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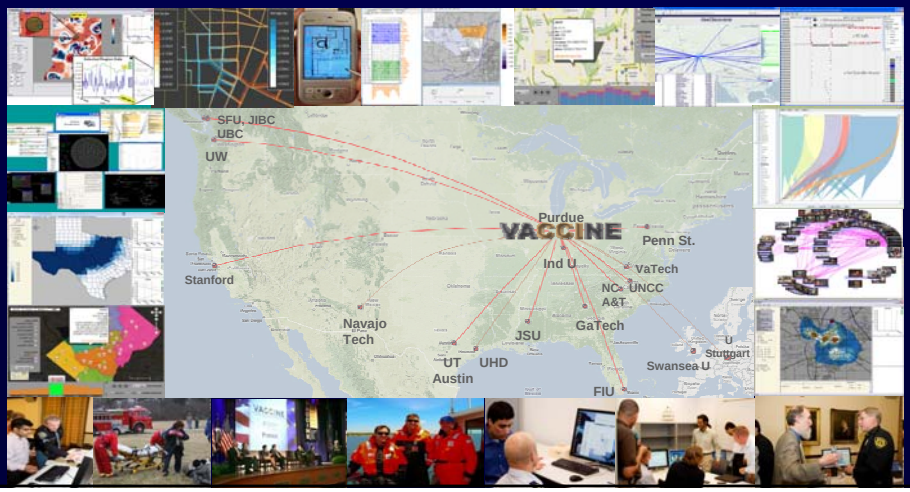
Risk-Based Visual Analytics for Maritime Resource Alloction



Motivation

- To solve today's and tomorrow's problems requires exploring, analyzing, and reasoning with massive, multisource, multiscale, heterogeneous, streaming data
- U/S O'Toole said the biggest problem is big data

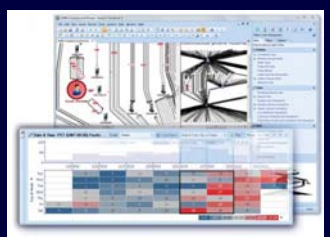
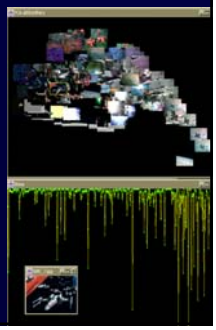


Image of Analyst's Notebook



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What We Do

- Enable effective decision making through interactive visual analytic environments
- Enable effective communication of information
- Provide quantitative, reliable, reproducible evidence
- Enable user to be more effective from planning to detection to response to recovery
- Enable proactive and predictive visual analytics

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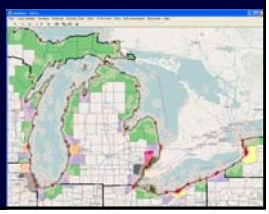
Visual Analytics Uses for Risk-based Decision Making

- Risk visualization and analysis
- Predictive analytics
- Uncertain decision making
- Alternative evaluation and consequence investigation
- Trend analysis, clustering, anomaly detection
- Interactive, multi-day, month, type investigation
- Multisource, multimedia data integration & analysis



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Our Maritime Projects

- Search and rescue resource allocation
- Swimmer death analysis
- PWCS analysis
- Economic impact analysis
- Resource allocation and risk-based decision making

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Visual Analytics Environment

- Supports decision making and risk assessment
- Interactive exploration and analysis of trends, patterns and anomalies
- Allows analysis of risks associated with closing one or more Coast Guard stations
  - Find optimal stations that absorb work load of the closing station
- Currently being used by analysts at the U.S. Ninth District & Atlantic Commands

