Impacts of Surface Water Diversions for Marijuana Cultivation on Aquatic Habitats in Four Northwestern California Streams.

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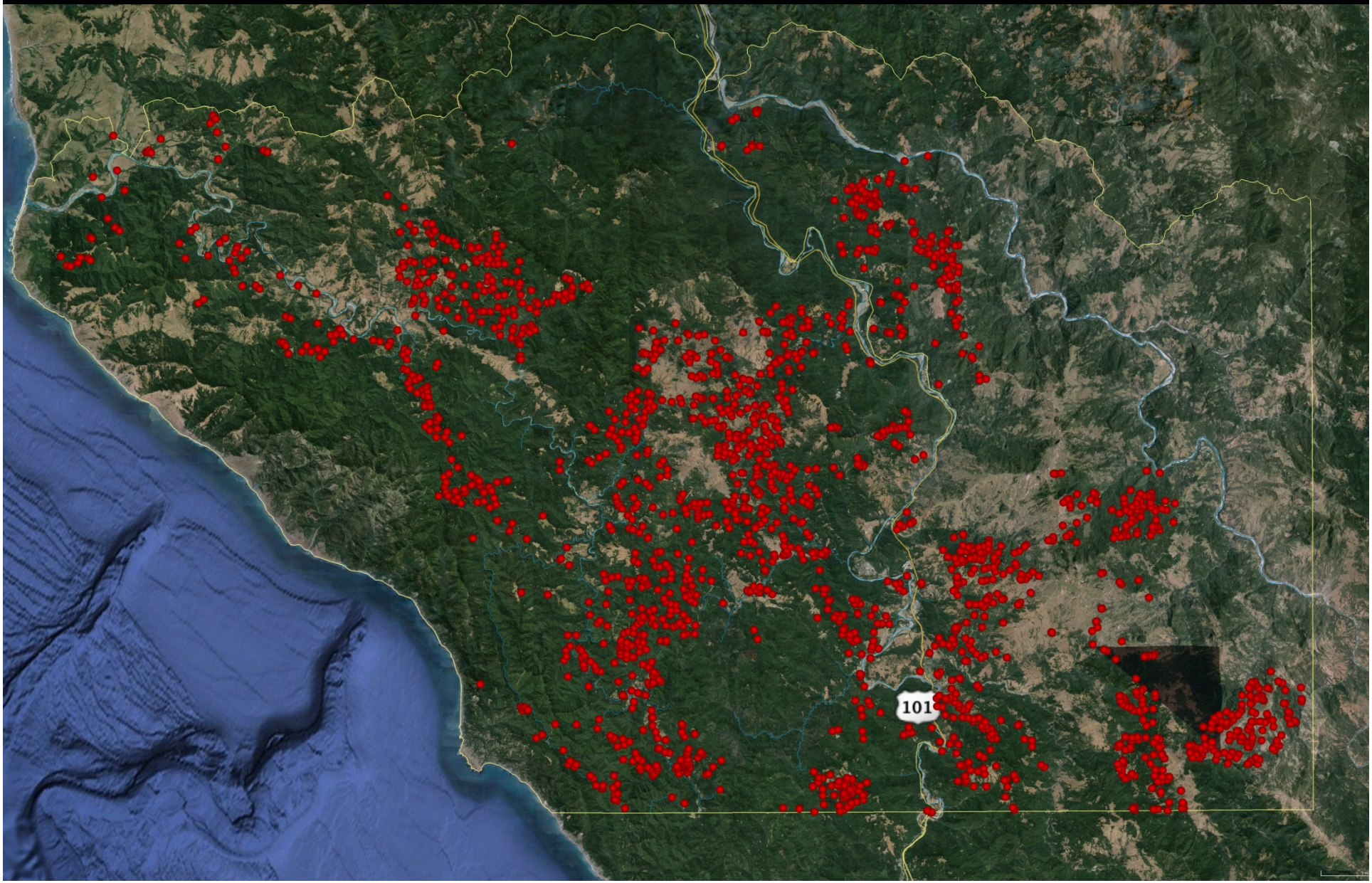
Region 1, Coastal Conservation Planning

