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

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TREC
Overview

• Purpose
• Review
• Data
• Methods
• Results
• Conclusions & Recommendations
PURPOSE
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
BMT and PMT

- Bicycle Miles Traveled (BMT)
- Pedestrian Miles Traveled (PMT)
TRAFFIC MONITORING PROGRAMS
State Traffic Monitoring

Permanent Counters

Commonly inductive loops

Short Duration Counters

Commonly pneumatic tubes

PERMANENT COUNT PROGRAM

AADT
Short Duration Counters
**PERMANENT COUNT PROGRAM**

**SHORT DURATION COUNT PROGRAM**

**APPLY FACTORS**

**AADT**
Sum (AADT X Segment Length) over network to compute Vehicle Miles Traveled (VMT)
Can we apply these methods to biking and walking?
AADB:
Annual Average Daily Bicyclists

AADT for bicyclists!
Acronyms

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

• Annual Average Daily Bicyclists (AADB)
• Annual Average Daily Pedestrians (AADP)
DATA
Permanent Counters in 2012

- Bicycle Counter
Permanent Counters now

- **Bicycle Counter**
- **Bicycle and Pedestrian Counter**
Short Duration Counts

2012 Washington State Bicycle and Pedestrian Documentation Project

Annual Sept/Oct, volunteer manual counts, morning and evening peak hours
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
Traffic Patterns

• Seattle – one year of data
Fremont Bridge, Seattle

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

Adapted from Traffic Monitoring Guide

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

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

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

December

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

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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</table>
# Created Daily/Hourly Factors

<table>
<thead>
<tr>
<th>Week</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>
</tr>
<tr>
<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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<tr>
<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>
<td>26.9</td>
<td>33.1</td>
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<tr>
<td>May</td>
<td>8.7</td>
<td>6.7</td>
<td>29.9</td>
<td>41.0</td>
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<td>5.6</td>
<td>7.5</td>
<td>21.4</td>
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<tr>
<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>
<td>6.2</td>
<td>7.9</td>
<td>19.2</td>
<td>18.0</td>
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<tr>
<td>August</td>
<td>9.8</td>
<td>6.8</td>
<td>24.6</td>
<td>33.4</td>
<td>11.7</td>
<td>5.7</td>
<td>7.1</td>
<td>22.1</td>
<td>19.8</td>
</tr>
<tr>
<td>September</td>
<td>8.7</td>
<td>5.8</td>
<td>23.7</td>
<td>31.6</td>
<td>10.8</td>
<td>4.9</td>
<td>6.2</td>
<td>27.6</td>
<td>24.5</td>
</tr>
<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>
<td>22.8</td>
</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>
<td>17.0</td>
<td>19.9</td>
</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>
Should these be factors be applied across the state?

NO
Non-motorized Data

Volume data:

<table>
<thead>
<tr>
<th>Type</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey/travel diary</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
METHODS

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

- Sample-based approach
- Aggregate demand model
- Travel surveys

BMT/PMT
AADB/AADP \times \text{Aggregate Demand Model} = \text{Sample Based BMT/PMT} = \text{Aggregate Demand BMT/PMT}
Count-based Method

• Stratified Random Sample
  – Where to count?
  – Which strata (attributes) impact bike/ped volumes?
# 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>Geographic and climatic regions</td>
<td>Coast Range, Puget Lowland, Cascades, Eastern Washington</td>
<td>4</td>
</tr>
</tbody>
</table>
Sample-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
AADB/AADP × Road Segment Length = Sample Based BMT/PMT

Aggregate Demand Model = Aggregate Demand BMT/PMT
Aggregate Demand Model

• Dependent Variable: AADB and AADP
• Independent Variables
  – Facility type: This variable has three categories.
    • Local and collector roads
    • Arterial roads and highways
    • Trail
  – Bridge: This is a dummy variable which indicates if the bicyclist or pedestrian is crossing a bridge.
  – Population density: Density of population in the census tract
  – Percent of the population aged 18 to 54
  – Percent of the population with a four year degree or more
• Ordinary Least Squares Regression
National Household Travel Survey (NHTS) Method

- “Back of the envelope” method
- Uses research from Pucher et al.
- NHTS and Census Data
- Puget Sound Regional Travel Survey
RESULTS
Sample-based Estimates

- Using the available data, PMT and BMT only estimated in 4 of 16 sampling groups.
- Trail traffic highest.
- Estimates are biased toward over estimation, since count sites were deliberately chosen at locations where bicycle and pedestrian activity tend to be high.
- This bias can be corrected in the future by randomly sampling count locations.

