



# **Center for Embedded Networked Sensing**

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# Center for Embedded Networked Sensing (CENS)

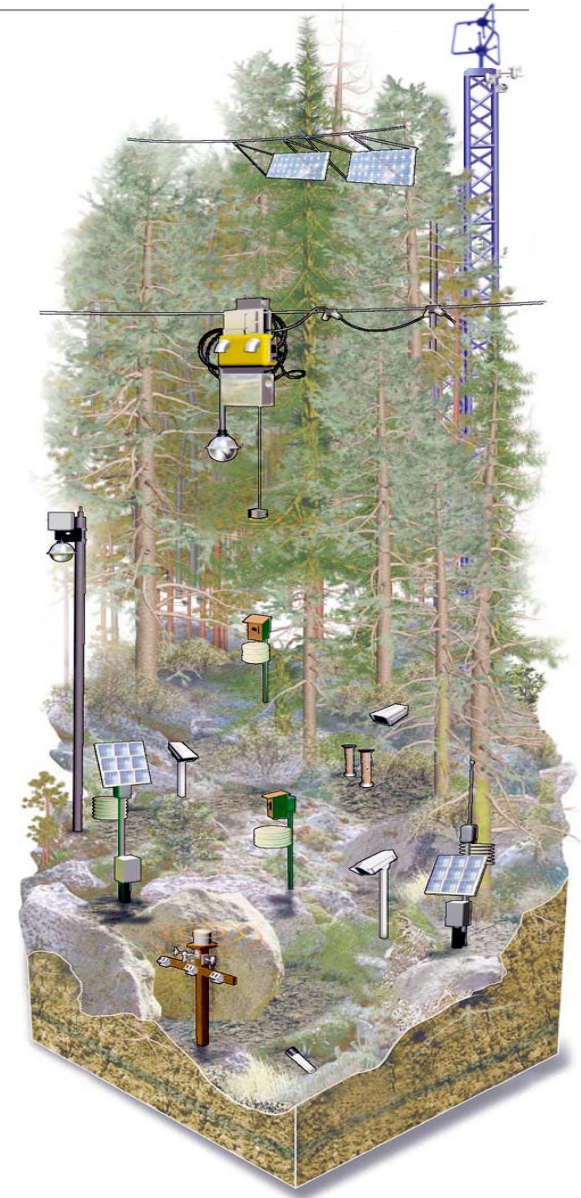
**The goal of CENS is to collaboratively develop Embedded Networked Sensing in terms of:**

- Technologies (hardware but mostly software)
- Systems (software and statistics)
- Applications (ecological and social)

And to create programmable, distributed, multi-modal, multi-scale observatories to address compelling science and engineering issues.

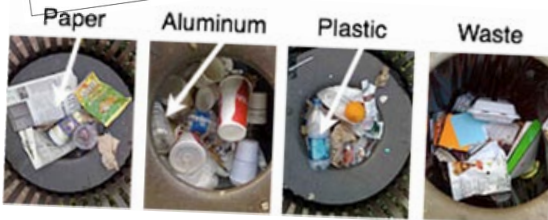
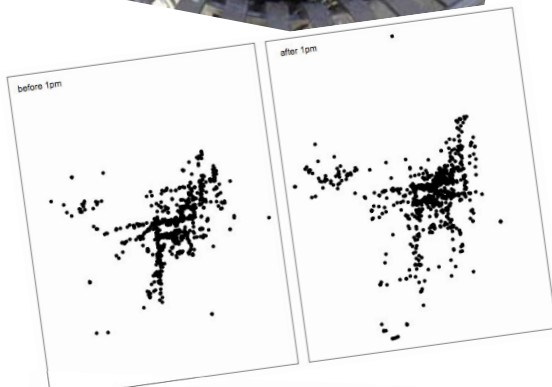
## **The Networked Naturalist**

