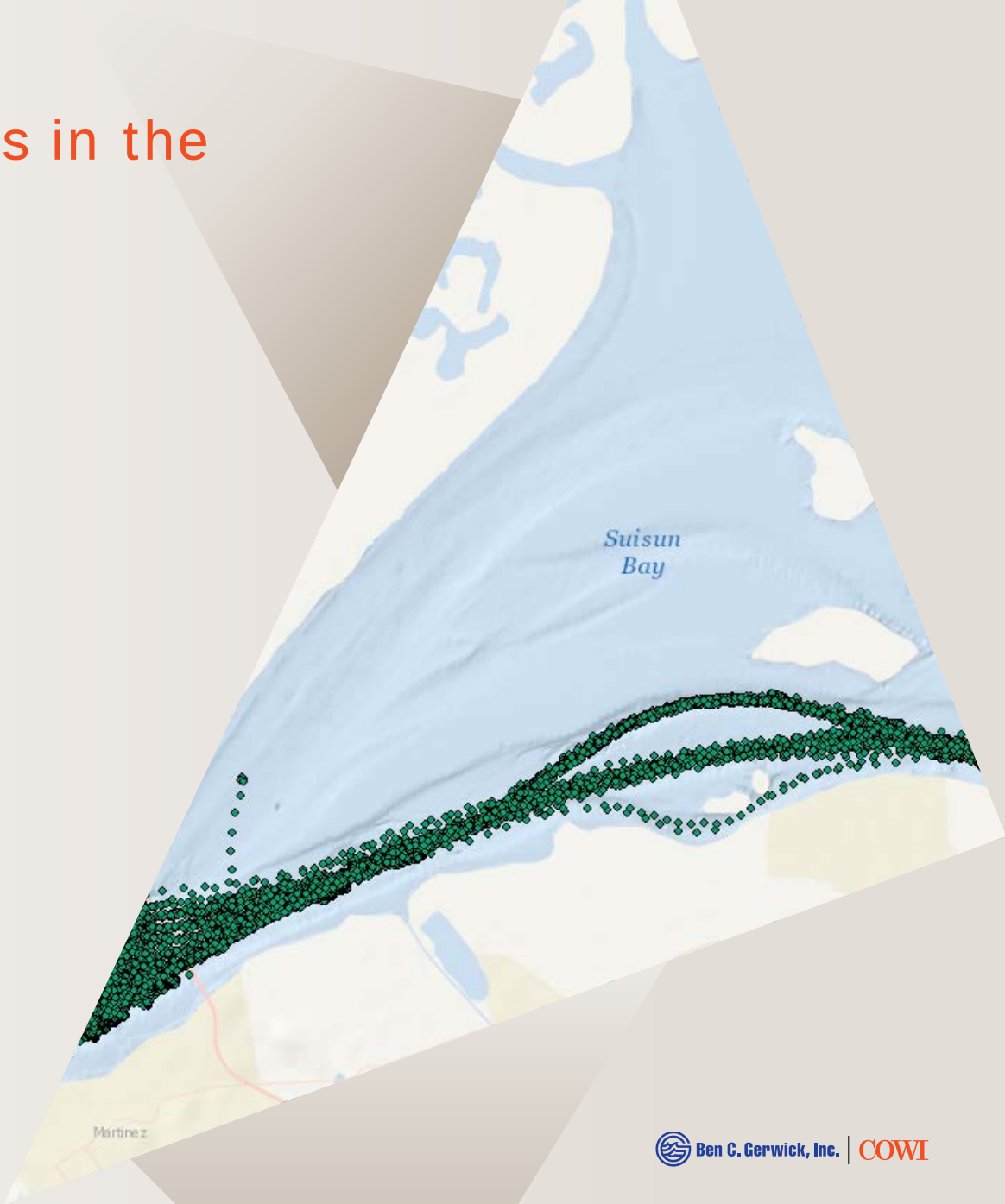
Prevention First 2014

Vessel Traffic Analysis in the Carquinez Strait



Jean O. Toilliez, PE, PhD
& Jack W. Gerwick, PE
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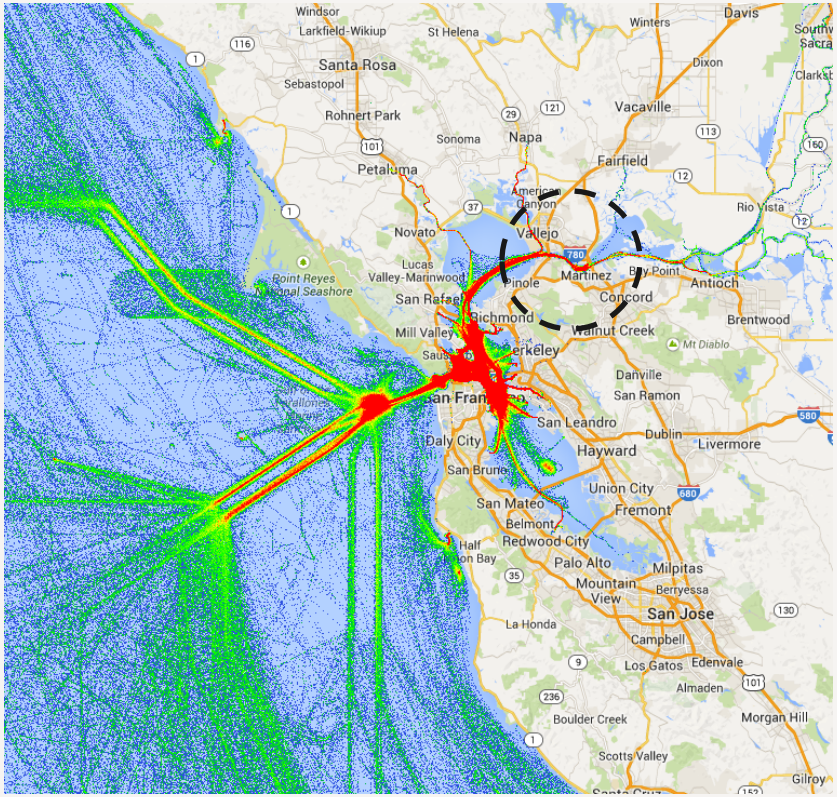
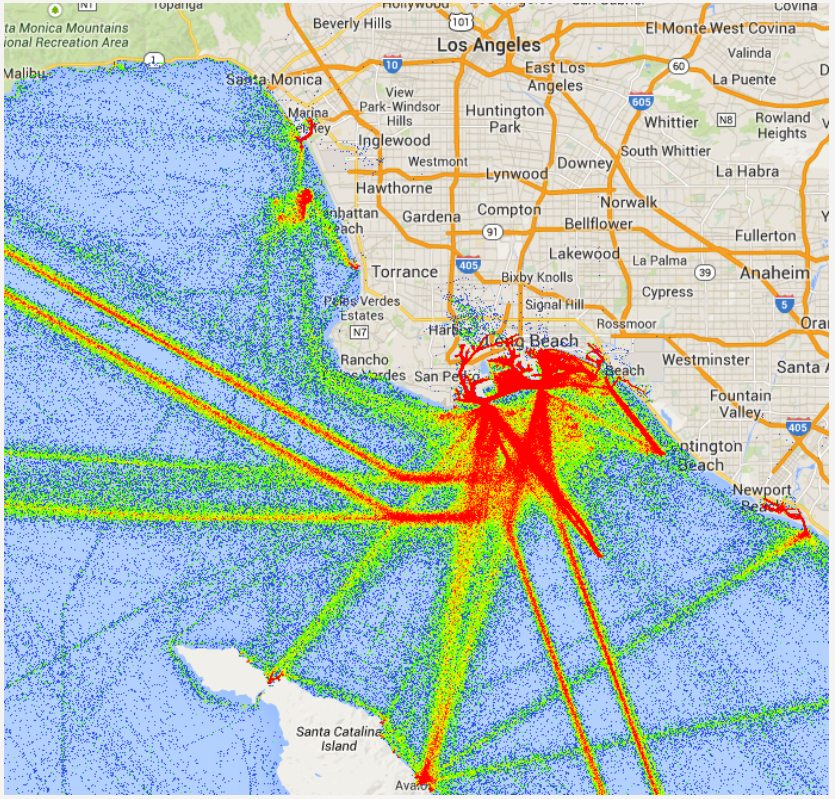
Context