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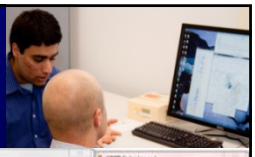
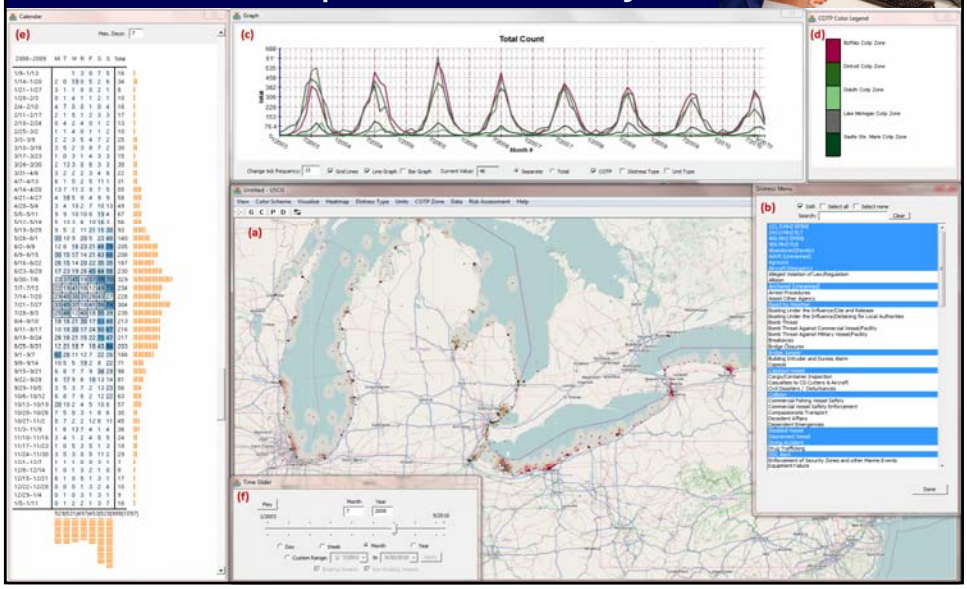
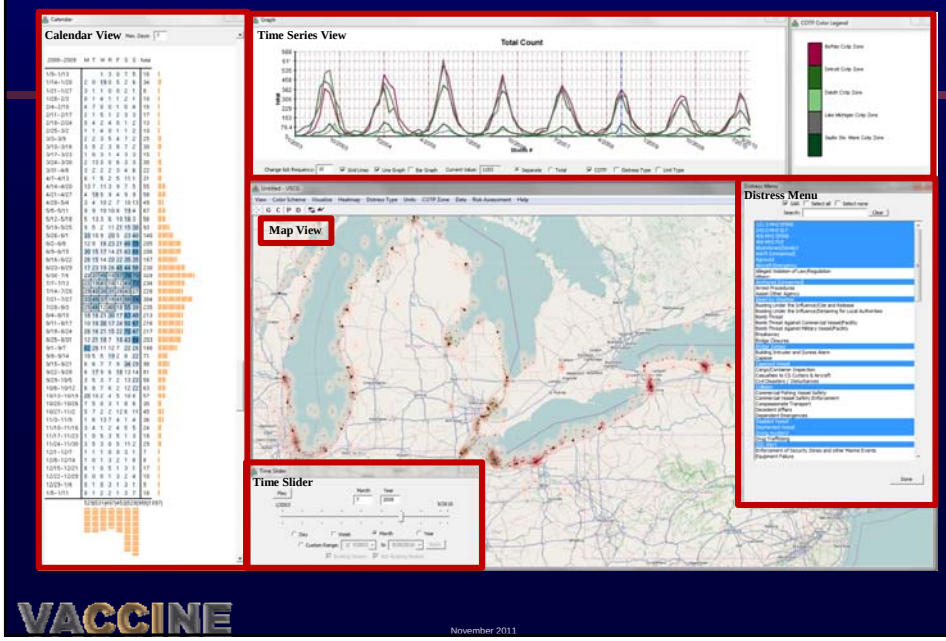
Example: USCG D9 Search And Rescue Operational Analysis