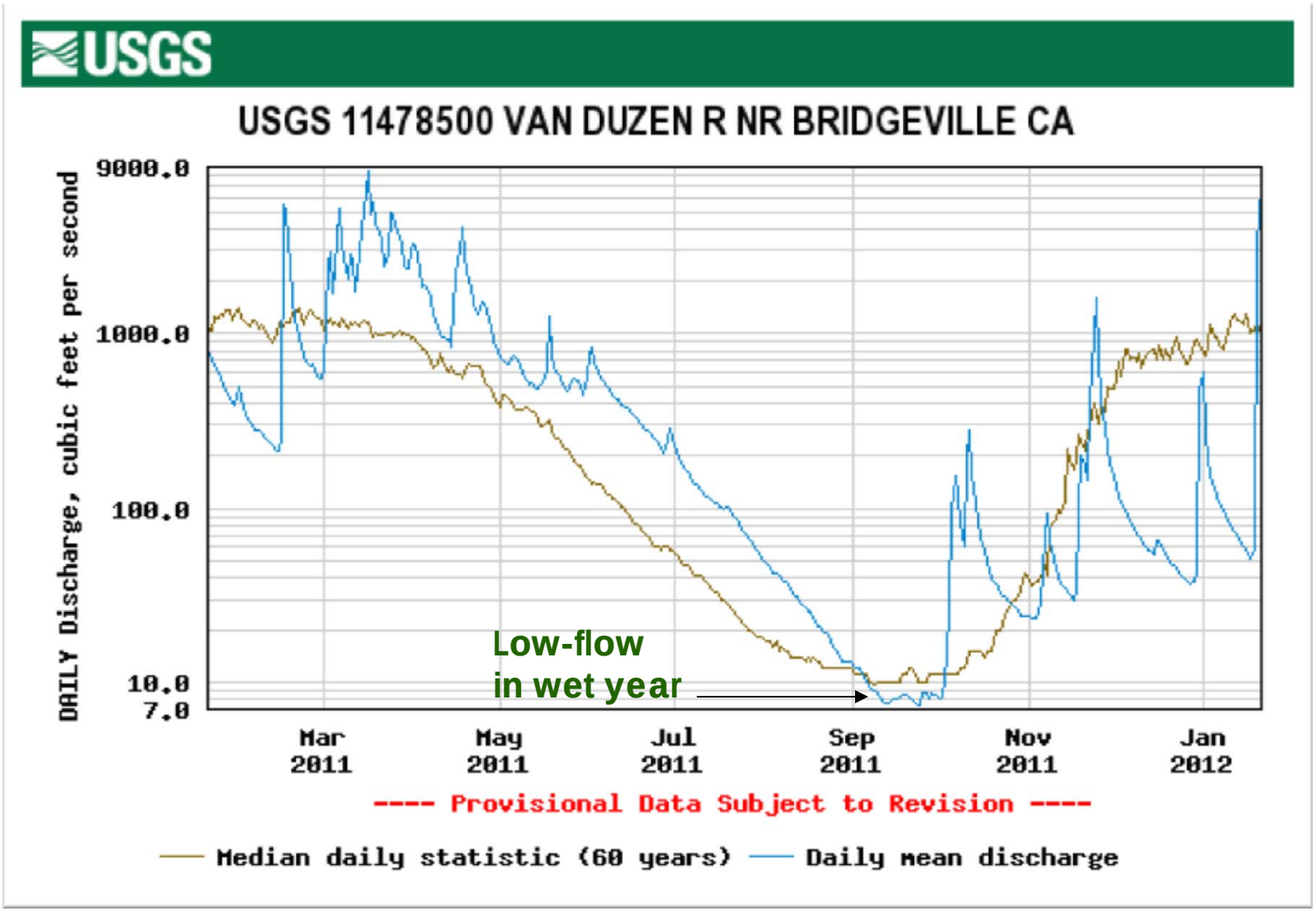
Southern Humboldt



Background

- *Cultivated in Northern California, at least since the 1960s with few documented environmental impacts.*
- ***Legal grey-area**:* creates a market with little threat of persecution.
- ***Anecdotal evidence***: CDFW documented fish kills, water diversions, land conversion have increased rapidly in the last few years.

Hydrograph


USGS
USGS 11478500 VAN DUZEN R NR BRIDGEVILLE CA
DAILY Discharge, cubic feet per second
9000.0
1000.0
100.0
10.0
7.0
Low-flow
in wet year
Mar 2011
May 2011
Jul 2011
Sep 2011
Nov 2011
Jan 2012
---- Provisional Data Subject to Revision ----
Median daily statistic (60 years)
Daily mean discharge

Plant water consumption

Documentation from an emerging industry

These numbers account for a watering season that runs from June thru October. Please note that this watering period can vary greatly. If it is a very wet spring the planting season may be delayed and conversely if it is a dry spring the planting season may be in May. I would also like to note that October also has variables associated with water usage. There is the potential for cannabis to finish in September. This is largely strain and growing style dependent. In a five-month period there are approximately 150 days multiplied by 6 gallons of allotted water usage per plant per day and each plant may consume 900 gallons per season. The following information is an estimate of water usage for various size permits.

Water Usage Based on 5' x 5' Plants

- 5,000 sq. ft. = 180,000 gallons of water
- 10,000 sq. ft. = 360,000 gallons of water
- 20,000 sq. ft. = 720,000 gallons of water
- 40,000 sq. ft. = 1,440,000 gallons of water

Background

Problem:

How do we <u>quantify</u> environmental impacts, in the poorly studied and inaccessible regions where marijuana persists?

Methods

Overview

- Mapped marijuana cultivation sites (MCSs) in four watersheds.
- Estimated plant water consumption.
- Developed water budget
- Measured growth in MCSs over time (2009-2012)

Methods

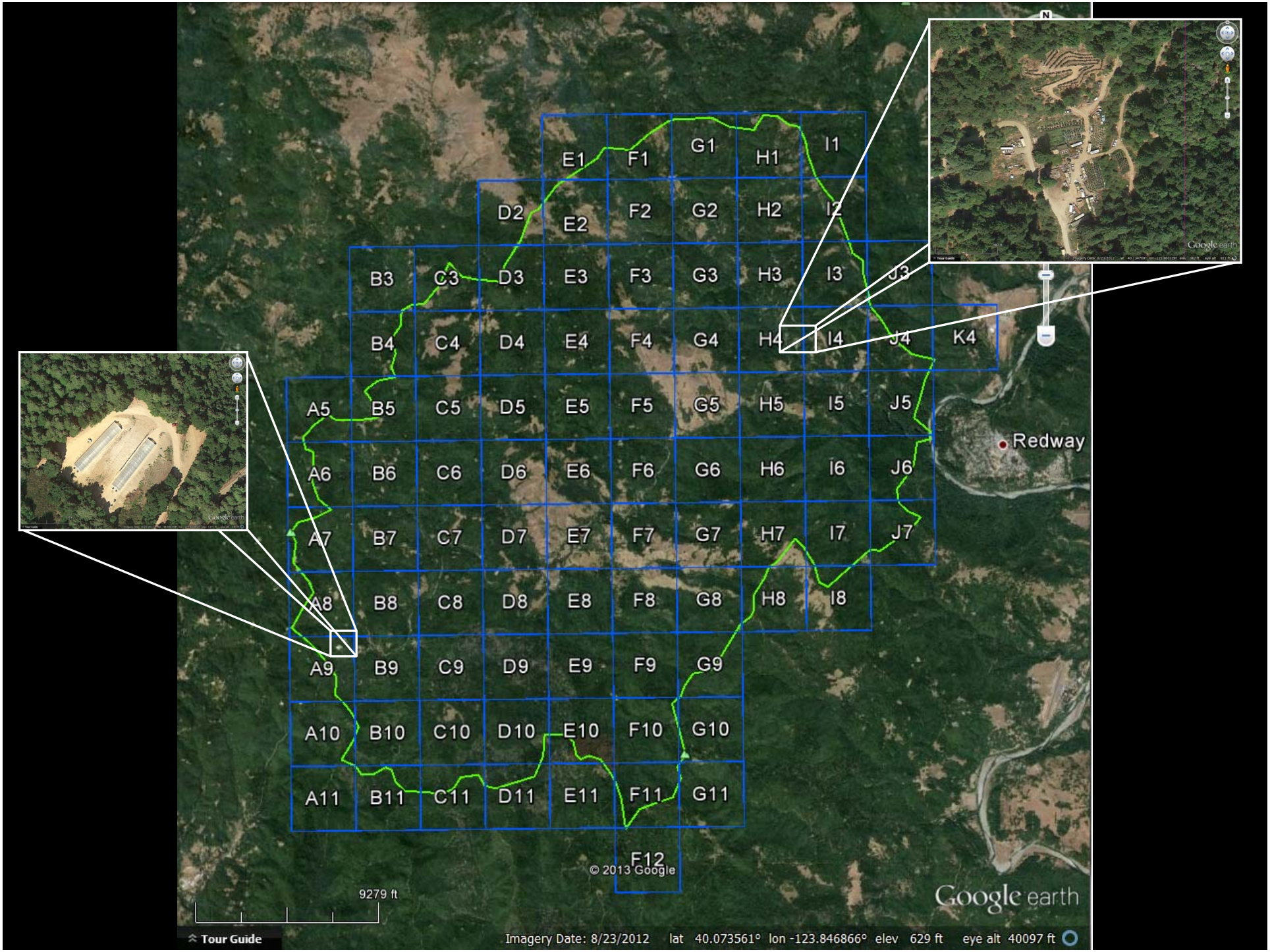
Marijuana Mapping
A Battle of Imagery vs. Analysis

