Highlights from the Green Lane: A Comprehensive Evaluation of Protected Cycling Facilities

Christopher Monsere  
*Portland State University, monsere@pdx.edu*

Jennifer Dill  
*Portland State University, jdill@pdx.edu*

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Highlights from
the Green Lane:
A Comprehensive
Evaluation of
Protected Cycling Facilities

Christopher M. Monsere, Jennifer Dill
Kelly Clifton, Nathan McNeil, Nick Foster,
Tara Goddard
Portland State University

PSU Friday Transportation Seminar
May 2, 2014

Photo credit: Nathan McNeil, PSU
Research Objectives

• A field-based evaluation of protected bikeways in five U.S. cities to study:
  – Safety of users (both perceived and actual)
  – Effectiveness of the design
  – Perceptions of residents and other road users
  – Attractiveness to more casual cyclists
  – Change in economic activity
Dearborn Street - Chicago, IL
Two-way protected lane on one-way street

Milwaukee Avenue - Chicago, IL
One-way protected lane on both sides on a two-way street

Multnomah Street – Portland, OR
One-way protected lane on both sides on a two-way street

L Street – Washington, DC
One-way protected lane on a one-way street
**Rio Grande Street - Austin, TX**
- **Two-way protected lane on one-way street**

**Barton Springs Road – Austin, TX**
- **One-way protected lane on the south side of the road (other direction is shared use path)**

**Oak/Fell Streets – San Francisco, CA**
- **Couplet of one-way protected lanes on one-way streets**

**Bluebonnet Lane – Austin, TX**
- **Two-way protected lane on a two-way street**
Data Collected

• Resident Surveys
  – 9,617 surveys mailed
  – 2,283 returned (34% used online option)
  – 24% response rate

• Bicyclist Surveys
  – 3,409 bicyclists intercepted
  – 1,111 surveys completed
  – 33% response rate

• Video Recorded at Intersections
  – 16 locations in 4 cities
  – 204 hours analyzed
  – 21,728 bicyclists and 23,347 turning vehicles observed
Source: Resident and Bicyclist surveys, Green Lane evaluation
Residents by Primary Commute Mode

- Non-commuter
- Mix
- Transit
- Bicycle
- Foot
- Car / Truck

Source: Resident surveys, Green Lane evaluation
Today...

1. Did the number of people bicycling change?
2. How well do the designs work?
3. Do the lane improve people’s perceptions of safety?
4. What do residents think about the lanes?
5. How attractive are the lanes for less comfortable cyclists?
1. Did the number of people bicycling change?
Change in Observed Bicycle Volumes

Source: City-provided before and after counts, PSU video counts, ACS Survey
Before the new facility was built, how would you have made this trip?

Source: Cyclist intercept surveys, Green Lane evaluation
2. How well do the designs work?
Design Elements Evaluated

• Intersections
  – Mixing zones
  – Fully signalized

• Providing curb access
  – Loading zone
  – Transit stops

• Other design elements
  – Width
  – Green pavement marking
  – Minor driveways
Mixing Zone Designs

NACTO-Style Yield Shark Tooth Mixing Zone
Photo from survey (shown): Multnomah and NE 9th, Video Location(s): Multnomah and NE 9th

Flexpost Delimited Mixing Zone with Advisory Bike Lane (ABL)
Photo from survey (shown): L Street
Video Location(s): L Street/15th Street, L Street/Connecticut

Mixing Zone with Advisory Bike Lane (ABL)
Photo from survey (shown): Oak St. and Divisadero St.
Video Location(s): Oak St. and Divisadero St.

Mixing zone w/ green-back sharrow mixing zone
Photo from survey (shown): Oak St. and Broderick St.
Video Location(s): Oak St. and Broderick St

Mixing Zone with Full Green Skip Marking
Photo from survey (shown): Fell St. and Broderick St.
Video Location(s): Fell St. and Baker

Mixing Zone with Advisory Bike Lane (ABL)
Photo from survey (shown): Fell St. and Divisadero St.
Video Location(s): No video
Total Video Observations

DC
- Connecticut Avenue
- 15th Street
- Btwn 19th St / 18th St (Hotel)

SF
- Divisadero Street
- Broderick Street
- Baker Street
- 11th Street (Transit Stop)
- 11th Street (intersection)

PDX
- 9th Street
- 7th Street
- Grand Avenue
- Elston Avenue
- 11th Street (intersection)

