



A Strategic Simulation Tool for Capability-Based Resource Planning

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Outline

- Force structure simulation using Tyche
 - Capability-based planning
 - Modelling approach
 - Supply and Demand
- Types of questions that can be answered
- Defining political risk
 - Relative fleet performance
- Selected examples from Fleet Mix Study II
 - Frigate replacement concept
 - Maritime Helicopters as a force multiplier



What is Tyche?

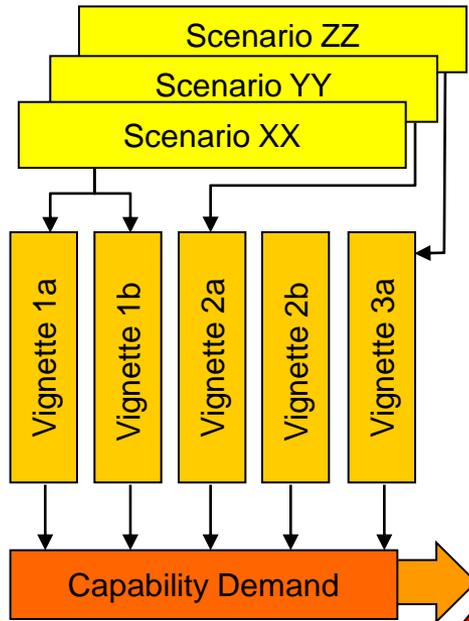
- A scheduling program that attempts to meet scenario demands by assigning assets (*capabilities via platforms*) in the same manner as a real military fleet scheduler
- Tyche uses capability-based simulation for asset scheduling over a given time period
 - Select assets based on a set of fixed rules
 - Assign assets to scenarios try to meet the capability requirements
 - Assets are assigned in chronological order
 - Scenarios are generated stochastically; in each iteration, given frequency of occurrence based on a Poisson distribution
 - Run in Monte Carlo mode to obtain an average operational schedule and fleet performance



Tyche Modelling Approach

TYCHE models operational scheduling options to “test” the notional fleet’s ability to meet the “demand” through many iterations of selected scenarios – including “random” events (deployments) and “scheduled” events (routine ops, exercises, and training)

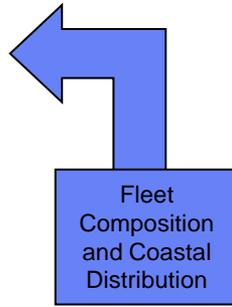
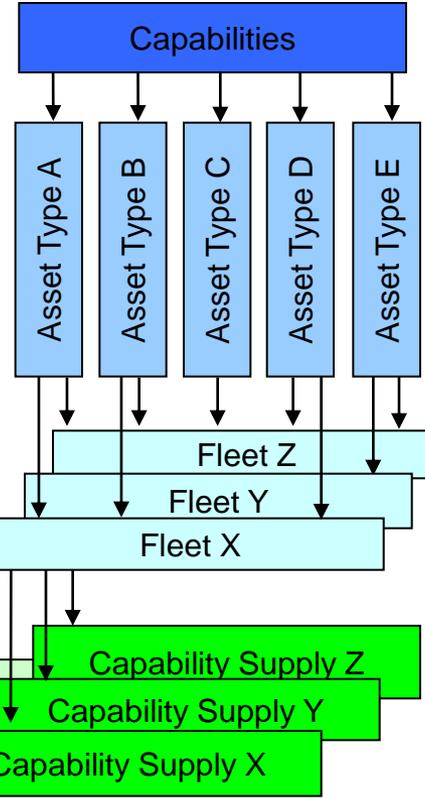
CF Scenarios and resultant Naval Vignettes are used to estimate future operational requirements (Demand)



Capabilities are defined and then attributed to pre-defined platforms (Supply)

Risk Assessment for each Fleet

Tyche tests Fleets' ability to meet strategic assumptions, definitions, requirements, demand & supply