Google Earth

- August 2012 – High quality imagery
- Peak of cultivation season
- Historical imagery & measuring tool

ArcGIS 10 (ESRI)

- Imagery limitations: NAIP & old Bing
- Multitude of capabilities
- Digitize areas & point data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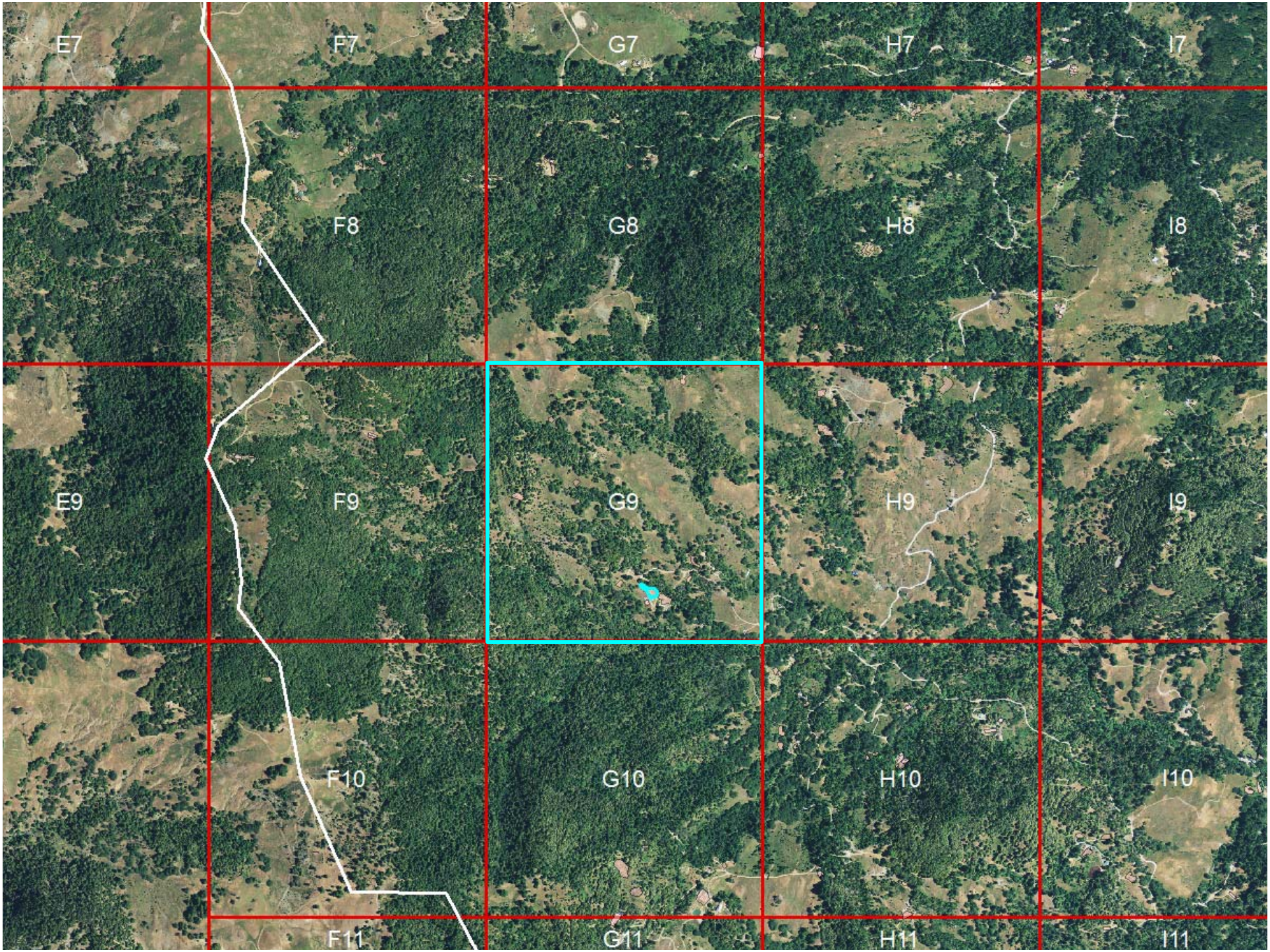
G11
F12
Redway
© 2013 Google
9279 ft
Google earth
Tour Guide
Imagery Date: 8/23/2012 lat 40.073561° lon -123.846866° elev 629 ft eye alt 40097 ft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Methods

