Invasive species holobiomes as bioindicators? Environmental DNA metabarcoding from community-collected CALeDNA samples makes holobiomes available for common invasive plants

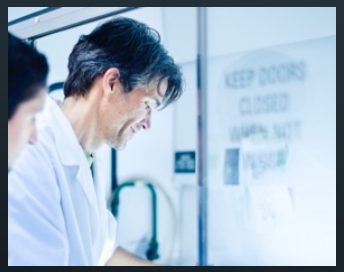
Rachel Meyer, UCSC

October 30, 2020

UC CONSERVATION GENOMICS CONSORTIUM

Emma Aronson, UCR

Rasmus Nielsen UCB

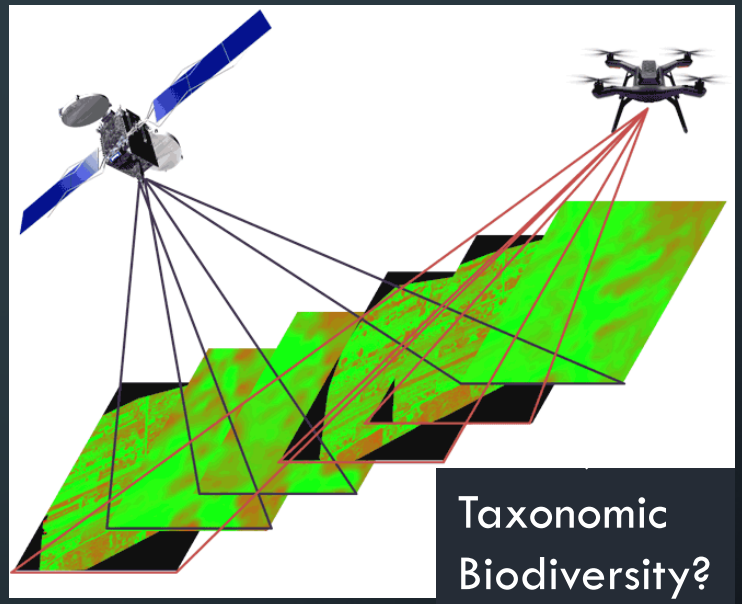


Mike Dawson UCM

Jeff Wall UCSF

Beth Shapiro UCSC

Bob Wayne UCLA



Can we make *in situ* biodiversity data available?

Can community science make and use these data?

Can we bring more creativity into thinking about biodiversity patterns?

CALeDNA

Revolutionize Conservation in California

How CALeDNA works

#1 Register

#2 Sign up for Bioblitzes

#3 Collect Samples

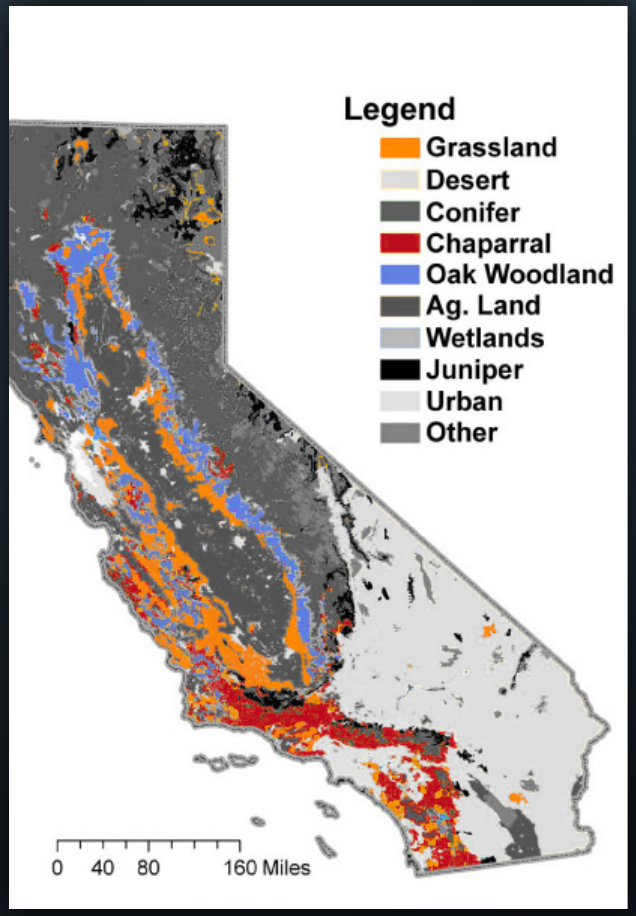
#4 Labs Analyze Sample DNA

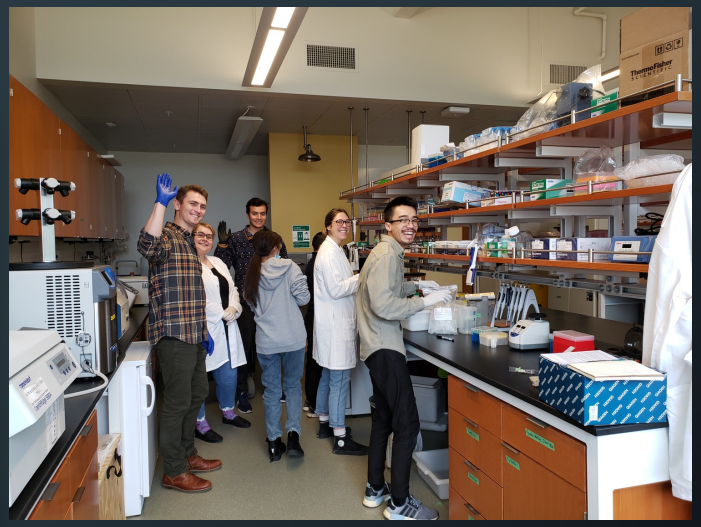
#5 Explore Results

eDNA + California = opportunity to solve complex challenges

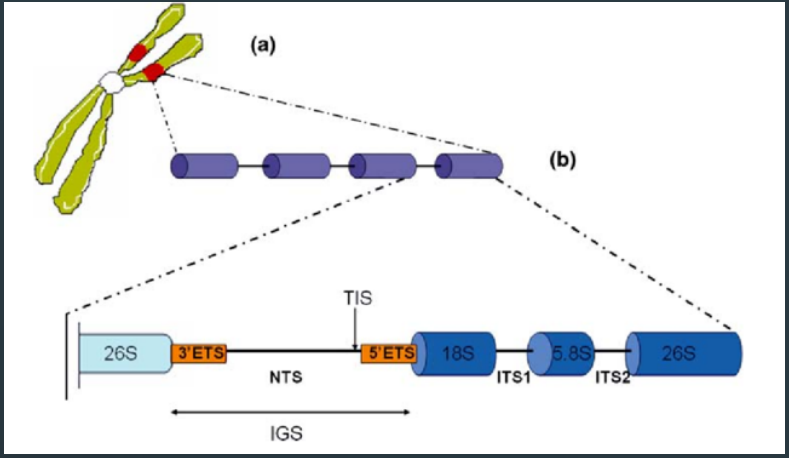
Agriculture
Archaeology
Biochemistry
Bioinformatics
Climatology
Earth Sciences
Ecology
Forensics
Forestry
Geography
Genetics
Hydrology
Marine Biology
Microbiology
Oceanography
Paleontology
Remote Sensing
Social Justice

eDNA



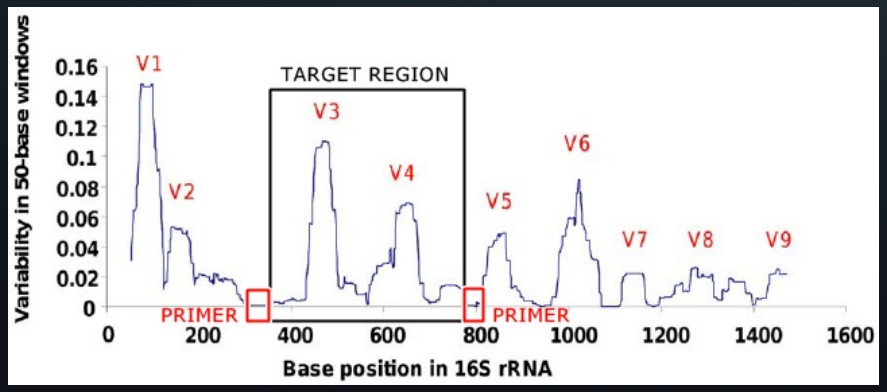


What is a DNA barcode?

