Genomic differentiation among Eastwood manzanita subspecies – with a focus on SD Co. taxa

Glen R Morrison – PhD candidate, UC Riverside

SD Bot Soc 2022

Arctostaphylos – a beautiful headache

Pros as a study system for an evolutionary/diversity study:

- Super-duper diverse
- Weak morphological differentiation among many species
- Hybridization known to occur

Arctostaphylos – a beautiful headache

Pros as a study system for an evolutionary/diversity study:

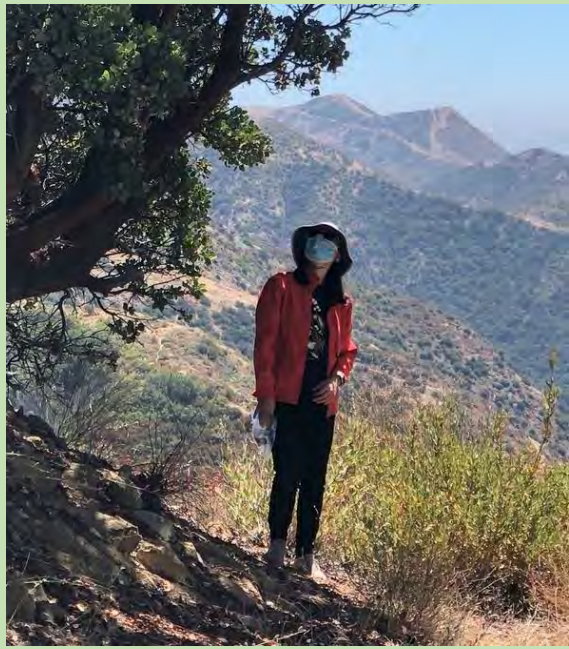
- Super-duper diverse
- Weak morphological differentiation among many species
- Hybridization known to occur

Cons (THE SAME THINGS!):

- Super-duper diverse
- Weak morphological differentiation among many species
- Hybridization known to occur

What we're doing in our lab at UCR

- PI: Amy Litt
- Grad students: Me, Angela Buehlman, Tito Abbo, Yi Huang (PhD)
- Genetics, genomics, morphology, ecophysiology, biogeography, phylogeny, of manzanitas
- **Big questions:**
  - How many manzanita species/taxa are there *really*..?
  - How did they get so diverse?
  - What can we learn more generally about diversity of the California Floristic Province



