

**Leveraging Open Source Technology
For Environmental Research**

EPA Community of Practice
November 19, 2014



www.nerdsfornature.org

@nerds4nature

Find us on Meetup and Google Groups!

Bringing together technologists and environmental professionals, students and citizen scientists...



... to help understand, protect, and revive the natural world.

People + Smartphones =



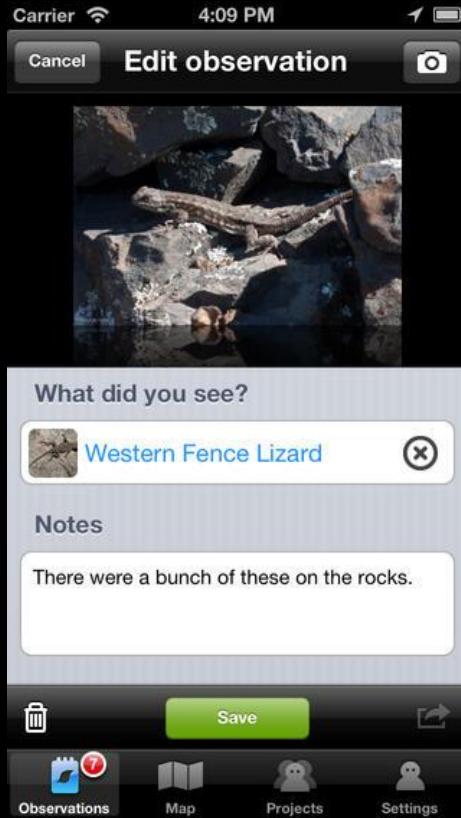
Remote sensor network

Grassroots Bioblitzes



Park partisans + Nature experts + Tech enthusiasts

iNaturalist.org



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BIOBLITZ

MCLAREN PARK

SAN FRANCISCO, CA
Saturday May 11, 2013

Join Nerds for Nature, Bay Nature, Save McLaren Park,
and iNaturalist.org as we explore this urban oasis.



**ADD
OBSERVATIONS**

Photo: Ed Brownson

Event Stats

Totals
1312
observations

234
species

43
people

Most observations

	loarie	112 observations
	greenrosettas	83 observations
	ranadray	76 observations
	kueda	69 observations
	toshi	67 observations

[All observations](#)

[All species](#)

[All people](#)

[About bioblitz results](#)

Most species

	loarie	75 species
	greenrosettas	69 species
	kueda	43 species
	robberyfly	28 species
	papiliogal	27 species

Most observed species

	California Poppy	21 observations
	Coyote Brush	13 observations
	Sweet Fennel	12 observations
	Italian thistle	11 observations
	Western Blue-eyed Grass	11 observations

[» Event Observations](#)



Map

Satellite

[« Projects](#)[Edit project](#)

Event Stats

Totals**1263**

observations

236

species

67

people

Most observations**greenrosettas**
76 observations**sea-kangaroo**
75 observations**loloscheiner**
66 observations**robberfly**
65 observations**All observations****All species****All people**[About bioblitz results](#)**Most species****greenrosettas**
67 species**sea-kangaroo**
56 species**dpom**
51 species**simo**
49 species**Most observed species****American Coot**
22 observations**Mallard**
18 observations**Canada Goose**
16 observations**Black-crowned Night-Heron**
16 observations



« Projects

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Event Stats

Totals**1418**
observations**238**
species**36**
people**Most observations**
dptom
98 observations
kueda
92 observations
rebeccafay
90 observations
baccharis
85 observations**All observations****All species****All people**[About bioblitz results](#)**Most species**
dptom
70 species
pbrastow
64 species
robberfly
61 species
kueda
58 species**Most observed species**
sea thrift
19 observations
seaside buckwheat
17 observations
California Poppy
17 observations
Beach strawberry
16 observations
Orange Bush Monkeyflower
16 observations

[« Projects](#)[Edit project](#) | [Leave this project](#)CALIFORNIA
ACADEMY OF
SCIENCESSAN MATEO
COUNTY
PARKSSEQUOIA
AUDUBON SOCIETYNERDS
FOR
NATURENATIONAL MARINE
SANCTUARIES
GULF OF THE
FARALLONES

