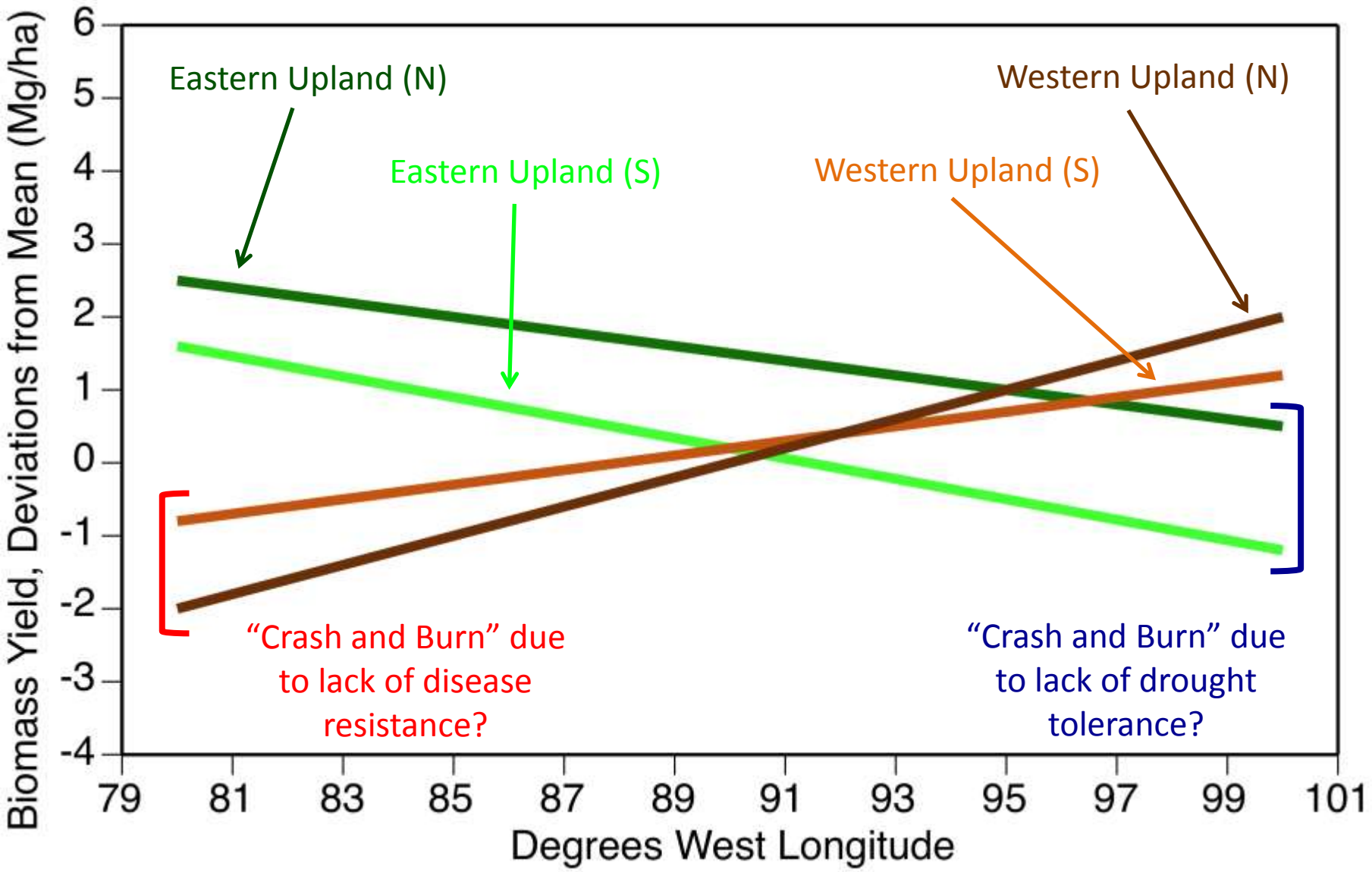
Geographic Distribution of Upland and Lowland Switchgrass Cytotypes