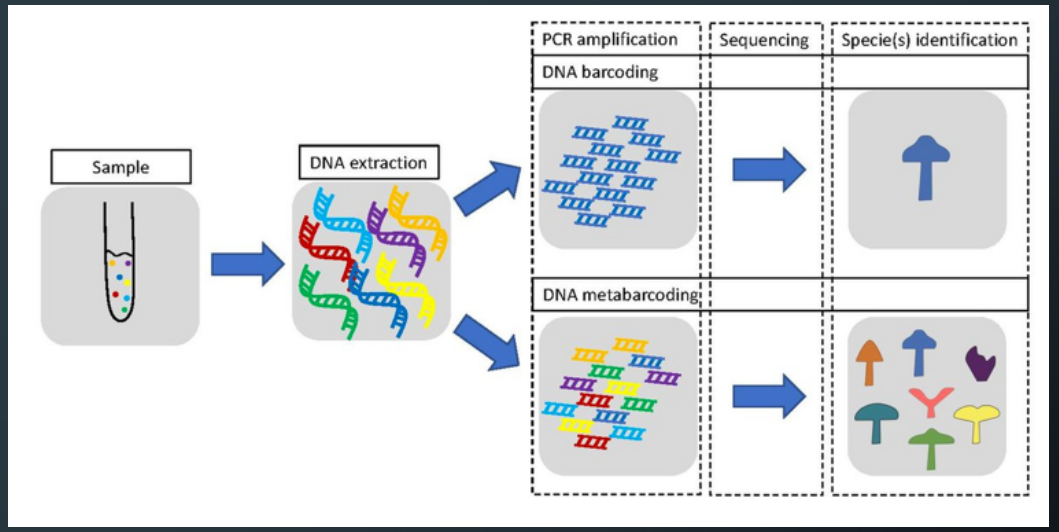


Markers that have been used for DNA barcoding in different organism groups, modified from Purty and Chatterjee.[21]

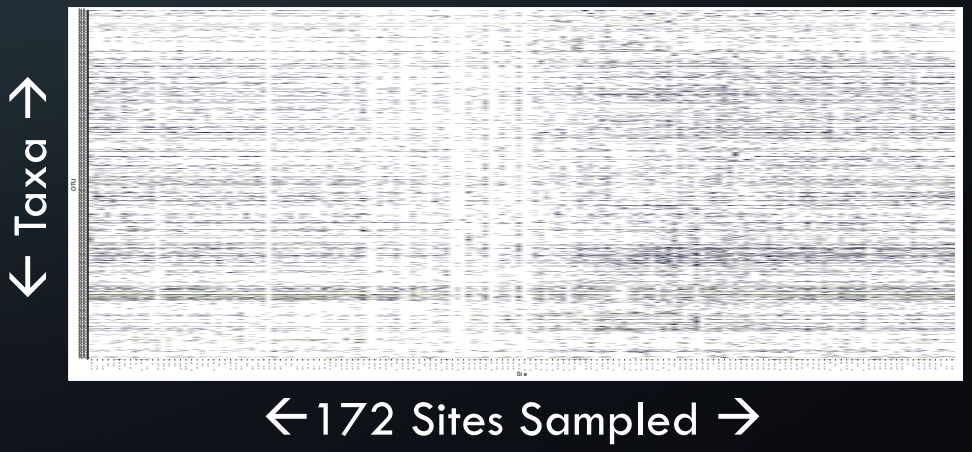
Organism group	Marker gene/locus
Animals	*COI*,[34] Cytb,[35] 12S,[36] 16S[37]
Plants	*matK*,[38] *rbcL*,[39] *psbA-trnH*,[40] *ITS*[41]
Bacteria	*COI*,[27] *rpoB*,[29] 16S,[42] *cpn60*,[28] *tuf*,[43] *RIF*,[44] *gnd*[45]
Fungi	*ITS*,[2][46] *TEF1a*,[47][48] *RPB1* (LSU), *RPB2* (LSU), *18S* (SSU)[33]
Protists	*ITS*,[49] *COI*,[50] *rbcL*,[51] *18S*,[52] *28S*[51]



What is DNA metabarcoding?