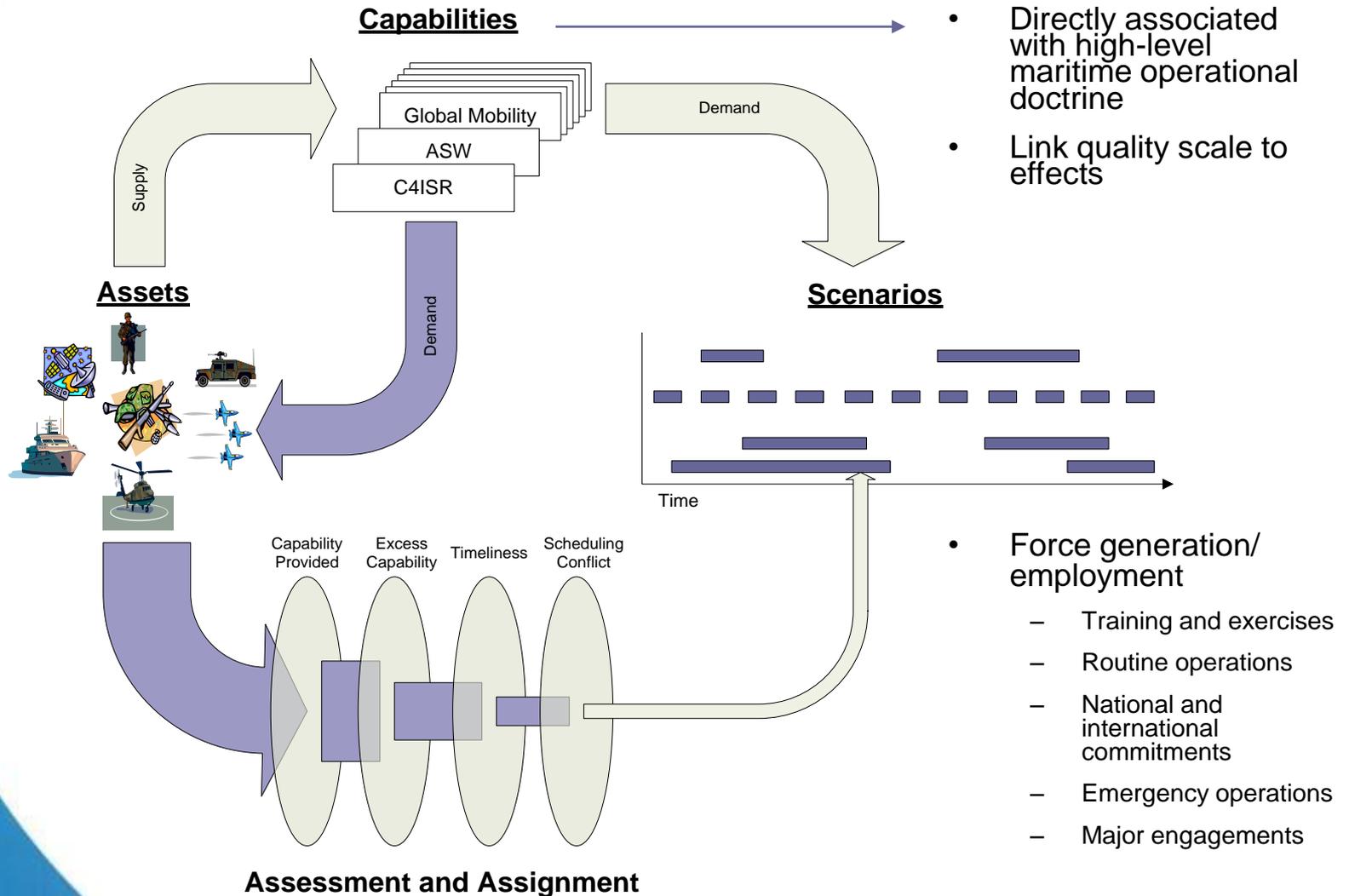


Strategic Definitions, Assumptions, Requirements

- Definitions: Political Risk Measure, Naval Capabilities, Scoring Criteria
- Vignette Frequencies, Durations & Categorizations/Groupings
- Requirements: Readiness, Response, Sustainment & Regeneration
- Other Strategic-level requirements/inputs/assumptions



