

MATH MODELING CAN

MAKE YOU FILTHY RICH

ROBERT KAPLINSKY

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robertkaplinsky.com

[@robertkaplinsky](https://www.instagram.com/robertkaplinsky)





Real-World Link



Common Core
State Standards

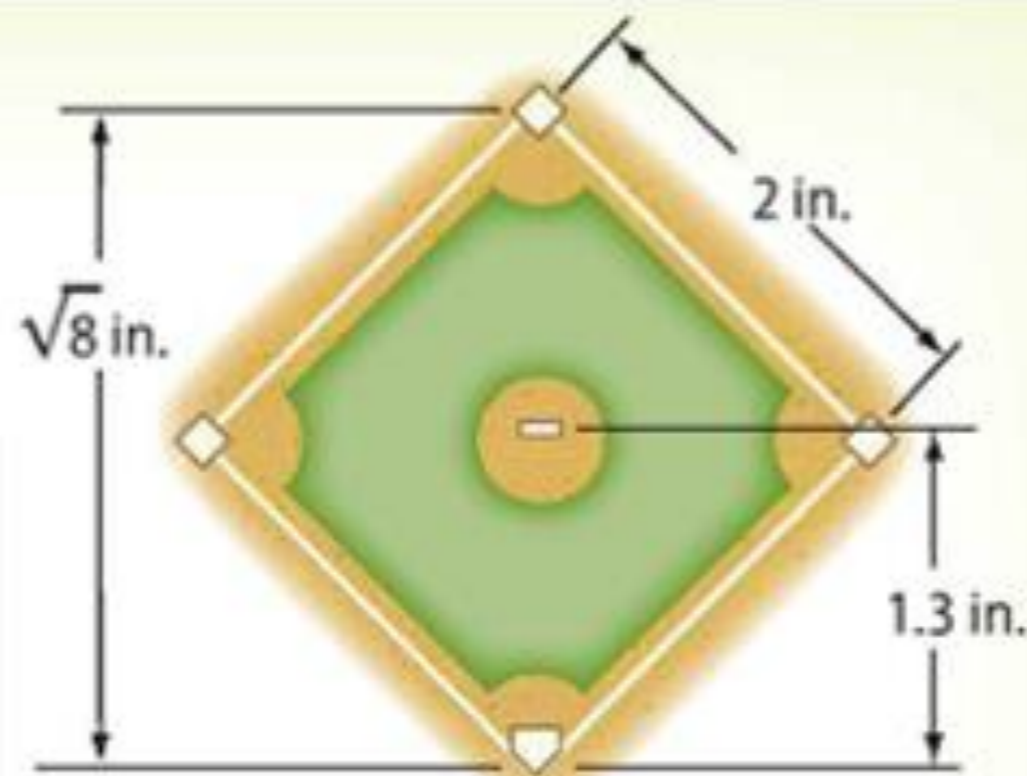
Content Standards

8.NS.1, 8.NS.2, 8.EE.2

Mathematical Practices

1, 3, 4, 6

Sports Major League baseball has rules for the dimensions of the baseball diamond. A model of the diamond is shown.



1. On the model, the distance from the pitching mound to home plate is 1.3 inches. Is 1.3 a rational number? Explain.

2. On the model, the distance from first base to second base is 2 inches. Is 2 a rational number? Explain.

3. The distance from home plate to second base is $\sqrt{8}$ inches. Using a calculator, find $\sqrt{8}$. Does it appear to terminate or repeat?





Real-World Link



Common Core State Standards

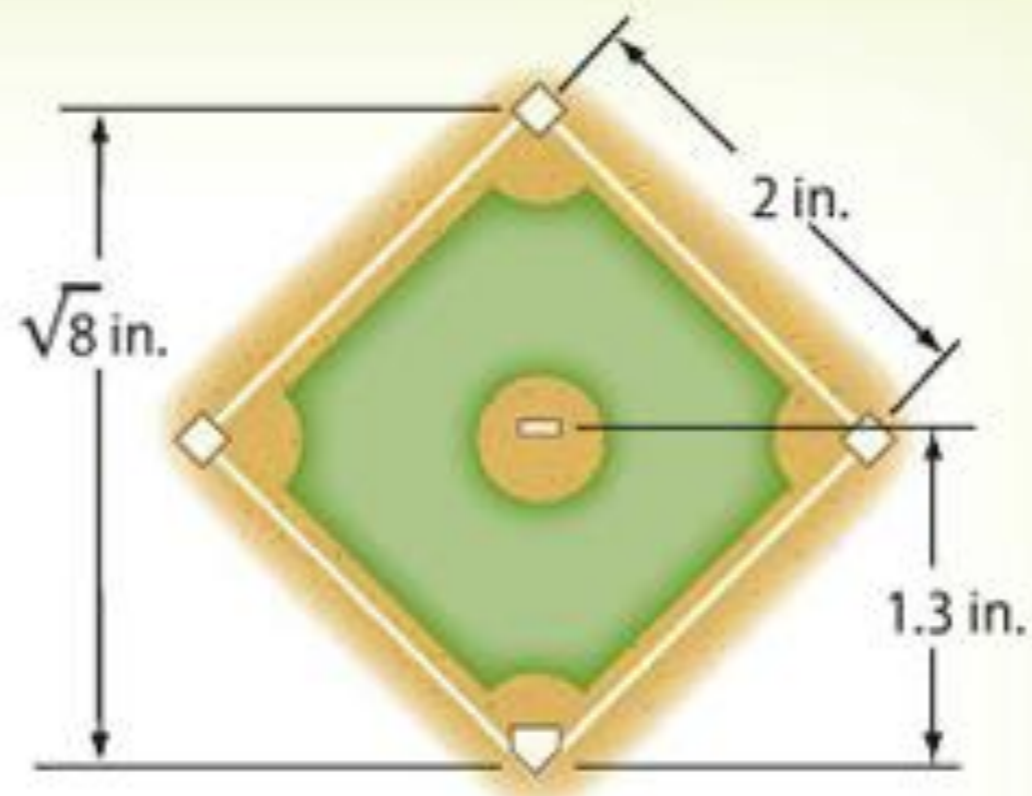
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Doritos® & Cheetos® Mix **20** Singles

DORITOS® Nacho Cheese Flavored Tortilla Chips 1 OZ. EA. DORITOS® COOL RANCH® Flavored Tortilla Chips 1 OZ. EA. CHEETOS® Puffs Cheese Flavored Snacks 7/8 OZ. EA. CHEETOS® Crunchy Cheese Flavored Snacks 1 OZ. EA.

20 INDIVIDUAL BAGS: 7/8 OZ. EACH, 1 OZ. EACH, TOTAL NET WT. 19 5/8 OZ. (1 LB. 3 5/8 OZ.) 556.3 g ⚠ WARNING: PREVENT ENTANGLEMENT AND STRANGULATION. KEEP THIS BAG AWAY FROM YOUNG CHILDREN. IT IS NOT A TOY.

THINKING TIME

- Why did many of you expect there to be five of each?
- Why was it not five of each?
- How might they decide on this combination?



Classic Mix

20
Singles

LAY'S® Classic Potato Chips. DORITOS® Nacho Cheese Flavored Tortilla Chips. DORITOS® COOL RANCH® Flavored Tortilla Chips. CHEETOS® Crunchy Cheese Flavored Snacks. SUNCHIPS® Original Multigrain Snacks. FRITOS® Original Corn Chips (All 1 OZ. Each)

20 INDIVIDUAL BAGS: 1 OZ. EACH, TOTAL NET WT. 20 OZ. (1 LB. 4 OZ.) 567 g

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GOALS

HOW DO WE MAKE SENSE OF MATH MODELING?

IS IT JUST ANSWERING QUESTIONS?

HOW DO YOU PROFIT FROM MATH MODELING?

HOW DO WE HELP OUR STUDENTS IMPROVE?

WHERE CAN WE FIND MORE RESOURCES?





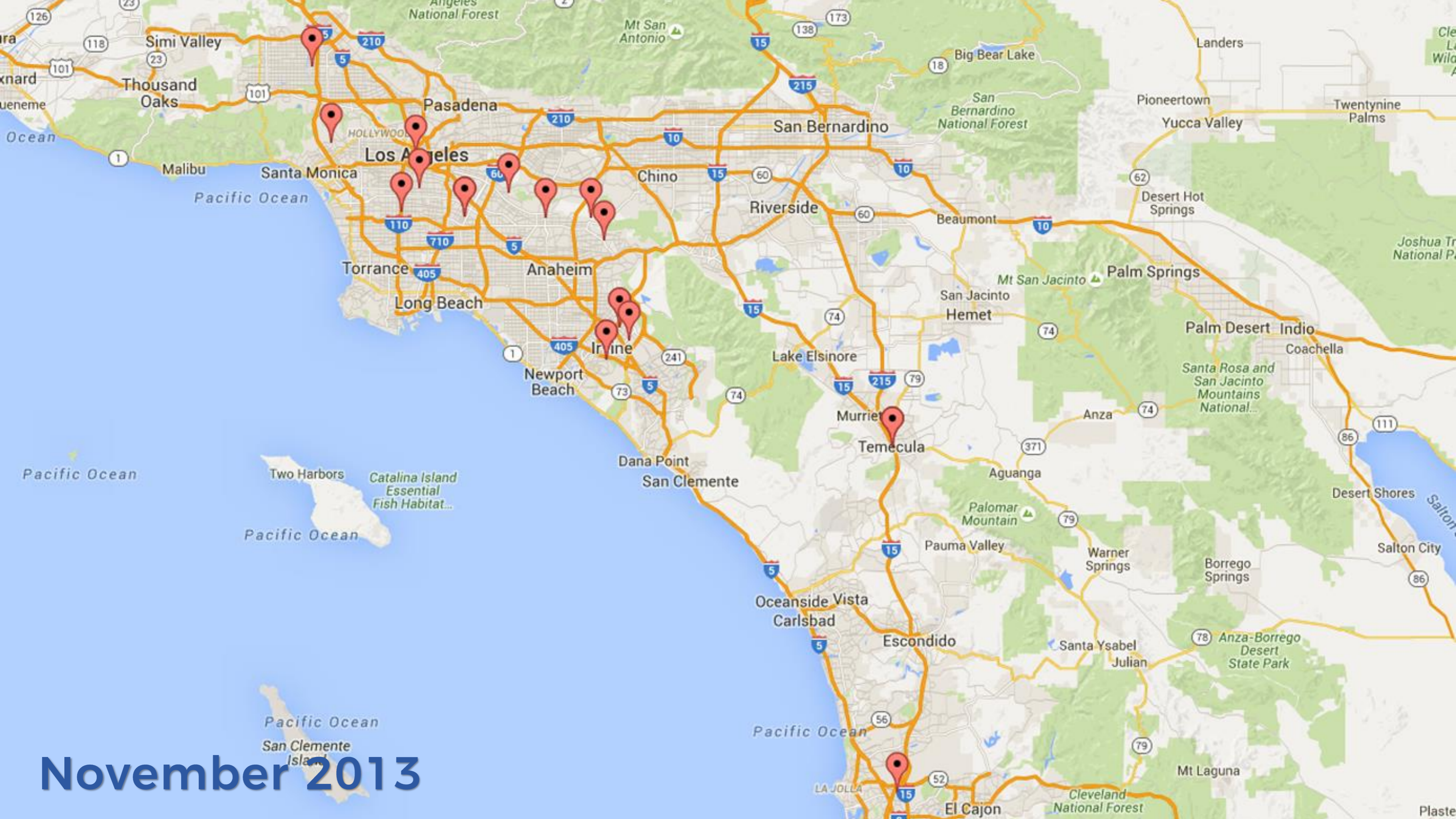



```
graph TD; Spies --> Analysts; Analysts --> Model; Model --> Spies;
```