Mobile phone data collection for citizen science and education

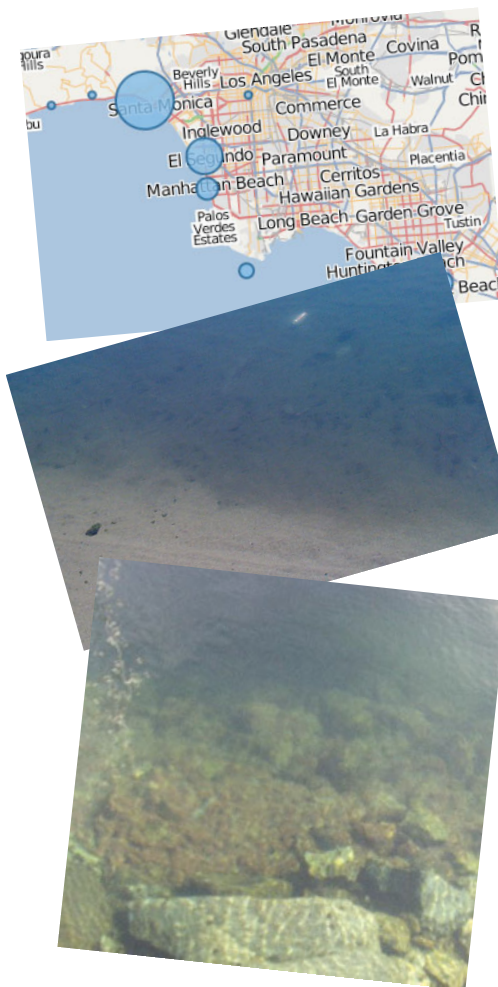


# CENS Pilot Campaigns

## GarbageWatch Recycling Practices



## HabWatch Harmful Algal Blooms



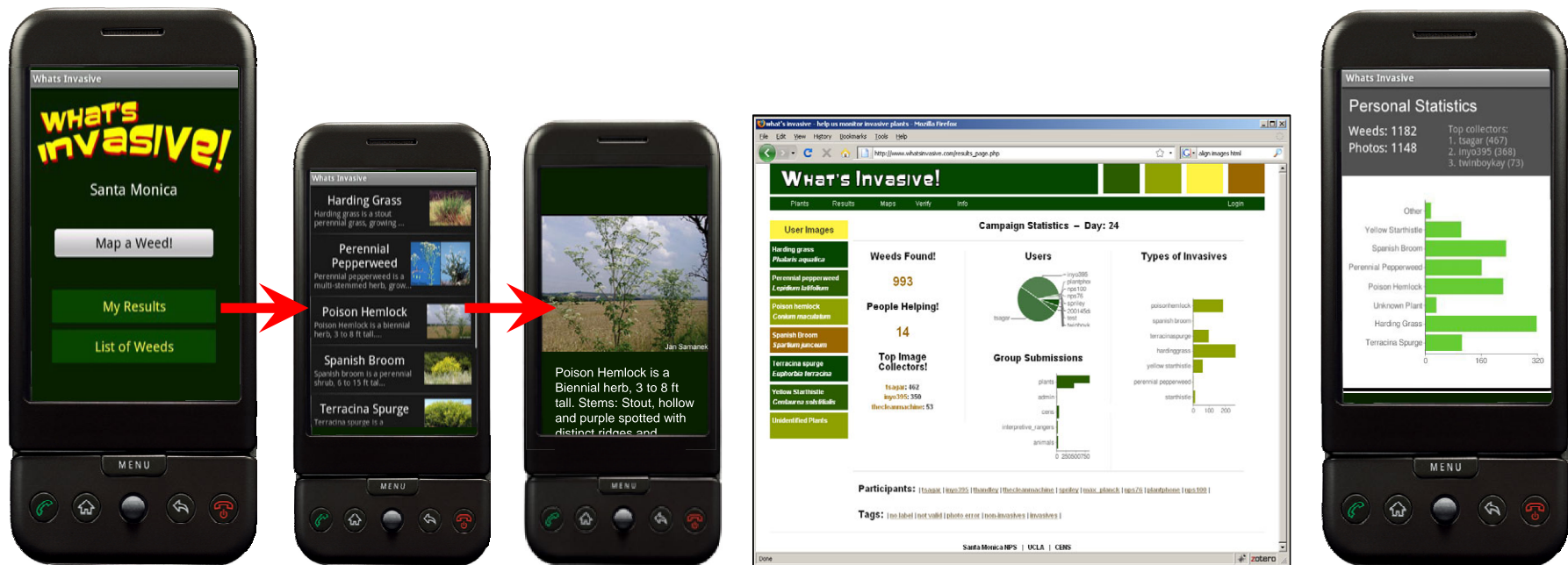
## What's Bloomin' Blooming Plants



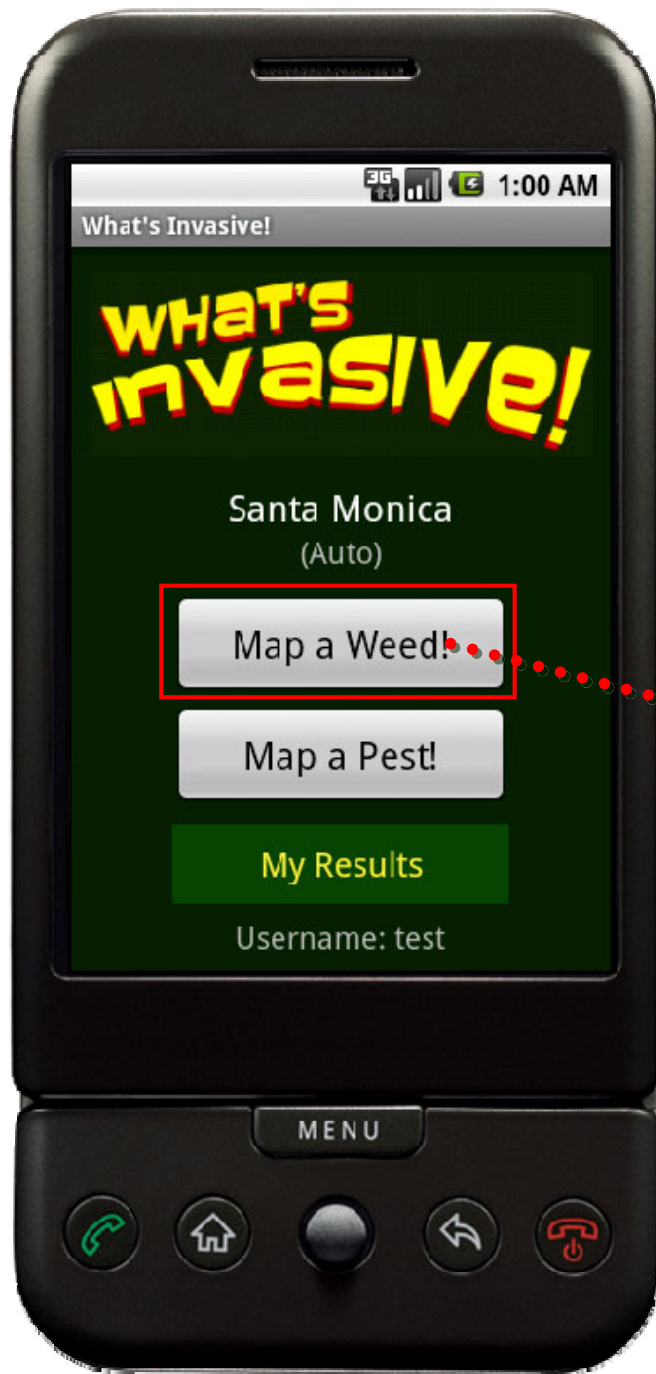
# What's Invasive! – Invasive Plants and Animals

Leveraging the millions of visitors to our National Parks, we have developed a smart phone + website system to help combat the spread of invasive species, allowing users to geo-tag invasive observations and NPS officials to obtain up-to-the-minute weed and pest location information.

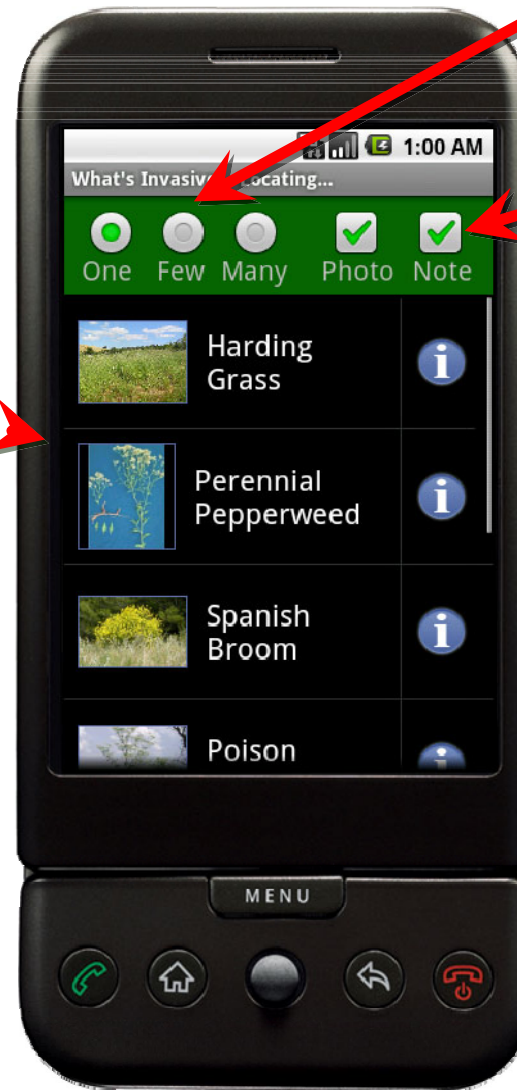
Nature Precedings : doi:10.1038/npre.2010.5198.1 : Posted 9 Nov 2010







## What's Invasive! – Lists of weeds



(1) **One, Few, or Many** is the amount of invasives you see.