CHI
- Desplaines Street
- Randolph Street
- Madison Street
- Congress Parkway

Turning/Merging Motor Vehicles
Bicyclists

Number Observed (6 hours)

0 1,000 2,000 3,000 4,000
<table>
<thead>
<tr>
<th>Mixing Zone Design</th>
<th>Survey</th>
<th>Video</th>
<th>Survey</th>
<th>Video</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent Strongly Agreeing Bicyclists “Understand”</td>
<td>Correctly Identified Location</td>
<td>Correct Lane Use</td>
<td>Percent</td>
</tr>
<tr>
<td></td>
<td>Thorough Bicycles</td>
<td>Bicycle Turning Right</td>
<td>Turning Motorist</td>
<td>Through Bicyclist</td>
</tr>
<tr>
<td>Flexpost Delimited Mixing Zone with Advisory Bike Lane (ABL): L Street</td>
<td>85%</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>NACTO-Style Yield Shark Tooth Mixing Zone: Multnomah/ 9th</td>
<td>63%</td>
<td>51%</td>
<td>98%</td>
<td>79%</td>
</tr>
<tr>
<td>Mixing Zone with Advisory Bike Lane (ABL): Oak/ Divisadero</td>
<td>75%</td>
<td>94%</td>
<td>73%</td>
<td>92%</td>
</tr>
<tr>
<td>Mixing Zone with Advisory Bike Lane (ABL): Fell/ Divisadero</td>
<td>81%</td>
<td>93%</td>
<td>74%</td>
<td>97%</td>
</tr>
<tr>
<td>Mixing zone w/ green-back sharrow mixing zone: Oak/Broderick</td>
<td>71%</td>
<td>79%</td>
<td>97%</td>
<td>95%</td>
</tr>
<tr>
<td>Mixing Zone with Full Green Skip Marking: Fell/ Broderick or Fell/Baker</td>
<td>74%</td>
<td>73%</td>
<td>96%</td>
<td>95%</td>
</tr>
</tbody>
</table>
Dearborn and Madison, Chicago, IL

Photo: C. Monsere
Bicycle Signals on Dearborn

• Using the small bicycle in the bicycle signal lens is a good way to communicate the signal is only for bicycles
  – 87% agree

• I like that bicyclists and turning cars each have their own signal
  – 74% agree

• At these intersections, it is always clear to me which signal I should use as a motorist
  – 66% agree
People on Bicycles

- **Waited for green/legal right-turn on red**
- **Proceeded illegally on red**

<table>
<thead>
<tr>
<th>Location</th>
<th>Waited for Green/Legal Right-Turn on Red</th>
<th>Proceeded Illegally on Red</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dearborn/ Randolph</td>
<td>92%</td>
<td>8%</td>
</tr>
<tr>
<td>Dearborn/ Madison</td>
<td>77%</td>
<td>23%</td>
</tr>
<tr>
<td>Dearborn/ Congress</td>
<td>93%</td>
<td>7%</td>
</tr>
</tbody>
</table>

People in Motor Vehicles

- **Legal Turn on Green**
- **Illegal Turn on Red Arrow**
- **Jumped into crosswalk**

<table>
<thead>
<tr>
<th>Location</th>
<th>Legal Turn on Green</th>
<th>Illegal Turn on Red Arrow</th>
<th>Jumped into Crosswalk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dearborn/ Randolph</td>
<td>92%</td>
<td>6%</td>
<td>2%</td>
</tr>
<tr>
<td>Dearborn/ Madison</td>
<td>90%</td>
<td>5%</td>
<td>6%</td>
</tr>
<tr>
<td>Dearborn/ Congress</td>
<td>84%</td>
<td>10%</td>
<td>6%</td>
</tr>
</tbody>
</table>
3. Do the lanes improve users’ perception of safety?
Because of the protected bike lanes, the safety of _____ on the street has...

Source: Resident Surveys, Green Lane evaluation
I feel the safety of bicycling on _____ has . . .

Source: Cyclist intercept surveys, Green Lane evaluation
Buffer type affects safety and comfort

Types of buffers used include:

- Flexposts and painted buffer (Fell Street, San Francisco)
- Parked vehicles and flexposts (Milwaukee Avenue, Chicago)
- Semi-permanent planter with colored pavement (Multnomah St., Portland)
The buffer section with ______ between the traffic lanes and the bikeway makes me feel safe.