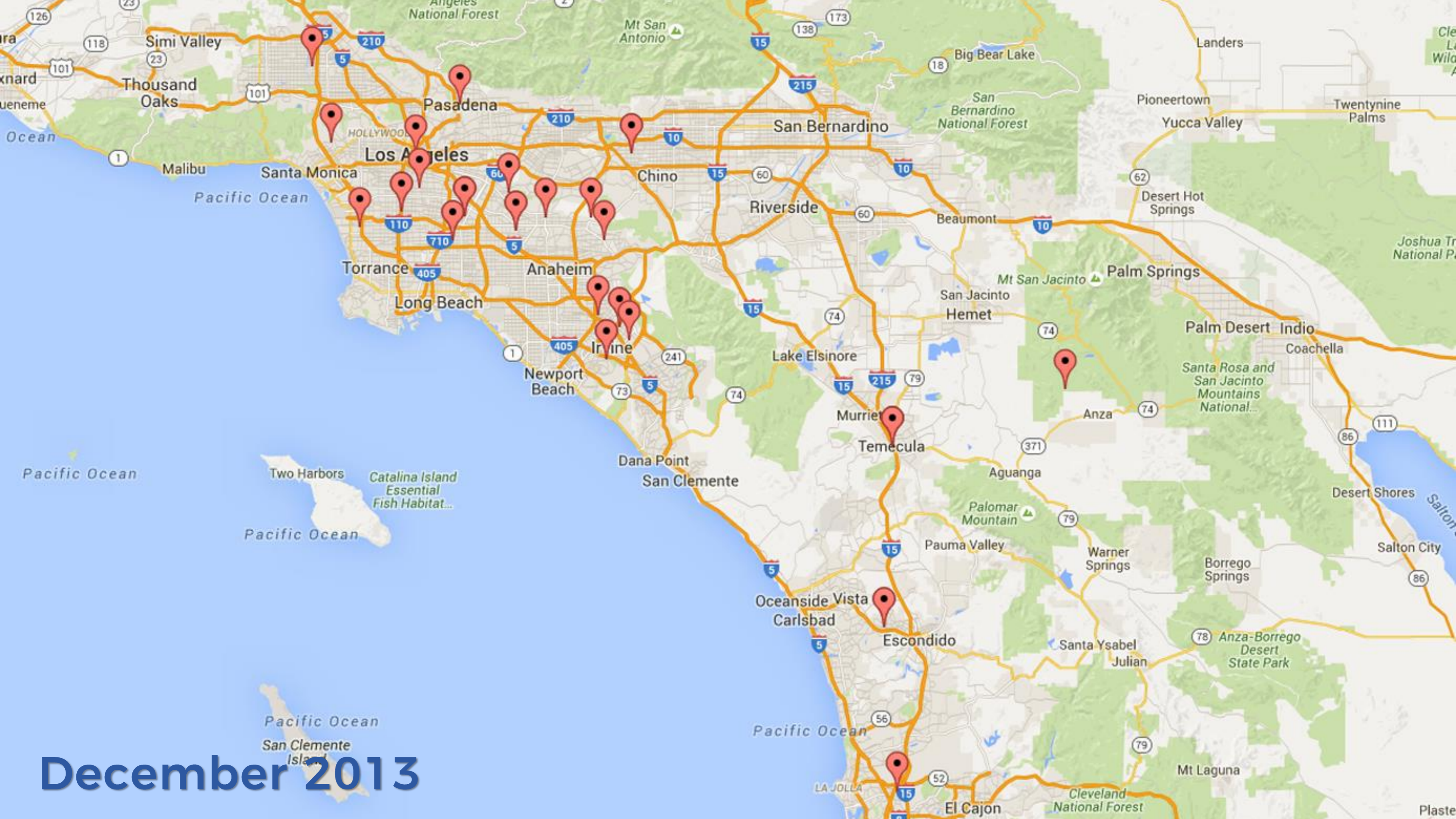
Spies

Analysts

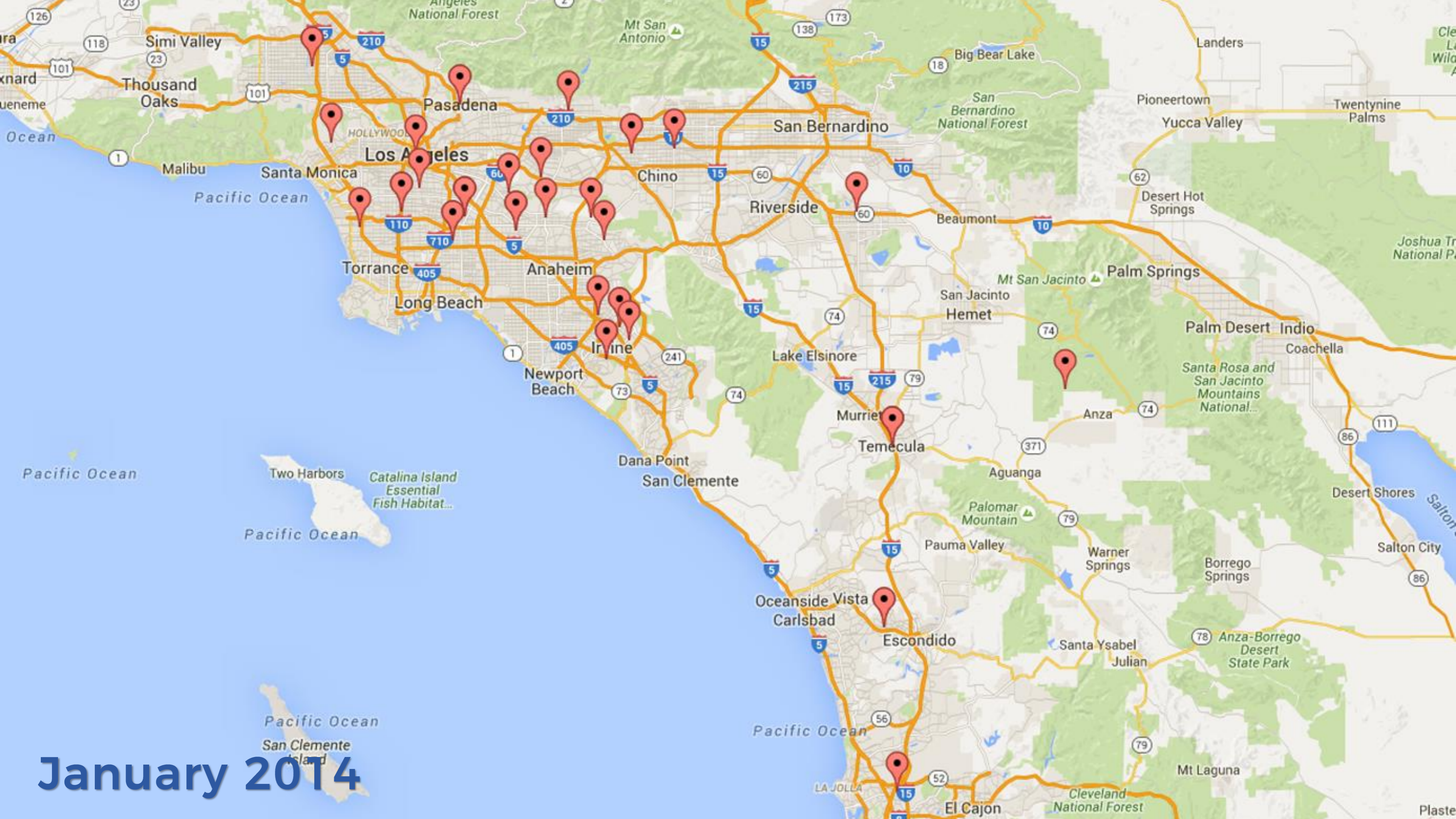
Model



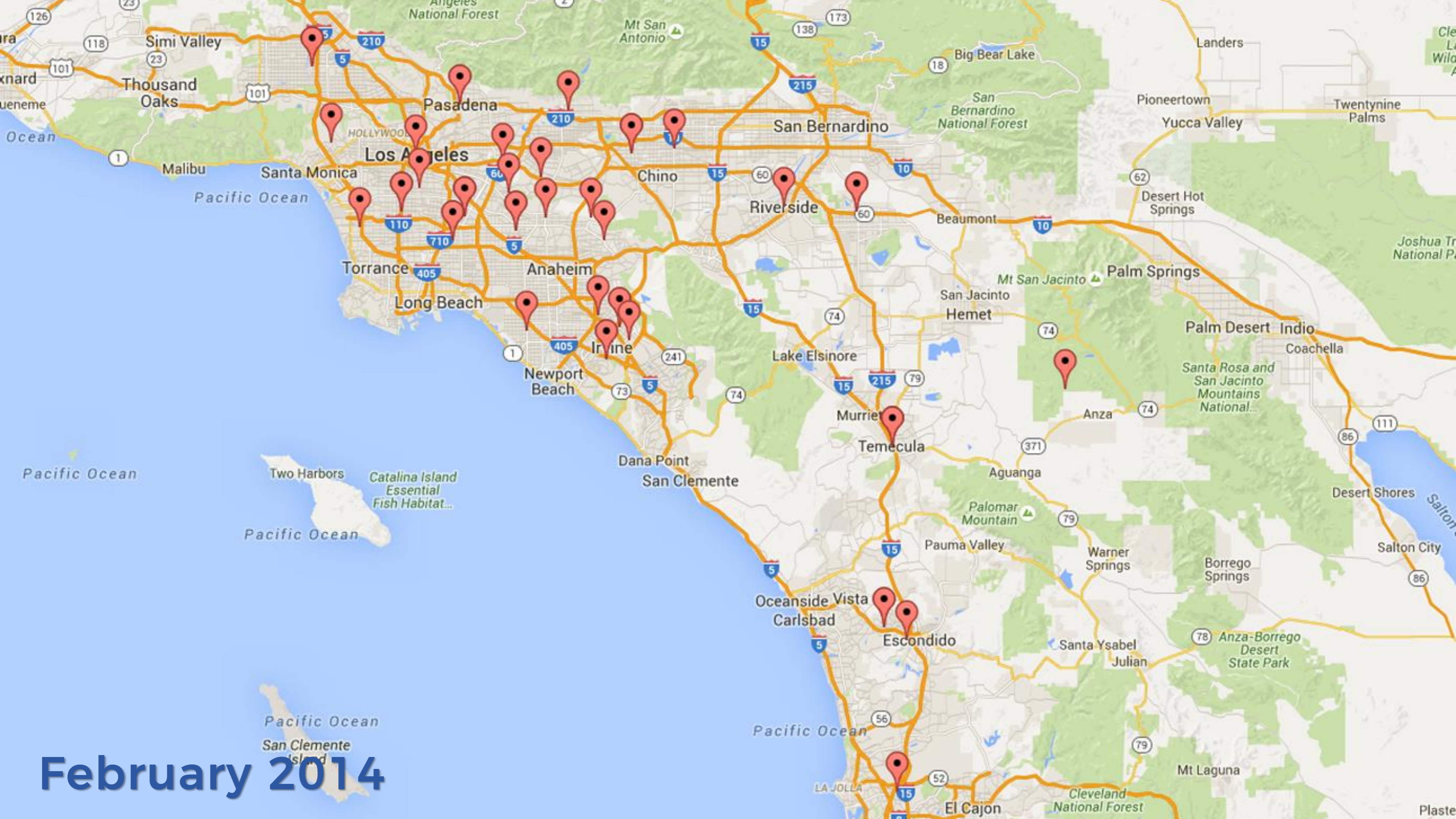
November 2013



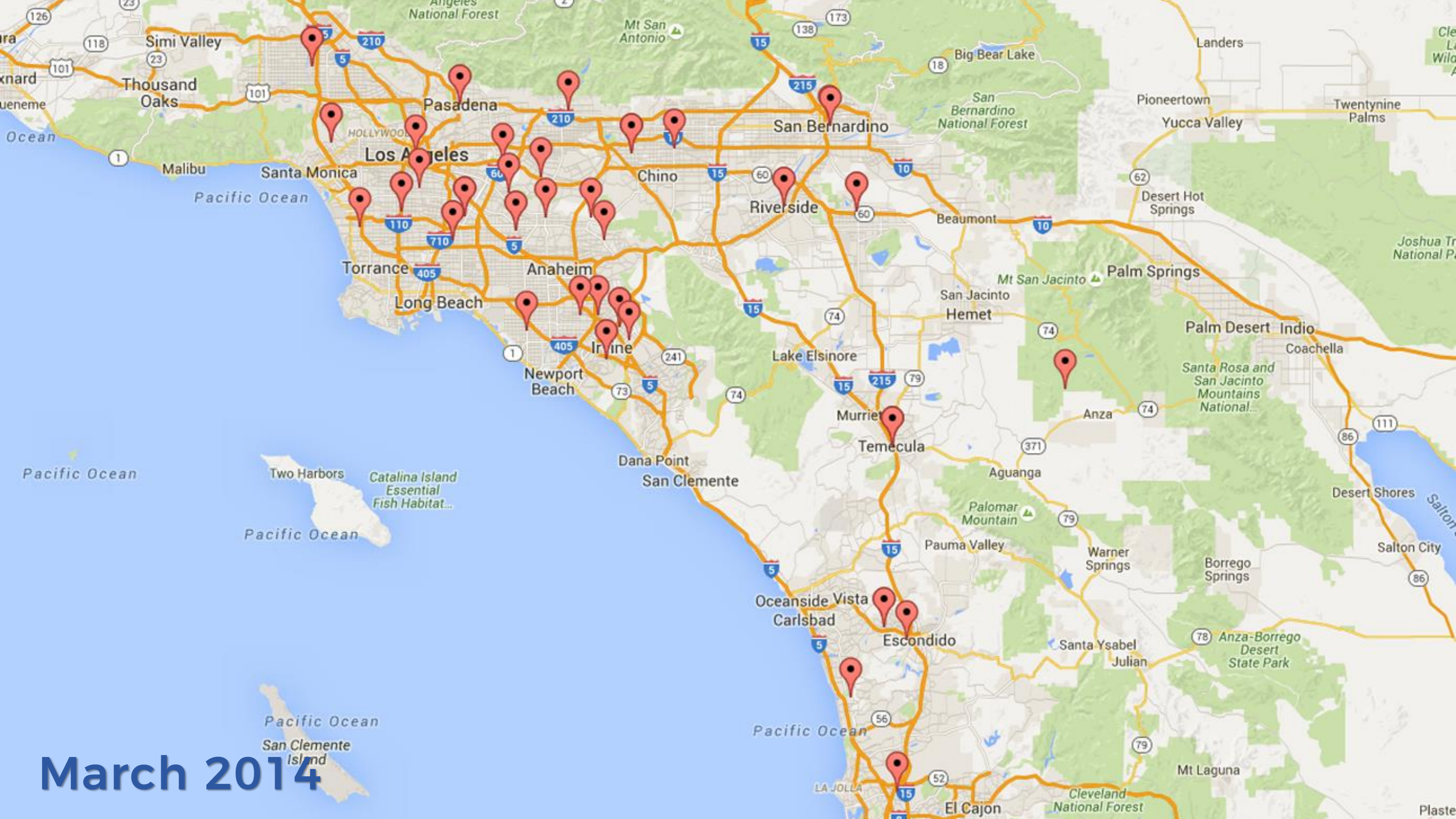
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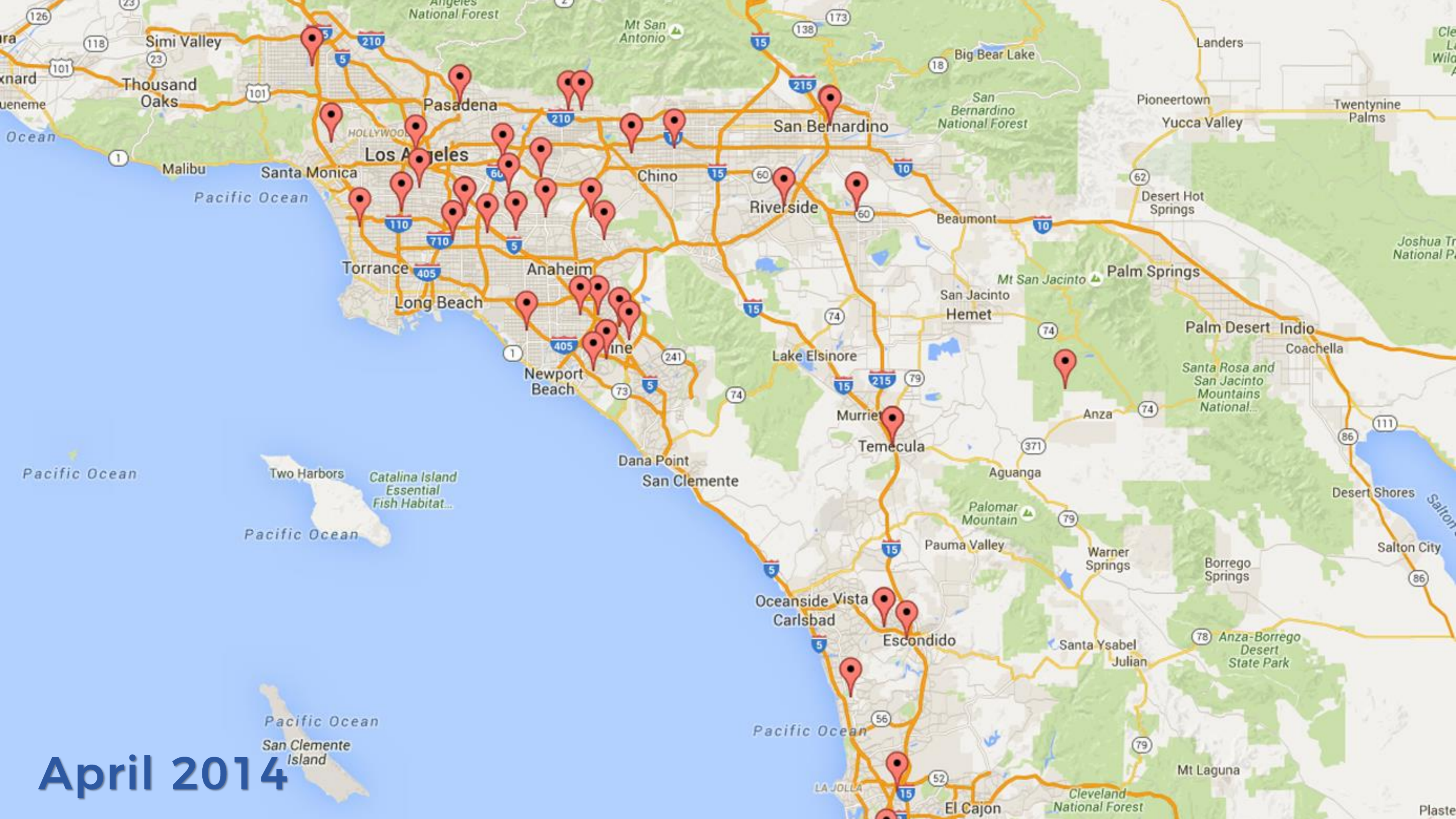
January 2014