<table>
<thead>
<tr>
<th>Region</th>
<th>PMT</th>
<th>BMT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Puget</td>
<td>3,500</td>
<td>1,200</td>
</tr>
<tr>
<td>Eastern</td>
<td>1,400</td>
<td>300</td>
</tr>
</tbody>
</table>
Aggregate Demand Estimates

- Too data intensive to compute statewide during scope of project
- To calculate BMT and PMT statewide:
  - Associate road and trail segments throughout the state with the corresponding census tract and American Community Survey (ACS) data.
  - Apply the explanatory variables to each segment to estimate AADB and AADP for the segment.
  - Multiply AADB and AADP by the length of the segment.
  - Sum all of the segments and multiply by 365.
NHTS Estimates

- 415 households surveyed in Washington State
- 891 individuals in the 2009 NHTS
- 96 (11%) reported making at least one bike trip in the past week
- 645 individuals (72%) reported making at least one walking trip in the past week
- Only 2 and 9 individuals biked and walked to work in the past week, respectively
- Necessary to use nationwide data in order to produce an acceptable sample size of bicyclists and walkers.

Statewide Estimates Using National Survey Method (in Millions of Miles)

<table>
<thead>
<tr>
<th></th>
<th>PMT</th>
<th>BMT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimate</td>
<td>700</td>
<td>200</td>
</tr>
</tbody>
</table>

* The confidence interval (CI) only accounts for error from the National Household Travel Survey as reported by Pucher et al. 2011 (Pucher, Buehler et al. 2011). Actual error is much higher.
## King County Comparison

### Annual PMT and BMT for King County within the Puget Lowlands (Millions of Miles)

<table>
<thead>
<tr>
<th>Method</th>
<th>Lower PMT</th>
<th>PMT</th>
<th>Upper PMT</th>
<th>Lower BMT</th>
<th>BMT</th>
<th>Upper BMT</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Survey Data</td>
<td>190</td>
<td>200</td>
<td>210</td>
<td>40</td>
<td>45</td>
<td>50</td>
</tr>
<tr>
<td>Count Based Method (All Puget Sites)</td>
<td>1,240</td>
<td>1,900</td>
<td>2,560</td>
<td>540</td>
<td>710</td>
<td>880</td>
</tr>
<tr>
<td>Count Based Method (All Puget Sites Trails and Local Separated)</td>
<td>1,160</td>
<td>1,800</td>
<td>2,430</td>
<td>370</td>
<td>510</td>
<td>650</td>
</tr>
<tr>
<td>Count Based Method (King County Sites Only)</td>
<td>1,290</td>
<td>2,190</td>
<td>3,090</td>
<td>770</td>
<td>1,050</td>
<td>1,330</td>
</tr>
<tr>
<td>Count Based Method (Trails and Local Separated)</td>
<td>1,430</td>
<td>2,360</td>
<td>3,280</td>
<td>460</td>
<td>690</td>
<td>930</td>
</tr>
<tr>
<td>Aggregate Demand Model</td>
<td>100</td>
<td>560</td>
<td>3,000</td>
<td>50</td>
<td>220</td>
<td>910</td>
</tr>
</tbody>
</table>

57,000 Million Miles VMT in 2011 for WA (FHWA)
CONCLUSIONS & RECOMMENDATIONS
## Conclusions

<table>
<thead>
<tr>
<th>Approach</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample-based</td>
<td>Data are at the facility level.</td>
<td>- Data tend to be biased towards high count locations.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- It is harder to sample pedestrian locations.</td>
</tr>
<tr>
<td>Aggregate demand model</td>
<td>More accurate estimate of PMT and BMT. Especially useful for pedestrian travel.</td>
<td>Difficult to do at the state level.</td>
</tr>
<tr>
<td>Travel survey</td>
<td>Expanding existing dataset is easier than creating new dataset.</td>
<td>Data are not at the facility level.</td>
</tr>
</tbody>
</table>
Recommendation: Better Data Needed

• Count 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
    • Select sites using random stratified sampling techniques

• Travel survey: over sample WA
Discussion & Questions

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