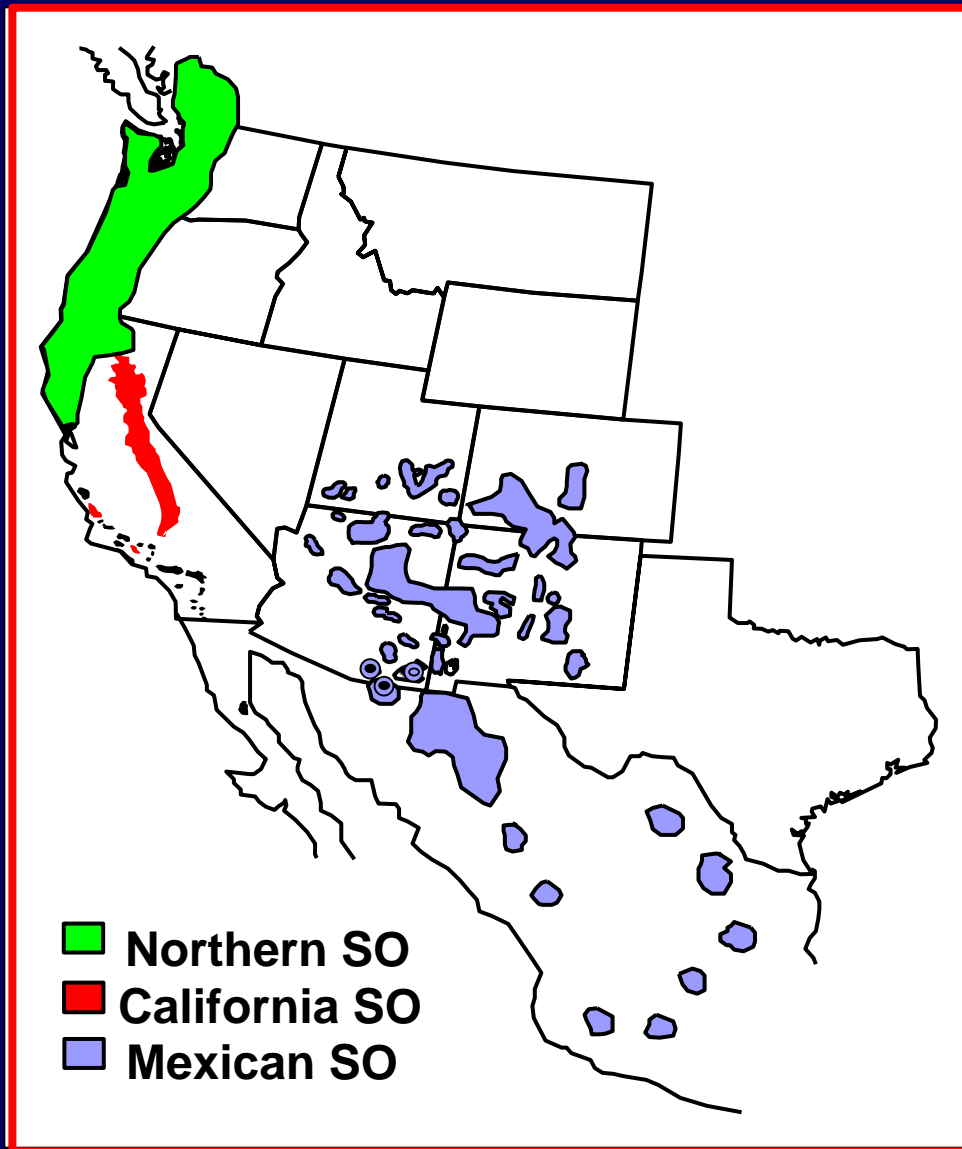


POPULATION GENETIC STRUCTURE IN SPOTTED OWLS

Susan Haig, Thomas Mullins, &
Eric Forsman



Distribution of Spotted Owls

Genetic Issues for Spotted Owls

- Should Spotted Owls be considered as separate subspecies or are other units more appropriate?
- What is the genetic structure and status of Spotted Owl populations?
- Can we genetically identify Spotted Owls, Barred Owls, and their hybrids?

Genetic Sampling in Spotted Owls

Field Sampling:

- 278 individuals from 30 breeding areas.
- 3 subspecies

mtDNA control region:

- Sequenced 522 bp of domain I & II.
- 63 polymorphic sites.

RAPDs:

- Screened 400 primers.
- 11 variable bands used in analyses.

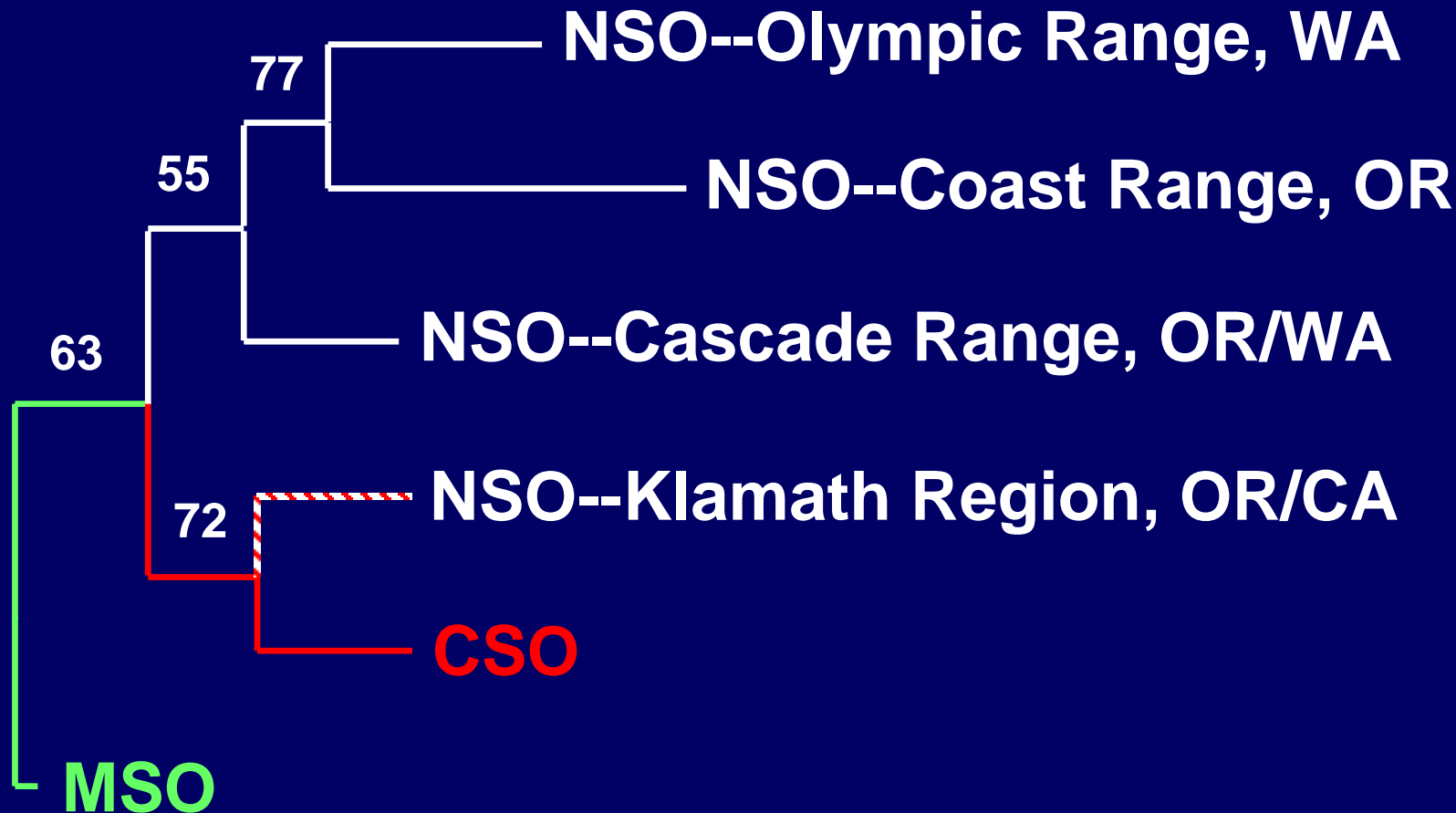
Relationships Among Subspecies of Spotted Owls