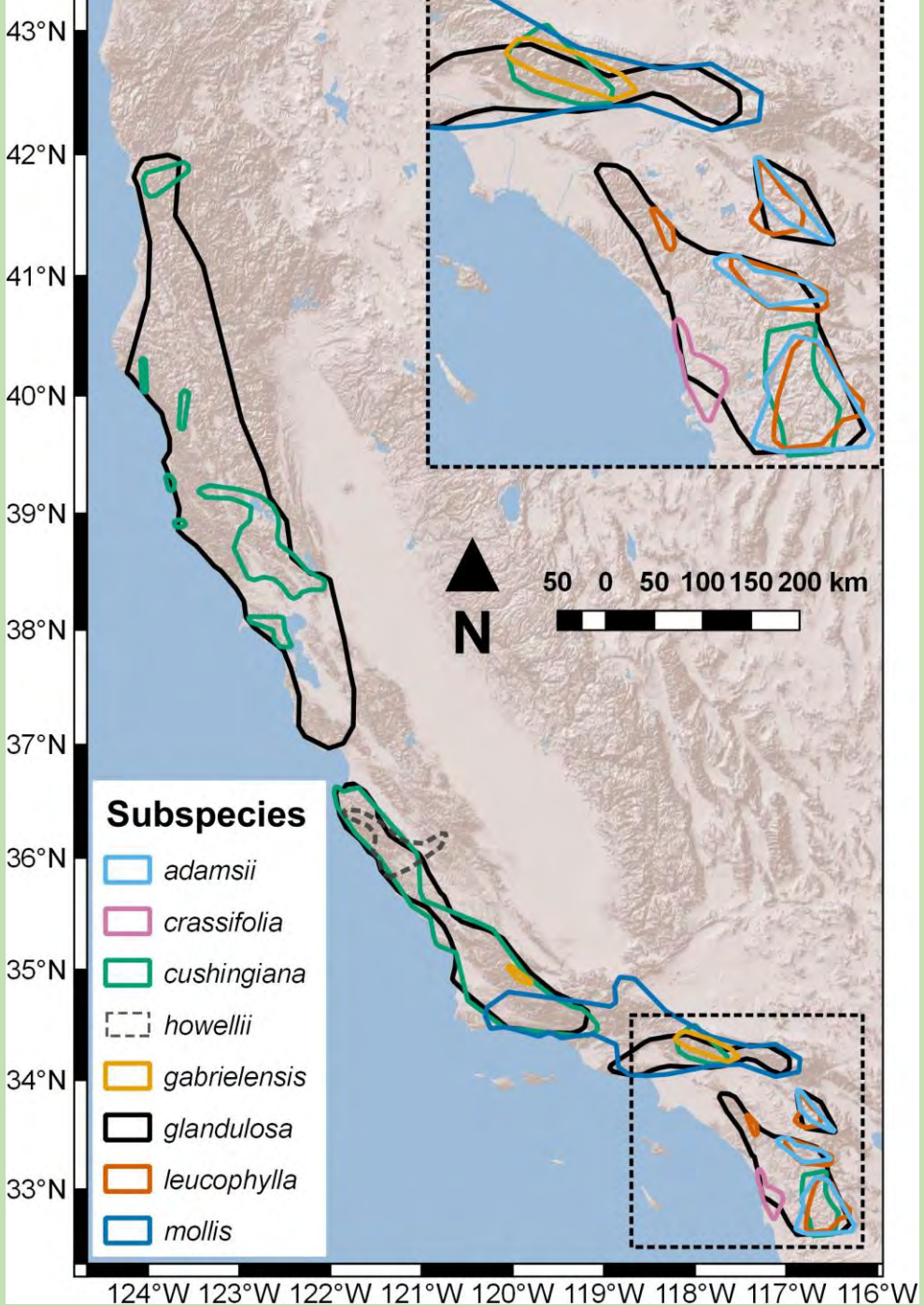
What I'm presenting today

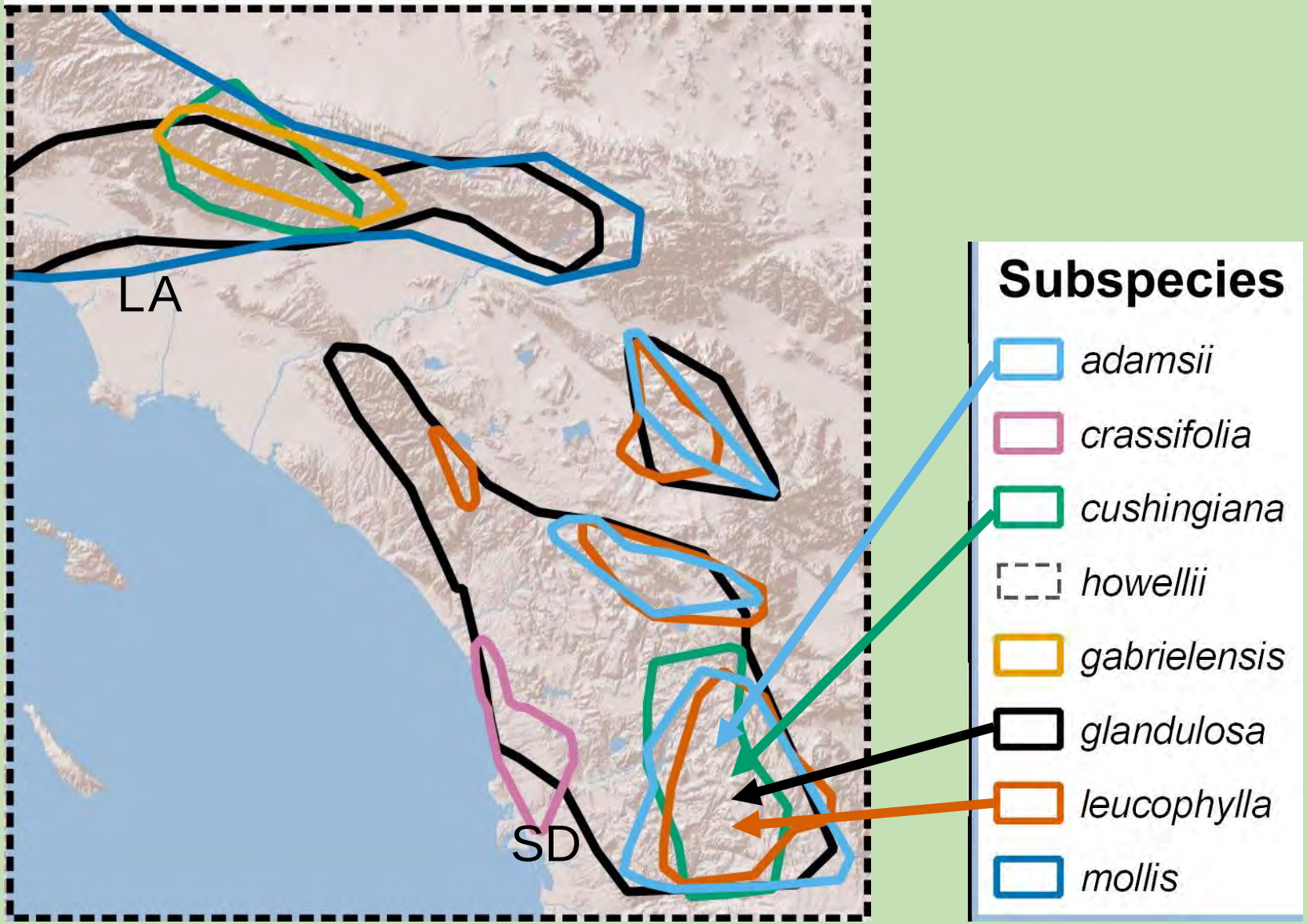
- Our first published study, on Eastwood's manzanita, *Arctostaphylos glandulosa* subspecies
- We focused on this species as a first major project for a few reasons:
  - A particular mess of a species, with 10 accepted subspecies, most found only in SoCal
  - Field work was accessible, given ease of travel
  - We wanted to deal with a polyploid early on, and see what genomic madness be there
- Paper in AJB in 2020

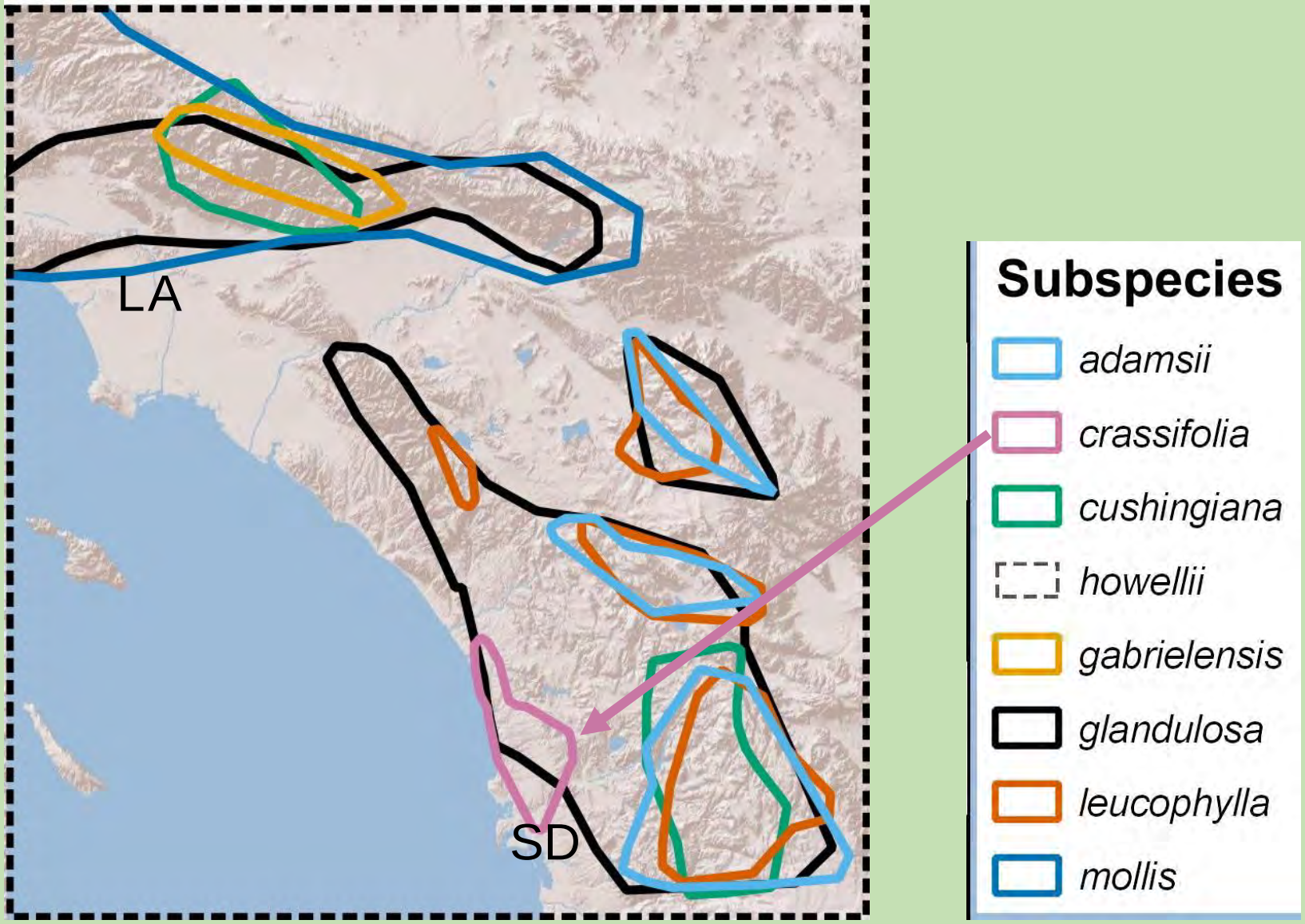
  "Subspecies differentiation in an enigmatic chaparral shrub", Yi Huang and Glen Morrison *et al*

