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

Legend
- Grassland
- Desert
- Conifer
- Chaparral
- Oak Woodland
- Ag. Land
- Wetlands
- Juniper
- Urban
- Urban
- Other

0 40 80 160 Miles
What is a DNA barcode?

What is DNA metabarcoding?

Markers that have been used for DNA barcoding in different organism groups, modified from Purdy and Chatterjee,21

<table>
<thead>
<tr>
<th>Organism group</th>
<th>Marker gene/locus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animals</td>
<td>COI,34 Cyb,35 12S,36 16S,37</td>
</tr>
<tr>
<td>Plants</td>
<td>matK,38 rbcl,39 psbA-trnH,40 ITS,41</td>
</tr>
<tr>
<td>Bacteria</td>
<td>COI,47 ppsB,28 16S,42 cpn60,43 tur,43 Rnf,44 gnd,45</td>
</tr>
<tr>
<td>Fungi</td>
<td>ITS,2,46 TEF1a,47,48 RPB1 (LSU), RPB2 (LSU), 18S (SSU),33</td>
</tr>
<tr>
<td>Protists</td>
<td>ITS,2 COI,50 rbcl,51 18S,52 28S,51</td>
</tr>
</tbody>
</table>

18S metabarcode results

Variability in 50-base windows
BioBlitz of the RUSSIAN RIVER
Sonoma County California

Synthetic Tree Made with Open Tree Of Life

Safari West

4.7 ★★★★★ 881 Google reviews
Wildlife park in Sonoma County,
California
BioBlitz of the RUSSIAN RIVER
Sonoma County California

Synthetic Tree Made with Open Tree Of Life

Discover Components of the Holobiome!

Eucalyptus

172 Sites

Leaf Bacteria

Make Co-occurrence Network
Natural Holobiome Engineering by Using Native Extreme Microbiome to Counteract the Climate Change Effects

Rodrigo Rodríguez and Paola Durán

Stress

Cry For Help

Foliar pathogens
i.e. Pseudomonas syringae

Protection against

(Rudrappa et al., 2008)

Bacterial Communities
i.e. Bacillus subtilis

Recruit

L-malic acid

Tryptophan

Raffinose

Arbuscular mycorrhizal fungi
i.e. Glomus intraradices

Protection against

(Liu et al., 2015)

Bacterial Communities
i.e. Bacillus amyloliquefaciens

Protection against

(Liu et al., 2017)

Soil-borne pathogens
i.e. Fusarium oxysporum

Protection against

(Liu et al., 2014)

Bacterial Communities
i.e. Bacillus amyloliquefaciens

Protection against

(Liu et al., 2014)

Low Temperature

Biotic stress

Abiotic stress

Increase

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

Image from Sonoma County Gazette
Ludwigia
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.
CAN WE COMBINE CASE STUDIES AND GET CANDIDATE HOLOBIOMES?
Landscape analyses using eDNA metabarcoding and Earth observation predict community biodiversity in California

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

Temperature precipitation
Photosynthetic activity, weather and climate
Sand percentage
Organic content, etc.

Lin et al., submitted to Ecological Applications
eDNA predicted community turnover
California-wide project

Endogonaceae
Azonexaceae
Desulfovibrionaceae
Chlamydomonadaceae

Lin et al., submitted to Ecological Applications

Families networked with Poaceae

Supply nutrients and anchoring
Involved in N mineralization?
Lactate, low oxygen, high salt?
Dominant soil algae, pioneer species in disturbed areas
Recruit beneficial bacteria
ARE HOLOBIOMES STABLE?
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.

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
THANK YOU!