Neighbor-Joining in Spotted Owls using RAPDs

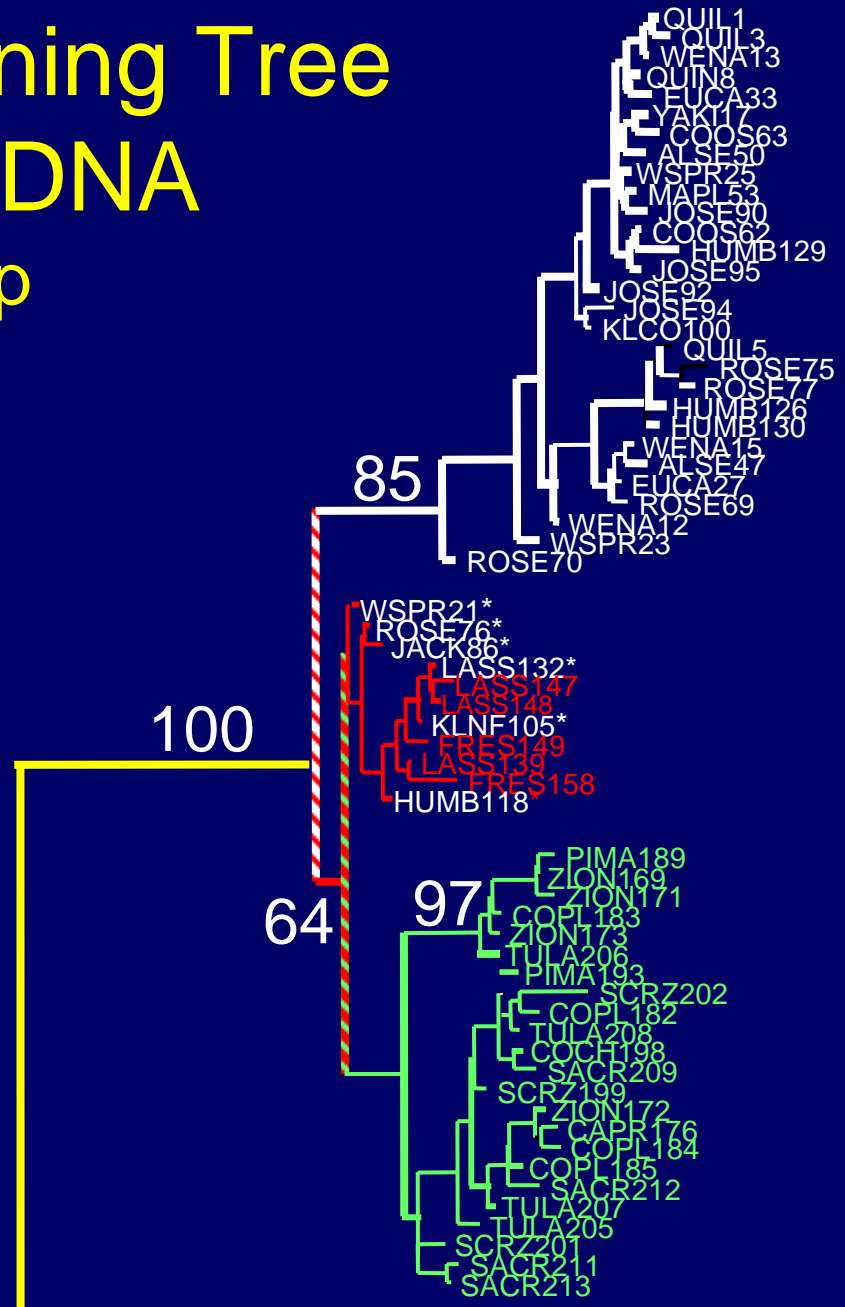


Neighbor-Joining Tree for Regional Comparisons using RAPDs



Neighbor-Joining Tree using mtDNA

522 bp