Eastwood's manzanita – *Arctostaphylos glandulosa*

- A burl-forming "sprouter" species
  - Forms abundant populations, often in patches, rather than being evenly scattered around an area
  - Recruitment from seed seems exceedingly uncommon
- Ten subspecies, 8 in California, 2 only in Baja CA
  - Delimiting differences among subspecies are:
    - Hair morphology – length, glandularity, stiffness
    - Leaf color – glaucous, dull green, or shiny green
    - Fruit morphology – fusion of nutlets, or not
- Relatively few populations of one subspecies
  - Sometimes three subspecies can be identified in one stand of plants


43°N
42°N
41°N
40°N
39°N
38°N
37°N
36°N
35°N
34°N
33°N
124°W 123°W 122°W 121°W 120°W 119°W 118°W 117°W 116°W
N
50 0 50 100 150 200 km
Subspecies
adamsii
crassifolia
cushingiana
howellii
gabrielensis
glandulosa
leucophylla
mollis


LA
SD
Subspecies
adamsii
crassifolia
cushingiana
howellii
gabrielensis
glandulosa
leucophylla
mollis


LA
SD
Subspecies
adamsii
crassifolia
cushingiana
howellii
gabrielensis
glandulosa
leucophylla
mollis

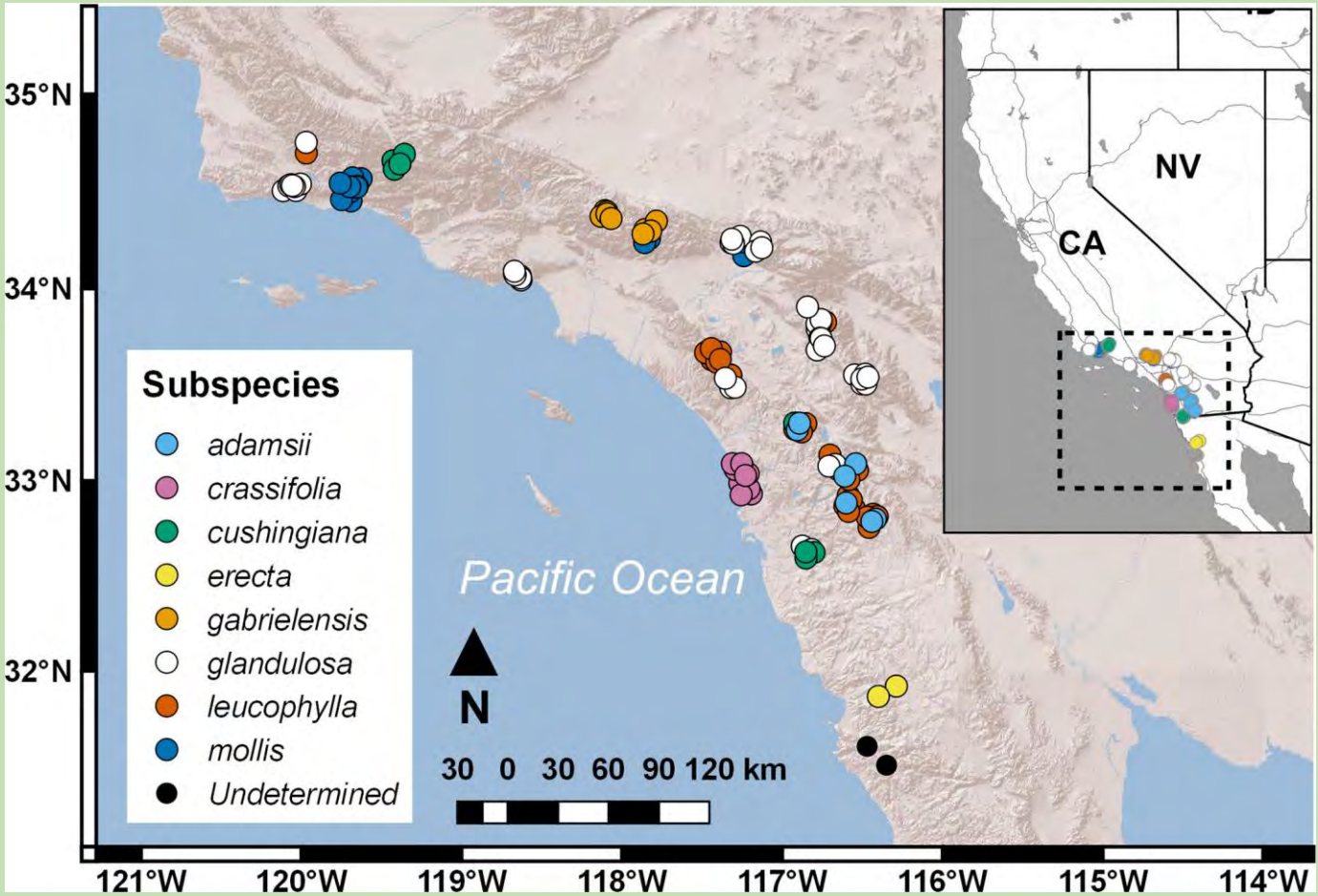
Del Mar manzanita – *A. glandulosa* ssp. *crassifolia*

- Endemic of remnant maritime chaparral on the SD Co. coast
- High conservation priority, due to loss of habitat
- With a fairly well defined and exclusive geographic range
  - But it does overlap with *A. glandulosa* ssp. *glandulosa*, because that thing is freaking everywhere...

