The Connection between Investments in Bus Stops, Ridership, and ADA Accessibility

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TRB 99th Annual Meeting, Washington, DC
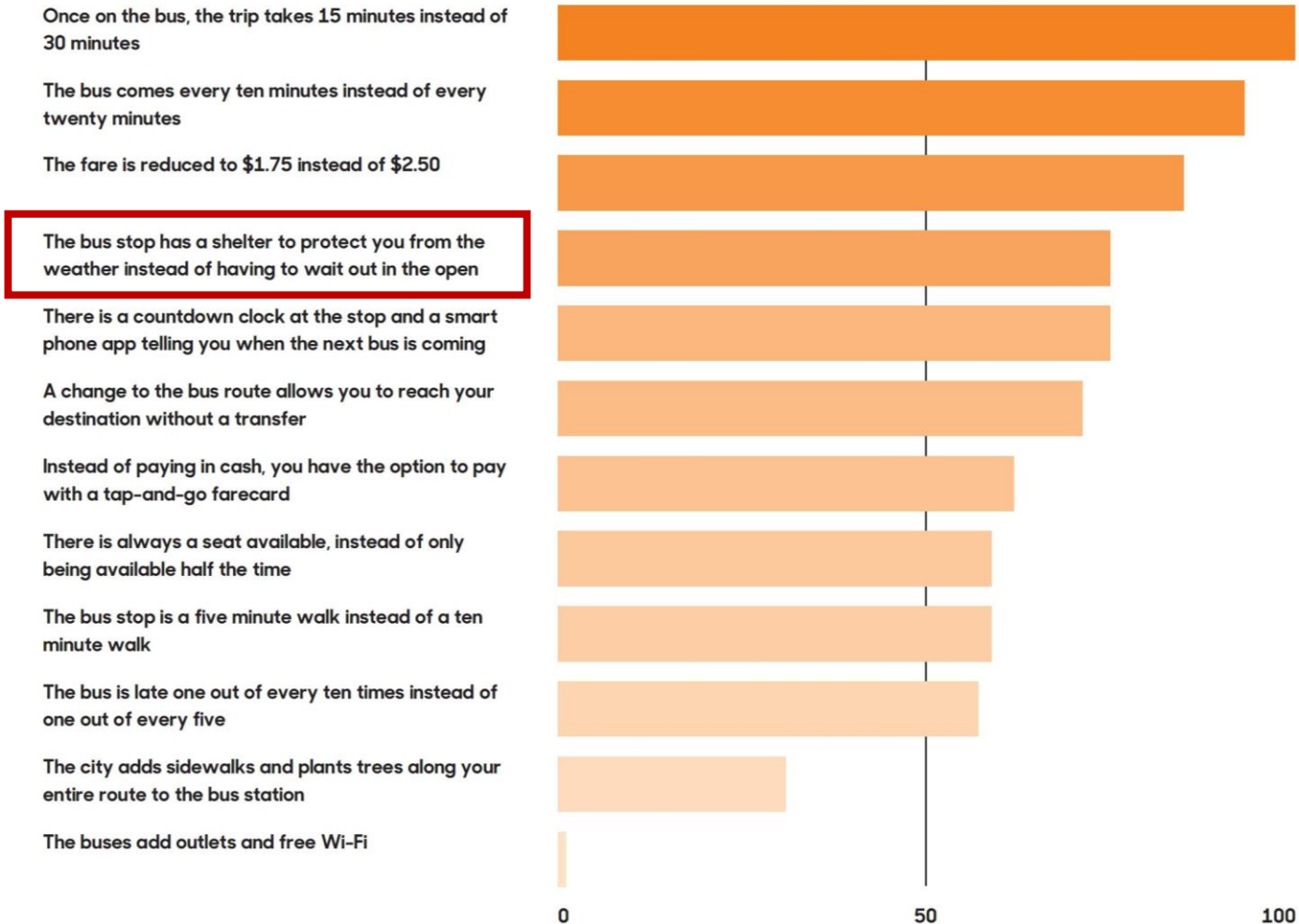January 14, 2020

2016 Sorriest Bus Stop in America
by STREETBLOG

Colesville Road and Crestmoor Drive, Silver Spring, MD

Source: Google Street View

2018 Sorriest Bus Stop in America
by STREETBLOG

Westbound Lougheed Hwy and Old Dewdney Trunk Rd, Pitt Meadows, BC, Canada

Source: Google Street View

Shelter is important

Relative Importance of Service Improvements

Once on the bus, the trip takes 15 minutes instead of 30 minutes

The bus comes every ten minutes instead of every twenty minutes

The fare is reduced to $1.75 instead of $2.50

The bus stop has a shelter to protect you from the weather instead of having to wait out in the open

There is a countdown clock at the stop and a smart phone app telling you when the next bus is coming

A change to the bus route allows you to reach your destination without a transfer

Instead of paying in cash, you have the option to pay with a tap-and-go farecard

There is always a seat available, instead of only being available half the time

The bus stop is a five minute walk instead of a ten minute walk

The bus is late one out of every ten times instead of one out of every five

The city adds sidewalks and plants trees along your entire route to the bus station