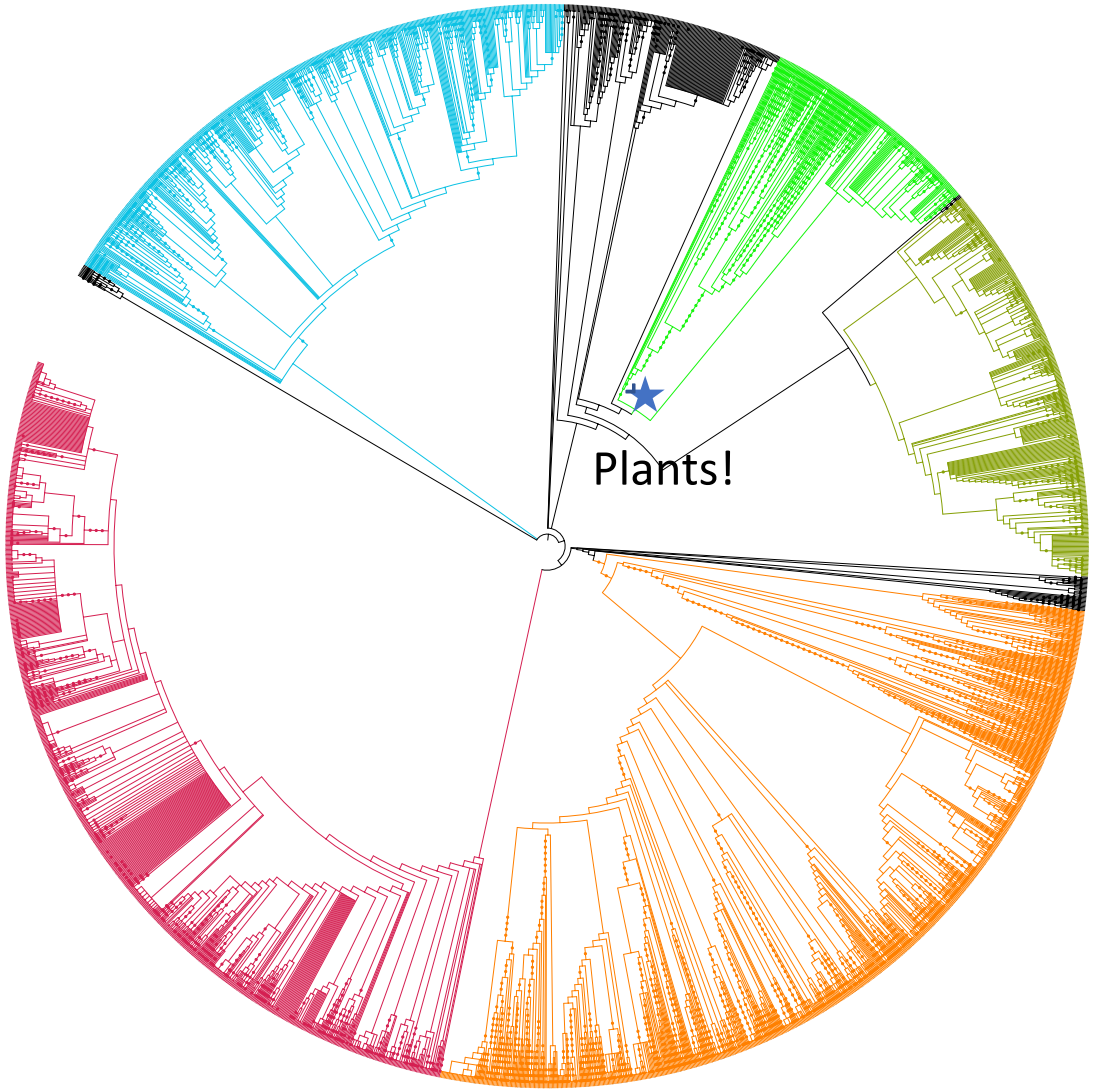


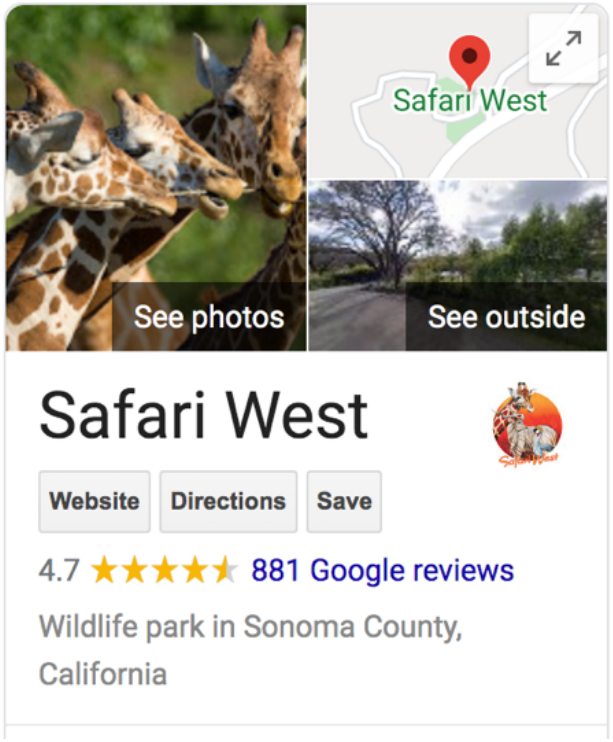
18S metabarcode results



BioBlitz of the RUSSIAN RIVER
Sonoma County California

Synthetic Tree Made with Open Tree Of Life

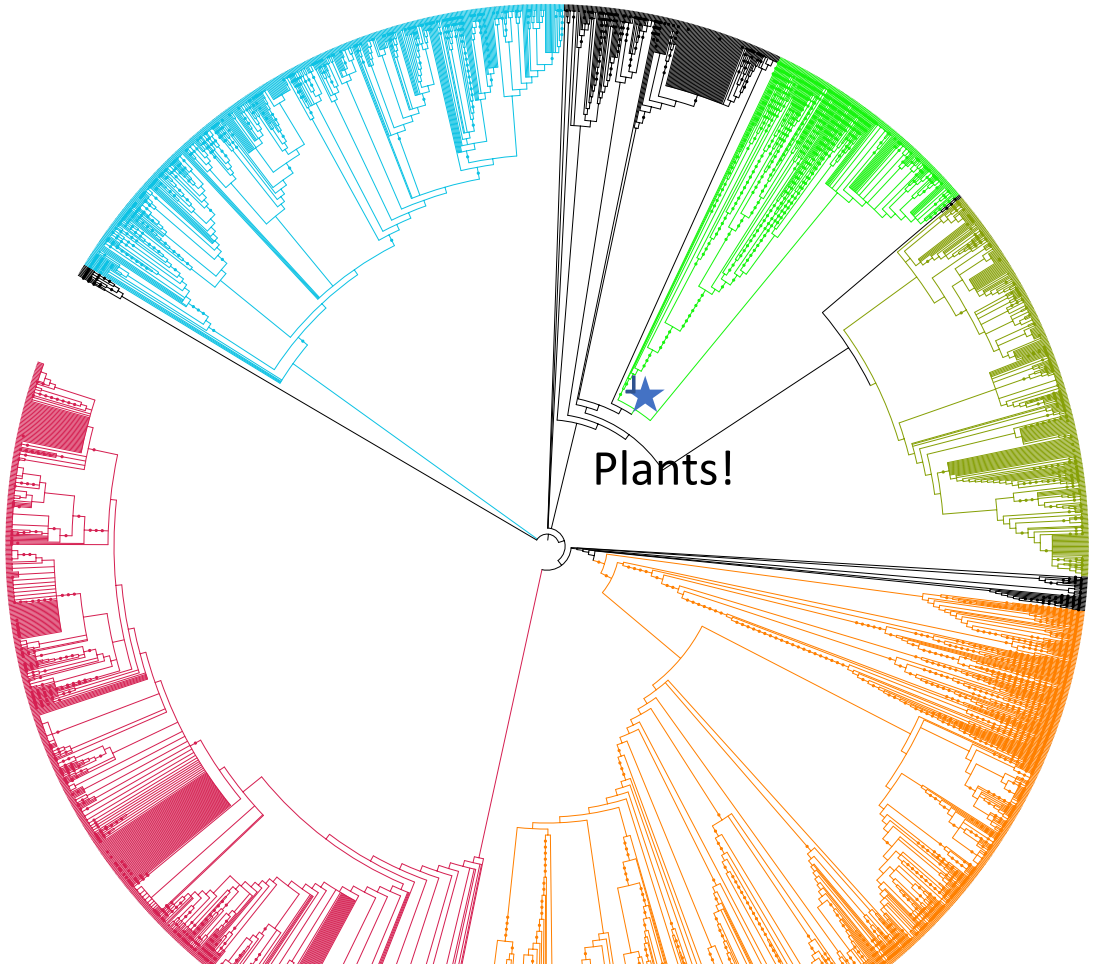


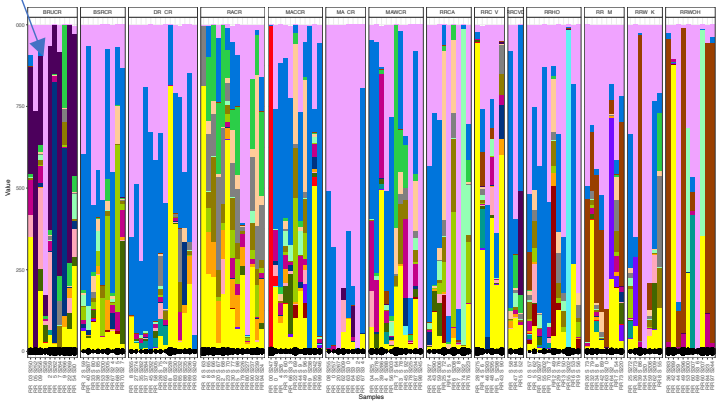


BioBlitz of the RUSSIAN RIVER Sonoma County California

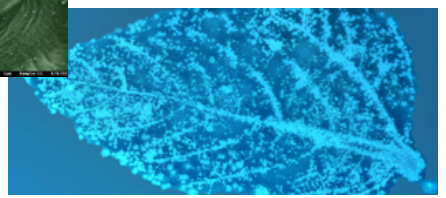
Eucalyptus

Synthetic Tree Made with Open Tree Of Life