Density Map by AIS

Marine Traffic in California





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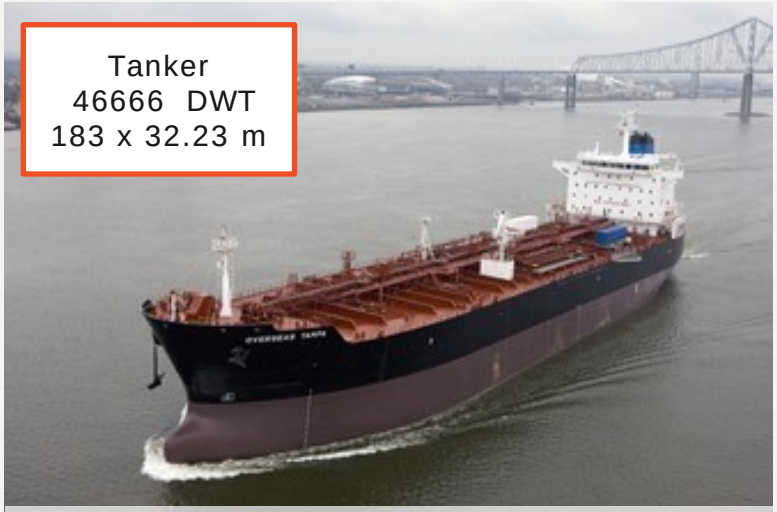
Passing Vessel Loads

- History of strong passing vessel incidents in the area
- Documented interaction (Jan. 2012)
  - The interaction occurred a vessel was transiting Pittsburg to sea (…).
  - On the passing of that vessel, a moored vessel experienced a sudden surge, **which pulled the ship off the dock approximately four feet**, moved her **seven feet fore and aft, and separated three mooring pendants**.
  - The estimated distance between the two ships was approximately **150 feet**.



Moved 4 ft off dock and 7 ft fore and aft

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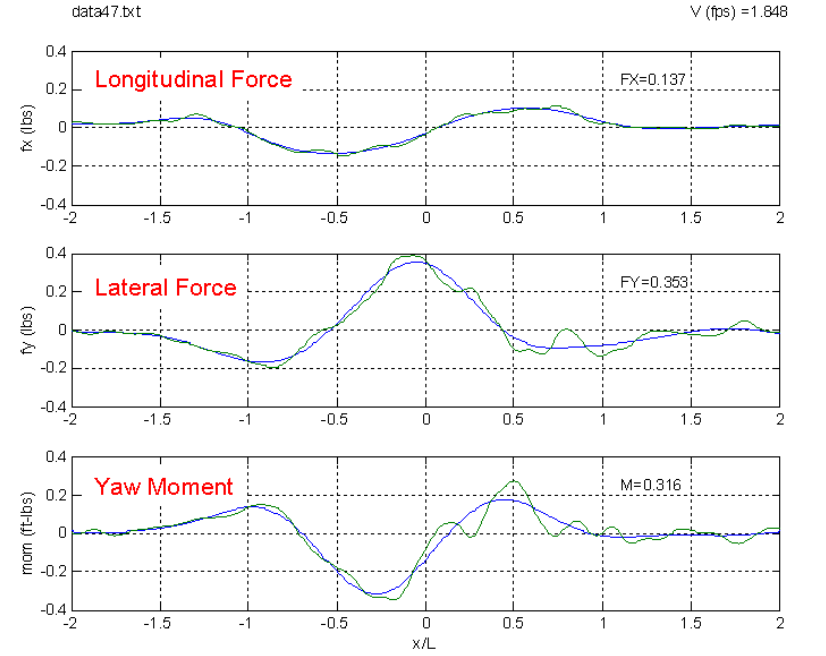
Assessing Passing Vessel Loads

Simplified methods

- PASS-MOOR (Kriebel & Seelig, 2005)
- OPTIMOOR passing vessel load module

Numerical methods

- VH-LU (S. Fenical et al.)
- DELPASS (Pinkster and Marin)
- Hydrodynamic codes with moving boundary



Sample data showing typical measured force and moment records along with low pass filtering. From TR-6056-OCN by Kriebel (2005)

