The Numbers Game: Integrated Transportation and User Capacity Research in Yosemite National Park

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Concept

• Determine if/how visitor experience and resource conditions are impacted by the amount of visitor use
• Determine what levels of visitation can occur while sustaining desired visitor experience and resource conditions
• Identify a cost-effective monitoring strategy
Characteristics of the approach

- Conditions reflected by indicators
- Desired conditions based on visitor surveys
- Entering traffic as proxy for visitation (confirmed by regression analysis)
- Predictive simulation modeling relating conditions to entering traffic
- Ongoing monitoring of entering traffic
Characteristics of the approach (cont.)

Related research


Application

• To date: locations in Yosemite Valley
• Planned: park-wide in Yosemite
Project background

- Draws on 10 years of research and data collection
- Pedestrian and vehicular measures of visitor experience
- Resource condition measures under development
Project Team

- Niki Nicholas, Ph.D., YOSE-RMS
- Bret Meldrum, YOSE-RMS, Project Manager
- Henrietta DeGroot, NPS Regional Trans. Assistant
- Dianne Croal, NPS Regional Trans. Coordinator
- Dave Henderson, YOSE-Traffic Manager
- Bill Byrne, Ian Chase, Stacy Tshour, Brenda Ostrom, David Evans and Associates
- Steve Lawson, Ph.D., Virginia Polytechnic Institute
- Peter Newman, Ph.D., Colorado State University
- Dave Pettebone, Ph.D. Candidate, Colorado State Univ.
- Dave White, Ph.D., Arizona State University
Research Components

1. Indicators and Standards of Quality
   • University of Vermont (1998 & 1999)
   • Arizona State University (2005 & 2007)

2. Statistical Correlation of Visitor Use and Traffic Data
   • Colorado State University & Virginia Tech (2007 & 2008)

3. Pedestrian Modeling – Trails and Attractions
   • Virginia Tech (2007 & 2008)

4. Traffic Modeling – Roads and Intersections
Indicators of Quality: 

*Trails and Attractions*

1. People per viewscape (PPV) on trails

2. People at one time (PAOT) at attractions
Indicators of Quality: 
Trails and Attractions
Standards of Quality:  
*Trails and Attractions*

1. Preference
2. Acceptability
3. Management Action
4. Displacement
Visitor-Based Standards of Quality – PPV

Preference – 7 PPV

Acceptability – 18 PPV

Management Action – 20 PPV
Visitor-Based Standards of Quality – PAOT

Preference – 8 PAOT

Acceptability – 19 PPV

Management Action – 19 PPV
Indicators of Quality:
*Transportation-related Experience*

Qualitative interviews & visitor surveys, multiple YV locations

Salient dimensions of experience include:

- Stress and conflict
- Freedom and access
Indicators of Quality:
*Transportation-related Experience*

1. Travel time on Northside Drive
   - Sentinel Drive to Camp 4
Indicators of Quality:
*Transportation-related Experience*

1. Free-flow travel time = 2.8 minutes

Standards to be developed
What are the relationships between park visitation and on-the-ground conditions of indicator variables?
Relate inbound traffic at entrance gates to:

- Daily visitation at recreation sites

- Traffic volumes on Northside Drive
Entrance Stations
Statistical Modeling

Regression Analyses

Data sources (summer 2007):

- Mechanical trail counters

- Permanent traffic counters at entrance stations

- Temporary traffic counters on Northside Drive
Site visitation $\sim f$ (inbound traffic, month, time of day)

<table>
<thead>
<tr>
<th>Recreation Site</th>
<th>$R^2$</th>
<th>Time Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridalveil Fall</td>
<td>0.81</td>
<td>3 hours</td>
</tr>
<tr>
<td>Trail to Vernal Fall</td>
<td>0.75</td>
<td>3 hours</td>
</tr>
<tr>
<td>Yosemite Falls</td>
<td>0.72</td>
<td>3 hours</td>
</tr>
</tbody>
</table>
Statistical Modeling
Regression Analyses