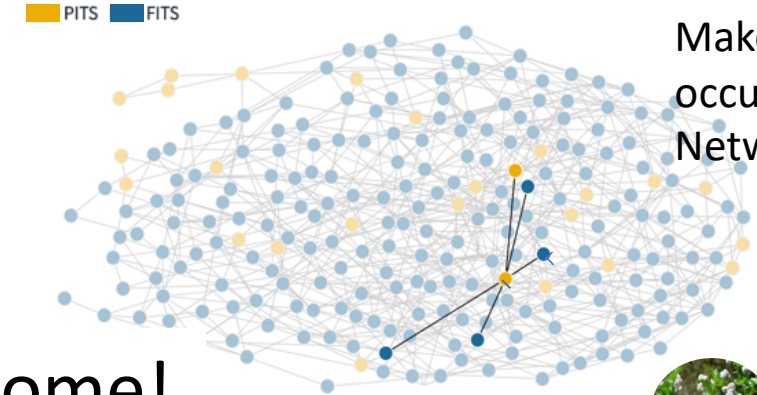




172 Sites



Leaf Bacteria



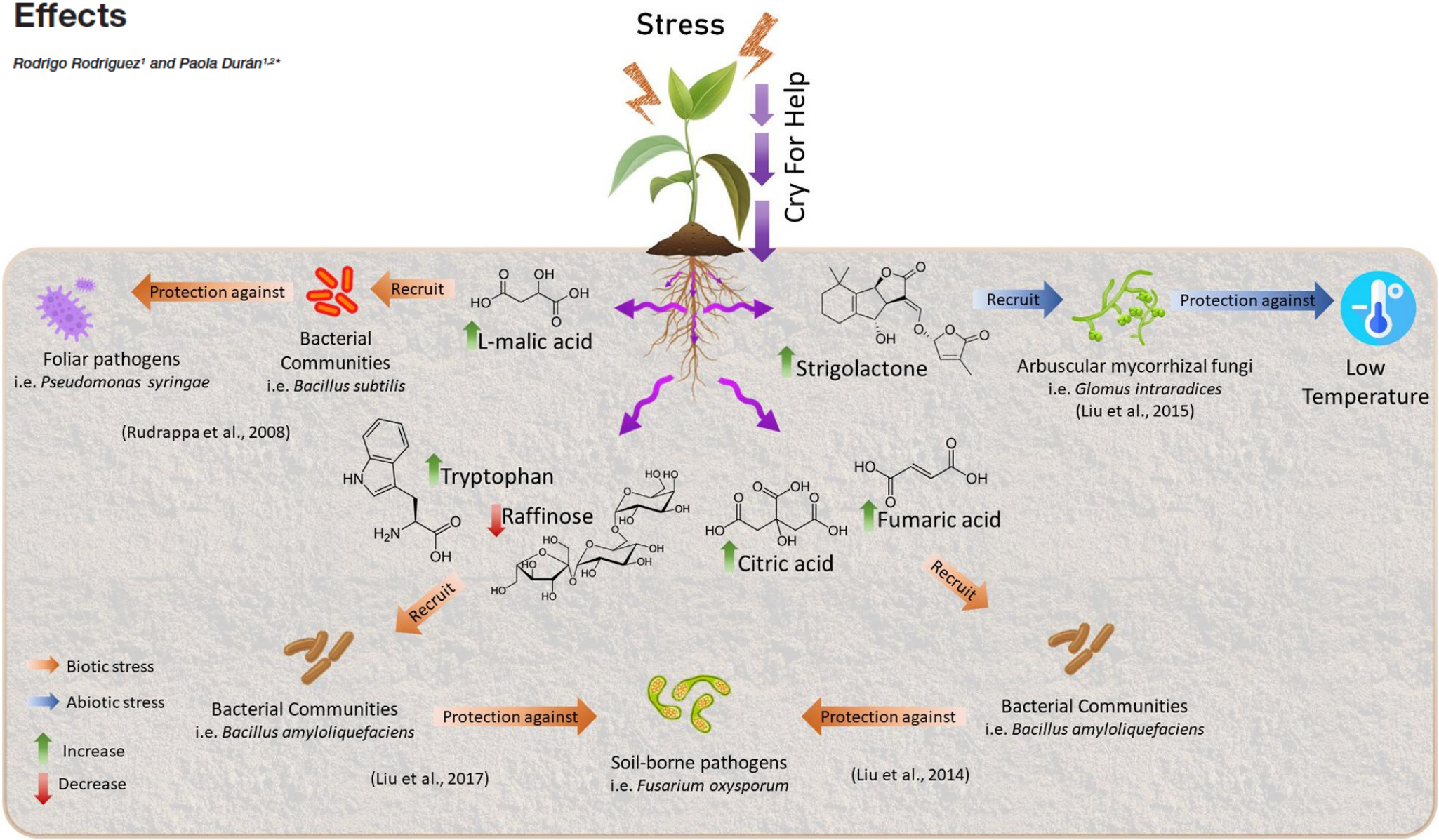
Make Co-occurrence Network

Discover Components of the Holobiome!

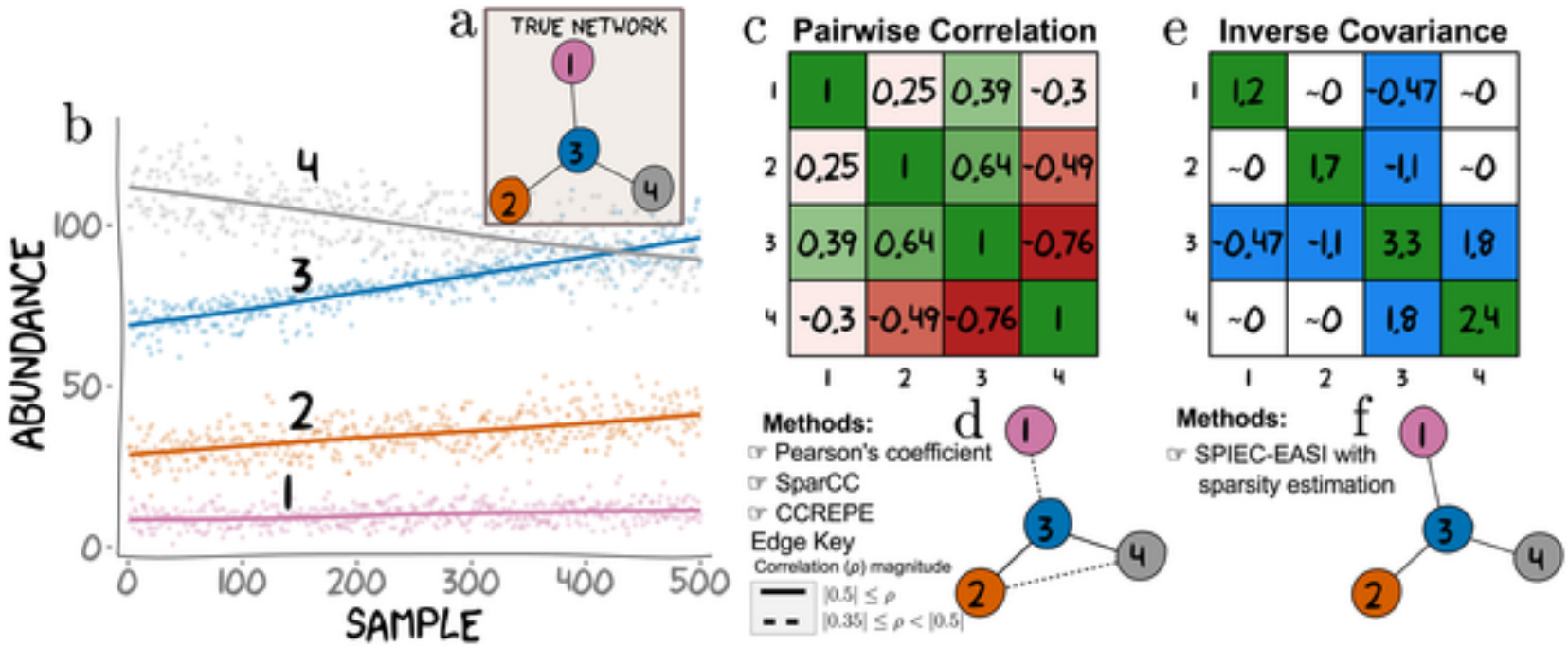
frontiers
in Bioengineering and Biotechnology

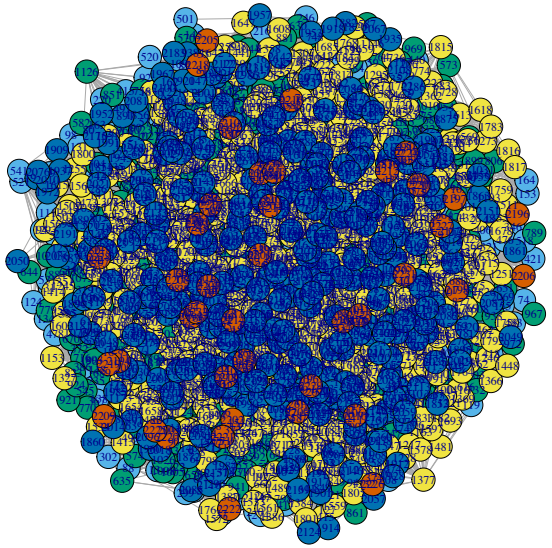
Natural Holobiome Engineering by Using Native Extreme Microbiome to Counteract the Climate Change Effects

