A Traffic Density Analysis of Proposed Ferry Service Expansions in San Francisco Bay Utilizing Maritime Simulation

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Building the Simulation
(Modeling Restricted Visibility)
Environmental Data

- Study Area has been divided into five separate zones to determine visibility pattern.
- Divisions made based on differences in visibility pattern noted in the Coast Pilot and data availability.
- Sea Visibility is generated using meteorological model utilizing Water Temp and Air Temp.
Environmental Data - Wind

• Hourly Wind direction and Speed Data
Environmental Data

- San Francisco International Airport
  - Hourly Air Temperature 1990-1995
  - Hourly Land Visibility 1990-1995
  - Hourly Dew Point 1990-1995
Sea Visibility Model

\[ W = \text{Water Surface Temperature (Celsius)} \]
\[ D = \text{Dewpoint Temperature (Celsius)} \]
\[ \Delta = W - D \]

\[
\text{Visibility} = \begin{cases} 
\text{Good,} & \Delta \leq 0^\circ\text{C} \\
\text{Bad,} & \Delta > 0^\circ\text{C} 
\end{cases}
\]

Good = More than 0.6 miles
Bad = Less than 0.6 miles

Environmental Data - VISIBILITY

• Hourly Air and Water Temperature Data

HOURLY DEW POINT DATA IS NOT AVAILABLE FOR THIS TIME PERIOD AND FOR THESE LOCATIONS!
Calculation of Dew Point Temp.

- **Used SFO Dew Point Data:**

  6 year averages of Dew points were calculated over the period from 1990-1995 per month and by an air temperature range of two degrees. These averages were used to convert 1998-2001 air temperature data to dew point data.

- **For example:** Average dew point for August was 13 in 1990-1995 when air temperature was between 14-16 degrees Celsius. An air temperature in August 1998 of 15 degrees would therefore be converted to a dew point of 13.
Visibility Model - Calibration

– To ensure the model more closely reflects restricted visibility conditions (mariners are required to use their fog signals) a calibration constant was added for each month and location.

Visibility = \[
\begin{cases}
\text{Good,} & \Delta \leq k^\circ C \\
\text{Bad,} & \Delta > k^\circ C
\end{cases}
\]
Calibrate to Sample Coast Pilot Data

Location Golden Gate:

- August: Fog signals operate 15-20% of the time in Golden Gate
- March and April, fog signals operate about 7-10% of the time.

WHAT ABOUT THE OTHER MONTHS?
WHAT ABOUT THE OTHER LOCATIONS?
Visibility Model Results

Visibility Pattern in: August  Location: Golden Gate
Average Bad Visibility: 19.89% of the time
Visibility Model

- To calibrate the percentage of times restricted visibility conditions occur within each location, information from the Coast Pilot 2000 was combined with expert judgment elicited using the Analytical Hierarchy Process technique.

Please compare the two locations in terms of the percentage of time that vessels operate in restricted visibility (i.e., vessels are required to use their fog signal) in the specified quarter.

**THIRD QUARTER: July - August - September**

<table>
<thead>
<tr>
<th>Location</th>
<th>Golden Gate</th>
<th>Location</th>
<th>San Pablo Bay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left Hand Side</td>
<td>More</td>
<td>Right Hand Side</td>
<td>More</td>
</tr>
</tbody>
</table>

1. Same amount of time
2. Three times more
3. Five times more
4. Seven times more
5. Nine times or more
Visibility Model

- There was remarkable agreement between the VTS Operators and the SF Bar Pilots regarding visibility conditions at Golden Gate.

Relative Comparison by Quarter: GOLDEN GATE

- % of Time with Restricted Visibility
- Graph showing comparison between VTS, Pilots, and Used visibility conditions.
Visibility Model

- There was some level of disagreement regarding visibility conditions in the first quarter of the year.

Relative Comparison by Location: FIRST QUARTER

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>% OF TIME WITH RESTRICTED VISIBILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Golden Gate</td>
<td>5.00%</td>
</tr>
<tr>
<td>San Pablo Bay</td>
<td>10.00%</td>
</tr>
<tr>
<td>South Bay</td>
<td>15.00%</td>
</tr>
<tr>
<td>Grizzly Bay</td>
<td>20.00%</td>
</tr>
</tbody>
</table>

Graph: VTS, PILOTS, USED
Visibility Model

- Estimated Percentages of Time that Restricted Visibility Occurs by Quarter and by Location

<table>
<thead>
<tr>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Golden Gate</td>
<td>5.17%</td>
<td>11.66%</td>
<td><strong>20.00%</strong></td>
<td>6.69%</td>
</tr>
<tr>
<td>San Pablo Bay</td>
<td>12.38%</td>
<td>6.17%</td>
<td>6.30%</td>
<td>9.62%</td>
</tr>
<tr>
<td>Alameda</td>
<td>7.49%</td>
<td>7.61%</td>
<td>10.61%</td>
<td>7.02%</td>
</tr>
<tr>
<td>South Bay</td>
<td>4.92%</td>
<td>5.00%</td>
<td>5.53%</td>
<td>4.74%</td>
</tr>
<tr>
<td>Grizzly Bay</td>
<td>14.40%</td>
<td>5.17%</td>
<td>5.34%</td>
<td>11.06%</td>
</tr>
</tbody>
</table>
Visibility Model Results – GOLDEN GATE 2000

Visibility Pattern in: February        Location: Golden Gate
Average Bad Visibility: 5.90% of the time

Visibility Pattern in: April        Location: Golden Gate
Average Bad Visibility: 12.04% of the time

Visibility Pattern in: May        Location: Golden Gate
Average Bad Visibility: 11.22% of the time

Visibility Pattern in: July        Location: Golden Gate
Average Bad Visibility: 19.89% of the time

Visibility Pattern in: September        Location: Golden Gate
Average Bad Visibility: 6.79% of the time

Visibility Pattern in: October        Location: Golden Gate
Average Bad Visibility: 9.69% of the time

Visibility Pattern in: November        Location: Golden Gate
Average Bad Visibility: 5.65% of the time

Visibility Pattern in: December        Location: Golden Gate
Average Bad Visibility: 5.82% of the time
Locations in Visibility Model