

TRENDS OBSERVED IN PLUG-IN ELECTRIC VEHICLE INFRASTRUCTURE DEMONSTRATIONS

John Smart, Idaho National Laboratory

SAE Government/Industry Meeting

January 23, 2014

Washington, DC



U.S. DEPARTMENT OF
ENERGY

Idaho National Laboratory

U.S. Department of Energy (DOE) federal laboratory

890 square mile site with 4,000 staff

Support DOE's strategic goal

- Increase U.S. energy security and reduce the nation's dependence on foreign oil

Multi-program DOE laboratory

- Nuclear Energy
- Fossil, Biomass, Wind, Geothermal and Hydropower Energy
- Advanced Vehicles and Battery Development
- Homeland Security and Cyber Security



Electric Vehicle Charging Infrastructure Demonstrations

The EV Project

Purpose is to build mature EV charging infrastructure in 17 US regions and study:

- Infrastructure deployment process
- Customer driving and charging behavior
- Impact on electric grid

12,000+ AC level 2 charging units, 100+ DC fast chargers

8,000+ Electric drive vehicles

INL data collection Jan 2011 – Dec 2013

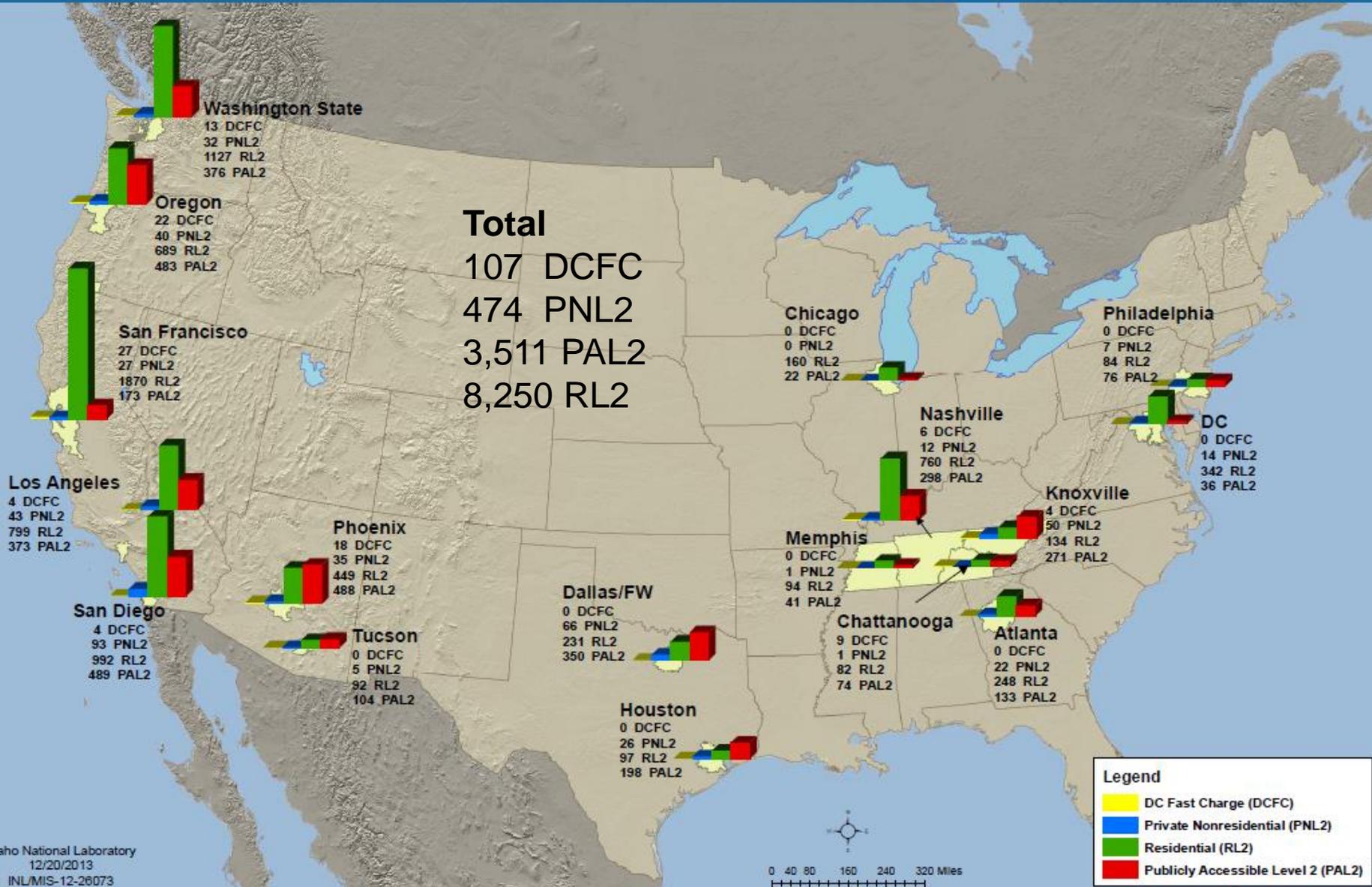
Project partners



blink

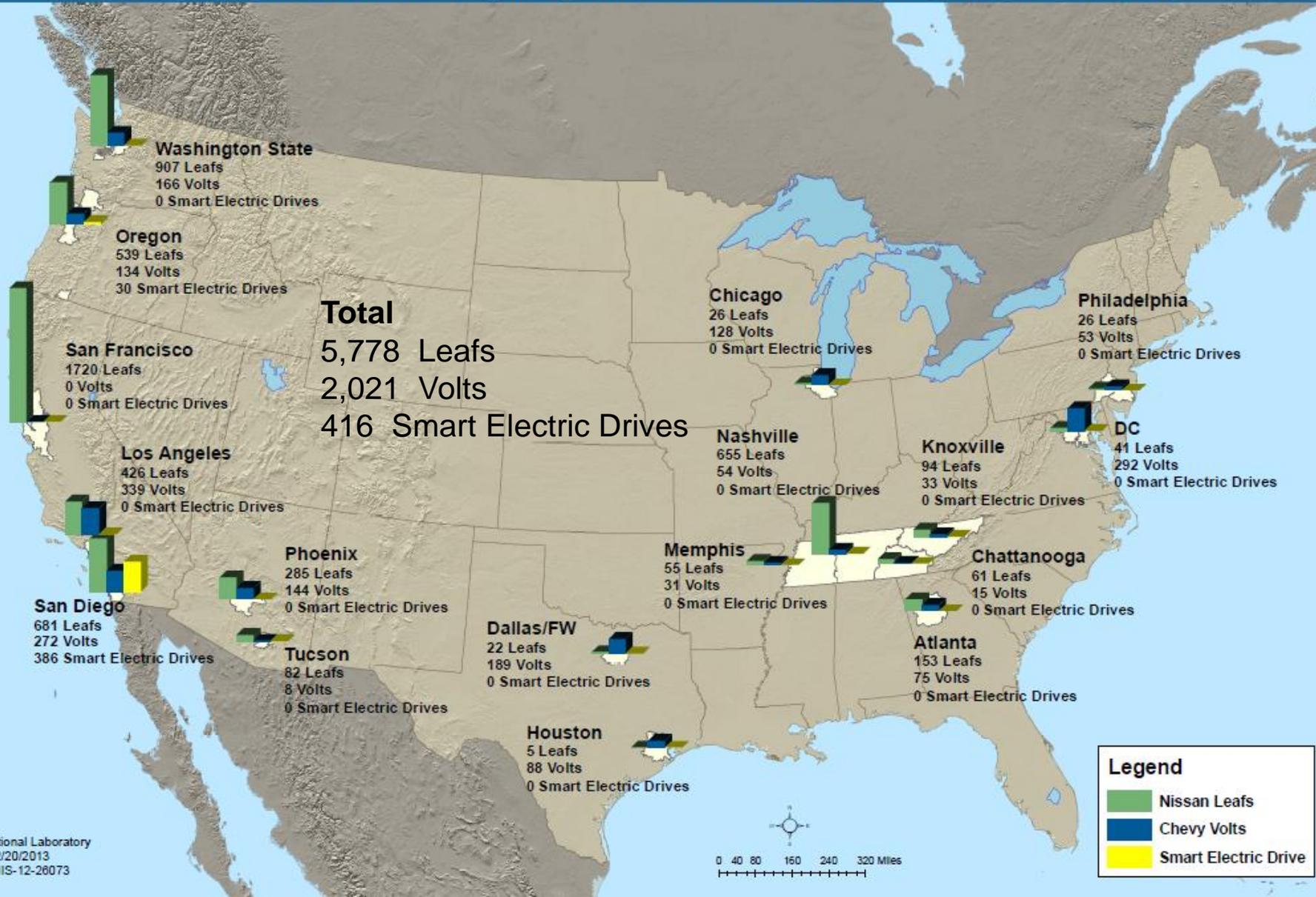
Infrastructure Deployment in The EV Project

Blink Charging Units Reporting Data in The EV Project through September 2013



Vehicle Enrollment in The EV Project

Nissan Leafs and Chevrolet Volts Reporting Data in The EV Project through September 2013



ChargePoint America

Deploy 4,600+ residential and public AC level 2 charging units in 11 US regions

Study customer usage of residential and public infrastructure

INL data collection May 2011 – Dec 2013

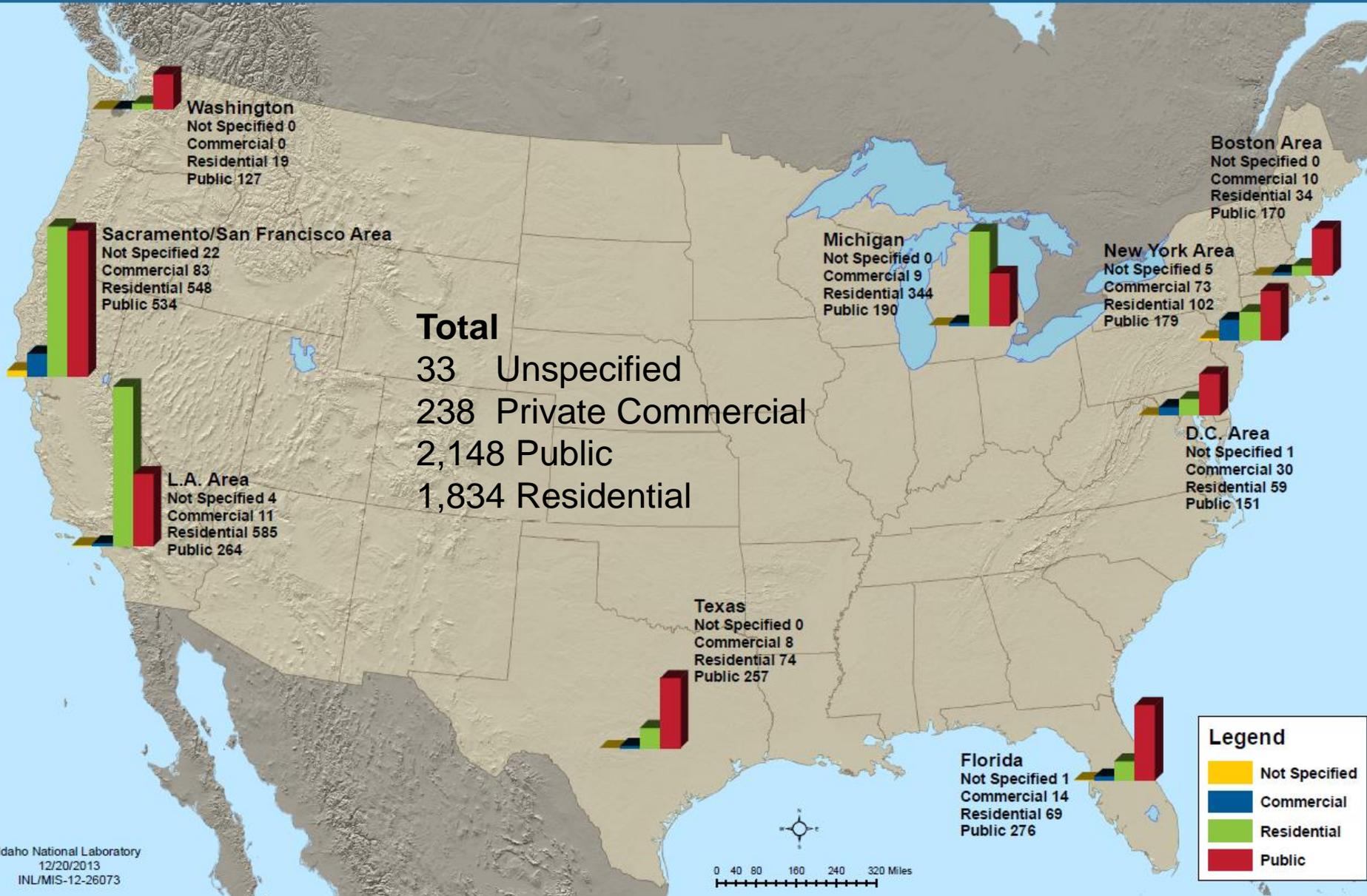
Project Partners



Infrastructure Deployment in ChargePoint America

(all units are AC level 2)

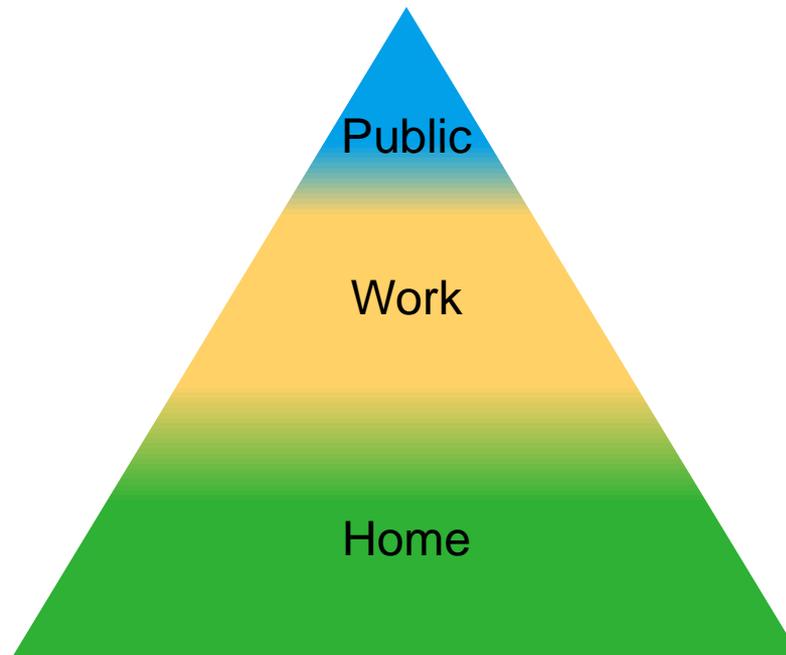
ChargePoint America Charging Units By Type - Through September 2013



Observations and Trends with EV Charging Infrastructure

Conventional wisdom

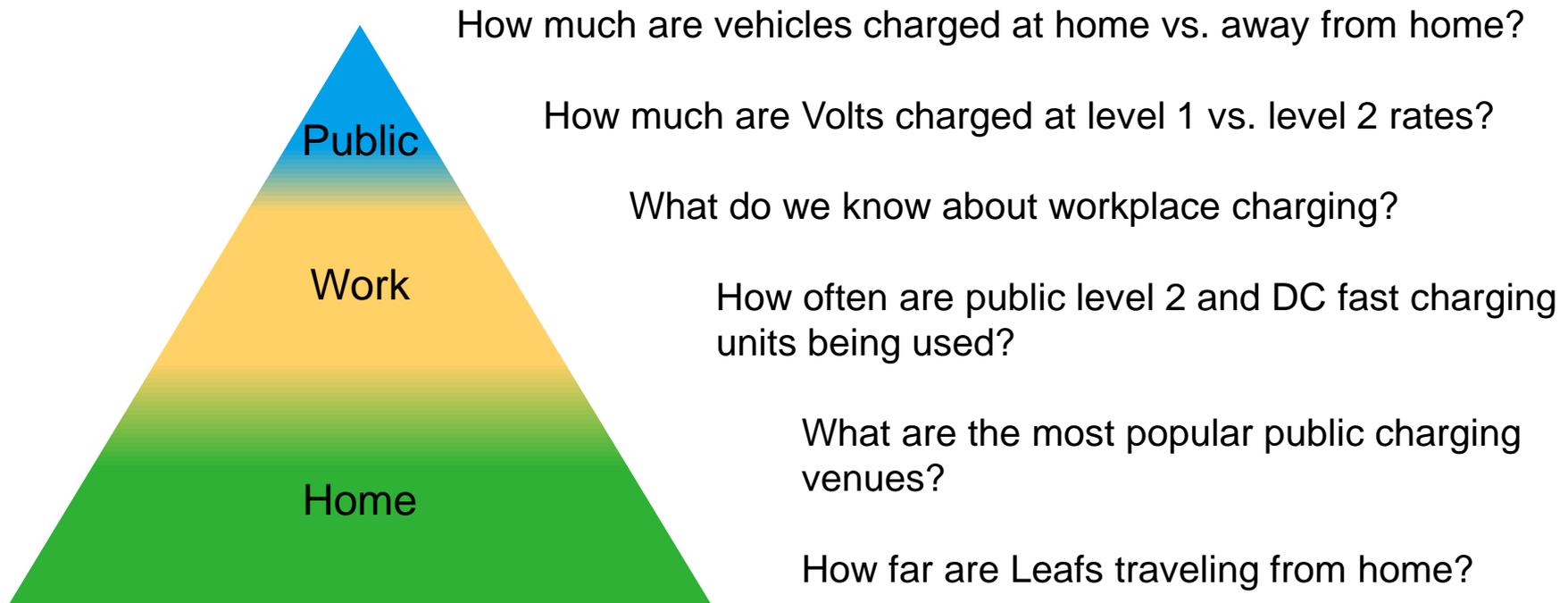
People spend most of their time at home and work, so most charging will be done there.



Observations and Trends with EV Charging Infrastructure

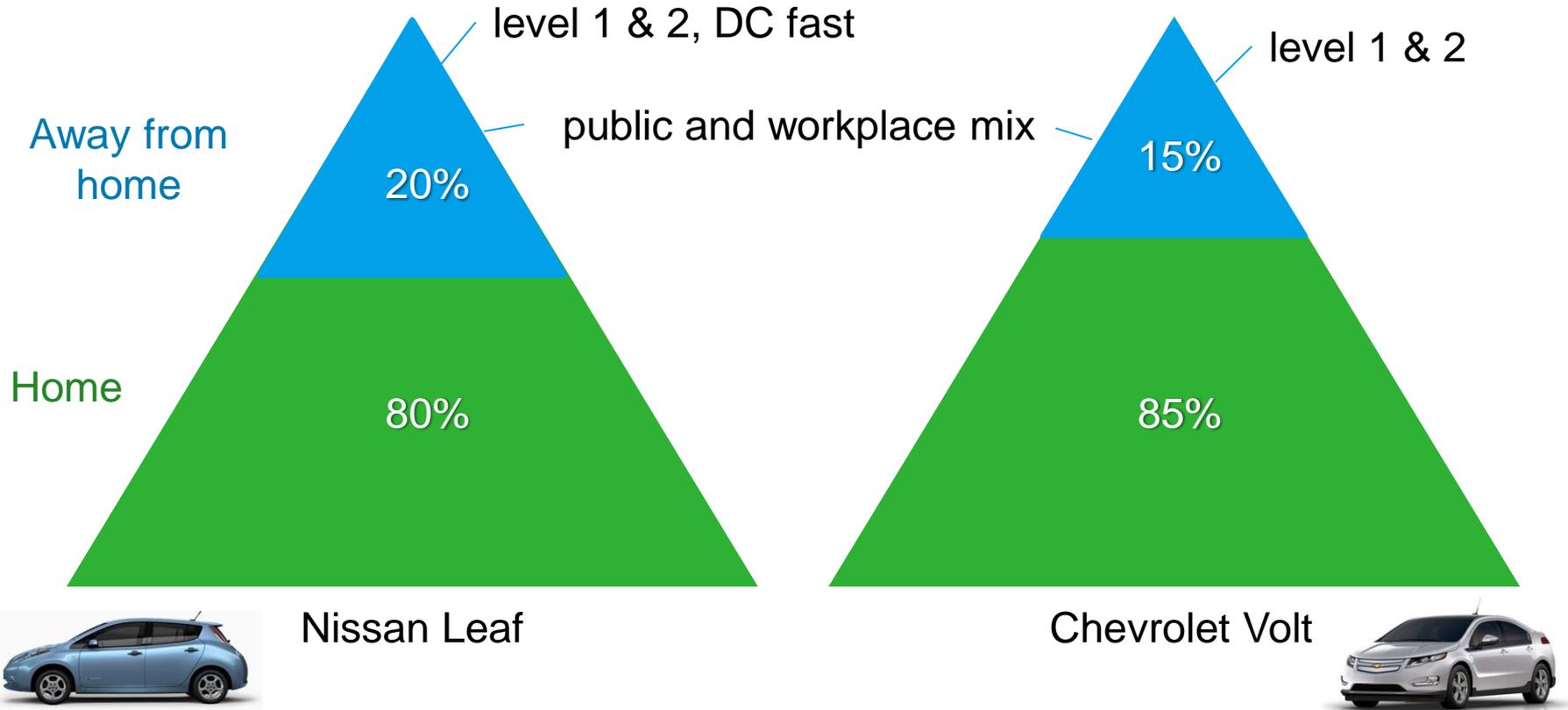
This presentation

Provides some insights from these infrastructure demos on actual charging behavior



Charging Location Frequency

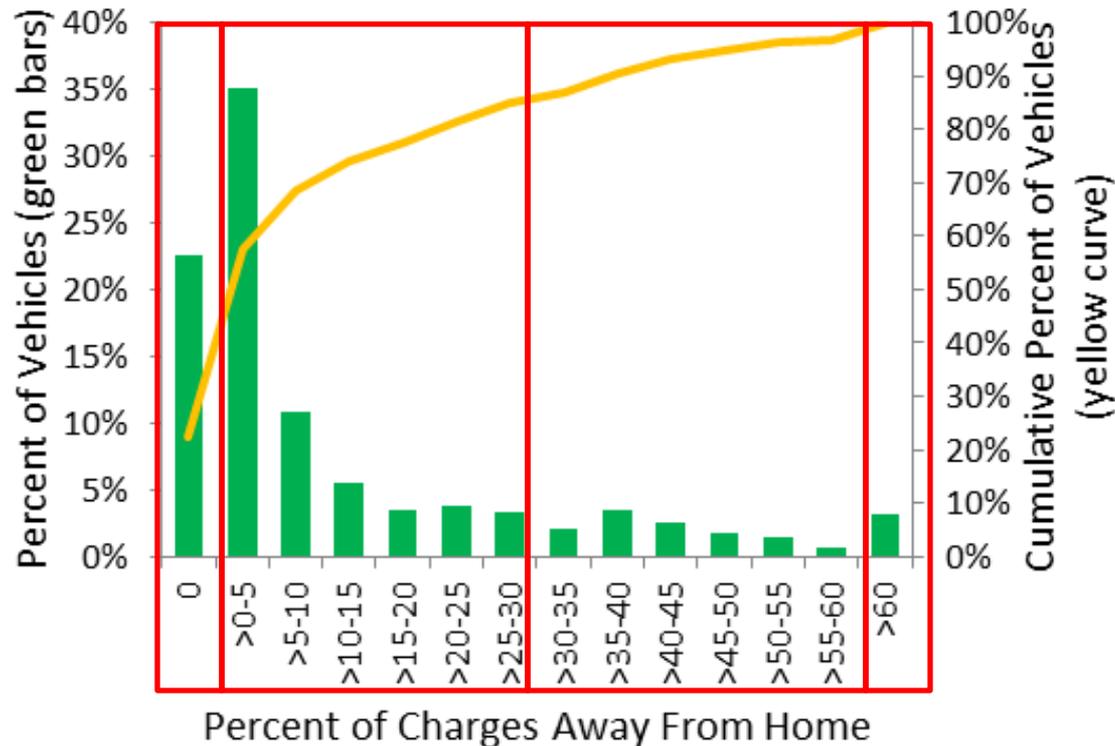
Actual vehicle charging locations between Jul 2013 – Sep 2013 in The EV Project



Based on 256,288 charging events from 4,036 Leafs and 179,681 charging events from 1,812 Volts in Q3 2013
Additional 15,099 Leaf and 11,579 Volt charging events occurred at unknown locations

Away-from-home Charging Frequency for Volts in The EV Project

Charging data from 1,405 Volts in 18 regions from Oct 2012 – May 2013



Effect of Away-from-home Charging for Volts in The EV Project

Charging data from 1,405 Volts in 18 regions from Oct 2012 – May 2013

% of Charging Away from Home:	0%
Vehicles (% of total)	259 (22%)
Home Charges Per Day	1.2
Away-from-home Charges Per Day	--
Home SOC Increase Per Charge	55.9
Away-from-home SOC Increase Per Charge	--
Average Miles Per Day Driven	34.6
Percent of Miles Driven in EV Mode	72%
Average EV Miles Per Day Driven	25.0

Effect of Away-from-home Charging for Volts in The EV Project

Charging data from 1,405 Volts in 18 regions from Oct 2012 – May 2013

% of Charging Away from Home:	0%	>0 - 30%
Vehicles (% of total)	259 (22%)	719 (62%)
Home Charges Per Day	1.2	1.3
Away-from-home Charges Per Day	--	0.1
Home SOC Increase Per Charge	55.9	54.7
Away-from-home SOC Increase Per Charge	--	45.3
Average Miles Per Day Driven	34.6	39.2
Percent of Miles Driven in EV Mode	72%	73%
Average EV Miles Per Day Driven	25.0	28.4

This group supplemented home charging with a little away-from-home charging

This group drove a little more each day

Additional charging provided energy for more EV miles per day

Effect of Away-from-home Charging for Volts in The EV Project

Charging data from 1,405 Volts in 18 regions from Oct 2012 – May 2013

% of Charging Away from Home:	0%	>0 - 30%	>30 -60%
Vehicles (% of total)	259 (22%)	719 (62%)	140 (12%)
Home Charges Per Day	1.2	1.3	1.1
Away-from-home Charges Per Day	--	0.1	0.8
Home SOC Increase Per Charge	55.9	54.7	60.5
Away-from-home SOC Increase Per Charge	--	45.3	48.3
Average Miles Per Day Driven	34.6	39.2	50.9
Percent of Miles Driven in EV Mode	72%	73%	75%
Average EV Miles Per Day Driven	25.0	28.4	38.3

Compared to vehicles with no away-from home charging...