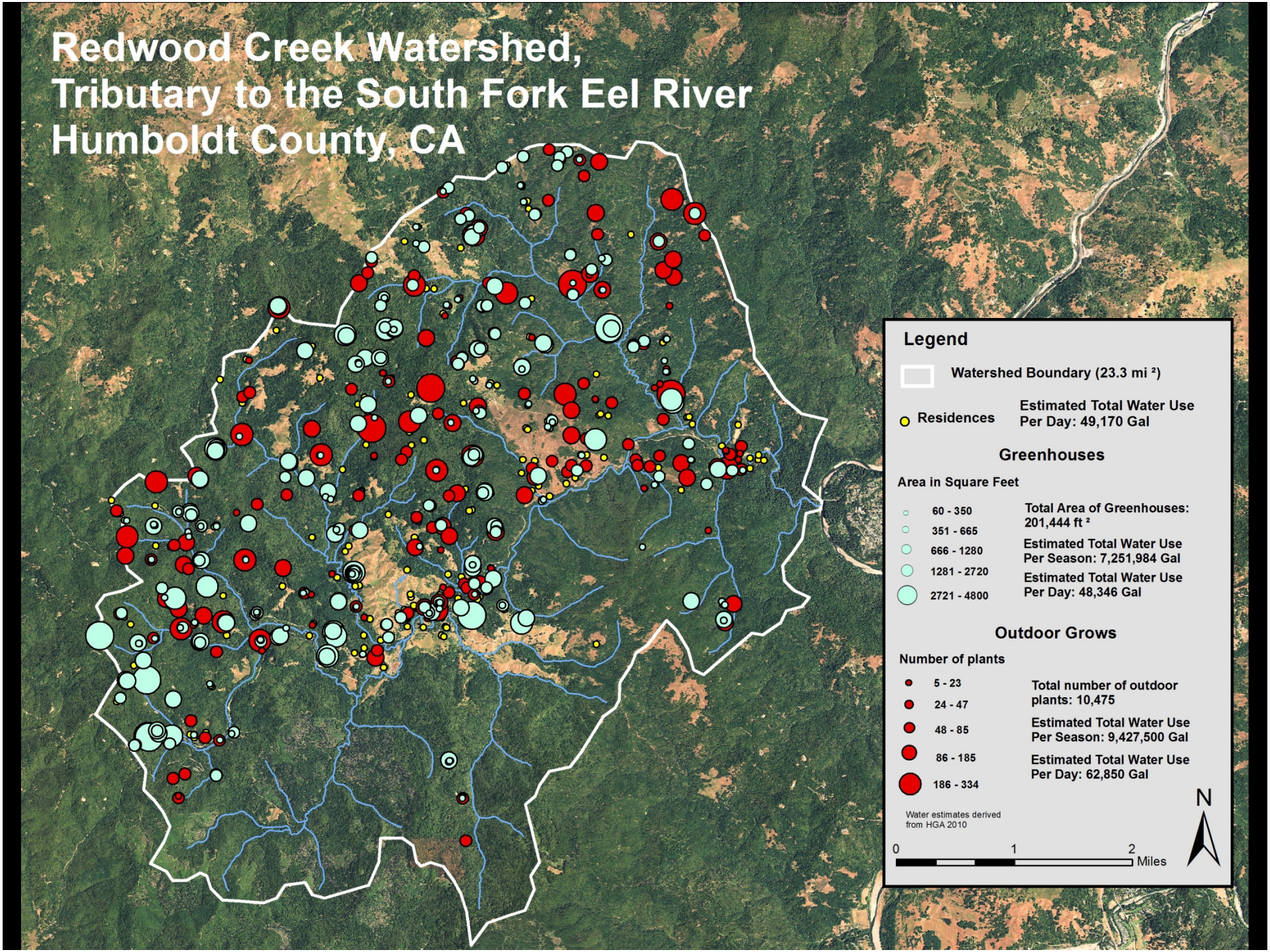
Measuring Greenhouses

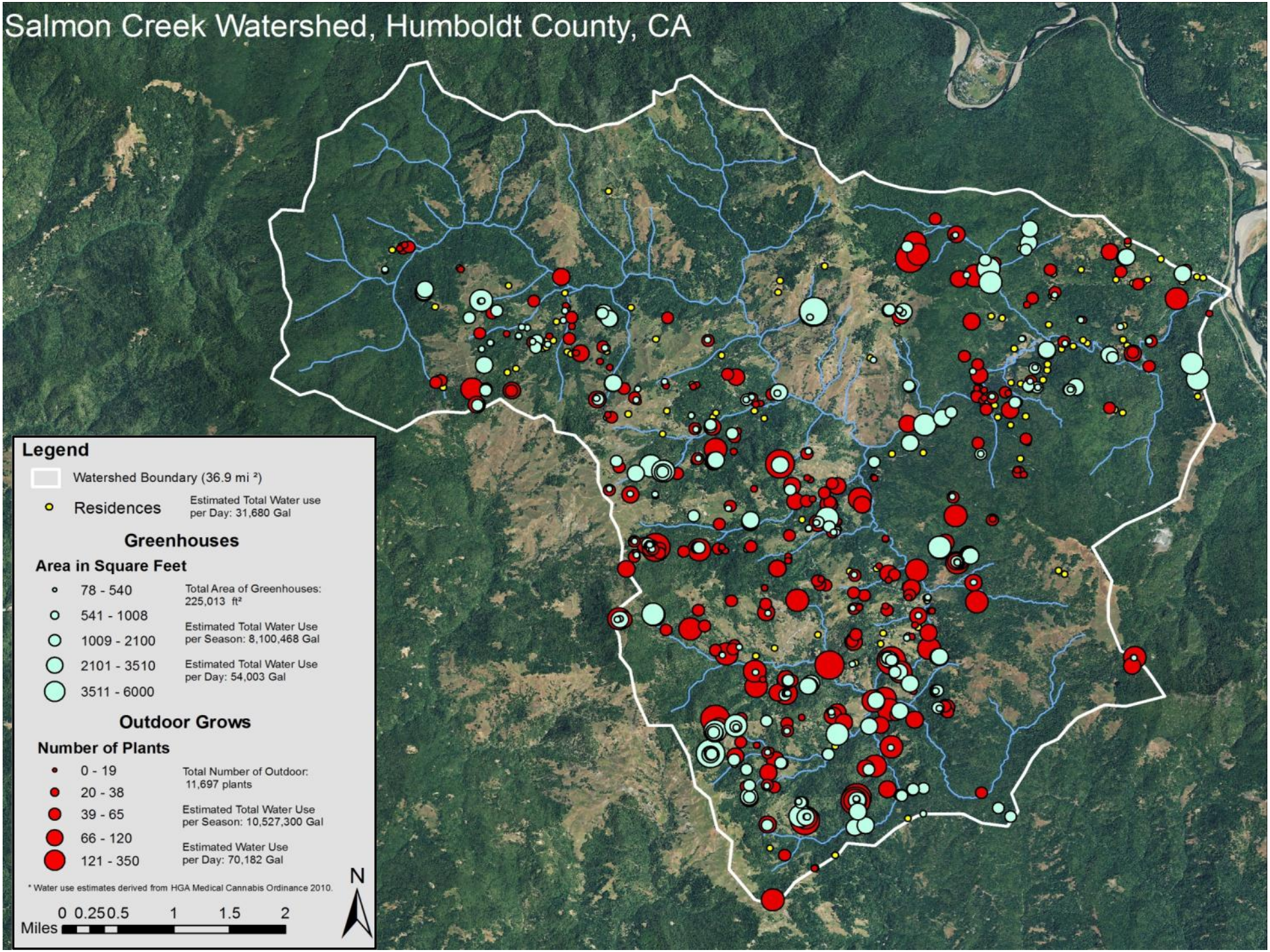
Methods

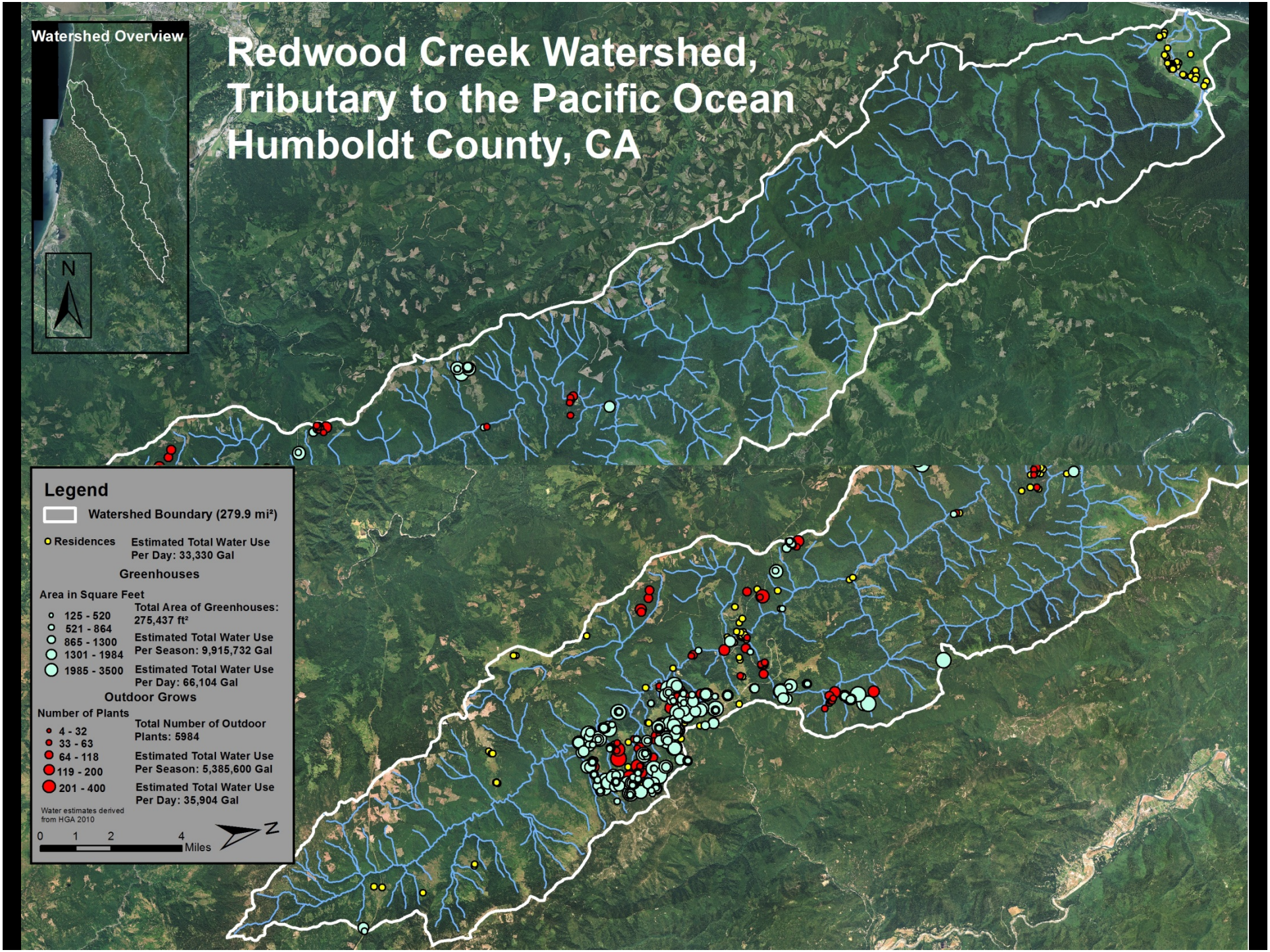
Measuring increase in land area over time

Methods

Measuring increase in land area over time


Redwood Creek Watershed,
Tributary to the South Fork Eel River
Humboldt County, CA
Legend
Watershed Boundary (23.3 mi ²)
Residences
Estimated Total Water Use
Per Day: 49,170 Gal
Greenhouses
Area in Square Feet
60 - 350
351 - 665
666 - 1280
1281 - 2720
2721 - 4800
Total Area of Greenhouses:
201,444 ft ²
Estimated Total Water Use
Per Season: 7,251,984 Gal
Estimated Total Water Use
Per Day: 48,346 Gal
Outdoor Grows
Number of plants
5 - 23
24 - 47
48 - 85
86 - 185
186 - 334
Total number of outdoor
plants: 10,475
Estimated Total Water Use
Per Season: 9,427,500 Gal
Estimated Total Water Use
Per Day: 62,850 Gal
Water estimates derived
from HGA 2010
N
0
1
2
Miles