System Overview



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Risk Assessment

- Strategic Risk: Future challenges and their mitigation
  - Search and Rescue (SAR) operations
- Coast Guard policy recommends a sortie launch within 30 minutes and have an asset on scene within 120 minutes
- Closing stations requires a thorough assessment to determine stations that:
  - Present the least maritime risks when closed
  - Can successfully absorb the case load of closing stations
- Finding the optimal balance between costs of different decisions in a visual analytics environment

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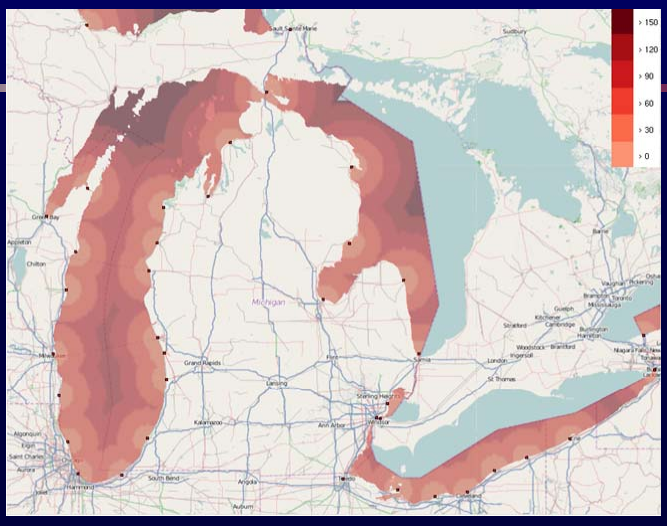
SAR Risk Profile: Average Response Time



Time taken by CG stations to deploy an asset to the Great Lakes to respond to a SAR incident (assuming transit speed of 15 knots)

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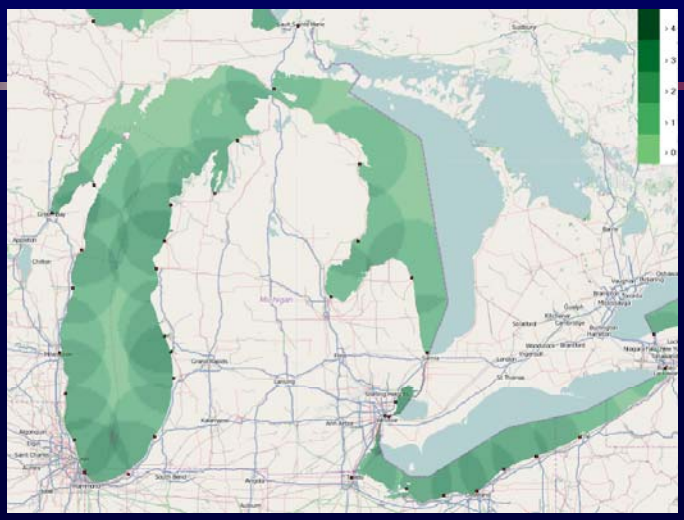
SAR Risk Profile: CG SAR Coverage



Coast Guard SAR coverage (number of stations that respond to a particular region)

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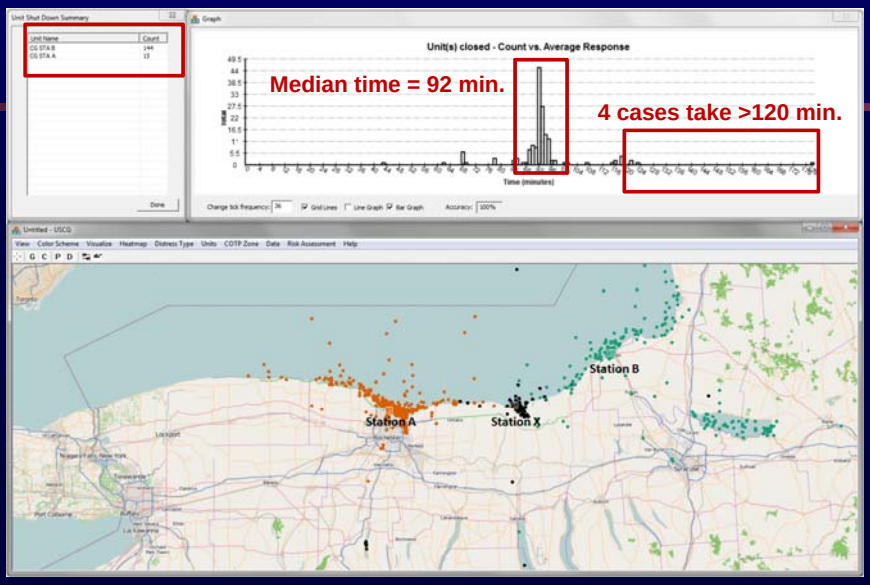
Risk Assessment Scenario – contd.



