Estimating Pedestrian and Bicycle Miles Traveled (PMT/BMT) in Washington State

Krista Nordback, P.E., Ph.D.
Michael Sellinger

Portland State University

OTREC
OREGON TRANSPORTATION RESEARCH AND EDUCATION CONSORTIUM
Overview

• Purpose & Scope
• Background
• Data
• Methods
• Progress
• Conclusions & Recommendations
• Next Steps
PURPOSE & SCOPE
Why measure walking & biking?

If we don’t count it, it doesn’t count.
Why measure walking & biking?

- Funding & policy decisions
- To show change over time
- Facility design
- Planning (short-term, long-term, regional...)
- Economic impact
- Public health
- Safety
Motivation

VMT is an accepted metric for motorized travel. A comparable metric is needed for walking and cycling. Needed by

- Policy makers
- Engineers
- Planners
- Researchers
SAFETY: Accurate estimation of bicyclist and pedestrian volumes are critical to evidence-based safety analysis of bicycling and walking.
BMT and PMT

• Bicycle Miles Traveled (BMT)
• Pedestrian Miles Traveled (PMT)
Scope

• Phase 1 – Recommendations to Improve State’s Count Program
  – Identify Data Sources
  – Identify Methods
  – Recommend Changes

• Phase 2 – Methods for Estimating Bicycling and Walking
  – Prepare existing count data
  – Outline a method to use count data to compute BMT/PMT
Future Scope

• Phase 3 – Washington State Bicycle and Pedestrian Miles Traveled (Funded by NITC – National Institute of Transportation and Community)
  – Estimate BMT/PMT for Washington State using counts
  – Comparison Metrics
  – Document
BACKGROUND
TRAFFIC MONITORING PROGRAMS
Permanent Counters
Commonly inductive loops

Short Duration Counters
Commonly pneumatic tubes

Permanent Counters
Short Duration Counters
AADT and VMT
Can we apply these methods to biking and walking?
Pedestrian/Bicycle Volume Estimates

• Sample based BMT/PMT:
  – Davis & Wicklatz, 2001, 3 Minneapolis Area Counties
  – Dowds & Sullivan, 2012, Chittenden County, Vermont

• Sketch planning (mode share to work)
• Aggregate behavior models
• Travel demand models
DATA
# Non-motorized Data

## Volume Data:

<table>
<thead>
<tr>
<th>Type</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey/travel dairy</td>
<td>Representative sample</td>
<td>No facility level info</td>
</tr>
<tr>
<td>GPS</td>
<td>Route choice included</td>
<td>Usually self-selection bias</td>
</tr>
<tr>
<td>Continuous and short-term counts</td>
<td>Facility level</td>
<td>Many locations needed</td>
</tr>
</tbody>
</table>

## Spatial Variables:
- Facility type, land use, geography
- Socio-demographics, population
Count Data

- State’s Count Program
- Olympia bike counts
- Seattle bike counts
Washington State Bicycle and Pedestrian Documentation Project

• Over 40 jurisdictions
2012 Washington State Bicycle and Pedestrian Documentation Project
Olympia

• TimeMark tube counters
• 7 day counts
• Three times per year (March, June, October)

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>9</td>
</tr>
<tr>
<td>2009</td>
<td>17</td>
</tr>
<tr>
<td>2010</td>
<td>17</td>
</tr>
<tr>
<td>2011</td>
<td>17</td>
</tr>
<tr>
<td>2012</td>
<td>19</td>
</tr>
</tbody>
</table>
Seattle

• Manual Counts
• 50 locations
• 4 times per year
  – 10:00 AM to noon Weekdays
  – 5:00 PM to 7:00 PM Weekdays
  – Noon to 2:00 PM Saturdays

• State’s only permanent counter: Fremont Bridge
• New permanent counter on the Spokane St. Bridge
METHODS

Estimating Pedestrian and Bicycle Miles Traveled (PMT/BMT) in Washington State
3 legged stool

- Three methods
  - Count-based
  - National survey based
  - Aggregate method

- Compare
Count-based Method

• Stratified Random Sample
  – Not random
  – Which strata (attributes) impact bike/ped volumes?
Grouping Spatial Variables

- Land use
- Distance from downtown
- Population density
- Employment density
- Slope (for bicycles)
- Schools
- Roadway Type
- Intersection Type
- Bus stops (for pedestrians)
- Demographics: income, education...