Biomass yield vs. Latitude



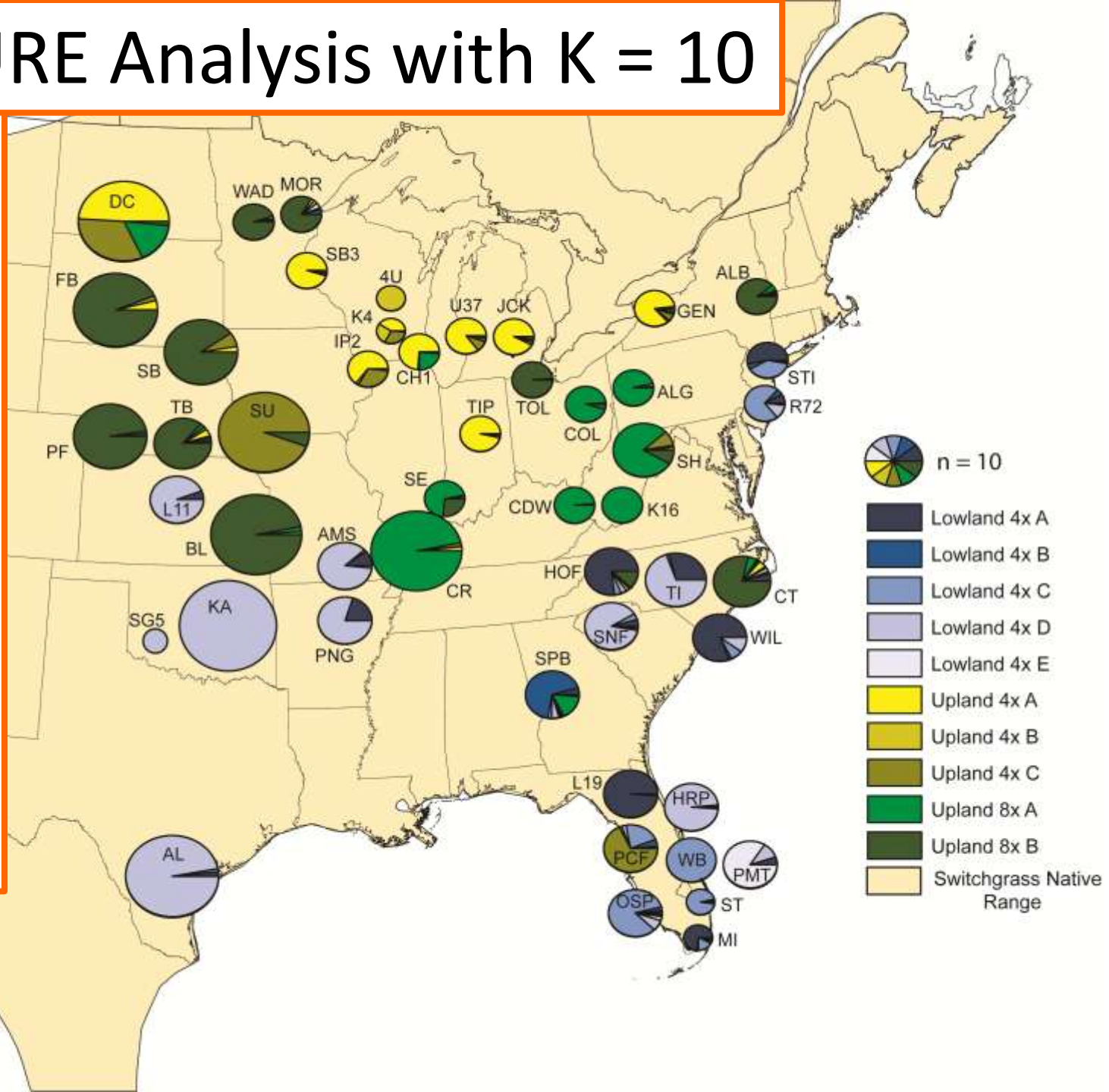
Biomass yield vs. Longitude



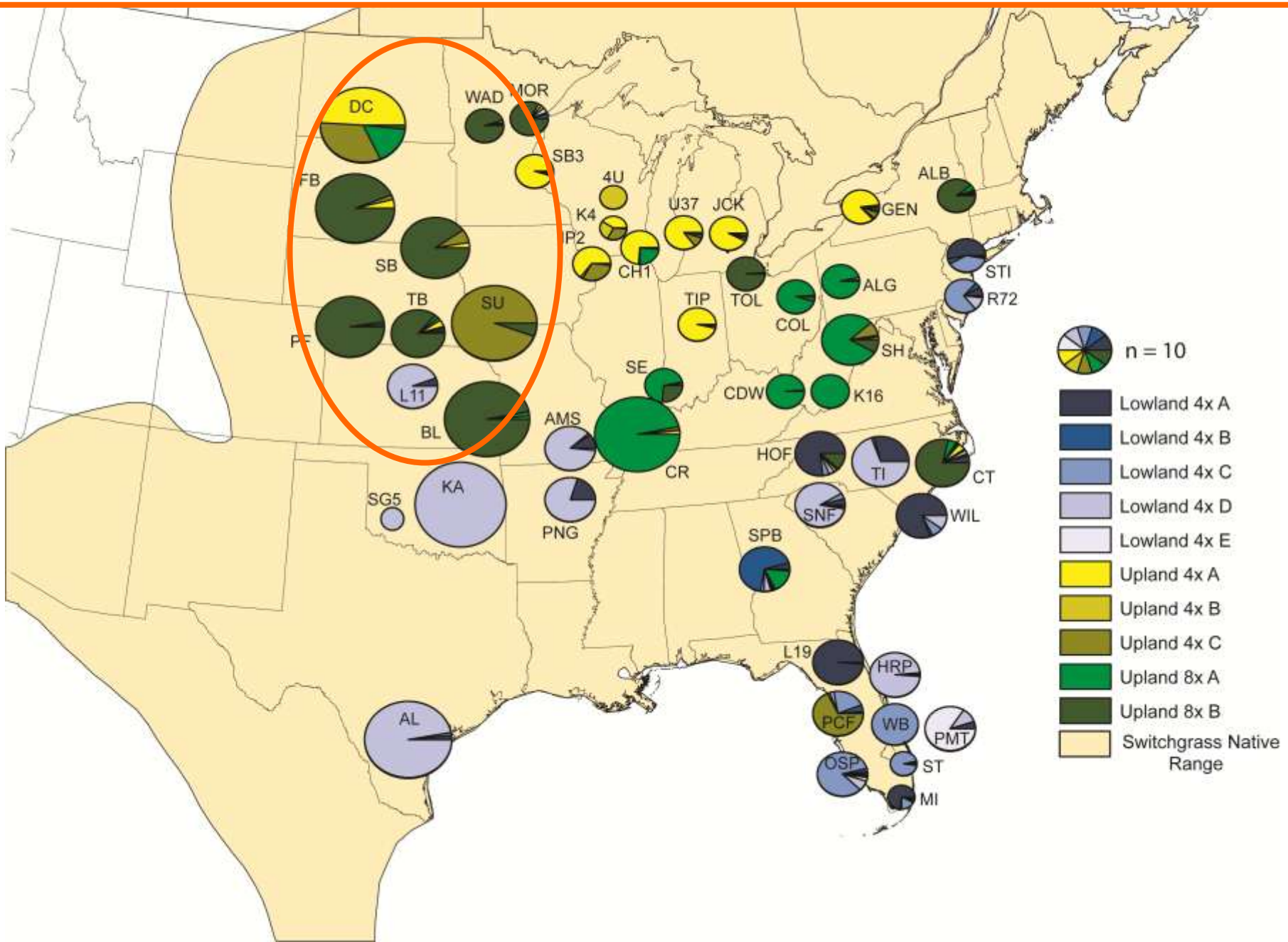
STRUCTURE Analysis with K = 10

Each "pie" represents one source-identified accession.

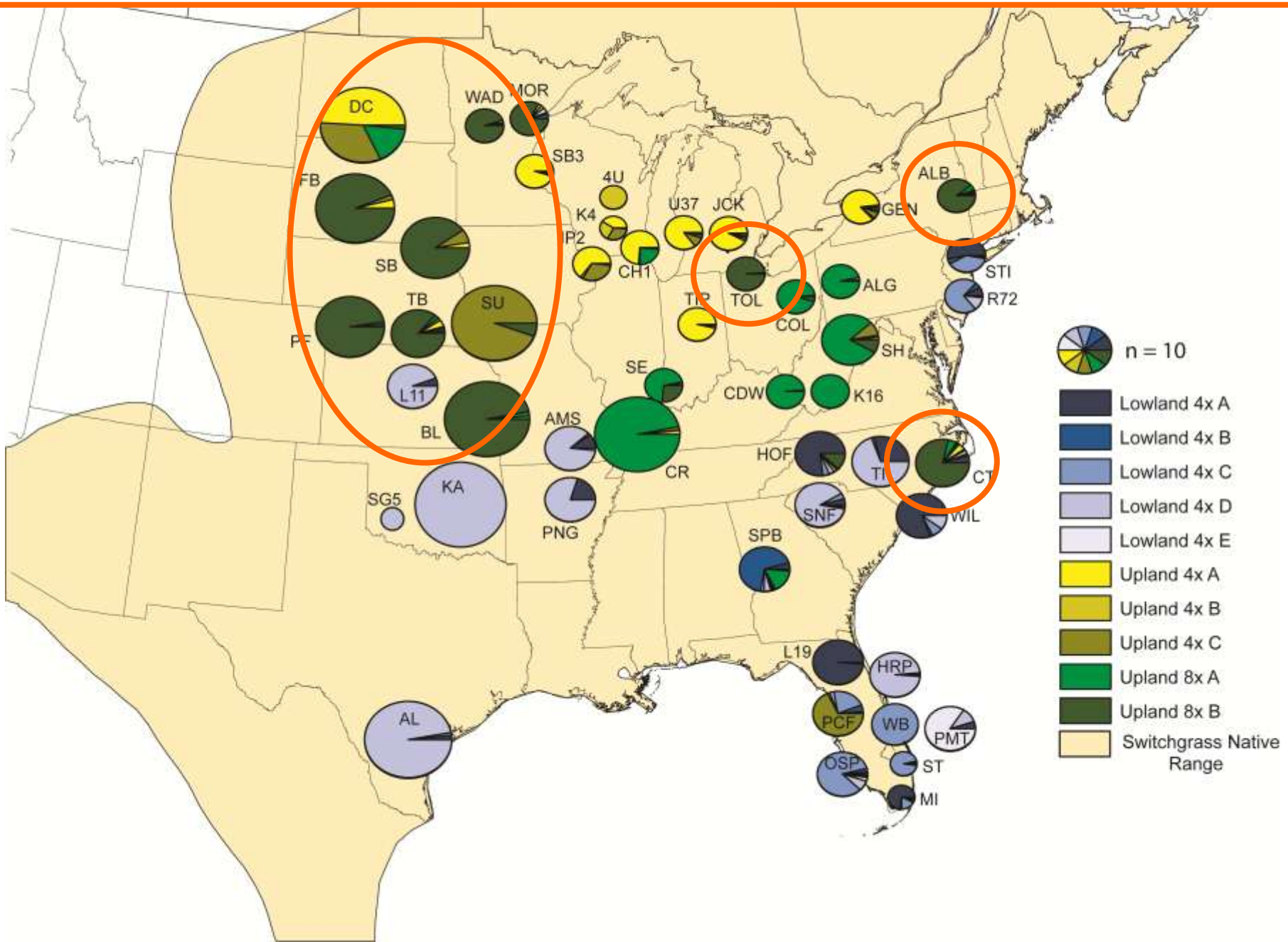
Each pie slice represents the probability of membership in the group identified by a specific color.