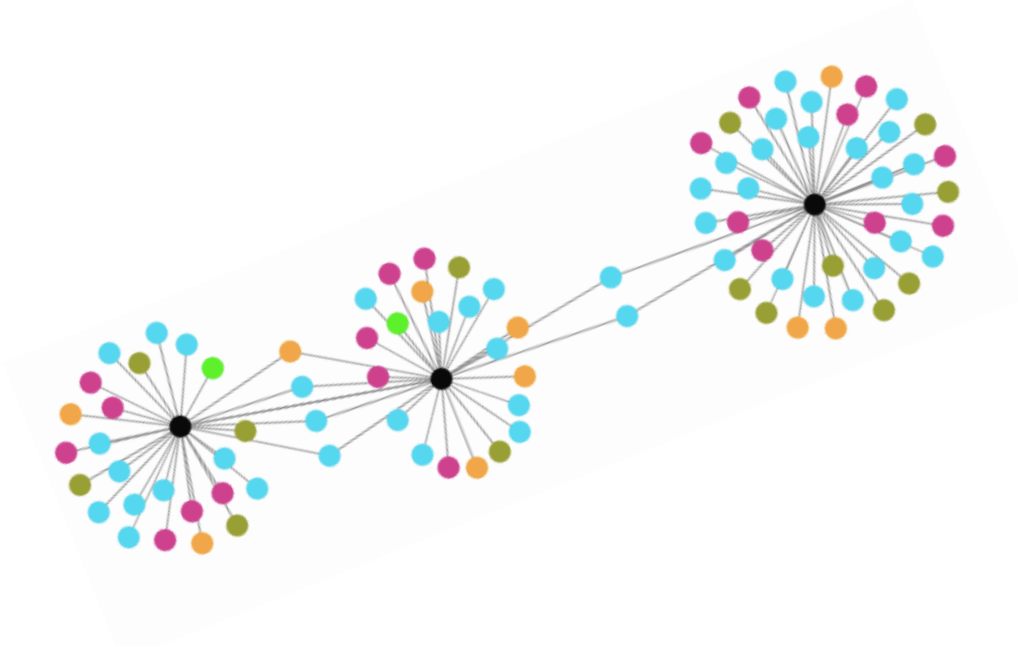
*Rodrigo Rodriguez[1] and Paola Durán[1,2]**



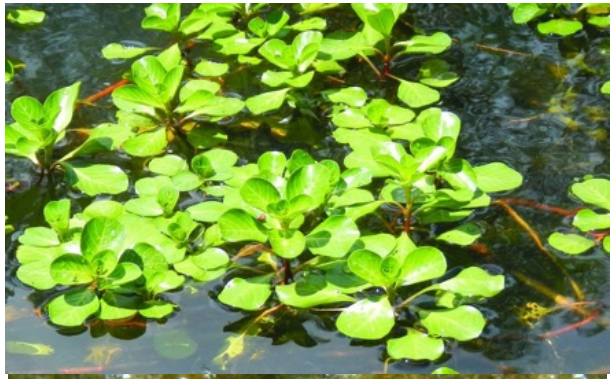
Synthetic Tree of Russian River Taxa
Made with Open Tree Of Life







Bacteria
Nitrite Oxidizer Guild 1
Animalia
Fungi
Chromista
Plantae



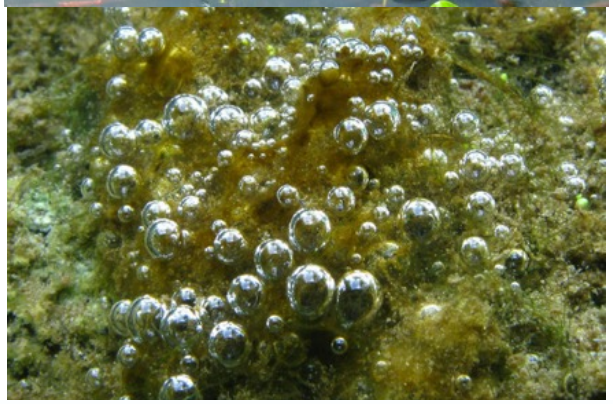
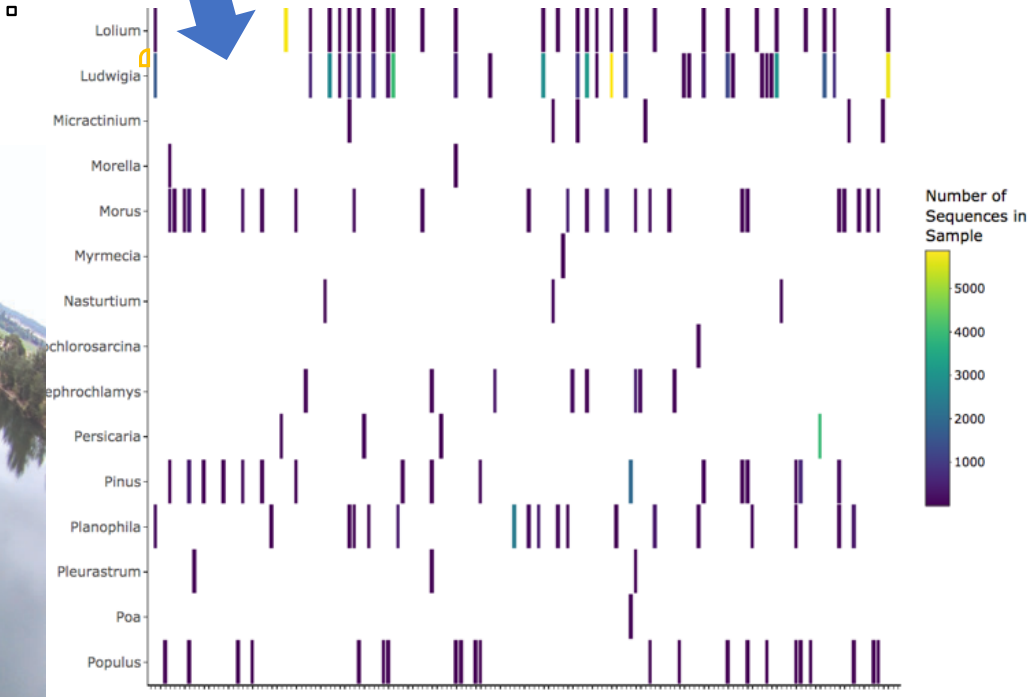
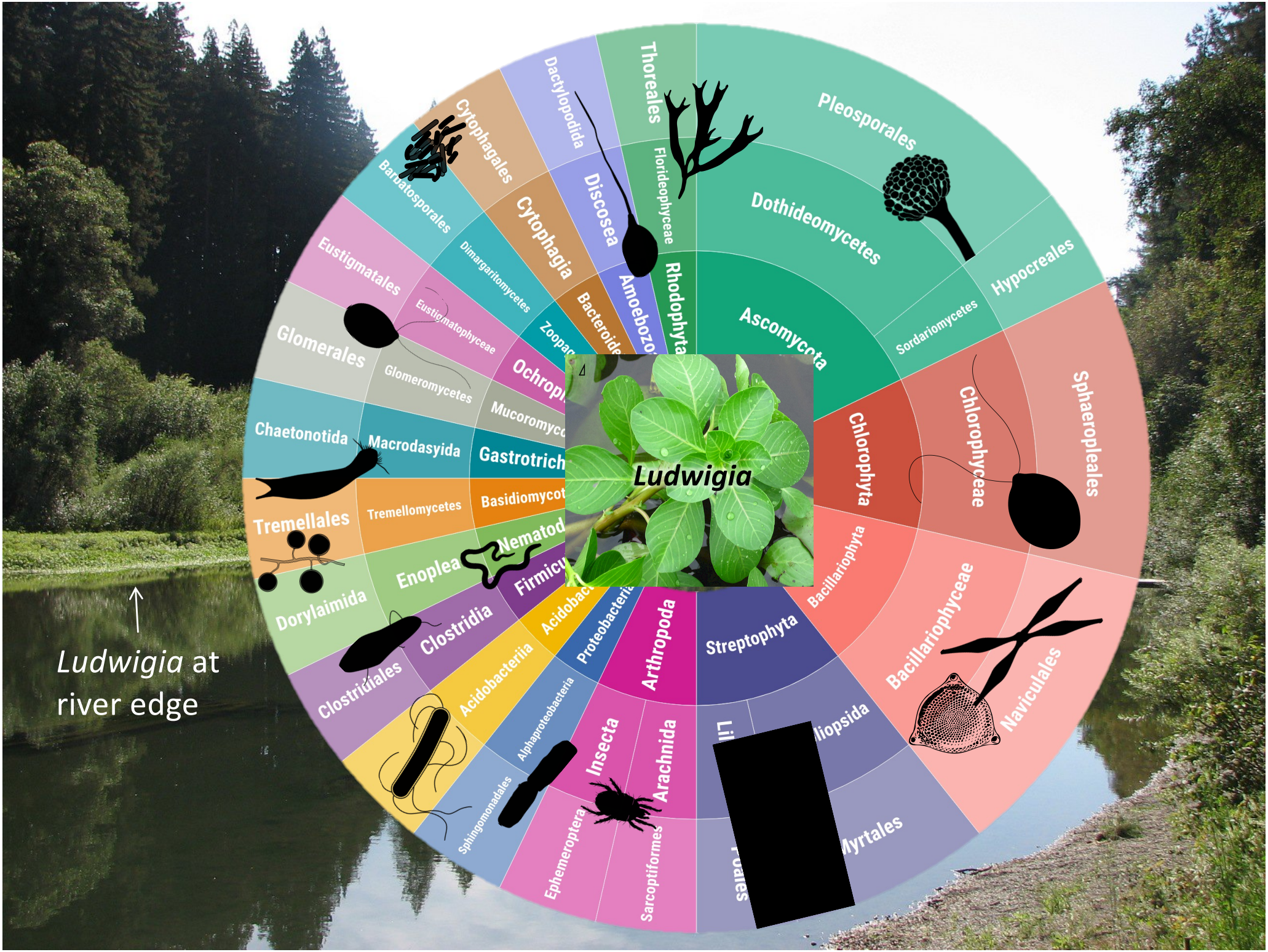