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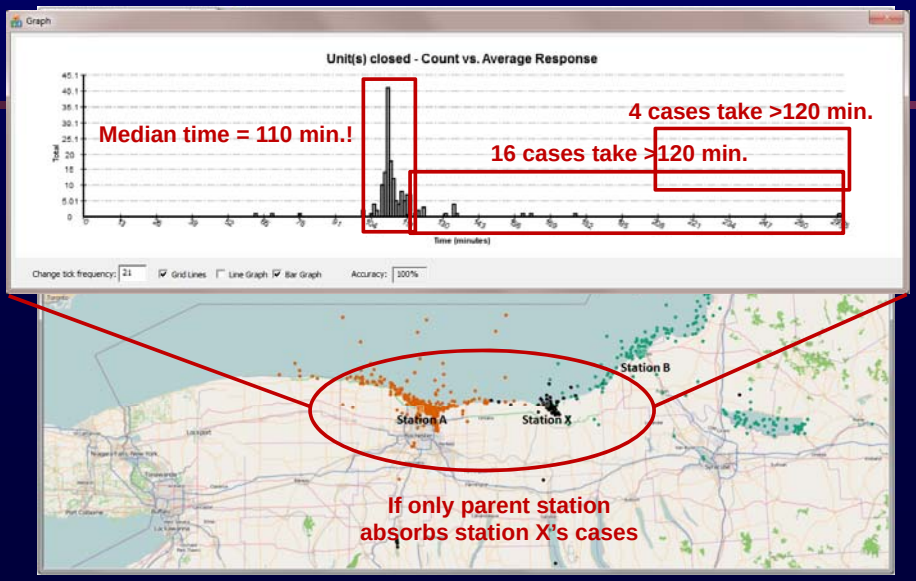
Risk Assessment Scenario – contd.



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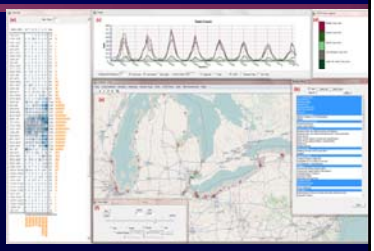
U.S. Coast Guard Search and Rescue VA (cgSARVA)

Partners: USCG LANT 7 (Operational Analysis) , USCG D9, USCG D5

IMPACTS:

- Analyzed impact of CG auxiliary stations on search and rescue mission in Great Lakes
- Used for resource allocation for SAR
- Provided evidence of temporal and spatial patterns used in planning – new insights to SAR mission
- Hurricane Irene resource allocation decision based on cgSARva analysis and visualization
  - Highest SAR workload that weekend for D9