This group supplemented home charging with a lot of away-from-home charging

This group drove a lot more each day

Additional charging provided energy for many more EV miles per day (53% increase)

Effect of Away-from-home Charging for Volts in The EV Project

Charging data from 1,405 Volts in 18 regions from Oct 2012 – May 2013

% of Charging Away from Home:	0%	>0 - 30%	>30 -60%	>60%
Vehicles (% of total)	259 (22%)	719 (62%)	140 (12%)	36 (3%)
Home Charges Per Day	1.2	1.3	1.1	0.3
Away-from-home Charges Per Day	--	0.1	0.8	1.2
Home SOC Increase Per Charge	55.9	54.7	60.5	48.5
Away-from-home SOC Increase Per Charge	--	45.3	48.3	52.7
Average Miles Per Day Driven	34.6	39.2	50.9	38.4
Percent of Miles Driven in EV Mode	72%	73%	75%	73%
Average EV Miles Per Day Driven	25.0	28.4	38.3	28.0

Compared to vehicles with no away-from home charging...

This group supplemented away-from-home charging with some home charging

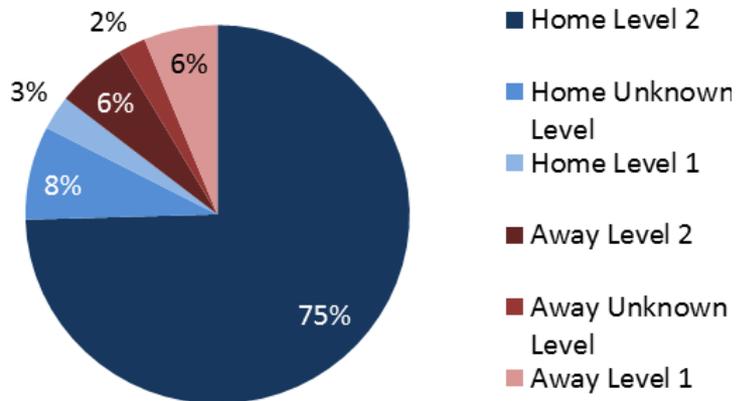
This group drove a little more each day

Additional charging provided energy for a little more EV miles per day

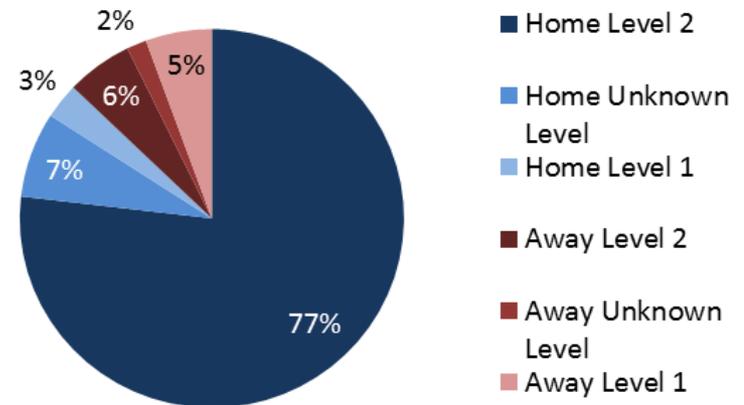
Charging Location and Power Level for Volts in The EV Project

Charging data from 1,405 Volts in 18 regions from Oct 2012 – May 2013

Charging Events by Location and Power Level



Charging Energy by Location and Power Level



- About 50/50 level 1 vs. level 2 split when charging away from home
- Energy per event is about equal for level 1 and level 2, even though level 1 charge rate is half as fast

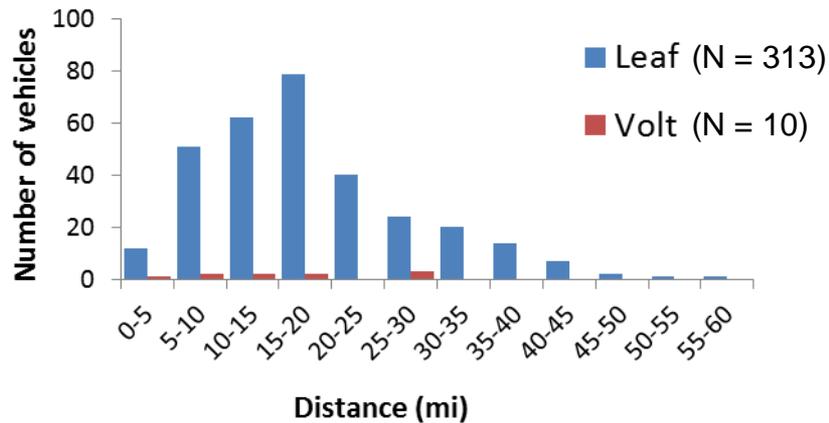
Workplace Charging Case Studies

Worksites identified where EV Project participant vehicles have parked and charged a significant number of times (excluding fleet vehicles)

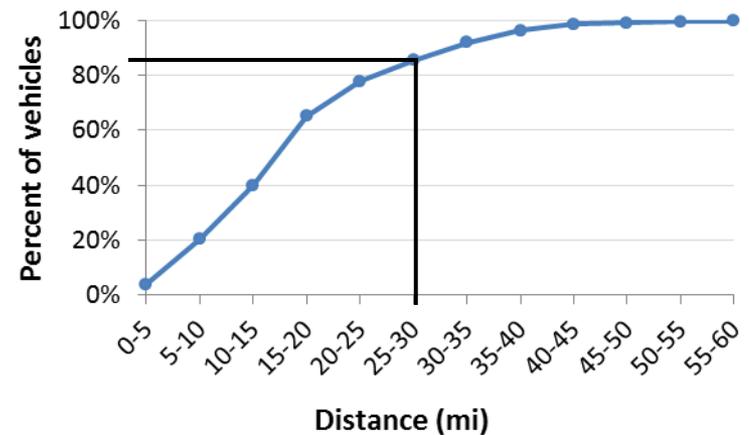
Region	Number of work sites	Charging locations per site	Types of companies
Knoxville, TN	2	1, 4	
Nashville, TN	6	1 - 6	Offices, manufacturing plants, and R&D facilities of companies in computer, telecom, pharmaceutical, biotech, automotive, aerospace, and other industries
Portland, OR	2	1, 4	
Phoenix, AZ	1	5	
San Diego, CA	11	1 - 15	
San Francisco, CA	51	1 - 10	
Total	73		

Workplace Charging Case Studies – Commuting Distance

Distributions of Average One-way Commuting Distance

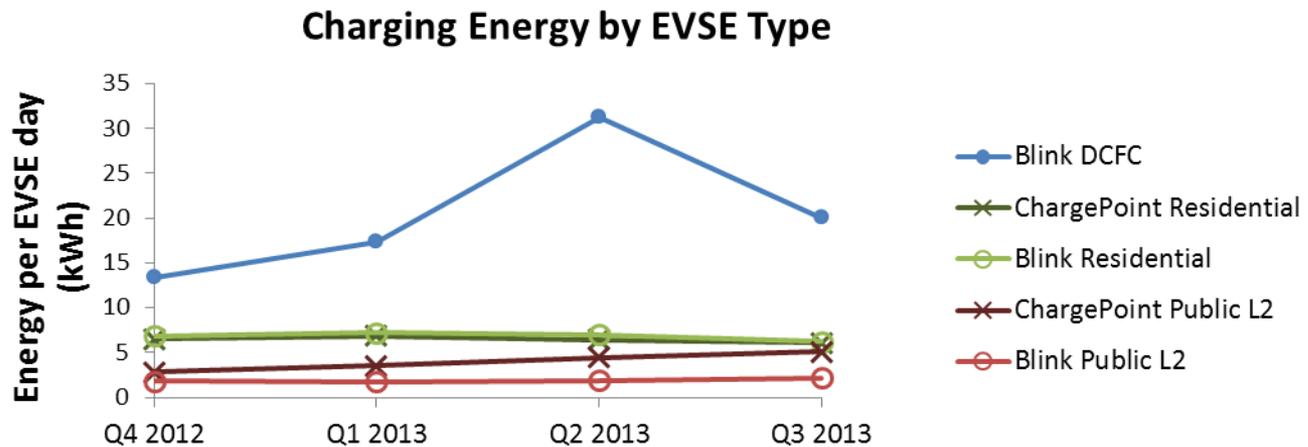
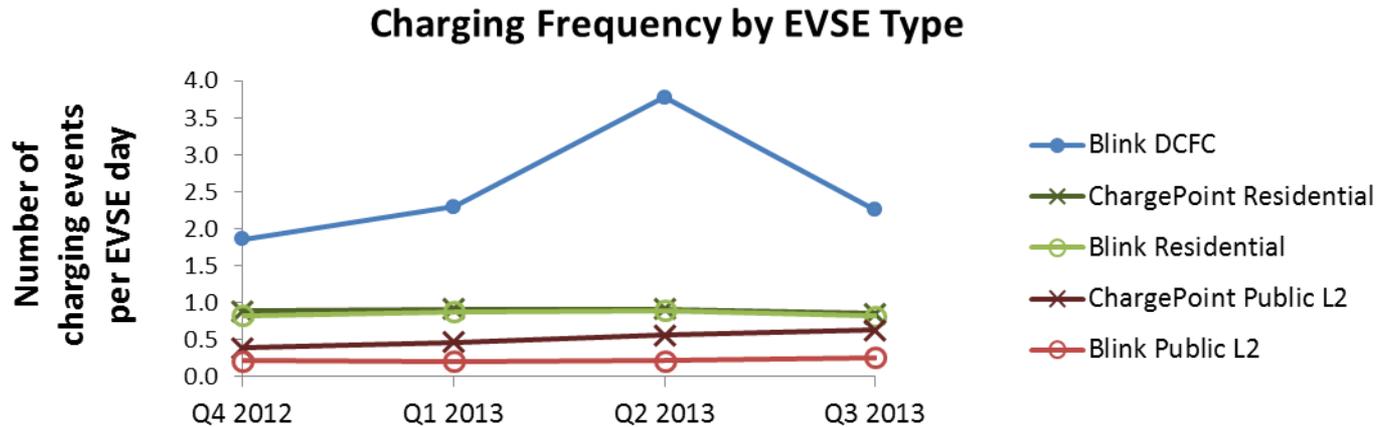


Leaf Cumulative Distribution of Average One-way Commuting Distance



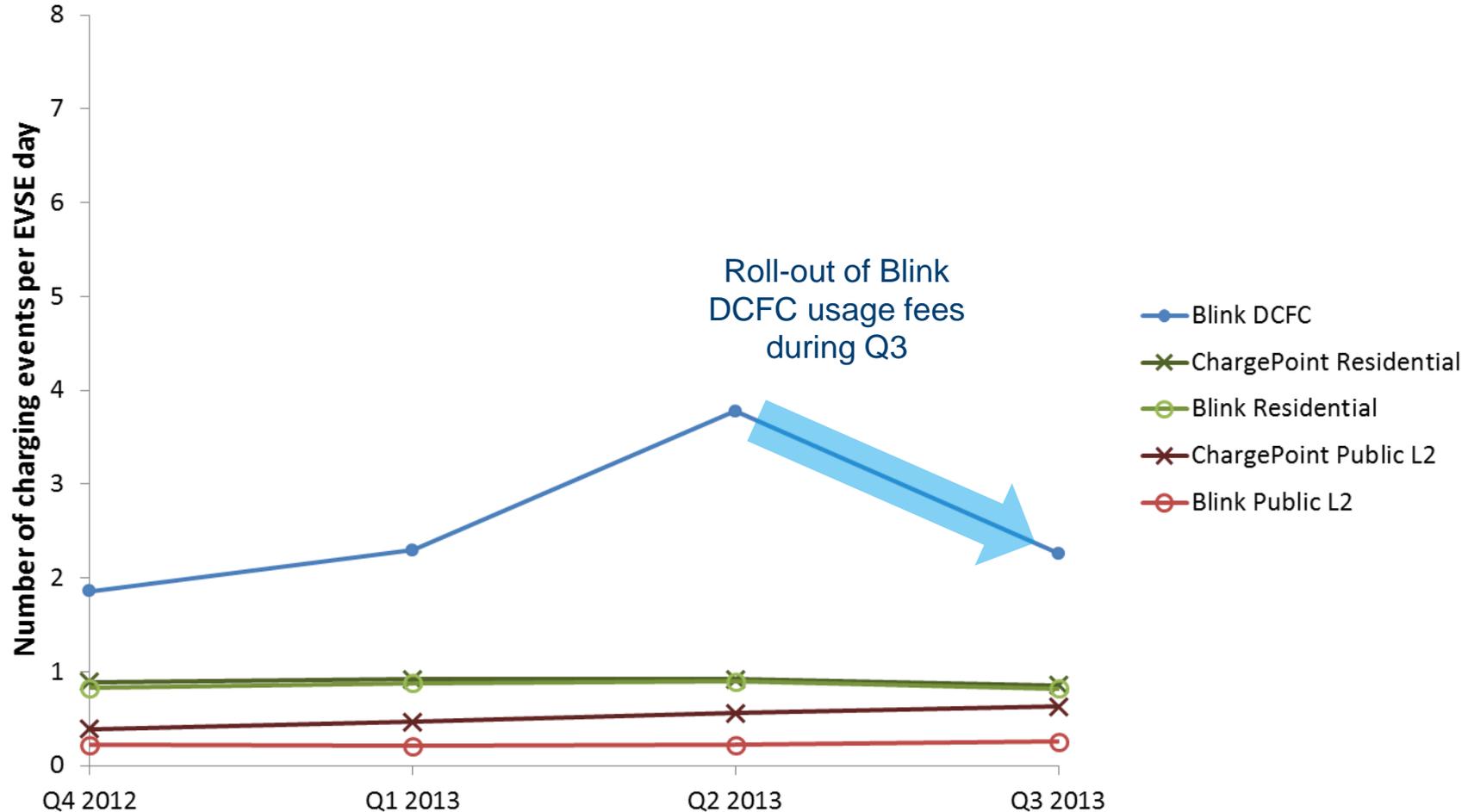
86% of EV Project Leafs parking at worksites identified average 30 miles or less between home and work

Usage Frequency of AC Level 2 EVSE and DC Fast Chargers



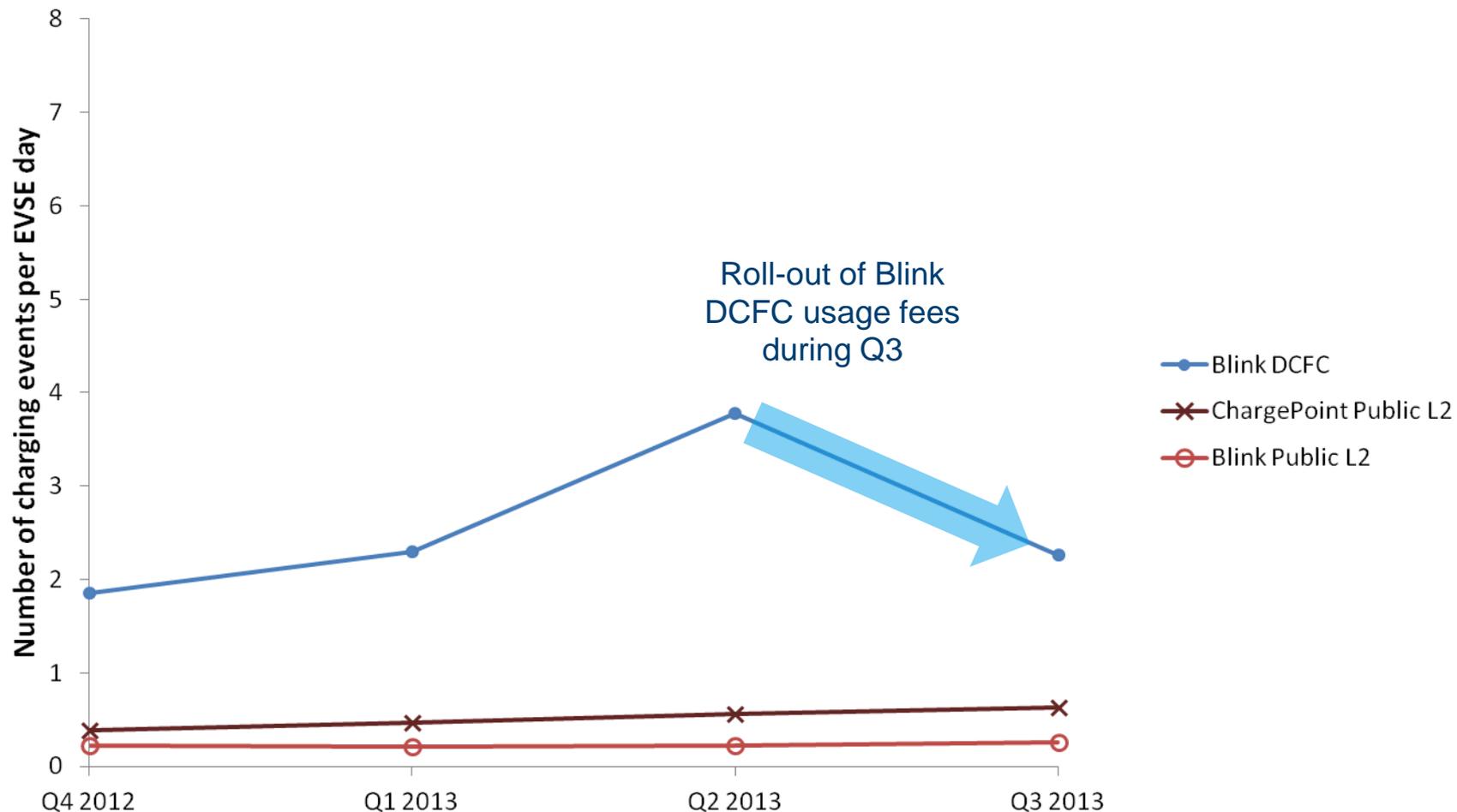
Usage Frequency of AC Level 2 EVSE and DC Fast Chargers