Image from Sonoma County Gazette

Ludwigia



Sites



Ludwigia at river edge

These organisms of the holobiome could reveal new mechanisms by which invasive species cause harm

They may be useful as bioindicators to detect invasive species early

They may show how much an invasive species left an imprint on the local environment after its removal

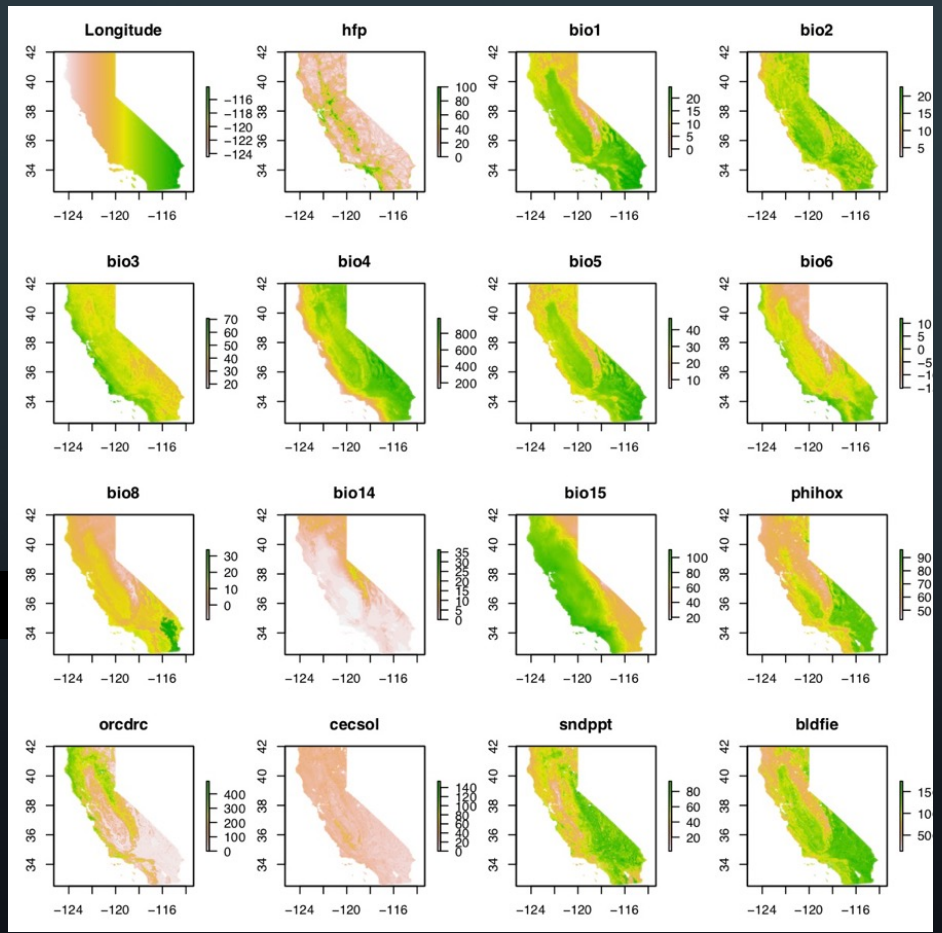
They may present new mitigation opportunities by disrupting the holobiome community network


SMOKE TREE RANCH

CAN WE COMBINE CASE STUDIES AND GET CANDIDATE HOLOBIOMES?

Meixi Lin

Landscape analyses using eDNA metabarcoding and Earth observation predict community biodiversity in California



Temperature precipitation

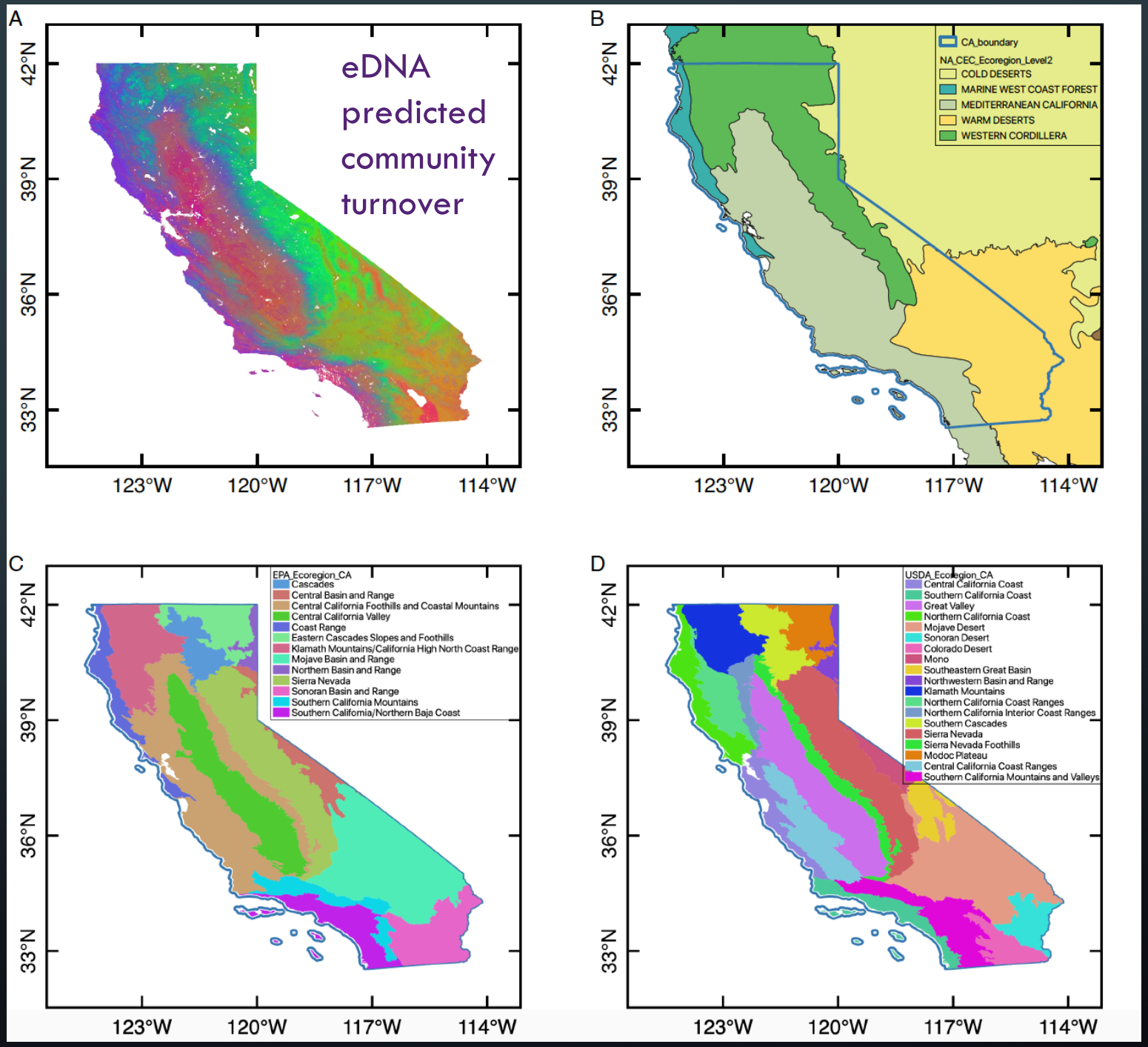
Photosynthetic activity, weather and climate

- Location
- Human Impact
- BioClim
- Soil properties
- Topology
- Sentinel bands
- Vegetation Index
- $R^2 < 0.8$
- Globally available

Sand percentage
Organic content, etc.