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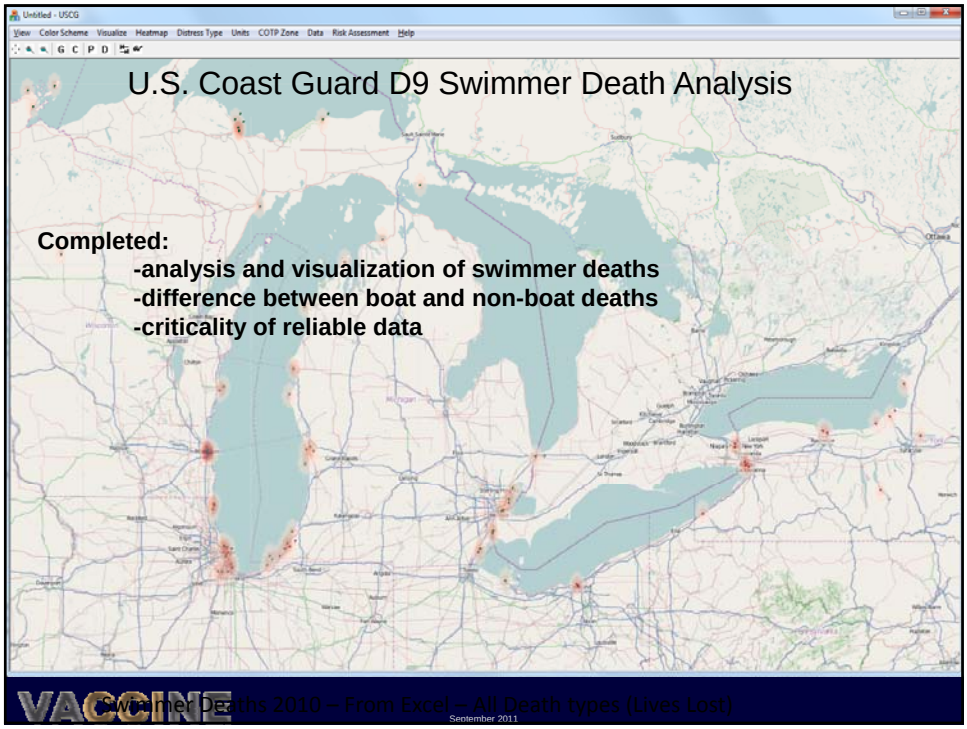
U.S. Coast Guard D9 Swimmer Death Analysis
Completed:
-analysis and visualization of swimmer deaths
-difference between boat and non-boat deaths
-criticality of reliable data
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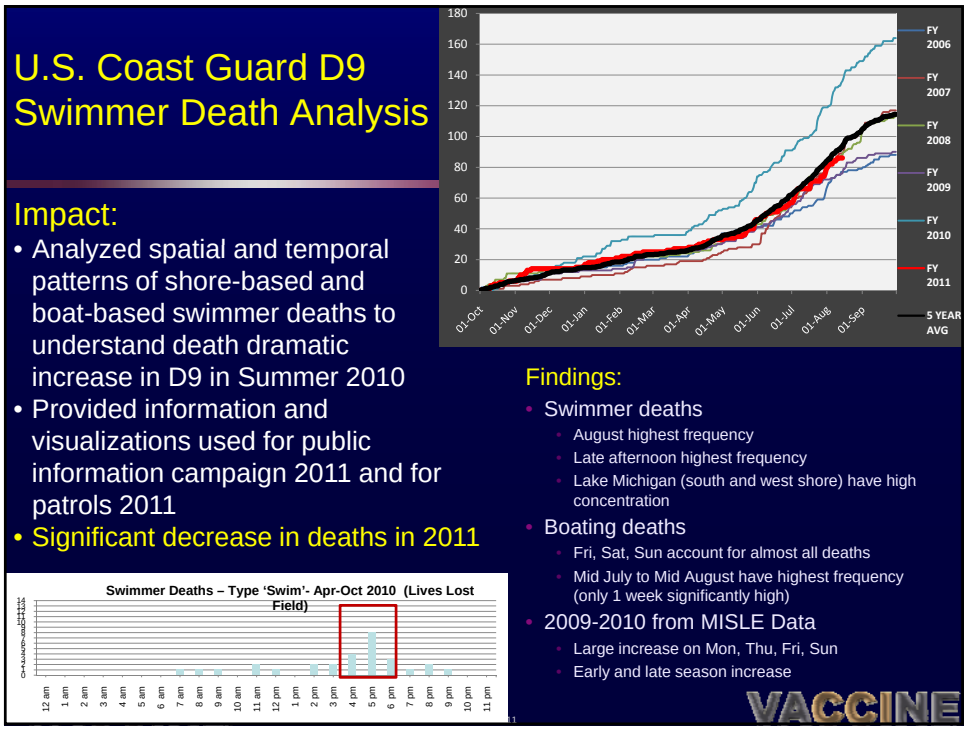
Swimmer Deaths 2010 – From Excel – All Death types (Lives Lost)
September 2011