Source: Cyclist intercept surveys, Green Lane evaluation
...buffer makes me feel safe

Mean Score

Total Width (ft)
Far Edge of Bicycle Facility to Near Edge of Motor Vehicle Lane

(shared-use path)
Buffer comfort

- With planters separating the bikeway
- With a 2-3 foot buffer and plastic flexposts
- With a raised concrete curb
- With a painted buffer and parked cars
- With a painted 2-3 foot buffer
- With a solid painted buffer

Source: Cyclist intercept surveys, Green Lane evaluation
4. What do residents think about the lanes?
Support for Protected Lanes

- Facilities that encourage bicycling for transportation are a good way to improve public health.
- I would support building more protected bike lanes at other locations.
- Because of the protected bike lanes, the desirability of living in my neighborhood has increased.

Source: Resident surveys, Green Lane evaluation
Because of the protected bike lanes,

...my satisfaction with the walking environment on this street

<table>
<thead>
<tr>
<th>Street</th>
<th>Increased</th>
<th>No Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>L Street</td>
<td>36%</td>
<td>53%</td>
</tr>
<tr>
<td>Oak/Fell</td>
<td>33%</td>
<td>49%</td>
</tr>
<tr>
<td>Multnomah</td>
<td>37%</td>
<td>56%</td>
</tr>
<tr>
<td>Milwaukee</td>
<td>19%</td>
<td>56%</td>
</tr>
<tr>
<td>Dearborn</td>
<td>17%</td>
<td>54%</td>
</tr>
<tr>
<td>Bluebonnet</td>
<td>49%</td>
<td>41%</td>
</tr>
<tr>
<td>Barton Springs</td>
<td>58%</td>
<td>37%</td>
</tr>
</tbody>
</table>

...my sense of safety when crossing this street has

<table>
<thead>
<tr>
<th>Street</th>
<th>Increased</th>
<th>No Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>L Street</td>
<td>27%</td>
<td>53%</td>
</tr>
<tr>
<td>Oak/Fell</td>
<td>24%</td>
<td>55%</td>
</tr>
<tr>
<td>Multnomah</td>
<td>35%</td>
<td>57%</td>
</tr>
<tr>
<td>Milwaukee</td>
<td>17%</td>
<td>46%</td>
</tr>
<tr>
<td>Dearborn</td>
<td>18%</td>
<td>38%</td>
</tr>
<tr>
<td>Bluebonnet</td>
<td>34%</td>
<td>57%</td>
</tr>
<tr>
<td>Barton Springs</td>
<td>43%</td>
<td>51%</td>
</tr>
</tbody>
</table>

Source: Resident Surveys, 78% of respondents have walked on street, Green Lane evaluation
Perceptions of residents driving on street

Percent responding increased

<table>
<thead>
<tr>
<th>Street</th>
<th>Percent Responding</th>
<th>Percent Increased</th>
</tr>
</thead>
<tbody>
<tr>
<td>L Street</td>
<td>27%</td>
<td>52%</td>
</tr>
<tr>
<td>Fell</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>Oak</td>
<td>22%</td>
<td>54%</td>
</tr>
<tr>
<td>Multnomah</td>
<td>32%</td>
<td>48%</td>
</tr>
<tr>
<td>Milwaukee</td>
<td>44%</td>
<td>63%</td>
</tr>
<tr>
<td>Dearborn</td>
<td>54%</td>
<td>53%</td>
</tr>
<tr>
<td>Bluebonnet</td>
<td>15%</td>
<td>59%</td>
</tr>
<tr>
<td>Barton Springs</td>
<td>18%</td>
<td>58%</td>
</tr>
</tbody>
</table>

Since the protected bike lanes were built, the amount of time it takes me to drive on this street has . . .