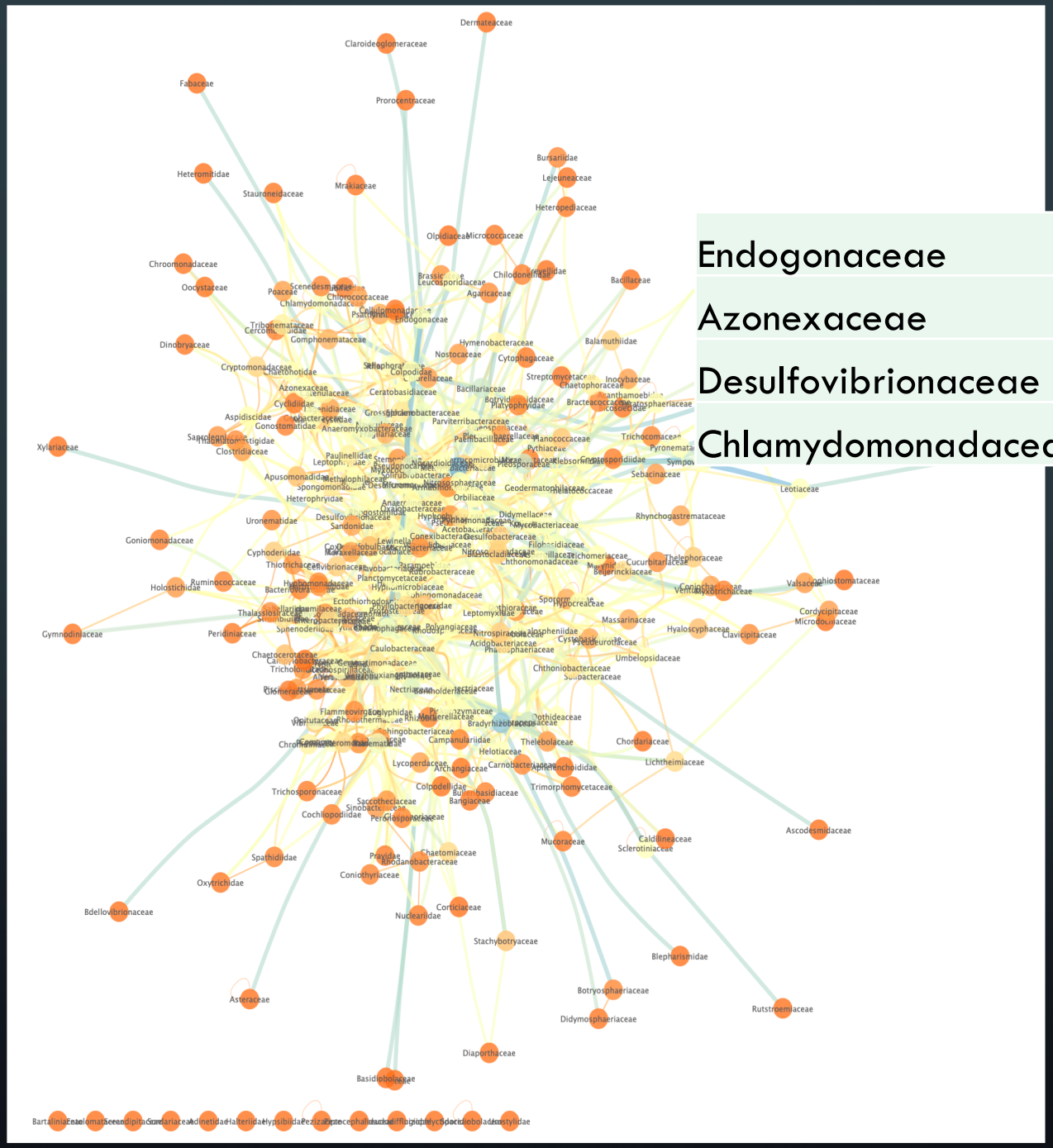
Lin et al., *submitted to Ecological Applications*

Meixi Lin



USFWS

California-wide project

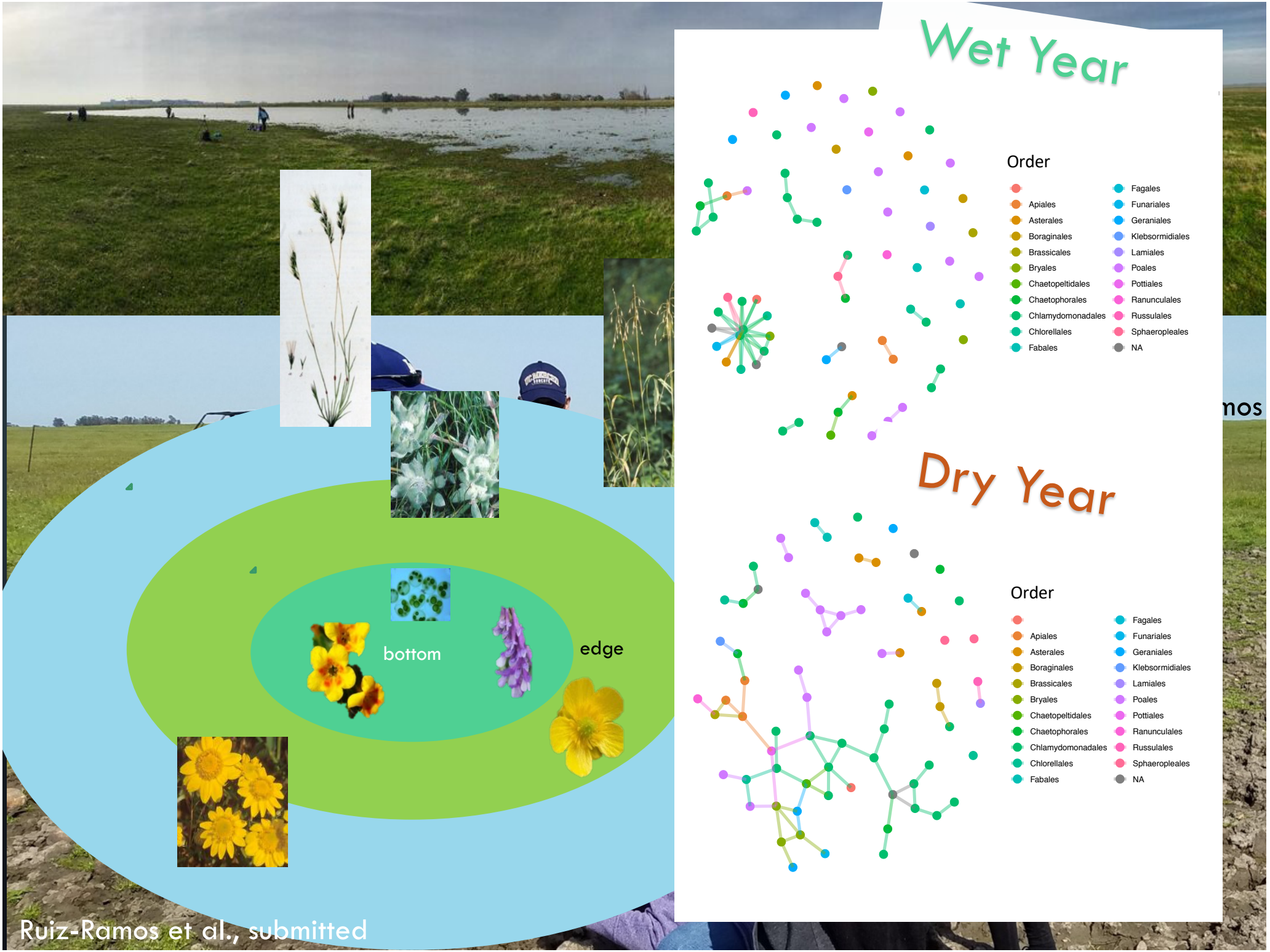


Families networked with Poaceae

Endogonaceae	Supply nutrients and anchoring
Azonexaceae	Involved in N mineralization?
Desulfovibrionaceae	Lactate, low oxygen, high salt?
Chlamydomonadaceae	Dominant soil algae, pioneer species in disturbed areas Recruit beneficial bacteria