(2) **Photo on/off** and **Note on/off** to add a photo and notes to your observation.

The phone has automatically selected the appropriate weed list based on your location.

# What's Invasive! – NPS Pilot Study

The Santa Monica Mountains National Recreation Area is the nation's largest urban national park, featuring over 500 miles of recreation trails, all within easy access to a metropolitan region of more than 17 million people.

In May, we handed out 10 Nokia phones to NPS staff ...



## TOP 6 invasives!

Harding grass

Perennial pepperwood

Poison hemlock

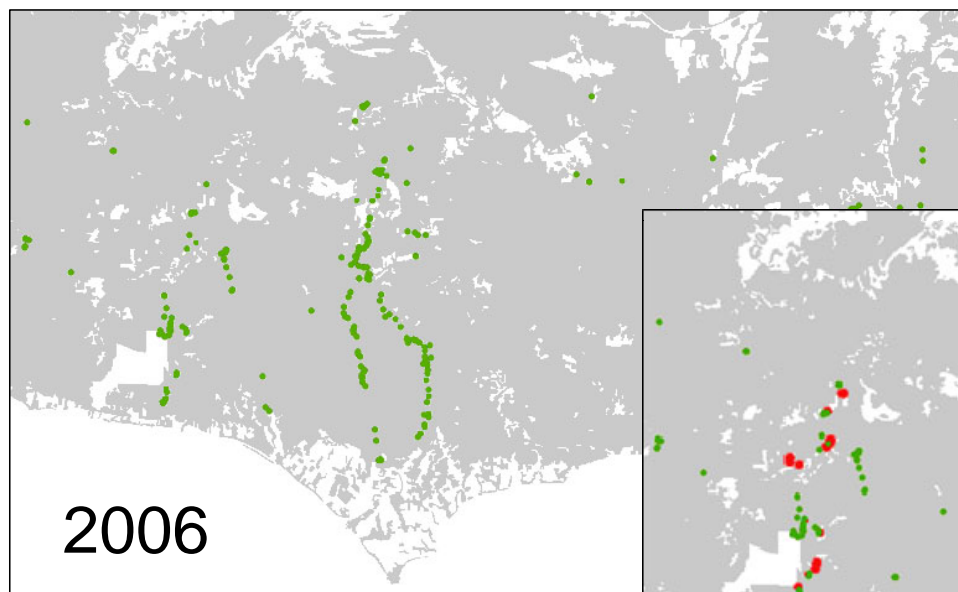
Spanish broom

Terracina spurge

Yellow starthistle

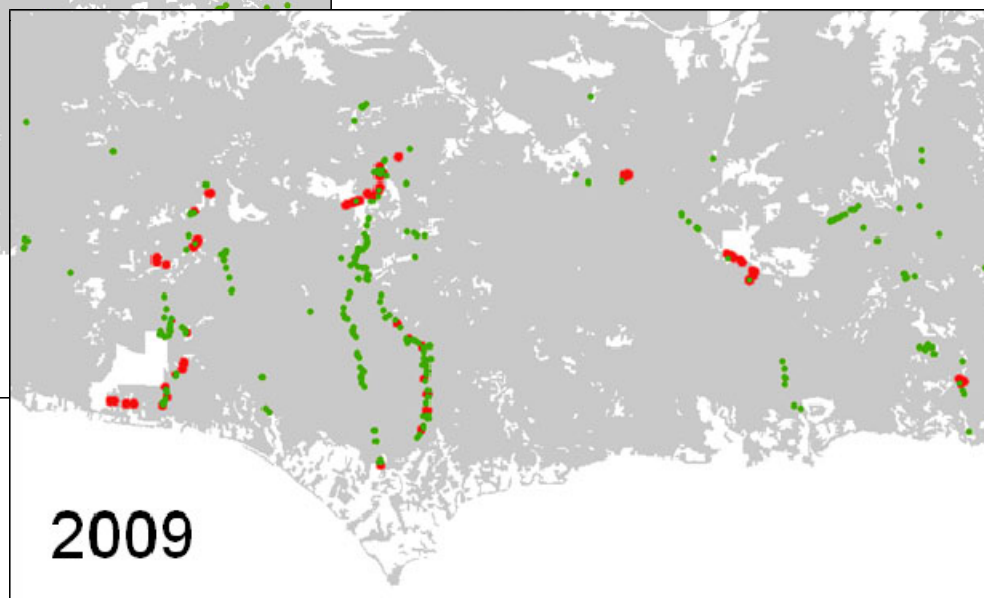


# What's Invasive! – NPS Pilot Study



*Results from the two-week  
What's Invasive! indicate  
data quality is comparable.*

*The weed survey that ended in  
2006 took 2 years and thousands  
of person-hours to complete.*



New weed distributions and significant advancement of some invasive species had occurred within the 3 years since the original survey.