Pillar Point Bluffs, Beach and Reef BioBlitz

July 13, 2014, 5:00 AM – 4:00 PM PDT

Event Stats

Totals
1072
observations

271
species

37
people

[All observations](#) [All species](#) [All people](#) [About bioblitz results](#)

Most observations



ivanparr
79 observations



rebeccafoy
74 observations



dpom
71 observations



robberfly

Most species



ivanparr
71 species



robberfly
58 species



dpom
57 species



tgosliner

Most observed species



Leather Star
20 observations



Opalescent Nudibranch
20 observations



Purple Sea Urchin
18 observations



Dorisopsilla albopunctata



growing, global dataset

Change Brackets

**Crowdsourced timelapse
images for eco-research**

inspired by...

monitorchange.org

**A simple, elegant concept developed
by Sam Droege, USGS Patuxent
Wildlife Research Center.**

**Nature Nerds added design and social media
elements, and created the Instructable and
codebase for easy replicability.**

Mt. Diablo Morgan Fire

We're documenting habitat change after the Morgan Fire on Mount Diablo, which burned 3,100 acres in September 2013.

We're collaborating with Mount Diablo State Park and the Wildlife Society, Western Section.



How It Works



Help us study 🔥
FIRE RECOVERY!

1. Place camera phone into the bracket.
2. Take a photo of the view, without a filter.
3. Post your picture using **#diablofire01** to Twitter, Flickr and Instagram.

Results are compiled into a crowdsourced timelapse of recovery.

See for yourself at
bit.ly/diabolfire



WILDLIFE SOCIETY



Installation



Four sign/bracket locations on hiking trail overlooks provide both close-up and distant views of the burn area.



February 15, 2014



May 3, 2014



October 4, 2014



Spreading the Model

Crowd-sourced Time Lapse Photography

www.instructables.com/id/Crowd-sourced-Time-Lapse-Photography/

instructables

Explore Create Contests Community let's make

Ford MAKESHIFT Intel IoT RadioShack DIY BLACK+DECKER Fix & Repair

shape what you make >

Download 12 Steps

+ Collection I Made it! Favorite Share

Crowd-sourced Time Lapse Photography by nerdsfornature

Help us study Fire Recovery!

A wildfire burned this area in September 2013. Now we are interested in how the environment responds, and you can help! Here's how:

Place device into

Author Options: Edit

Change Category/Channel, Keywords, License, Locale

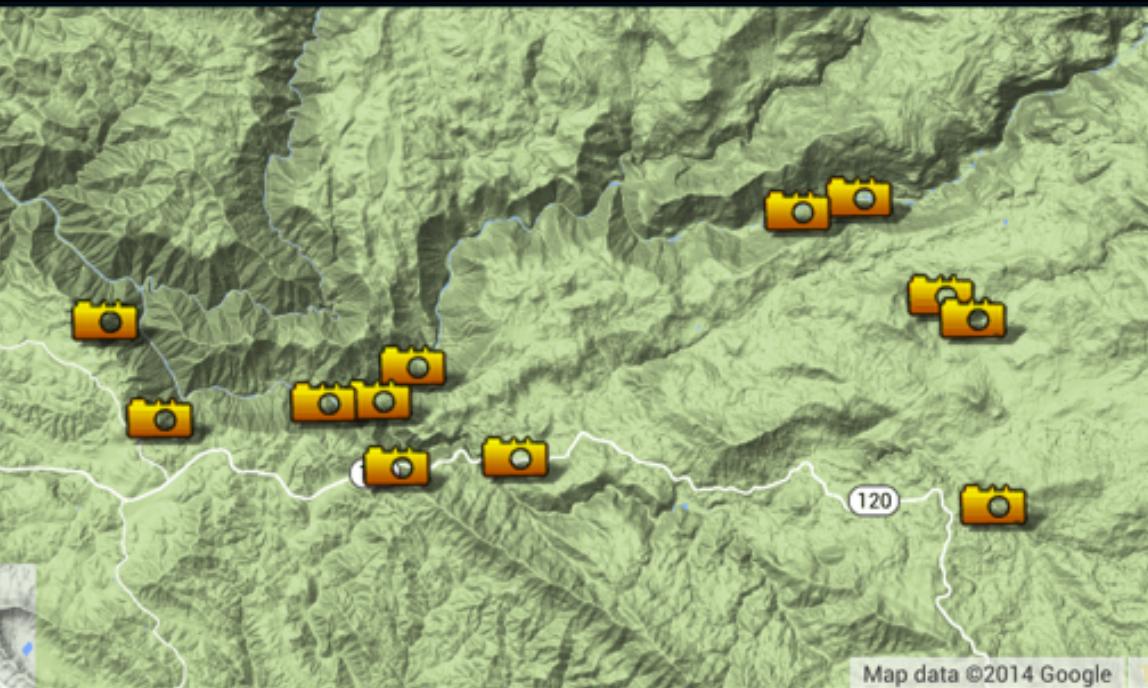
Intel® IoT Roadshows

Join our hackathon, Get a dev kit .

REGISTER NOW

The screenshot shows a web browser displaying an Instructables project page. The title of the project is "Crowd-sourced Time Lapse Photography" by user "nerdsfornature". The page includes a thumbnail image of a sign asking for help to study fire recovery. There are buttons for "Download", "12 Steps", "+ Collection", "I Made it!", "Favorite", and "Share". A yellow callout box labeled "Author Options" contains links to edit category, keywords, license, and locale. To the right, there is an advertisement for "Intel® IoT Roadshows" with a "REGISTER NOW" button.

Yosemite's Rim Fire



Wetlands Restoration Sites



Miami



Palo Alto

Looking ahead

Monitor other natural areas

- **Miami Science Center looking to install in various ecosystems and restoration sites**
- **Spread the idea to other areas in the fire-prone West**

Develop better software

- **Computer vision (openCV) to stitch timelapses. EcoHack Success!**
- **On-line web interface to set up hashtags, credentials, and copy code for embeddable widgets.**

Other uses

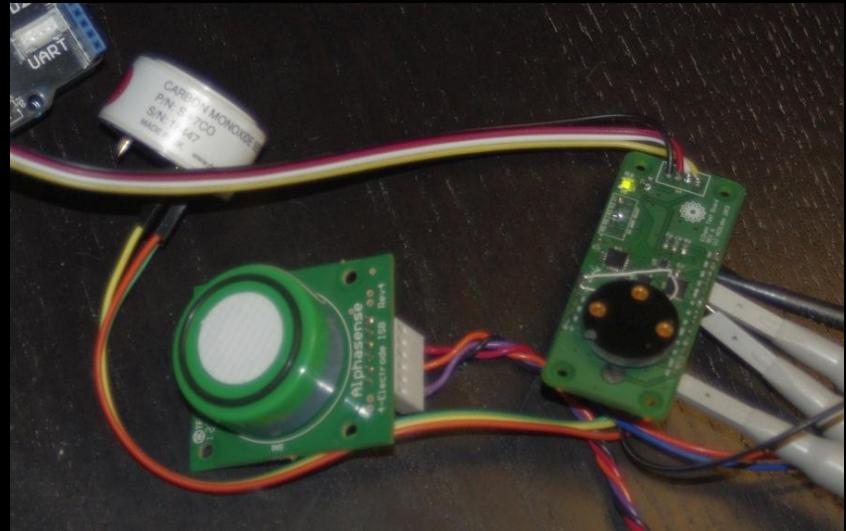
- **Construction and habitat restoration sites**
- **Potential pollution sites**
- **Gardens, greenhouses, and farms**

Understanding Our Air:

Bringing together engineers,
researchers, and communities to
innovate solutions

Sensor technologies

- ❑ Metal-oxide technology is out due to excessive drift and cross-sensitivities
- ❑ We use dust sensors for PM monitoring as developed by David Holstius, Ph. D. et al
- ❑ We are starting to explore pellistor (CH_4) and NDIR (CO_2) technologies



Evaluating electrochemical sensor circuits on the bench - Ken McGary.