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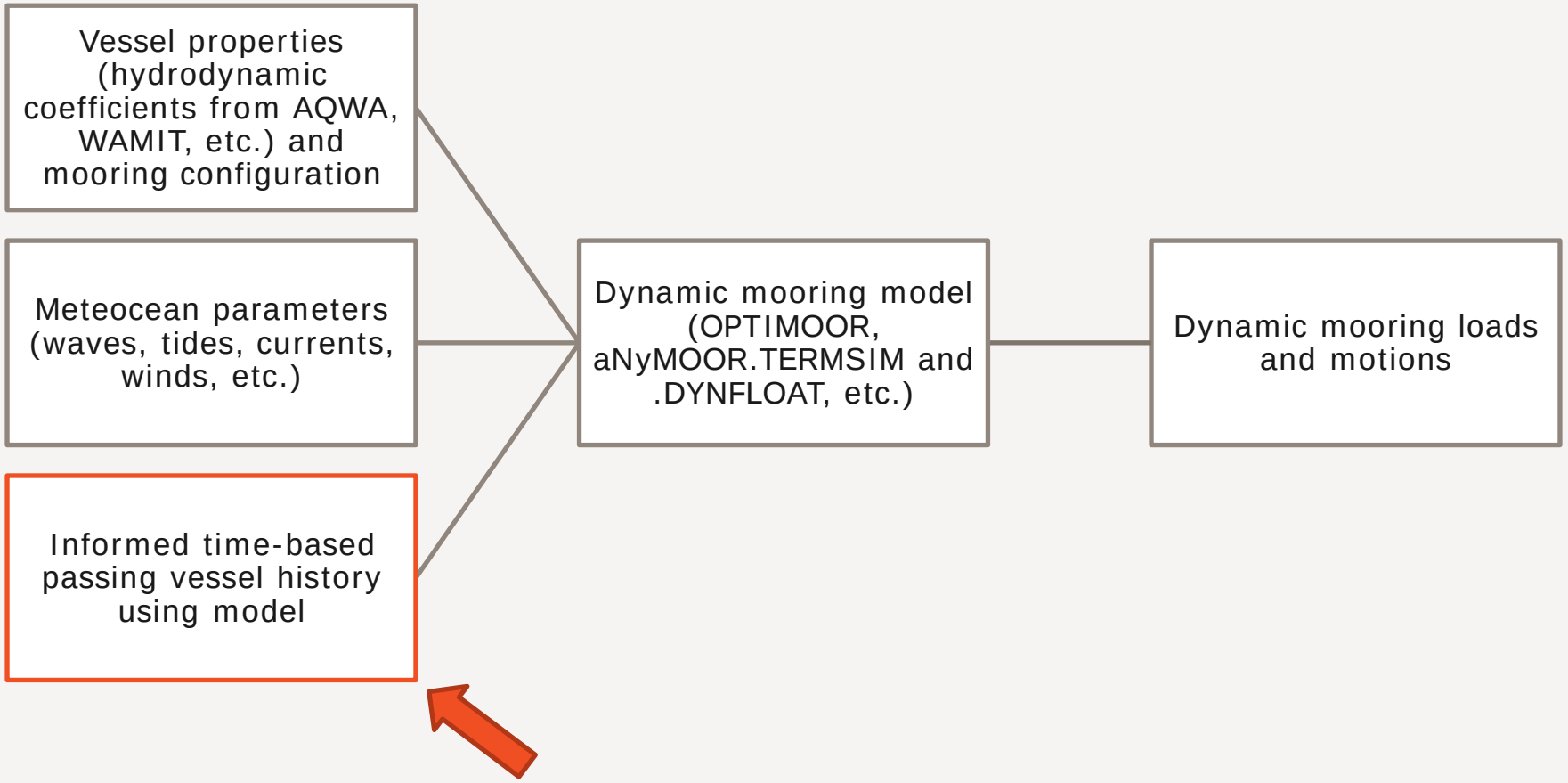
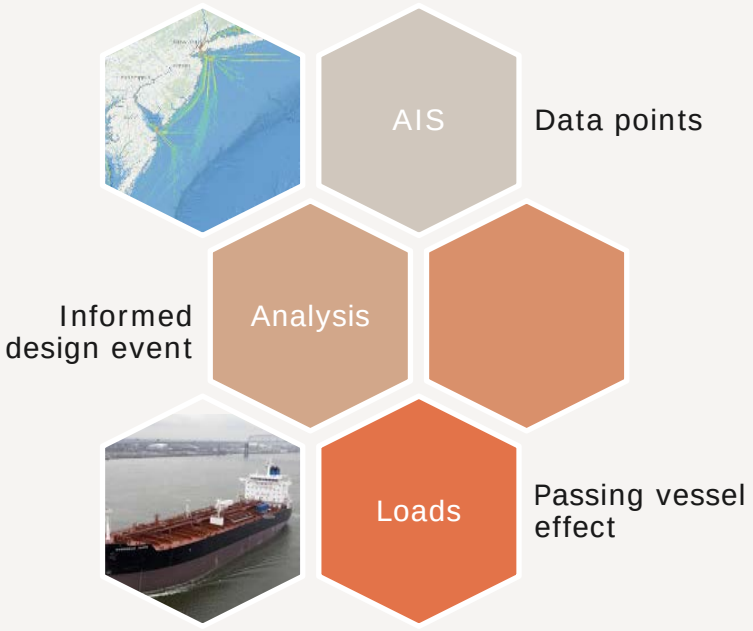
Work Flow


Vessel properties (hydrodynamic coefficients from AQWA, WAMIT, etc.) and mooring configuration
Meteocean parameters (waves, tides, currents, winds, etc.)
Informed time-based passing vessel history using model
Dynamic mooring model (OPTIMOOR, aNyMOOR.TERMSIM and .DYNFLOAT, etc.)
Dynamic mooring loads and motions

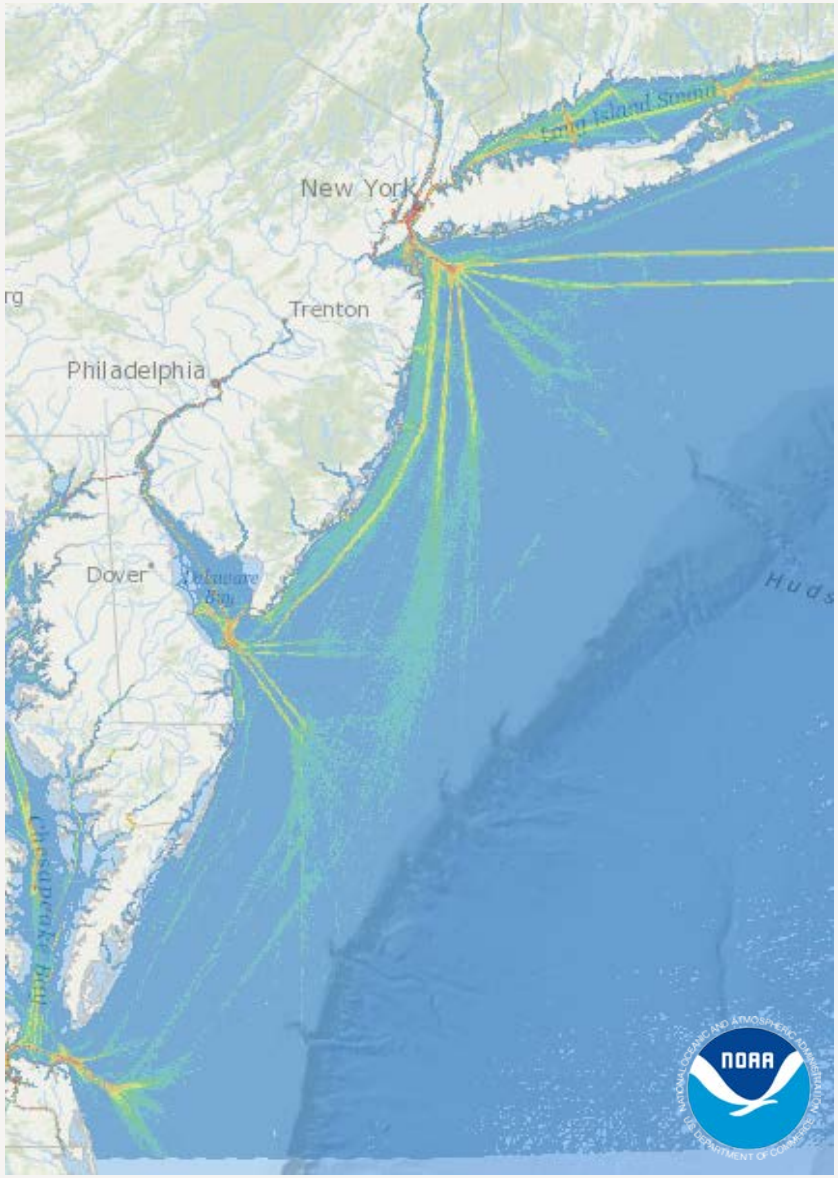
Objectives and Methods

- Motivations
  - Inform design of new MOT in the San Francisco North Bay
  - History of passing vessel loads with documented incidents in that region
- Model Selected
  - PASS-MOOR by Kriebel (per MOTEMS requirements)
- Needs
  - Dimensions of likely vessel
  - Measured distance from MOT
  - Draft conditions
  - Other traffic data
- Methods
  - AIS data provided by the Marine Cadastre by NOAA
  - Use scripting tools and ArcGIS to extract data