Traffic volume, Northside Drive ~ f (inbound traffic)

<table>
<thead>
<tr>
<th>Entrance Stations</th>
<th>$R^2$</th>
<th>Time Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excluding Hetch Hetchy</td>
<td>0.83</td>
<td>6 hours</td>
</tr>
<tr>
<td>Excluding Hetch Hetchy &amp; South</td>
<td>0.93</td>
<td>7 hours</td>
</tr>
<tr>
<td>Excluding Hetch Hetchy &amp; Tioga Pass</td>
<td>0.81</td>
<td>6 hours</td>
</tr>
</tbody>
</table>
Pedestrian Modeling

*Trails and Attraction Sites*

Model daily site visitation to estimate:

- PPV on trails
- PAOT at attractions

BF, YF, VF
PAOT at Base of Fall

PPV on Trail
Model traffic volumes on Northside Drive to estimate:

- Travel time, Sentinel Drive to Camp 4
- LOS, Yosemite Falls Intersection
Integrated Transportation & User Capacity Analysis

- Inbound Traffic
- Traffic Volume
- Site Visitation
- PPV / PAOT
- TT / LOS
- VE Conditions

Relationships:
- Regression from Inbound Traffic to Traffic Volume and Site Visitation
- Traffic Model from Traffic Volume to Site Visitation and TT / LOS
- Pedestrian Model from Site Visitation to PPV / PAOT and VE Conditions
Preliminary Traffic/Visitation Thresholds

• Based on ad-hoc observations of traffic conditions
  – “Busy”: Median day in summer season (50th)
  – “Busier”: 7th busiest day
  – “Busiest”: Busiest day of season
# Model Specified Levels of Inbound Traffic

## Pedestrian Models

<table>
<thead>
<tr>
<th>Scenario</th>
<th>PPV Trail to BV</th>
<th>PAOT Base of BV</th>
<th>PPV Trail to YF</th>
<th>PAOT Base of YF</th>
<th>PPV Trail to VF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Busiest day</td>
<td>28.2%</td>
<td>72.3%</td>
<td>0.1%</td>
<td>10.1%</td>
<td>11.9%</td>
</tr>
<tr>
<td>7th busiest day</td>
<td>20.5%</td>
<td>66.4%</td>
<td>0.0%</td>
<td>0.9%</td>
<td>0.7%</td>
</tr>
<tr>
<td>50th busiest day</td>
<td>10.2%</td>
<td>59.4%</td>
<td>0.0%</td>
<td>0.1%</td>
<td>0.1%</td>
</tr>
</tbody>
</table>
# Model Specified Levels of Inbound Traffic

## Traffic Model

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Total Entrance Volumes 10:00-11:00 AM*</th>
<th>Travel Time (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free-flow conditions</td>
<td>NA</td>
<td>2.8</td>
</tr>
<tr>
<td>Busiest day</td>
<td>1310</td>
<td>9.0</td>
</tr>
<tr>
<td>7th busiest day</td>
<td>880</td>
<td>7.0</td>
</tr>
<tr>
<td>50th busiest day</td>
<td>770</td>
<td>3.3</td>
</tr>
</tbody>
</table>

* Not including South or Hetch Hetchy
Pedestrian Model Site Capacity Estimates for Trail to Vernal Fall

<table>
<thead>
<tr>
<th></th>
<th>Maximum Hourly Arrivals at Entrances (not including Hetch Hetchy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preference</td>
<td>110</td>
</tr>
<tr>
<td>Acceptability</td>
<td>1385</td>
</tr>
<tr>
<td>Management Action</td>
<td>1846</td>
</tr>
</tbody>
</table>
Management Judgement & Decision-Making

- Standards of quality/desired conditions

- Management actions in the event standards are violated
Status of Project

- VE/Visitation relationships established for Yosemite Valley
- Alternative Transportation in Parks and Public Lands (ATPPL) funding for expansion to park-wide and to research resource condition relationships – underway in 2009
- Target fully implemented transportation user capacity management program