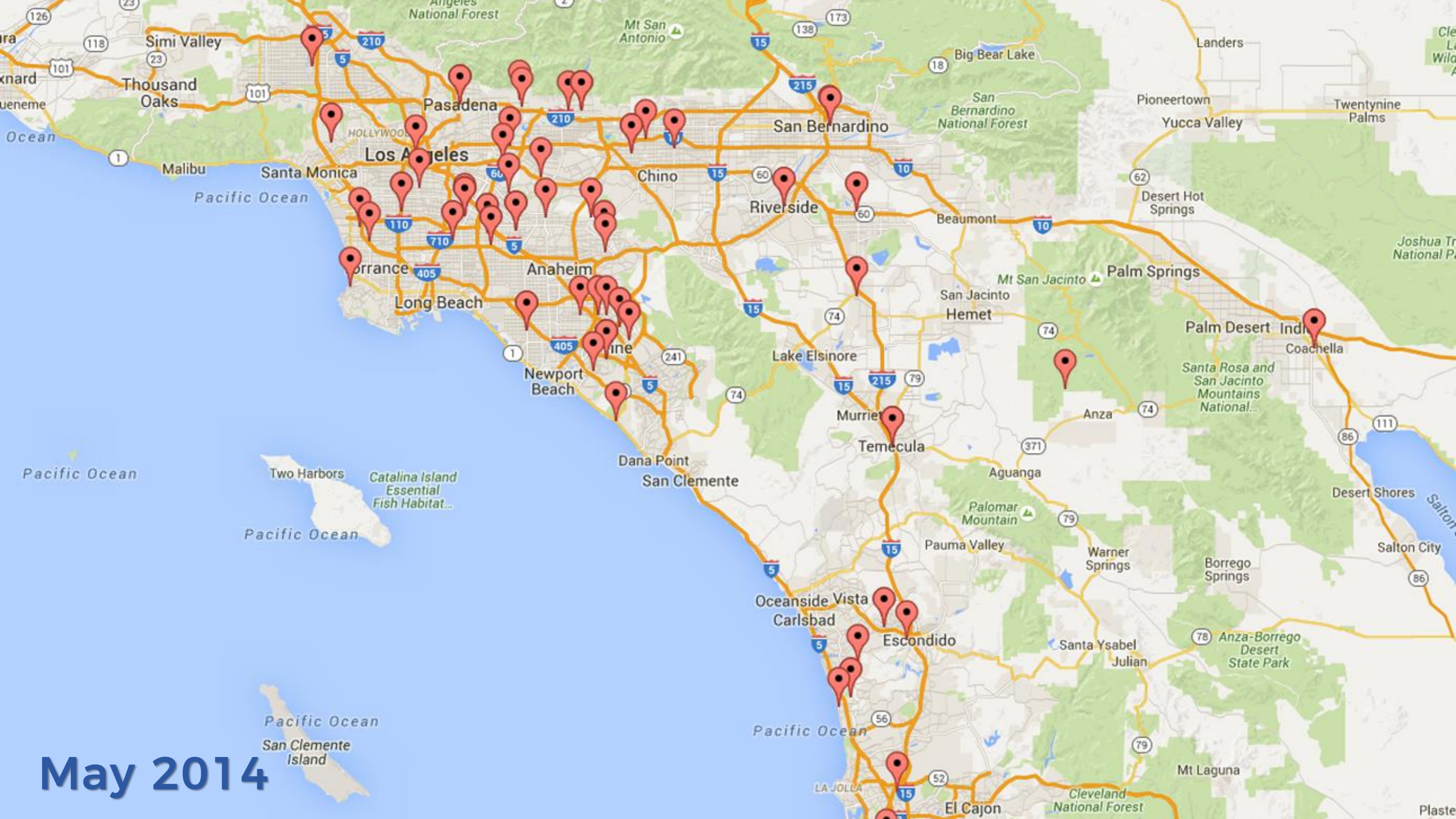
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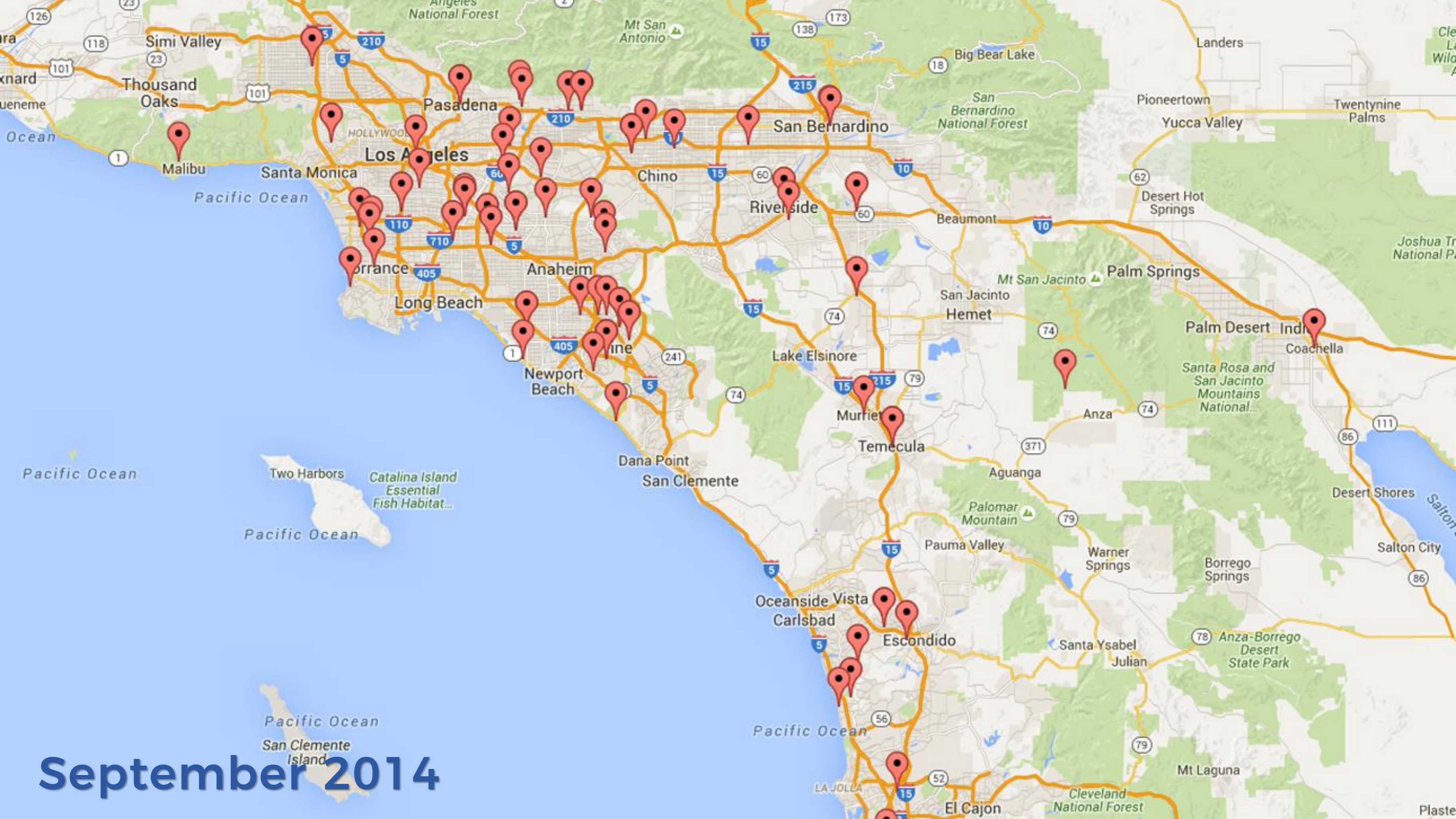
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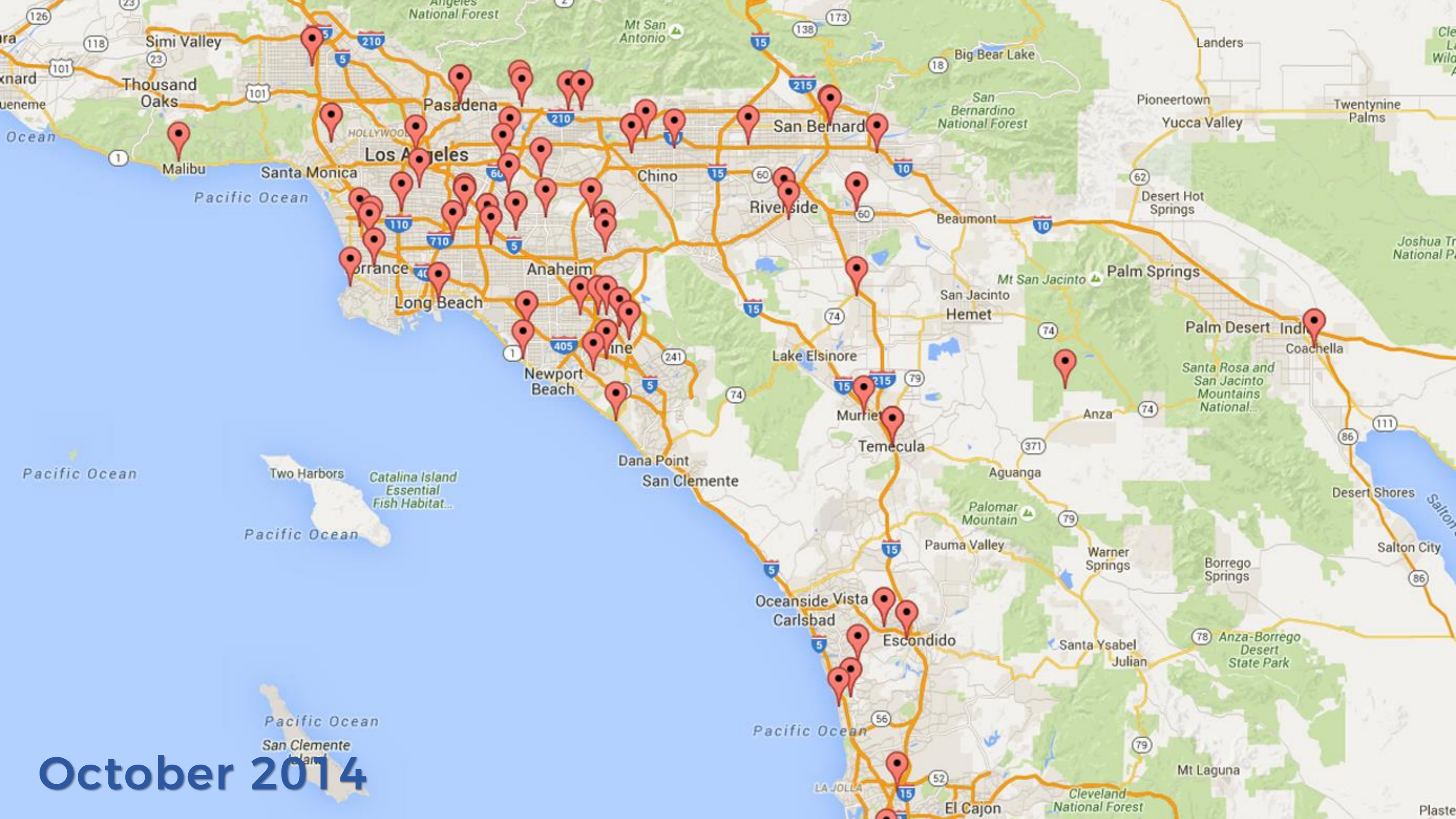
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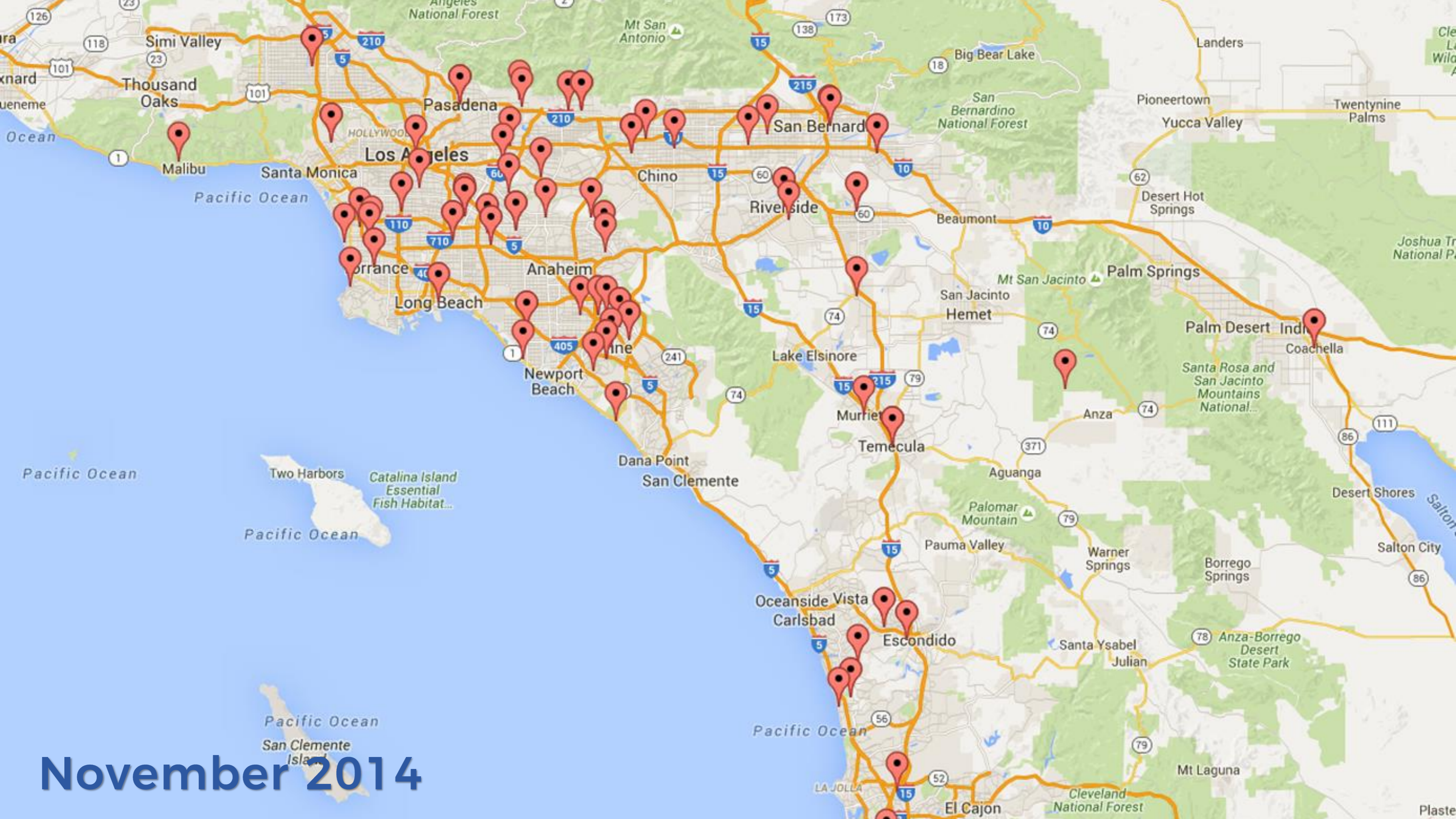
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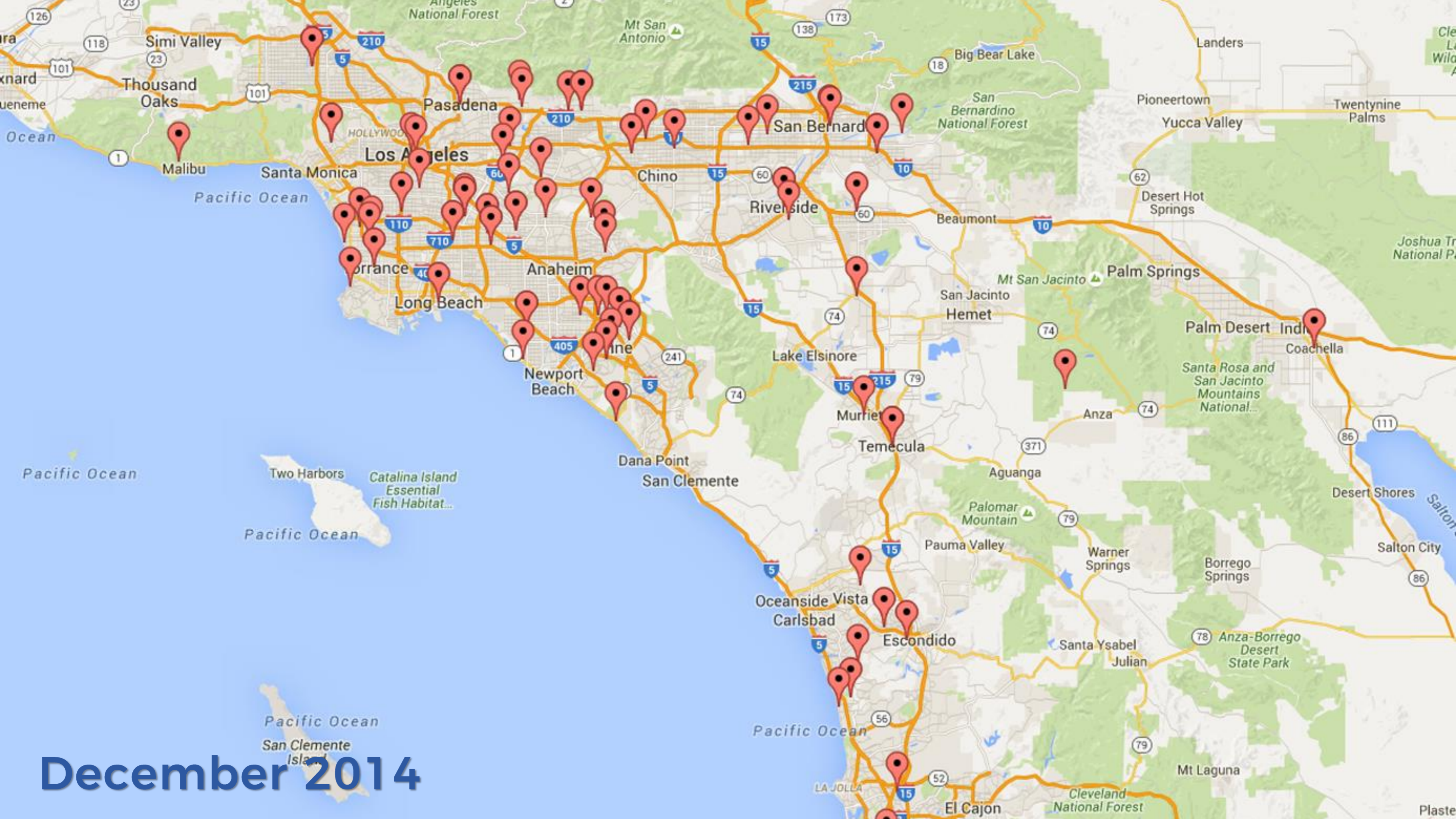
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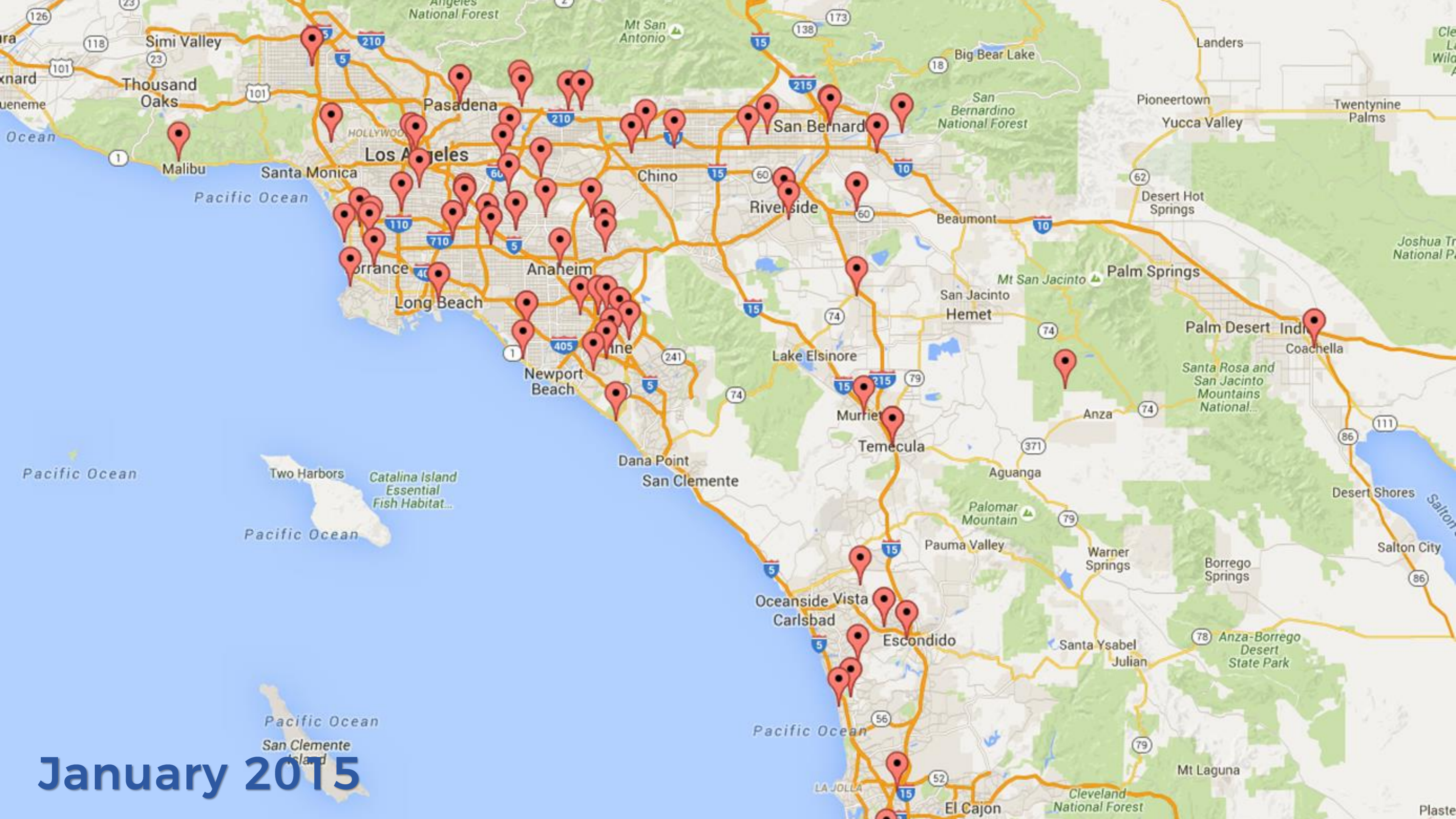
October 2014