The NOAA Marine Cadastre

- MarineCadastre.gov
  - Partnership between NOAA Coastal Services Center and DOI Bureau of Ocean Energy Management (BOEM)
- Coverage
  - 48 states
  - All types of vessels equipped with AIS
  - Some data restricted by USCG
- Data
  - 1-minute Automated Information System (AIS)
  - Curated and hosted by the National Ocean Service (NOS), Coastal Services Center (CSC)



Keys and Fields

Broadcast
•OBJECTID •SOG •COG •Heading •ROT •BaseDateTime •Status •VoyageID •MMSI •ReceiverType •ReceiverID

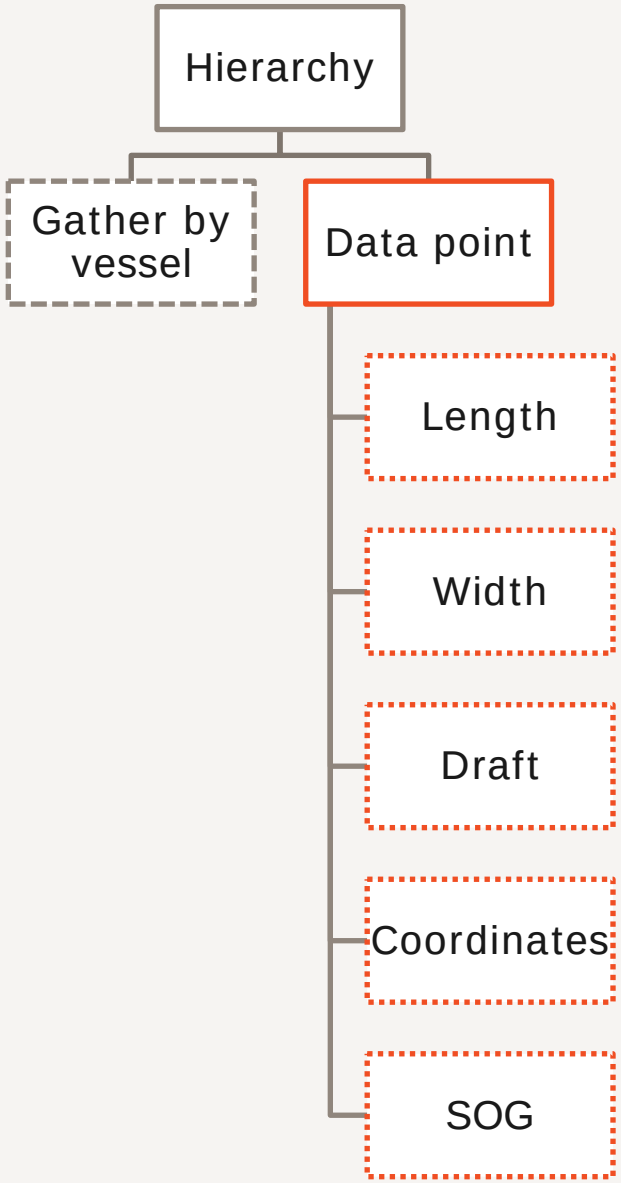
Ship
•OBJECTID •Status •VoyageID •MMSI •X_Long and Y_Lat

Vessel
•OBJECTID •MMSI •IMO •CallSign •Name •VesselType •Length •Width •DimensionComponents

Voyage
•OBJECTID •VoyageID •Destination •Cargo •Draught •ETA •StartTime •EndTime •MMSI

Data Structure

- Availability
  - 2009, 2010 and 2011 available online
  - Provided as GIS database
- Length and depth
  - One dataset per month (20M points)
  - One year record: complete 2010 dataset comprises over 200M AIS points.
- Attributes
  - The database maintained by the MMC features unit/attribute pairs
  - UTM Zone 10, and spans the entire calendar year of 2010
  - Time is provided in the Coordinated Universal Time (UTC) 24-hour format ("1600Z" is 0700a UTC-0800 (PDT)).
- Restrictions
  - MMSI (Maritime Mobile Service Identity) field has been encrypted for the 2010 and 2011 data at the request of the U.S. Coast Guard.