Since the protected bike lanes were built, how safe and predictable bicyclists are acting has . . .
Perceptions about Parking

<table>
<thead>
<tr>
<th>Location</th>
<th>% indicating negative impact on...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oak/Fell (-50 spots)</td>
<td>55%</td>
</tr>
<tr>
<td>Milwaukee (-some)</td>
<td>49%</td>
</tr>
<tr>
<td>L Street (-150 spots)</td>
<td>46%</td>
</tr>
<tr>
<td>Bluebonnet (-some)</td>
<td>44%</td>
</tr>
<tr>
<td>Dearborn (-minimal)</td>
<td>41%</td>
</tr>
<tr>
<td>Multnomah (+20 spots)</td>
<td>30%</td>
</tr>
</tbody>
</table>

- **ability to find a parking spot on the street**
- **how stressful it is to park on the street**
5. How attractive are the lanes for less comfortable cyclists?
By the “Four Types”

I would be more likely to ride a bicycle if motor vehicles and bicycles were physically separated by a barrier.
Because of the protected bike lanes, the safety of _____ on the street has . . .

- **No Way No How**
  - Walking: 17%
  - Driving: 21%
  - Bicycling: 59%

- **Interested But Concerned**
  - Walking: 37%
  - Driving: 41%
  - Bicycling: 88%

- **Enthused and Confident**
  - Walking: 42%
  - Driving: 46%
  - Bicycling: 87%

- **Strong and Fearless**
  - Walking: 37%
  - Driving: 36%
  - Bicycling: 76%

Source: Resident Surveys, Green Lane evaluation
Because of the ____ Street separated bikeway, how often I ride a bicycle overall has . . .

Source: Cyclist intercept surveys, Green Lane evaluation
Summary

• Analysis of data show increased bicycle volumes with some evidence of “attraction”
• Strong improved perception of safety for people riding on the facilities
• Generally positive perceptions for other road users
• Support for the protected lane concept
• Design choices affect safety and comfort
• ....more to come!
Questions?

Thanks to students:
Chase Ballew, Dan Stumpf, Dan Mercer, Lisa Okimoto, Alison Duncan, Belinada Judelman

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## Resident Survey

<table>
<thead>
<tr>
<th>City</th>
<th>Route</th>
<th>Distributed</th>
<th>Paper Returns</th>
<th>Web Returns</th>
<th>Returned</th>
<th>Response Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washington, DC</td>
<td>L Street</td>
<td>1800</td>
<td>148</td>
<td>88</td>
<td>236</td>
<td>13%</td>
</tr>
<tr>
<td>Austin, TX</td>
<td>Bluebonnet Lane</td>
<td>1300</td>
<td>304</td>
<td>135</td>
<td>439</td>
<td>34%</td>
</tr>
<tr>
<td></td>
<td>Barton Springs Road*</td>
<td>300</td>
<td>55</td>
<td>36</td>
<td>91</td>
<td>30%</td>
</tr>
<tr>
<td></td>
<td>Rio Grande Street</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>San Francisco, CA</td>
<td>Oak /Fell</td>
<td>1967</td>
<td>318</td>
<td>199</td>
<td>517</td>
<td>26%</td>
</tr>
<tr>
<td>Chicago, IL</td>
<td>N/S Dearborn Street</td>
<td>1200</td>
<td>121</td>
<td>76</td>
<td>197</td>
<td>16%</td>
</tr>
<tr>
<td></td>
<td>N Milwaukee Avenue</td>
<td>1500</td>
<td>185</td>
<td>126</td>
<td>311</td>
<td>21%</td>
</tr>
<tr>
<td>Portland, OR</td>
<td>NE Multnomah Street</td>
<td>1550</td>
<td>368</td>
<td>124</td>
<td>492</td>
<td>32%</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td></td>
<td><strong>9617</strong></td>
<td><strong>1499</strong></td>
<td><strong>784</strong></td>
<td><strong>2283</strong></td>
<td><strong>24%</strong></td>
</tr>
</tbody>
</table>
# Bicyclist Survey