The buses add outlets and free Wi-Fi

0   50   100

Riders with Disabilities Want to Use Regular Bus Service

28% of riders who currently use only ADA paratransit

53% of riders who currently use both ADA paratransit and regular bus services
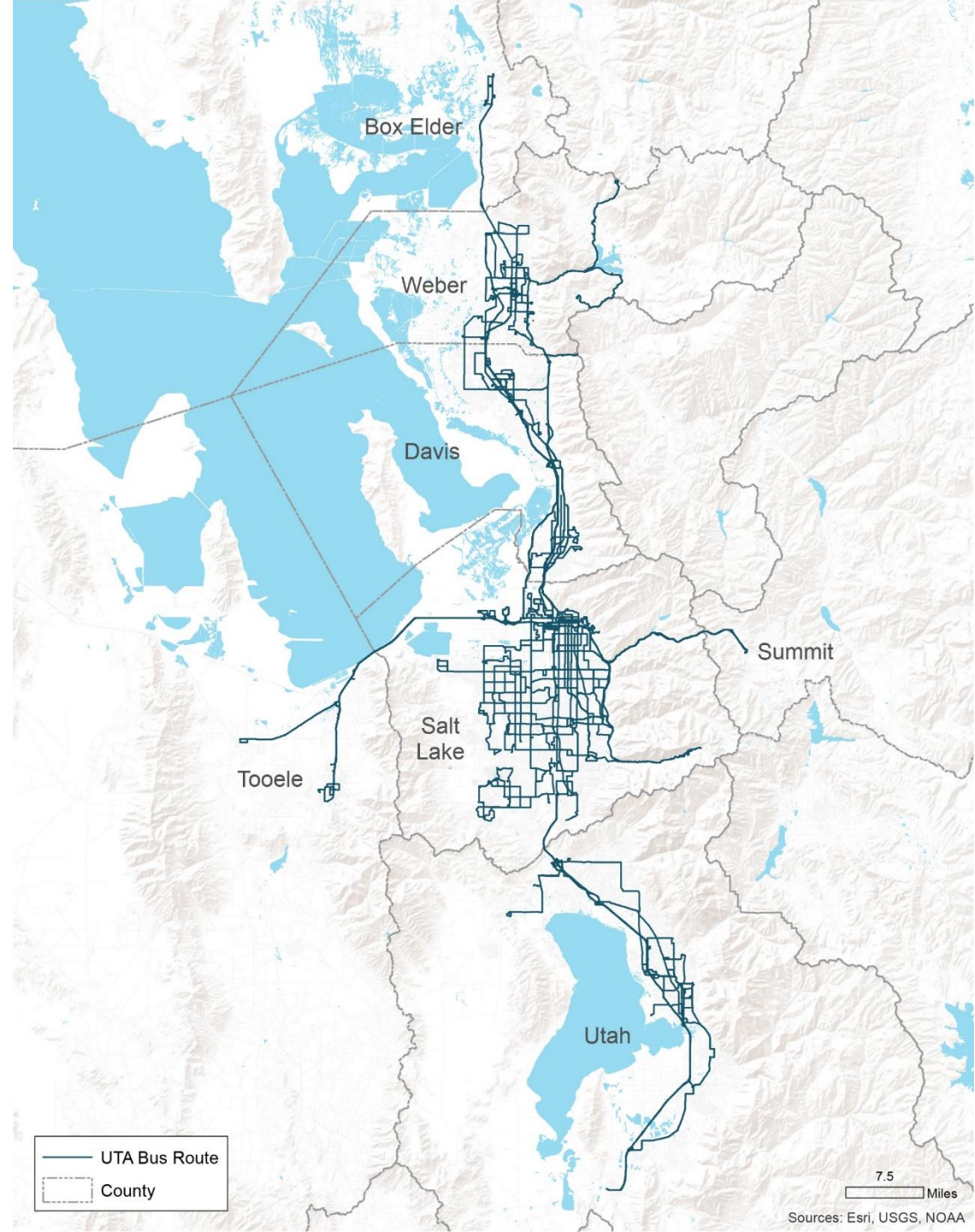
Barriers to using regular bus service
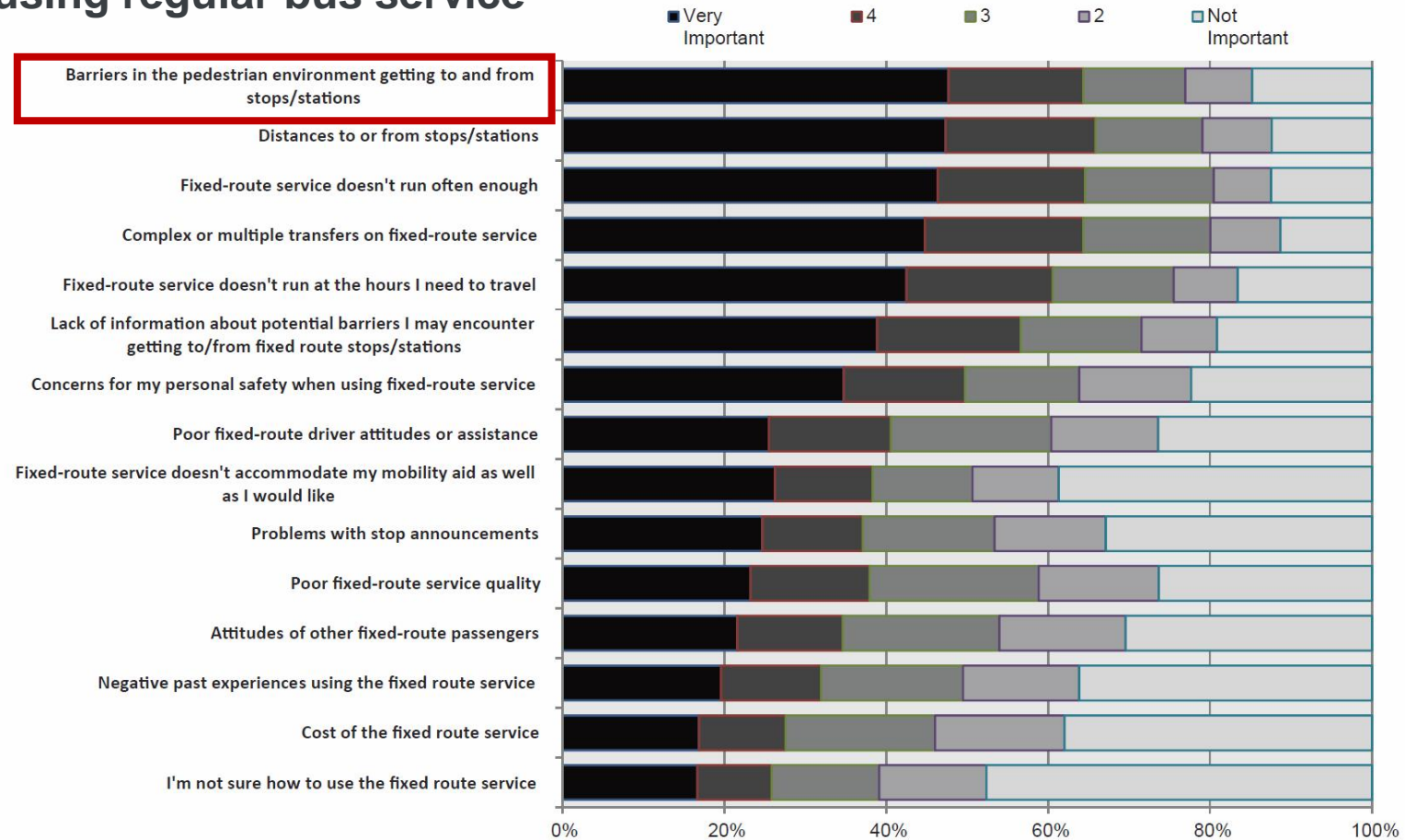
source: Thatcher & Ferris, 2013
n = 1,927 nationwide