Image: Morgan Stickrod

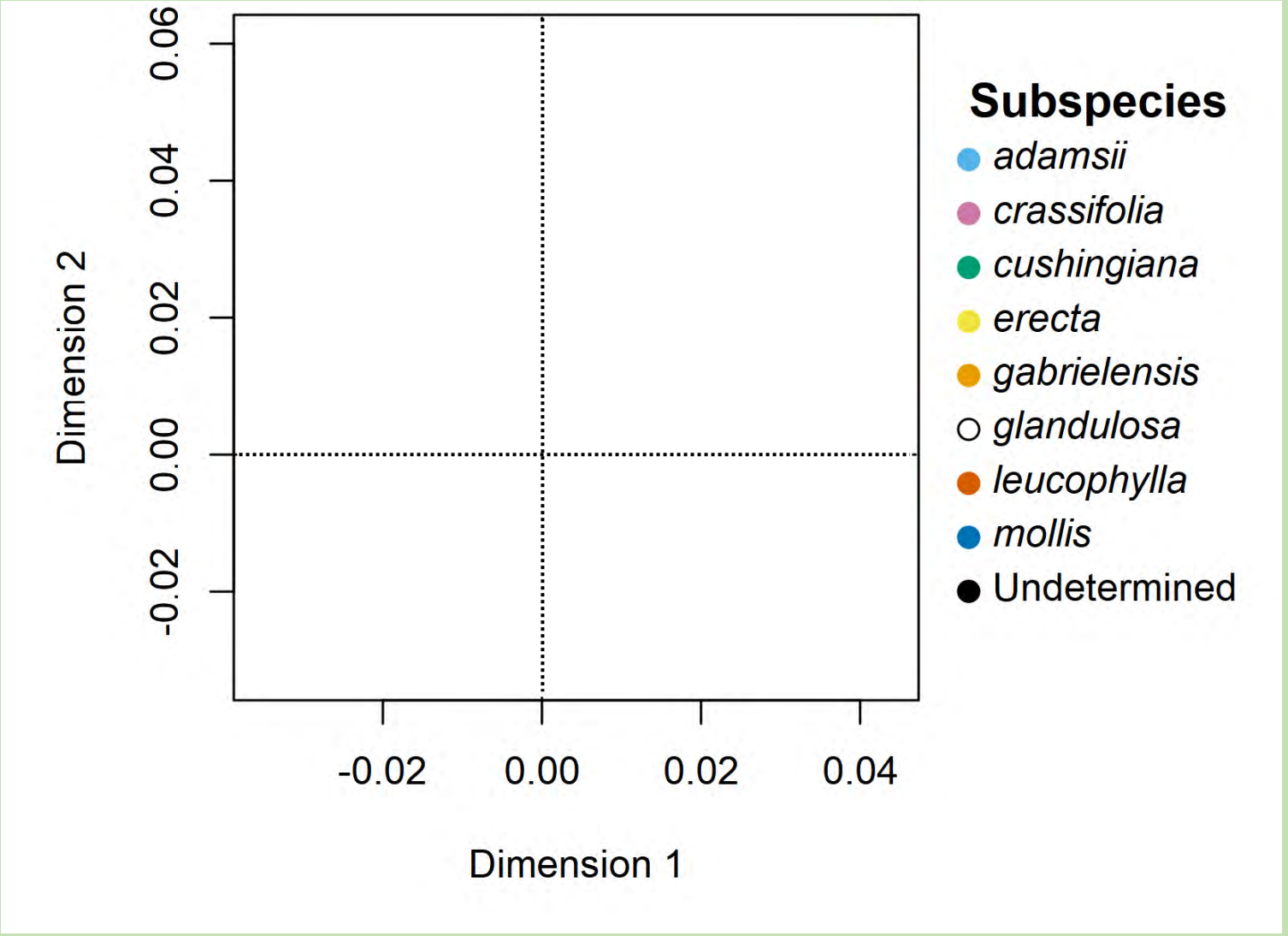
Our study of *A. glandulosa*

- Collected ~140 samples from 8 subspecies of *A. glandulosa*
- Used ddRADseq to generate genome-wide seq. data
- Analyzed genetic differentiation among subspecies, and across geography



A. glandulosa

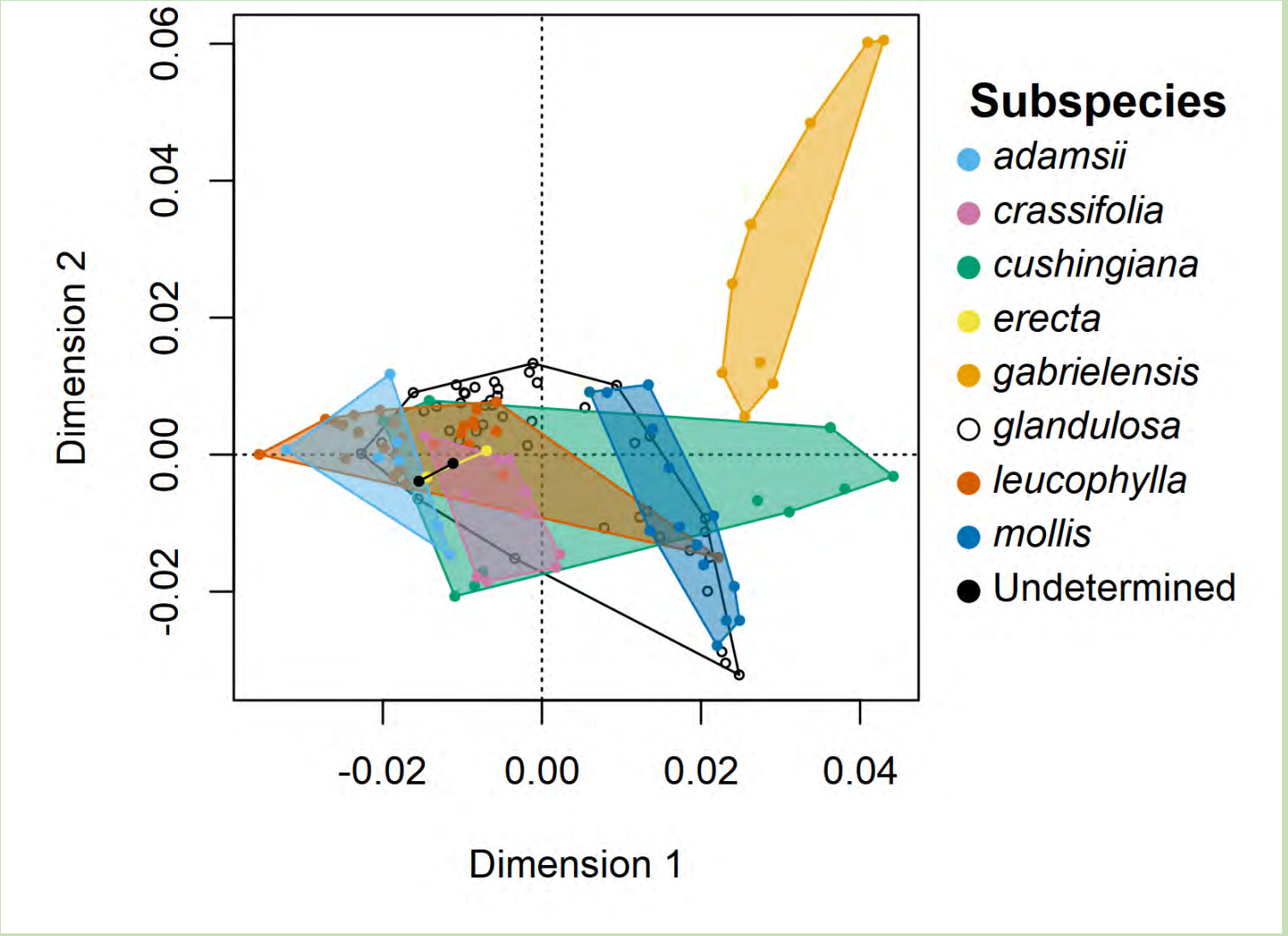
Multi-dimensional Scaling (MDS) -
Closer points more gen. similar