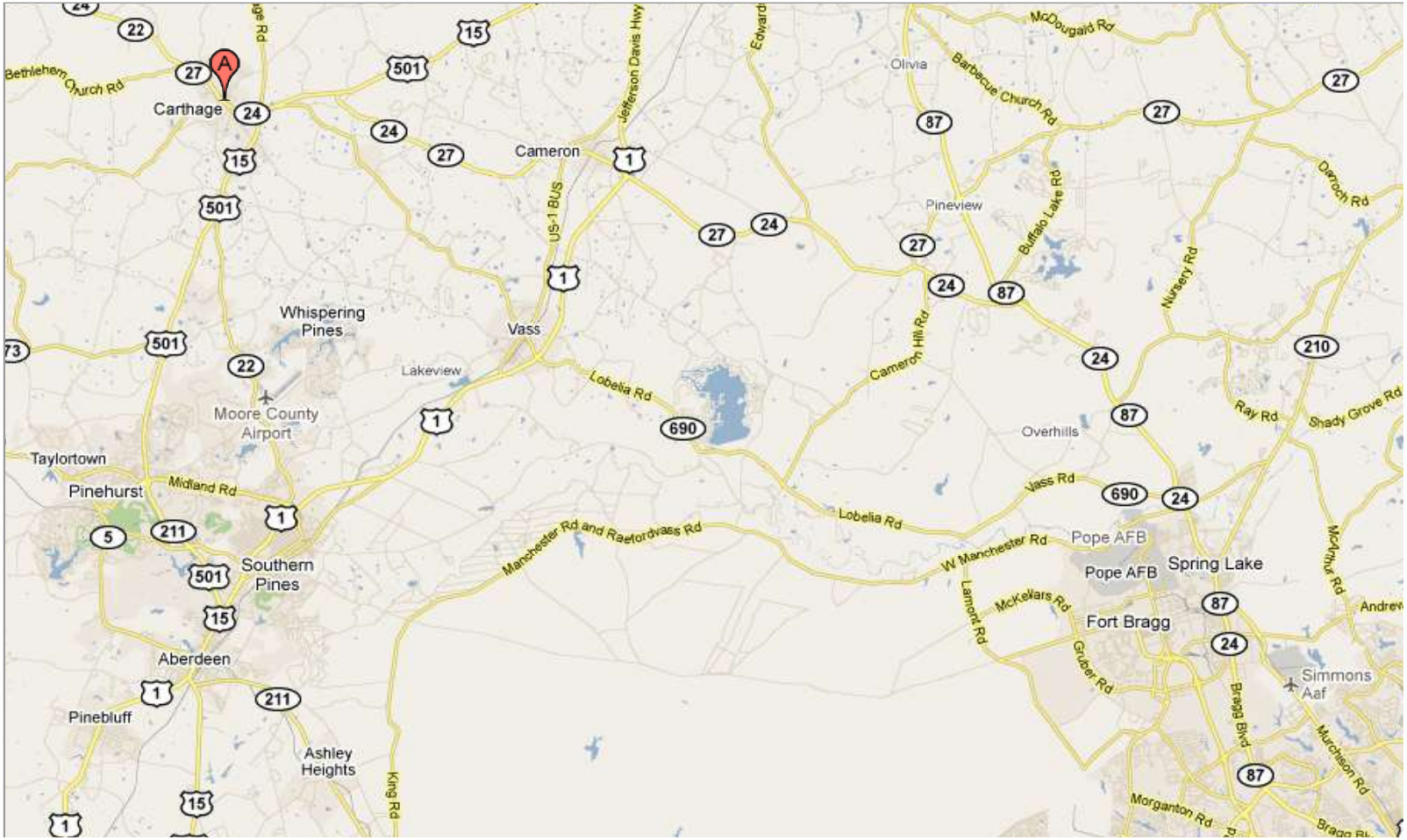
Central and Northern Great Plains 8x Upland Lineage



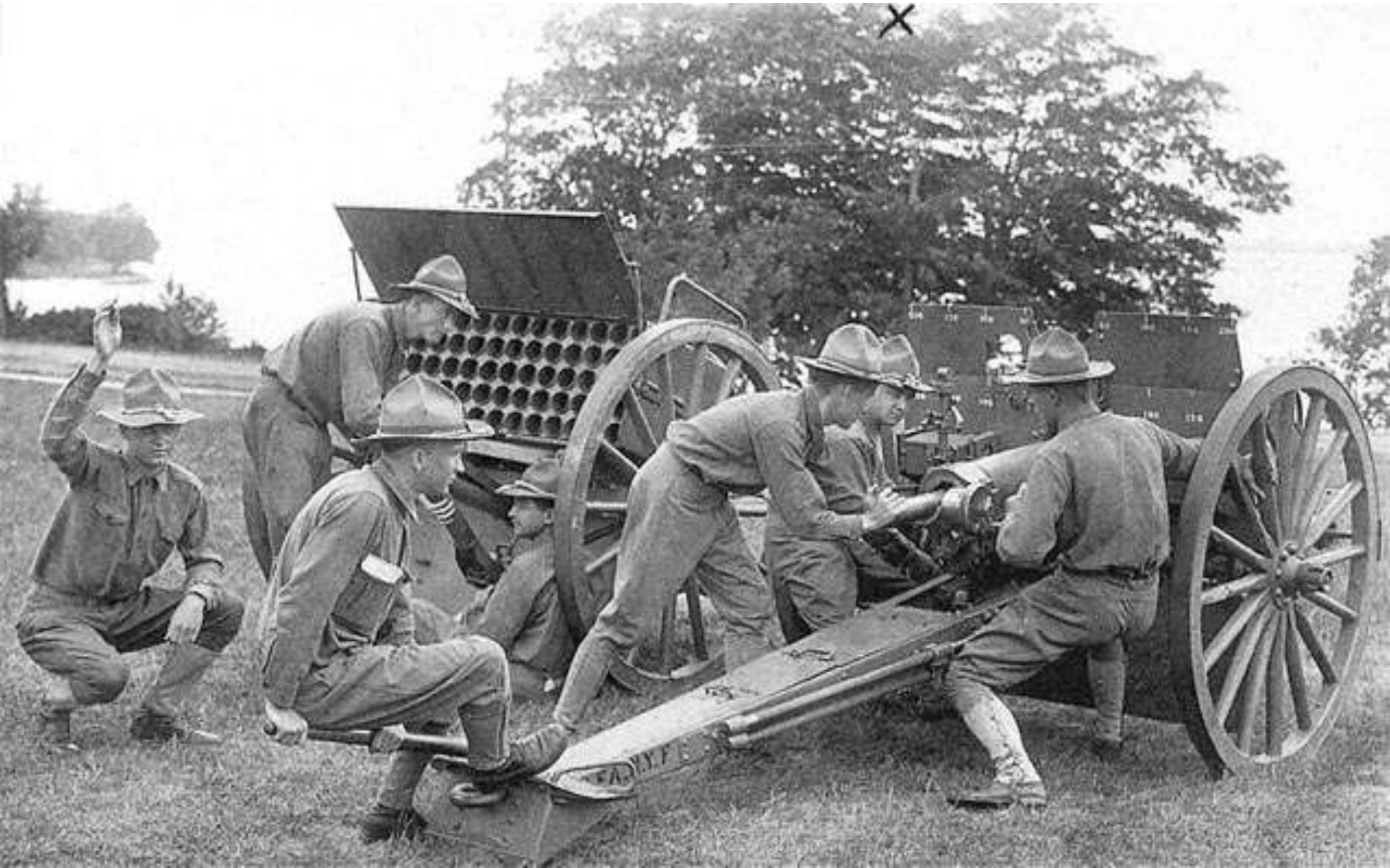
Central and Northern Great Plains 8x Upland Lineage