NSO

CSO

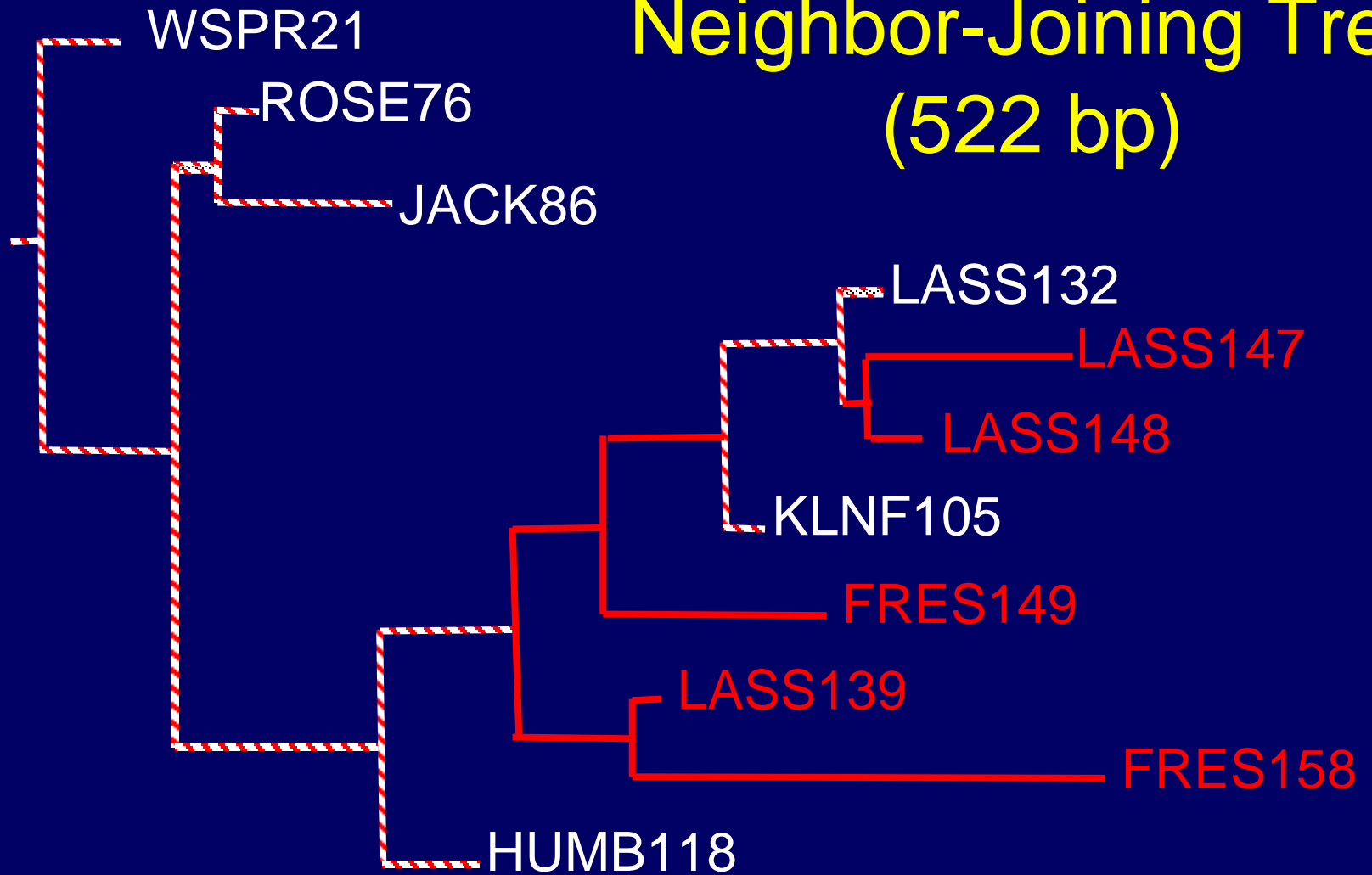
MSO

0.001 substitutions/site



Strix varia

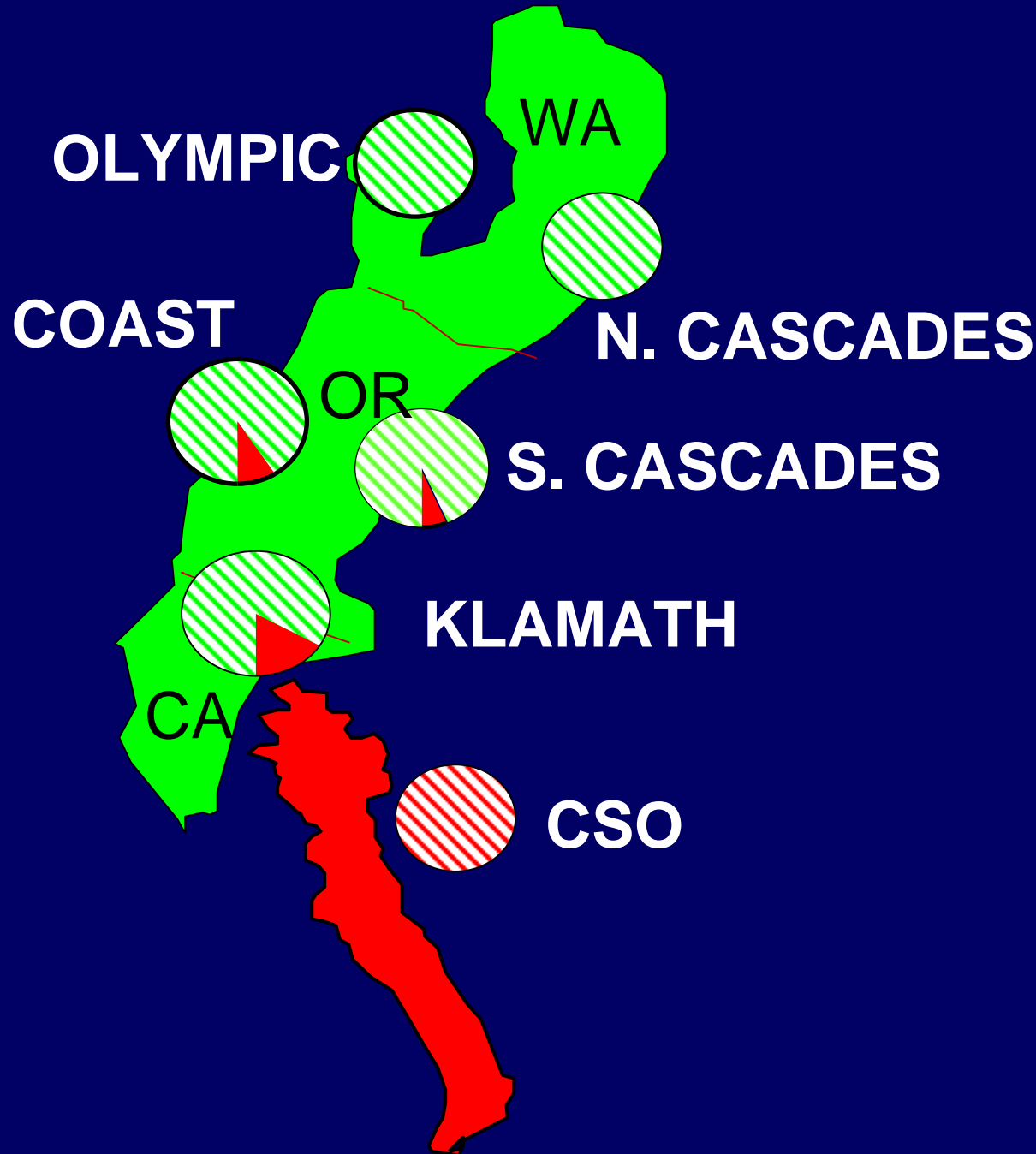
California Spotted Owl Neighbor-Joining Tree (522 bp)