**Total weeds found in the two-year NPS survey: 5426.**

**Total weeds found using What's Invasive in two weeks: 975 = 18%**



# *What's Invasive!* – UCLA Classroom Campus Activities

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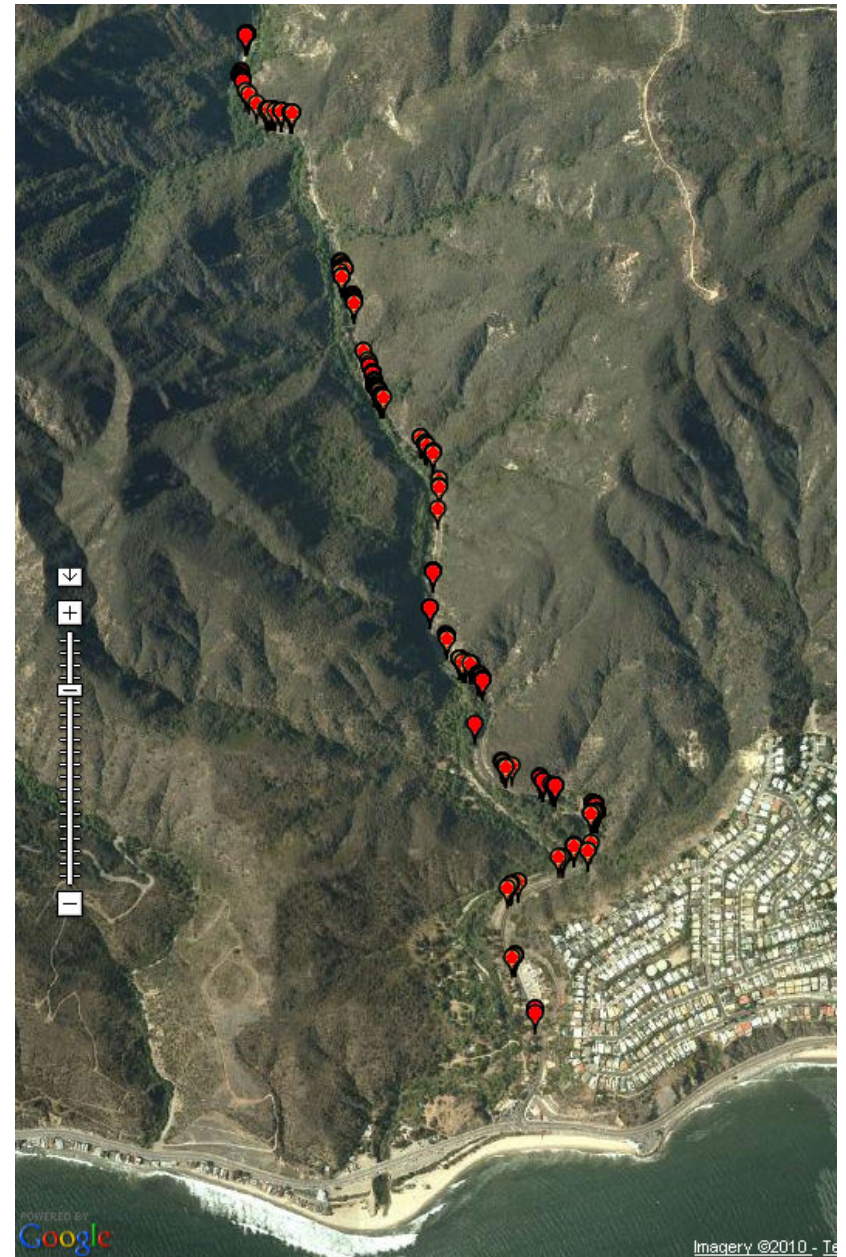




# ***What's Invasive!* – UCLA Classroom Fieldtrip**

As part of a UCLA course in California Ecosystems, Professor Philip Rundel wanted to have his students map invasive plants along Topanga Canyon in the Santa Monica Mountains.

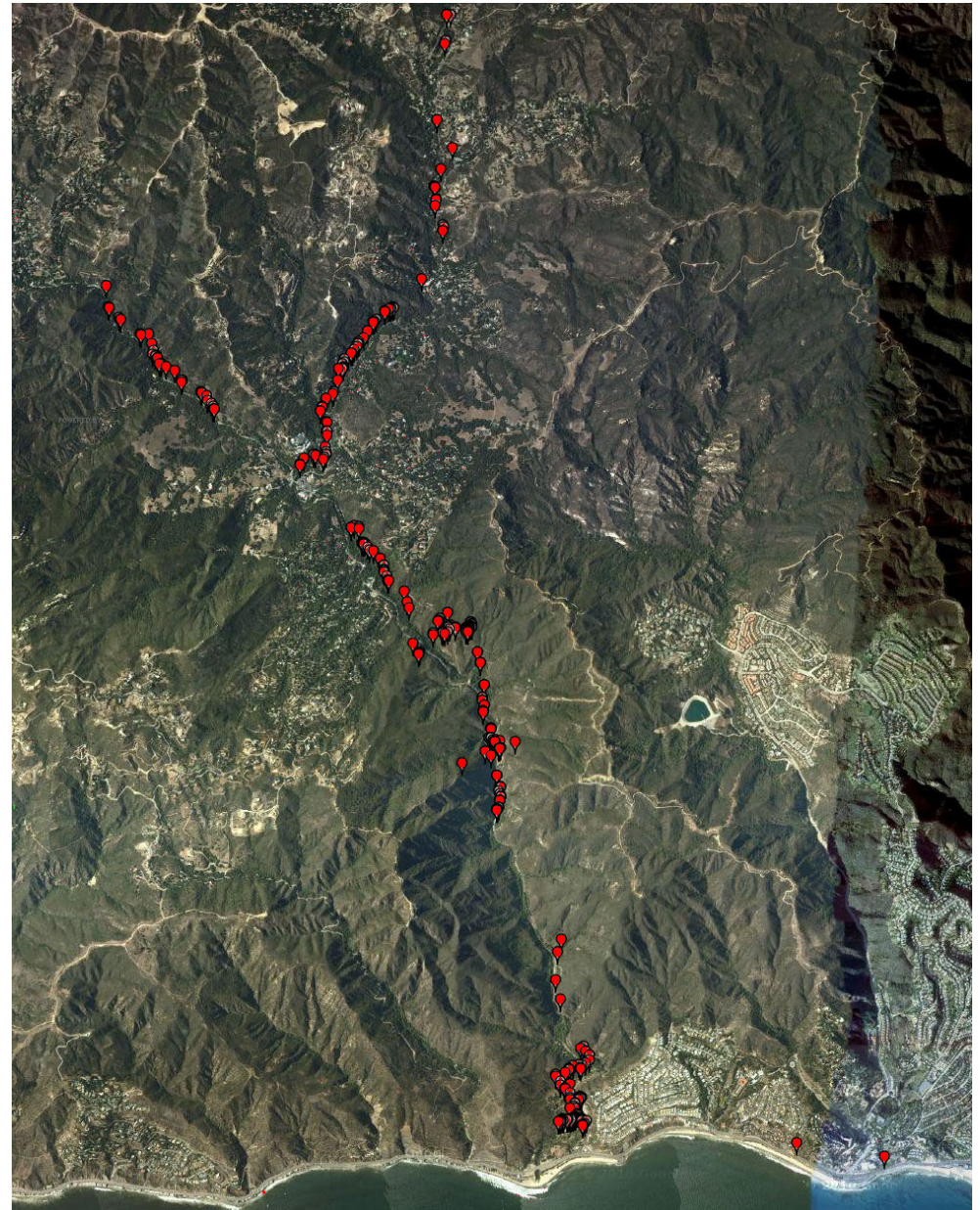
He decided to try out the system himself first, and in a couple hours walking down the canyon and concentrating on one invasive species (*Euphorbia terracina*), he mapped 373 locations.