Urban vs Rural
## Possible Sampling Groups

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Recommended Categories</th>
<th>Number of Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of urbanism</td>
<td>Urban, Rural</td>
<td>2</td>
</tr>
<tr>
<td>Road or path type</td>
<td>Arterials &amp; highway, Local Roads, Collectors, &amp; Paths</td>
<td>2</td>
</tr>
<tr>
<td>Proximity to transit (walking only)</td>
<td>Transit Route within 0.5 mile, No Transit Route</td>
<td>2</td>
</tr>
<tr>
<td>Slope (cycling only)</td>
<td>Greater than a given percent grade, Less than a given percent grade</td>
<td>2</td>
</tr>
<tr>
<td>Geographic and climatic regions</td>
<td>Coast Range, Puget Lowland, Cascades, Eastern Washington</td>
<td>4</td>
</tr>
</tbody>
</table>
Urban vs. Rural
Arterial/Highway vs. Local/Collector/Path
WSDOT EcoRegions
# Available Data in 16 Groups

<table>
<thead>
<tr>
<th>Sampling Groups</th>
<th>Region</th>
<th>Level of urbanism</th>
<th>Road/Path Type</th>
<th>Number of Continuous Stations Available</th>
<th>Stations Available in State’s Count Program</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coast Range</td>
<td>Rural</td>
<td>Arterial/Highway</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rural</td>
<td>Local/Collector/Path</td>
<td>0</td>
<td>0</td>
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<tr>
<td></td>
<td></td>
<td>Urban</td>
<td>Arterial/Highway</td>
<td>0</td>
<td>0</td>
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<tr>
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<td>Urban</td>
<td>Local/Collector/Path</td>
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<td>Puget Lowland</td>
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<td>Arterial/Highway</td>
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<td>1</td>
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<td>157</td>
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<td></td>
<td>Urban</td>
<td>Local/Collector/Path</td>
<td>1</td>
<td>99</td>
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<tr>
<td></td>
<td>Cascades</td>
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<td>Arterial/Highway</td>
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<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rural</td>
<td>Local/Collector/Path</td>
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<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Urban</td>
<td>Arterial/Highway</td>
<td>0</td>
<td>0</td>
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<tr>
<td></td>
<td></td>
<td>Urban</td>
<td>Local/Collector/Path</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Eastern Washington</td>
<td>Rural</td>
<td>Arterial/Highway</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rural</td>
<td>Local/Collector/Path</td>
<td>0</td>
<td>0</td>
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<tr>
<td></td>
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<td>Urban</td>
<td>Arterial/Highway</td>
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<td>37</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Urban</td>
<td>Local/Collector/Path</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td></td>
<td>304</td>
<td>Note: There are 13 count sites for which the location is ambiguous or unknown.</td>
</tr>
</tbody>
</table>
Count-based Method

- Groups
  - 4 Regions X 2 Urban/Rural X 2 Road Type = 16 Groups
- Compute center lane miles for each
- Compute Average Annual Daily Bicycle and Pedestrians (AADBP) for each.
- Compute PMT or BMT
  - = Miles X AADBP X 365 days/year
PROGRESS
# Miles of Road/Path