Salmon Creek Watershed, Humboldt County, CA
Legend
Watershed Boundary (36.9 mi ²)
Residences
Estimated Total Water use per Day: 31,680 Gal
Greenhouses
Area in Square Feet
78 - 540
541 - 1008
1009 - 2100
2101 - 3510
3511 - 6000
Total Area of Greenhouses: 225,013 ft²
Estimated Total Water Use per Season: 8,100,468 Gal
Estimated Total Water Use per Day: 54,003 Gal
Outdoor Grows
Number of Plants
0 - 19
20 - 38
39 - 65
66 - 120
121 - 350
Total Number of Outdoor: 11,697 plants
Estimated Total Water Use per Season: 10,527,300 Gal
Estimated Water Use per Day: 70,182 Gal
* Water use estimates derived from HGA Medical Cannabis Ordinance 2010.
0 0.250.5 1 1.5 2
Miles
N


Watershed Overview
N
Redwood Creek Watershed,
Tributary to the Pacific Ocean
Humboldt County, CA
Legend
Watershed Boundary (279.9 mi²)
Residences
Estimated Total Water Use
Per Day: 33,330 Gal
Greenhouses
Area in Square Feet
125 - 520
521 - 864
865 - 1300
1301 - 1984
1985 - 3500
Total Area of Greenhouses:
275,437 ft²
Estimated Total Water Use
Per Season: 9,915,732 Gal
Estimated Total Water Use
Per Day: 66,104 Gal
Outdoor Grows
Number of Plants
4 - 32
33 - 63
64 - 118
119 - 200
201 - 400
Total Number of Outdoor
Plants: 5984
Estimated Total Water Use
Per Season: 5,385,600 Gal
Estimated Total Water Use
Per Day: 35,904 Gal
Water estimates derived
from HGA 2010
0 1 2 4
Miles
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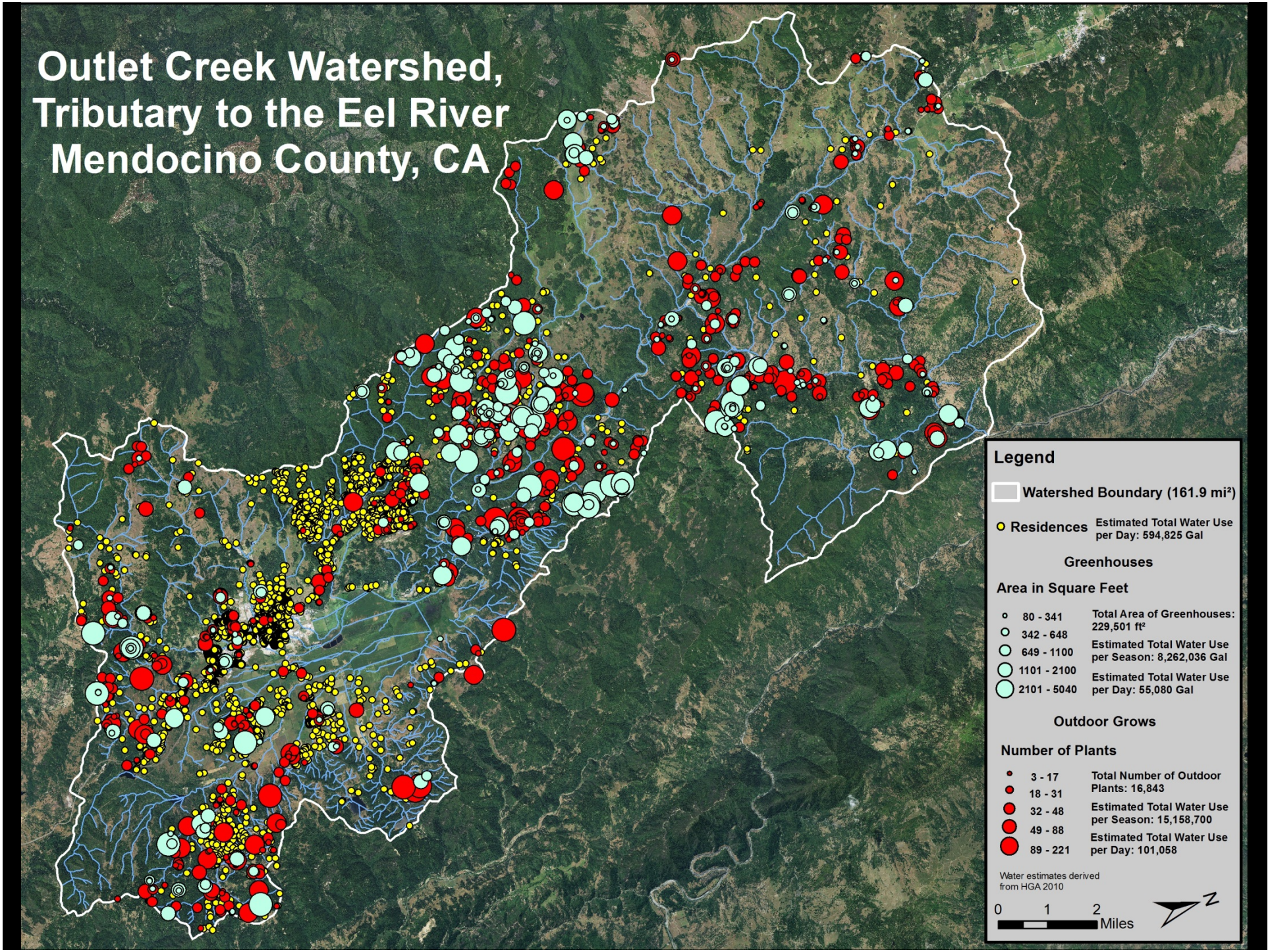

Outlet Creek Watershed,
Tributary to the Eel River
Mendocino County, CA
Legend
Watershed Boundary (161.9 mi²)
Residences
Estimated Total Water Use per Day: 594,825 Gal
Greenhouses
Area in Square Feet
80 - 341
342 - 648
649 - 1100
1101 - 2100
2101 - 5040
Total Area of Greenhouses: 229,501 ft²
Estimated Total Water Use per Season: 8,262,036 Gal
Estimated Total Water Use per Day: 55,080 Gal
Outdoor Grows
Number of Plants
3 - 17
18 - 31
32 - 48
49 - 88
89 - 221
Total Number of Outdoor Plants: 16,843
Estimated Total Water Use per Season: 15,158,700
Estimated Total Water Use per Day: 101,058
Water estimates derived from HGA 2010
0 1 2 Miles
N

Totals of Plants and Greenhouses

TABLE 1. Total Number of Cultivation Sites, Outdoor Plants and Estimated Plants per Greenhouse for each Subject Watershed.