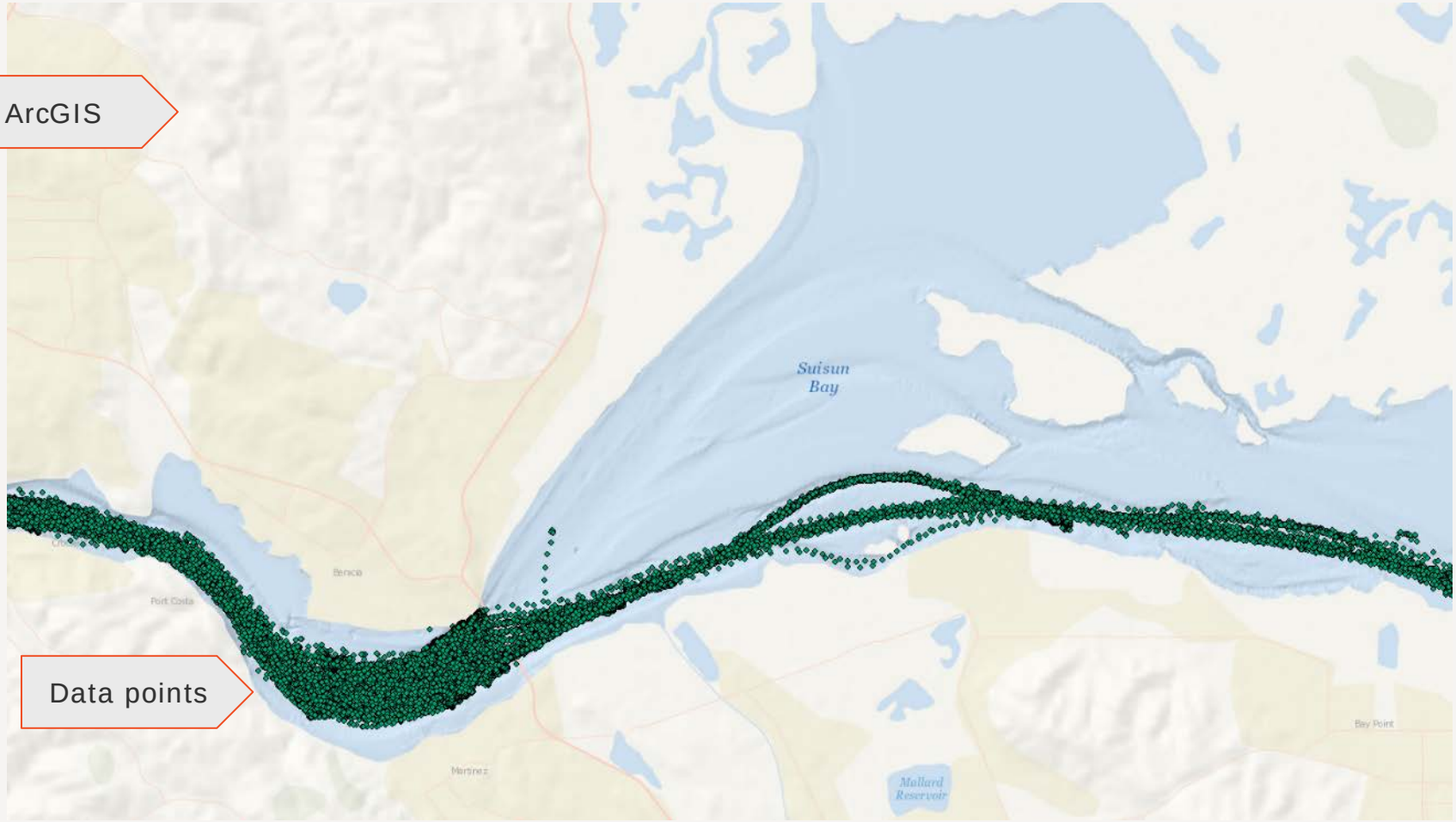
Structure

Standard Vessel Types

Code	Definition
0-9	Not Available
10-19	Reserved for future use
20-20	WIG
30-30	Fishing
31-31	Towing
32-32	Towing and length of the tow exceeds 200m or breadth exceeds 25m
33-33	Engaged in dredging or underwater operations
34-34	Engaged in diving operations
35-35	Engaged in military operations
36-36	Sailing
37-37	Pleasure craft
38-38	Reserved for future use
40-49	HSC
50-50	Pilot vessel

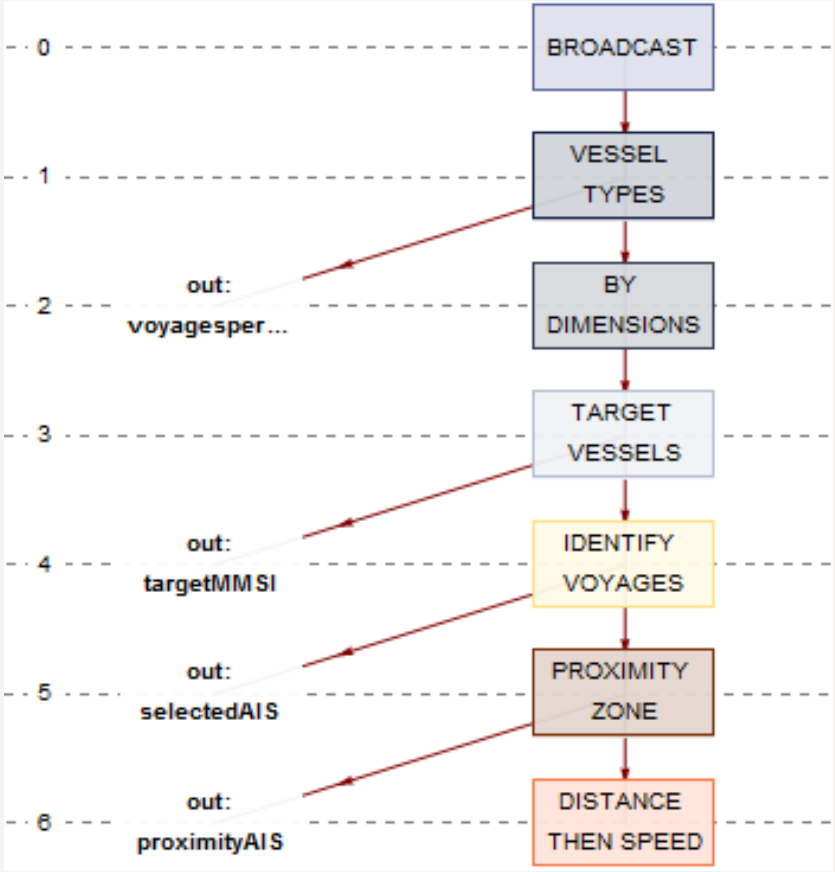
51-51	Search and rescue vessels
52-52	Tugs
53-53	Port tenders
54-54	Vessel with anti-pollution facilities or equipment
55-55	Law enforcement vessel
56-57	Spare for assignments to local vessel
58-58	Medical Transport
60-69	Passenger ships
70-79	Cargo ships
80-89	Tankers
90-99	Other types of ship
140-140	Reserved for regional use