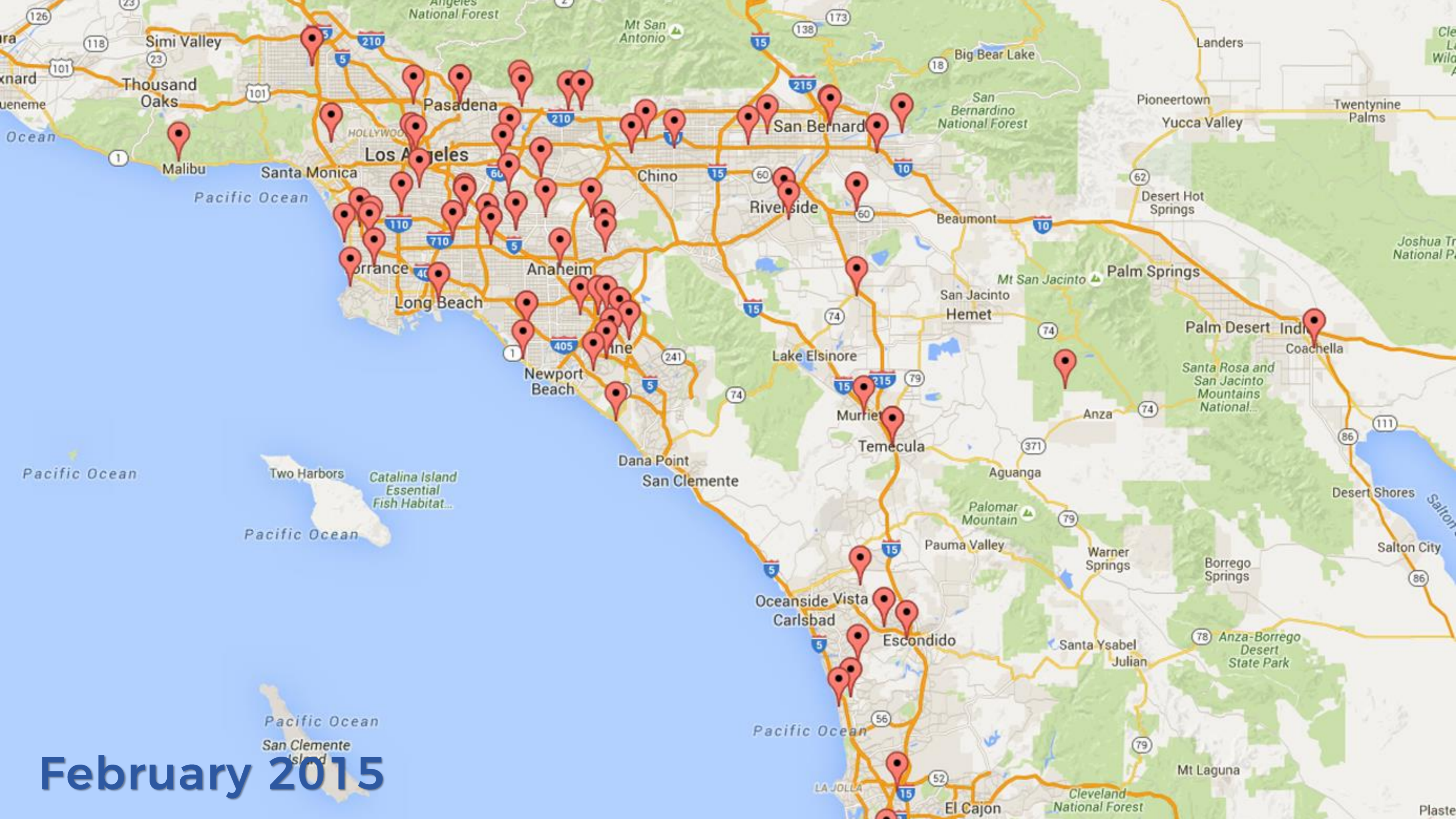
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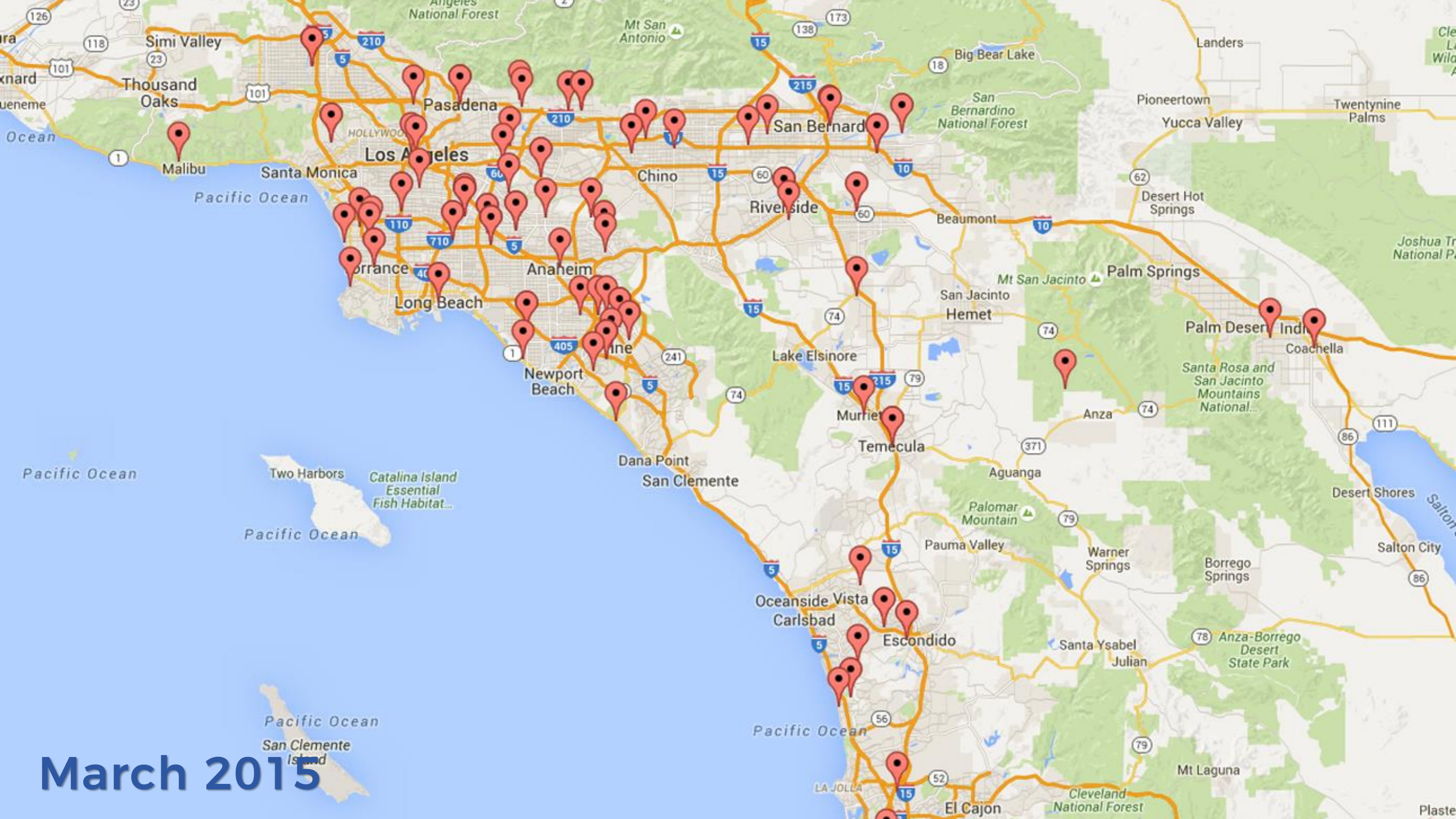
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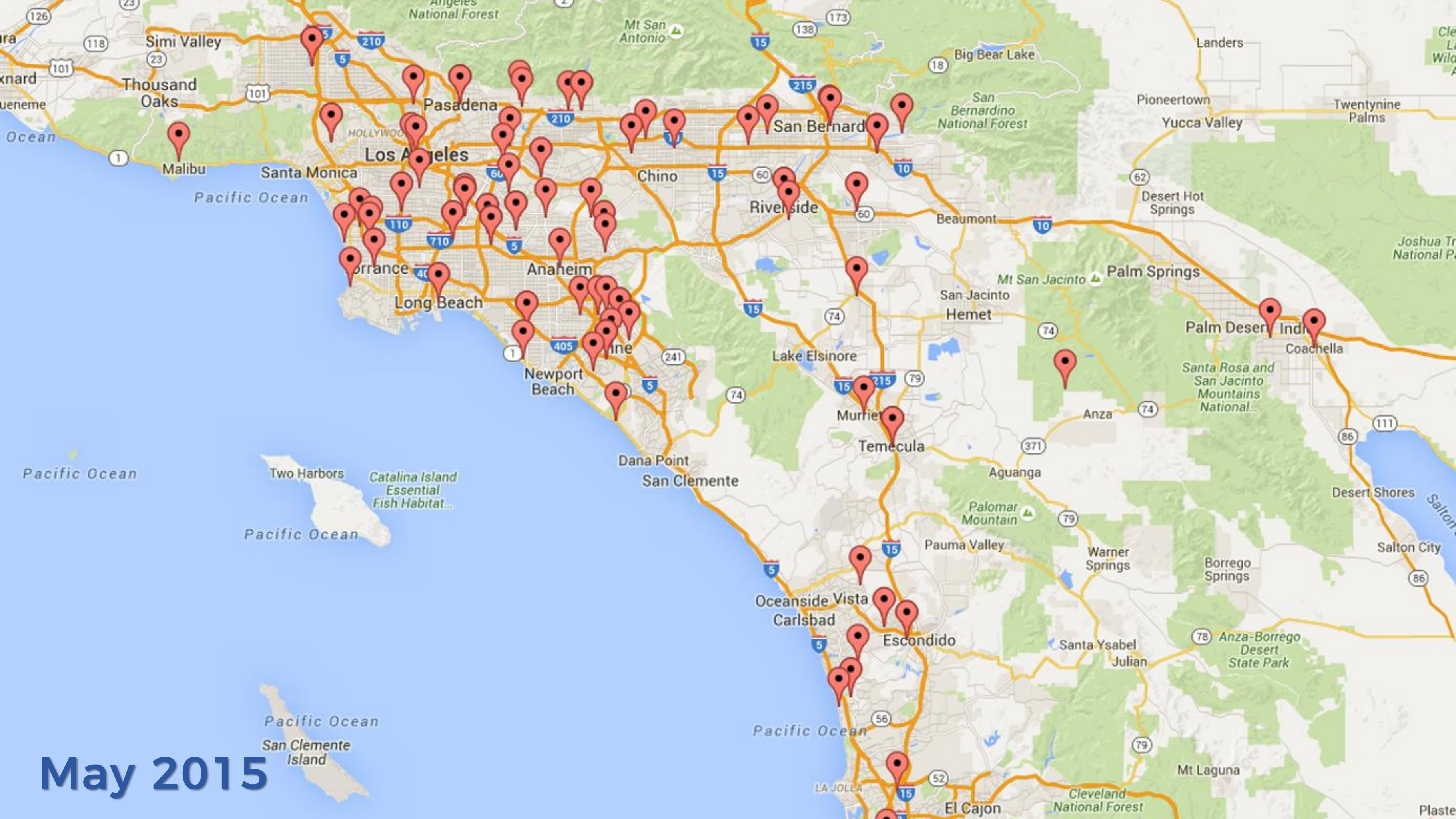
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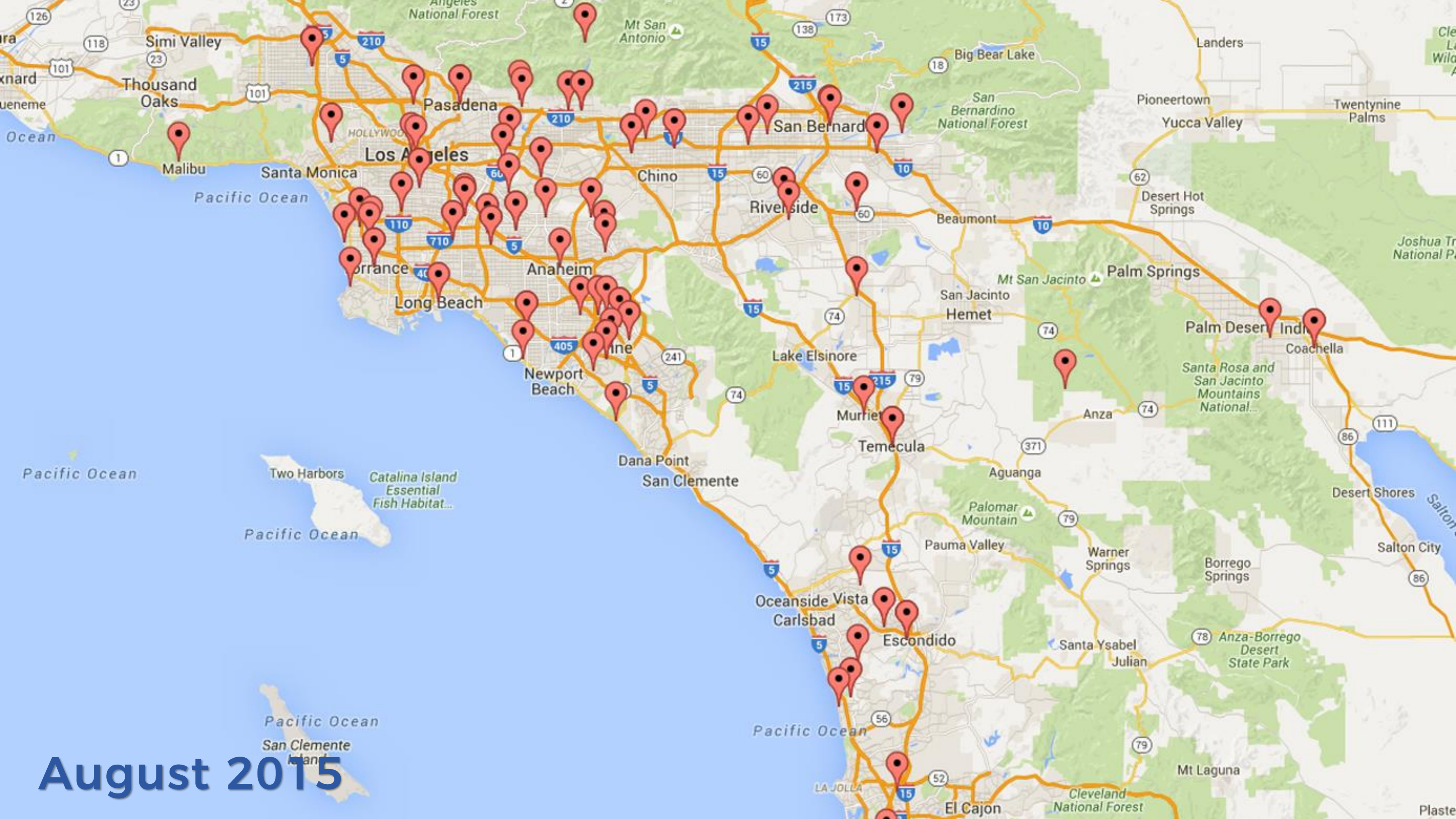
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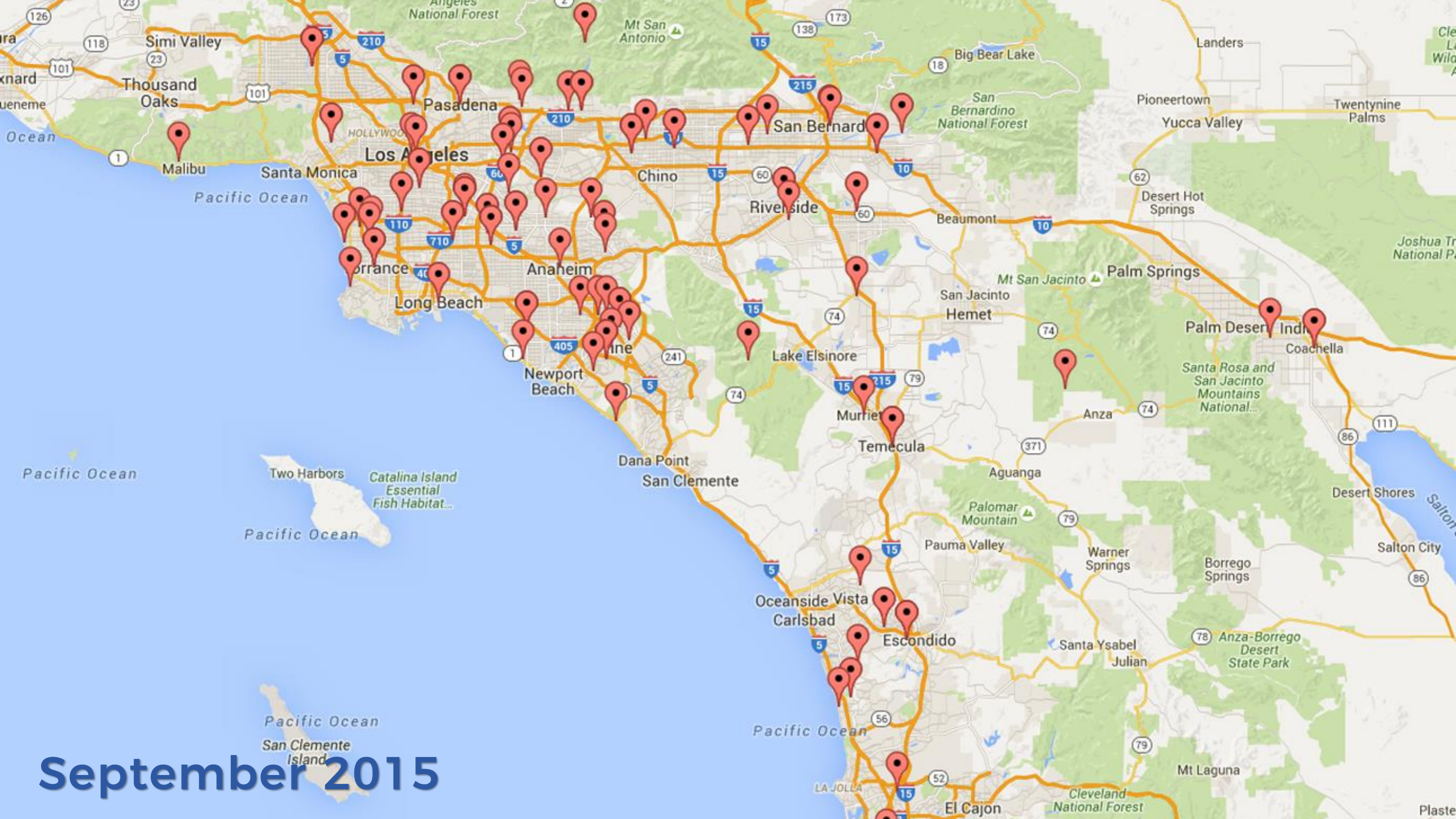
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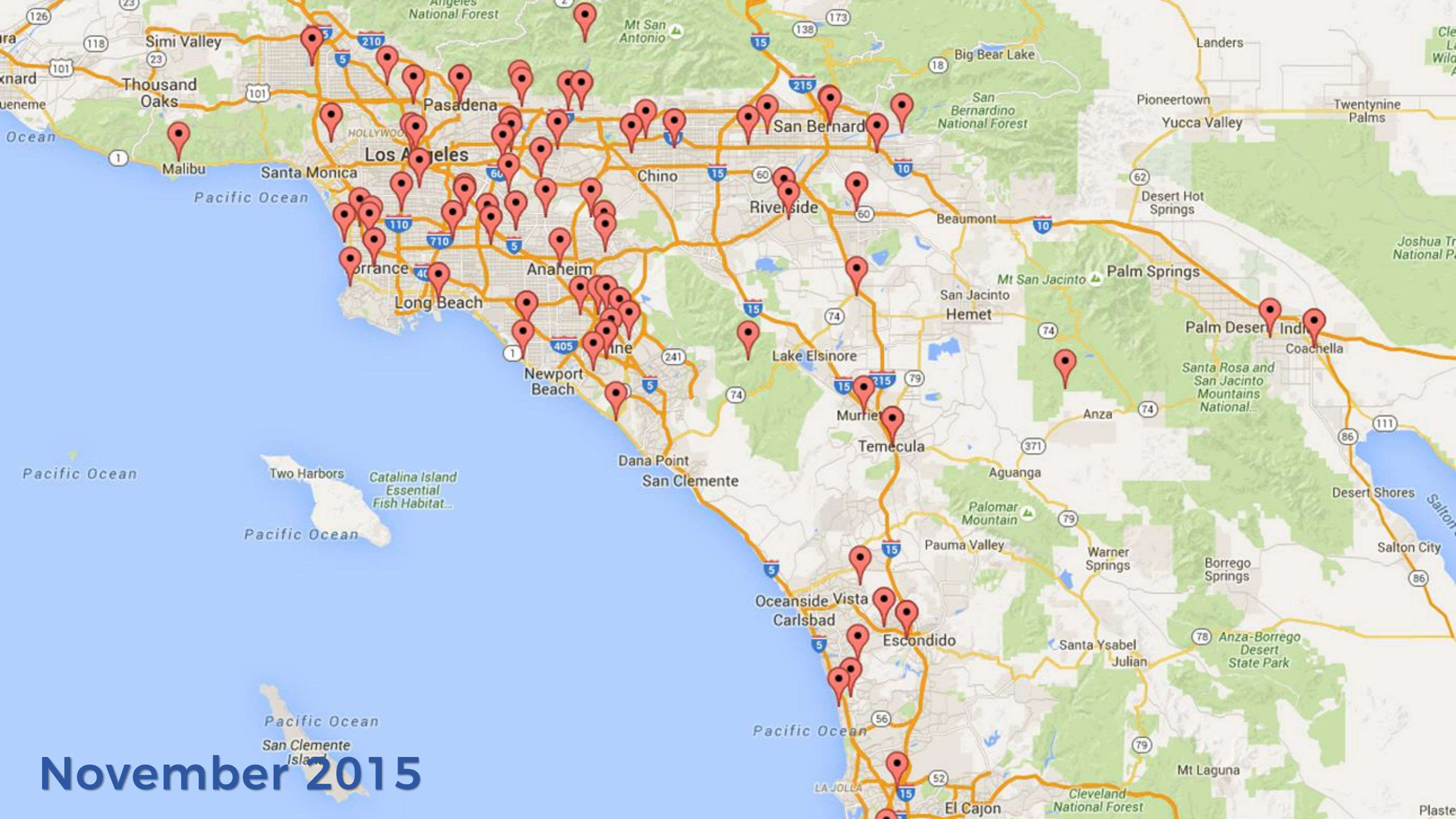
May 2015