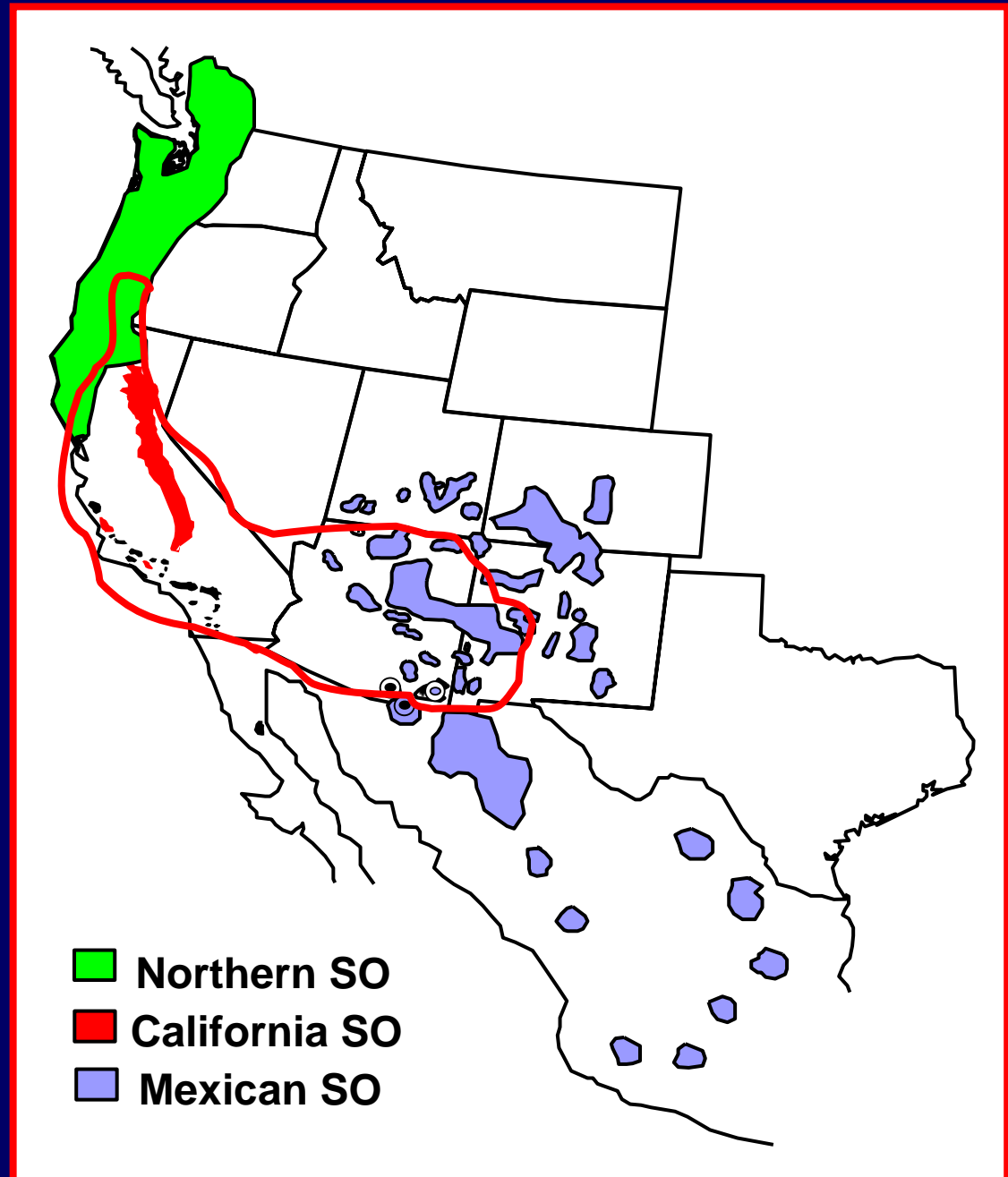
CSO Haplotypes in NSO Range

Region	Location	<u>Haplotypes</u>	
		NSO	CSO
Olym/Casc	Washington	20	0
Coast	Siuslaw, OR	18	2
Cascade	Warm Spr., OR	4	1
Klamath	Roseburg, OR	9	1
	Coos Bay, OR	6	1
	Josephine, OR	6	2
	Jackson Co, OR	7	3
	Klamath NF, CA	7	3
	Humboldt, CA	18	2
Total		116	15

Distribution of NSO and CSO Haplotypes



Nested Clade Analyses for Spotted Owls



Maximum Likelihood Estimates of Asymmetric Migration Among Subspecies

To	From		
	NSO	CSO	MSO
NSO	—	1.6	6.9×10^{-10}
CSO	2.7×10^{-16}	—	0.07
MSO	2.3×10^{-15}	8.4×10^{-10}	—

Divergence Times

- NSO:CSO 1.42 Million Years Ago
 - NSO:MSO 1.36 Million Years Ago
 - CSO:MSO 0.68 Million Years Ago
-

Summary of Genetic Evidence for Subspecies in Spotted Owls

mtDNA

- Subspecies differentiation between NSO/CSO.
- NS subspecies differentiation between CSO/MSO.
- Occurrence of CSO in traditional range of NSO.
- Occurrence of CSO in traditional range of MSO.

RAPDs


- Lack of differentiation between NSO/CSO.
- MSO differentiated somewhat from NSO/CSO.

→ NSO are a definable subspecies, CSO/MSO are not.


Genetic Diversity Within and Among Spotted Owl Populations



Genetic Diversity Among Subspecies

	N	Hap. Div		D (p)
NSO	131	0.88	0.0114	-0.38 (0.38)
CSO	37	0.38	0.0015	-1.36 (0.09)
MSO	45	0.93	0.0098	-0.96 (0.18)

Genetic Diversity Among NSO





	N	Hap. Div		D
Olympic Range	10	0.80	0.0071	0.17
Cascade Range	30	0.83	0.0068	-1.37
Coast Range	20	0.75	0.0079	-0.88
Klamath Region	71	0.91	0.0142	0.38

Population Differentiation

Grouping	F_{ST}
All Spotted Owls	0.71*
NSO	0.02
CSO	0.02
MSO	0.44*

* $P < 0.001$, using mtDNA data.

Differentiation Within and Among NSO

	df	Var	% total	
Among regions	3	0.15	4.68	 $c_T = .05^*$
Am. br. areas w/i regions	14	-0.07	-2.19	 $s_C = -.02$
Am. ind. w/i br. areas	113	3.04	97.51	 $s_T = .02$