U.S. Coast Guard D9 Swimmer Death Analysis
Impact:
• Analyzed spatial and temporal patterns of shore-based and boat-based swimmer deaths to understand death dramatic increase in D9 in Summer 2010
• Provided information and visualizations used for public information campaign 2011 and for patrols 2011
• Significant decrease in deaths in 2011
Swimmer Deaths – Type 'Swim'- Apr-Oct 2010 (Lives Lost Field)
12 am 1 am 2 am 3 am 4 am 5 am 6 am 7 am 8 am 9 am 10 am 11 am 12 pm 1 pm 2 pm 3 pm 4 pm 5 pm 6 pm 7 pm 8 pm 9 pm 10 pm 11 pm
180 160 140 120 100 80 60 40 20 0
01-Oct 01-Nov 01-Dec 01-Jan 01-Feb 01-Mar 01-Apr 01-May 01-Jun 01-Jul 01-Aug 01-Sep
FY 2006
FY 2007
FY 2008
FY 2009
FY 2010
FY 2011
5 YEAR AVG
Findings:
• Swimmer deaths
◦ August highest frequency
◦ Late afternoon highest frequency
◦ Lake Michigan (south and west shore) have high concentration
• Boating deaths
◦ Fri, Sat, Sun account for almost all deaths
◦ Mid July to Mid August have highest frequency (only 1 week significantly high)
• 2009-2010 from MISLE Data
◦ Large increase on Mon, Thu, Fri, Sun
◦ Early and late season increase
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2010 Summary Findings

- Swimmer deaths
  - August highest frequency
  - Late afternoon highest frequency
  - Lake Michigan (south and west shore) have high concentration
- Boating deaths
  - Fri, Sat, Sun account for almost all deaths
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- 2009-2010 from MISLE Data
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  - Early and late season increase

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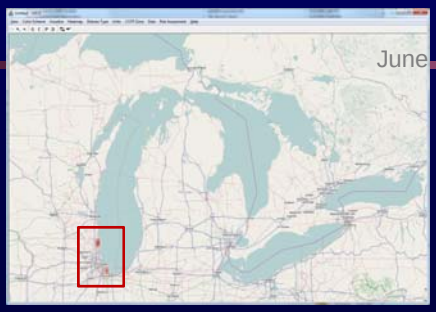
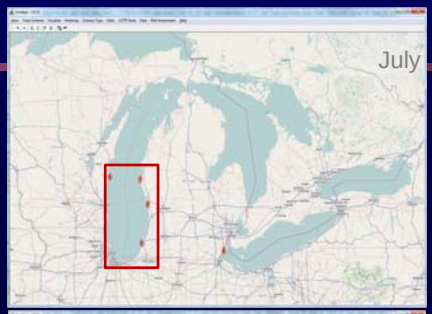
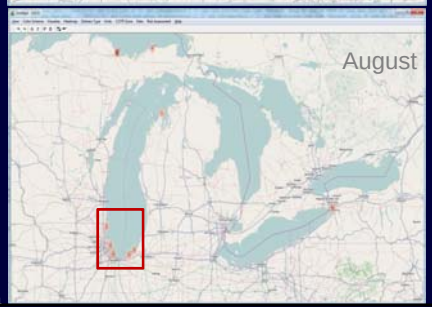
"Swimmer" Lives Lost by Month







Concentration in Lake Michigan
June, August concentration in South and Western shores