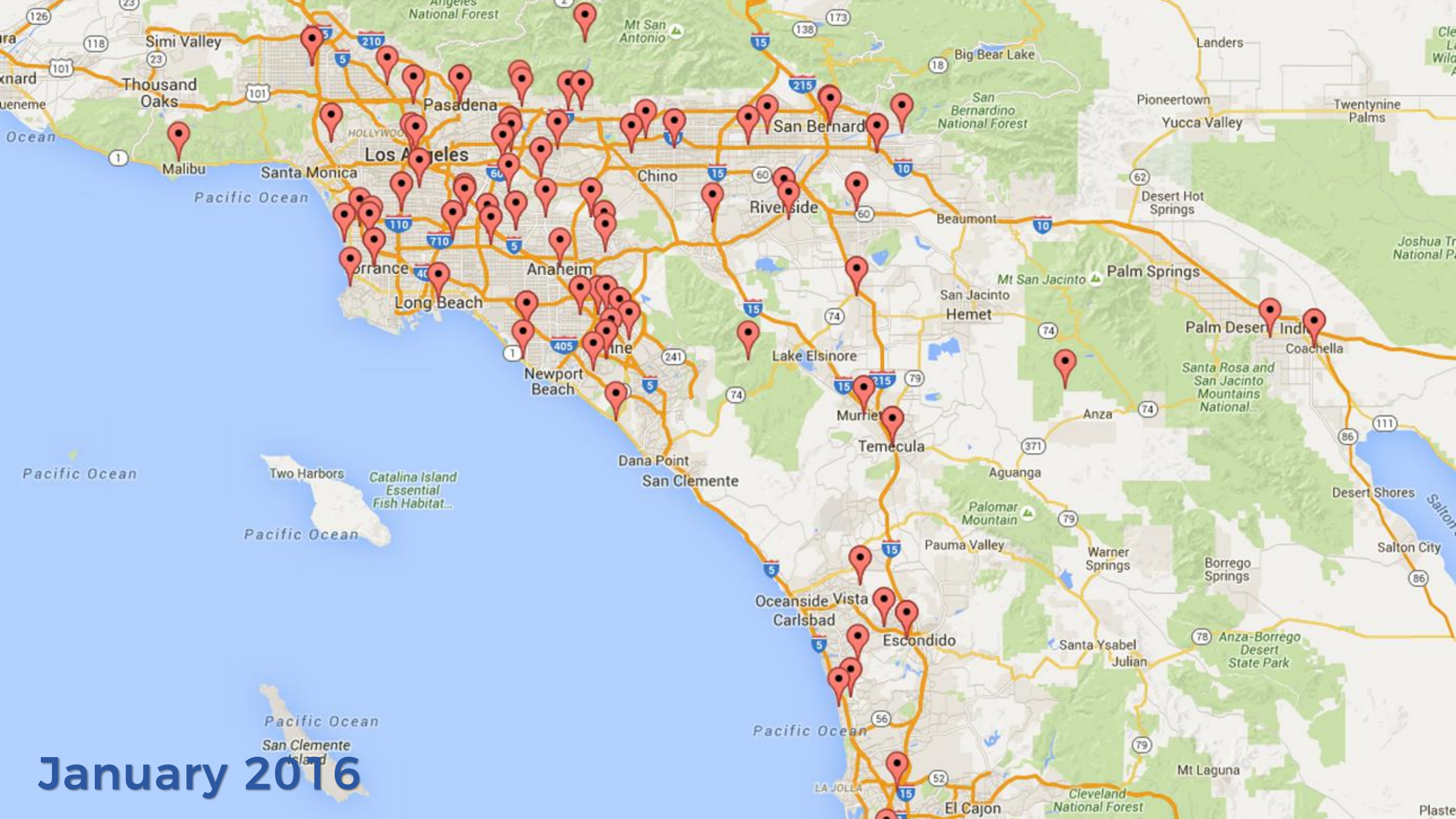
August 2015



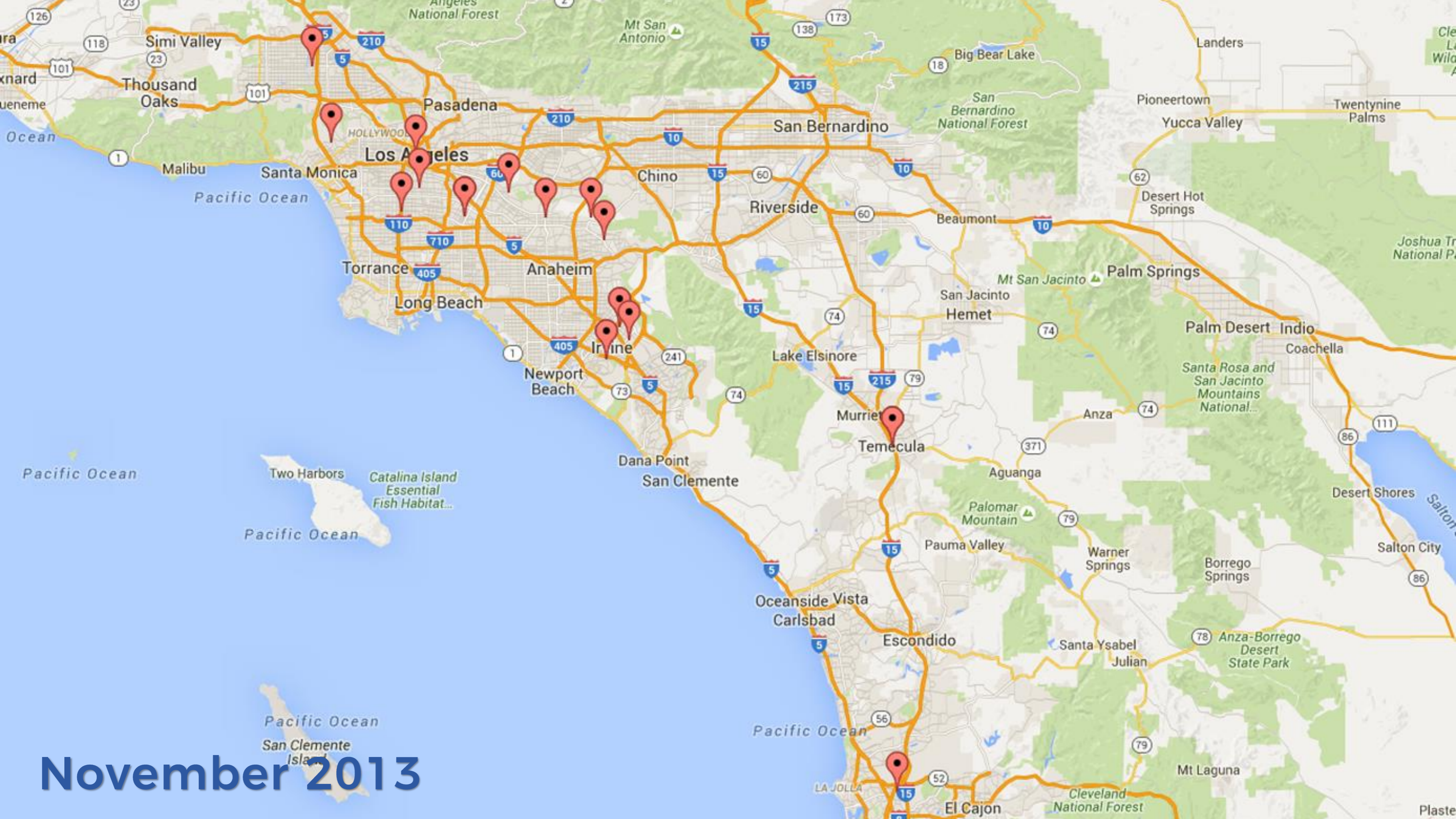
September 2015



November 2015



January 2016



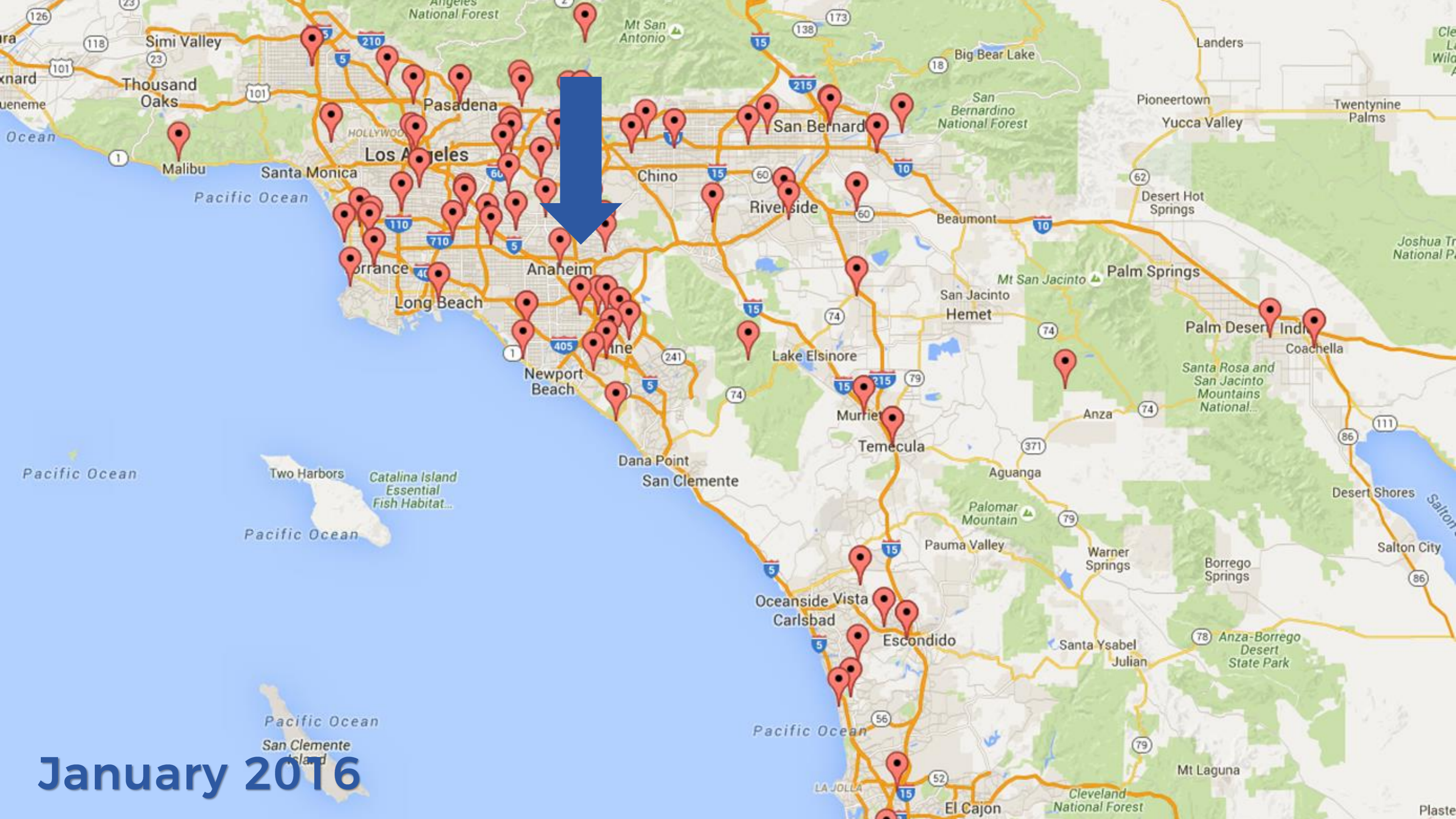
November 2013



Spies

Analysts

Model



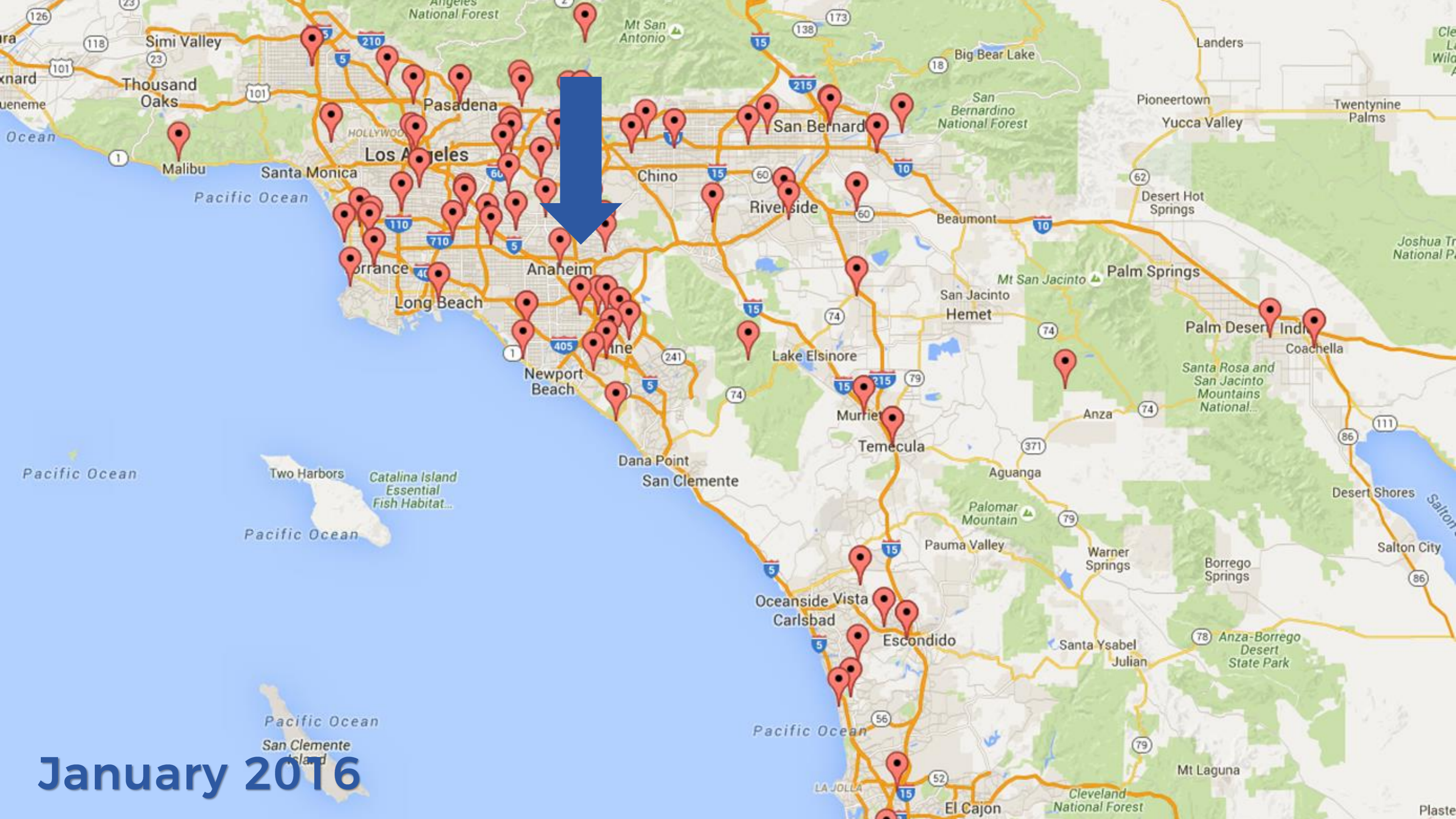
January 2016


```
graph TD; Spies --> Analysts; Analysts --> Model; Model --> Spies;
```


Spies

Analysts

Model



January 2016



All models are
wrong, but some
are useful.

GEORGE E. P. BOX



Classic Mix

20
Singles

LAY'S® Classic Potato Chips, DORITOS® Nacho Cheese Flavored Tortilla Chips, DORITOS® COOL RANCH® Flavored Tortilla Chips, CHEETOS® Crunchy Cheese Flavored Snacks, SUNCHIPS® Original Multigrain Snacks, FRITOS® Original Corn Chips (All 1 OZ. Each)

20 INDIVIDUAL BAGS: 1 OZ. EACH, TOTAL NET WT. 20 OZ. (1 LB. 4 OZ.) 567 g

⚠ WARNING: PREVENT ENTANGLEMENT AND STRANGULATION. KEEP THIS BAG AWAY FROM YOUNG CHILDREN. IT IS NOT A TOY.

The diagram consists of three white text labels: 'Spies' on the left, 'Analysts' on the right, and 'Model' at the bottom center. A blue curved arrow points from 'Spies' to 'Analysts', and another blue curved arrow points from 'Analysts' to 'Model'. The background is a solid green color with a decorative blue and green zigzag pattern at the top.

Spies

Analysts

Model

THINKING TIME

EASY TO STORE.



Classic Mix **20**
Singles

4 LAY'S® Classic Potato Chips, 4 DORITOS® Nacho Cheese Flavored Tortilla Chips, 2 DORITOS® COOL RANCH® Flavored Tortilla Chips, 4 CHEETOS® Crunchy Cheese Flavored Snacks, 2 SUNCHIPS® Original Multigrain Snacks, 4 FRITOS® Original Corn Chips (All 1 OZ. Each)
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Robert Kaplinsky

@robertkaplinsky



Hey #MTBoS, can you do me a favor and complete this 3 question anonymous survey about your favorite chips? I need data for a presentation. Please RT.

goo.gl/forms/etPtujll... #iteachmath



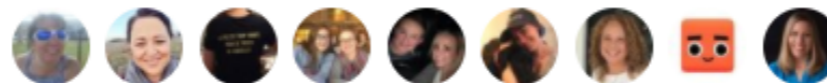
Favorite Chips

Please complete this anonymous survey. I'll be using this data in a presentation.

docs.google.com