Charging Frequency by EVSE Type

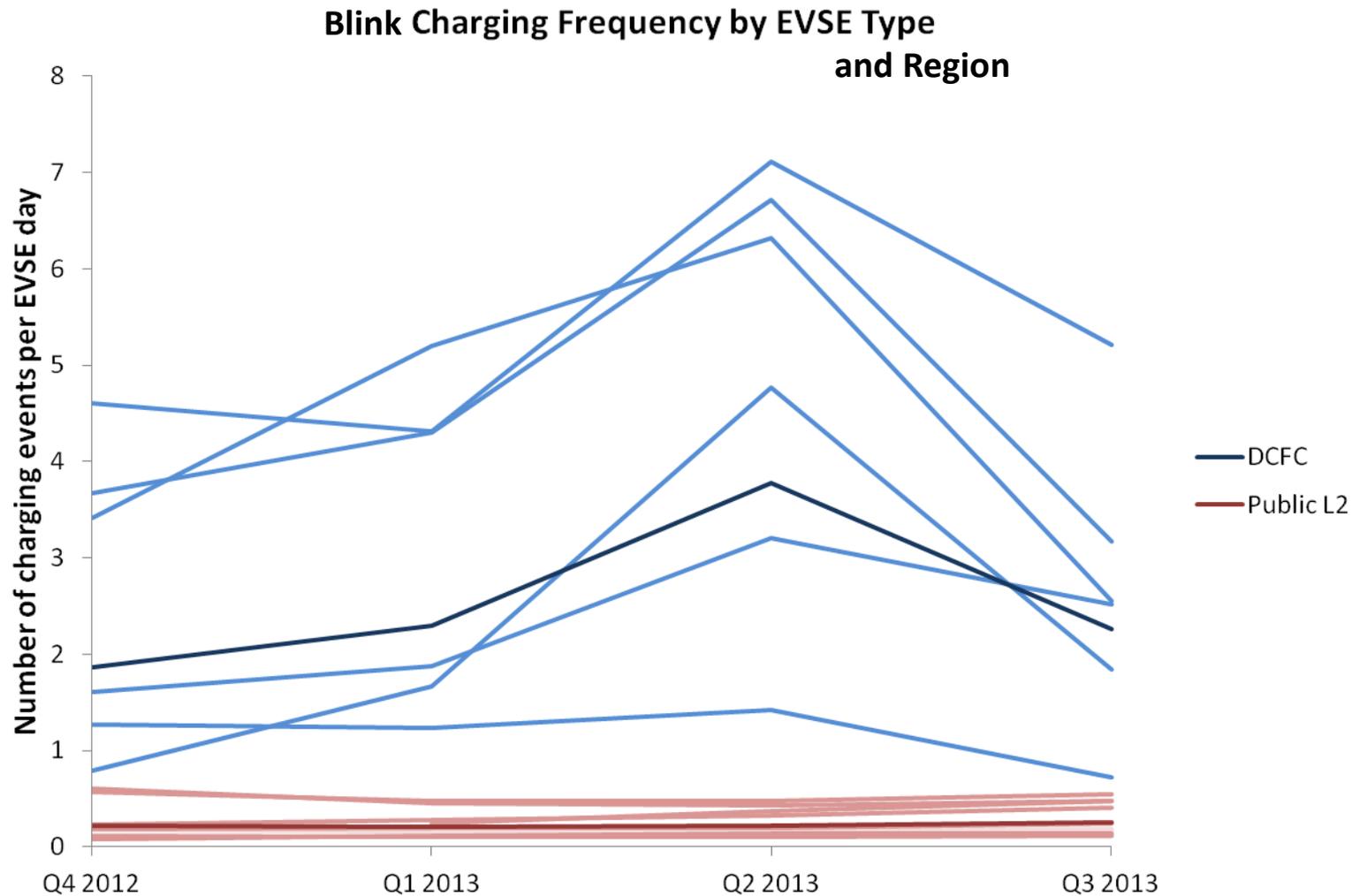


Usage Frequency of Public Level 2 EVSE and DC Fast Chargers

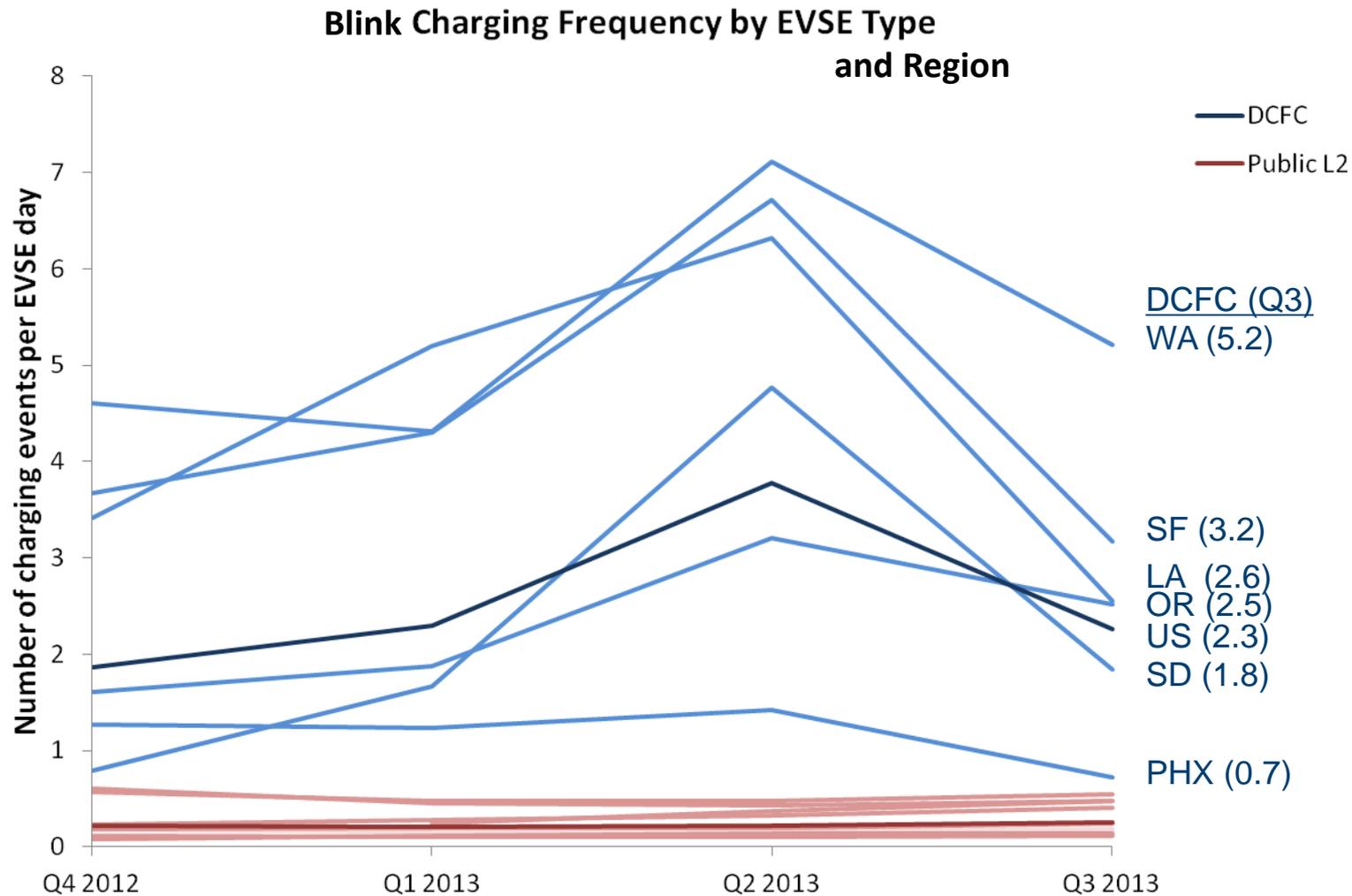
Charging Frequency by EVSE Type



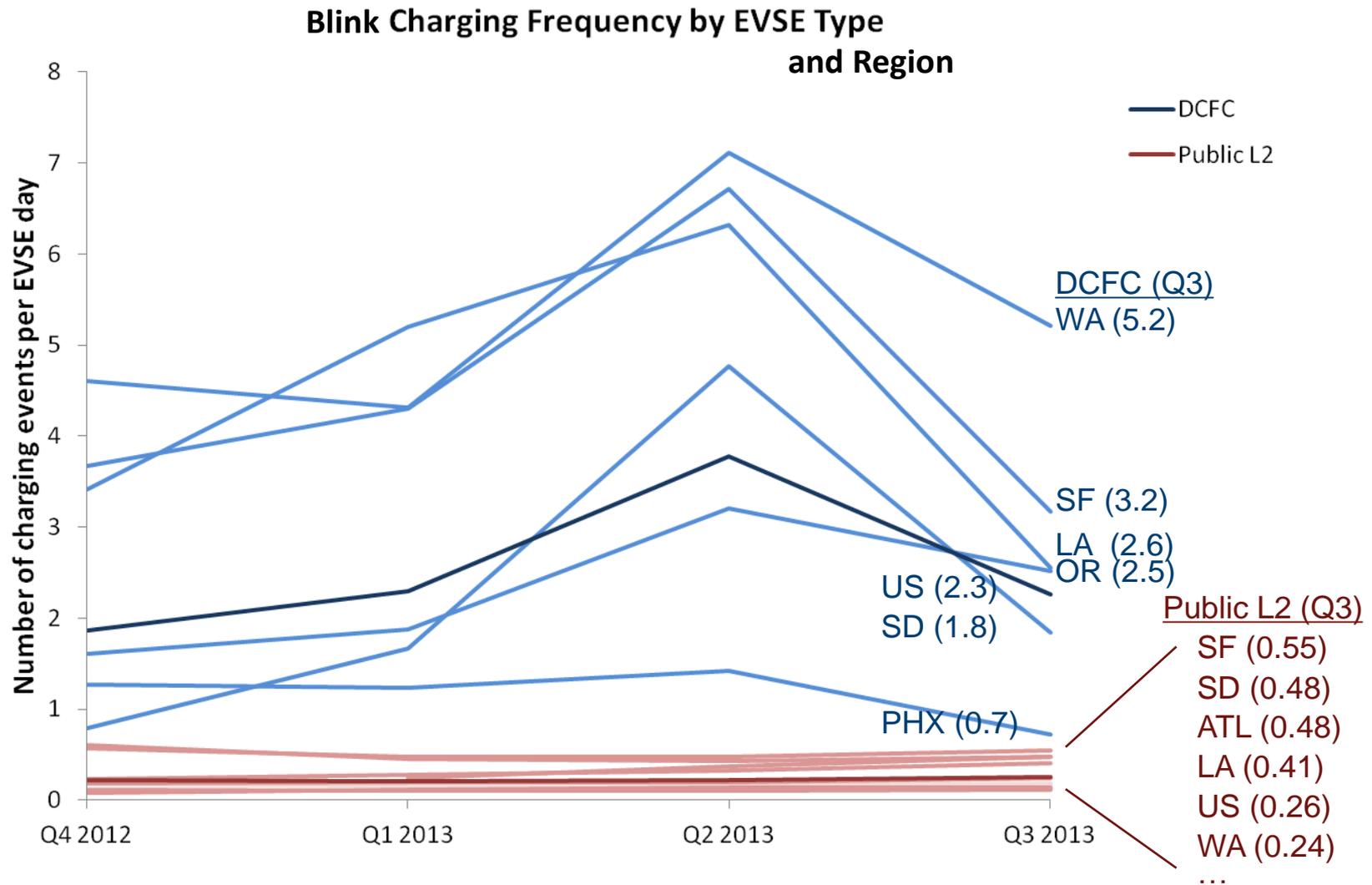
Usage Frequency of Public Level 2 EVSE and DC Fast Chargers



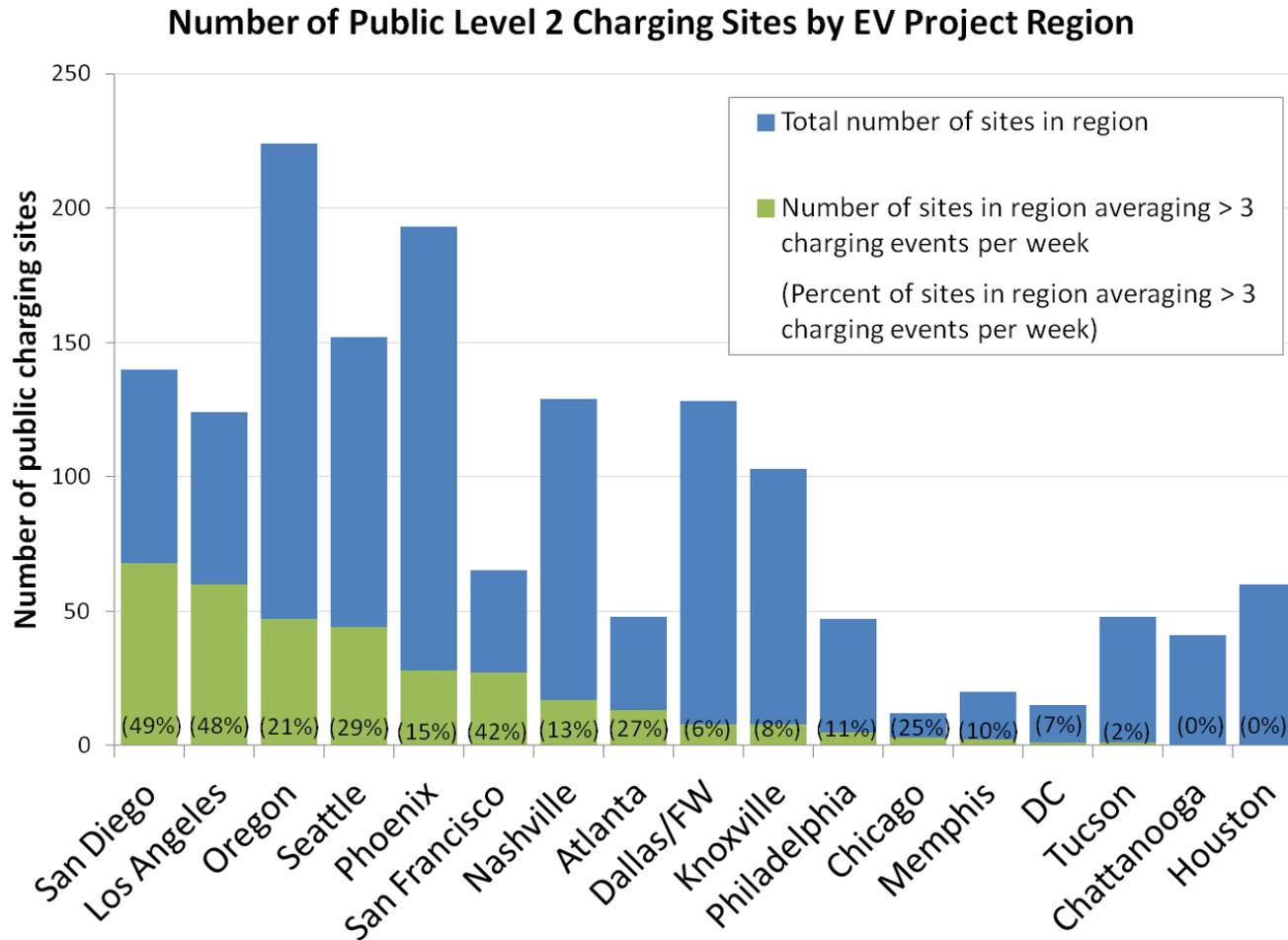
Usage Frequency of Public Level 2 EVSE and DC Fast Chargers



Usage Frequency of Public Level 2 EVSE and DC Fast Chargers



Where are the most popular public charging venues?

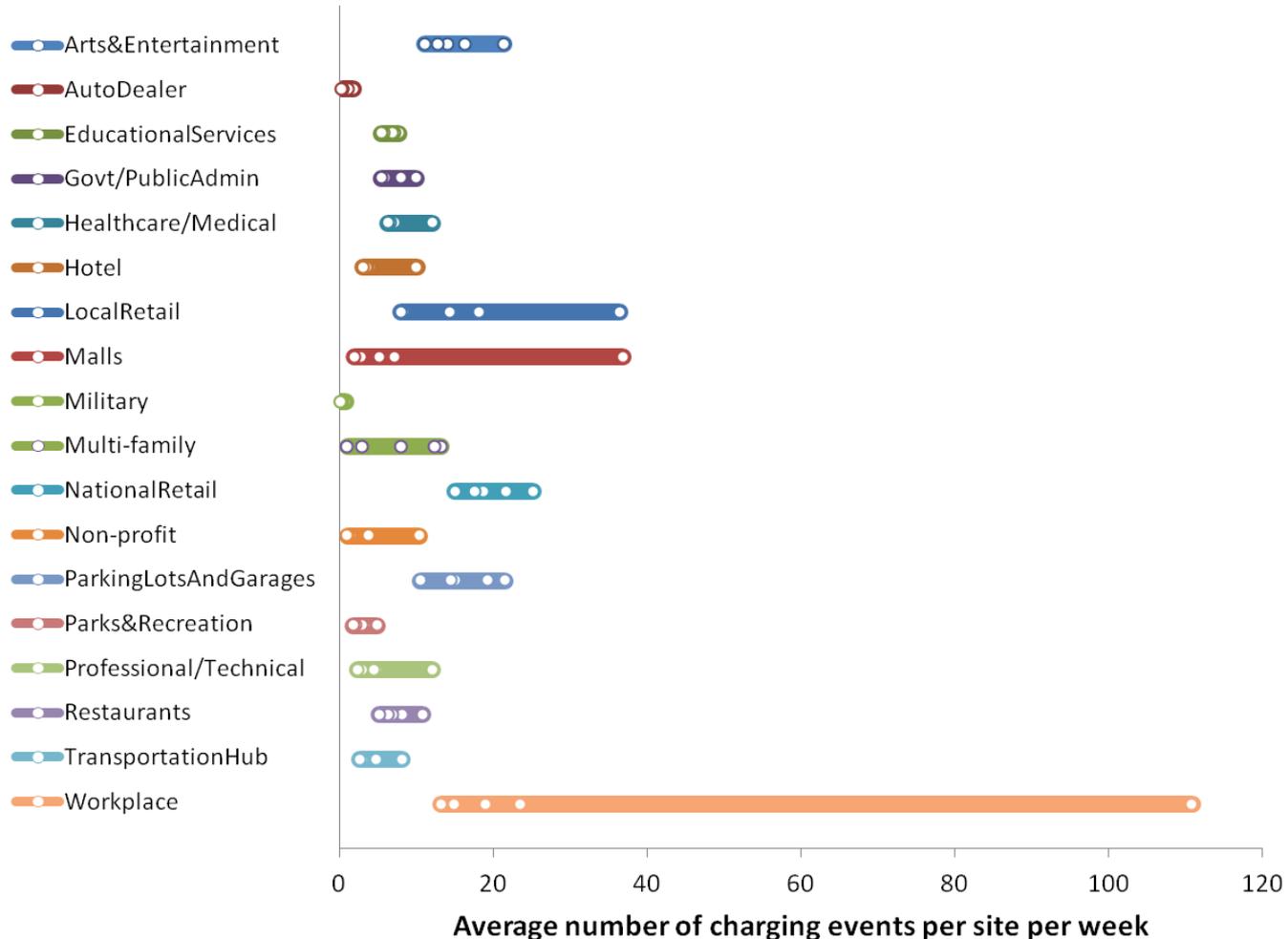


Based on Blink public level 2 EVSE data from 9/1/2012 through 12/21/2013

Excludes first 4 weeks in service

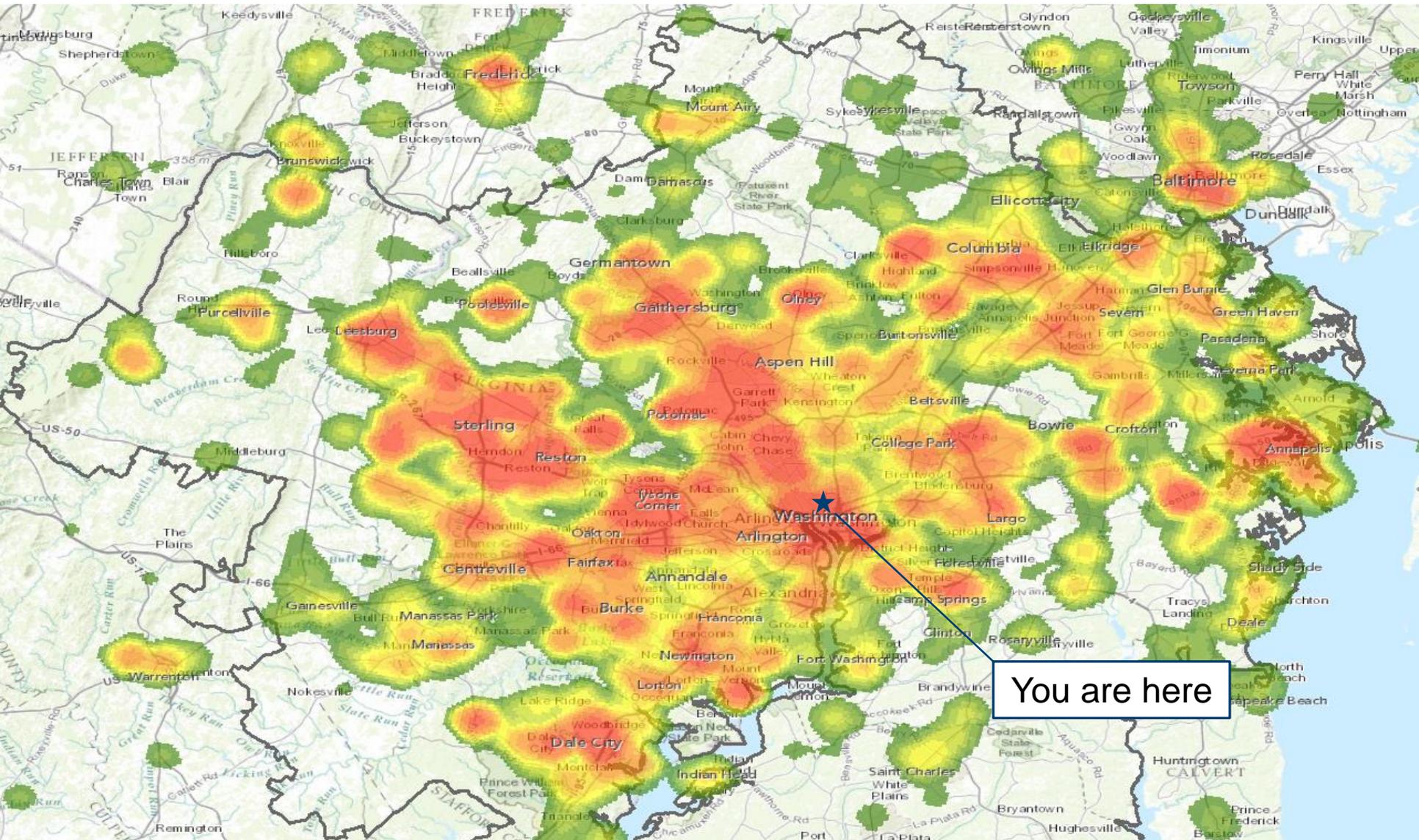
Where are the most popular public charging venues?

Usage frequency of top 5 for-cost Blink public level 2 EVSE in each venue category from 9/1/2012 to 12/15/2013

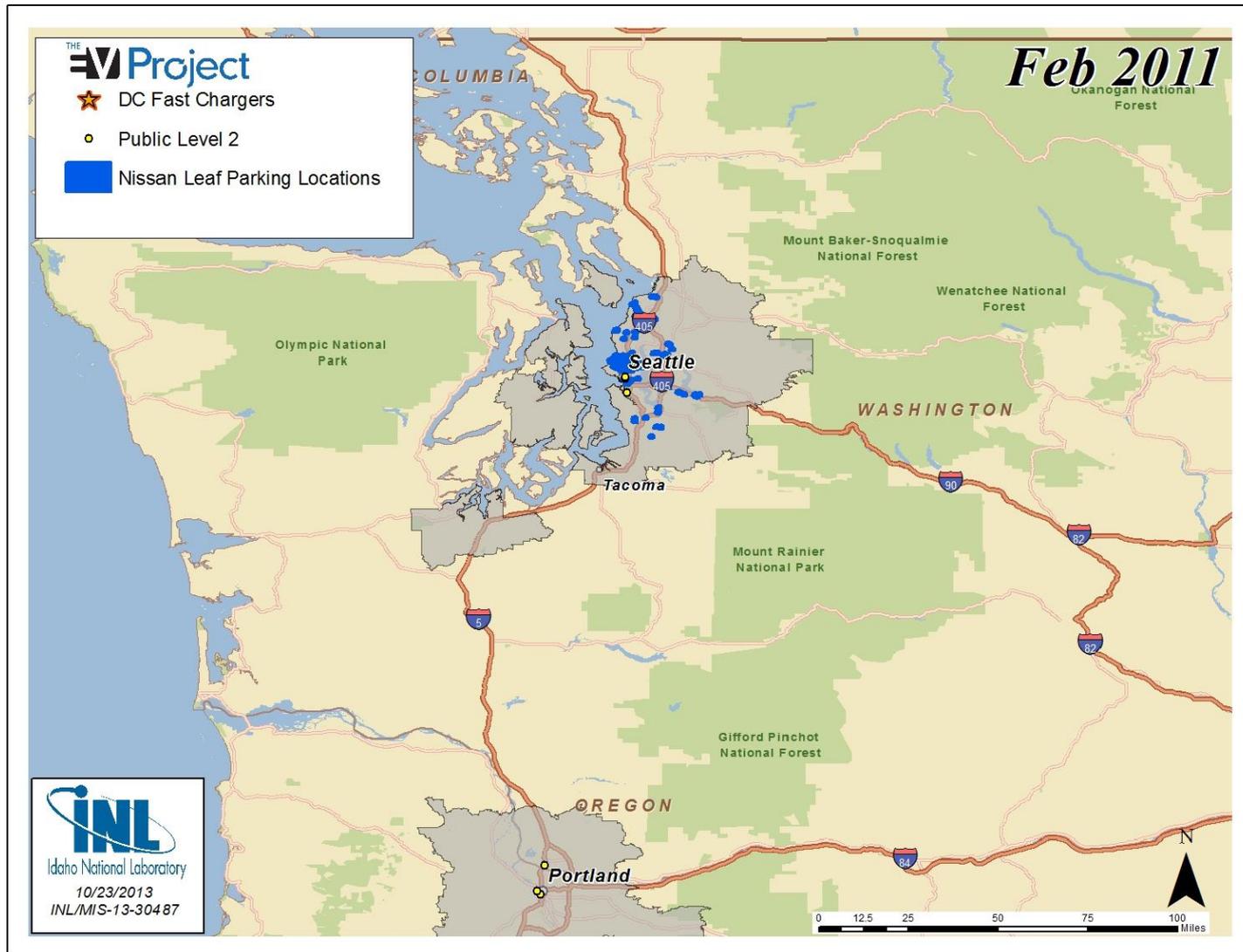


Where is the best place to put public charging stations?