<table>
<thead>
<tr>
<th>Region</th>
<th>Level of Urbanism</th>
<th>Road/Path Type</th>
<th>Total Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coast Range</strong></td>
<td>Urban</td>
<td>Arterial/Hwy</td>
<td>409</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>Non-Arterial</td>
<td>739</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>Arterial/Hwy</td>
<td>128</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>Non-Arterial</td>
<td>13,062</td>
</tr>
<tr>
<td><strong>Puget Lowlands</strong></td>
<td>Urban</td>
<td>Arterial/Hwy</td>
<td>4,042</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>Non-Arterial</td>
<td>20,730</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>Arterial/Hwy</td>
<td>183</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>Non-Arterial</td>
<td>15,380</td>
</tr>
<tr>
<td><strong>Eastern Washington</strong></td>
<td>Urban</td>
<td>Arterial/Hwy</td>
<td>2,574</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>Non-Arterial</td>
<td>7,140</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>Arterial/Hwy</td>
<td>1,448</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>Non-Arterial</td>
<td>54,407</td>
</tr>
<tr>
<td><strong>Cascades</strong></td>
<td>Urban</td>
<td>Arterial/Hwy</td>
<td>219</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>Non-Arterial</td>
<td>352</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>Arterial/Hwy</td>
<td>576</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>Non-Arterial</td>
<td>33,526</td>
</tr>
<tr>
<td><strong>Total Centerline Miles in Washington State</strong></td>
<td></td>
<td></td>
<td><strong>154,915</strong></td>
</tr>
</tbody>
</table>
Traffic Patterns

• Seattle – one year of data
• Olympia – multiple sites with 7 days of data
Fremont Bridge, Seattle

Annual Average Daily Bicyclists (AADB) = 2,461
Fremont Bridge, Seattle

% of AADB

- Sunday
- Monday
- Tuesday
- Wednesday
- Thursday
- Friday
- Saturday

Blue = Winter
Red = Summer
Fremont Bridge, Seattle

Annual Average Daily Bicyclists (AADB) = 2,461
Factoring Method

Adapted from Traffic Monitoring Guide

\[ AA DB = C_{\text{known}} \times M \times D \]

\( C_{\text{known}} = \text{hourly count} \)
\( M = \text{Monthly Factor} \)
\( D = \text{Daily/Hourly Factor} \)
Monthly Factor

\[ M = \frac{AADB}{MADB} \]

\[ = \frac{2,000}{1,000} = 2 \]

December

Daily counts in December are half of AADB.

where

\( MADB = \text{Ave daily bike count in that month} \)
# Created Monthly Factors

<table>
<thead>
<tr>
<th>Month</th>
<th>Monthly AADB</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>1,448</td>
<td>1.7</td>
</tr>
<tr>
<td>February</td>
<td>1,787</td>
<td>1.4</td>
</tr>
<tr>
<td>March</td>
<td>2,132</td>
<td>1.2</td>
</tr>
<tr>
<td>April</td>
<td>2,400</td>
<td>1.0</td>
</tr>
<tr>
<td>May</td>
<td>3,502</td>
<td>0.7</td>
</tr>
<tr>
<td>June</td>
<td>3,237</td>
<td>0.8</td>
</tr>
<tr>
<td>July</td>
<td>3,806</td>
<td>0.6</td>
</tr>
<tr>
<td>August</td>
<td>3,373</td>
<td>0.7</td>
</tr>
<tr>
<td>September</td>
<td>2,691</td>
<td>0.9</td>
</tr>
<tr>
<td>October</td>
<td>2,254</td>
<td>1.1</td>
</tr>
<tr>
<td>November</td>
<td>1,688</td>
<td>1.5</td>
</tr>
<tr>
<td>December</td>
<td>1,173</td>
<td>2.1</td>
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</tbody>
</table>
Created Daily/Hourly Factors