Restrict Geographical Area of Interest

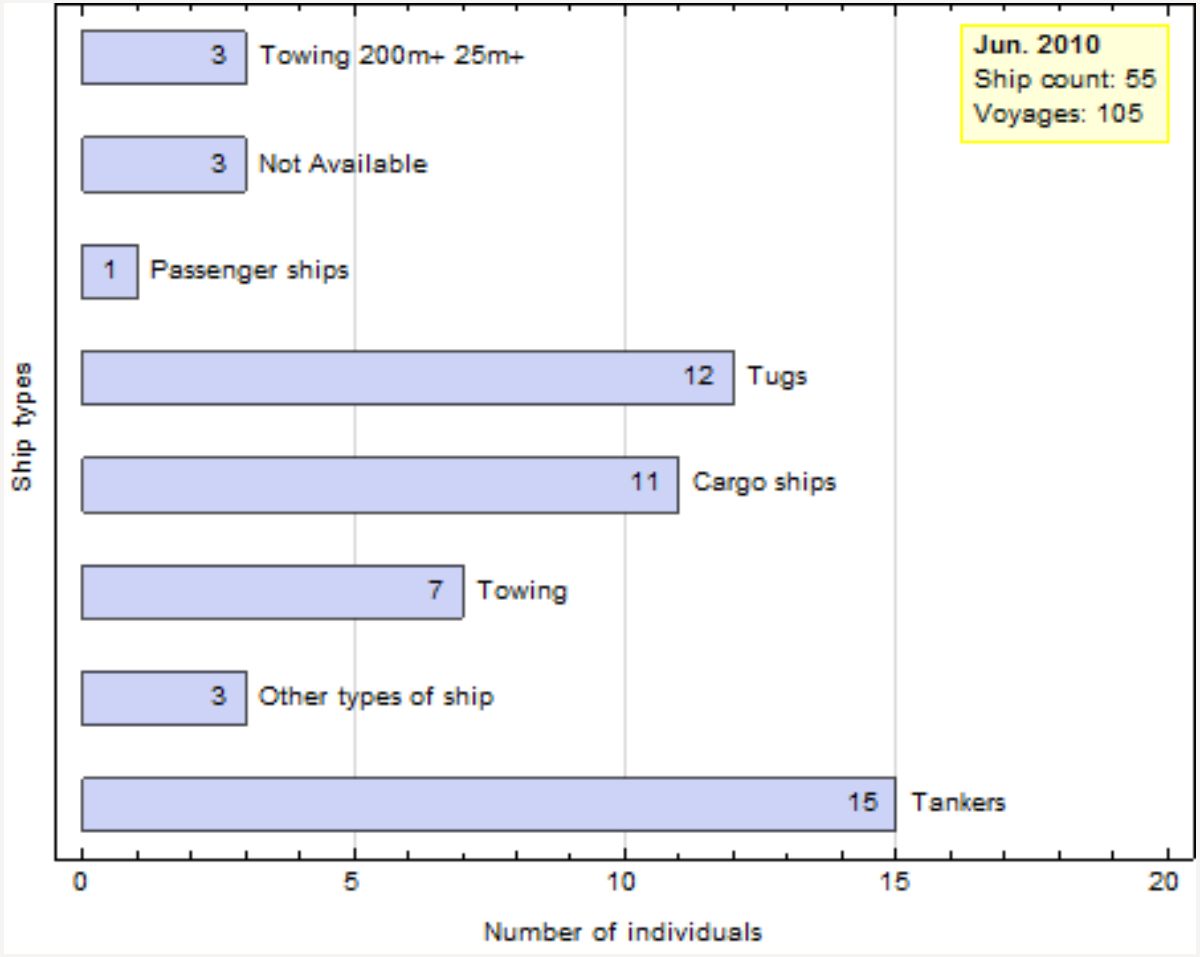


Work flow

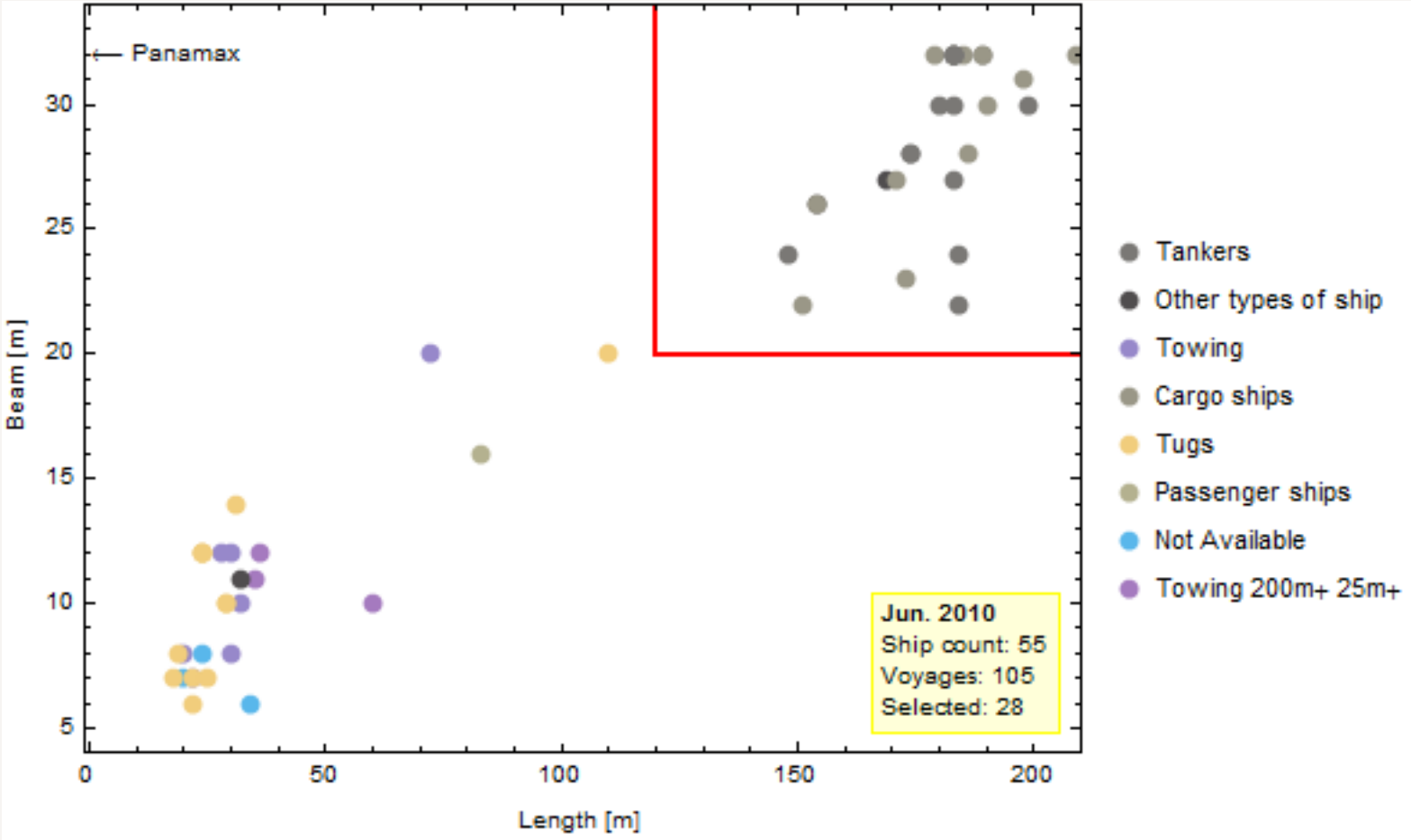
- From 200M points to a manageable list of events
- Filter by relevance
  - Distance to MOT
  - Within specified time-window
- Tools
  - AIS database handled in ESRI ArcGIS
  - SQL queries designed to extract data points based on select criteria
  - Some scripting (repeatable in MatLab, Mathematica, Python, R, etc.) necessary