DC area away-from-home parking locations for Volts that average > 35 mi per day (excluding parking locations of single vehicles)



Leaf Travel Extents in the Seattle Area



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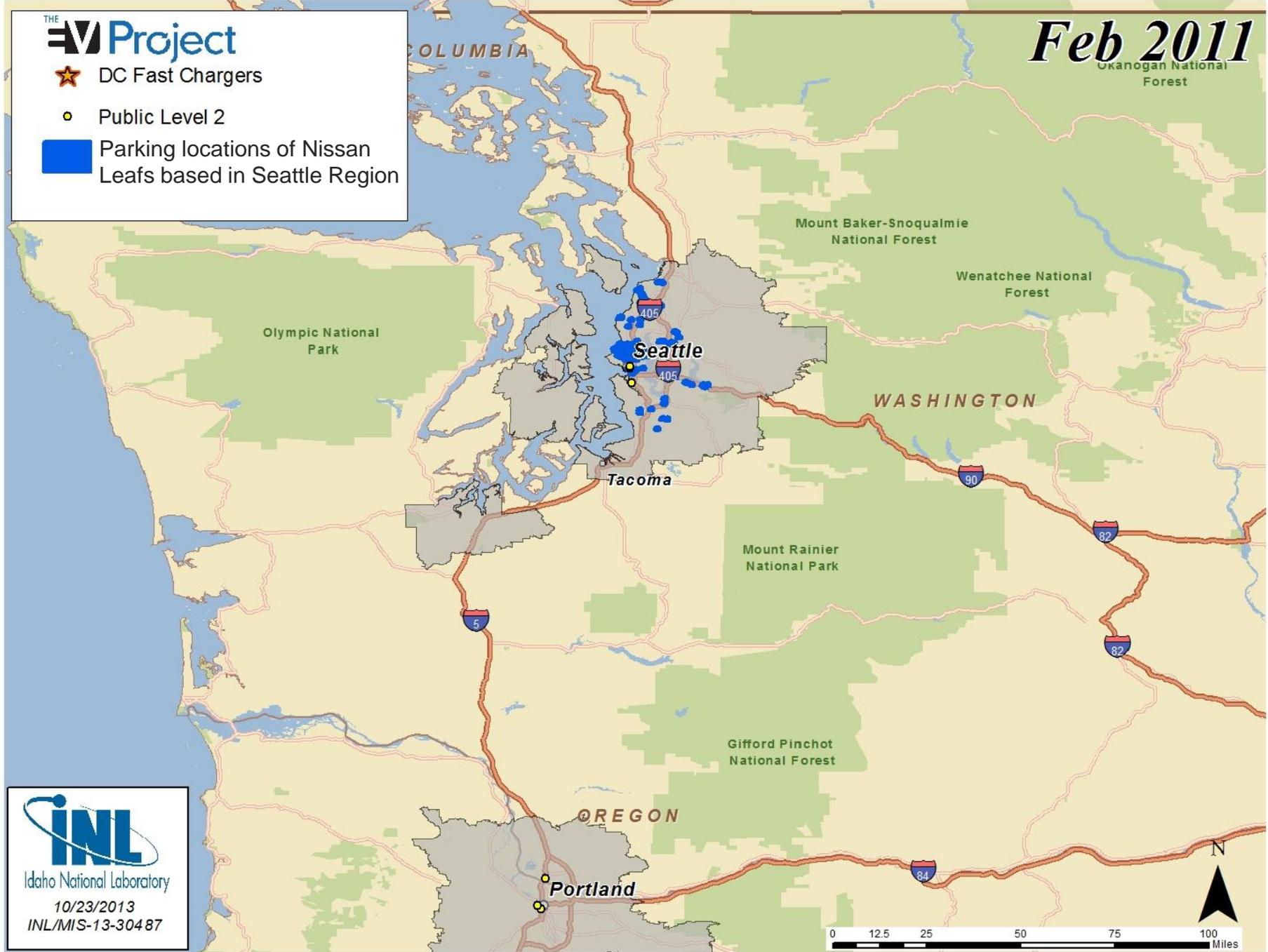
★ DC Fast Chargers

○ Public Level 2

■ Parking locations of Nissan Leafs based in Seattle Region

Feb 2011

Okanogan National Forest



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0 12.5 25 50 75 100 Miles

N

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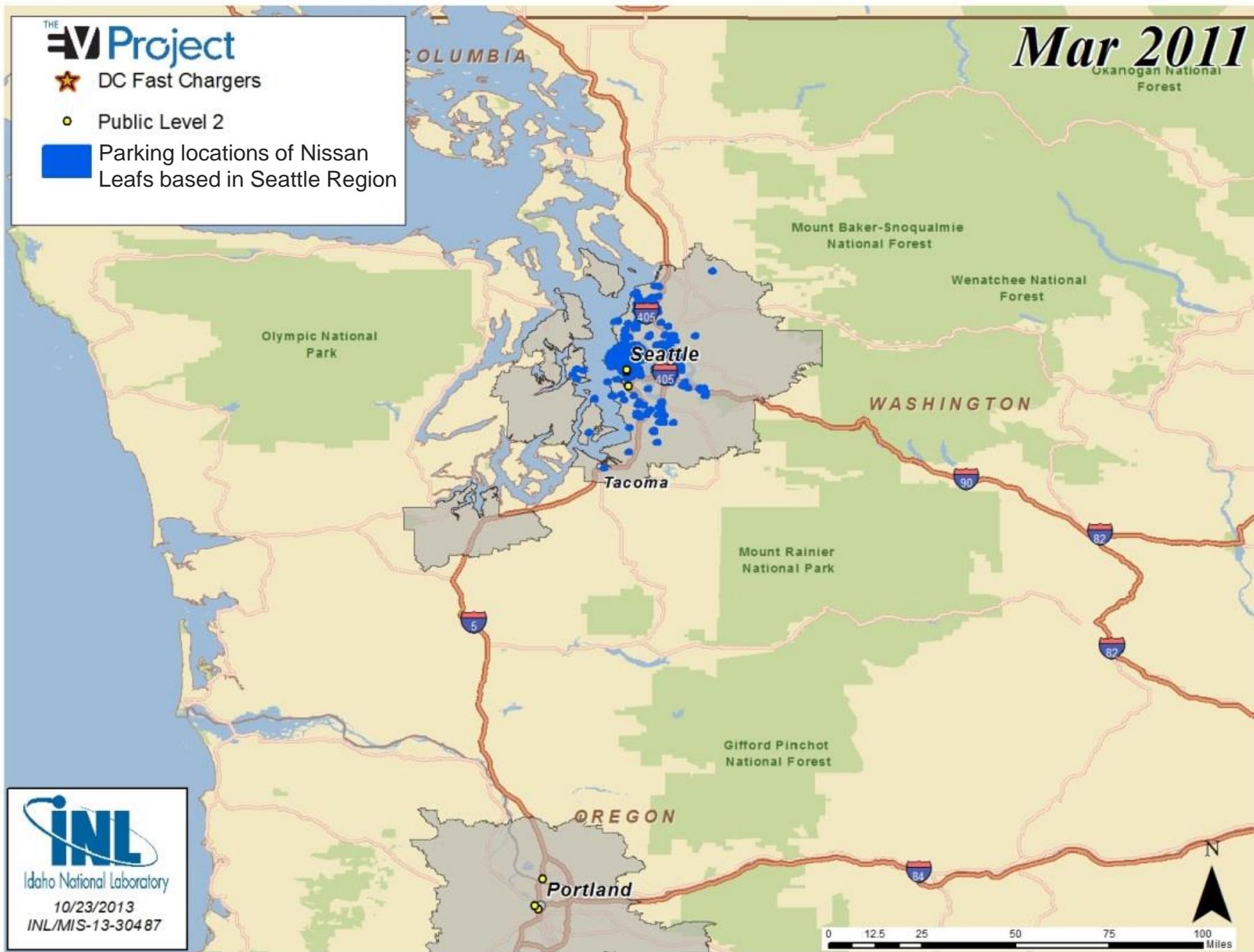
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○ Public Level 2

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Mar 2011

Okanogan National Forest



Idaho National Laboratory

10/23/2013

INL/MIS-13-30487

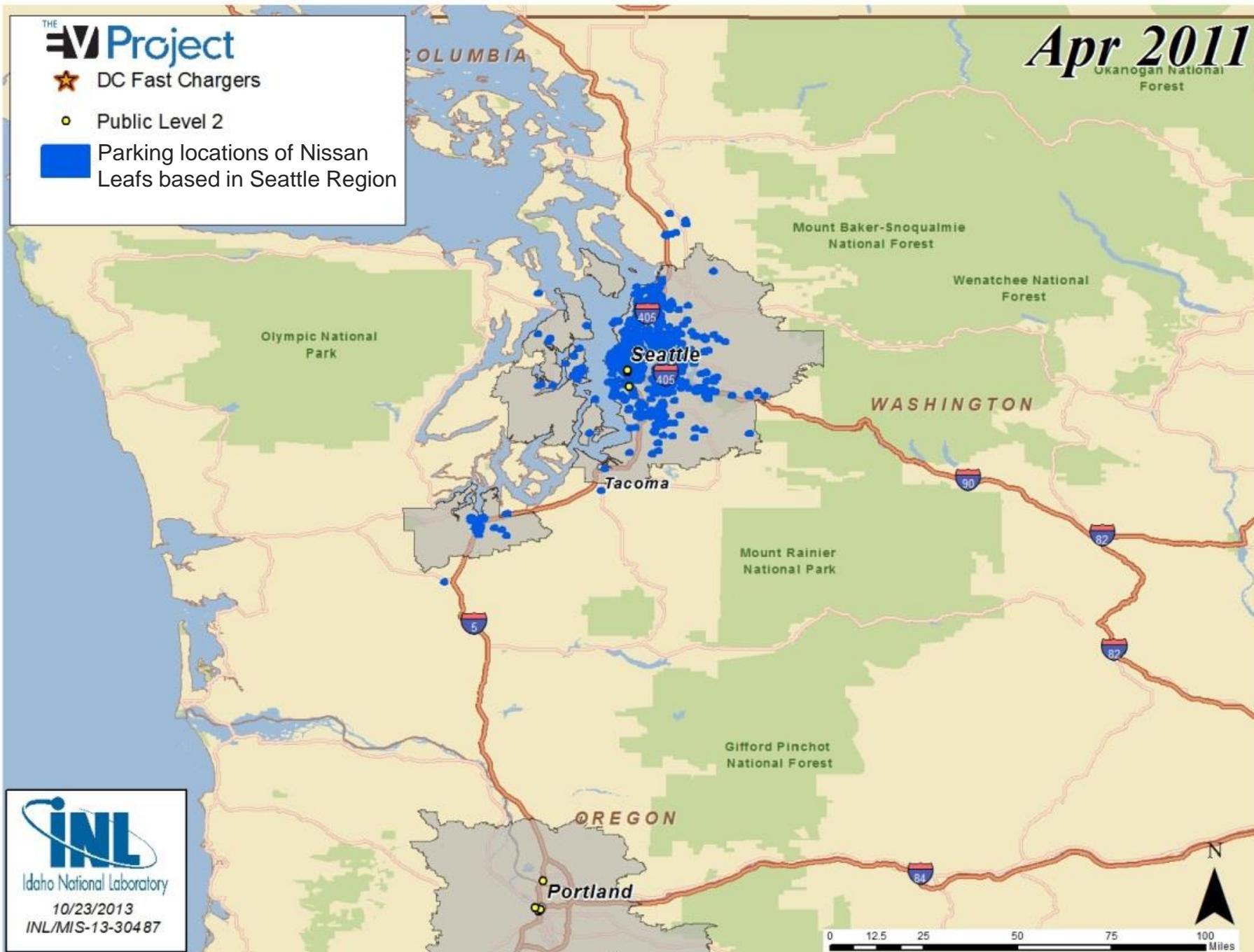
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Apr 2011
Okanogan National Forest

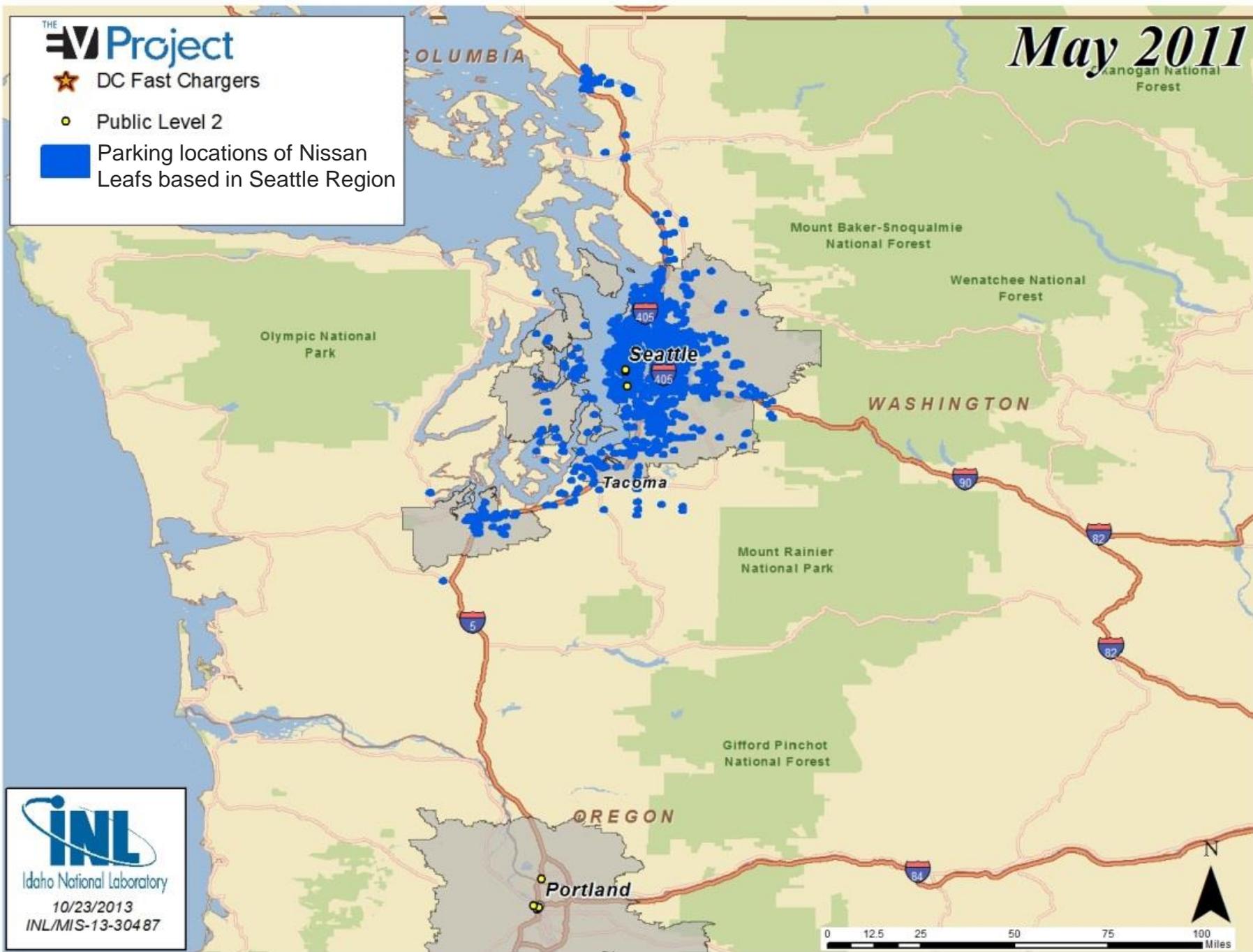


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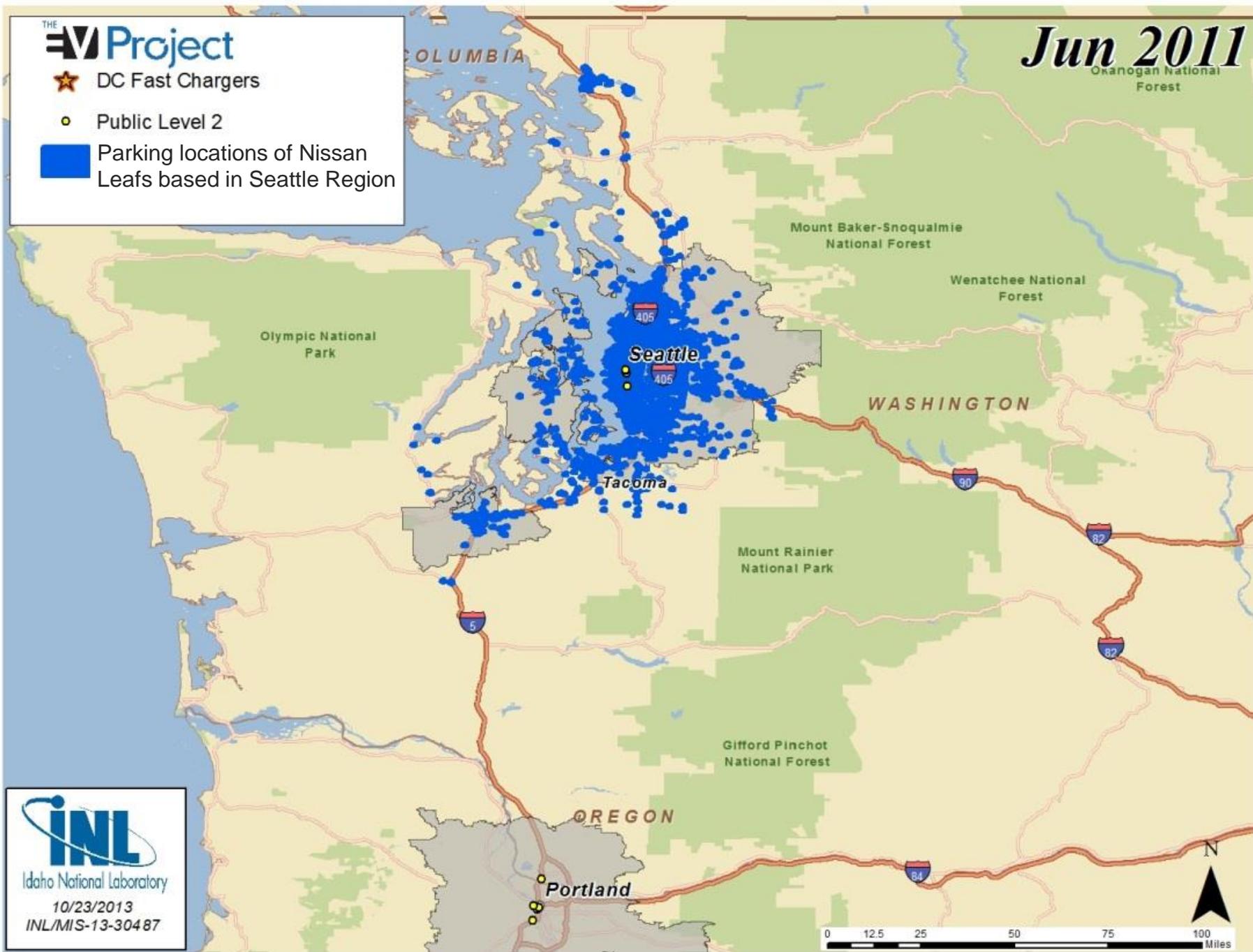
May 2011
Knapogon National Forest



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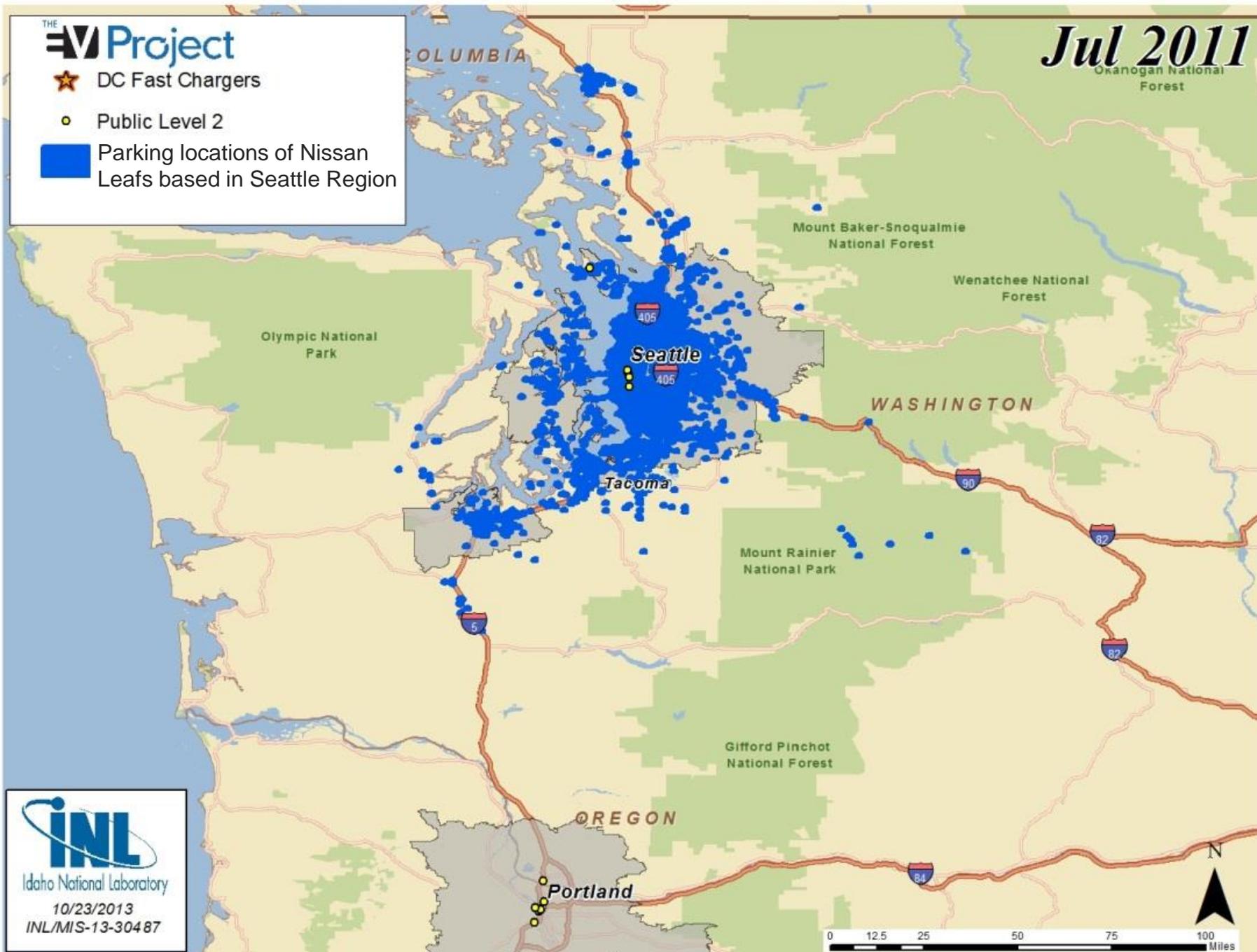
Jun 2011
Okanogan National Forest



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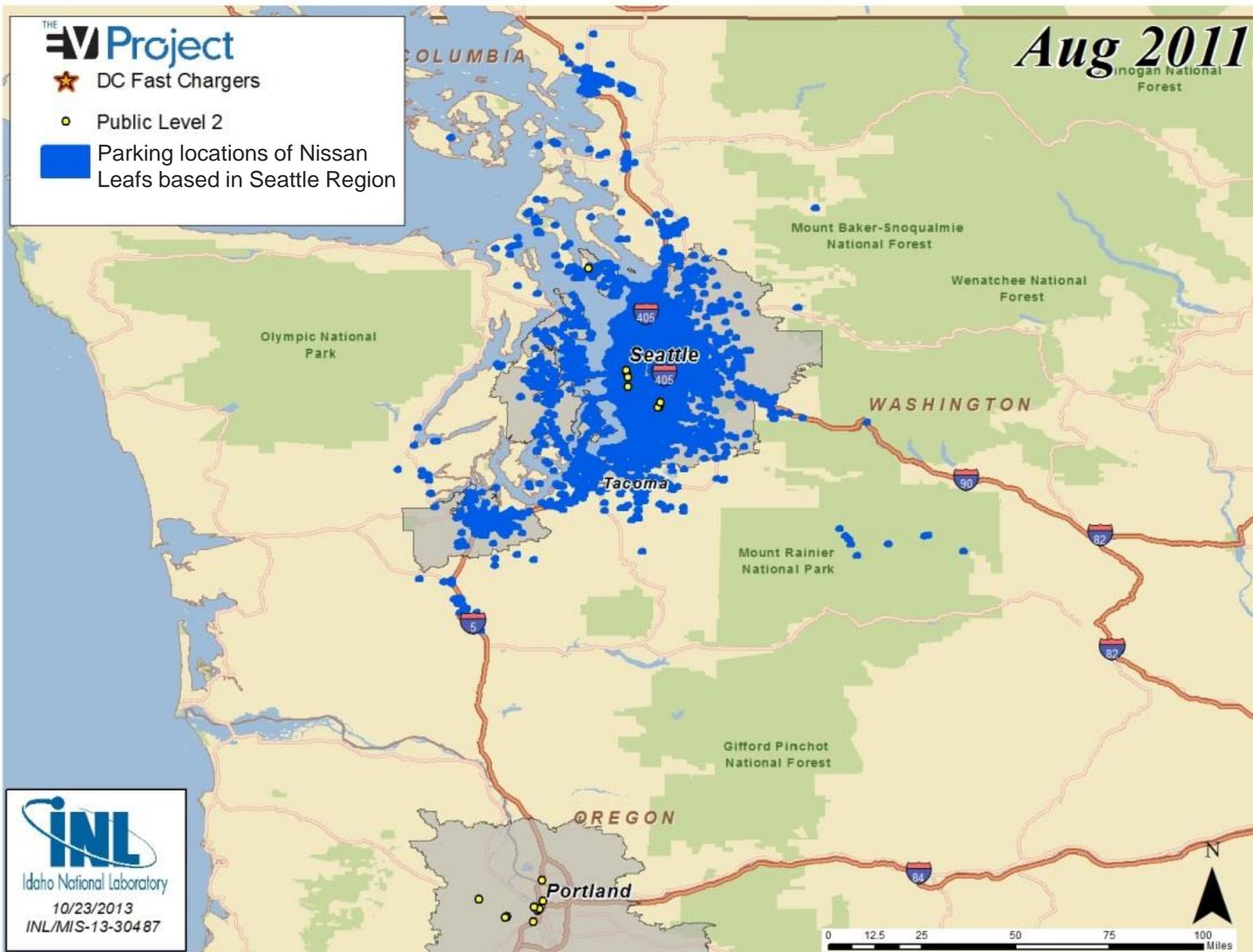


★ DC Fast Chargers

○ Public Level 2

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Aug 2011
Inogan National Forest