A. glandulosa

- Primary finding: Most subspecies overlap genetically

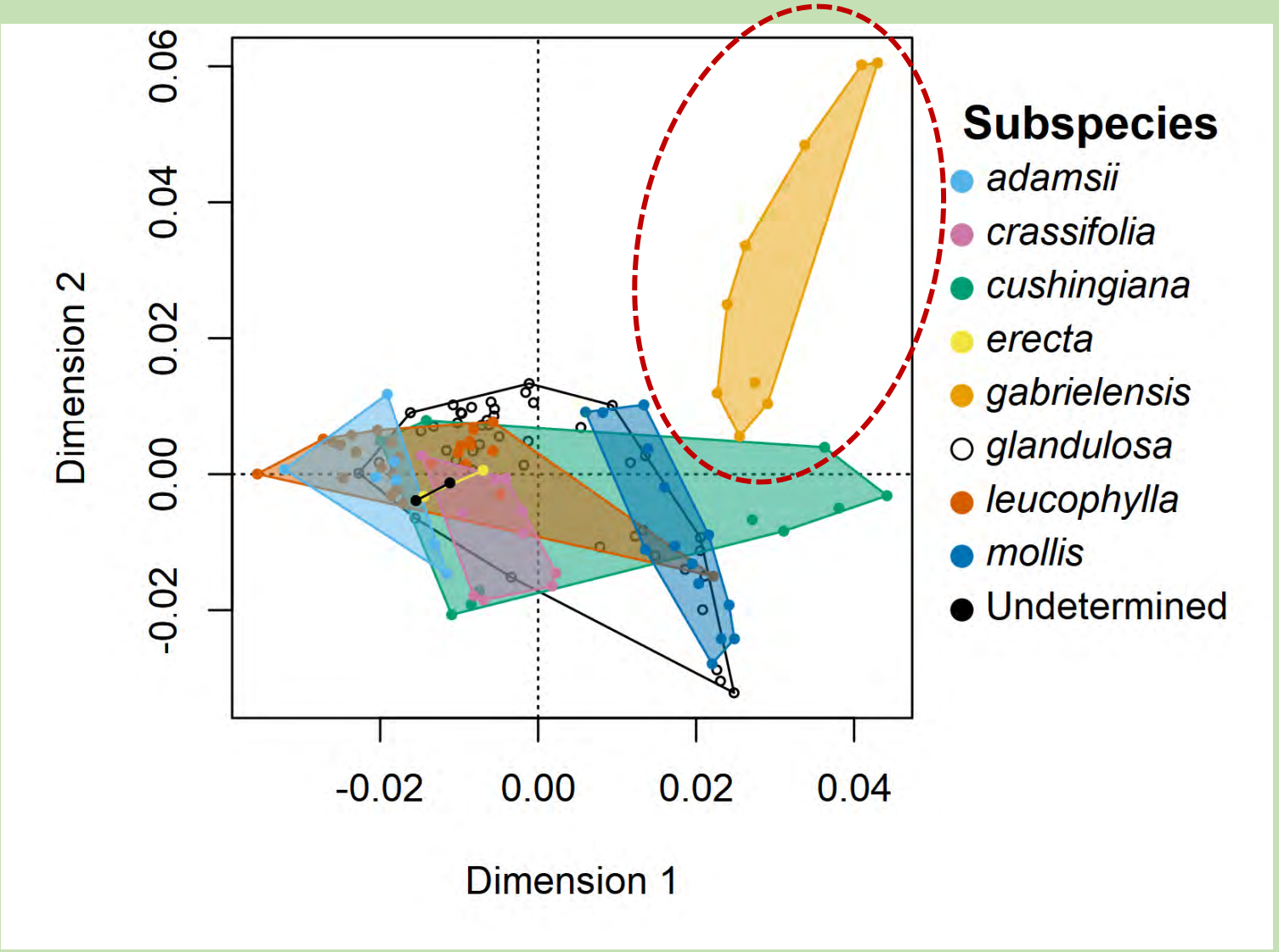
Multi-dimensional Scaling (MDS) - Closer points more gen. similar



A. glandulosa

- Primary finding: Most subspecies overlap genetically
- One subspecies is reasonably distinct
  - San Gabriel manzanita, *A. glandulosa* ssp. *gabrielensis*