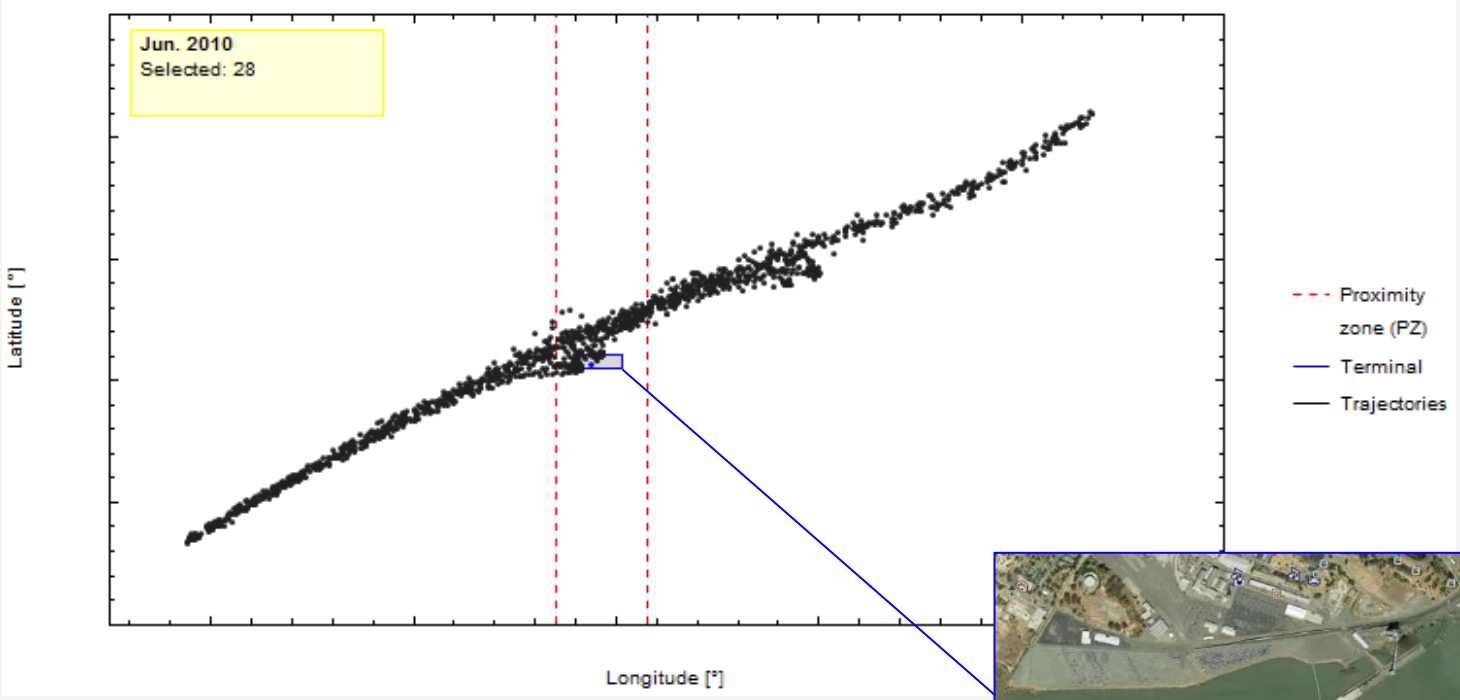
Vessel Types and Frequency Analysis



First Pass Filtering: Size



Second Pass Filtering: Proximity



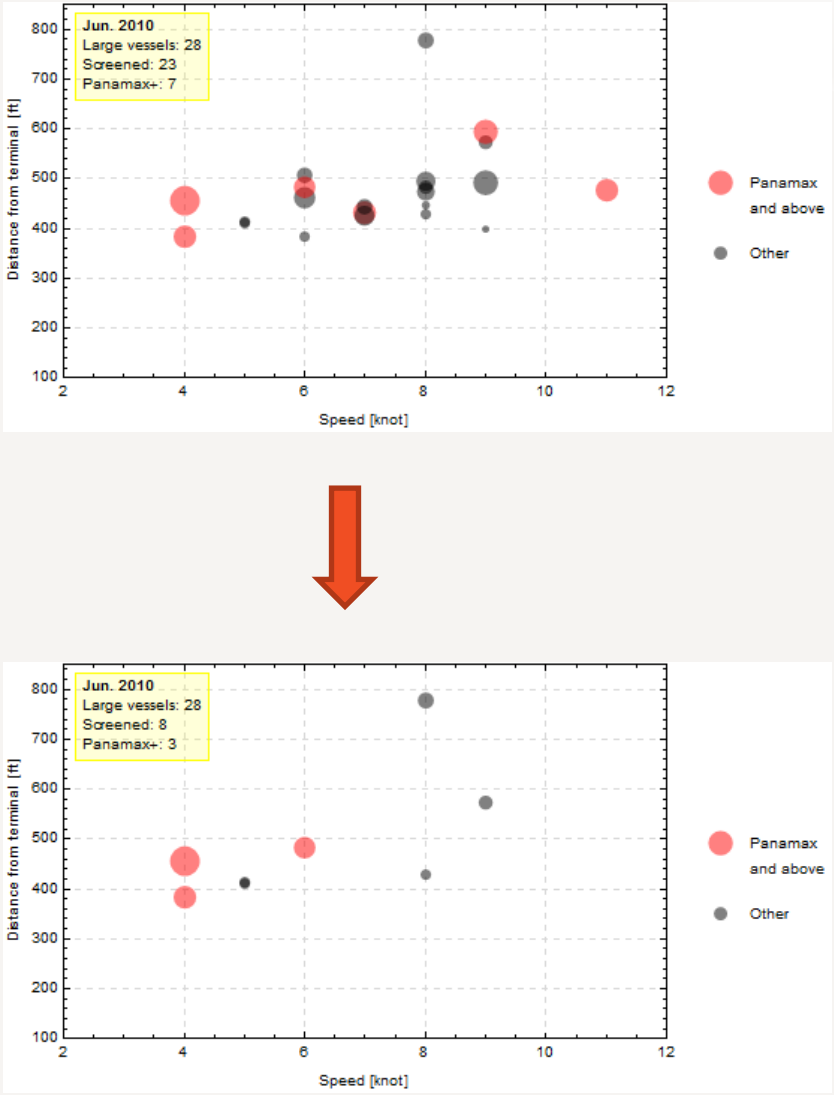
Preliminary Event List

- Criterion
  - Enforce a **time constraint** in order to discard any vessel passing event occurring while no vessel is moored at the MOT
- Additional steps
  - Determine the minimum distance at which a passing vessel comes during each selected voyage
  - Extract speed when the minimum distance is achieved.

Speed [knot]	Distance [ft]	Heading [deg]	Length [m]	Beam [m]	Type
8	777.923	65	183	27	Tankers
9	574.483	241	171	27	Cargo ships
6	482.607	245	179	32	Cargo ships
4	457.003	67	209	32	Cargo ships
8	428.595	64	154	26	Cargo ships
5	412.954	68	184	22	Tankers
5	409.737	246	154	26	Other types of ship
4	384.658	63	183	32	Tankers

Monthly Design Events

- Illustration
  - Final passing vessel dataset for June 2010
  - Each dot is sized according to the dimensions of the passing vessel. Panamax vessels, with a beam of 32 m, are highlighted in red.
- Time-based filtering
  - **Top figure** Passing events occurring regardless of moored vessel conditions at the Plains terminal
  - **Bottom figure** Passing events screened to match moored vessel conditions