# ***What's Invasive!* – UCLA Classroom Fieldtrip**

The next weekend, his students were provided with 15 Android cell phones and walking in pairs over shorter sections of the canyon, they mapped a total of 369 locations for the invasive *Arundo donax* (Giant reed) corresponding to 267 new observations (relative to the previous NPS survey) and 102 repeat verification observations.





# BudBurst Mobile – National Plant Phenology Watch

## Project BudBurst – National citizen science education campaign

- A CENS Summer Intern project expanded on Project BudBurst to create a user-friendly website to submit and update observations, add geo-tags, and upload photos and comments.
- Participants can view the progress of their own data collection relative to historical data.
- Mobile phone users can submit via SMS, MMS, or e-mail and get regular SMS reminders and updates.

Project BudBurst

Welcome test | MyBudBurst Space | Logout | f | blog

For Students For Educators Participate! Resources Report Observations Phenology Climate Change Results

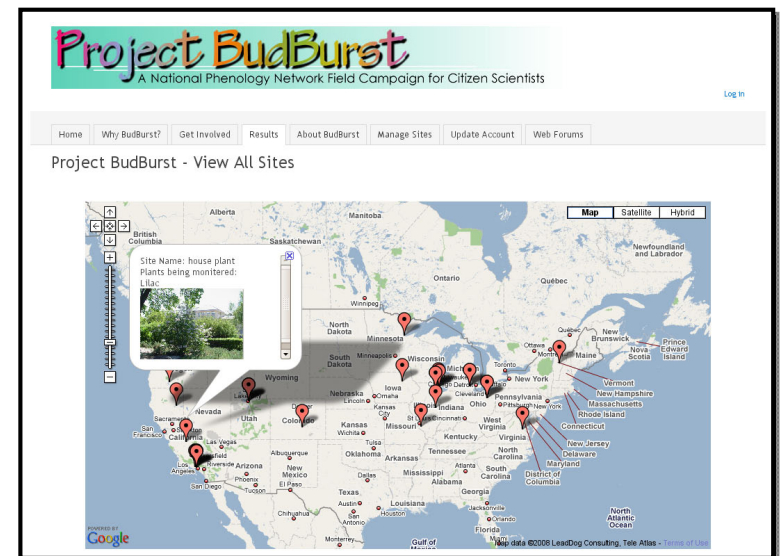
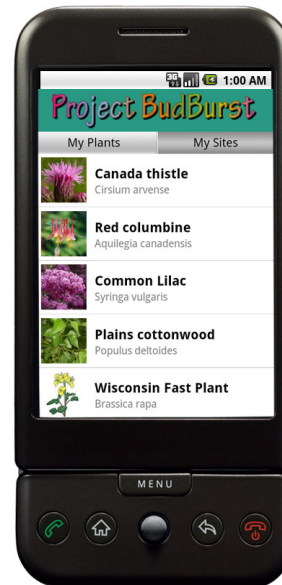
General Info  
My BudBurst Space  
Logout

Select Site -> Select Plant -> Report Phenophase Dates  
Please select the dates of the phenophases that you observed.

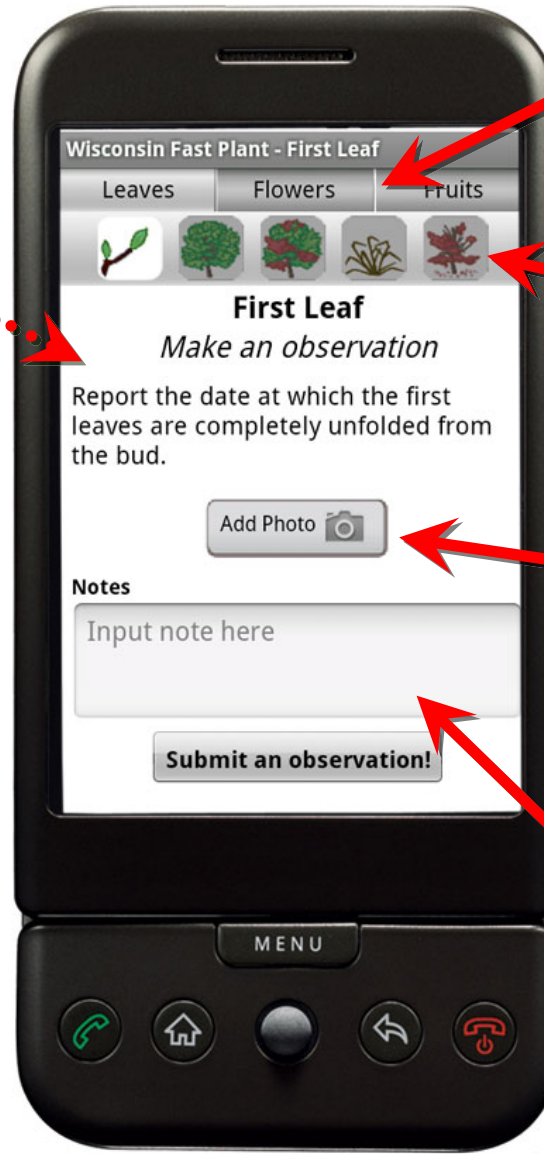
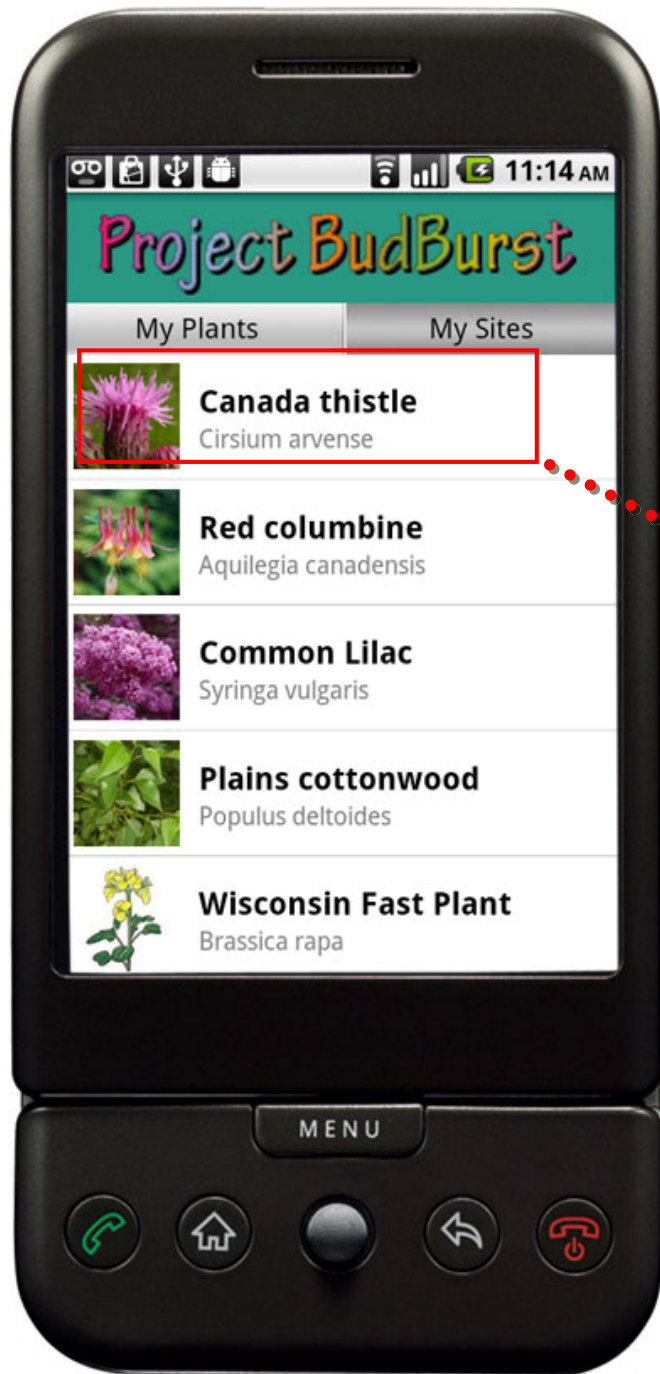
MyBudBurst Site: testsite MyBudBurst Plant: Wisconsin Fast Plant ID: 14