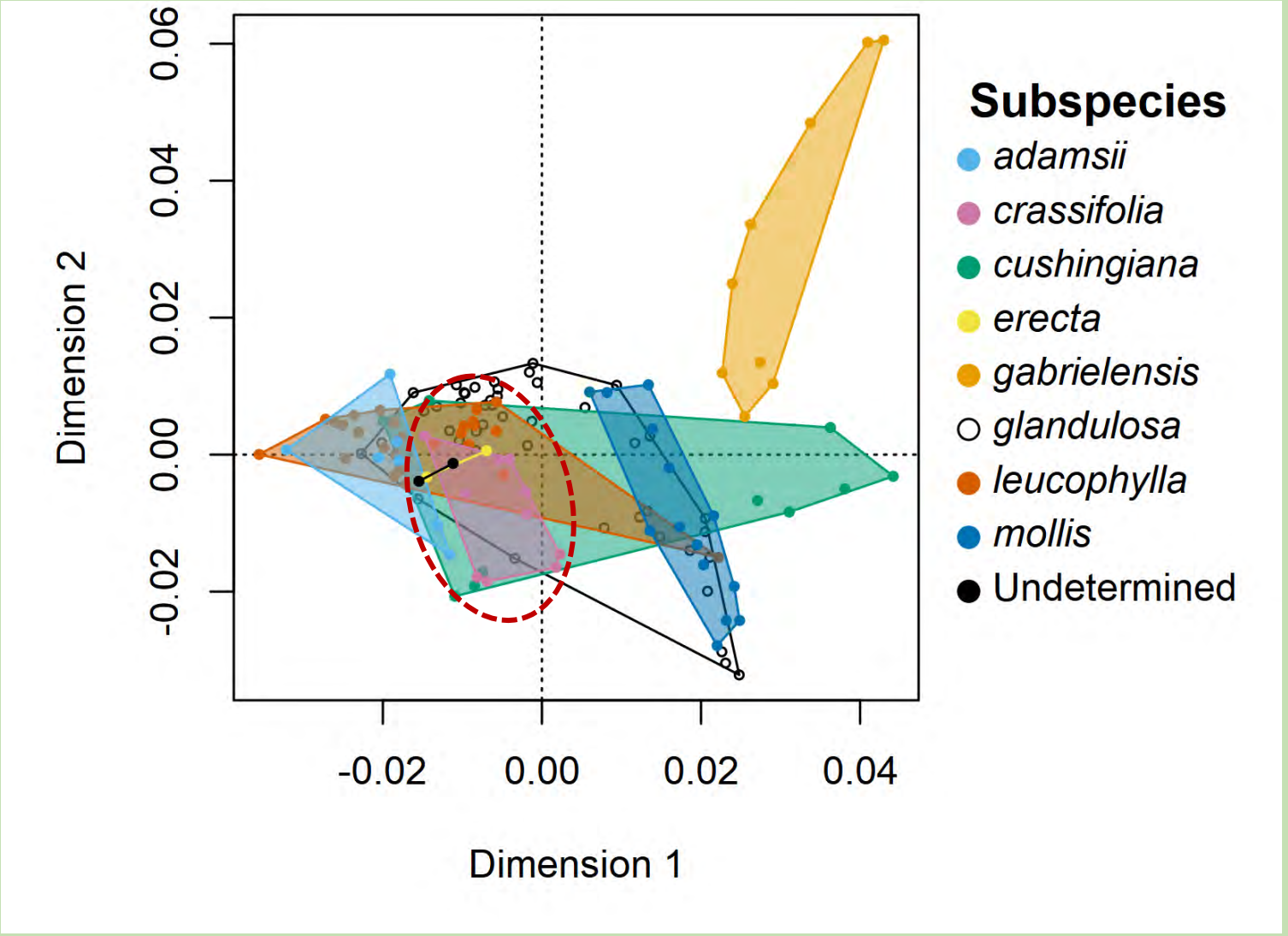
Multi-dimensional Scaling (MDS) - Closer points more gen. similar



A. glandulosa

- Primary finding: Most subspecies overlap genetically
- One subspecies is reasonably distinct
  - San Gabriel manzanita, *A. glandulosa* ssp. *gabrielensis*
- Ssp. *crassifolia*, overlaps other subspecies

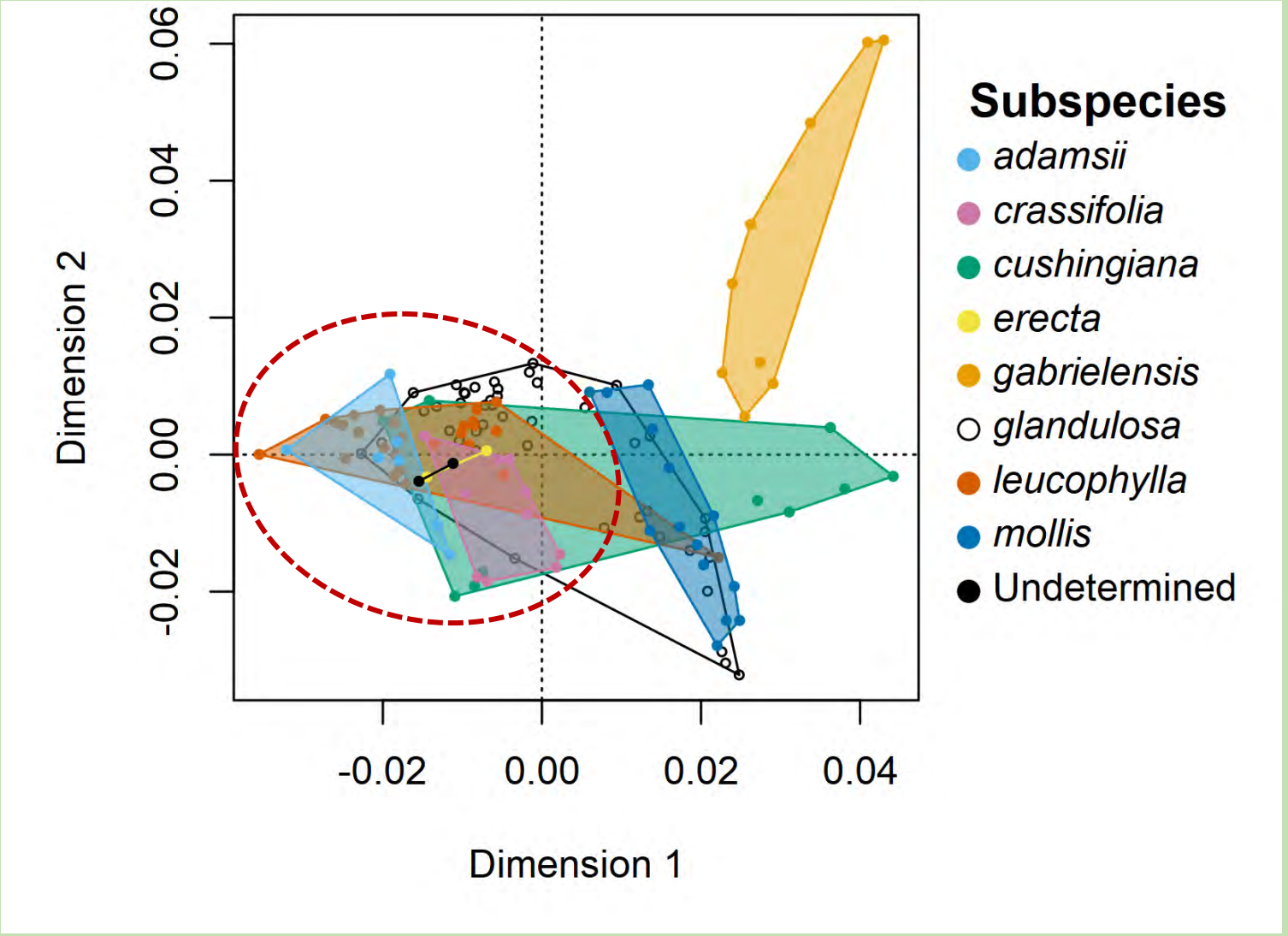
Multi-dimensional Scaling (MDS) - Closer points more gen. similar