A focus on toxic gas sensors

**Our goal is reliable,
affordable, and accurate
sensor technology that can be
easily**

- replicated**
- modified**
- calibrated**

**by citizen scientists and
professional researchers alike.**

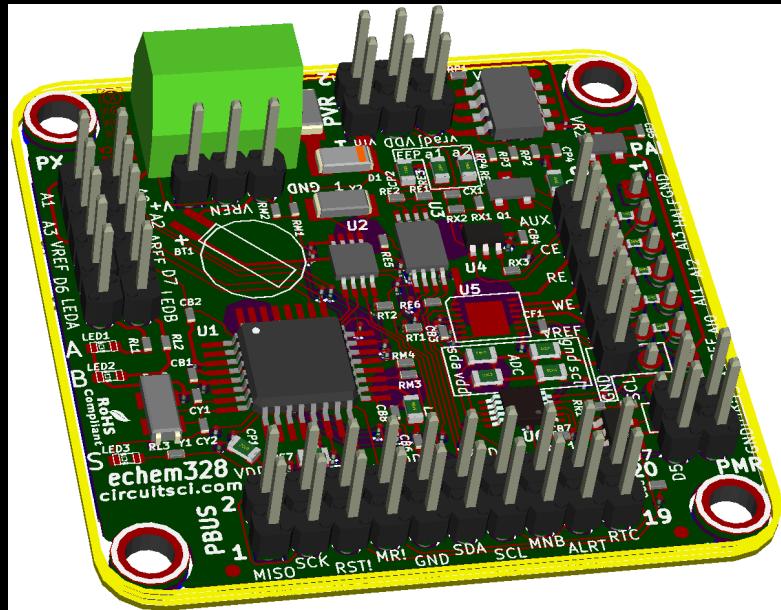


**PIC-based, Bluetooth-enabled electrochemical
gas sensor prototype - *Shaun Houlihan*.**

Smart Sensor Board

We have developed a Smart Transducer Interface Module for electrochemical gas sensors that is

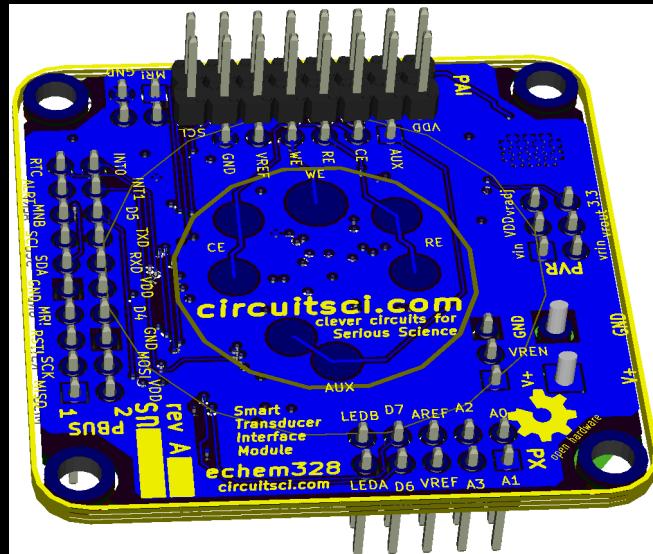
- Arduino-based**
- self-calibrated** (board retains all sensor and other calibration meta-data)
- compact & low-power**
- open source**



CAD rendering of new “echem328” smart gas sensor board - *Ken McGary*.

Smart Sensor Features

- **Real Time Clock w/ alarms**
- **128KByte logging memory**
- **Programmable Analog Front End**
- **Four-channel 16-bit A/D Converter**
- **3.3 - 16V power @ ~10 mA**
- **Complex four-layer circuit board
for low noise and high signal
integrity**



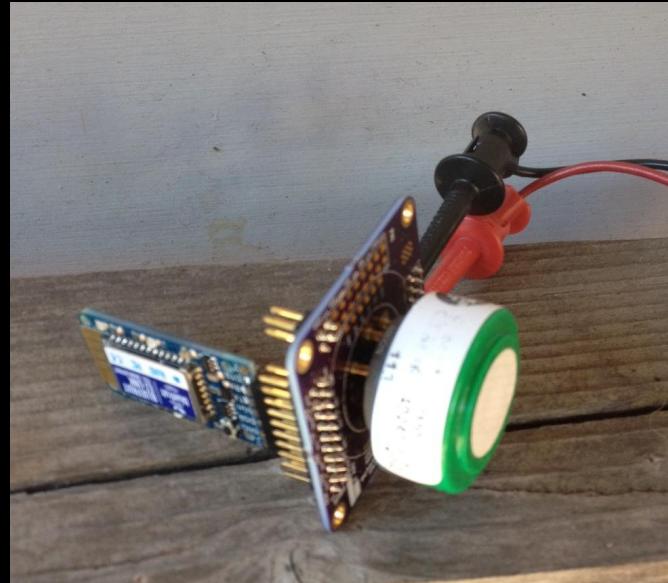
**Universal socket pads on back of board
accommodate most available sensors -
Ken McGary.**