8:05 PM - 4 Feb 2018

63 Retweets **45** Likes



18

63

45



Favorite Chips (Responses)

File Edit View Insert Format Data Tools Form Add-ons Help

Comments

Share

100%
 \$ % .0 .00 123
Arial
10
B *I* ~~U~~ A

...

fx Timestamp

	A	B	C	D	E	F	G	H
1	Timestamp	Lays (Classic)	Doritos (Nacho Cheese)	Doritos (Cool Ranch)	Cheetos (Crunchy)	Sun Chips (Original)	Fritos (Original)	Time Zone
2	2/4/2018 20:06:53	6	5	4	2	3	1	Central Time Zone
3	2/4/2018 20:06:55	1	5	6	3	2	4	Eastern Time Zone
4	2/4/2018 20:06:56	5	2	1	3	6	4	Central Time Zone
5	2/4/2018 20:06:57	2	1	6	3	5	4	Pacific Time Zone
6	2/4/2018 20:07:36	4	1	2	3	5	6	Pacific Time Zone
7	2/4/2018 20:08:02	5	1	6	4	2	3	Pacific Time Zone
8	2/4/2018 20:08:05	6	2	4	3	5	1	Pacific Time Zone
9	2/4/2018 20:08:07	4	2	1	5	3	6	Pacific Time Zone
10	2/4/2018 20:08:29	5	3	4	1	6	2	Central Time Zone
11	2/4/2018 20:08:56	4	5	6	1	2	3	Central Time Zone
12	2/4/2018 20:09:54	5	6	5	6	5	4	Pacific Time Zone
13	2/4/2018 20:10:01	4	2	3	1	5	6	Pacific Time Zone
14	2/4/2018 20:10:04	6	2	3	1	5	4	Central Time Zone
15	2/4/2018 20:10:04	3	5	6	1	4	2	Central Time Zone
16	2/4/2018 20:10:05	4	2	6	1	3	5	Eastern Time Zone
17	2/4/2018 20:10:06	3	2	6	5	1	2	Pacific Time Zone
18	2/4/2018 20:10:10	4	2	6	3	5	1	Mountain Time Zone
19	2/4/2018 20:10:12	3	1	5	6	2	4	Eastern Time Zone
20	2/4/2018 20:10:26	5	3	6	2	4	1	Pacific Time Zone

+ Sheet3

Explore

THINKING TIME

- The available data includes:
 - Lays, Nacho Cheese Doritos, Cool Ranch Doritos, Cheetos, Sun Chips, and Fritos ranked from 1 to 6
 - Geographic region: West, Central, or Eastern

ANALYSTS' JOB FOR THE TOP 1

1. **Count** all the first place votes for each chip type.
2. **Divide** the total first place votes for each chip type by the total number of votes.
3. **Multiply that fraction** by 20 to find how many bags there would be in a twenty pack, **rounding** as necessary.

ANALYSTS' EXAMPLE

CHIP BAG RESULTS

GOALS

HOW DO WE MAKE SENSE OF MATH MODELING?

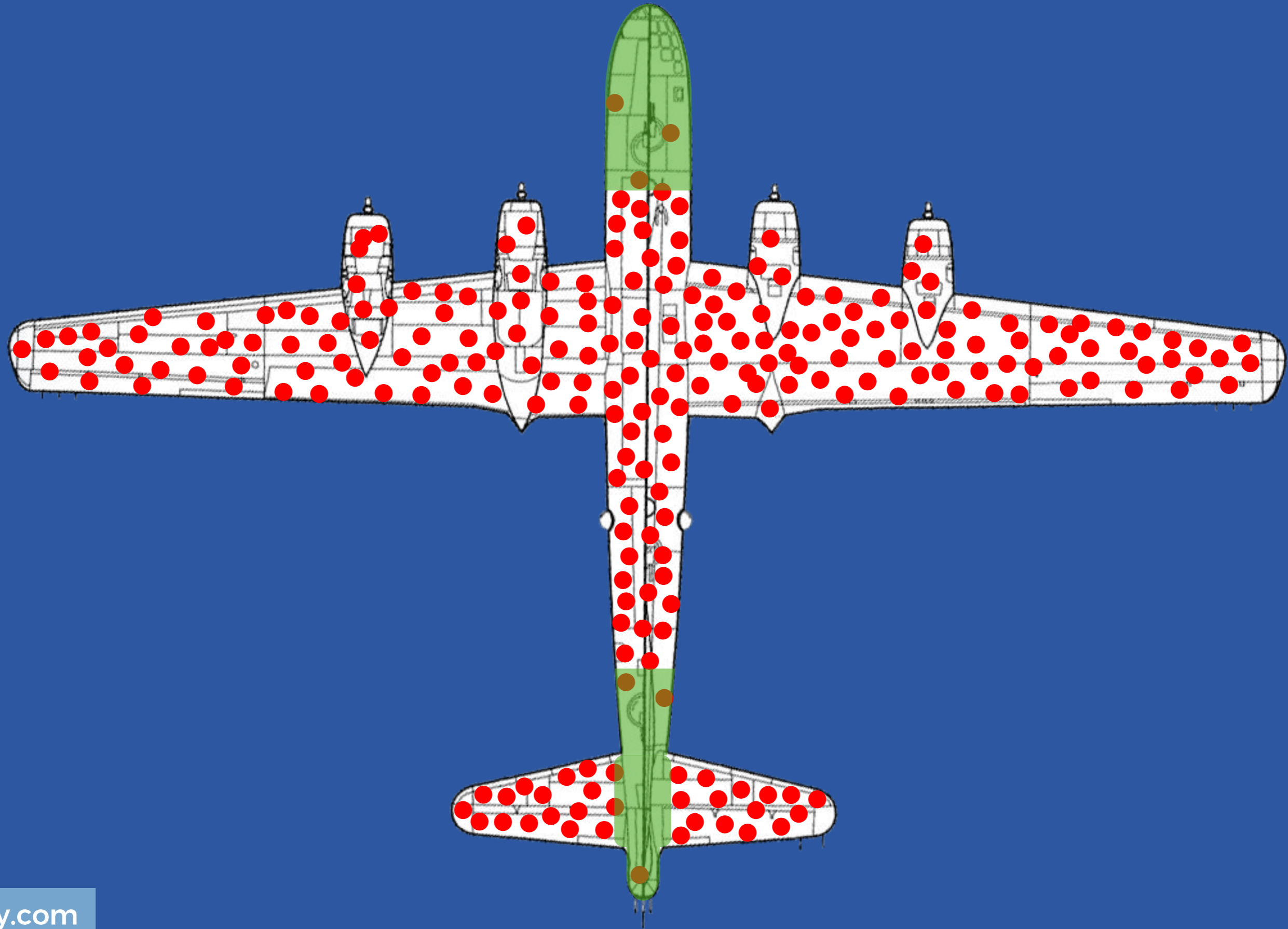
IS IT JUST ANSWERING QUESTIONS?

HOW DO YOU PROFIT FROM MATH MODELING?