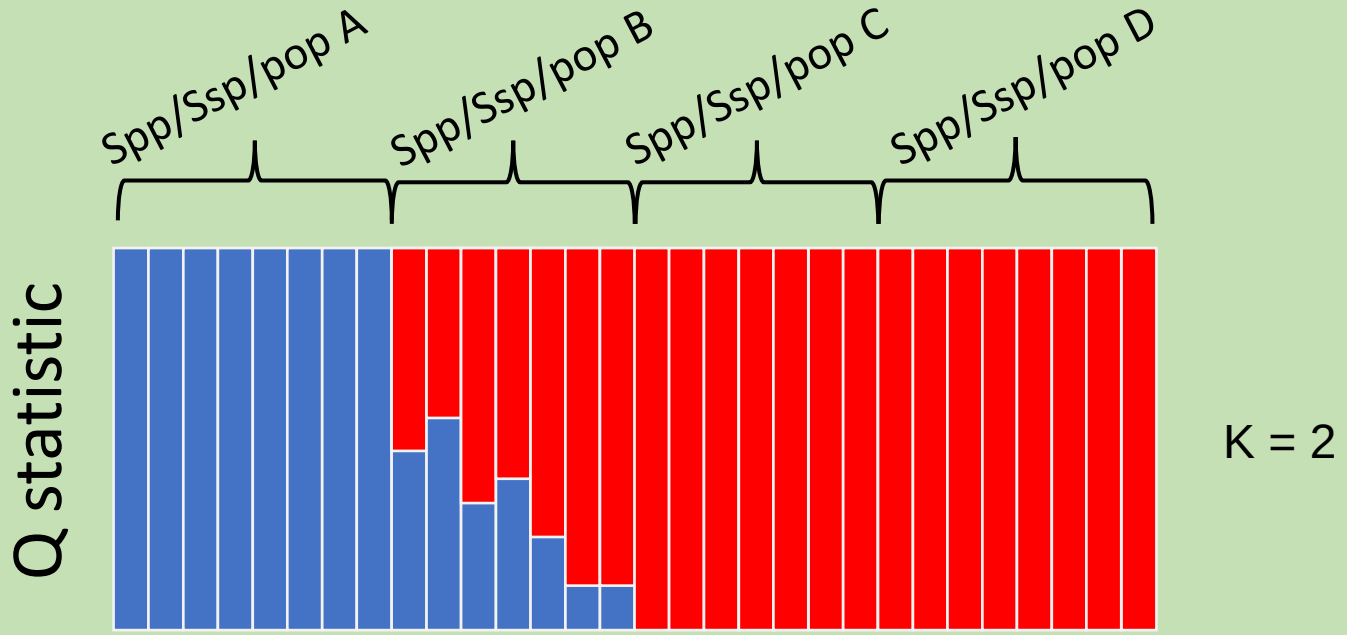
A. glandulosa

- Primary finding: Most subspecies overlap genetically
- One subspecies is reasonably distinct
  - San Gabriel manzanita, *A. glandulosa* ssp. *gabrielensis*
- Ssp. *crassifolia*, overlaps other subspecies
- SD Co. subspecies overlap substantially