Pairwise F_{ST} and Gene Flow in NSO

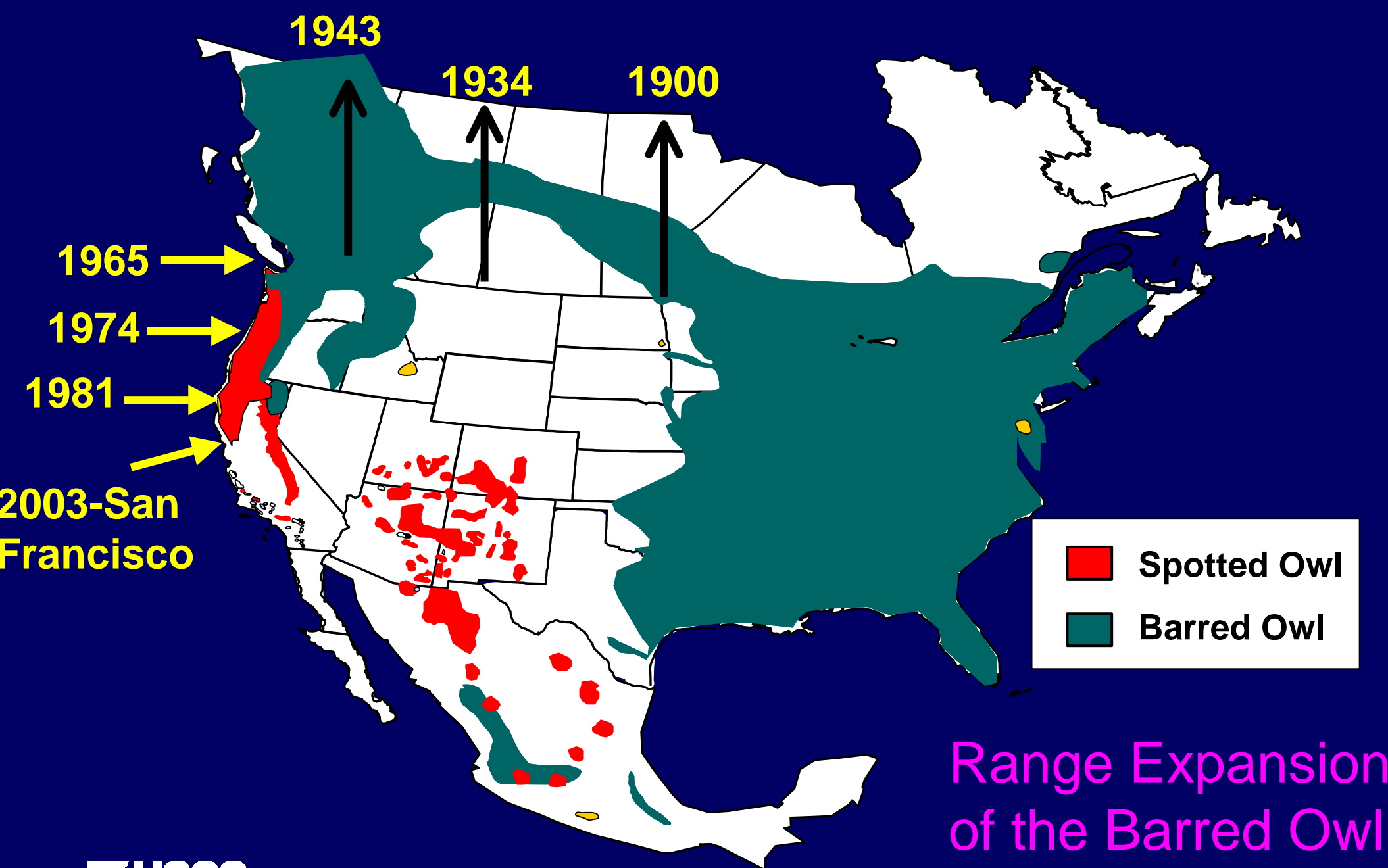
Region	1	2	3	4
• Olympic	---	4.7	3.7	5.6
• Cascades	0.10	---	inf	inf
3. Coast Range	0.12	-0.03	---	inf
4. Klamath	0.08	-0.00	-0.02	---

Summary of Genetic Diversity in Spotted Owls

- Genetic diversity is adequate in NSO and MSO.
 - There is low genetic diversity in CSO.
 - Gene flow is adequate among NSO regions.
 - There is significant differentiation among MSO regions.
-