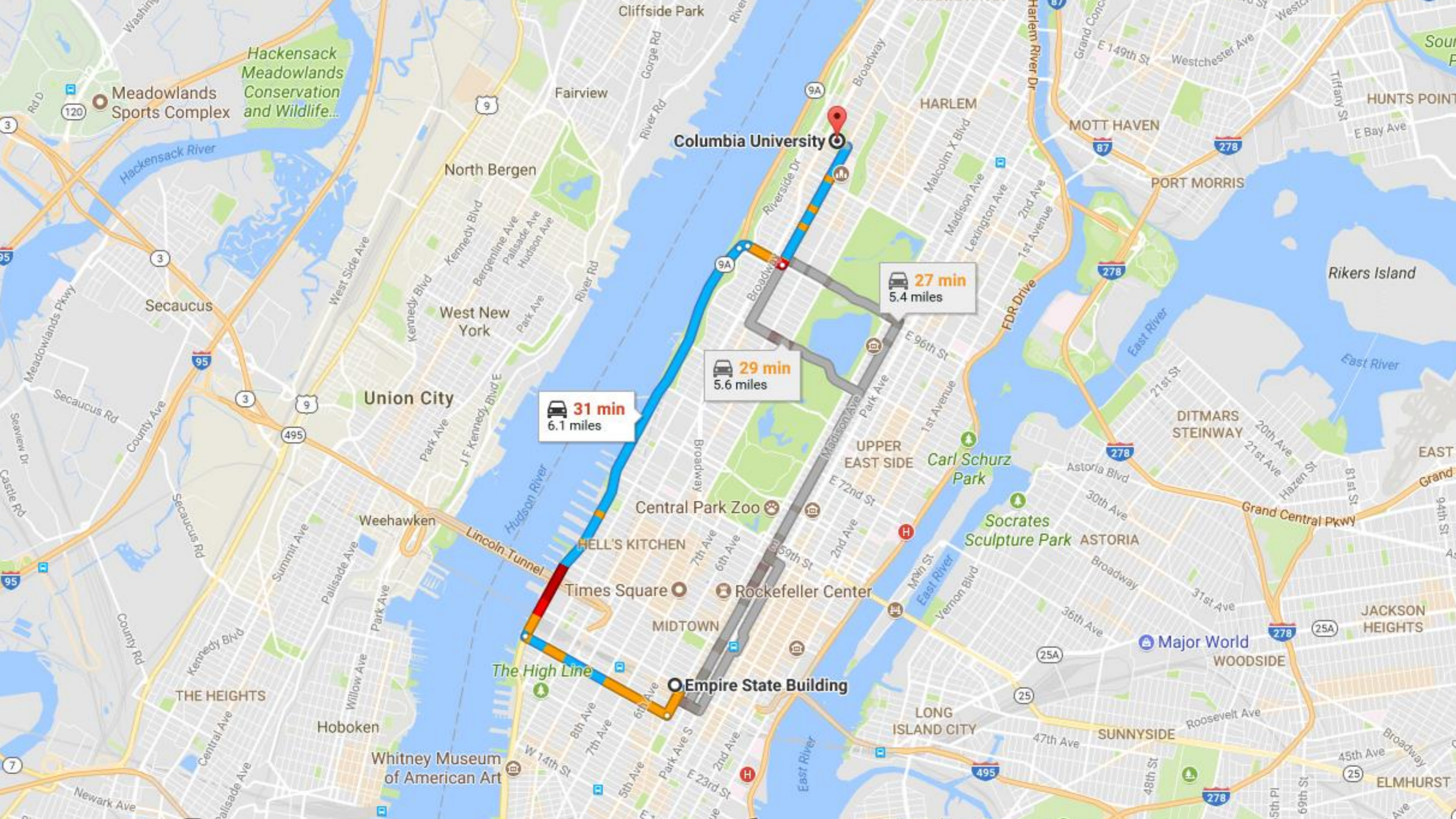
HOW DO WE HELP OUR STUDENTS IMPROVE?

WHERE CAN WE FIND MORE RESOURCES?





- ~~How do we protect our planes?~~
- ~~Which parts of the plane are being hit by the most bullets?~~
- Which parts of the plane are the most critical to protect?



Columbia University

Empire State Building

31 min
6.1 miles

29 min
5.6 miles

27 min
5.4 miles

- ~~How do we find the fastest route for each customer?~~
- How do we find the fastest route for each customer without impacting our other customers?



Classic Mix

20
Singles

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⚠ WARNING: PREVENT ENTANGLEMENT AND STRANGULATION. KEEP THIS BAG AWAY FROM YOUNG CHILDREN. IT IS NOT A TOY.

- ~~How many of each flavor should we put in a package?~~
- ~~How many of each flavor should we put in a package for each region?~~
- How can we determine if the extra cost of creating different packages will make us more money?

Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later.

CCSS MATH PRACTICE 4



They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.

CCSS MATH PRACTICE 4

GOALS

HOW DO WE MAKE SENSE OF MATH MODELING?

IS IT JUST ANSWERING QUESTIONS?

HOW DO YOU PROFIT FROM MATH MODELING?

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WHERE CAN WE FIND MORE RESOURCES?



TARGET PARKING





```
graph TD; Spies --> Analysts; Analysts --> Model; Model --> Spies;
```

Spies

Analysts

Model



They used 25 products for a pregnancy prediction' score including:

- **unscented lotion**
- **mineral supplements**
- **cotton balls**

Source: New York Times



UNITED



N4047

B G →

B →

← G A

A319
4047


```
graph TD; Spies --> Analysts; Analysts --> Model; Model --> Spies;
```

Spies

Analysts

Model

Priority is determined by:

- passenger's fare class
- itinerary
- frequent flyer program membership
- check-in time

Source: United Airlines



Search



Robert

Home



Robert Kaplinsky

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Insights

Games 7

Fundraisers

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Pokes

See More...

Create

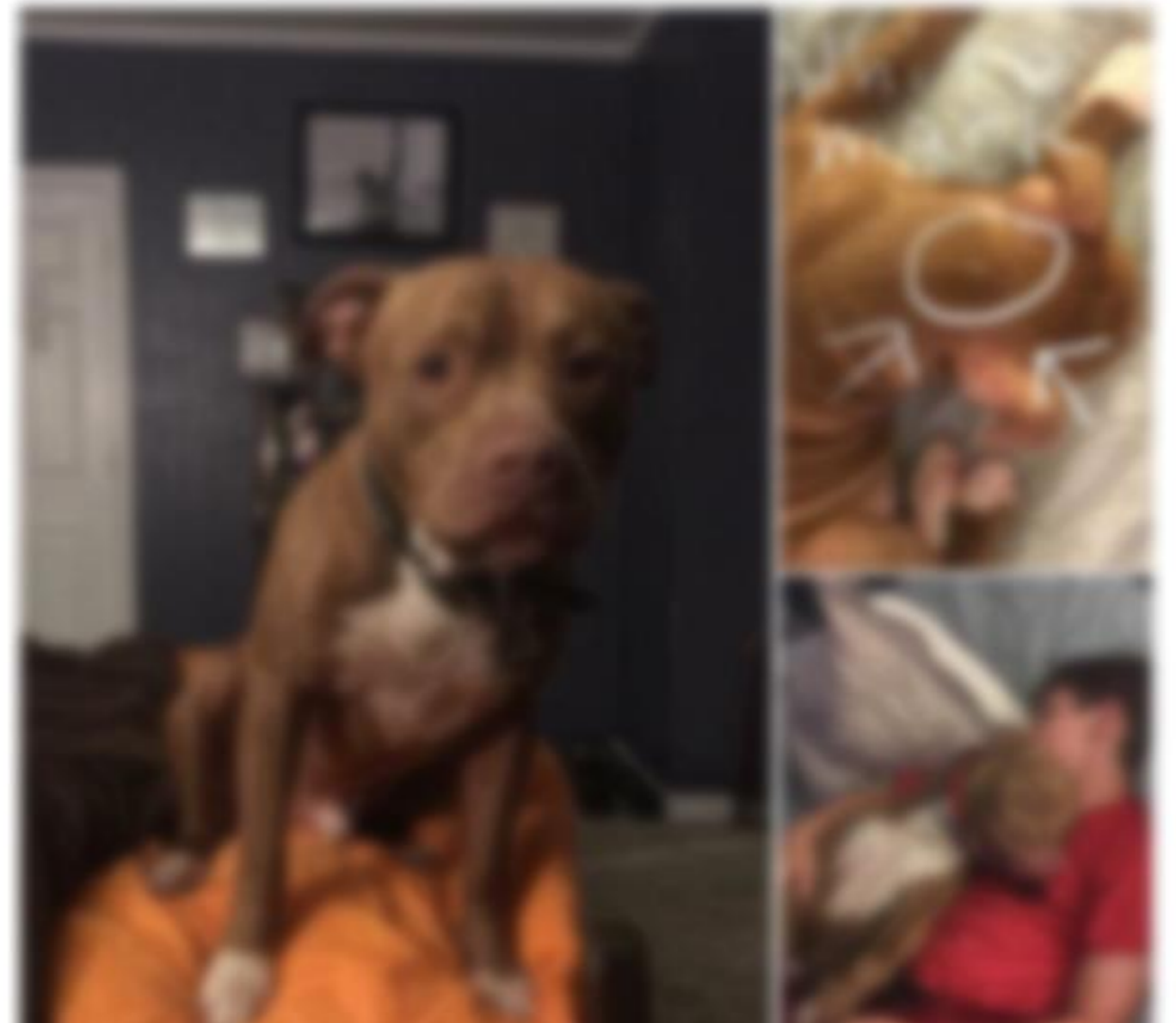
Ad · Page · Group · Event · Fundraiser

Make Post | Photo/Video Album | Live Video

What's on your mind, Robert?

Photo/Video | Feeling/Activity

Ad Schedule...
Missing this dog gets back to his family



News Center

Trending

- James Madison: The Disappearance of James and Isabella's Personal Email Server
- Fredericksburg, Virginia: Mother recovering from copperhead snake bite at Virginia Wildlife
- Anthony Weiner: Anthony Weiner Sentenced to 21 Months in Prison

Watchlist: Latest Episodes

- Episode 1: The Making of a Legend
- Episode 2: The Making of a Legend
- Episode 3: The Making of a Legend

See All

Sponsored

Create Ad




```
graph TD; Spies --> Analysts; Analysts --> Model; Model --> Spies;
```

Spies

Analysts

Model

The stories that show in your News Feed are influenced by:

- friends you interact with the most
- the number of comments and likes a post receives
- what kind of story it is (ex: photo, video, status update)

Source: Facebook

MORE EXAMPLES

- How does US News and World Reports rank colleges?
- How does Google know which results to show?
- How do sports teams know who to draft?
- How does Amazon know what products to recommend?
- How does Zillow estimate home prices?
- How does Pandora know what music to play?
- How does eHarmony know which people to show you?
- How do they figure out who should speak at a conference?

GOALS

HOW DO WE MAKE SENSE OF MATH MODELING?

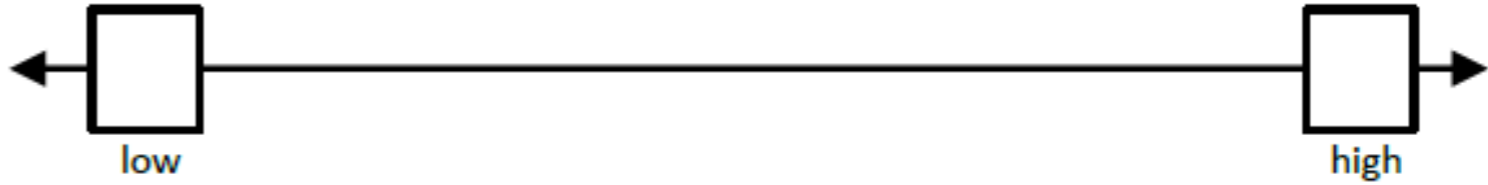
IS IT JUST ANSWERING QUESTIONS?

HOW DO YOU PROFIT FROM MATH MODELING?

HOW DO WE HELP OUR STUDENTS IMPROVE?

WHERE CAN WE FIND MORE RESOURCES?

Name: _____ Period: _____ Date: _____

What problem are you trying to figure out?	What estimates do you have?
	 <p data-bbox="2059 714 2768 752">Place your estimate on the number line.</p>
What info do you already know about the problem?	What info do you need about the problem?
<p data-bbox="736 1001 1685 1365">TOP SECRET!</p>	<p data-bbox="1725 767 2558 1103">SPIES ONLY</p>
What is your conclusion? How did you reach that conclusion?	

Your work

DANGER

**ANALYSTS
AT WORK**



IVE

FOX
NEWS

Junction

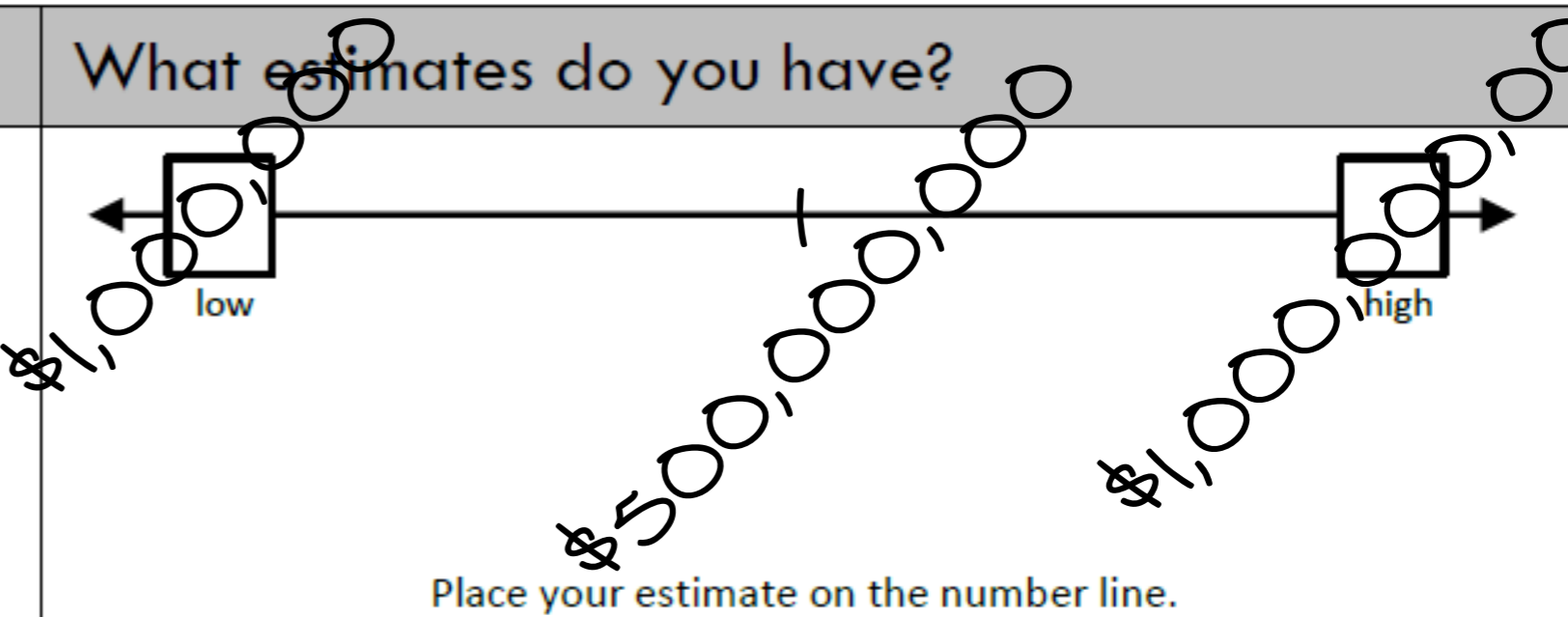

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graph TD; Spies --> Analysts; Analysts --> Model; Model --> Spies;
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Spies