Multi-dimensional Scaling (MDS) - Closer points more gen. similar

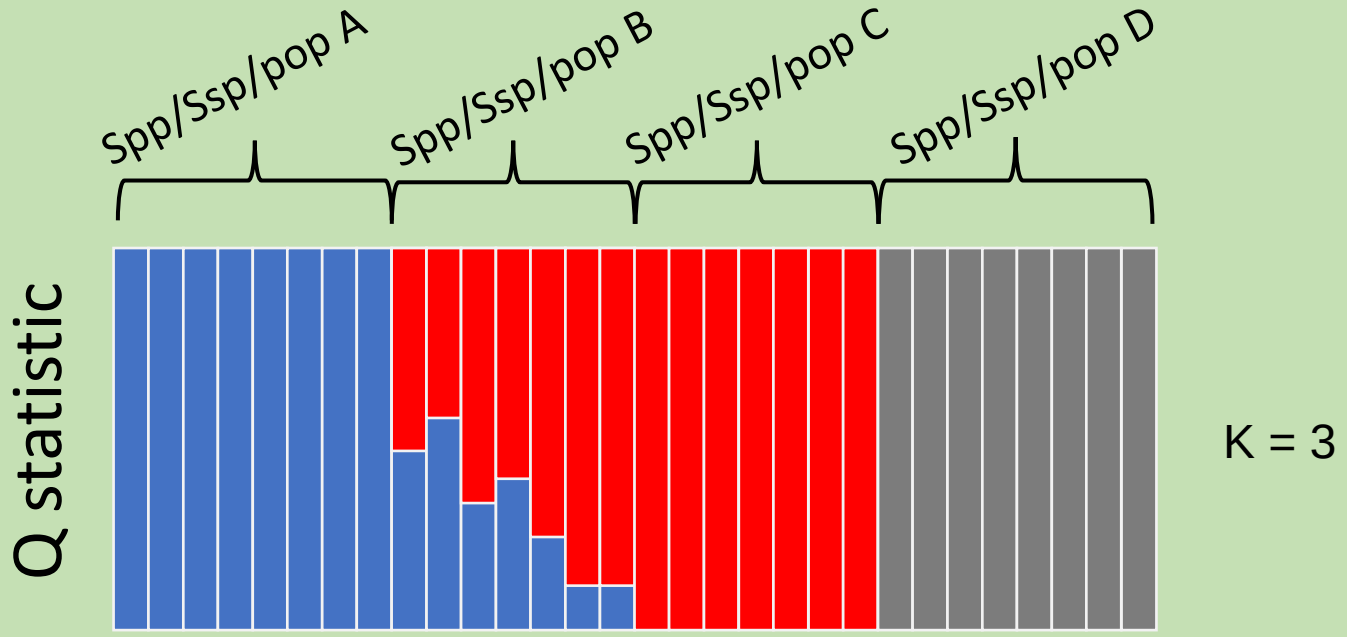


- STRUCTURE analysis



Only an example

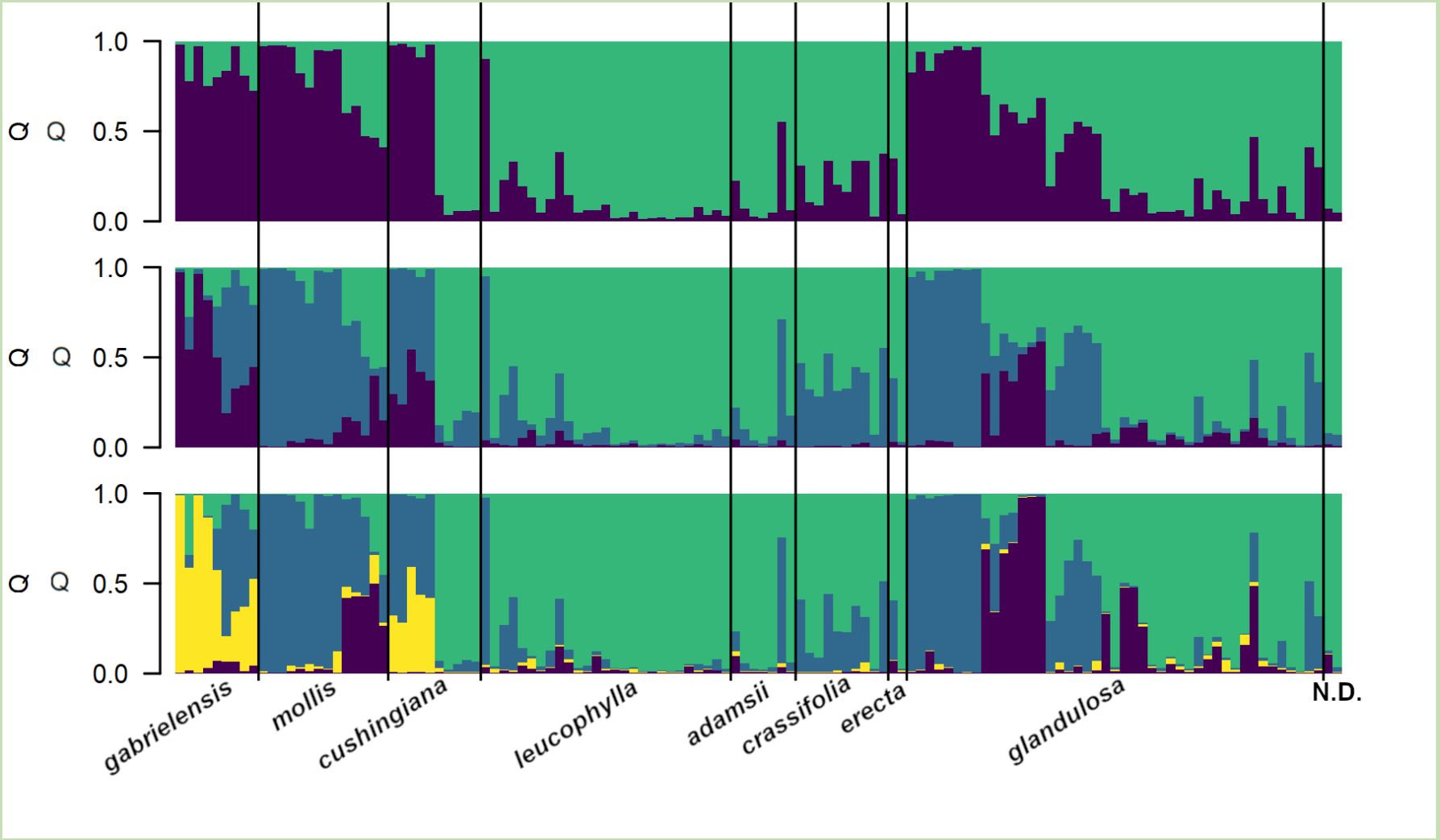
- STRUCTURE analysis



Only an example

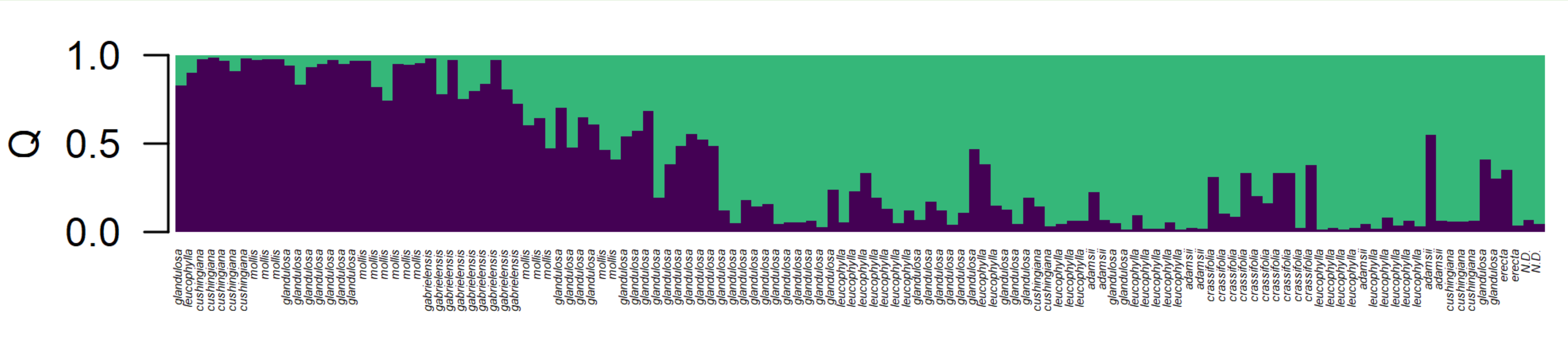
STRUCTURE analysis

A. glandulosa



A. glandulosa

- K = 2, sorted by latitude of collection, consistent with isolation by distance



Considering the lack of genomic differentiation among other subspecies

Morphological differences that we now recognize as subspecies likely have a some genetic basis, but possibly just in one locus, or just a few

Our sequencing would not be fine enough to detect this kind of situation

Considering the lack of genomic differentiation among other subspecies

Morphological differences that we now recognize as subspecies likely have a some genetic basis, but possibly just in one locus, or just a few

Our sequencing would not be fine enough to detect this kind of situation

However, we must also ask: How different should subspecies have to be? Should subspecific differentiation be greater than geographic or other differentiation?

Advice on how to you can succeed in IDing manzanitas (in SD Co., at least)

- Look for a **burl**, and try to determine if one is present
- Immature **inflorescences and fruits** are very helpful for IDs, flowers are not so much
- Take note of **leaf color**
- Take note of the presence/absence of **hairs, and glands** on hairs

Thank you!!!

- Andy Sanders, Natalie Saavedra, Menka Jagad, Tommy Stoughton, Dylan Burge, Diana Jolles, Matt Guilliams, Greg Wahlert, Janet Franklin, Alan Brelsford, Dinusha Maheepala, Alex Rajewski, and many more
- Those who facilitated and granted permits
- Funding sources
- **And San Diego Botanical Society for the invitation to speak!!!**