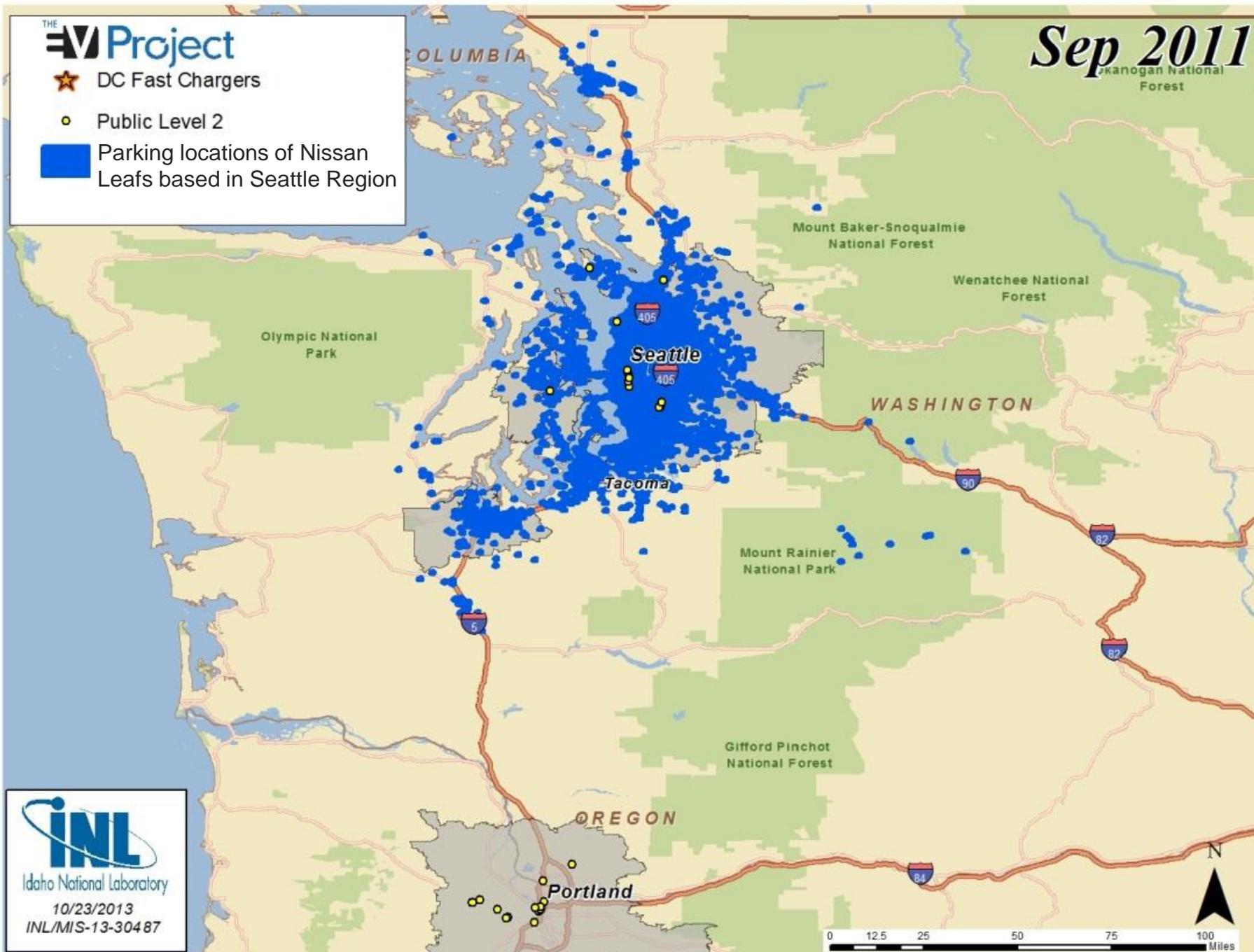


★ DC Fast Chargers

● Public Level 2

■ Parking locations of Nissan Leafs based in Seattle Region

Sep 2011
Columbia River
Okanogan National Forest



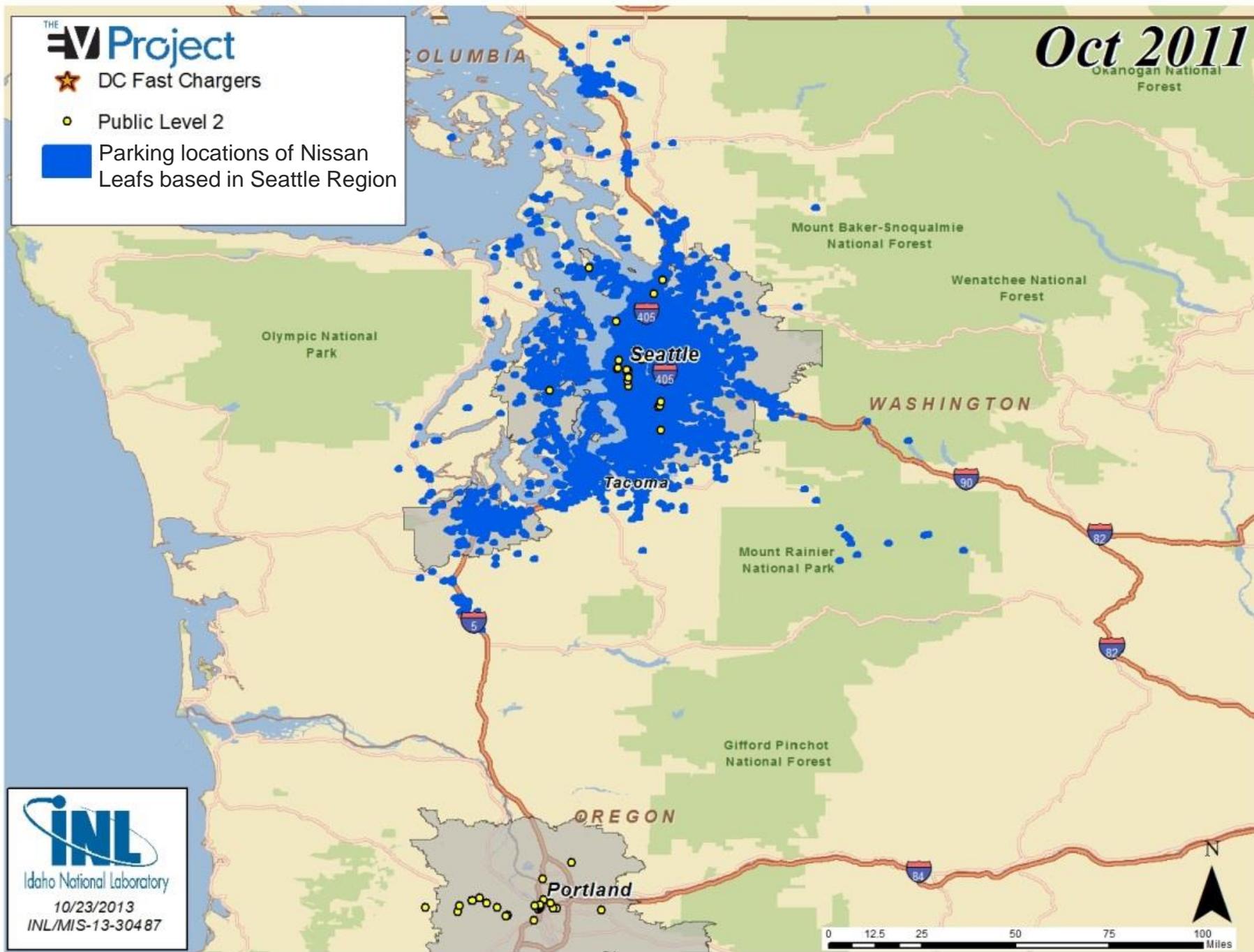
★ DC Fast Chargers

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Oct 2011

Okanogan National Forest



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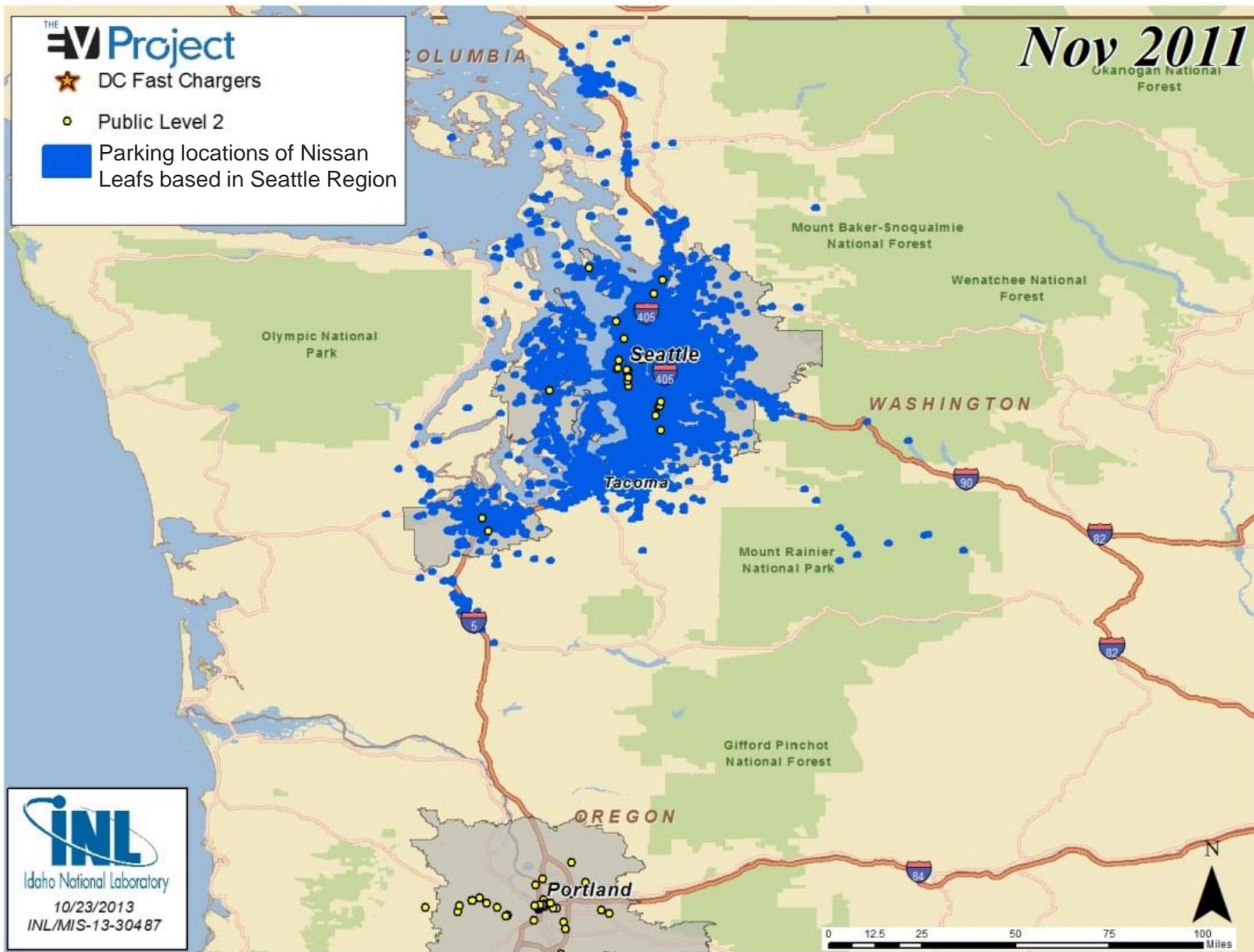
★ DC Fast Chargers

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■ Parking locations of Nissan Leafs based in Seattle Region

Nov 2011

Okanogan National Forest



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10/23/2013

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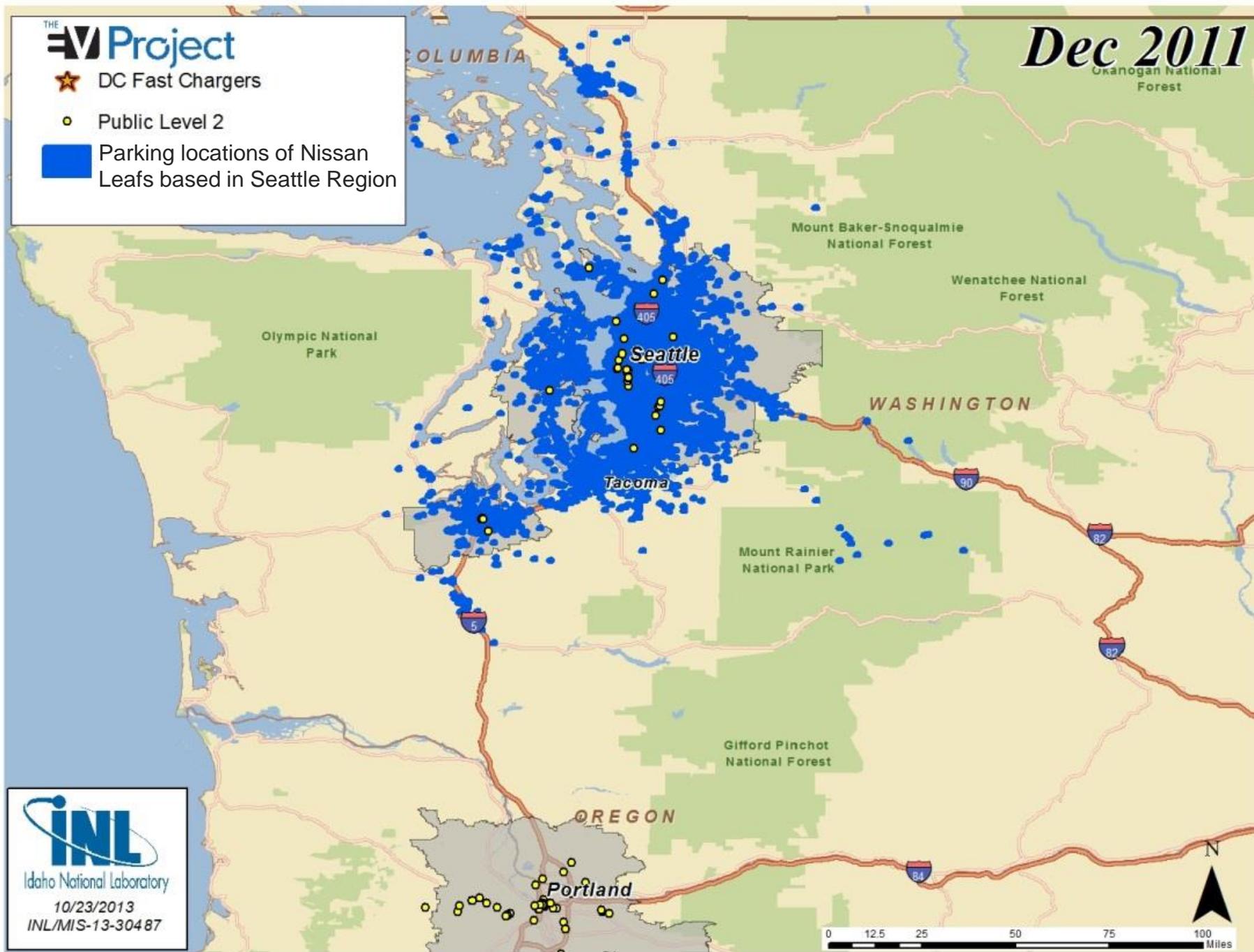
★ DC Fast Chargers

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Dec 2011

Okanogan National Forest



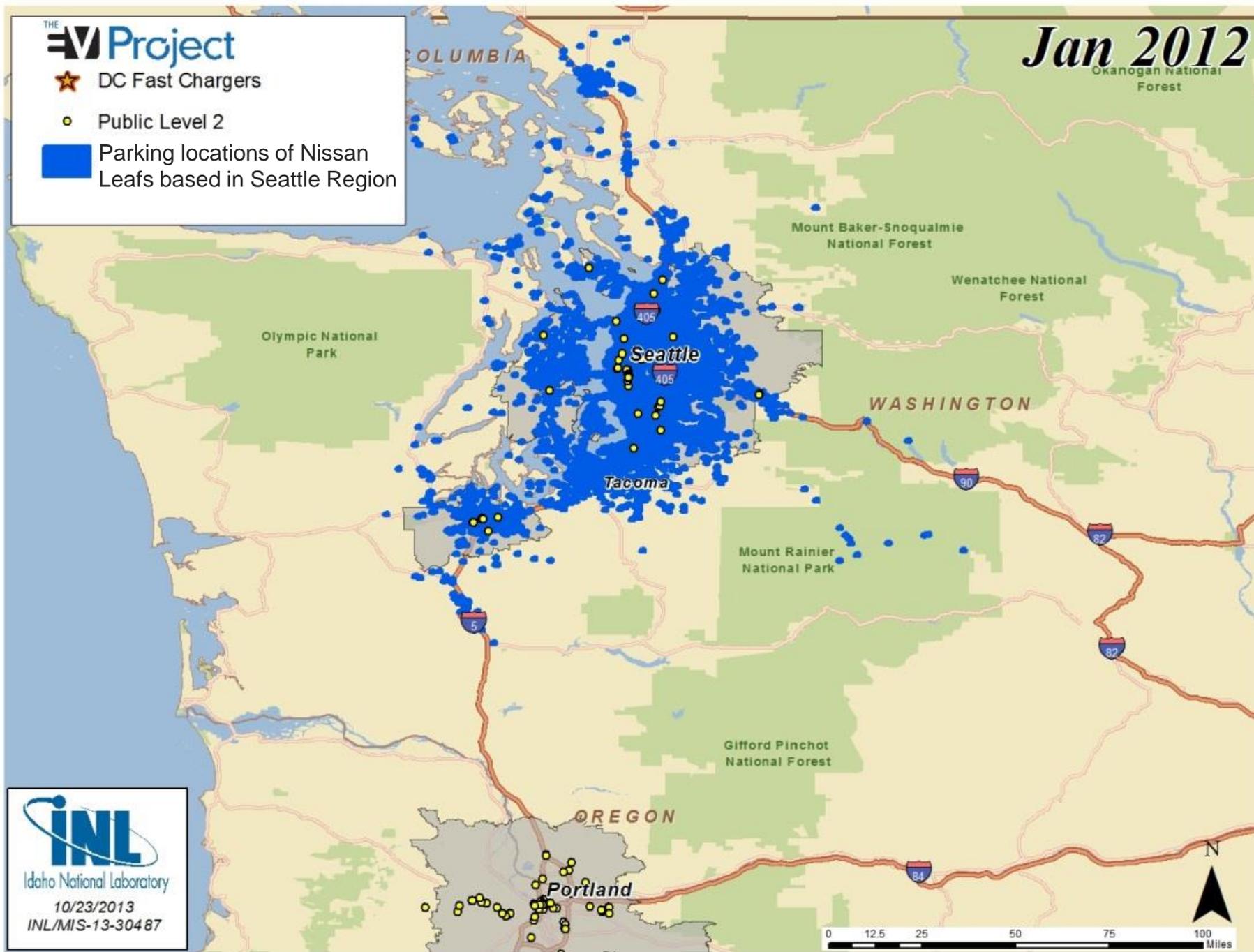
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Jan 2012