Sensor Board Communications

Interface options include

- Bluetooth (BLE)**
- Wi-Fi**
- GSM/GPRS cell networks**
- RS232 / RS485 / TTL serial**
- USB**

**Custom backpack board
templates allow easy customized
solutions.**

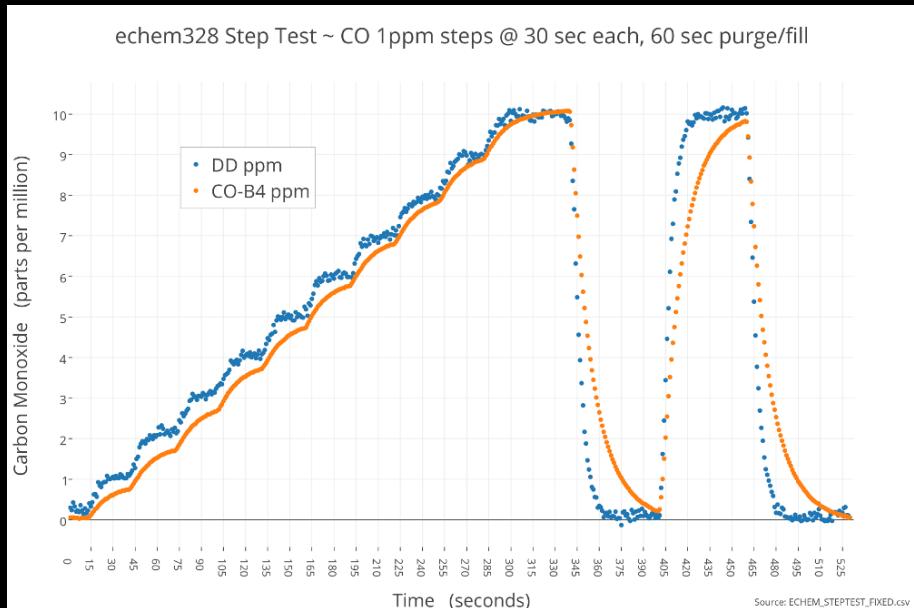


**echem328 prototype sending CO sensor
data via Bluetooth - Ken McGary.**

Calibration is Crucial

We are developing several DIY gas calibrators at different cost/ performance points, using

- pre-mixed cal gases
- Alphasense reference sensors
- open source controllers
- common hardware where possible



Comparison of two CO sensor models with our mass flow controller-based calibration system - Ken McGary.

Sensor Field Testing

“Pipe Sniffer” prototype for carbon monoxide

- Teflon-impregnated fiber protects sensor and moderates airflow**
- Convenient size fits in water bottle holders, backpack pouches, cupholders, etc.**
- Easy and cheap to make!**
- Good enough for general AQ explorations**

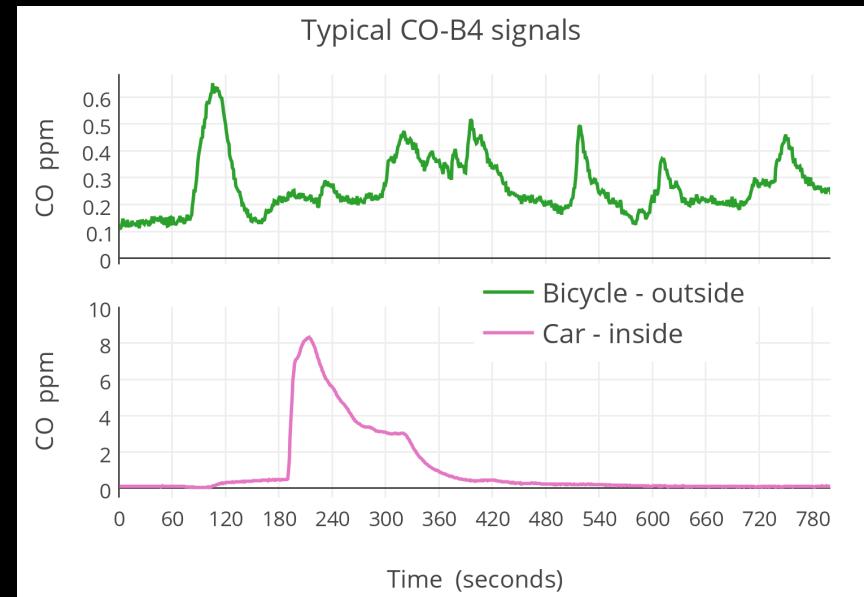


echem328 prototype sending CO sensor data via Bluetooth - Ken McGary.