Enter the dates when did you observe: (Phenophases Help)

Leaves	Stage	Date Observed	Notes	Image
50% Color				Browse...
All Leaves Withered				Browse...
50% Leaf Fall				Browse...



## ***BudBurst Mobile – Keeping track***



**Phenology stages** are available for leaves, flowers, and fruits.

You can easily **see the plant stages** that scientists want you to observe.

**Taking a photo** of the plant is an easy way to make an observation and serves as validation of your work.

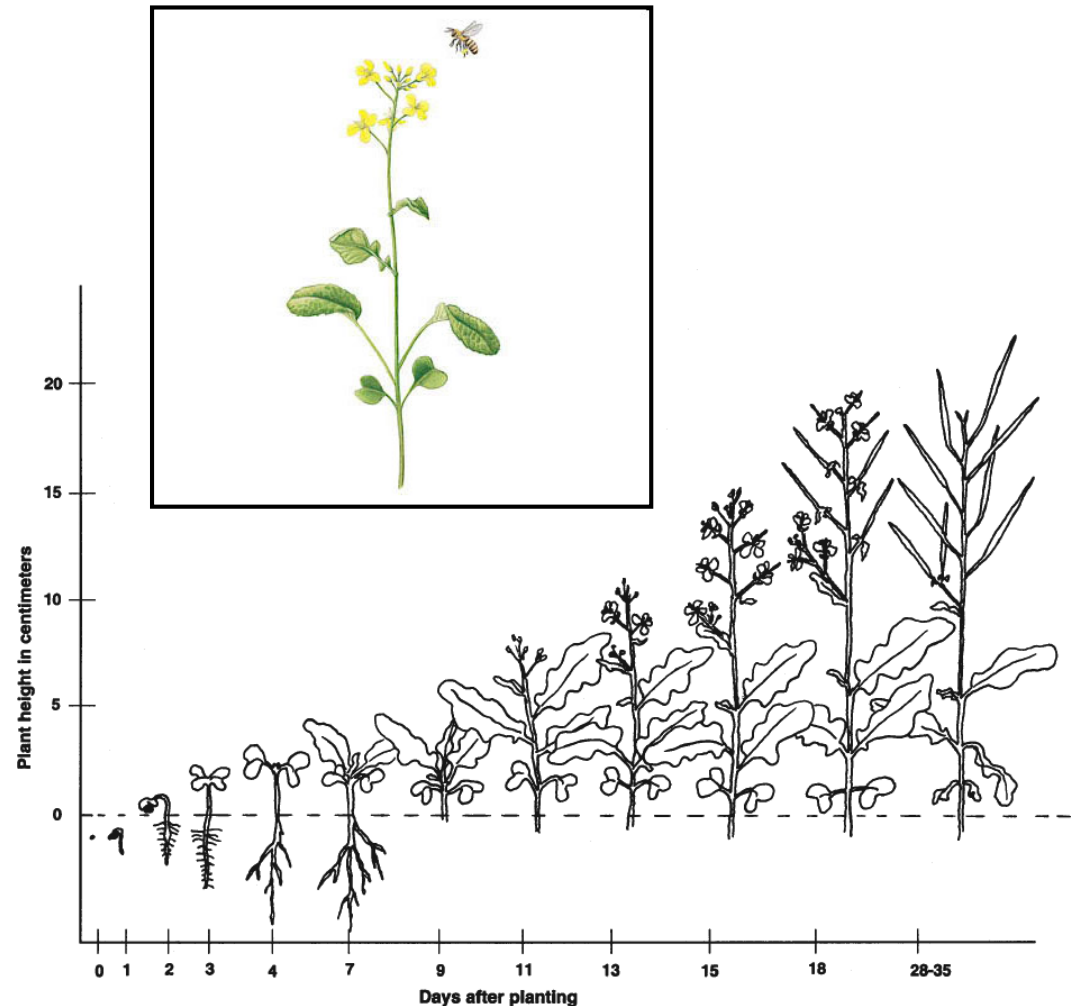
**Make notes** on your observation, too.