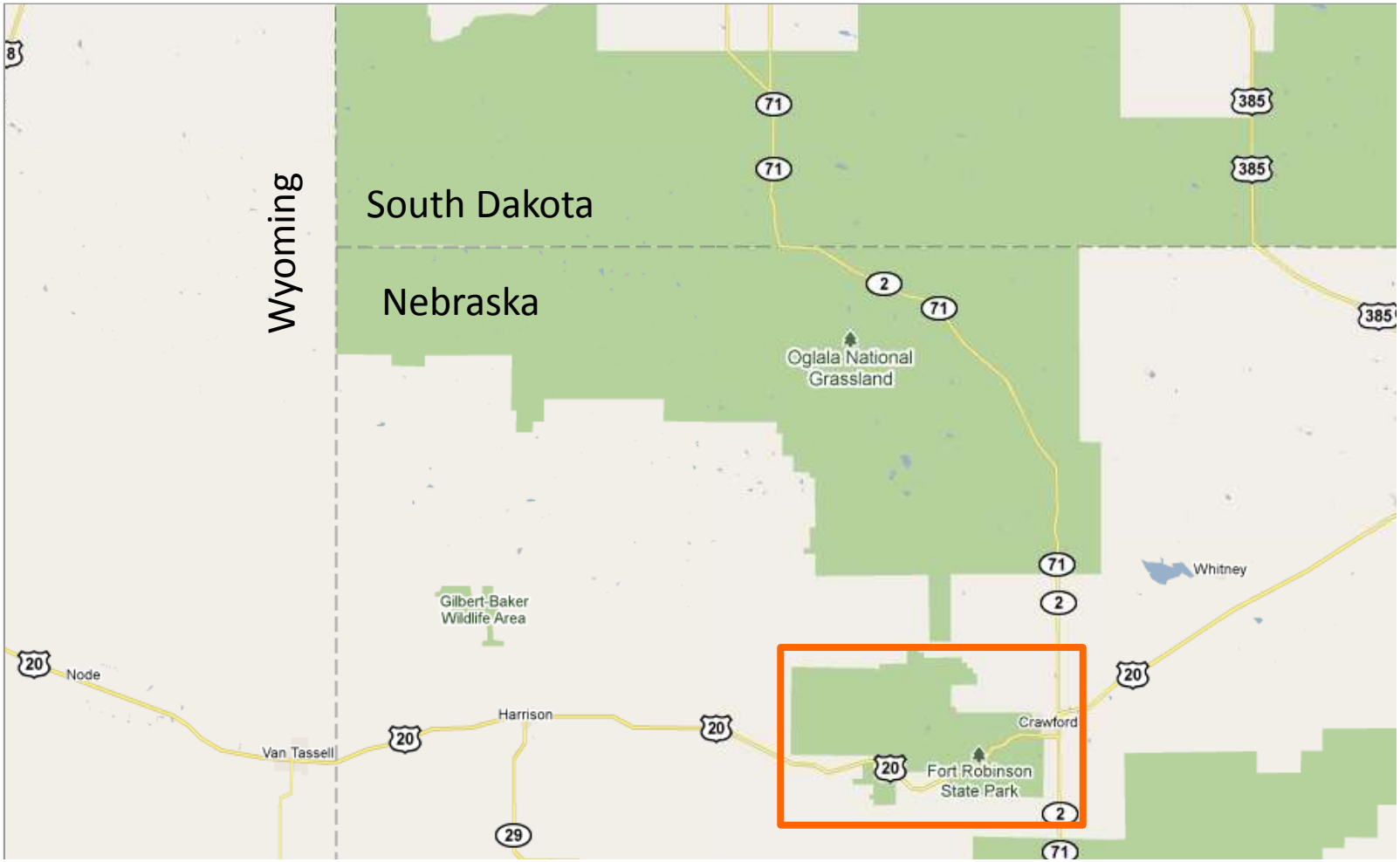
Origin of the ‘Carthage’ Accession



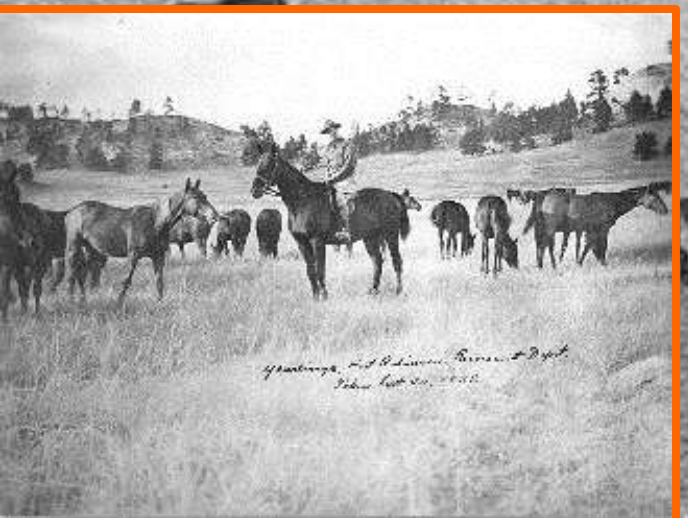
Fort Bragg: 1918 - 1939

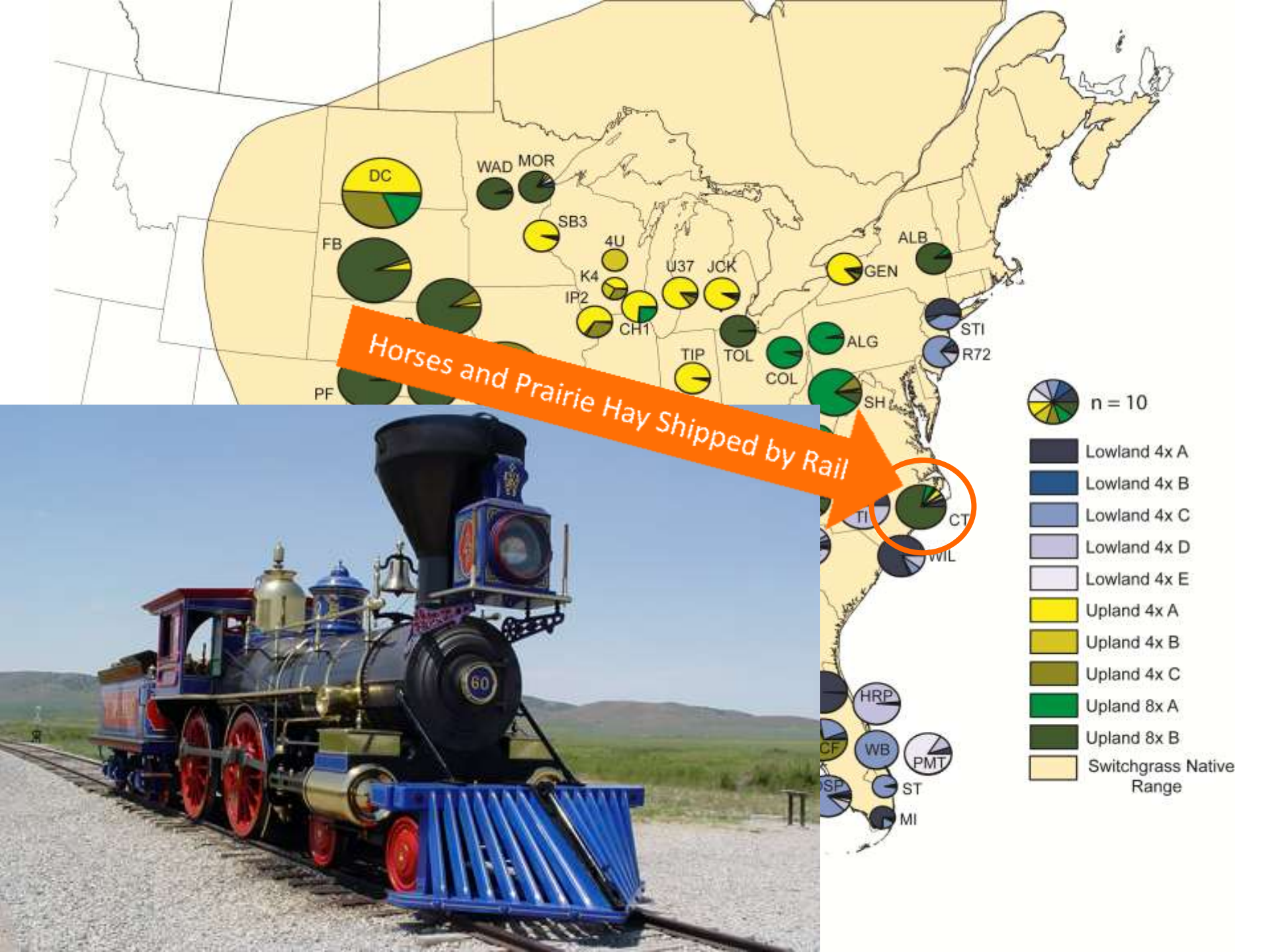


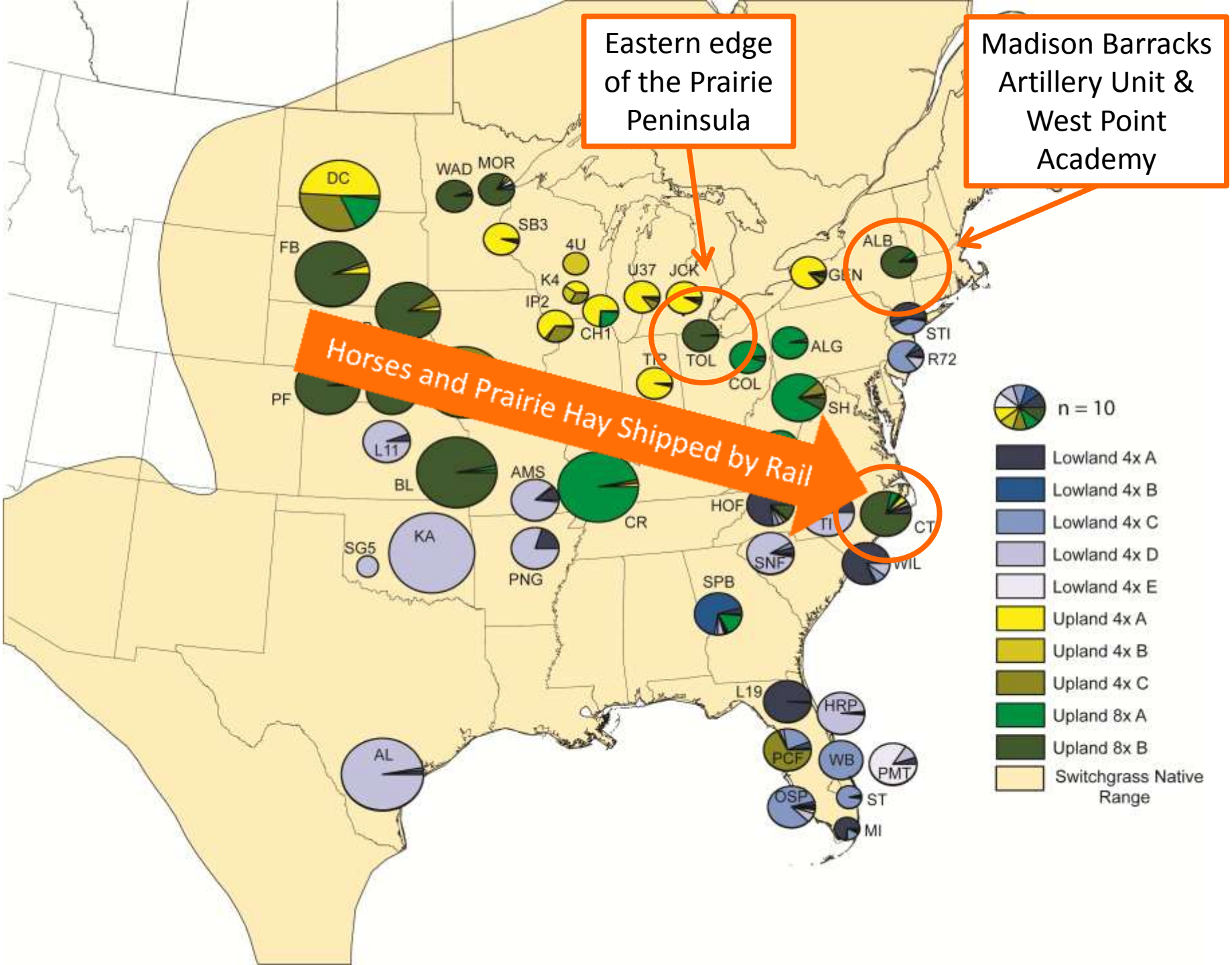
Fort Robinson
Sand Hills Region of Nebraska



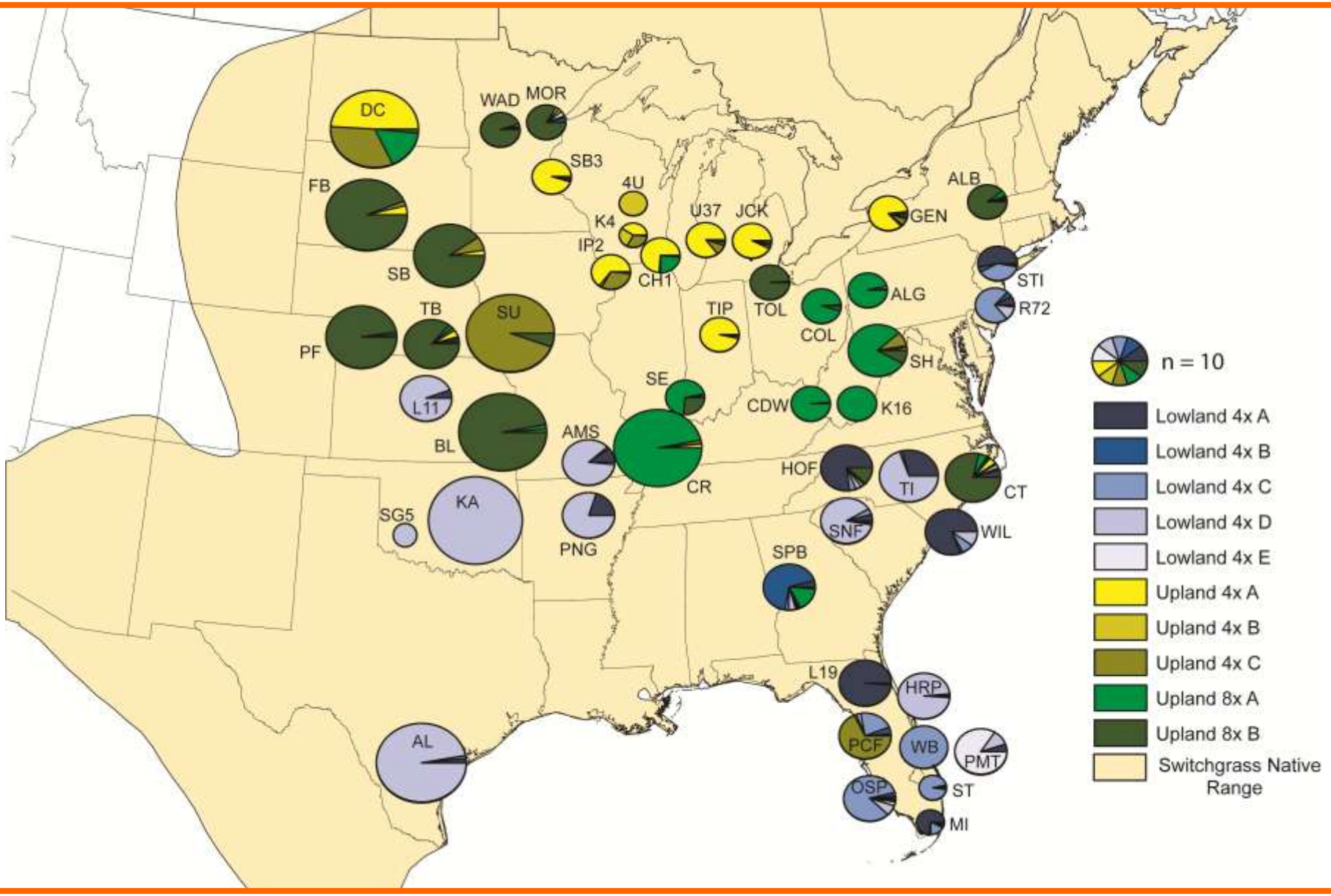
Fort Robinson
U.S. Army Remount Station, 1919-1943




Horses and Prairie Hay Shipped by Rail
DC
WAD
MOR
SB3
FB
4U
K4
IP2
CH1
U37
JCK
TIP
TOL
COL
ALB
GEN
ALG
STI
R72
SH
PF
CT
WIL
HRP
WB
PMT
ST
MI
n = 10
Lowland 4x A
Lowland 4x B
Lowland 4x C
Lowland 4x D
Lowland 4x E
Upland 4x A
Upland 4x B
Upland 4x C
Upland 8x A
Upland 8x B
Switchgrass Native Range