Okanogan National Forest

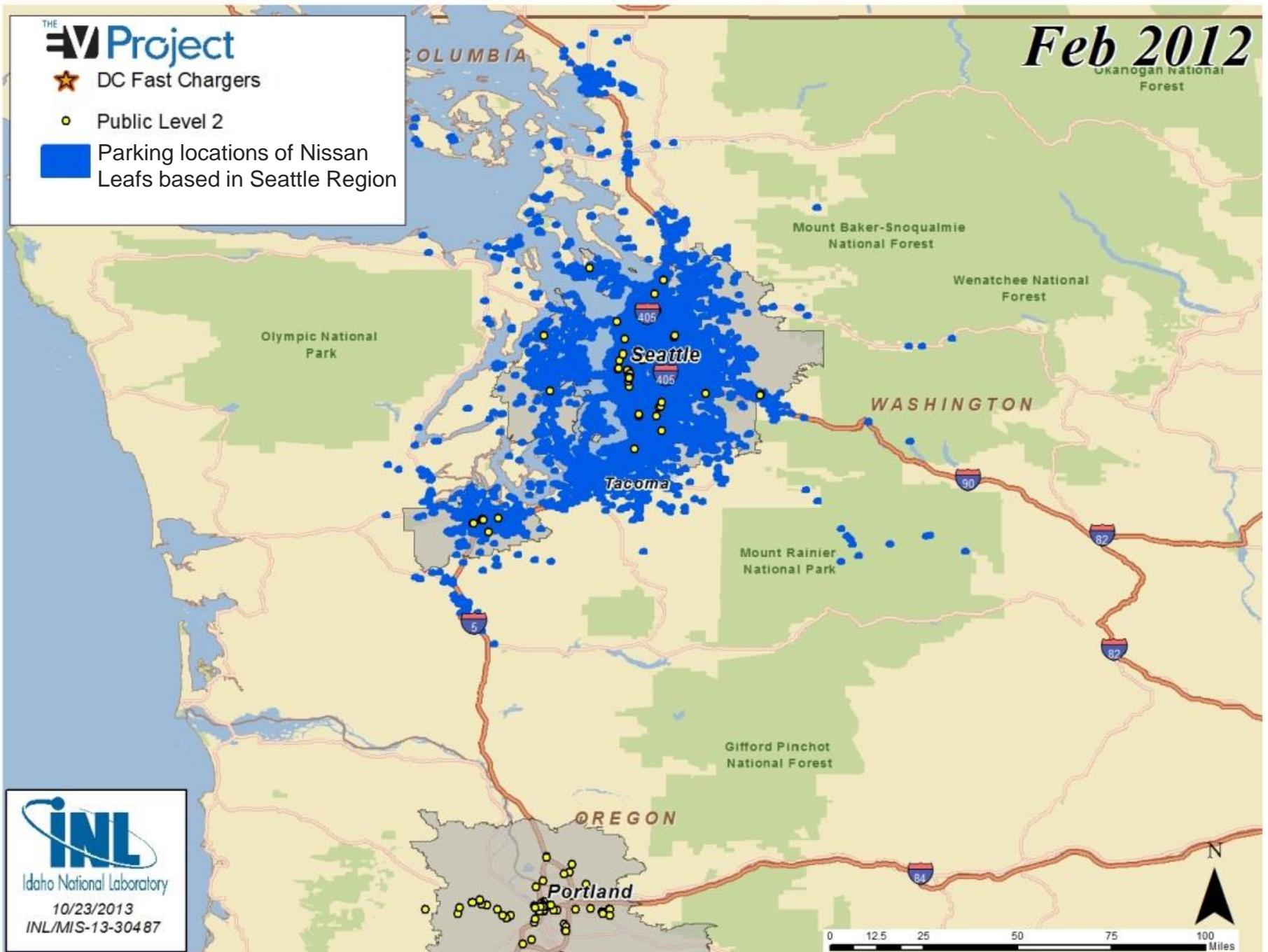


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Feb 2012



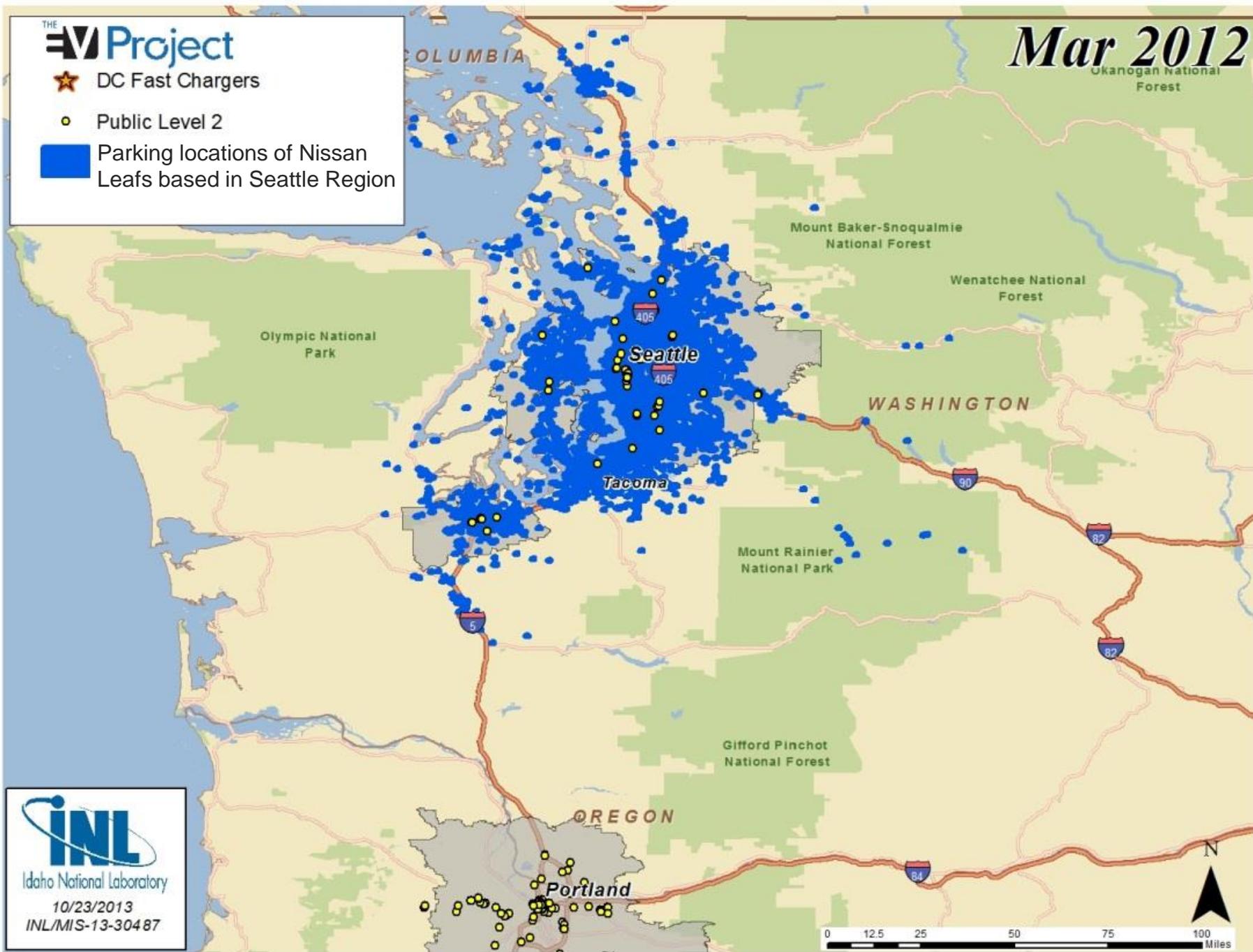
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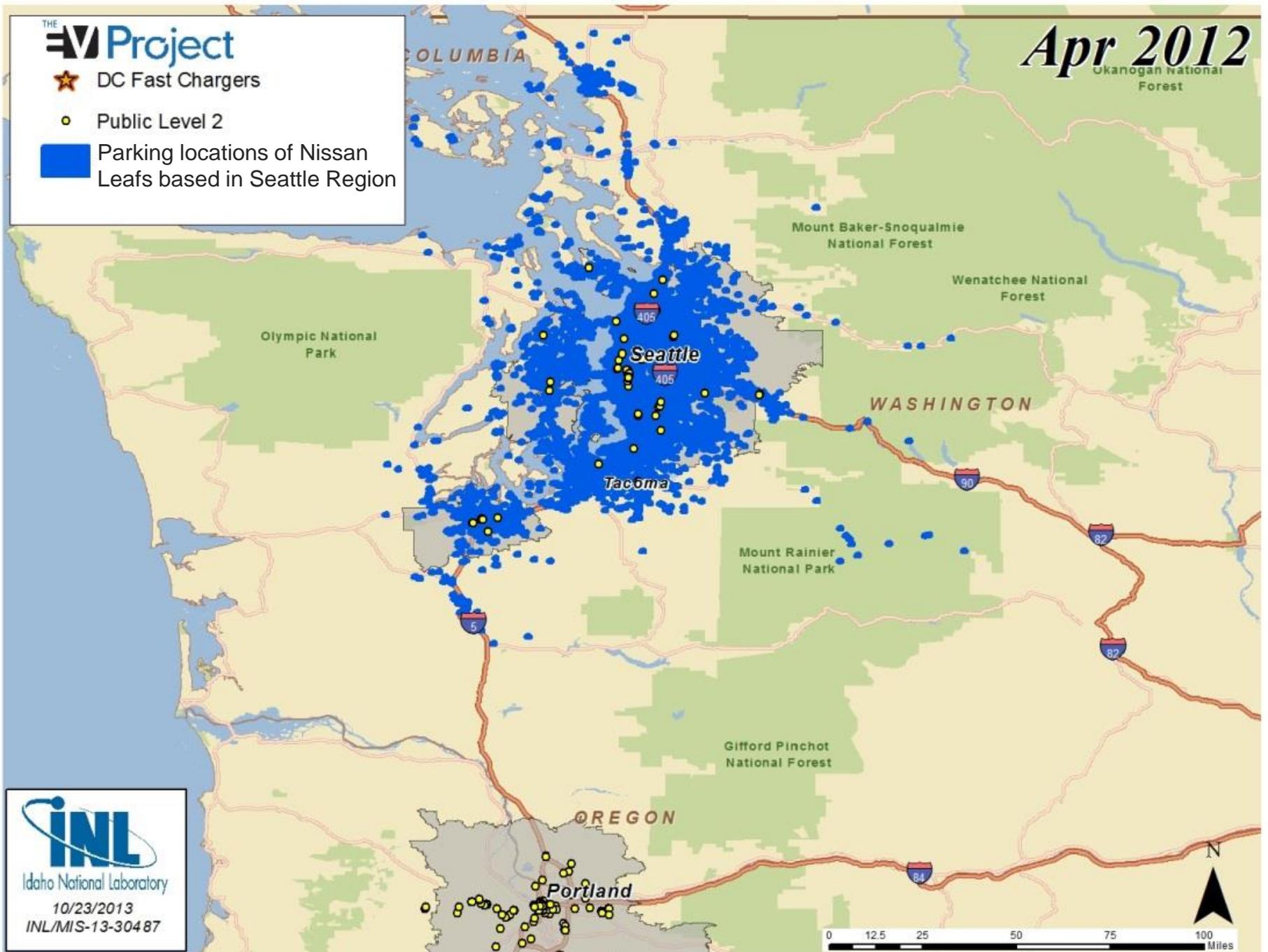
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- Parking locations of Nissan Leafs based in Seattle Region

Apr 2012
Okanogan National Forest

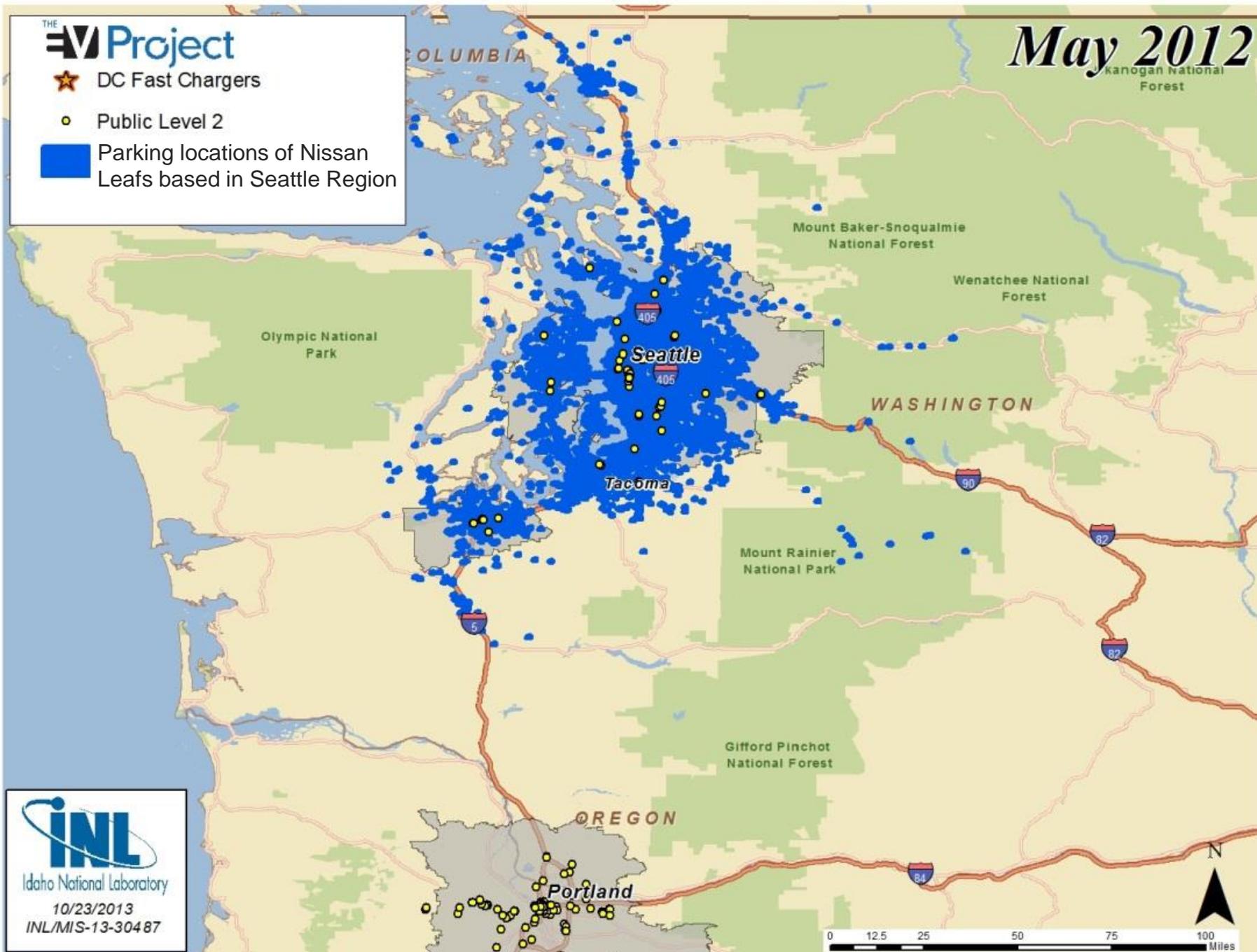


★ DC Fast Chargers

○ Public Level 2

■ Parking locations of Nissan Leafs based in Seattle Region

May 2012
Kanogon National Forest

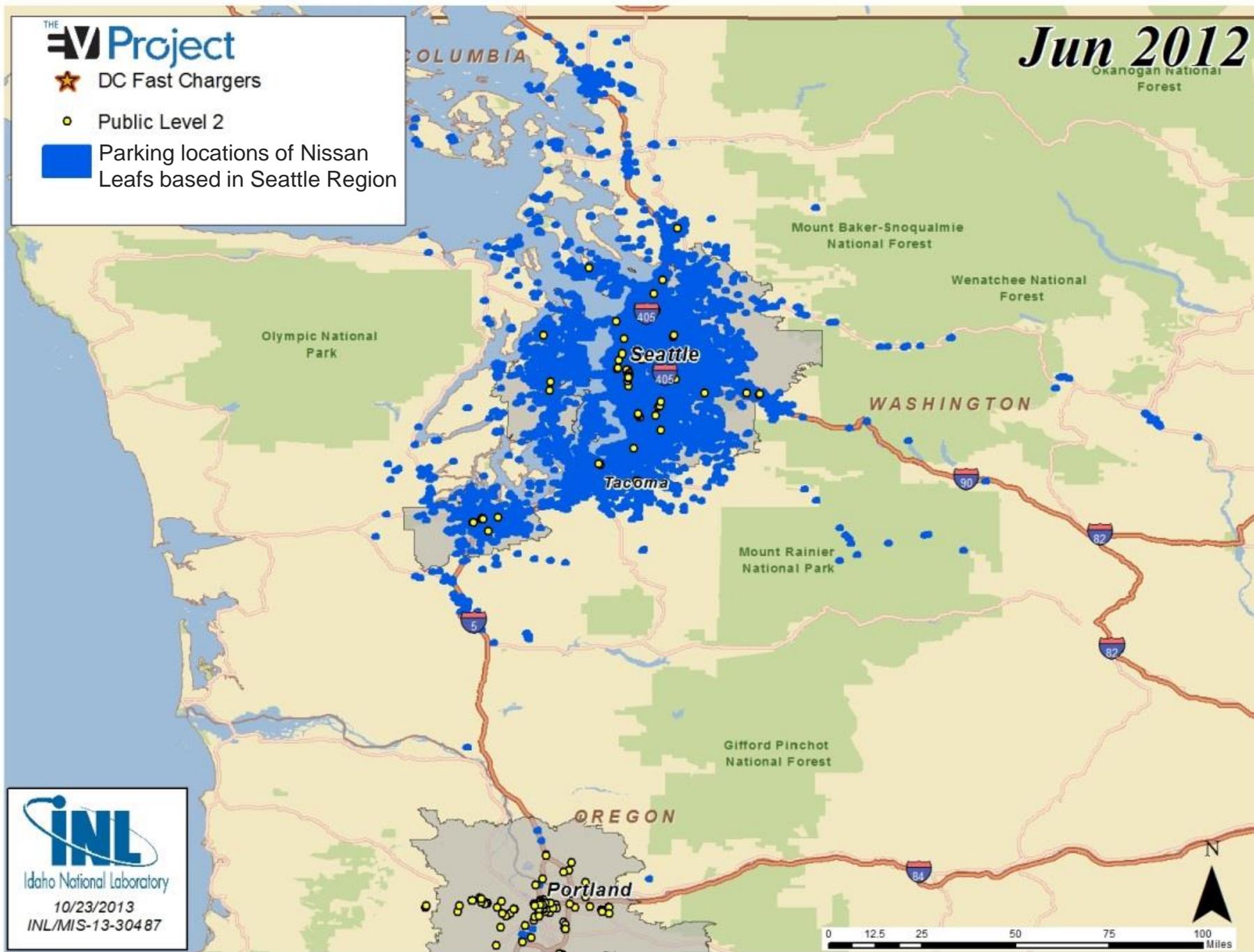


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Jun 2012

Okanogan National Forest



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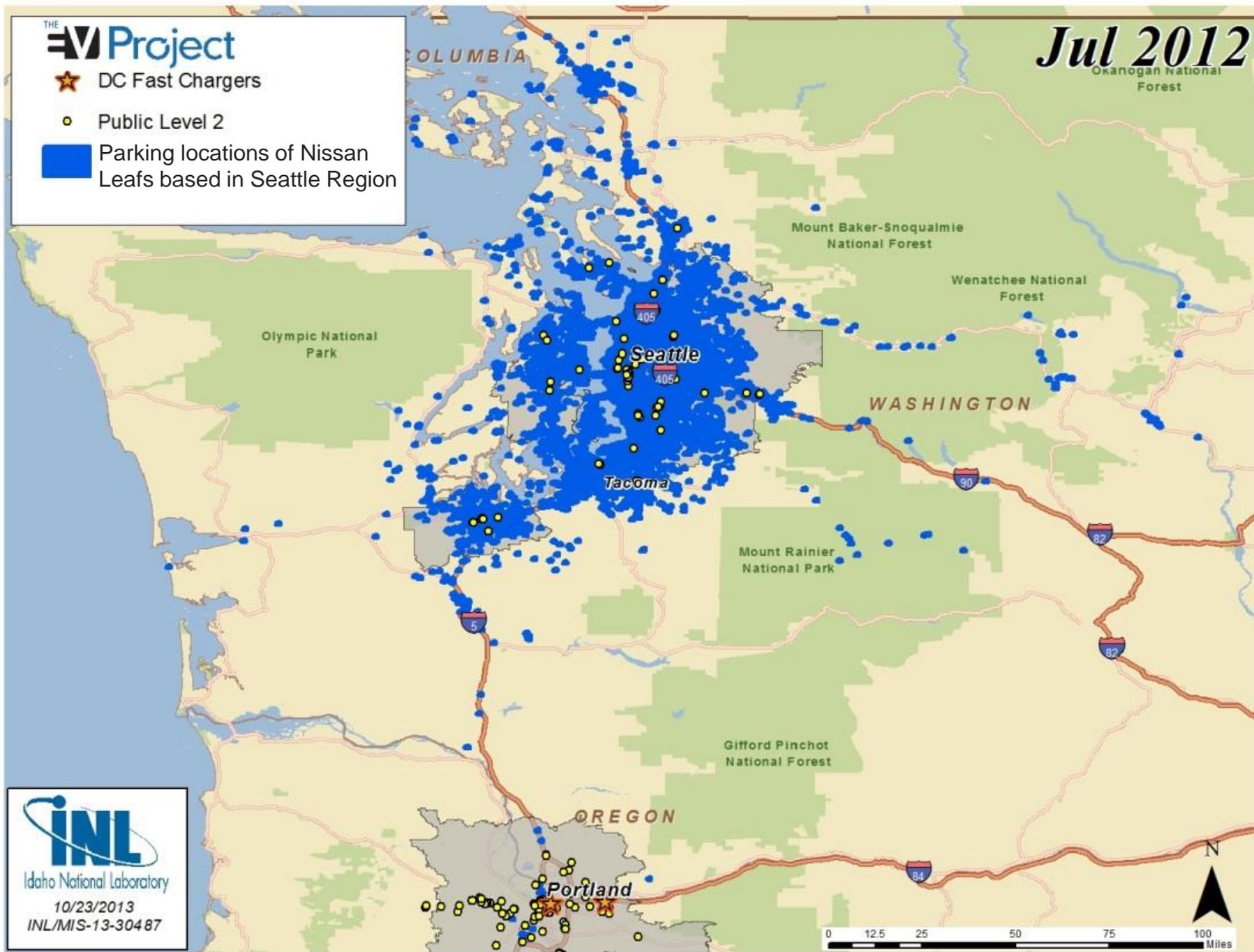
★ DC Fast Chargers

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Jul 2012

Okanogan National Forest

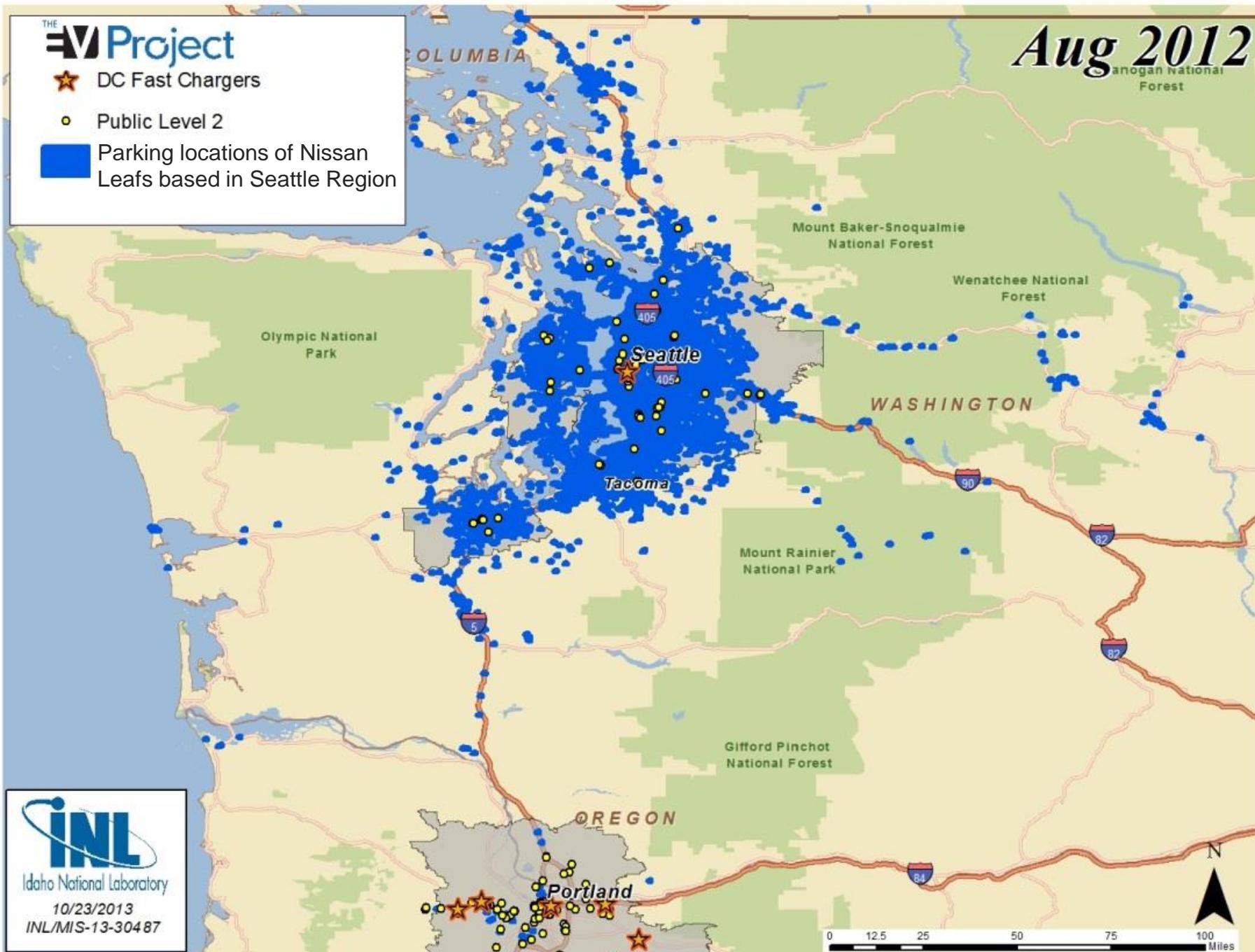


★ DC Fast Chargers

○ Public Level 2

■ Parking locations of Nissan Leafs based in Seattle Region

Aug 2012
Anogan National Forest

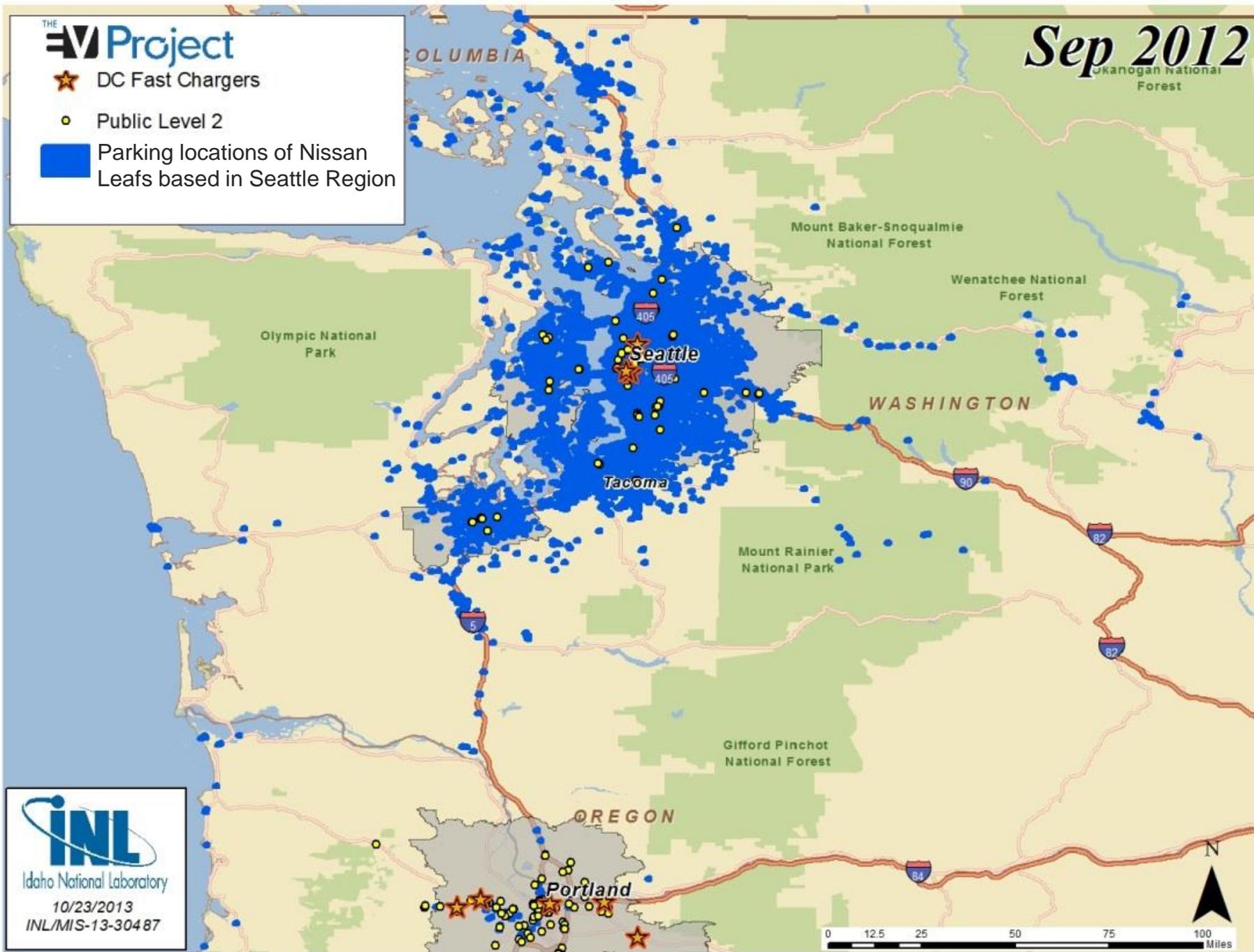


★ DC Fast Chargers

● Public Level 2

■ Parking locations of Nissan
Leaves based in Seattle Region

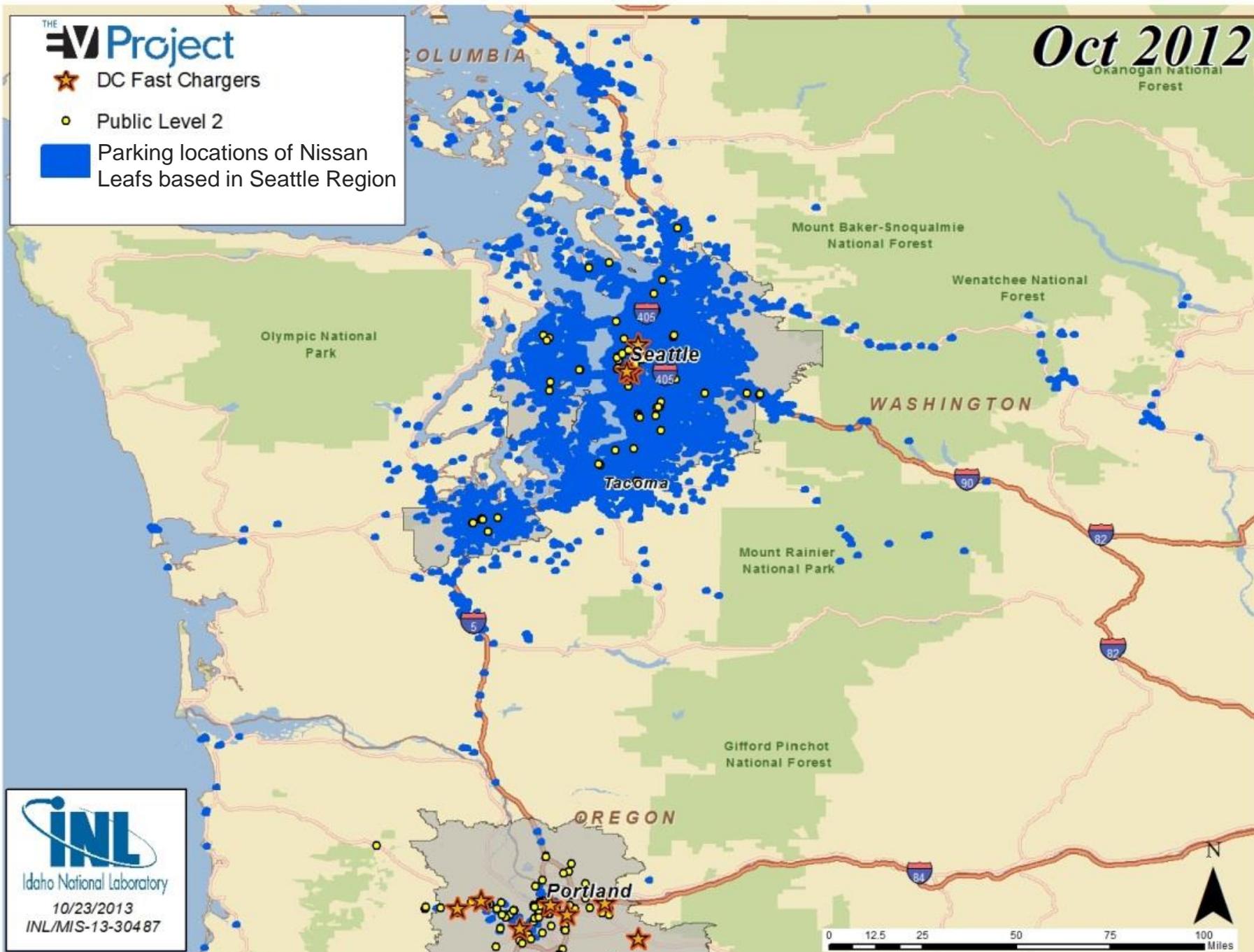
Sep 2012



THE **EV Project**

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Oct 2012
Okanogan National Forest