Study Area

Utah Transit Authority (UTA)

Service Area

Box Elder, Weber, Davis, Tooele, Salt Lake, Summit and Utah County

UTA Bus Stops: Amenities

Total Bus Stops: 6,347

- benches: 497 (**7.8%**)
- shelters: 449 (**7.1%**)
- trash cans: 542 (**8.5%**)

source: Elias Flores, BYU 2016

UTA Bus Stops: ADA Compliance

ADA Compliance Requirement:

- 8'x5' landing zone
- Slope under 2%
- Hard, stable surface
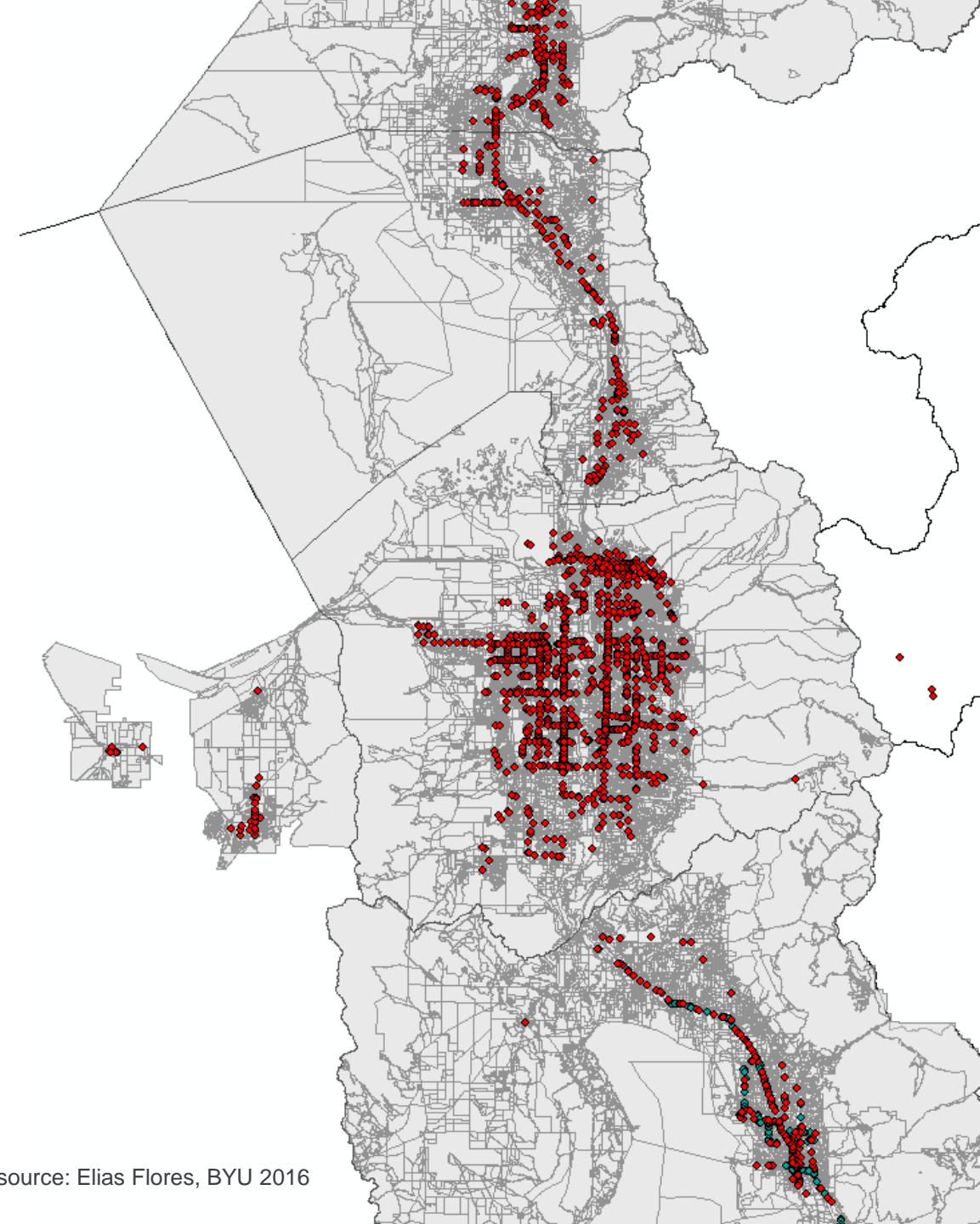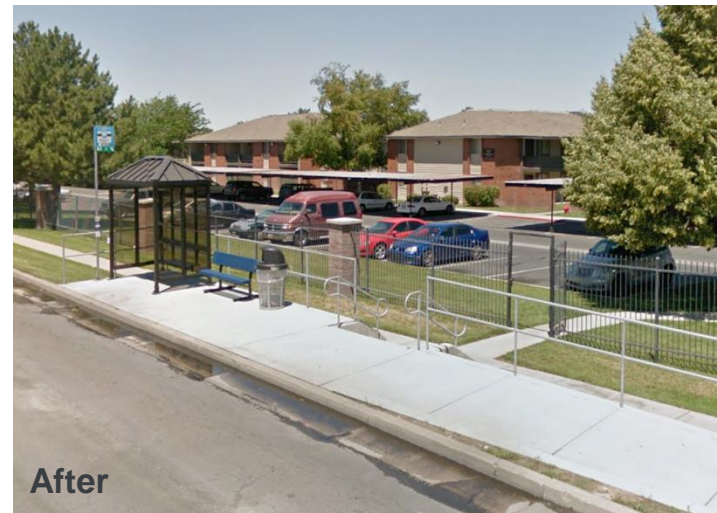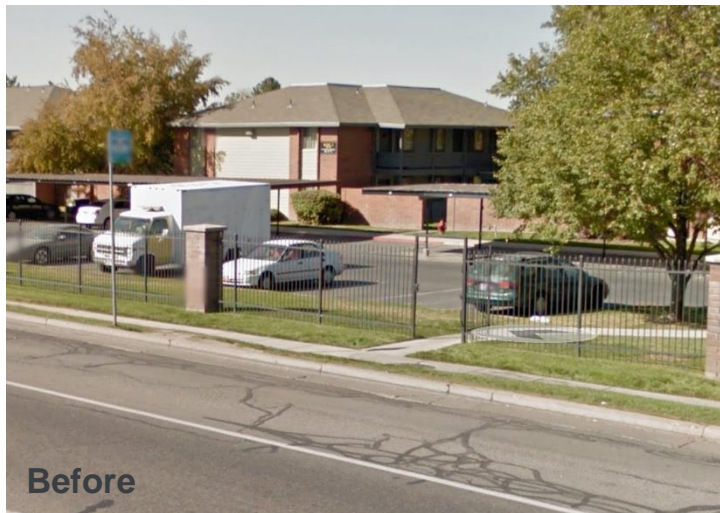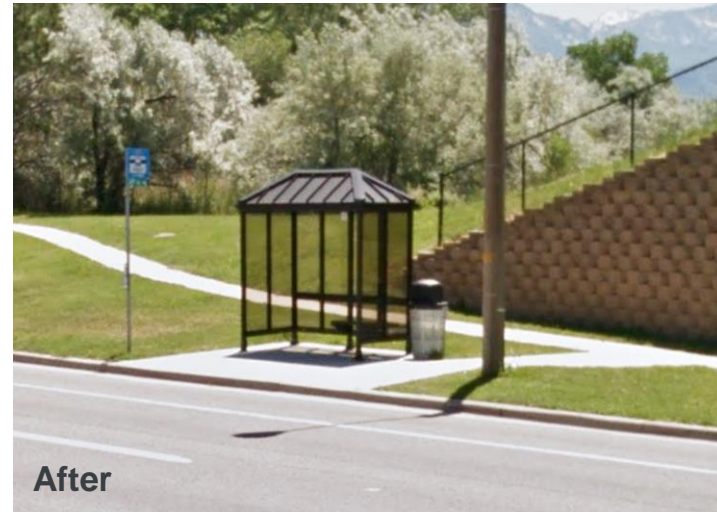- Connected to path/sidewalk
- Free from obstructions