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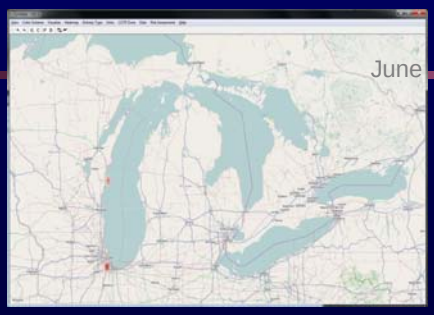
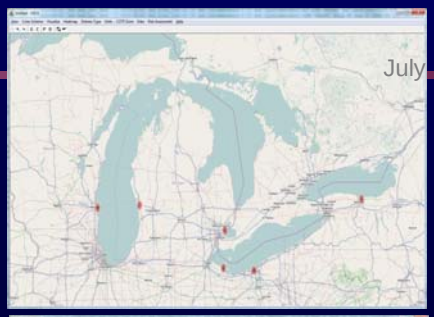
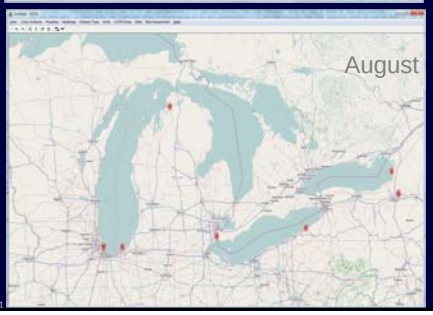
"Boat" Lives Lost by Month







Boat Lives Lost spatially distributed

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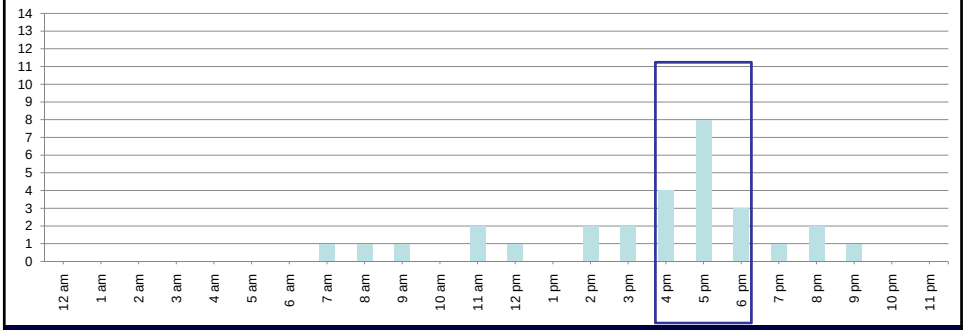
Swimmer Deaths – Type 'Swim'- Apr-Oct 2010 (Lives Lost Field)



Late afternoon highest frequency

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USCG PWCS PROTECT Project

Partners: USC CREATE, USCG RDC, USCG D1, USCG LANT, USCG PAC

Impact:

- Provided insight and analysis into historical security patrols in Boston
- Analyzed developing PROTECT model and provided pattern analysis to improve model during operational deployment in Boston and for improvements for deployment in NYC
- Developed end-user tool for evaluation and validation of patrol routes

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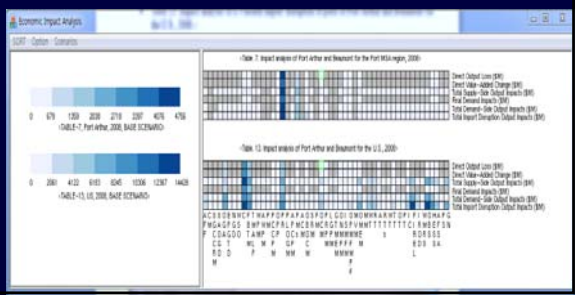
USCG Port Closure Economic Impact VA

Partners: USC CREATE, USCG RDC, USCG D7, USCG LANT

IMPACT:

- Provided tool for use analysis and planning for impact of port closure in Port Arthur, Tx
- Economic sector impact, local and national impact
- Impact and effectiveness of alternative mitigation strategies