Analysts

Model

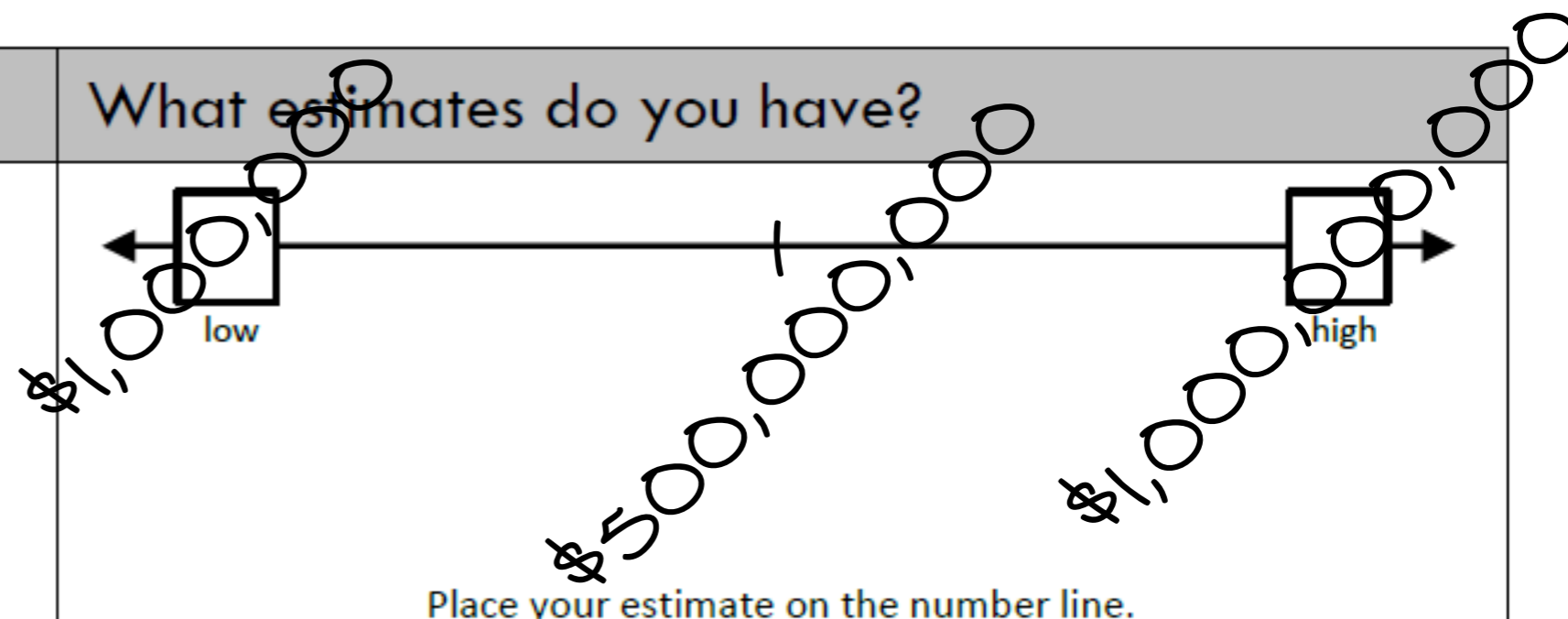
THINKING TIME

What problem are you trying to figure out?	What estimates do you have?
<p>How much money was that?</p>	 <p>Place your estimate on the number line.</p>
What info do you already know about the problem?	What info do you need about the problem?
<ul style="list-style-type: none"> • There is a lot of money. • It is in a pile. • It is in bundles. 	<ul style="list-style-type: none"> • Is it all the same denomination? • How much does one bill weigh? • How much does all the money weigh?
What is your conclusion? How did you reach that conclusion?	

What problem are you trying to figure out?

How much money was that?

What estimates do you have?



What info do you already know about the problem?

- There is a lot of money.
- It is in a pile.
- It is in bundles.

What info do you need about the problem?

- Is it all the same denomination?
- How many rows and columns are there?
- How many bills are in one stack?

What is your conclusion? How did you reach that conclusion?



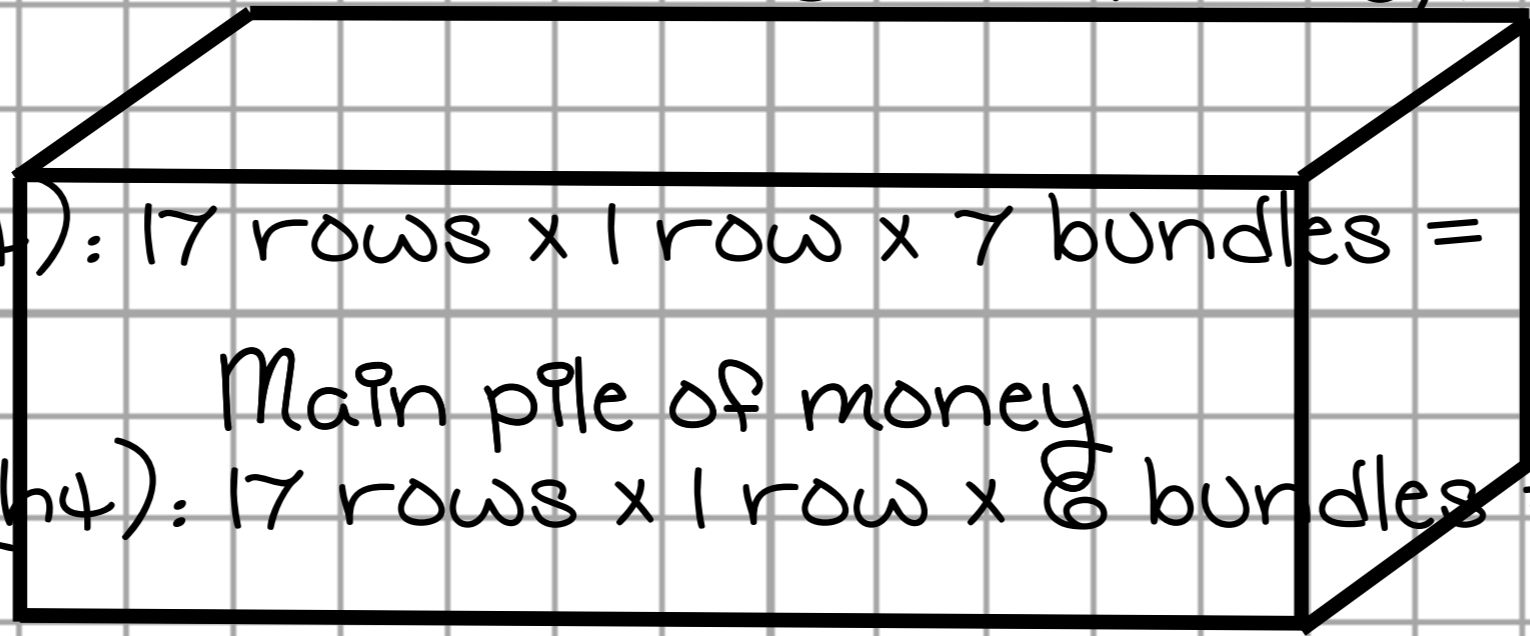


Your work

Main pile: 34 rows x 11 rows ~~rows~~ bundles = 3,740 bundles

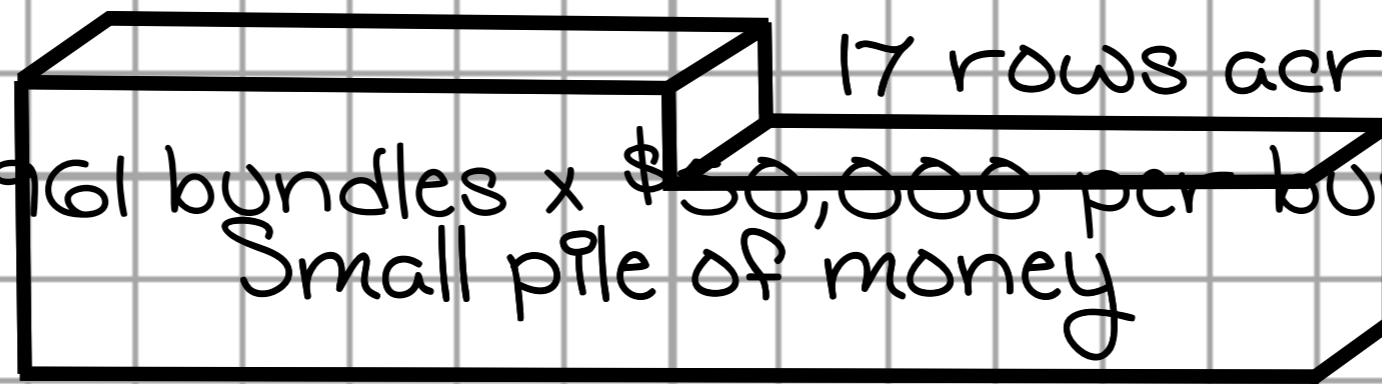
Small pile (left): 17 rows x 1 row x 7 bundles = 19 bundles
10 bundles

Small ^{high} pile (right): 17 rows x 1 row x 8 bundles = 102 bundles
11 rows deep



Total bundles: 3,740 + 19 + 102 = 3,961 bundles
17 rows across

Total money: 3,961 bundles x \$50,000 per bundle = \$198,050,000



8 bundles
high

7 bundles
high

FOX



So you

GOALS

HOW DO WE MAKE SENSE OF MATH MODELING?

IS IT JUST ANSWERING QUESTIONS?

HOW DO YOU PROFIT FROM MATH MODELING?

HOW DO WE HELP OUR STUDENTS IMPROVE?

WHERE CAN WE FIND MORE RESOURCES?

PBL RESOURCES

- Problem-based lesson search engine:
robertkaplinsky.com/prbl-search-engine
- My lessons (Elementary, Middle, and High School)
robertkaplinsky.com/lessons
- Dan Meyer (Middle and High School)
threeacts.mrmeyer.com
- Andrew Stadel (Elementary and Middle School)
www.estimation180.com/lessons.html
- Graham Fletcher (Elementary and Middle School)
gfletchy.com/3-act-lessons

Home

Math resources that create problem solvers, not robots.

Download my favorite lessons for elementary, middle, and high school.

[GET FREE LESSONS](#)[TAKE MY WORKSHOP](#)

What happens next?



Keep coming back for more free lessons and resources.



Learn implementation tips from my blog and weekly emails.



Take my online workshop for more implementation support.

Lessons

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- [1st](#)
- [2nd](#)
- [3rd](#)
- [4th](#)
- [5th](#)
- [6th](#)
- [7th](#)
- [8th](#)
- [Alg.1](#)
- [Geo](#)
- [Alg.2](#)



How Much Money Were Those Pennies?



How Can We #SaveNelly?



How Many Chip Bags Will There Be?



How Can We Make Stronger Passwords?



Search

Get My Emails

Do you like the ideas you're reading? If so, you'll love having the best ones sent to you via email!

First Name

Last Name

Email address

Zip Code (optional)

Job Role(s)

- Elementary School
- Middle School
- High School
- Higher Education

Resources

Depth of Knowledge

- [Open Middle](#)
- [Open Middle Worksheet - English \(student version\)](#)
- [Open Middle Worksheet - English \(document camera version\)](#)
- [Open Middle Worksheet - Spanish \(student version\)](#)
- [Open Middle Worksheet - Spanish \(document camera version\)](#)
- [Robert's blog posts on Depth of Knowledge](#)
- [Tool to Distinguish Between Depth of Knowledge Levels](#)

Problem-Based Lesson Tools

- [Problem-Based Lesson Search Engine](#)
- [Problem Solving Framework v8.1](#)
- [Robert's blog posts on Problem-Based Learning](#)

Problem-Based Lesson Sources

- [101 Questions](#)
- [Andrew Gael](#)
- [Andrew Stadel](#)
- [Catherine Castillo](#)
- [Christina Tondevold](#)
- [Dan Meyer](#)
- [Dane Ehlert](#)
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	A	B	C	D	E	F	G	H	I
1	Lesson	Concept / Skill	Standard 1	Standard 2	Standard 3	Standard 4	Standard 5	Standard 6	Standard 7
2	How Much Money Were Those Pennies?	Money, Multiplying Decimals, Proportions	4.MD.2	5.NBT.5	5.NBT.7	7.RP.3			
3	How Can We #SaveNelly?	Dividing Decimals	6.NS.3						
4	How Many Chip Bags Will There Be?	Ratio and Proportions, Population Sampling	6.RP.3	6.RP.3c	7.RP.2	7.RP.3	7.SP.1	7.SP.2	
5	How Can We Make Stronger Passwords?	Permutations, Combinations, Probability, Exponents, Exponential Growth	7.SP.8	8.EE.1	S-MD.7	S-CP.5	S-CP.9		
6	How Many Hot Dogs And Buns Should He Buy?	Least Common Multiple (LCM)	6.NS.4						
7	What Does 2000 Calories Look Like?	Unit Rates, Ratios, Solving Equations, and Solving Inequalities	6.EE.3	6.EE.4	6.EE.5	6.EE.6	6.EE.7	6.EE.8	6.RP.2
8	How Much Money Are The Coins Worth?	Decimal Operations and Coin Counting	2.MD.8	5.NBT.7	6.NS.3				
9	How Many Times Will A Case of Paper Jam?	Interpreting Percentages	6.RP.3c	7.RP.3					
10	How Many Soda Combinations Are There On A Coke Freestyle?	Counting, Composing, and Decomposing Numbers	K.CC.5	K.CC.6	K.OA.1	K.OA.2	K.OA.3	K.OA.4	K.NB.1
11	What Should The Freeway Sign Show?	Fractions on Number Lines, Converting Units, Decimal and Fraction Operations	3.NF.1	3.NF.2	3.NF.2a	3.NF.2b	3.NF.3	3.NF.3a	4.MD.1
12	How Fast Was The Fastest Motorcycle Speeding Ticket Ever?	Converting Units and Unit Rates	5.MD.1	6.RP.3d	7.RP.1	N.Q.1			
13	How Much Did Patrick Peterson Lose By Not Cashing His Check?	Compound and/or Simple Interest	7.RP.3	N-RN.2	A-SSE.1	A-SSE.3c	A-SSE.4	A-REI.11	F-IF.4
14	How Many Biscuits Can You Make?	Dividing Fractions and Mixed Numbers	5.NF.7	5.NF.7a	5.NF.7b	5.NF.7c	6.NS.1		
15	How Much Bigger Should They Make Zoolander's School?	Scale and Proportions	5.NF.5A	7.RP.2	7.G.1				
16	Where Is The Freeway Sign Located?	Identifying Fractions on a Number Line	3.NF.1	3.NF.2	3.NF.2a	3.NF.2b	3.NF.3	3.NF.3a	3.NF.3b
17	How Far Apart Are Exits On A Ring Road?	Arc length measures	G-C.5						
18	How Much Is One Third Of A Cup Of Butter?	Identifying Fractions on a Number Line	3.NF.1	3.NF.2	3.NF.2a	3.NF.2b	3.NF.3	3.NF.3a	3.NF.3b
19	How Do Skytypers Write Messages?	Transformations (Rotations, Reflections, Dilations, and Translations)	8.G.1	8.G.2	8.G.3	8.G.4	G-CO.2	G-CO.3	G-CO.4
20	How Big Is The Bermuda Triangle?	Coordinate Geometry: Area of Triangle	G-GPE.7						
21	What Fraction Of Children Are In The Right Car Seat?	Representing and Comparing Fractions	3.NF.1	3.NF.2	3.NF.3	4.NF.1	4.NF.2		
22	How Much Did The Temperature Drop?	Absolute Value	6.NS.7c	7.NS.1c					
23	How Much Shorter Are Staggered Pipe Stacks?	Circles, Pythagorean Theorem, trigonometric ratios, and linear functions	8.G.7	A-CED.1	A-CED.3	A-CED.4	A-SSE.1a	A-SSE.1b	A-SSE.1c
24	How Do You Write A Check To Pay For Something?	Expanded Form	2.NBT.3	4.NBT.2	5.NBT.3a				
25	How Can We Correct The Scarecrow?	Pythagorean Theorem	8.G.6	G-SRT.4					
26	How Much Does A 100x100 In-N-Out Cheeseburger Cost?	Building and Interpreting Linear Functions	8.F.1	8.F.3	8.F.4	8.F.5	F-IF.4	F-IF.5	F-IF.6
27	How Can We Water All Of The Grass?	Circles, Pythagorean Theorem, trigonometric ratios	7.G.4	8.G.7	G-SRT.8	G-MG.1	G-MG.3		
28	How Much Money IS That?!	Volume of rectangular prism	5.MD.3	5.MD.4	5.MD.5	5.MD.5b	5.MD.5c	6.G.2	7.G.6
29	How Much Money Should Dr. Evil Demand?	Exponential Growth	N-RN.2	A-SSE.1	A-SSE.3c	A-SSE.4	A-REI.11	F-IF.4	F-IF.7
30	How Tall Is Mini-Me?	Scale and Dividing Decimals	5.NF.5	5.NF.5a	5.NF.5b	6.NS.3			
31	How Did They Make Ms. Pac-Man?	Transformations (Rotations, Reflections, and Translations)	8.G.1	8.G.2	8.G.3	8.G.4	G-SRT.2	G-CO.4	G-CO.5
32	Which Ticket Option Is The Best Deal?	Unit Rates and Ratios	6.RP.2	6.RP.3	6.RP.3a	6.RP.3b			
33	How Far Apart Are The Freeway Exits?	Fractions on a Number Line and Subtracting Fractions	3.NF.2	3.NF.2b	4.NF.2	4.NF.3a	4.NF.3c	4.NF.3d	5.NF.1
34	Do We Have Enough Paint?	Area	3.MD.5	3.MD.6	3.MD.7				

GOALS

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