Collecting Real World Data

Bike ride on a residential street near a busy freeway shows groups of nearby cars passing as well as elevated background levels from freeway due to winds and hills.

Short car trip shows trapped CO through a briefly opened door, then eventual dissipation after opening window at 320 seconds.

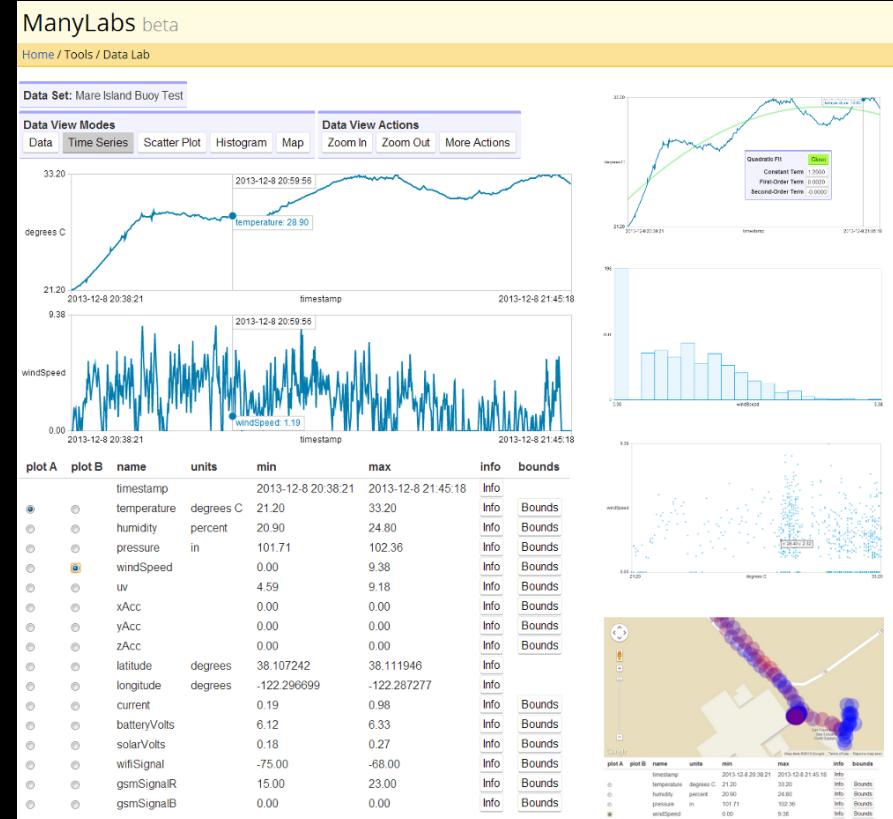


Sensor data collected from moving vehicles with “pipe sniffer” prototype - Ken McGary.

Mapping Data

Manylabs.org (Peter Sand and Elliot Dicus) hosts net-based, open source sensor data management tools called the Data Hub.

ManyData.org is a more complete and robust version now in development.



Examples of different data views, analysis, and mapping available with the Manylabs Data Hub.

Projects

- **Sensored City/Louisville, KY (40 AQ monitoring stations)**
 - Manylabs, CircuitSci, and Creative Commons, funded by R.W. Johnson Foundation
- **Leveraging to other community and education-oriented AQ projects - In discussions with WestEd, Rose Foundation, Oakland schools, others.**



An AQ monitoring unit prototype, assembled on a laser-cut plastic frame inside a modified water bottle - Peter Sand.