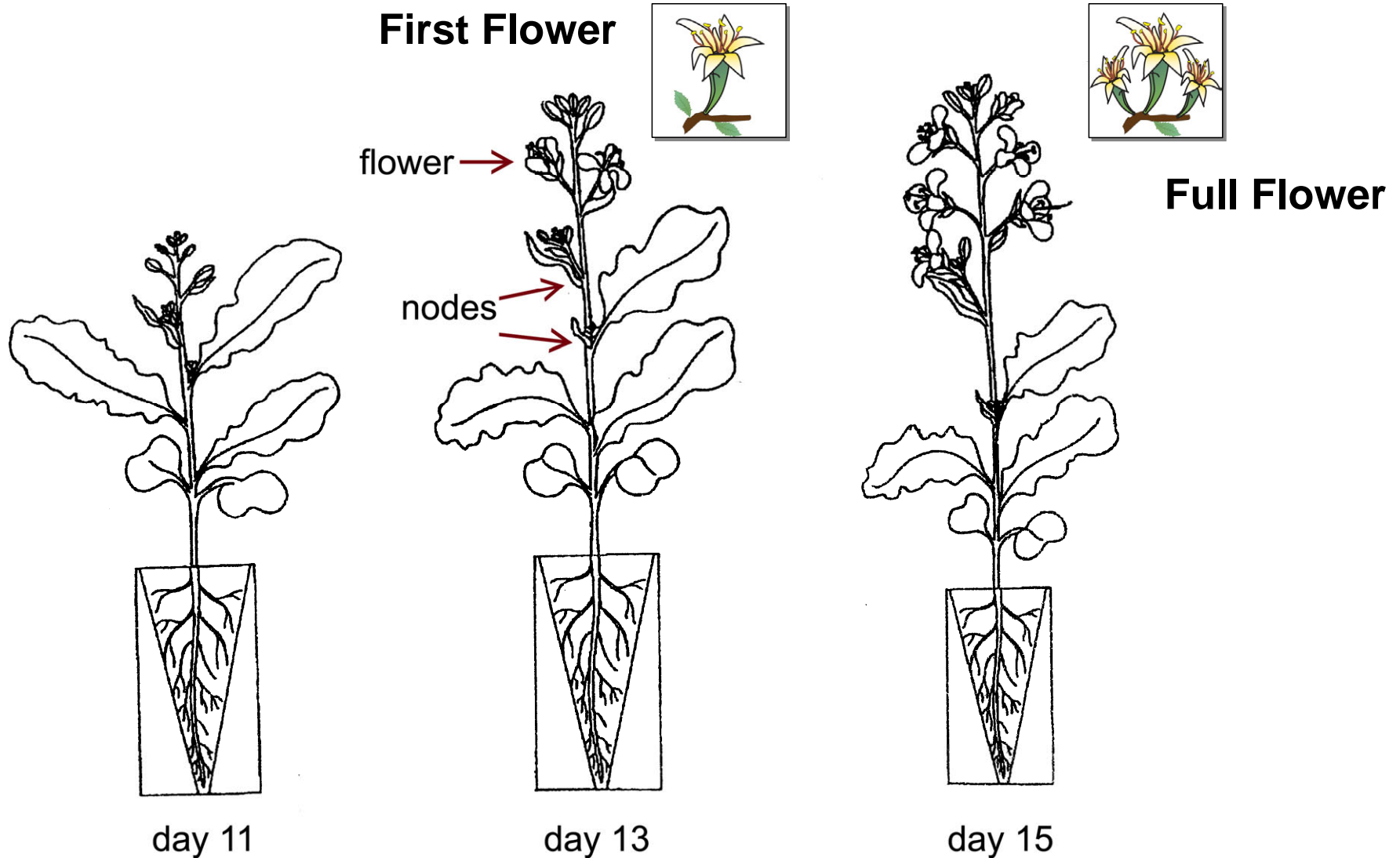
# Project BudBurst – Classroom / Home Activity

Wisconsin Fast Plants® <http://www.fastplants.org/>

Fast Plants® are a type of crucifer (the group of plants that includes mustard, radish, cabbage, etc.) that have been bred and selected to have a uniform, short flowering time (14 days) and grow well under in a small indoor space, with little soil, under artificial lights.



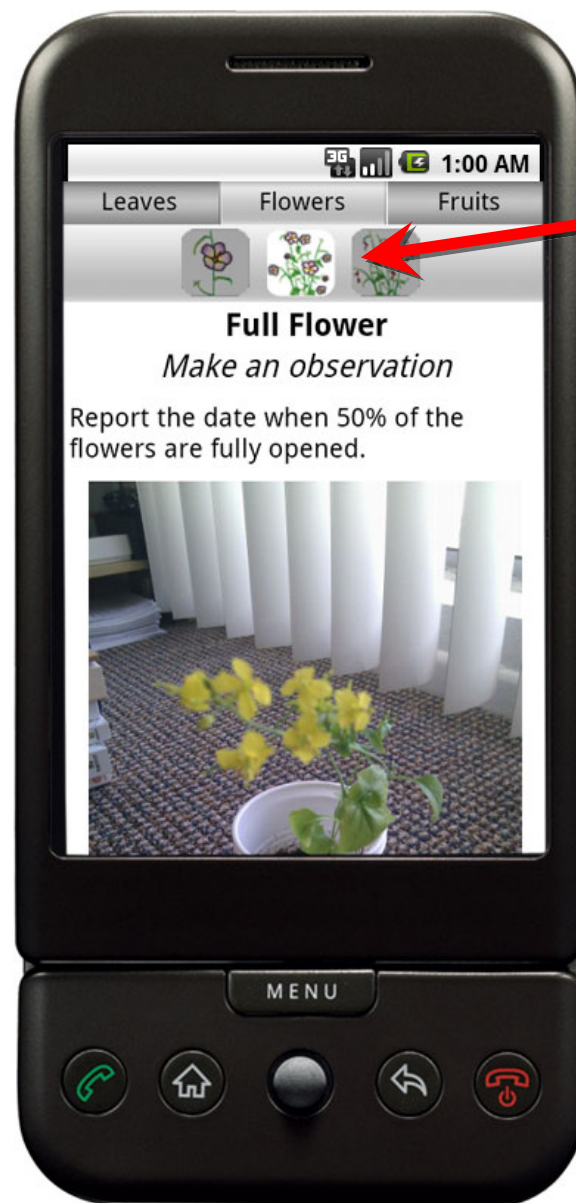
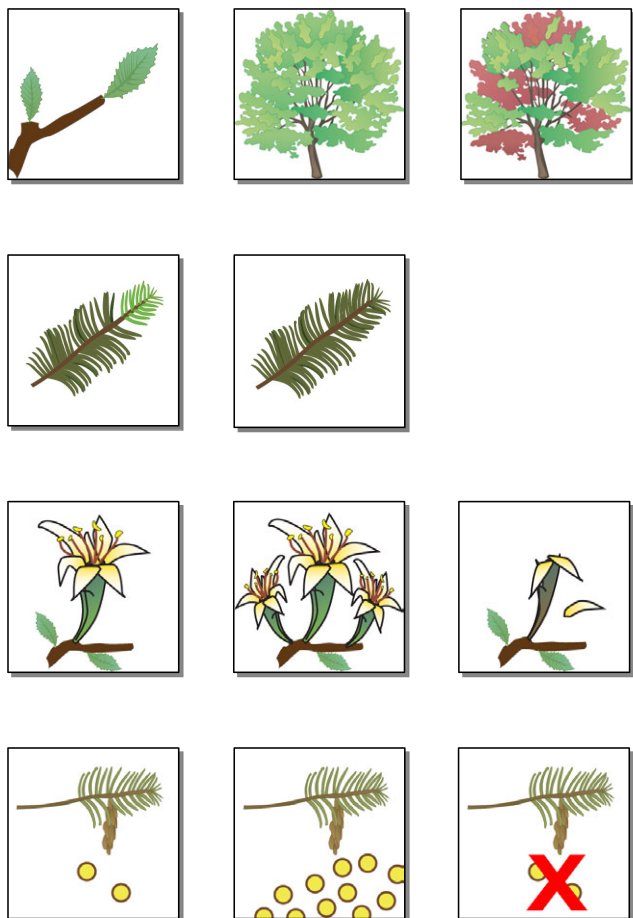
# Project BudBurst – Classroom / Home Activity