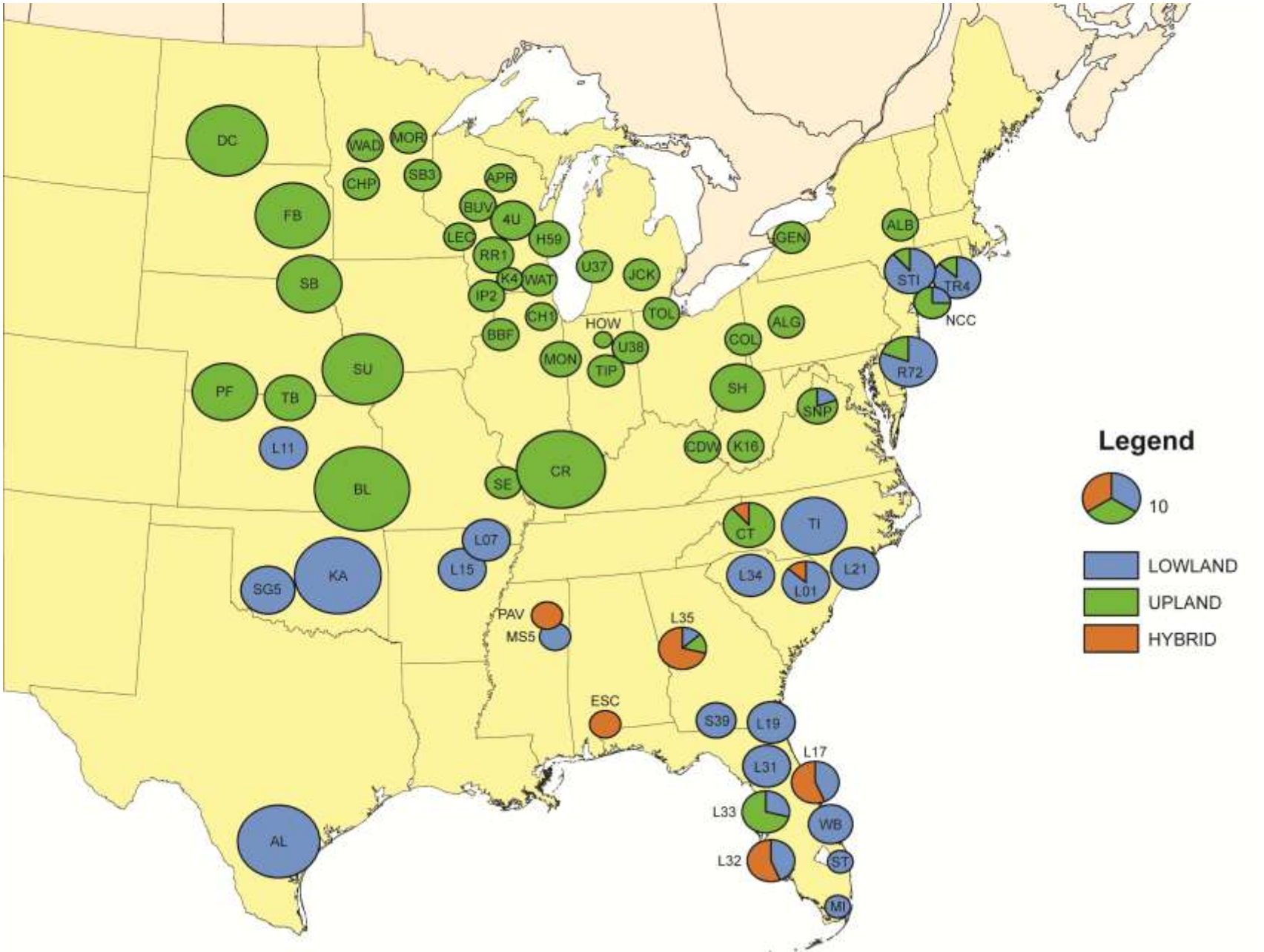

Eastern edge of the Prairie Peninsula
Madison Barracks Artillery Unit & West Point Academy
Horses and Prairie Hay Shipped by Rail
DC
WAD
MOR
SB3
FB
4U
K4
IP2
CH1
U37
JCK
TOL
TIP
COL
ALB
GEN
STI
R72
ALG
SH
PF
L11
BL
AMS
CR
HOF
TI
CT
WIL
SG5
KA
PNG
SNF
SPB
L19
HRP
PCF
WB
PMT
ST
OSP
MI
AL
n = 10
Lowland 4x A
Lowland 4x B
Lowland 4x C
Lowland 4x D
Lowland 4x E
Upland 4x A
Upland 4x B
Upland 4x C
Upland 8x A
Upland 8x B
Switchgrass Native Range

Strong patterning in the Upland Accessions (North).

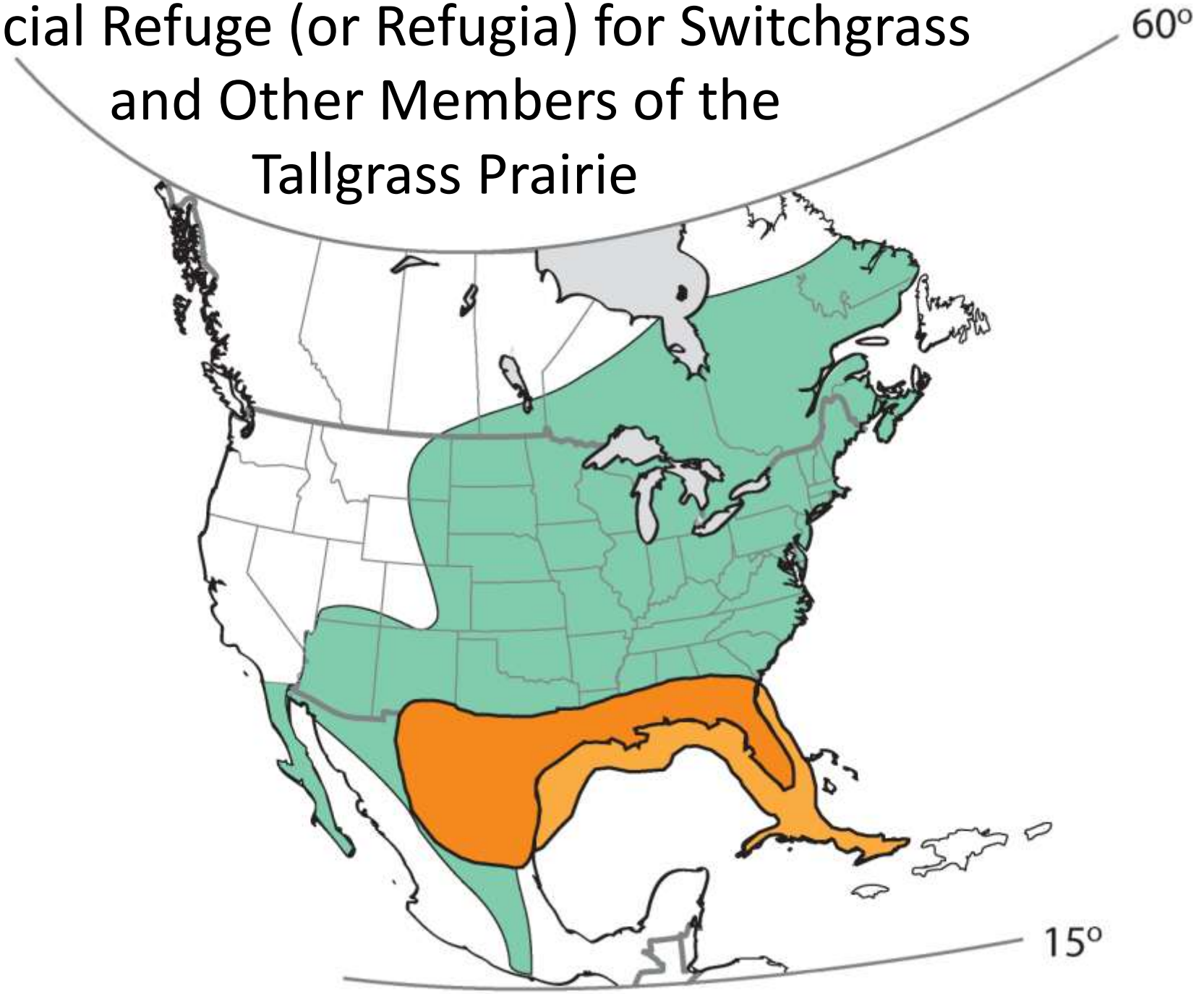


Weak patterning in the Lowland Accessions (South).