Capability-Based Relationships



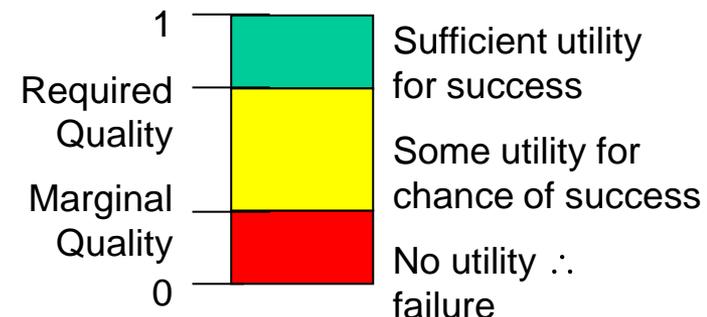
- Directly associated with high-level maritime operational doctrine
- Link quality scale to effects

- Force generation/employment
 - Training and exercises
 - Routine operations
 - National and international commitments
 - Emergency operations
 - Major engagements



Capability Demand: Maritime Vignettes

- 54 vignettes
 - Historical events
 - Policy review
 - Maritime component of CF Force Development Scenarios
 - Analysis of future security environment
- Assigned to political impact categories
- Assessed order of importance for rescheduling instructions
- Levels of capability demand for mission success
- Scoring criteria





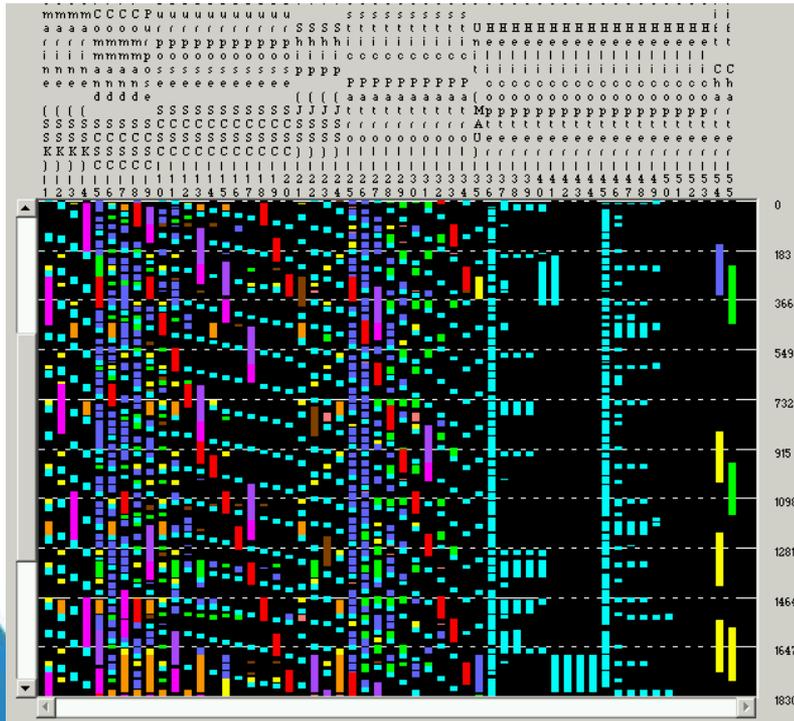
Capability Supply: Asset Types

- Current ships, future ship concepts + maritime helicopters (MH)
 - Destroyers (DDH)
 - Frigates (FFH)
 - Auxiliary Oil Replenishment (AOR)
 - Maritime Coastal Defence Vessels (MCDV)
 - Submarines (SSK)
 - Sea Kings (CH-124)
 - Destroyer Replacements
 - Frigate Replacements
 - Joint Support Ships (JSS)
 - Arctic Offshore Patrol Ship (AOPS)
 - Littoral Manoeuvre Ships (LMS)
 - Submarines (SSK)
 - Cyclones (CH-148)
- Force multiplier effect of increased capability when MH assigned with ship
- Readiness postures and maintenance cycles
- Personnel tempo constraints and Quality of Life breaks