Hybrids: SPARRED OWLS



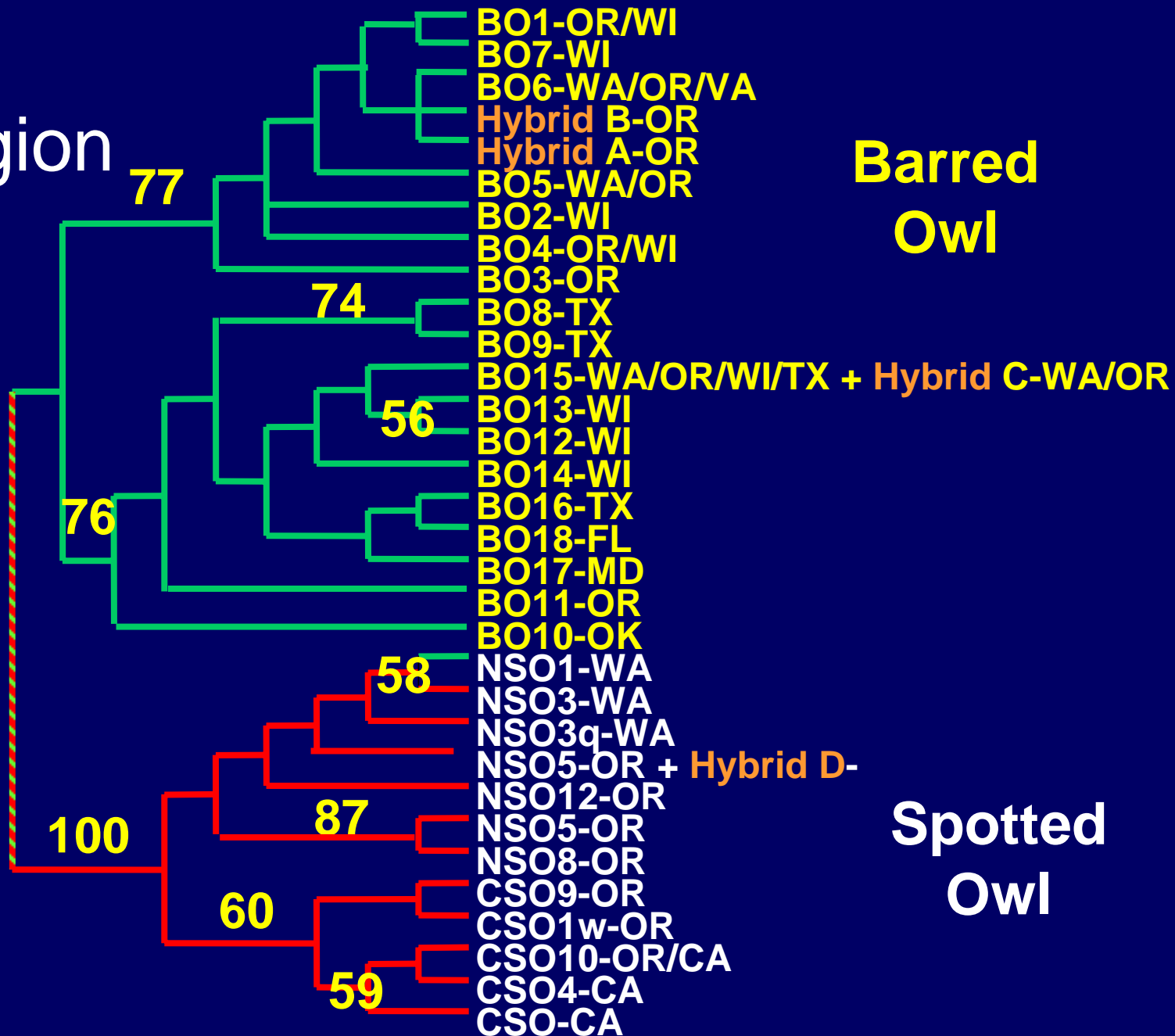


Range Expansion of the Barred Owl

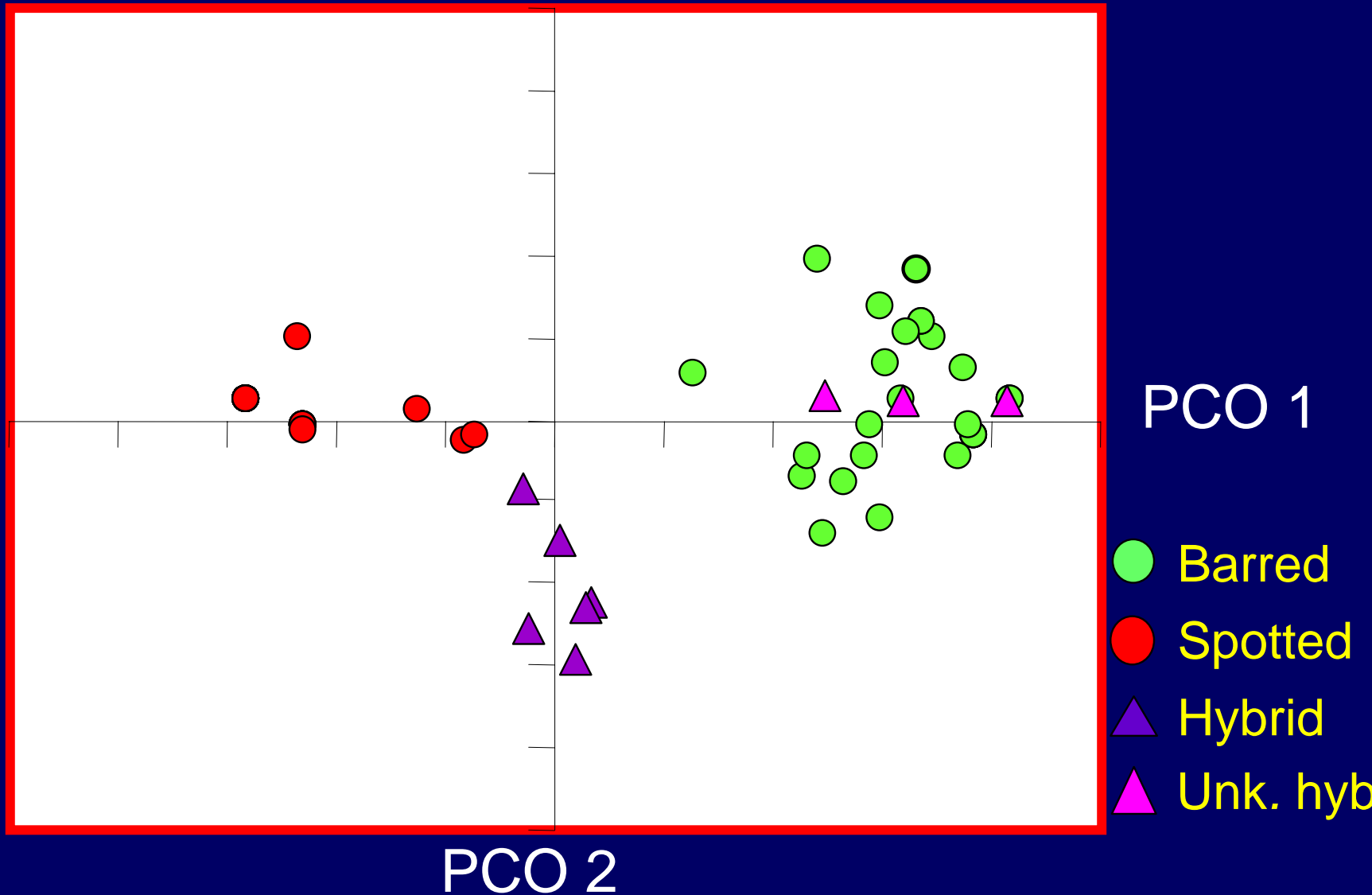
Sparred Owls?



mtDNA
Control Region
(524 bp)



AFLP ANALYSIS OF SPOTTED, BARRED & HYBRID OWLS



Summary: Areas of Genetic Concern

Northern Spotted Owls:

- Mixing with CSO and Barred Owls.

California Spotted Owls:

- Lack of genetic diversity in Southern CA.
- Mixing with NSO and/or Barred Owls.
- Not significantly different than MSO.

Mexican Spotted Owls:

- Not significantly different than CSO.
- Population fragmentation and low levels of gene flow.