Lin et al., *submitted to Ecological Applications*

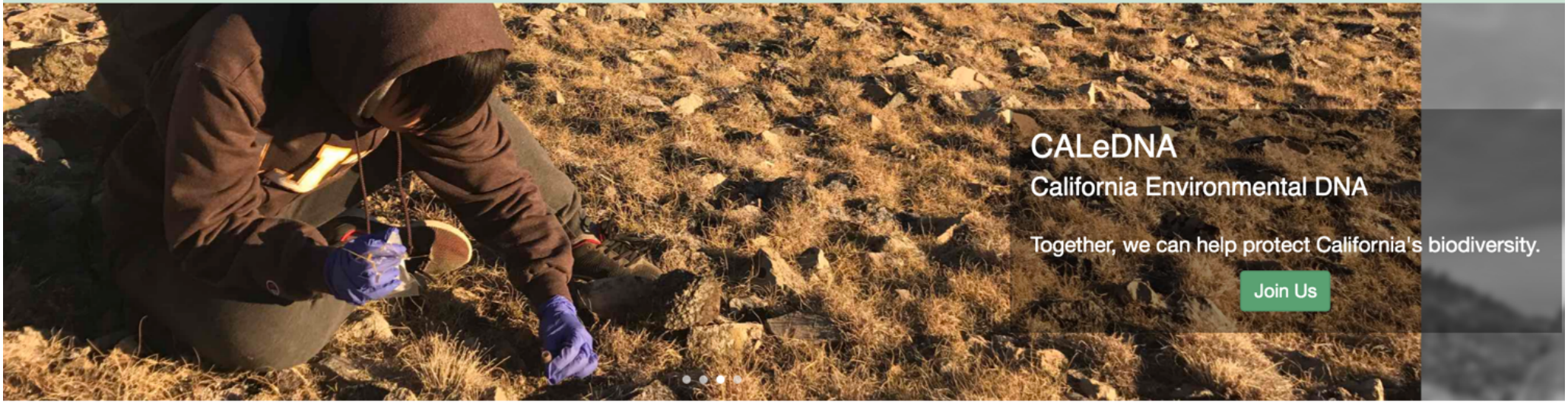
ARE HOLOBIOMES STABLE?


bottom
edge
Wet Year
Dry Year
Order
Apiales
Asterales
Boraginales
Brassicales
Bryales
Chaetopeltidales
Chaetophorales
Chlamydomonadales
Chlorellales
Fabales
Fagales
Funariales
Geraniales
Klebsormidiales
Lamiales
Poales
Pottiales
Ranunculales
Russulales
Sphaeropleales
NA
Ruiz-Ramos et al., submitted

www.ucedna.com

UNIVERSITY OF CALIFORNIA CALeDNA

ABOUT EXPLORE DATA GET INVOLVED NEWS SIGN IN



Collect, Analyze, and Protect

California has thousands of species found nowhere else in the world, but over 70% of its natural habitat has been lost.

CALeDNA aims to address problems in biodiversity monitoring by pairing volunteer community scientists with University of California researchers to collect soil samples from across California. By analyzing the environmental DNA (eDNA) from the soil samples, we can assess the biodiversity of microbes, fungi, plants and animals.

3,116 Sites

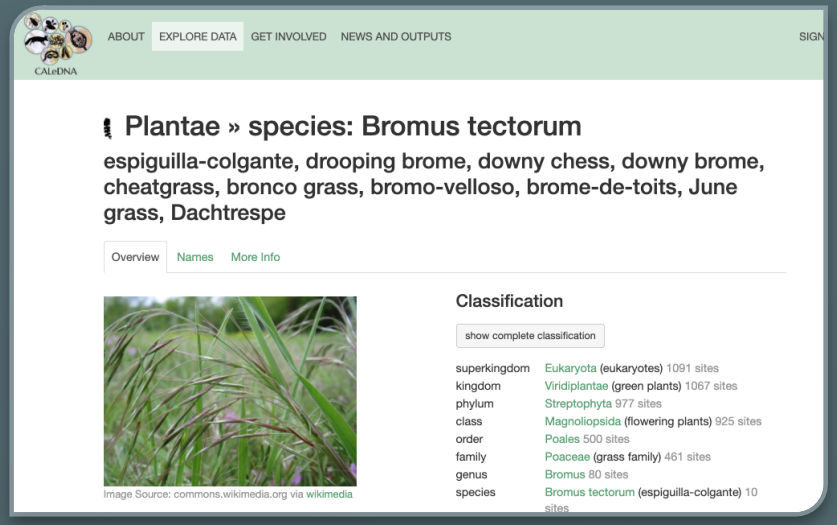
36,611 Organisms identified

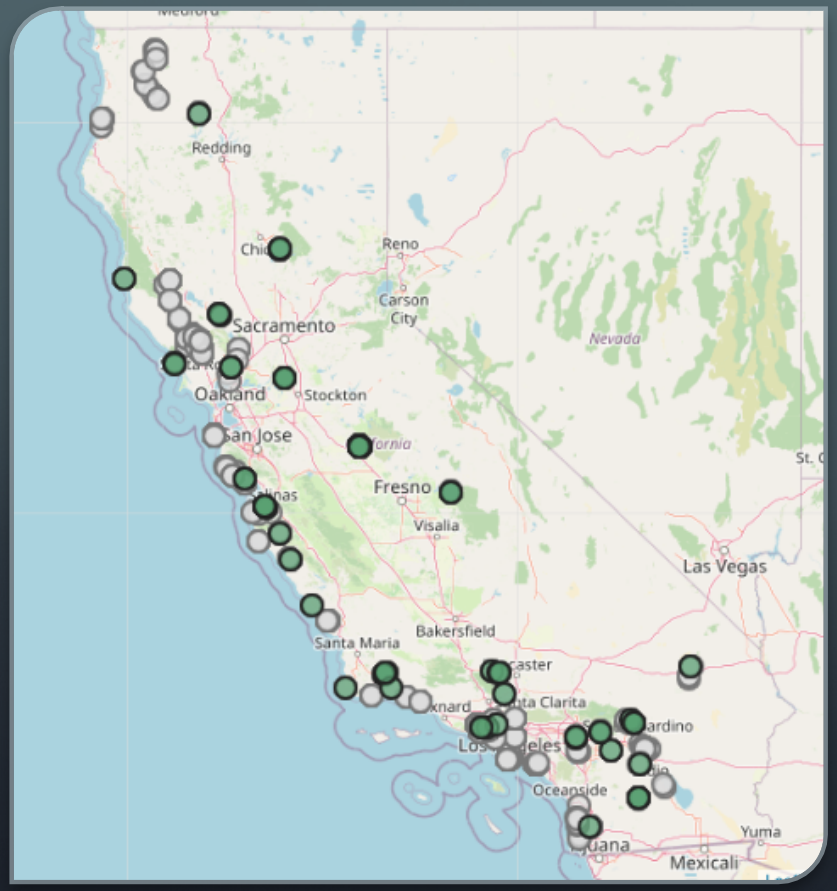
2,091 Registered users

Open Biodiversity Data for Everyone

We openly share our methods and results to understand the potential of eDNA for conservation.

Anyone can view the field data from our community scientists and the eDNA data from our researchers.





Over 30 observations in eDNA?

We can make a candidate holobiome

Under 30 observations in eDNA?

Help us add new collections


NATIONAL
PARK
SERVICE

THANK YOU!

UNIVERSITY OF CALIFORNIA
SANTA CRUZ
Genomics Institute

NASA GGBN NOAA METABOLIC STUDIO

UNIVERSITY of CALIFORNIA
OFFICE OF THE PRESIDENT

Natural Reserve System
university of california

The Nature Conservancy

THE PORT OF LOS ANGELES

Center for Natural Lands Management

hhmi
Howard Hughes Medical Institute