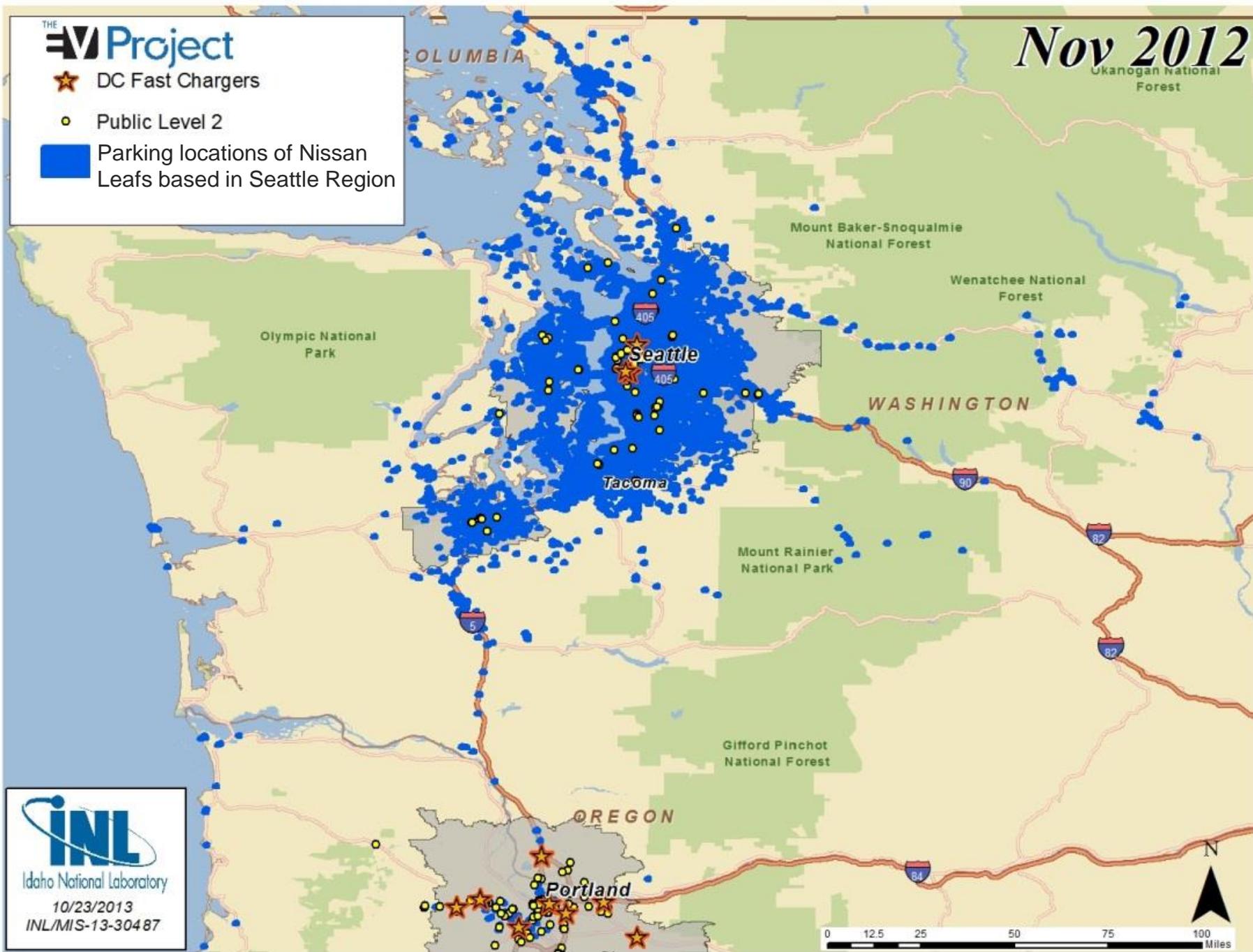


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Nov 2012



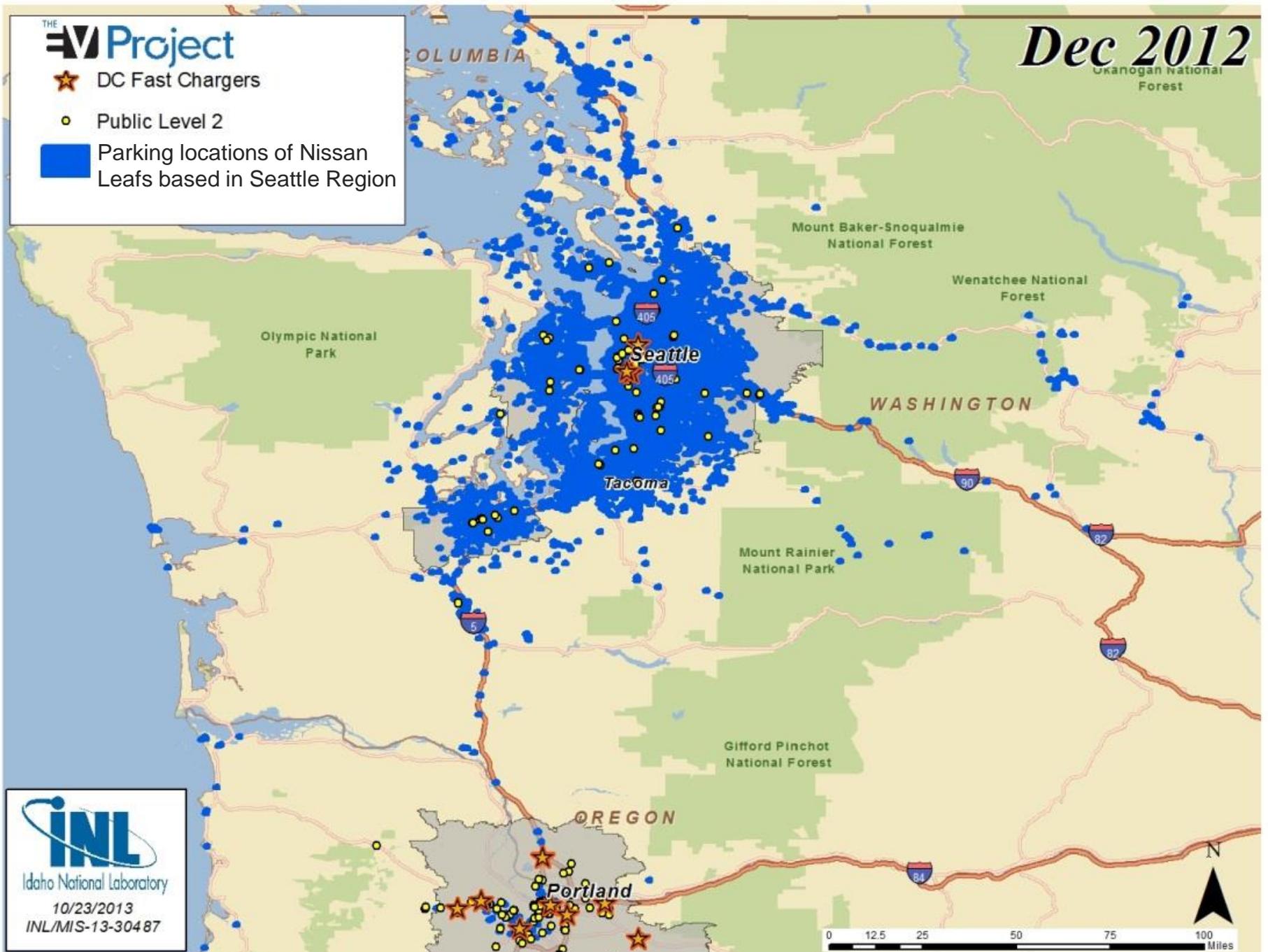
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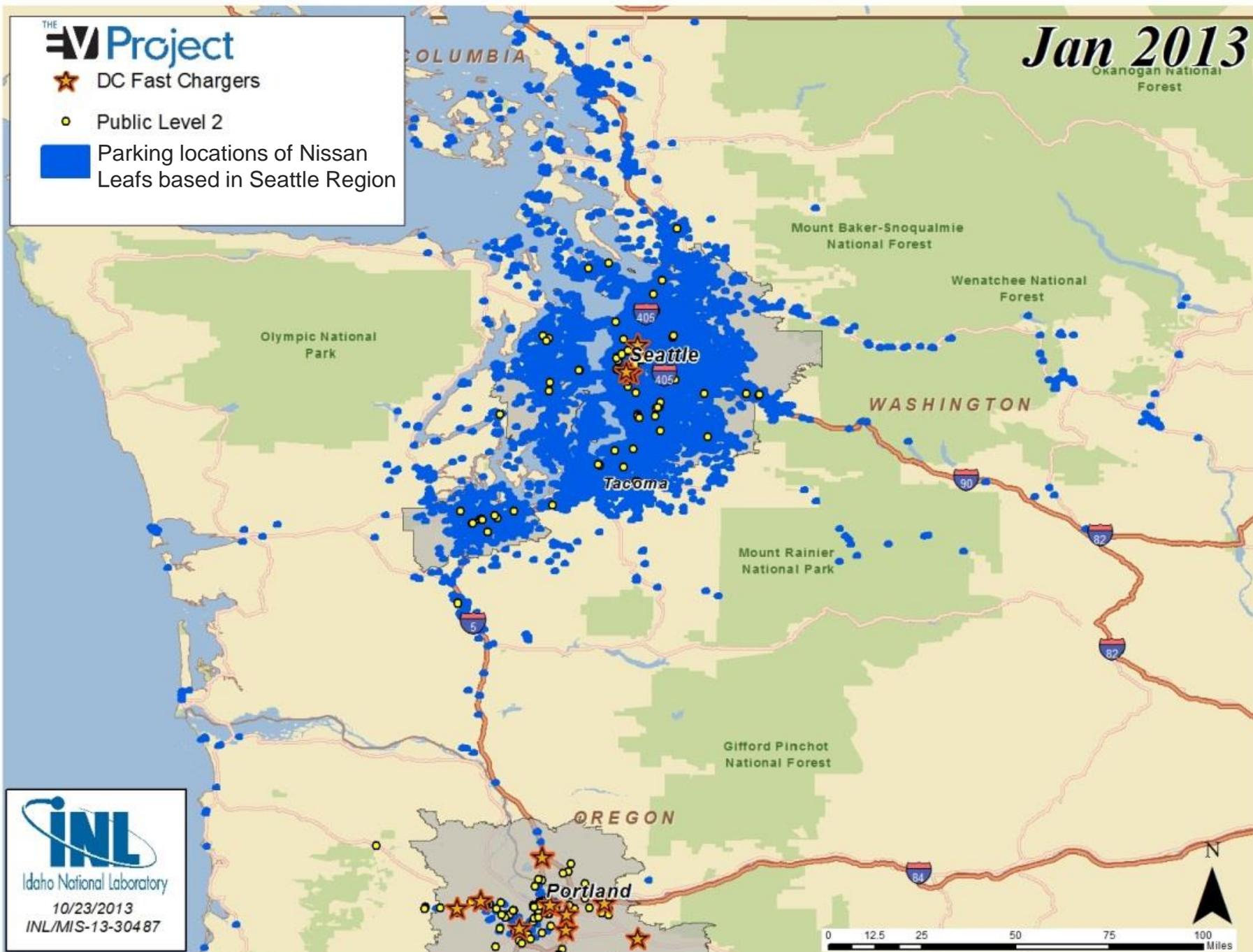
Dec 2012



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Jan 2013

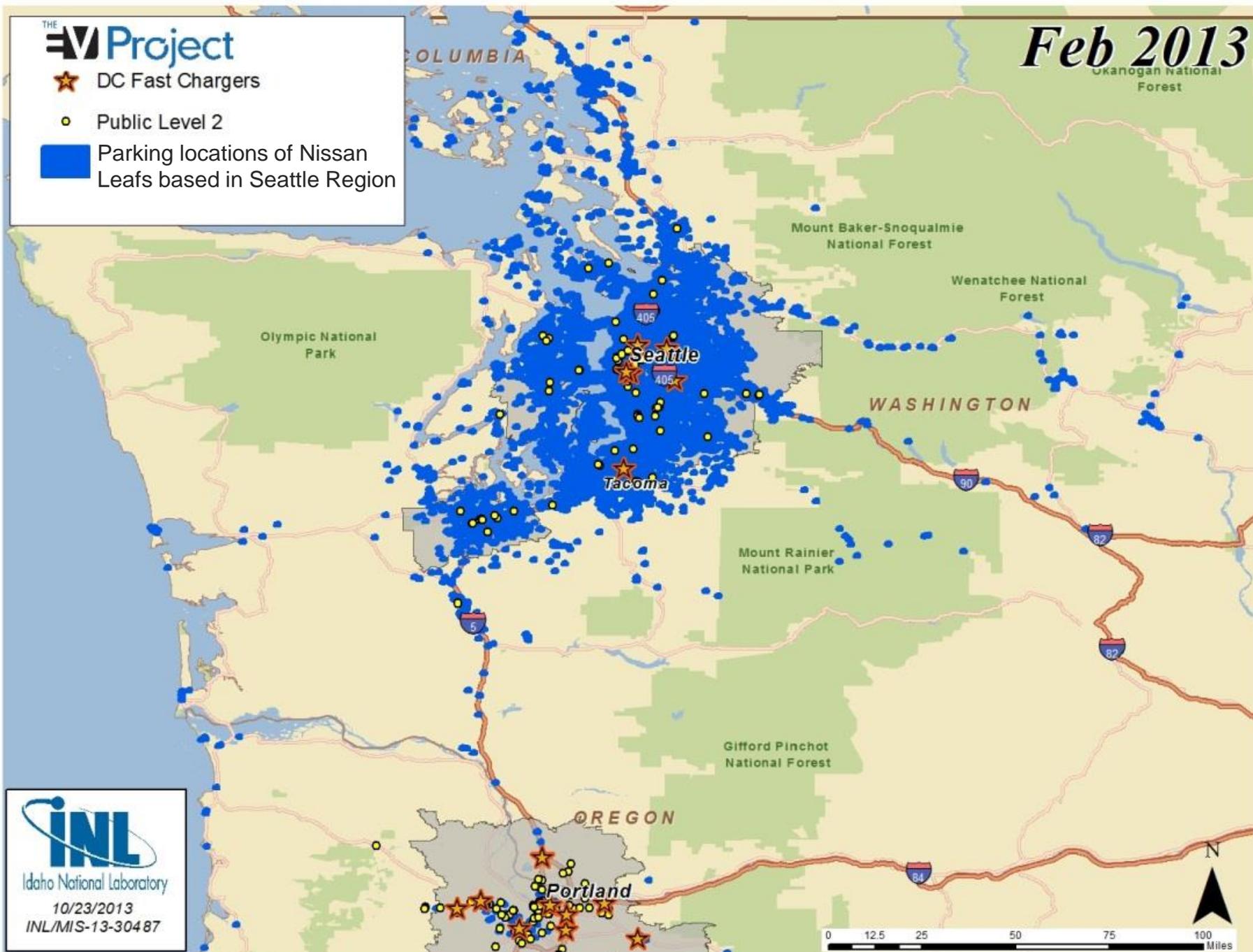


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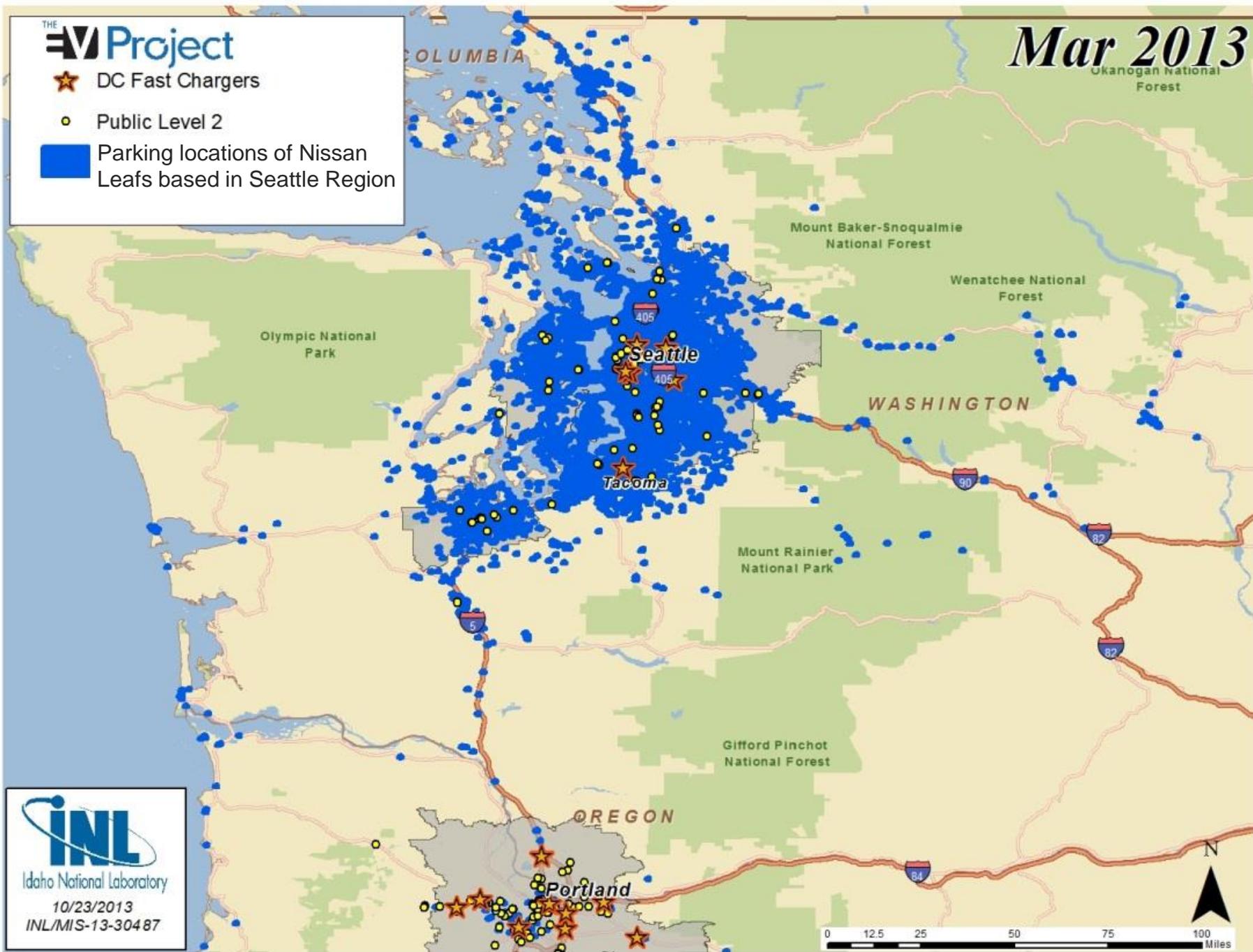
Feb 2013