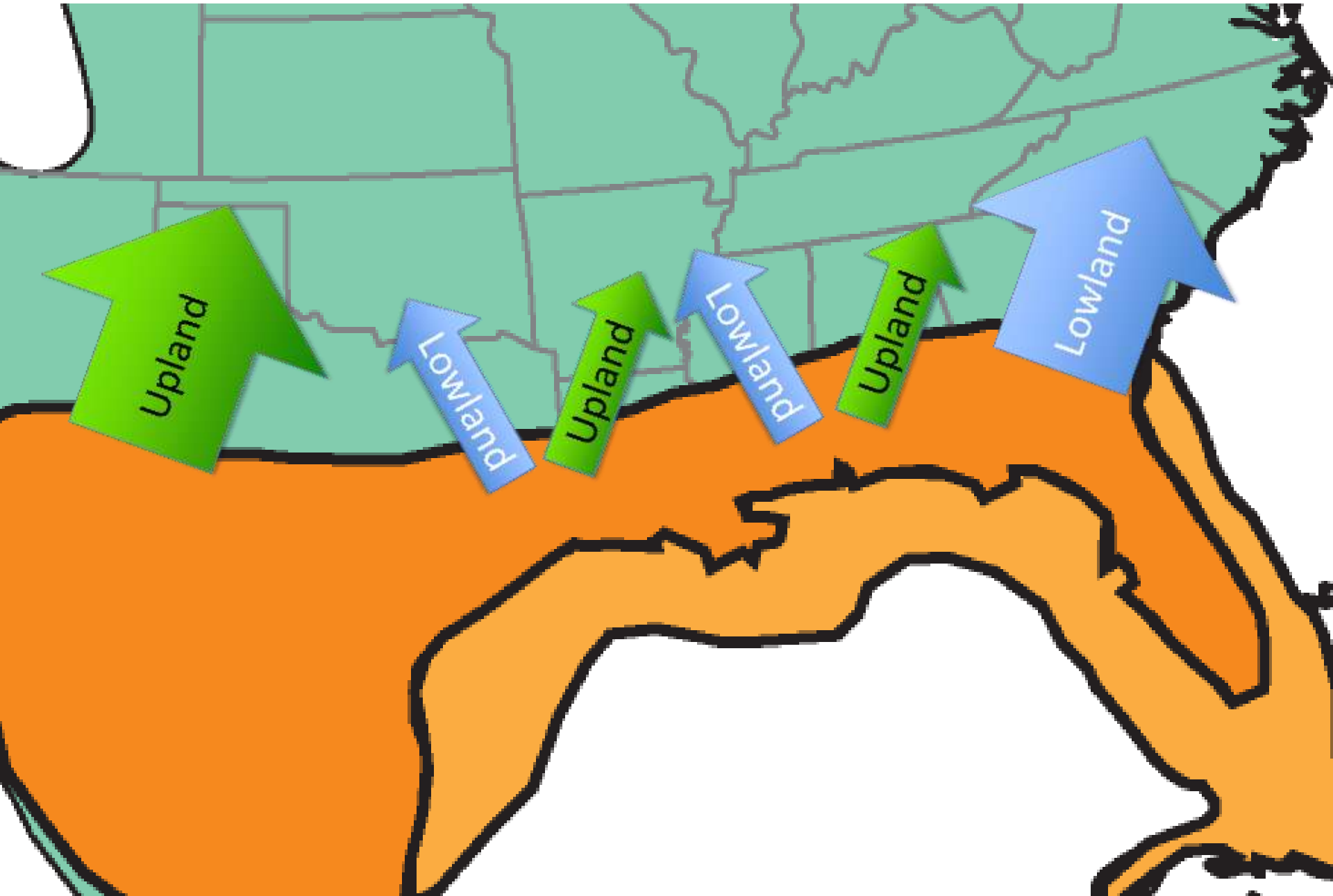
Distribution of Putative Hybrids



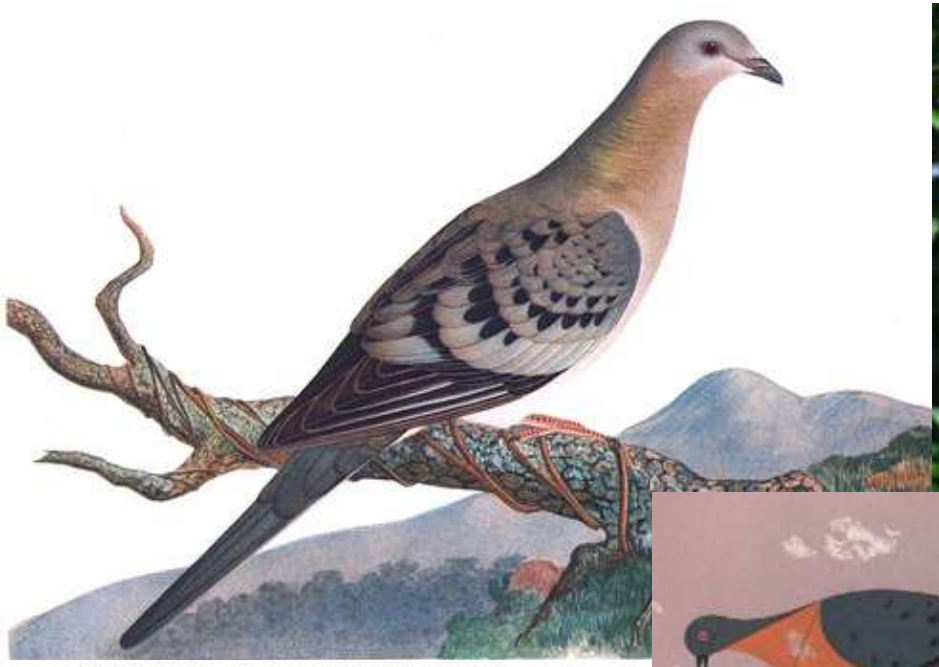
Glacial Refuge (or Refugia) for Switchgrass and Other Members of the Tallgrass Prairie

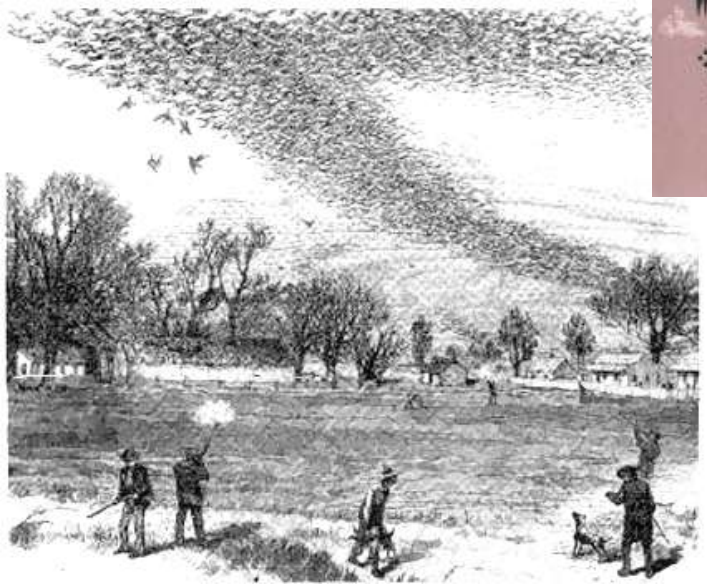


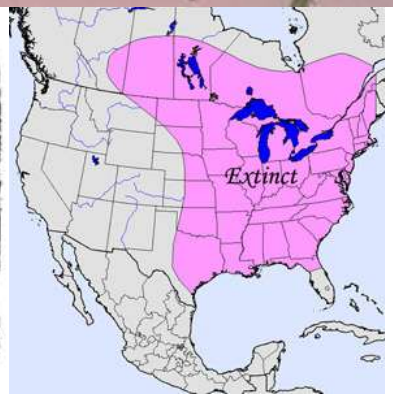
Post-Glacial Migration Routes



How Did Switchgrass Migrate Northward?