UTA Bus Stops: ADA Compliance
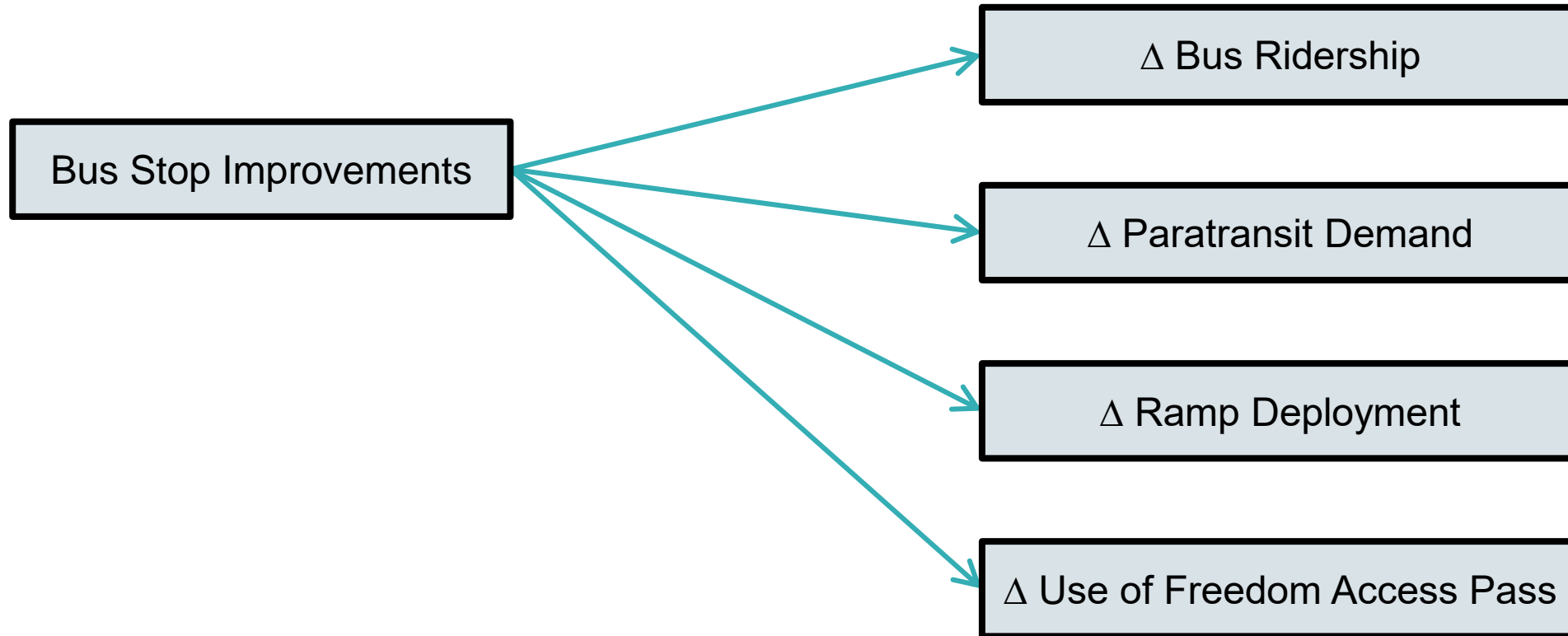
34% of UTA bus stops are

ADA-Compliant

- Box Elder: 23%
- Weber: 33%
- Davis: 23%
- Salt Lake: 36%
- Tooele: 35%
- Utah: 38%

source: Elias Flores, BYU 2016

UTA Bus Stop Amenity Improvements

Research Questions

Methods

- Interventions are not randomly assigned.

- Simple comparison between improved and unimproved stops will be biased.