Tyche Output

- Operational schedules
 - Numerical
 - Graphical
- Average performance indicators
 - Combination of assets sent to particular scenarios
 - Percentage of time a particular combination is sent to a scenario
 - How often no assets are sent to a scenario
 - Days of usage per asset
 - Probability that capabilities are not being met for a given scenario





Types of Questions That Tyche Can Answer

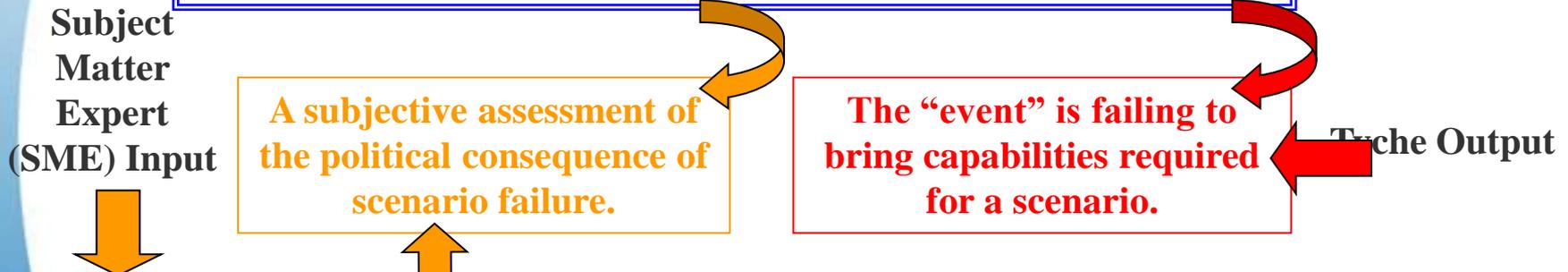
- Individual scenarios vs. entire set
 - Performing capability-gap analysis
- Platform vs. capability effects
 - Support to platform-capability design
 - Prioritize future capability requirements
- Fleet comparison (time slice) vs. fleet evolution (transition over time)
 - Number and type of platforms
 - Testing new capability architectures, joint capability and resources requirements
 - Assist scheduling of capability development



Political Risk as Measure of Effectiveness

- Top-down strategic approach, where government policy dictates military operations and objectives
- Expression of the impact and likelihood of an event

Political Risk = Political Impact * Frequency of Failure



Category Description	Political Risk Impact	# Vignettes
Minor	No or negligible political interest (e.g. scheduling problem results in HMCS HALIFAX missing a collective training opportunity). No direct impact on domestic security.	21
Measurable	Inability to either participate in a range of domestic and international activities and/or fulfill standing commitments. Slight political interest domestically and/or internationally.	7
Significant	Navy is not able to meet specific operational requirements regarding Canadian sovereignty issues or international commitments of the CF. Generates long-term but sporadic interest on the international stage.	17
Critical	Military assistance required from another country to resolve an issue to Canada's satisfaction (both domestic and international). Creates lasting international embarrassment.	7
Severe	Inability to provide substantial support and assistance to international coalition/military operations resulting in significant military losses (CF Forces and/or allies). Domestically, either a severe threat to Canadian territory or sovereignty.	2



Political Impact Category Score

- Quantitative evaluation of impact is subjective
 - Perspective: dictates how impact will be perceived

Political perspective selected to better reflect top-down strategic approach, where government policy dictates the military operations and objectives
 - Measure: obtained a relative numerical value for each level of ordinal impact scale through a survey conducted on naval officers
- Allows for “apple to orange” comparison between categories
- Relative between fleet comparisons



Determining a Risk Threshold

- Expression of the tolerance of failure
- Total over the category

$$\text{Risk Threshold} = \text{Political Impact} * \text{Acceptable Frequency of Failure}$$

SME
Input

A subjective assessment of
the political consequence of
scenario failure.