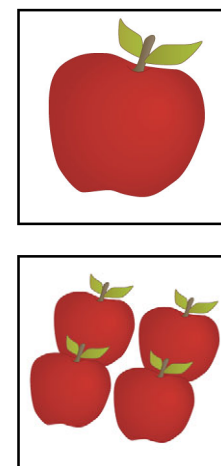


# Project BudBurst – Classroom / Home Activity

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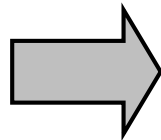
**Phenology stage icons** are the same on the phone as they are on the website.



# Next Steps for Advancing Our Mobile Citizen Science

- Data sharing among systems in an environmental network.
- Back-end data analysis for real-time models .

We are working with Invasive.org and other networks to provide easy access to and extensive broadcast of *What's Invasive!* data sets through automated uploads and data sharing.



National Association of  
**EPPCs**

**EDD MapS**  
Early Detection & Distribution Mapping System

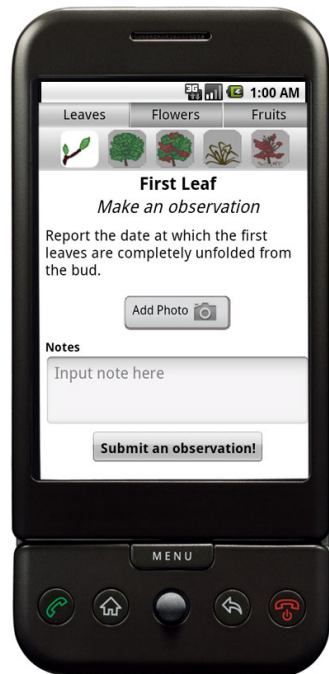




# Next Steps for Advancing Our Mobile Citizen Science

- Data sharing among systems in an environmental network.
- Back-end data analysis for real-time models .

We are combining Project BudBurst user collected data with using external data sources (local weather) and models to create daily, real-time feedback and predictions of plant events.

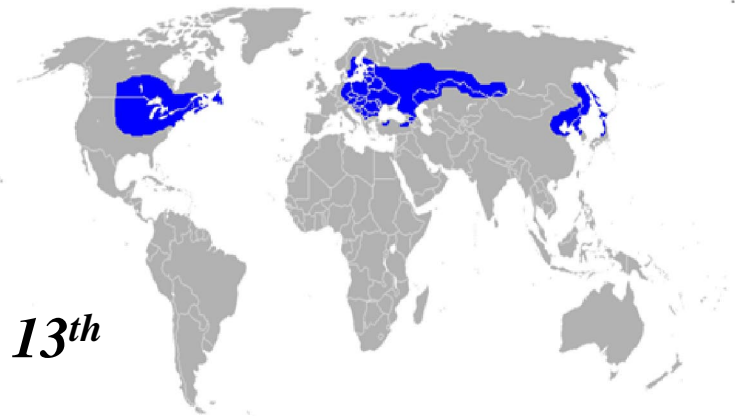


# NOAA

*Is your plant leafing out?*

$$GDD = \frac{T_{\max} + T_{\min}}{2} - T_{\text{base}}$$

*Growing Degree Days  
prediction of Spring: **March 13<sup>th</sup>***





Sign up, provide your email...  
What's Invasive:

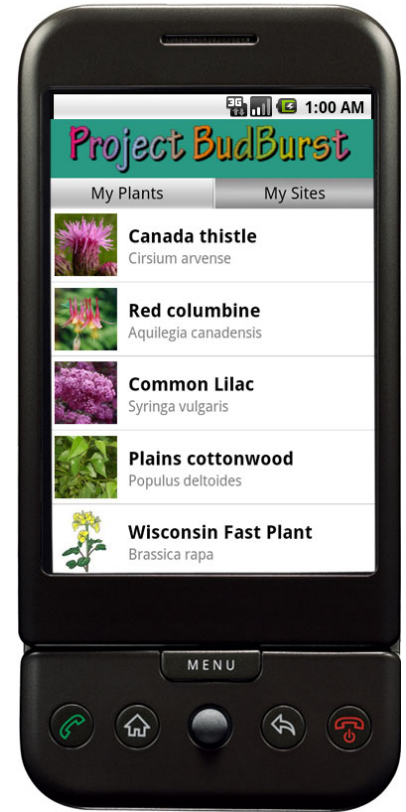
[whatsInvasive.com](http://whatsInvasive.com)

[bit.ly/whatsinvasive](http://bit.ly/whatsinvasive)

BudBurst Mobile:

[bit.ly/mobileBB](http://bit.ly/mobileBB)

[bit.ly/mobileBBapp](http://bit.ly/mobileBBapp)



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