Acknowledgements

USGS Forest & Rangeland Ecosystem Science Center

USFS Pacific Northwest Forest Experiment Station

USFS Pacific Southwest Forest Experiment Station

U.S. Fish and Wildlife Service Wildlife Forensic Lab

Bureau of Land Management

Confederated Tribes of Warm Springs

National Park Service

NCASI

Oregon Cooperative Wildlife Research Unit

Oregon Zoo

Simpson Timber

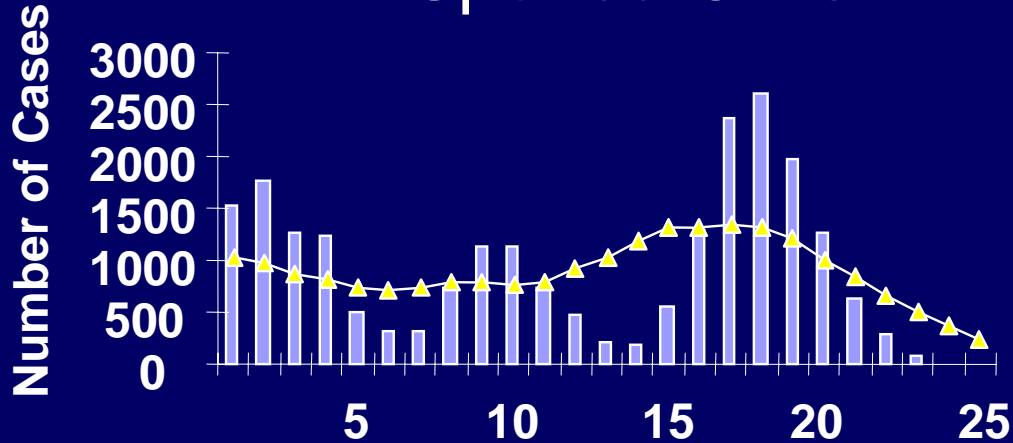
Yakima Indian Nation



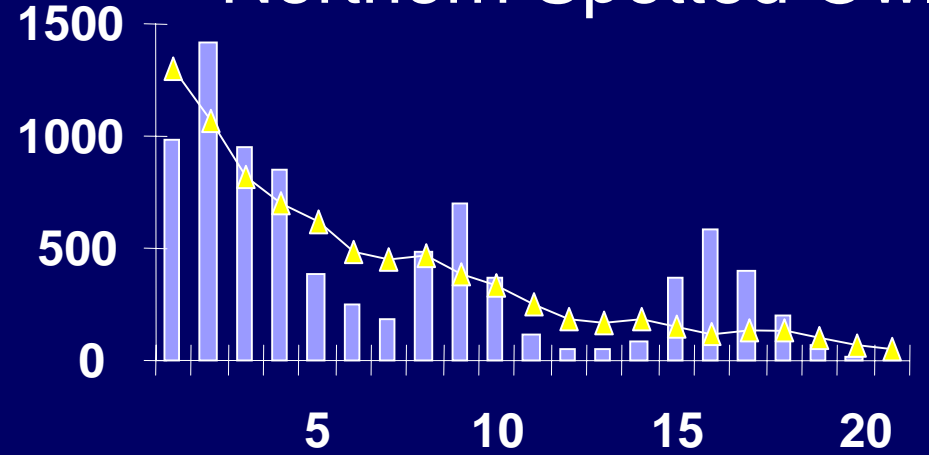


MISMATCH DISTRIBUTIONS

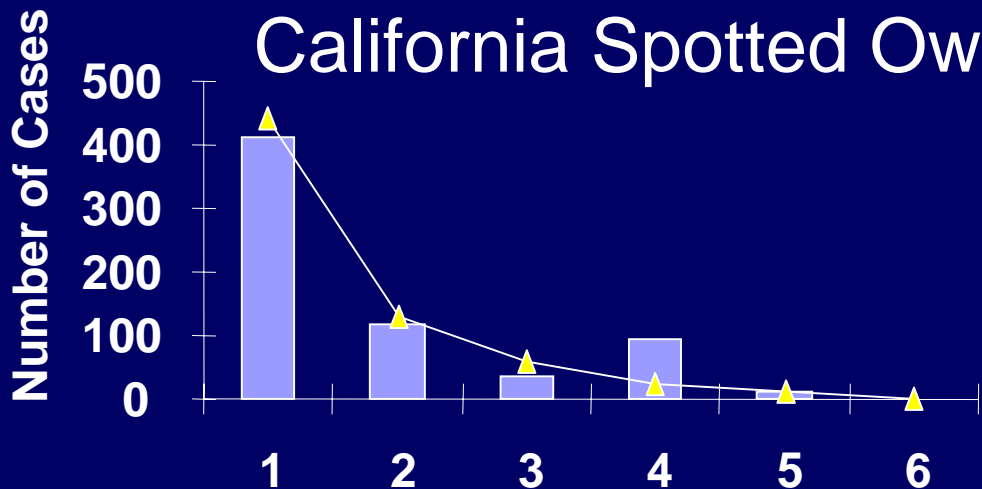
All Spotted Owls



Northern Spotted Owl



California Spotted Owl

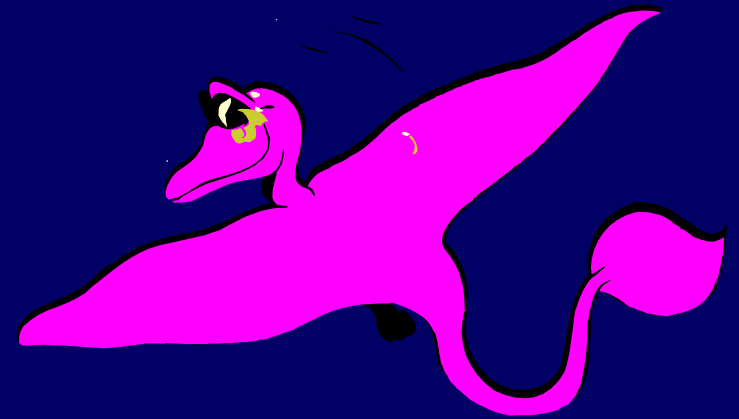
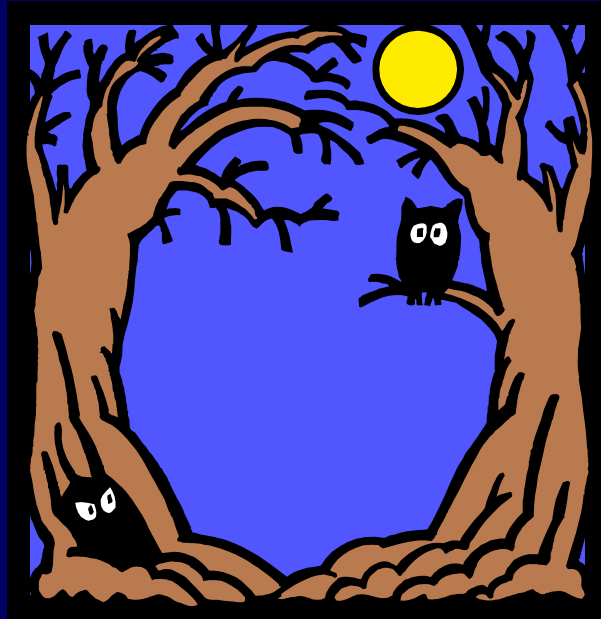