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Risk-Based Allocations

- Comparative visual analysis of mission cases/hours vs. staffing hours
- Comparative visualization of resources vs. risk
- Trend visual analytics
  - Increase/decrease in resource allocation
  - Increase/decrease in risk (total, mitigated, residual)
  - Increase/decrease in incidents
- Exploration of alternatives and effect on risk
- Predictive analytics based on historical data (STL and EWMA)

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187 boats at 47 stations respond to over 5,000 rescue, enforcement & response missions each year

Change in force laydown for best ROI
-communicate to stakeholders

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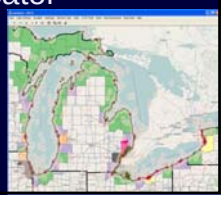
Uncertain Information for Decision Making

- What numbers make sense?
- Counts vs. rates?
  - How many boats are in an AOR over a year?
    - No reliable data source
    - Registered boats by county not accurate
    - Marina slips not a reliable indicator
    - Marina fuels sales probably not reliable indicator



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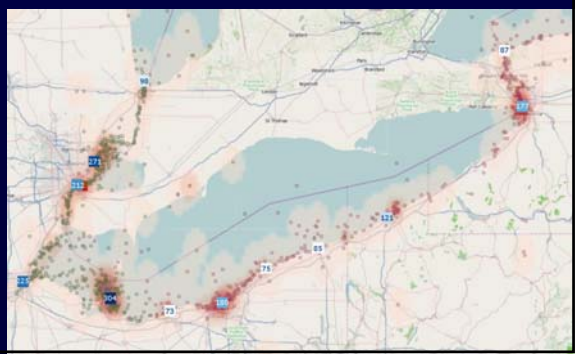
Comparative Visual Analysis of SAR Cases vs. SAR Boat Hours

- Explore less intrusive way to visualize Boat Hours while enabling effective comparison
- Spatio-temporal analysis and exploration at varying granularities and areas of interest



Boat Hours for 2009 and SAR Risk.

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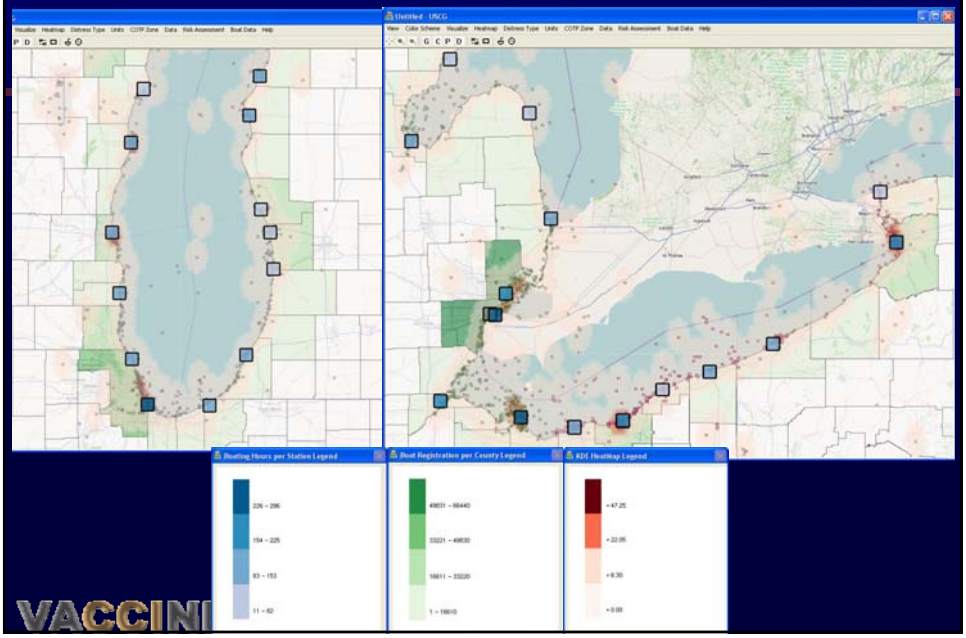
2010: Total SAR Risk vs. Boat Hours



For Further Information

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