Collaborators & Advisors

- **Peter Sand & Elliot Dicus / ManyLabs** - software, project development and support
- **Ken McGary / CircuitSci & KSF Labs** - circuit and systems design
- **Shaun Houlihan / HEDLabs** - prototype and engineering support
- **Virginia (Jill) Teige / UC Berkeley BeACON project** - technical/curriculum advice
- **James Kalin / VirtuallyGreen** - Energy Chickens/indoor AQ and gamification
- **Sean Headrick / Aerotestra, Inc.** - UAV platforms and tech support
- **Stephan deWekker, Ph.D. / U of Va** - fenceline & UAV monitoring of fracking sites
- **Adriano Quiroga / Stanford Univ** - microclimate and AQ monitoring with UAV



Eco-drones: Using semi-autonomous robots for ecological research

©2013 Google - Map data ©2013 Tele Atlas, Imagery ©2013 TerraMetrics

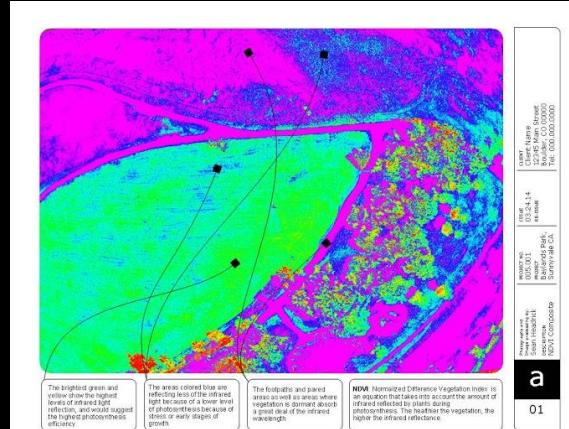
Waypoints

	WP Radius	Loiter Radius	Default Alt	30	<input checked="" type="checkbox"/> Verify Height	Add Below	
1	5	45					
2							
3							
4							
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7							
8							
9							
10							
11							
12							



orthomosaic photography

**mapping
water
quality**



all images by Sean Headrick / Aerotestra Inc.

**Normalized
Difference
Vegetation
Index**

Water Sensing:

**Developing lower cost sensors
and open networks with high
data quality.**

Projects

- Prototype wireless CTD reporting station for USGS WERC, funded by Innovation Center for Earth Sciences - Manylabs, CircuitSci, Azonde (Neil Hancock)
- DIY, STEM-friendly stream gage systems being tested by local agencies, looking to improve designs and expand reach
- Exploring smart sensor concepts for EC, impedance spectroscopy.



A self-contained stream gage monitor for remote locations - Neil Hancock.

ENVIO APP-TYSON
Externality Elizabeth

Who are we?

Mix and Mingle:

"The IDEAS one hears in brainstorming shout-outs are fantastic, original and brave."

Liam O'Brien

NatureNerdFest field events

@ Mare Island w/USGS Western Ecological Research Center

@ Sherman Island w/ CA Department of Water Resources



I love being a Nerd for Nature.
..Whether you're a technologist building software or a birder building a life list, you have an **obsession with understanding how the world works**, a curiosity about what's around you, and a strong desire to make **the world a better place**. Those are ideals we can all get behind!



DAN RADEMACHER
NERD FOR NATURE

Project Night in SF or Oakland / Berkeley every month

Find us on Meetup & Google Groups!

EXTEND COMMUNITY!

Nature Nerd Friends & Partners

- ★ California Academy of Sciences
- ★ iNaturalist
- ★ Bay Area Citizen Science Coalition
- ★ Nature In The City ~ SF
- ★ Wild Oakland
- ★ Save The Bay
- ★ Sequoia & GG Audubon Society
- ★ Stamen Design
- ★ Public Lab
- ★ Aerotestra, Inc.
- ★ openROV
- ★ openExplorer
- ★ @SFriedScientist
- ★ Counter Culture Labs
- ★ USGS Western Ecological Research Center





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ksflabs.com

circuitsci.com

sensors ~ circuits ~ systems ~ eco-drones

A close-up photograph of a man with light brown hair and glasses, smiling. He is wearing a green baseball cap with the words "BAY NATURE" printed on it in white, and a red and green safety vest over a dark shirt. The background shows a dark blue door or window frame and a blurred view of the ocean and other people.

@DanRademacher

dan.r.rademacher@gmail.com

stamen.com

monitor change ~ bioblitz ~ datavis ~ maps

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