	Redwood Creek (67.3 km^2)	Salmon Creek (95.6 km^2)	Redwood Creek North (730 km^2)	Outlet Creek (419 km^2)
Total outdoor cultivation sites	231	306	120	633
Total outdoor plants	10,475	11,697	5,984	16,843
Plant : Land area $\left(\frac{1}{km^2}\right)$	173.7	122.4	8.2	40.2
Total Greenhouses	324	302	273	320
Estimated Total Plants in Greenhouses	8,053	8,851	11,029	9,180
Greenhouse : Land Area $\left(\frac{1}{km^2}\right)$	4.8	3.1	0.4	0.8
Total Plants per Watershed*	**18,528**	**20,548**	**17,013**	**26,023**

**Field data indicate these totals may be underestimates.*

Hydrology

Estimates for un-gaged WS

TABLE 2. Estimates of 7-Day Low flow for Redwood and Salmon Creeks (NMFS 2013).

		Q min (cfs)	Q max (cfs)	Q average (cfs)
Redwood Creek	Based on SF Eel at Miranda	0.6	3.1	1.5
	Based on Bull Creek	0.2	2.8	2.8
	Based on Elder Creek	1.1	5.2	2.6
	Average	0.6	3.7	2.3
Salmon Creek	Based on SF Eel at Miranda	0.8	4.3	2.1
	Based on Bull Creek	0.3	3.9	3.9
	Based on Elder Creek	1.5	7.3	3.6
	Average	0.9	5.2	3.2

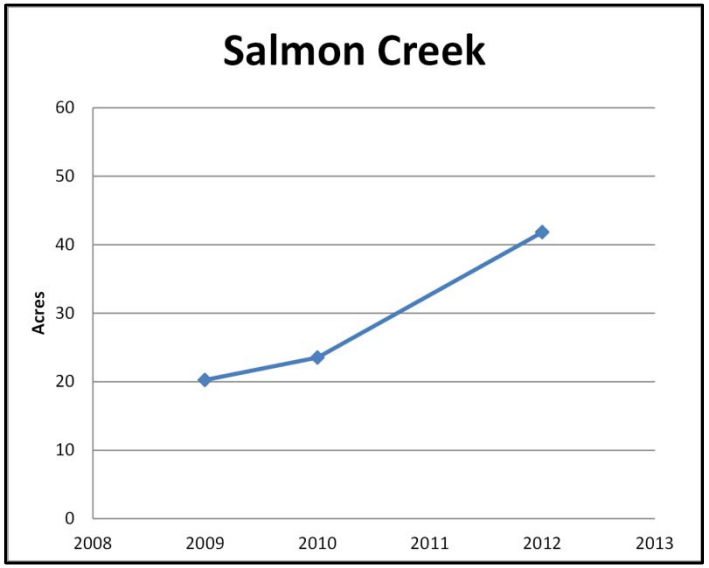
Water Use Estimates

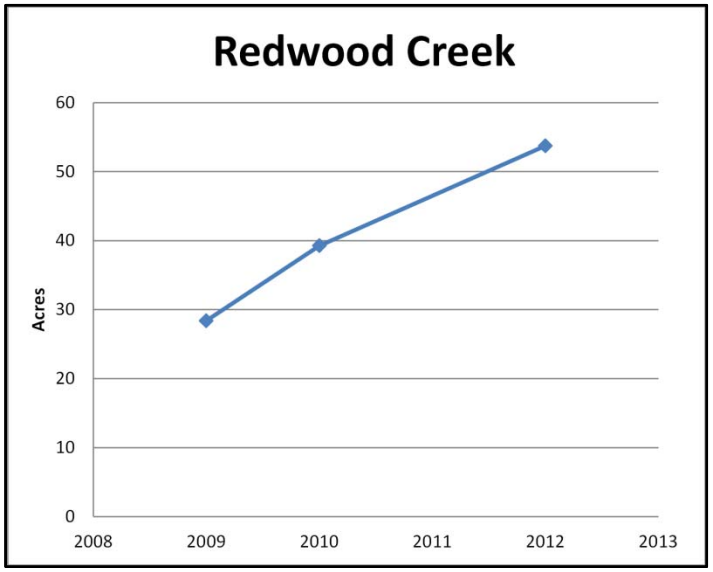
TABLE 3. Estimated Water Use for Marijuana Cultivation. *Water use estimates were calculated based on a figure of 6 gallons per plant per day (HGA 2010).*

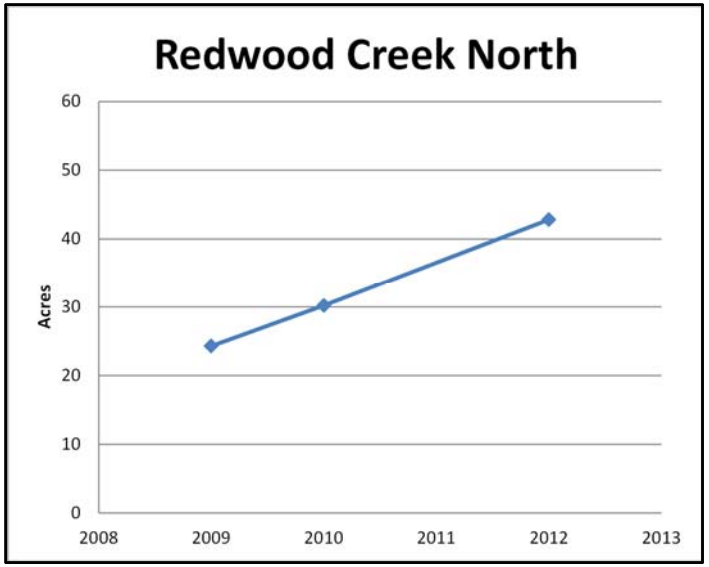
	Redwood Creek	Salmon Creek	Redwood Creek North	Outlet Creek
Daily Water Use (gpd)	111,167	123,289	102,078	156,138
Minimum Streamflow (gpd)	387,763	581,645	---	---
Percent Use	**28.7%**	**21.2%**	---	---
Water Use per 150 Day Season (gal)	16,675,308	18,493,344	15,311,700	23,420,700