Propensity scores
- a conditional probability of treatment assignment, given observed covariates
- reduces all information in the predictors to one number

Propensity score weight regression

- neutralize the influence of non-treatment-related differences between treated and untreated subjects
- all subjects are used and the values of each case are weighted
- applied initially in social science, medical, and epidemiological research to estimate the treatment effects of non-experimental data

Data & Variables

- **Physical Stop Data**

- **Demographic & Built Environment Data**

- **Travel Behavior and Transit Service Data**

    Bus Ridership Data

    ADA Paratransit Deployment Data

    Ramp Deployment Data

    Freedom Access Pass Data

- **Physical Stop Data**

  - **Identifying treatment group stops**

    - Newly-improved between the beginning of 2014 and the end of 2017

    - With an ADA-compliant concrete pad, a shelter, and a bench

    - Excluded: stops on ski-bus routes, at rail-transit stations, in remote rural areas

  - **Identifying control group stops**

    - Remain unimproved by the end of 2017

    - Excluded: stops on ski-bus routes, at rail-transit stations, in remote rural areas

- **Physical Stop Data**

Treatment group (N=87)

Control group (N=3,707)

★ Treated Stops

· Control Stops
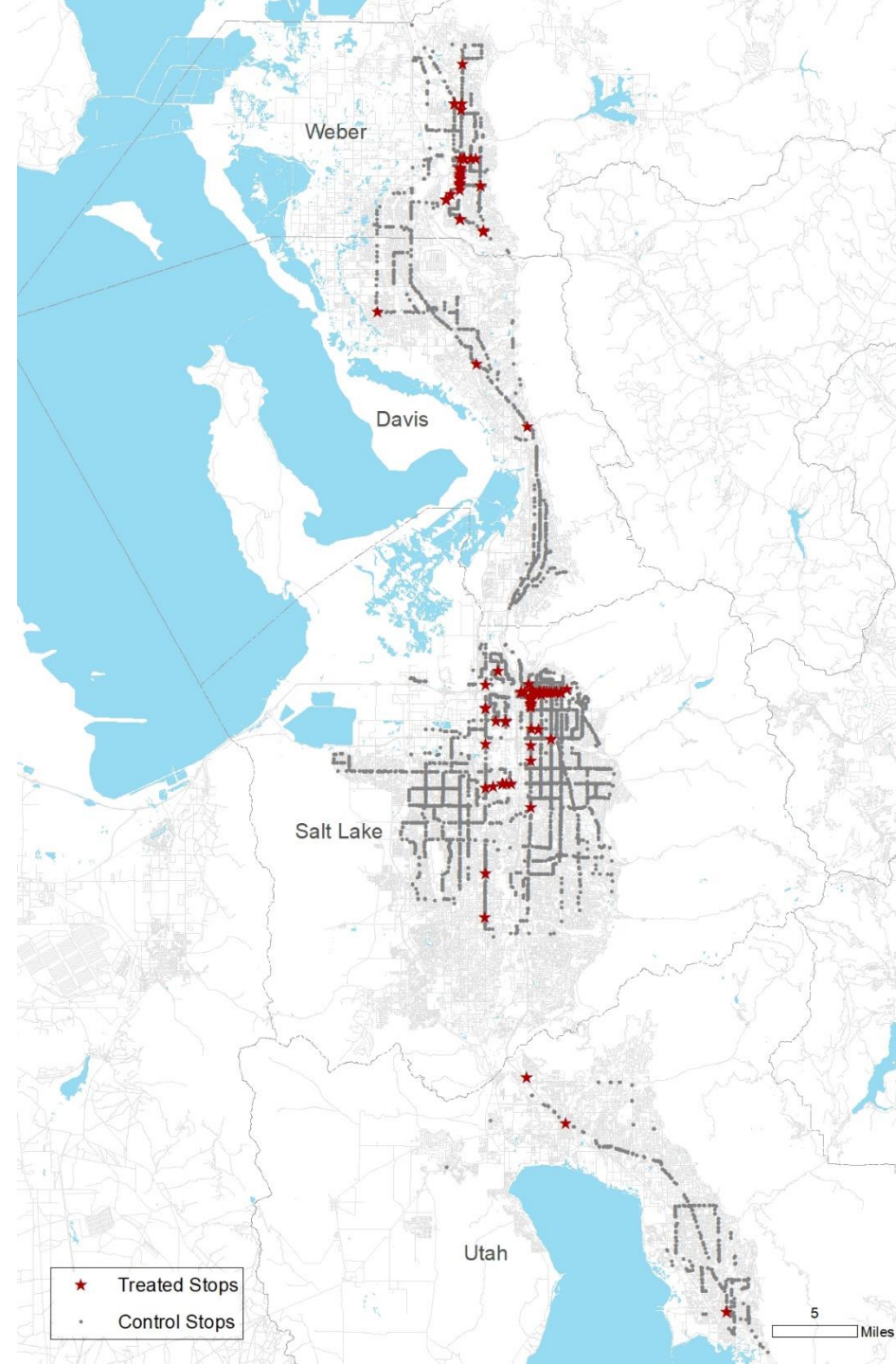
- ## Demographic and Built Environment Data

Variables	Description
White	% of Non-Hispanic white population
Worker	% of total workers 16 years and over
Commuter by car	% of workers who commute by car
Working at home	% of workers who work at home
Household	Total household
Household size	Household size
Household living alone	Household living alone
Household with 18	% of Households with one or more people under 18 years
Household with 65	% of Households with one or more people 65 years and over
Students in college	Students enrolled in college, graduate or professional school
Higher education	Higher educational attainment for the population 25 years and over
Median household income	Median household income
Renter	% of renter occupied household
Job	Total job
Household with poverty level	% of household annual income below poverty level
Household with public assistance	Household with public assistance income
No car	% of household with no vehicle available
Disability	% of Population 18 years and over with a disability
Entropy	Land use mix
Activity Den	Activity density (population + employment / gross land area in square mile)
JobPop balance	Job-Population balance within a quarter mile buffer
Intersection Den	Intersection density
Transit stop Den	Transit stop density
Employment within 10 min by car	% of regional employment within 10 min by car in a TAZ where a stop located in
Employment within 30 min by car	% of regional employment within 30 min by car in a TAZ where a stop located in
Employment within 30 min by transit	% of regional employment within 30 min by transit in a TAZ where a stop located in