<table>
<thead>
<tr>
<th>City</th>
<th>Route</th>
<th>Distributed</th>
<th>Returned</th>
<th>Response Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washington, DC</td>
<td>L Street</td>
<td>763</td>
<td>300</td>
<td>39%</td>
</tr>
<tr>
<td>Austin, TX</td>
<td>Bluebonnet Lane</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Barton Springs Road*</td>
<td>73</td>
<td>18</td>
<td>25%</td>
</tr>
<tr>
<td></td>
<td>Rio Grande Street</td>
<td>98</td>
<td>43</td>
<td>44%</td>
</tr>
<tr>
<td>San Francisco, CA</td>
<td>Oak /Fell</td>
<td>900</td>
<td>278</td>
<td>31%</td>
</tr>
<tr>
<td>Chicago, IL</td>
<td>N/S Dearborn Street</td>
<td>600</td>
<td>124</td>
<td>21%</td>
</tr>
<tr>
<td></td>
<td>N Milwaukee Avenue</td>
<td>775</td>
<td>236</td>
<td>30%</td>
</tr>
<tr>
<td>Portland, OR</td>
<td>NE Multnomah Street</td>
<td>200</td>
<td>112</td>
<td>56%</td>
</tr>
<tr>
<td>Overall</td>
<td></td>
<td>3409</td>
<td>1111</td>
<td>33%</td>
</tr>
<tr>
<td>Facility</td>
<td>Cross Street</td>
<td>Type</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>---------------------------------</td>
<td>----------------------</td>
<td>------------</td>
<td>-------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Chicago N/S Dearborn Street</td>
<td>Congress Parkway</td>
<td>Intersection</td>
<td>Two-way facility, MV left-turn signalized</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Madison Street</td>
<td>Intersection</td>
<td>Two-way facility, MV left-turn signalized</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Randolph Street</td>
<td>Intersection</td>
<td>Two-way facility, MV left-turn signalized</td>
<td></td>
</tr>
<tr>
<td>N Milwaukee Avenue</td>
<td>Desplaines Street</td>
<td>Intersection</td>
<td>MVs and Bicyclists weave to make left-turns</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Elston Avenue</td>
<td>Intersection</td>
<td>Bicycle signal, right-turn over facility</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grand Avenue</td>
<td>Intersection</td>
<td>Right-turn lane on right side of facility</td>
<td></td>
</tr>
<tr>
<td>Portland NE Multnomah Street</td>
<td>7th Street</td>
<td>Intersection</td>
<td>Right turn over facility, skip crossing markings</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9th Street</td>
<td>Intersection</td>
<td>Mixing zone w/ right-turning MVs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11th Street</td>
<td>Transit</td>
<td>Right turn over facility, skip crossing markings</td>
<td></td>
</tr>
<tr>
<td>San Francisco Fell Street</td>
<td>Baker Street</td>
<td>Intersection</td>
<td>Mixing zone w/ left-turning MVs, green bars across mixing zone</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Broderick Street</td>
<td>Intersection</td>
<td>Mixing zone w/ right-turning MVs and green backed sharrows</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Divisadero Street</td>
<td>Intersection</td>
<td>Mixing zone w/ right-turning MVs and advisory bike lane (ABL)</td>
<td></td>
</tr>
<tr>
<td>D.C. L Street NW</td>
<td>Btw 19th St and 18th St</td>
<td>Hotel Zone</td>
<td>Loading zone with MV entrance and exit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15th Street</td>
<td>Intersection</td>
<td>Mixing zone w/ left-turning traffic and ABL</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Connecticut Avenue</td>
<td>Intersection</td>
<td>Mixing zone w/ left-turning traffic and ABL</td>
<td></td>
</tr>
</tbody>
</table>
Residents Typed to Geller’s Typology

- **All**: 27% Strong and Fearless, 43% Enthused and Confident, 25% Interested but Concerned, 25% No Way No How
- **Washington, DC**: 26% Strong and Fearless, 40% Enthused and Confident, 28% Interested but Concerned, 22% No Way No How
- **San Francisco**: 31% Strong and Fearless, 40% Enthused and Confident, 22% Interested but Concerned, 25% No Way No How
- **Portland**: 32% Strong and Fearless, 36% Enthoused and Confident, 27% Interested but Concerned, 27% No Way No How
- **Chicago**: 25% Strong and Fearless, 40% Enthused and Confident, 30% Interested but Concerned, 30% No Way No How
- **Austin**: 22% Strong and Fearless, 56% Enthused and Confident, 18% Interested but Concerned, 18% No Way No How

Source: Resident surveys, Green Lane evaluation
Buffer design affects comfort

How comfortable would you feel bicycling on a commercial street with two lanes of traffic in each direction, with traffic speeds of 35 miles per hour, but with the following types of separation from traffic?

1. With a solid painted buffer
2. With a painted 2-3 foot buffer
3. With a painted buffer and parked cars
4. With a raised concrete curb
5. With a 2-3 foot buffer and plastic flexposts
6. With planters separating the bikeway

Source: Cyclist intercept surveys, Green Lane evaluation
Since the ______was built, do you travel on this route?

Source: Cyclist intercept surveys, Green Lane evaluation