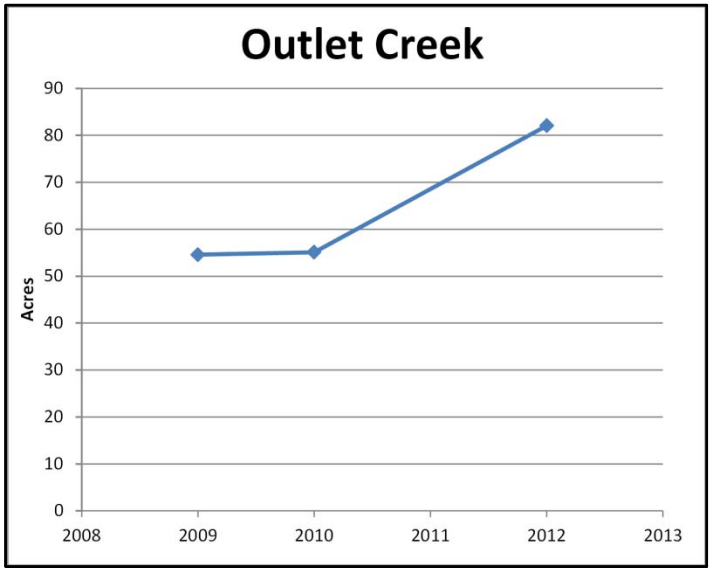
Results

Trends in Growth





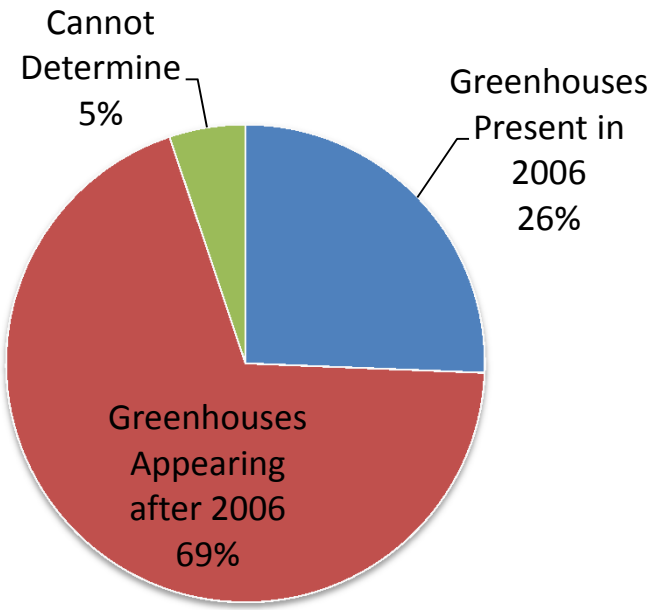




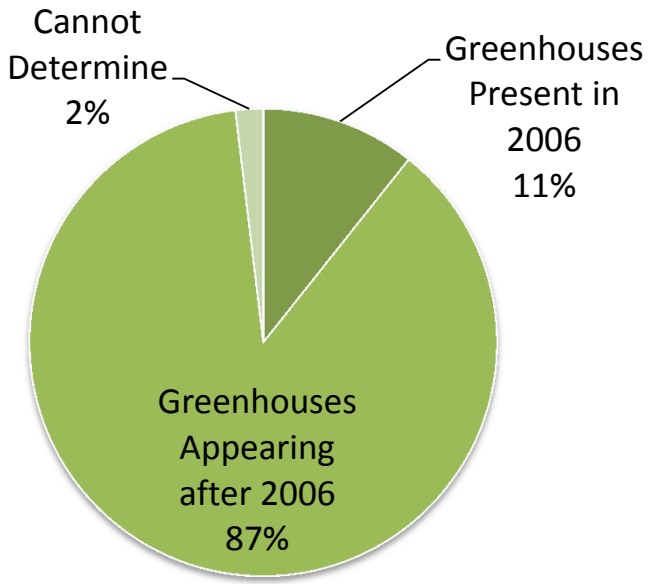
Results

Greenhouse appearances over time – 4 watersheds

Greenhouses Appearing After 2006



Greenhouses Larger than 1000 ft²



Results/Assumptions

- Average number of outdoor MCSs per watershed = 322
- Average number of plants per watershed = 20,526 (total = 82,104)
  - **Assumes we can see and count all the MCSs and plants accurately**
- Average number of greenhouses per watershed = 304
  - **Assumes all greenhouses are in use and contain marijuana plants**

Results/Assumptions

- Estimated volume of stream flow consumed by plants during dry summer low flow (two watersheds) = **20-30%**
  - **Assumes all water for cultivation = surface water**
  - **Assumes certain behavior (pumping during low flow periods)**
  - **Assumes no differences between watersheds**
  - **Worst case scenario**
- Number and size of grows that we measured increased in <u>all watersheds</u> by **68% to104%** from 2009-2012

Preliminary results indicate marijuana cultivation in the four study watersheds may have a significant negative effect on watershed health and sensitive aquatic species.

Next Steps

- Water quality monitoring in partnership with CDFW's Aquatic Bioassessment Lab.
  - Gives us analytical data & reference sites!
- **Seek funding** to insure continuity and growth of the Project.
  - Map additional watersheds
  - Hire Full-time Staff
- Continue outreach within local communities.

Thank you!

Questions?

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Jen Olson & Adam Cockrill, Scientific Aids (707) 445-5387