- **Stop-level Travel Behavior and Transit Service Data**

  - **Bus Ridership**

    - APC(Automatic Passenger Counting) data

    - Annual weekday ridership per stop

  - **Paratransit Deployment**

    - ADA paratransit pick-ups in a ¼ mile buffer of each stop

  - **Ramp Deployment**

    - All ramp deployment for each stop

  - **Use of Freedom Access Pass**

    - Freedom Access Pass: A card given to patrons who qualify for ADA paratransit to use scheduled service transit free of charge

    - Tap-on/tap-off data with stop info

Stop Improvements and Change in Bus Ridership & ADA Paratransit Deployment

Variable	ΔBus Ridership				ΔParatransit Ridership			
	Unweighted		Weighted		Unweighted		Weighted	
	Estimate	Std. Error	Estimate	Std. Error	Estimate	Std. Error	Estimate	Std. Error
(Intercept)	1378.554	2339.009	13340.000 ***	3438.000	1335.794 ***	237.2951	1163.000 ***	285.100
Bus Stop Treatment	487.745	361.529	**719.300** ***	**187.300**	-17.642	35.70515	**-28.450** *	**15.030**
White	-3.961	6.631	-6.751	9.645	-0.679	0.672	-2.349 **	0.795
Worker	20.580	18.116	36.610	26.570	-8.448 ***	1.83684	-11.290 ***	2.202
Commuter by car	-53.374 ***	14.541	-151.200 ***	21.210	-2.665 *	1.47376	0.474	1.757
Working at home	-100.327 **	32.300	-470.600 ***	46.400	-4.740	3.27231	-8.462 *	3.844
Household size	407.173 *	233.469	1302.000 ***	360.000	-32.491	23.67261	-0.441	29.910
Household	1.476 *	0.864	5.323 ***	1.247	-0.179 *	0.08763	-0.462 ***	0.103
Household living alone	-0.909	0.746	-5.106 ***	1.027	0.089	0.07563	0.331 ***	0.085
Household with 18	16.669	12.241	-46.480 **	18.000	-5.075 ***	1.24083	-6.504 ***	1.493
Household with 65	15.067	12.232	27.800 *	16.860	-6.015 ***	1.23939	-9.013 ***	1.385
Students in college	-0.292	0.179	-1.367 ***	0.267	-0.025	0.01815	-0.003	0.022
Higher education	-0.152	0.258	0.019	0.387	0.026	0.02611	0.080 *	0.032
Median household income	14.014 *	6.160	35.290 ***	9.456	-0.973	0.62466	0.591	0.779
Renter	5.330	6.565	-54.430 ***	9.200	-0.697	0.66705	5.906 ***	0.763
Job	0.433 *	0.210	1.258 ***	0.305	-0.049 *	0.02133	-0.092 ***	0.025
Household below poverty level	-14.311	15.068	39.900 *	22.130	-2.804 *	1.5273	-11.220 ***	1.830
Household with public assistance	-1.564	2.693	1.644	3.951	0.460 *	0.273	-0.109	0.328
No car	32.721 *	19.622	-30.340	27.850	-6.319 **	1.99018	-8.769 ***	2.291
Disability	-39.016	29.273	-176.300 ***	42.490	-0.162	2.9648	13.330 ***	3.499
Activity Den	-0.245	0.161	-0.691 **	0.235	0.042 *	0.01631	0.075 ***	0.019
JobPop Balance	58.920	298.800	-1010.000 *	436.400	-55.076 *	30.30502	-92.760 **	35.990
Entropy	-44.702	341.714	-1468.000 **	486.800	35.585	34.72626	-30.550	40.780
Intersection Den	1.176	1.830	-4.891 *	2.832	-0.201	0.18564	0.175	0.235
Transit Stop Den	0.592	7.366	23.090 *	9.814	-1.871 *	0.74751	-4.778 ***	0.813
Employment within 10 min by car	17.719	16.444	0.321	21.730	-1.055	1.66765	-0.507	1.800
Employment within 30 min by car	-5.182	3.773	-19.890 ***	5.470	0.715 *	0.38244	-0.063	0.454
Employment within 30 min by transit	1.968	12.415	-5.809	17.300	1.512	1.25839	4.511 **	1.436
Bus ridership in 2013	0.048 ***	0.014	0.054 ***	0.010	-0.370 ***	0.01166	-0.4531 ***	0.015
F	6.65		37.33		39.48		49.16	
Prob<F	< 0.001		< 0.001		< 0.001		< 0.001	
R-squared	0.047		0.217		0.230		0.268	
Adjusted R-squared	0.040		0.212		0.221		0.262	