<table>
<thead>
<tr>
<th>Month</th>
<th>7-8 AM Weekday</th>
<th>8-9 AM Weekday</th>
<th>10-11 AM Weekday</th>
<th>11-Noon Weekday</th>
<th>4-5 PM Weekday</th>
<th>5-6 PM Weekday</th>
<th>6-7 PM Weekday</th>
<th>Noon-1 PM Saturday</th>
<th>1-2 PM Saturday</th>
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</thead>
<tbody>
<tr>
<td>January</td>
<td>9.0</td>
<td>6.1</td>
<td>26.5</td>
<td>32.3</td>
<td>11.0</td>
<td>5.5</td>
<td>8.1</td>
<td>28.3</td>
<td>21.0</td>
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<tr>
<td>February</td>
<td>8.8</td>
<td>6.0</td>
<td>28.4</td>
<td>33.4</td>
<td>11.2</td>
<td>5.4</td>
<td>7.8</td>
<td>17.1</td>
<td>16.3</td>
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<td>March</td>
<td>9.9</td>
<td>7.1</td>
<td>29.4</td>
<td>39.3</td>
<td>13.2</td>
<td>6.3</td>
<td>8.6</td>
<td>13.9</td>
<td>12.5</td>
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<td>April</td>
<td>8.2</td>
<td>6.2</td>
<td>25.7</td>
<td>31.4</td>
<td>10.0</td>
<td>5.3</td>
<td>6.7</td>
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<td>May</td>
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<td>7.5</td>
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<td>June</td>
<td>9.3</td>
<td>7.1</td>
<td>27.8</td>
<td>34.8</td>
<td>11.4</td>
<td>5.7</td>
<td>7.3</td>
<td>16.2</td>
<td>14.4</td>
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<tr>
<td>July</td>
<td>10.3</td>
<td>7.5</td>
<td>25.7</td>
<td>33.9</td>
<td>12.0</td>
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<td>August</td>
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<td>5.7</td>
<td>7.1</td>
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<td>September</td>
<td>8.7</td>
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<td>31.6</td>
<td>10.8</td>
<td>4.9</td>
<td>6.2</td>
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<tr>
<td>October</td>
<td>14.5</td>
<td>15.2</td>
<td>17.4</td>
<td>17.0</td>
<td>14.4</td>
<td>15.3</td>
<td>22.0</td>
<td>25.1</td>
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</tr>
<tr>
<td>November</td>
<td>8.1</td>
<td>5.8</td>
<td>24.0</td>
<td>31.0</td>
<td>9.4</td>
<td>5.5</td>
<td>8.4</td>
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</tr>
<tr>
<td>December</td>
<td>8.6</td>
<td>5.6</td>
<td>24.2</td>
<td>33.6</td>
<td>10.1</td>
<td>5.3</td>
<td>8.3</td>
<td>24.7</td>
<td>25.1</td>
</tr>
</tbody>
</table>
Olympia

% of AADB

Sunday Monday Tuesday Wednesday Thursday Friday Saturday

0% 2% 4% 6% 8% 10% 12%

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

Average
CONCLUSIONS & RECOMMENDATIONS
Conclusions

• Count based method could be used
• Existing count data are not sufficient for BMT/PMT estimation
• More data needed
• Multiple methods may triangulate on the magnitude of BMT/PMT
Recommendations for Counting Program

• In coming years:
  – Expand program to include rural areas and mountain regions
  – Install at least 1 permanent counter in each of the 16 groups

• In the coming decades:
  – At least 7 permanent counters per group.
  – Ideally count 7 days per location
  – At least 150 short duration count sites per group
Phase 3

• Finish Count-based BMT/PMT Estimates
  – Average AADB and AADP estimates
  – Multiply by lanes miles and days of the year

• Two other methods
  – National survey based method
  – Aggregate method

• Pilot City
Future Research

• Apply to Safety
Discussion & Questions

Krista Nordback, P.E., Ph.D.
nordback@pdx.edu
503-725-2897

Michael Sellinger
mike.sellinger@gmail.com

Oregon Transportation Research and Education Consortium
Problem

- I want to know AADB at 2,000 intersections.
Problem

- I want to know AADB at 2,000 intersections.
- I know AADB at 25 stations.
Problem

- I want to know AADB at 2,000 intersections.
- I know AADB at 25 stations.
- I have manual counts at <140 intersections.
What Kind of Data is Available — 2 Hour Manual Counts? CDOT Data Prior to 2009?

Cherry Creek Trail, Colorado
Bicycle and Pedestrian Traffic
2-hour Duration MONDAYS - Manual Counts
Total Volumes
(September, 2009 - April, 2010)

Source: Elizabeth Stolz, Sprinkle Consulting
Why daily counts?
Why daily counts?
Why daily counts?

![Graph showing average hourly count from 12:00 AM to 9:00 PM]

Average Hourly Count

12:00 AM  3:00 AM  6:00 AM  9:00 AM  12:00 PM  3:00 PM  6:00 PM  9:00 PM
Why annual average?
Why annual average?

Average Daily Count

Month

1 2 3 4 5 6 7 8 9 10 11 12

0 100 200 300 400 500 600 700 800 900 1000 1100 1200

635

Average Daily Count

Month