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Mar 2013



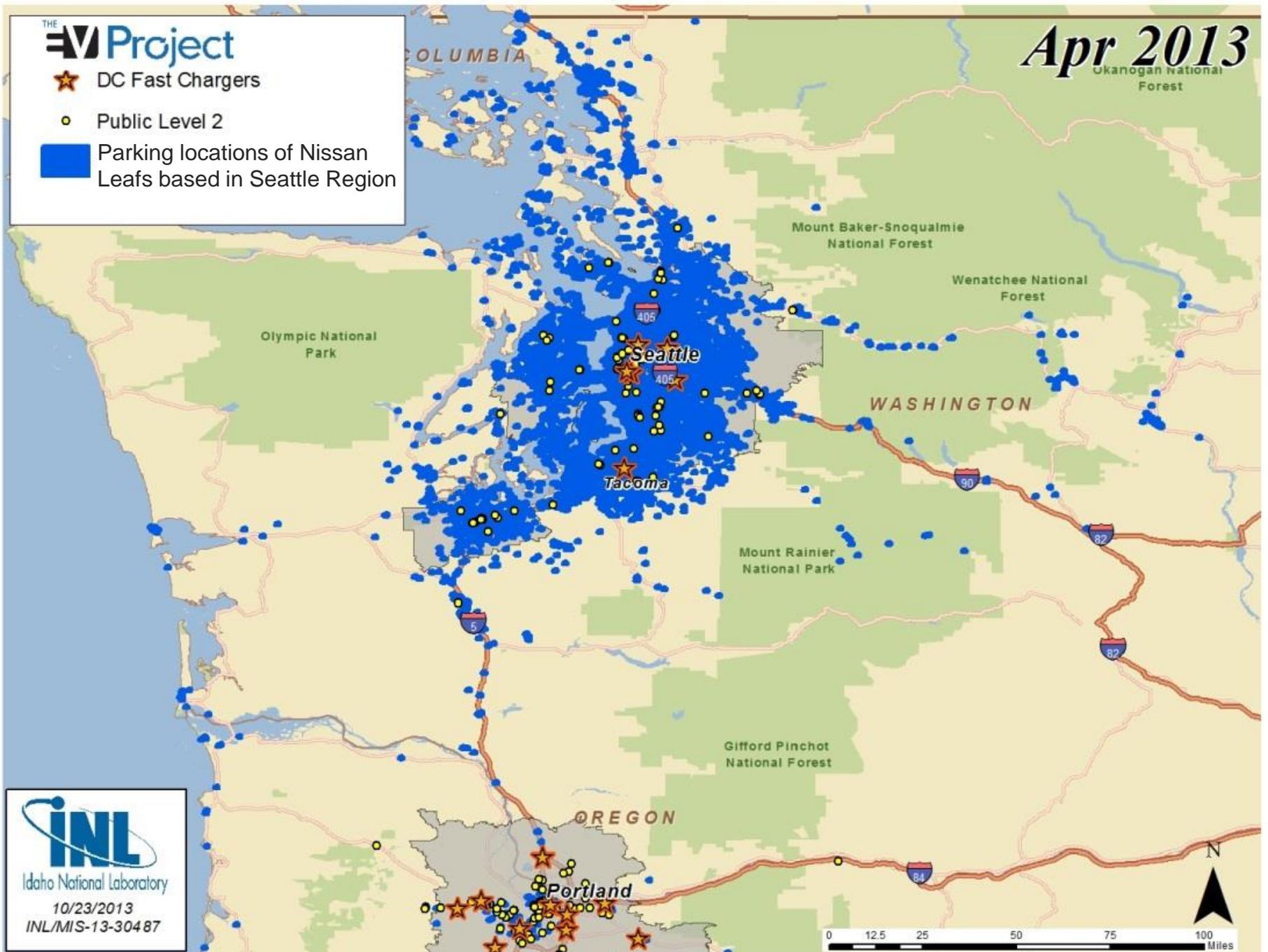
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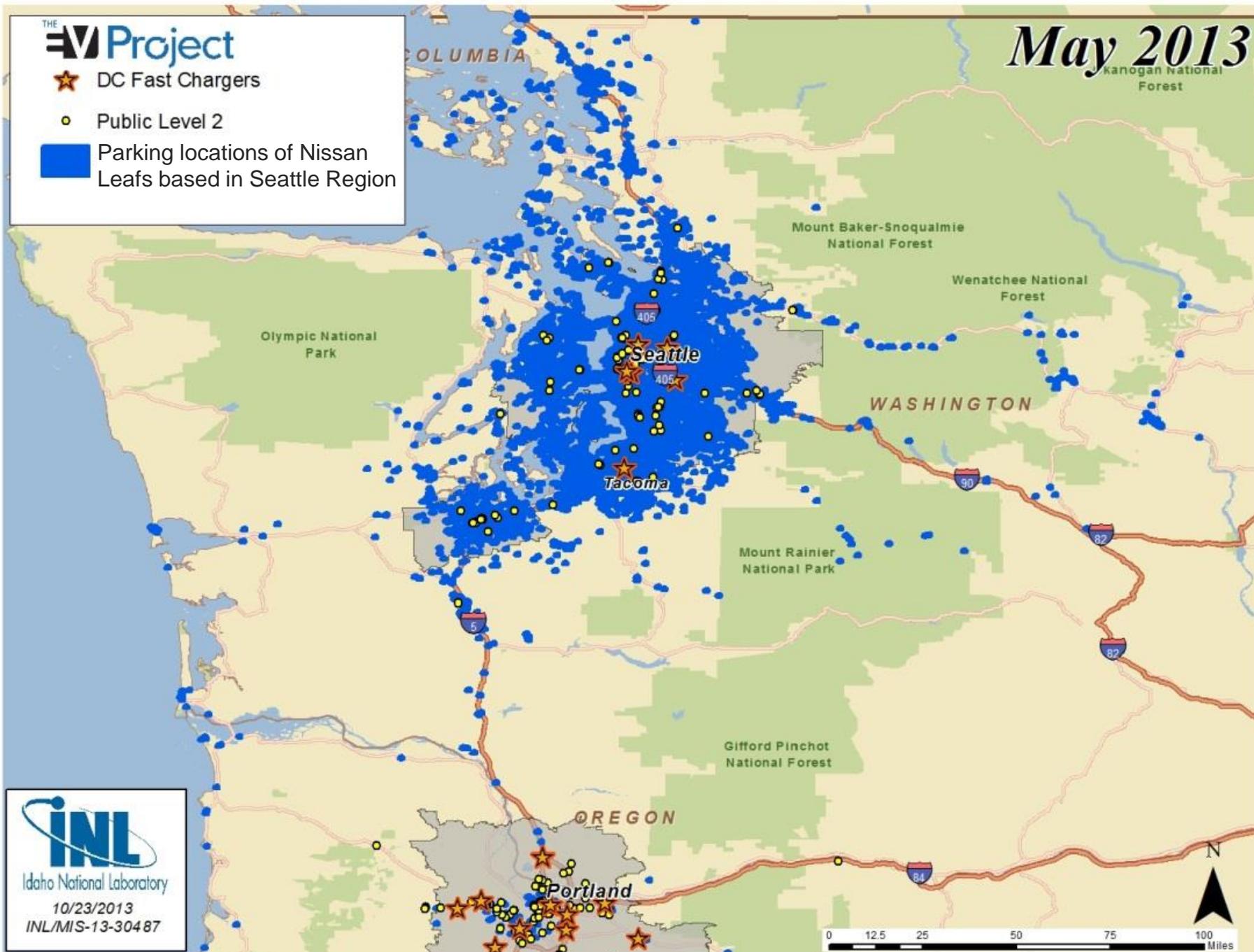
Apr 2013
Okanogan National Forest



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May 2013
Kanogon National Forest



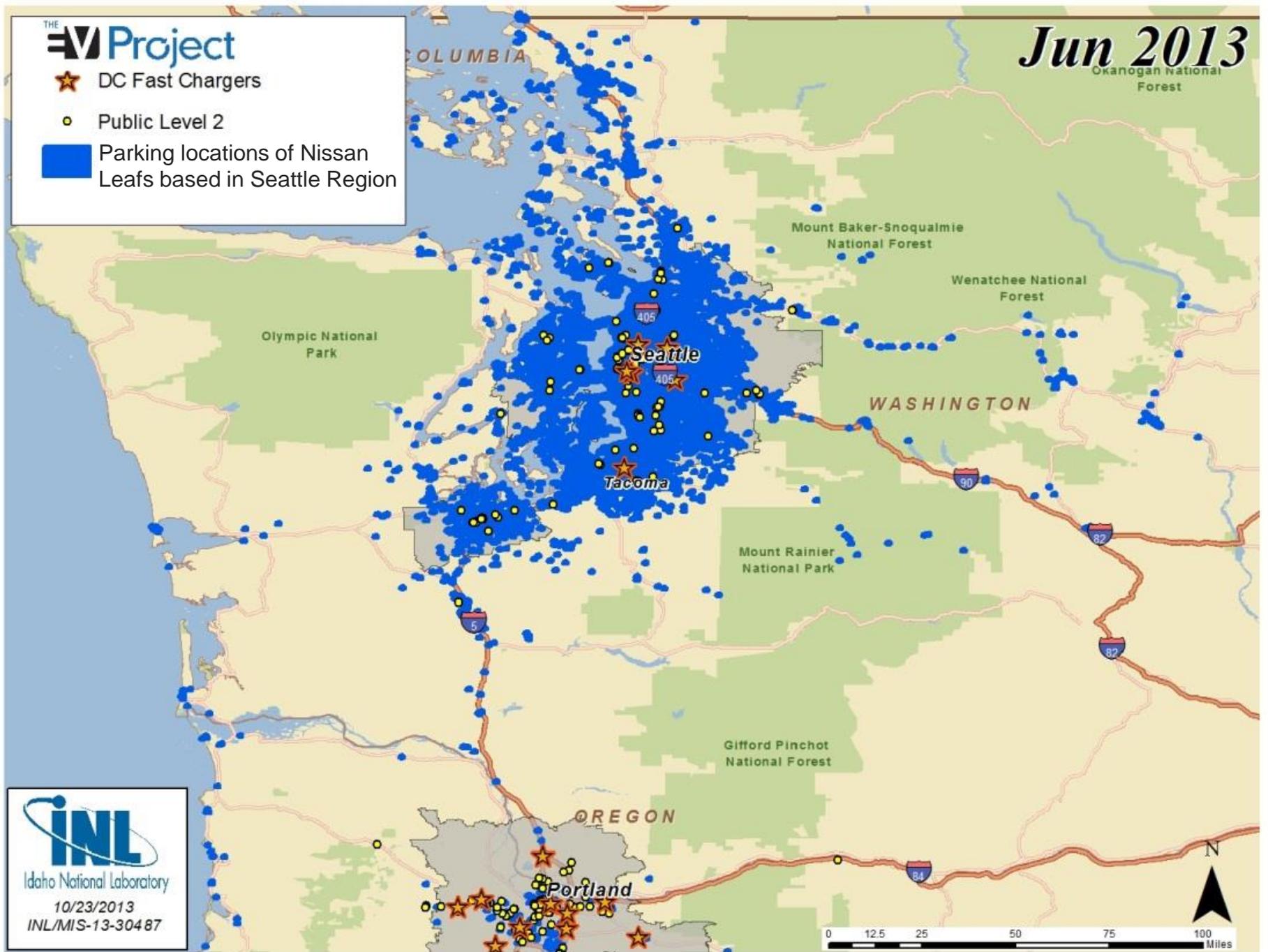
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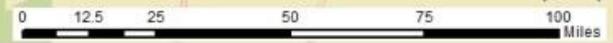
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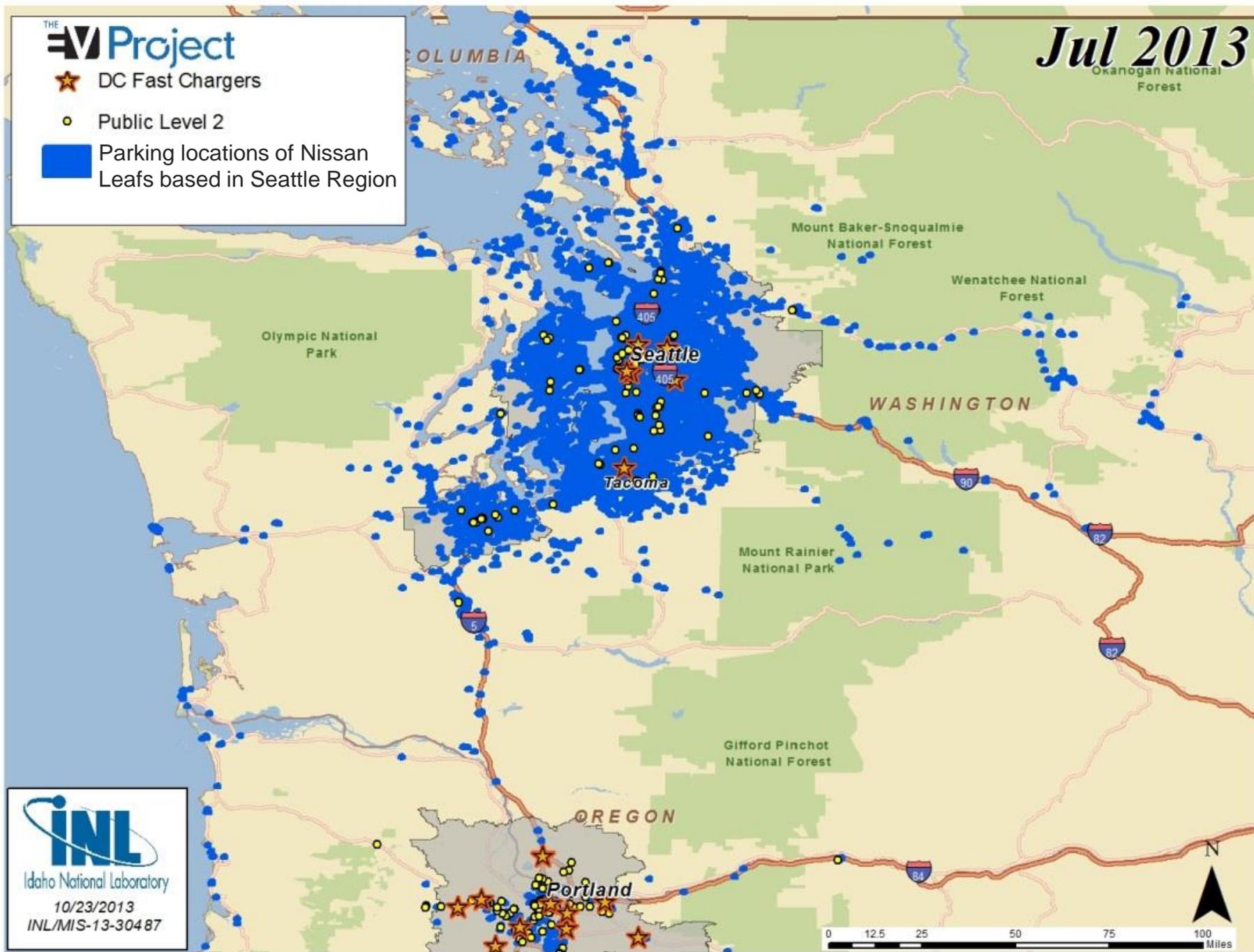
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■ Parking locations of Nissan Leafs based in Seattle Region

Jul 2013

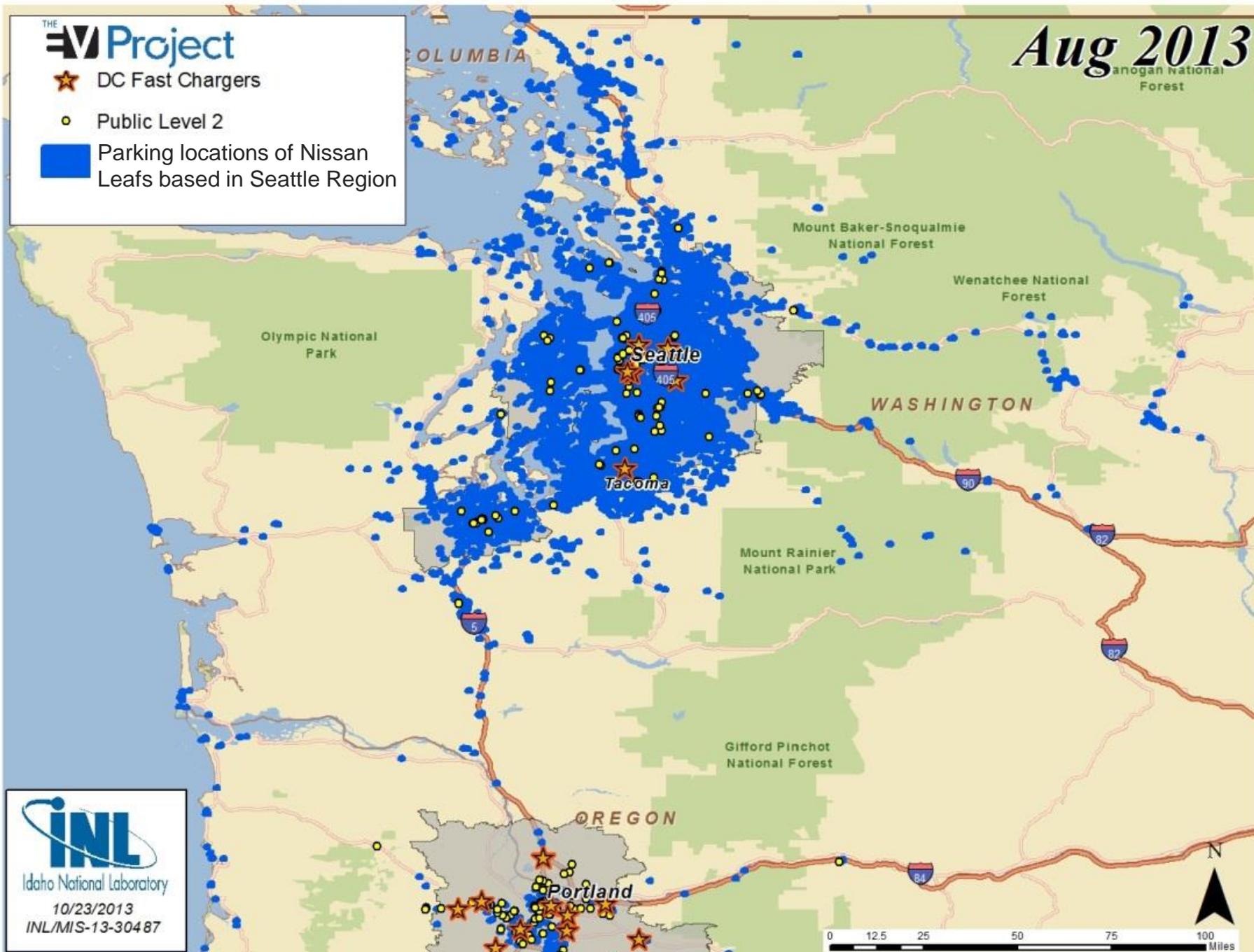
Okanogan National Forest



THE **EV Project**

- ★ DC Fast Chargers
- Public Level 2
- Parking locations of Nissan Leafs based in Seattle Region

Aug 2013
Anogan National Forest

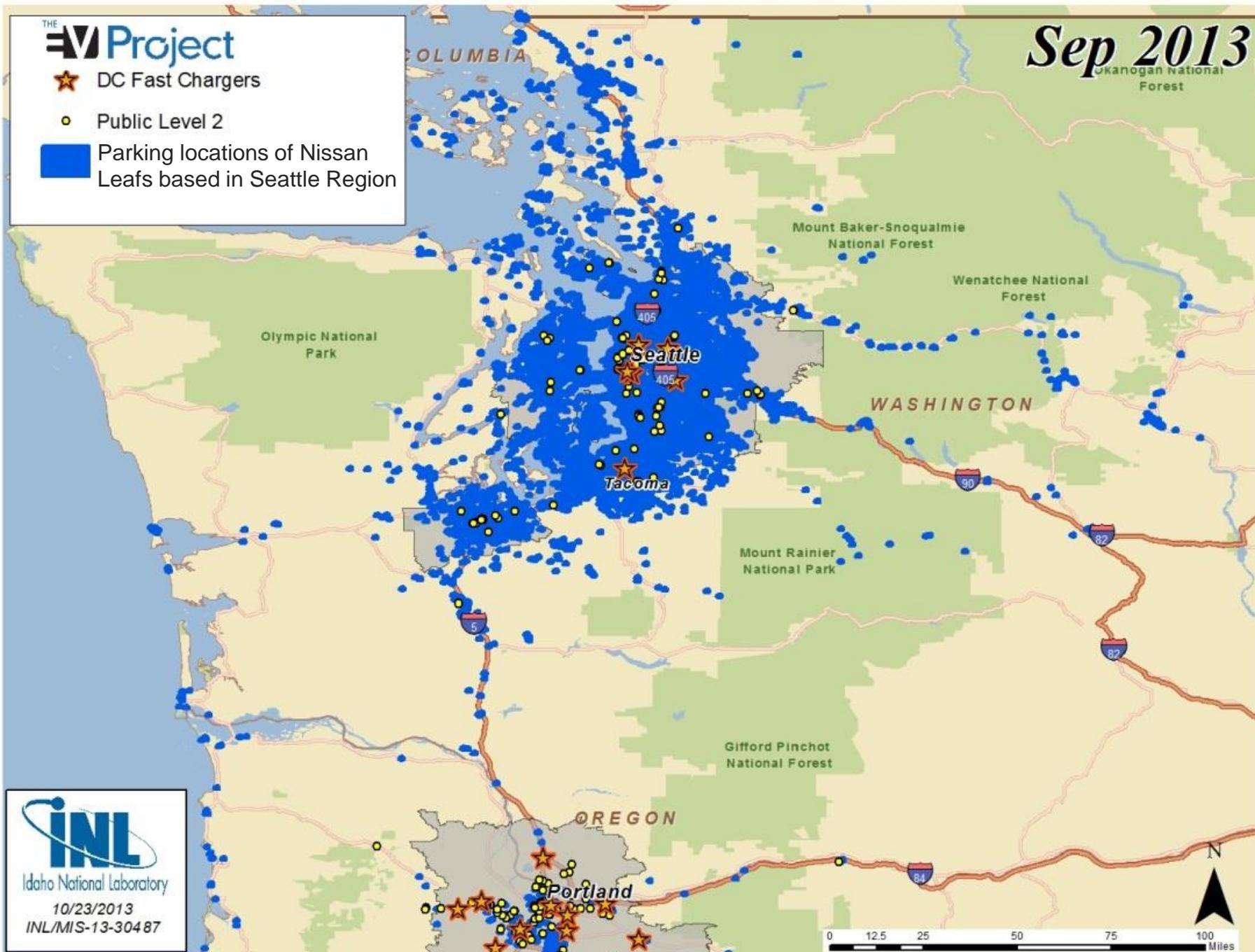


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THE **EV** Project

- ★ DC Fast Chargers
- Public Level 2
- Parking locations of Nissan Leafs based in Seattle Region

Sep 2013

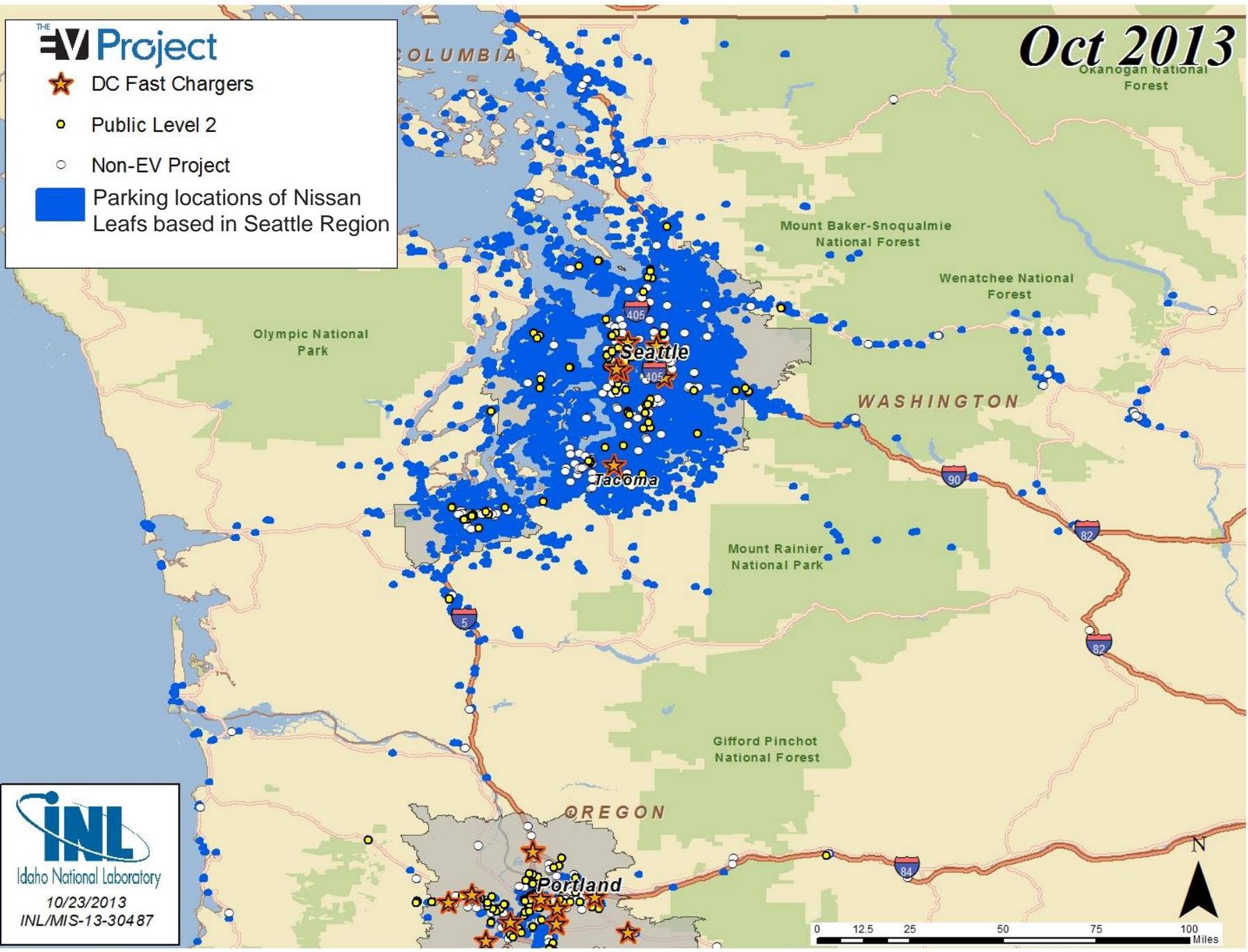


THE **EV** Project

- ★ DC Fast Chargers
- Public Level 2
- Non-EV Project
- Parking locations of Nissan Leafs based in Seattle Region

Oct 2013

Okanogan National Forest



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10/23/2013

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Publications coming soon:

- **Q4 2013 reports**
- **White papers on**
 - Leaf L2 vs. DCFC usage,
 - public charging venues,
 - workplace charging case studies
 - EVSE installation costs
- **and more**

For all EV Project and ChargePoint America publications, visit

avt.inl.gov/evproject.shtml

avt.inl.gov/chargepoint.shtml

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