*Signif.codes ***: p<.001, **: p<.01, *: p<.1*

Stop Improvements and Change in Ramp Deployment and Use of Freedom Access Pass

Variable	ΔRamp Deployment			ΔUse of Freedom Access Pass		
	Estimate		Std. Error	Estimate		Std. Error
(Intercept)	-17.950		39.220	128.800	***	24.050
Bus Stop Treatment	**16.260**	***	**4.534**	**15.400**	***	**2.712**
White	0.302		0.209	-0.401	**	0.127
Household size	-7.295		5.553	-17.410	***	3.388
Household	0.042	**	0.013	-0.007		0.008
Household living alone	-0.048	***	0.013	-0.021	*	0.008
Household with 65	0.449		0.338	-0.312		0.204
Higher education	-0.031	***	0.009	-0.008		0.006
Median household income	0.208		0.222	0.061		0.136
Renter	-0.815	***	0.223	0.030		0.136
Household below poverty level	-0.870	*	0.469	-1.220	***	0.286
Household with public assistance	0.229	*	0.096	0.018		0.058
No car	3.495	***	0.648	2.150	***	0.396
Disability	-4.575	***	1.034	-2.831	***	0.626
Activity Den	0.006	***	0.001	0.004	***	0.001
JobPop Balance	10.290		10.530	15.940	*	6.436
Entropy	53.350	***	11.730	-9.503		7.149
Intersection Den	-0.108		0.066	-0.036		0.040
Transit Stop Den	0.813	***	0.235	0.367	*	0.143
Employment within 10 min by car	2.118	***	0.535	-0.651	*	0.327
Employment within 30 min by car	-0.511	***	0.137	-0.383	***	0.083
Employment within 30 min by transit	-0.420		0.428	0.794	**	0.260
Ramp Deployment / Freedom Access Card Tap-on in 2013	2.182	***	0.042	0.072	***	0.016
F	270.20			34.54		
Prob<F	<0.001			< 0.001		
R-squared	0.612			0.168		
Adjusted R-squared	0.610			0.163		

*Signif. codes ***: p<.001, **: p<.01, *: p<.1*

Stop-level Effects of Stop Improvements

Average annual effect per stop for treatment group

	Observed Total Effect (A)	Average Bus Stop Treatment Effect (ATE)	Proportion of Treatment Effect in Total Effect (ATE)/(A)
∆Bus Ridership	1406.44	719.30	51%
∆Paratransit Ridership	-21.28	-28.45	134%
∆Ramp Deployment	142.64	16.26	11%
∆Freedom Access Pass Use	37.57	15.40	41%

Conclusion

- Improvements in bus stop amenities are associated with the **increase in bus ridership** and **decrease in ADA paratransit demand**.

- The increased ridership may be tied to **modal shifts from ADA paratransit to scheduled-service buses**.

- Improving stops is a way to **increase accessibility to transit and to the opportunities that transit serves** for those with mobility-related disabilities.

Limitations

- **Limited geographical scope and sample**

- **Uncontrolled variables affecting transit use by those with disabilities**

Source: Google Street View

Thank you!

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Descriptive Statistics of Covariates

Variables	Mean	SD	Median	Min	Max
White	71.52	17.46	75.74	19.01	97.82
Worker	48.65	6.59	47.82	26.59	68.84
Commuter by car	86.28	8.29	88.68	43.64	97.38
Working at home	4.21	2.27	3.94	0.04	15.07
Household	1442.91	802.02	1363.88	3.55	5142.00
Household size	3.02	0.64	2.96	1.42	7.87
Household living alone	415.82	445.51	281.51	0.68	3139.25
Household with 18	37.68	12.42	37.85	3.73	83.07
Household with 65	20.99	7.49	20.36	1.95	50.70
Students in college	448.00	657.86	279.93	0.63	9166.19
Higher education	1639.71	934.67	1501.21	3.05	5868.44
Median household income	56.34	18.34	54.54	8.24	180.75
Renter	39.92	19.63	38.70	1.35	99.92
Job	2177.60	2482.77	1361.33	32.53	18988.65
Household with poverty level	14.78	9.31	12.88	0.39	66.03
Household with public assistance	30.74	27.38	23.31	0.00	160.35
No car	6.93	5.95	5.10	0.00	48.98
Disability	9.53	3.22	9.06	1.12	25.19
Entropy	0.63	0.19	0.63	0.00	1.06
Activity Den	7926.55	4102.38	7318.23	230.72	27940.50
JobPop balance	0.59	0.26	0.61	0.01	1.00
Intersection Den	141.81	43.92	144.00	11.00	278.00
Transit stop Den	21.57	12.20	20.00	1.00	71.00
Employment within 10 min by car	10.78	6.70	9.90	0.00	30.12
Employment within 30 min by car	53.39	20.13	64.28	0.00	75.53
Employment within 30 min by transit	13.56	8.50	12.84	0.00	35.22
Change in Bus ridership	432.65	3170.72	103.21	-43029.71	123977.89
Change in Paratransit ridership	-9.79	356.88	0.00	-3735.00	4518.00
Change in Ramp Deployment	39.13	101.17	5.00	-147.00	1405.00
Change in use of Freedom Access Pass	5.67	46.27	0.00	-990.00	498.00