Mexican Spotted Owl

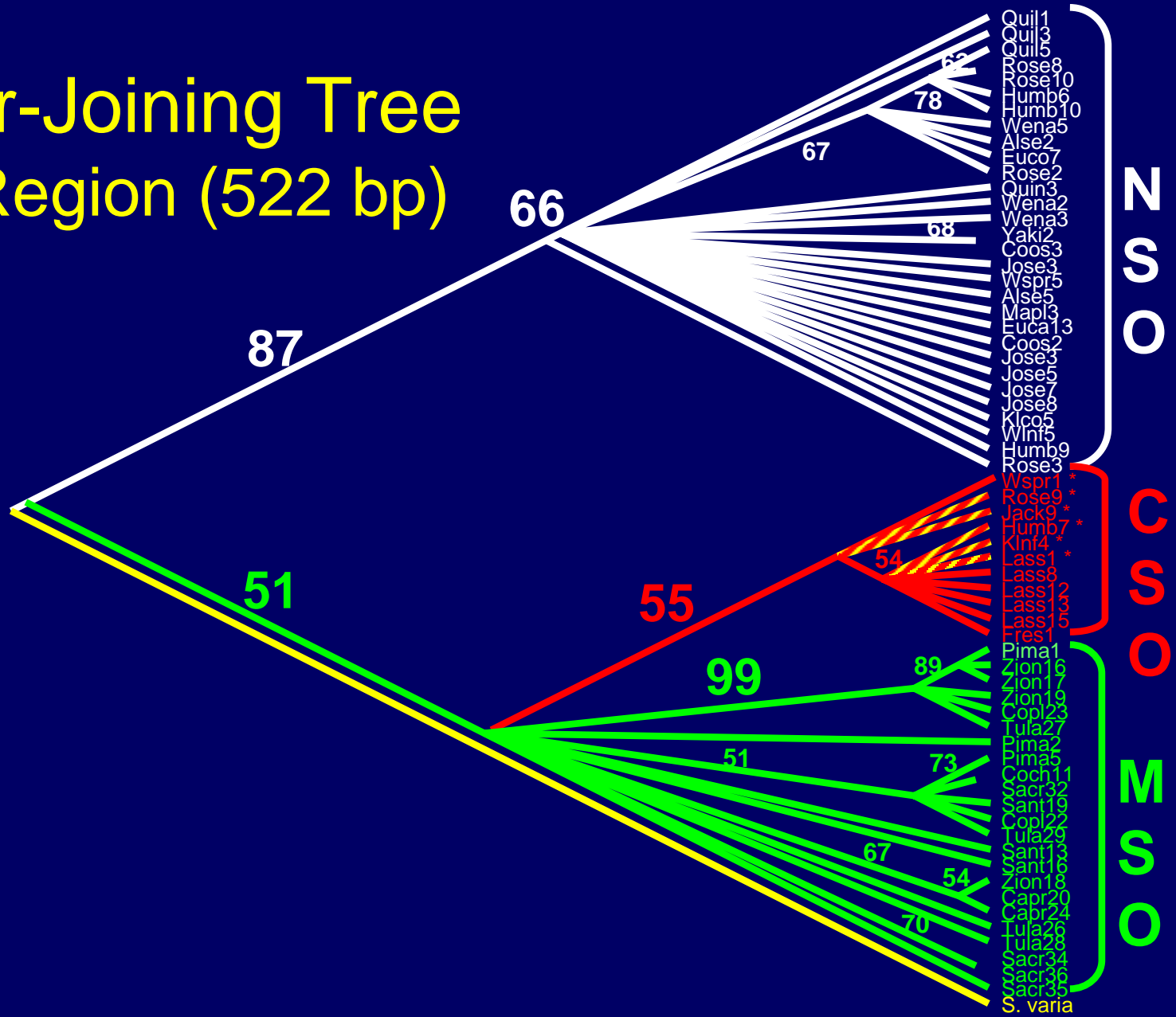


Pairwise Differences

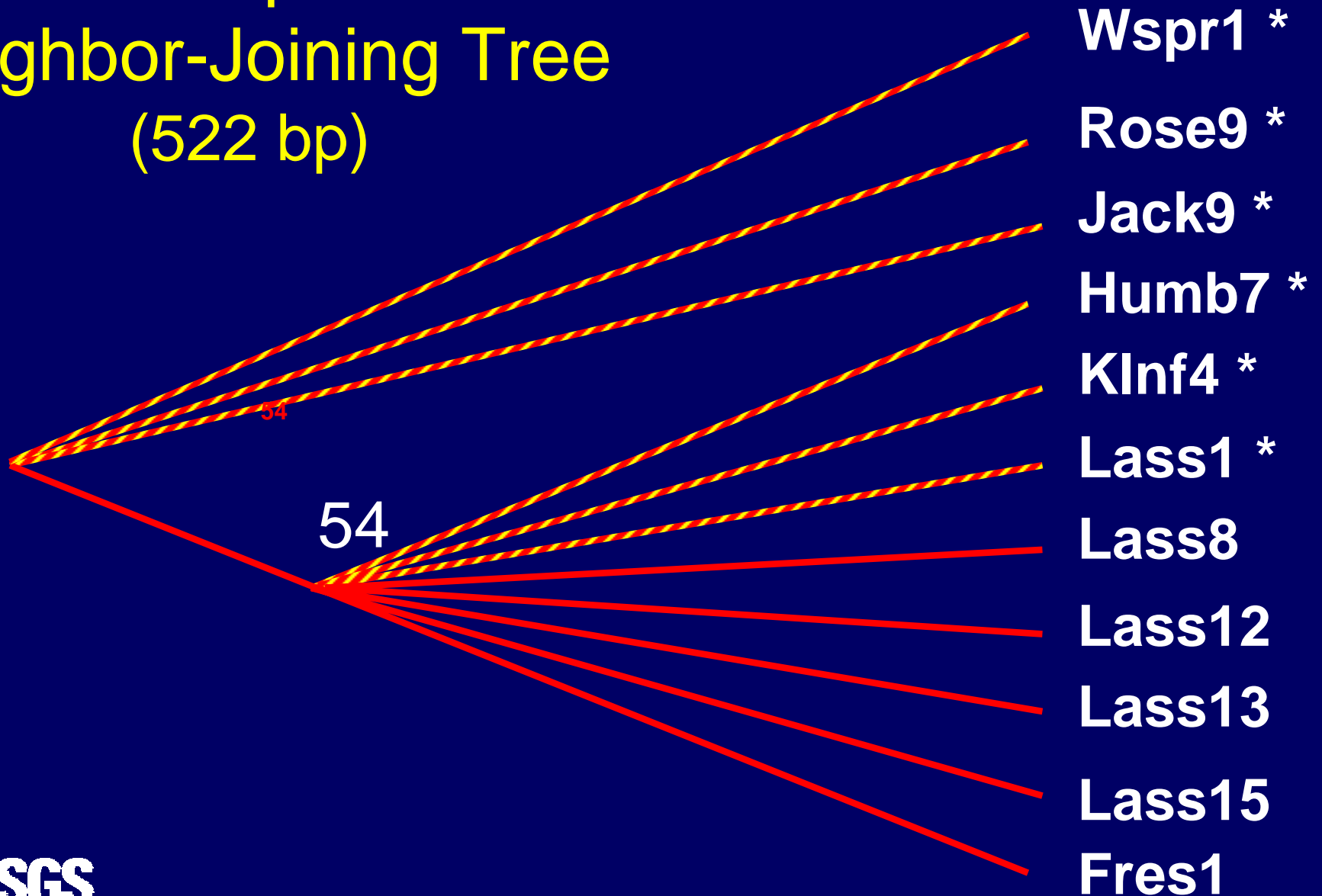
Pairwise Differences



Neighbor-Joining Tree Control Region (522 bp)



California Spotted Owl Neighbor-Joining Tree (522 bp)



Geographic vs Genetic Distance

Group	Mantel r
All Spotted Owls	0.74*
NSO	0.15
CSO	-0.98
MSO	0.54*

* $P < 0.05$

**using mtDNA data