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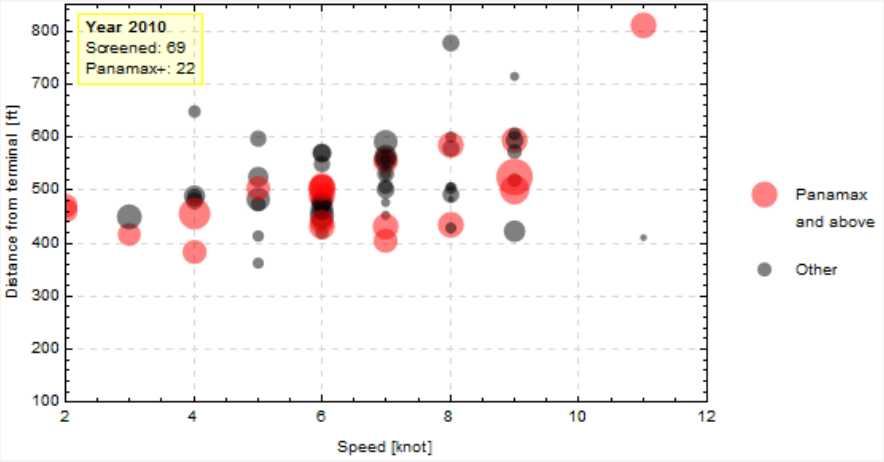
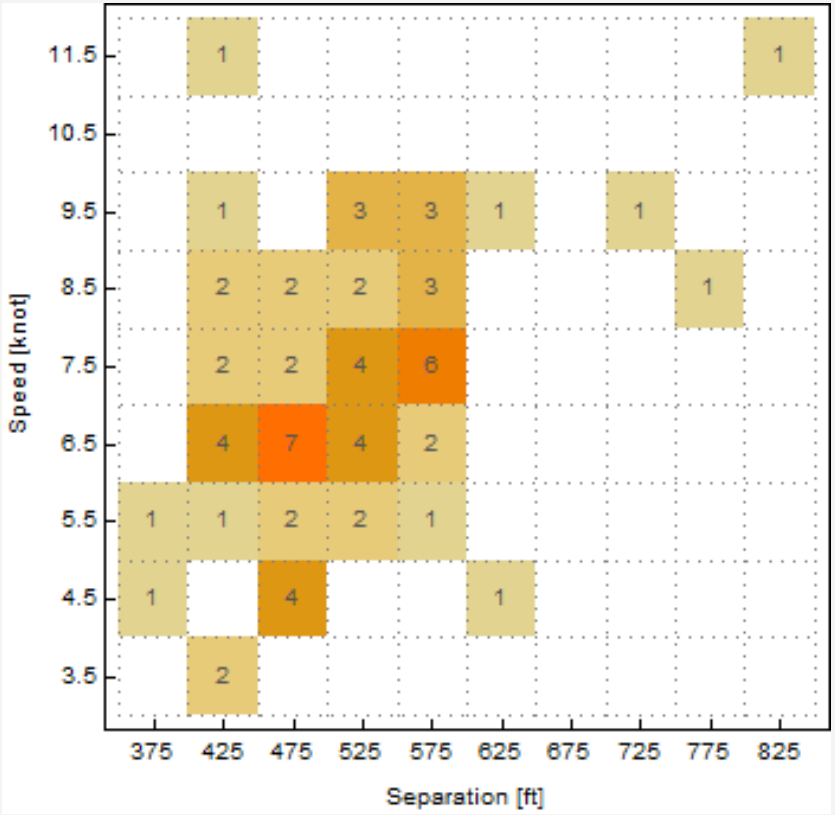
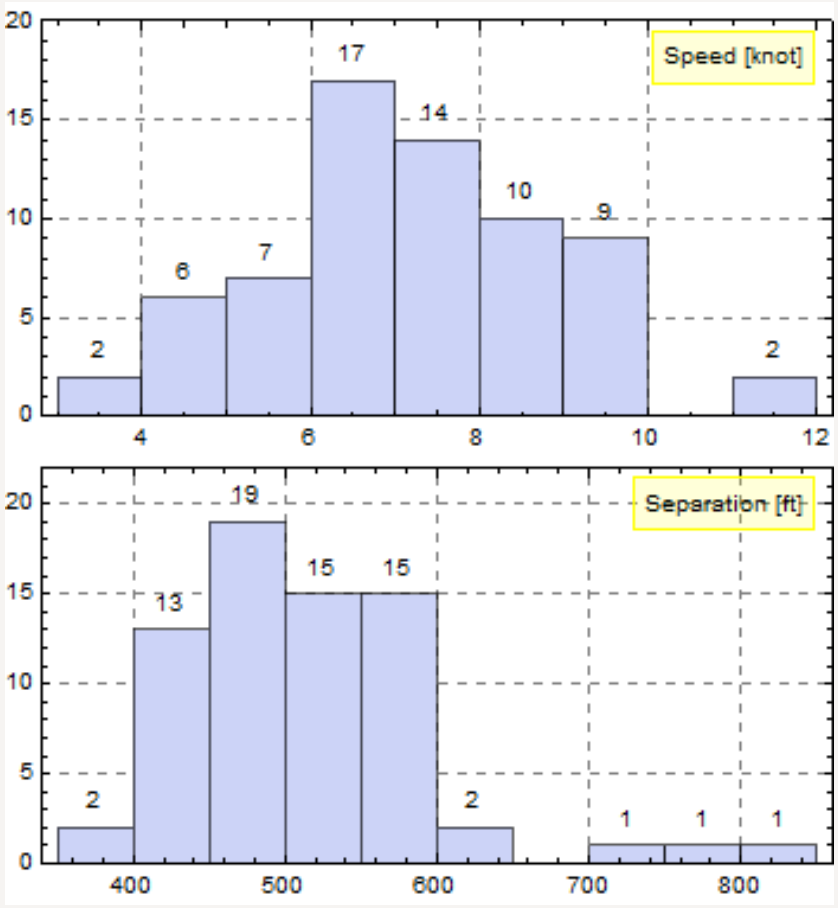
Annual List of Event



Yearly dataset characteristics	
Year of record	2010
Length of record	69
Large vessels	69
Panamax+	22

Joint Probability Distribution





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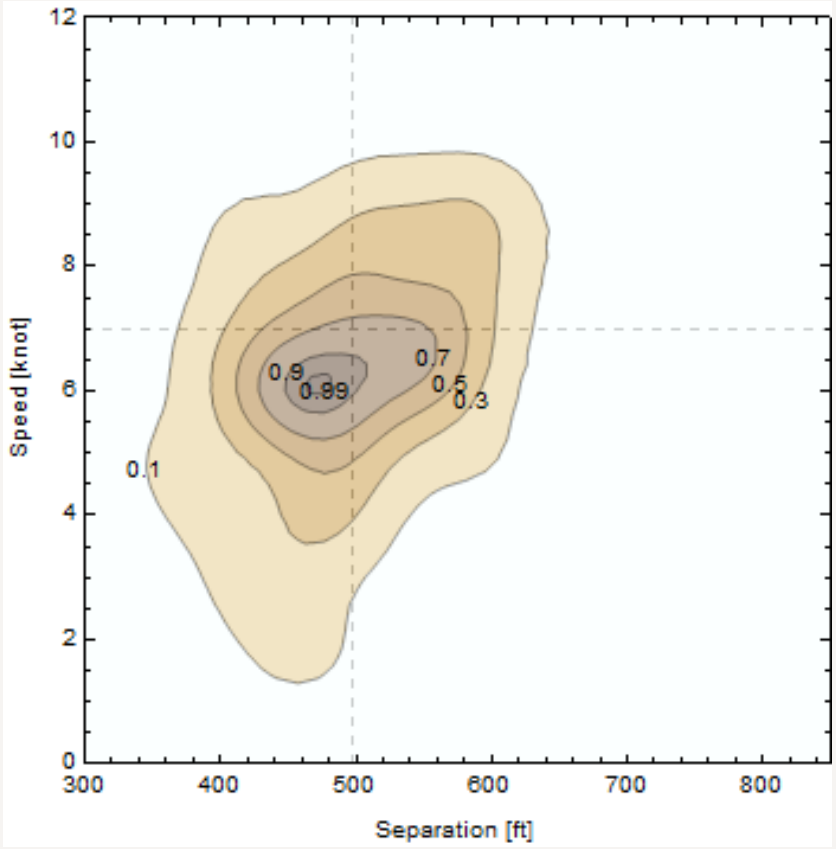
AIS Data a Key Component for Passing Vessel Analysis

- **Portable**
  - Straightforward GIS format
  - Exported data may be re-used for future risk analysis
- **Scalable**
  - Scalable from small to medium sized projects
  - Good geographical coverage and point density
- **Comprehensive**
  - AIS a powerful tool for ocean management
  - Provides realistic design events for passing vessel load assessments
- **Useful**
  - Allows for a well-informed implementation of passing vessel load model and subsequent dynamic mooring analysis



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