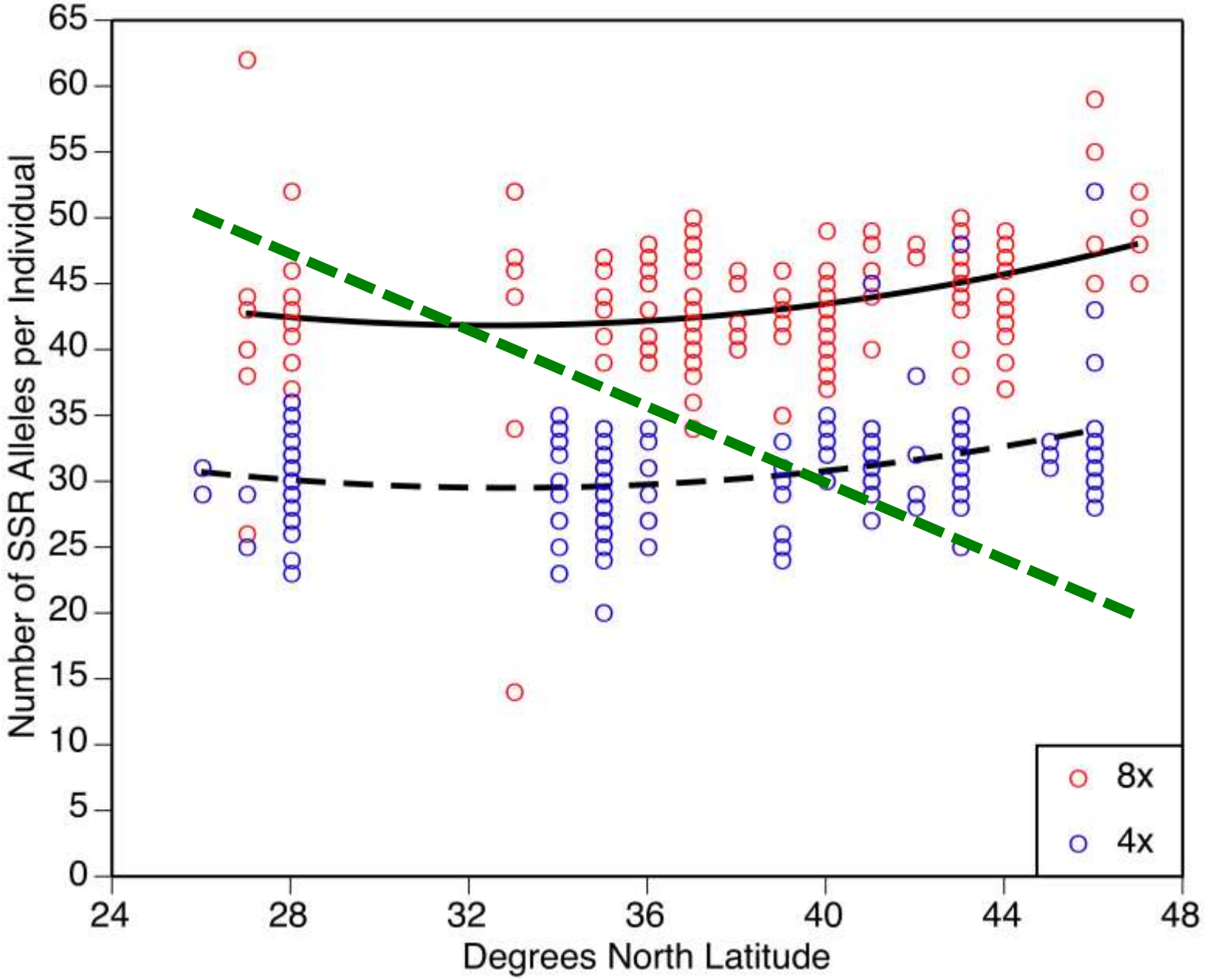






Migration, Mixing, and the Existence of Genetic Bottlenecks?

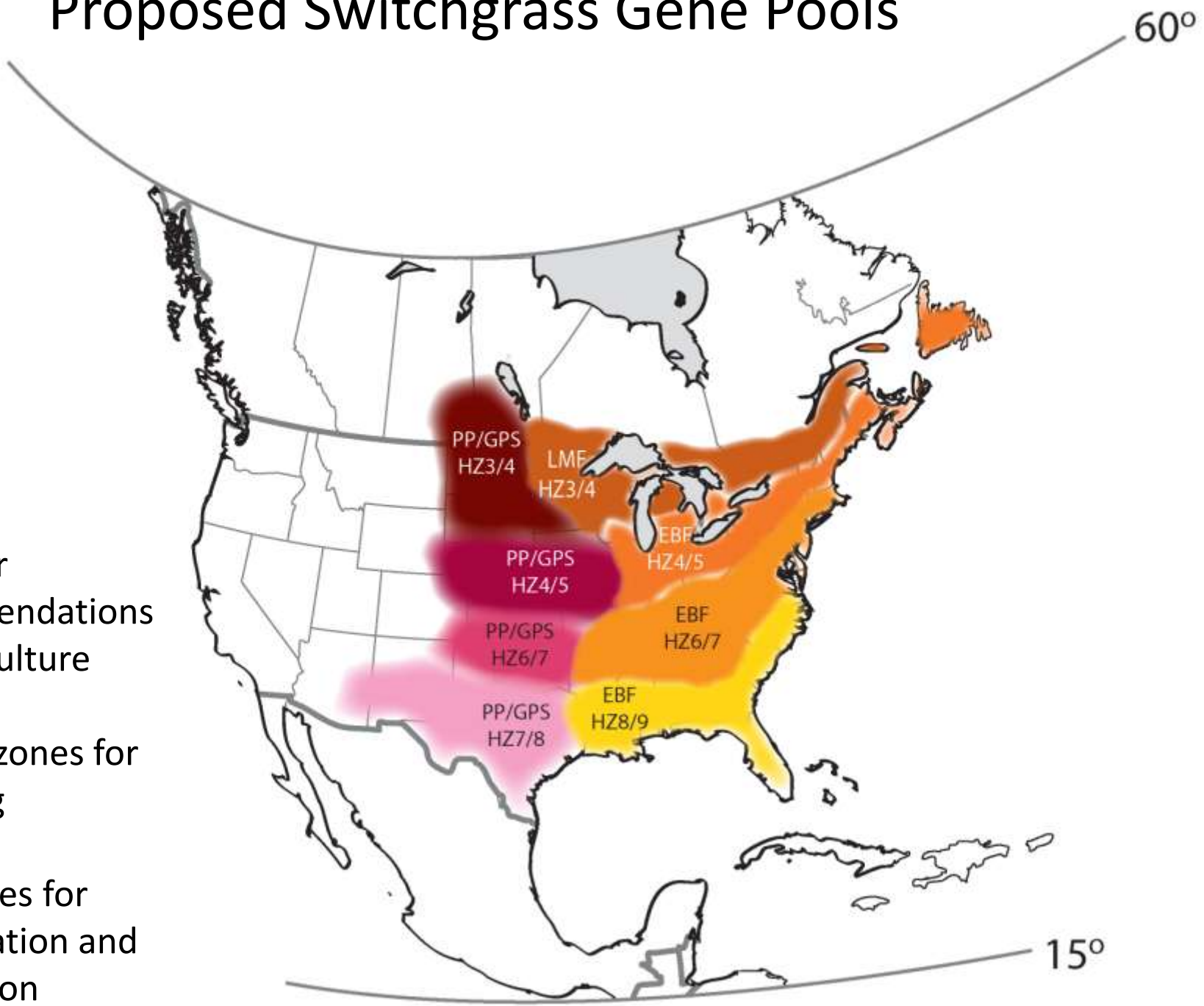
No Genetic Bottleneck for Switchgrass



Ice Age Cycles

- Major Northern Hemisphere glaciations began ~2.7 Mya.
- Since the earliest estimated divergence between upland and lowland types, there have been about 15-20 major North American glaciation events.
- Tallgrass prairie species have undergone massive forward and reverse migrations within each cycle. Due to migration patterns and causes, most sites contain multiple haplotypes, some of widely divergent origins.

Proposed Switchgrass Gene Pools



- Cultivar recommendations for agriculture
- Target zones for breeding
- Localities for conservation and restoration

Conclusions

- We have identified one Center of Diversity in the SE USA and suspect that others exist all along the Gulf Coast and perhaps in West TX.
- Genetic diversity exists throughout the range of switchgrass; genetic bottlenecks associated with northward migration have been overcome by long-range east-west migration and hybridization.
- Phenotypic and genotypic studies have led to identification of a gene-pool concept to assist in a wide range of germplasm decisions.

Acknowledgements

- Casler lab (USDA-ARS, University of Wisconsin, & DOE Great Lakes Bioenergy Research Center)
  - Yunwei Zhang, Visiting Professor, CAU, Beijing
  - Juan Zalapa, Post-doc, GLBRC
  - Andy Jakubowski, Ph.D. graduate student
  - David Price, Ph.D. graduate student
  - Shawn Kaeppler, Professor, UW
- Brummer lab (UGA and Noble Foundation)
  - Ananta Acharya, Ph.D. graduate student
  - Yanling Wei, Post-doc, University of Georgia

Funding Sources

- USDA-ARS
- Department of Energy, Great Lakes Bioenergy Research Center (UW, MSU, ISU)
- University of Wisconsin, Agricultural Research Stations
- University of Georgia
- Department of Energy, BioEnergy Sciences Center (UGA, ORNL, Noble)
- The Samuel Roberts Noble Foundation, Ardmore, OK

QUESTIONS?