Limited resources,
therefore must assume
some failure (maximum)

Category Description	Acceptable Frequency of Failure
Minor	Once every 1.5 years
Measurable	Once every 4.5 years
Significant	Once every 10 years
Critical	Once every 30 years
Severe	Once every 75 years

SME Input



The Fleet Mix Study (FMS II)

- Purpose:

To provide an updated estimation of the capacity of naval fleet assets required to meet anticipated future security and defence challenges

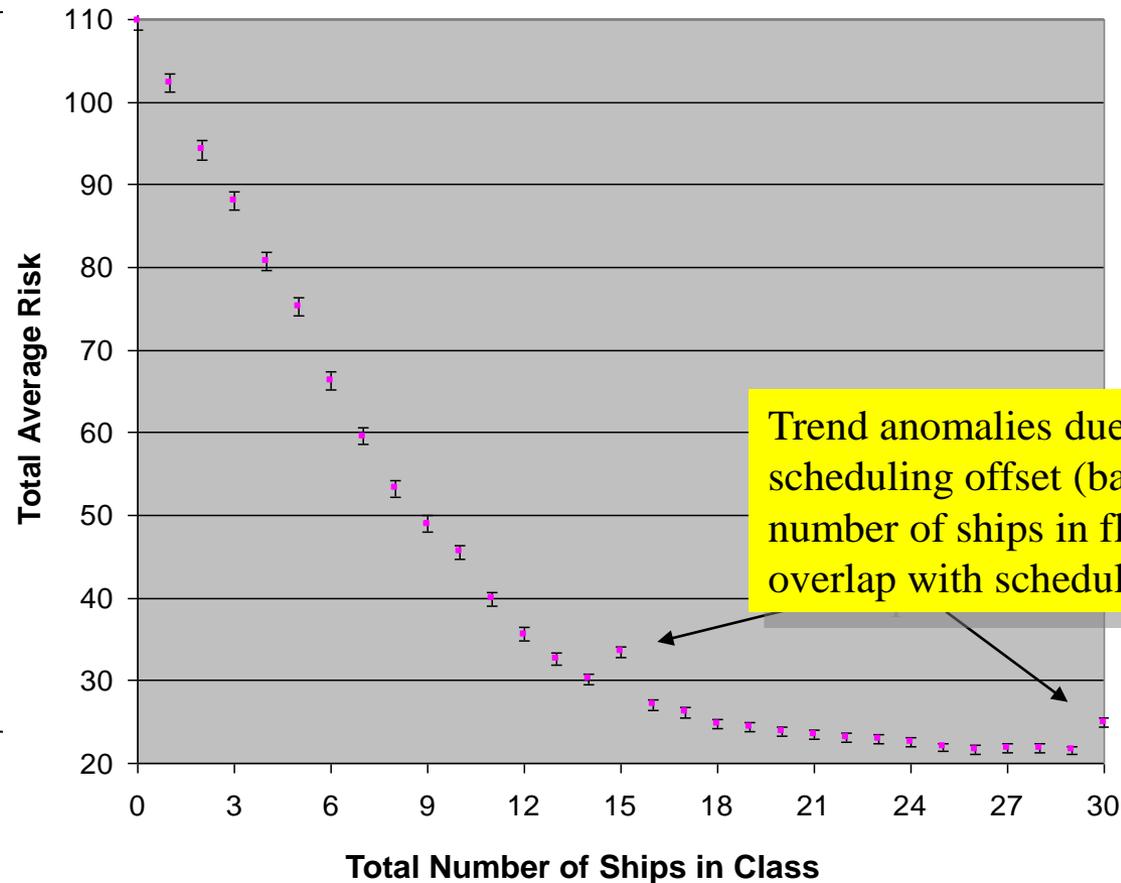
- Utilizing capability-based planning

- Link procurement decisions to strategic goals through analysis of force development scenarios
- Scenarios based on national policy and interests, and assessment of the current and future security environment
- Focus on what needs to be done, instead of what needs to be replaced



Example: Variation in Number of FFH Replacements

Significant portion of demand satisfied, indicating the Frigate as a class is the backbone of the Navy

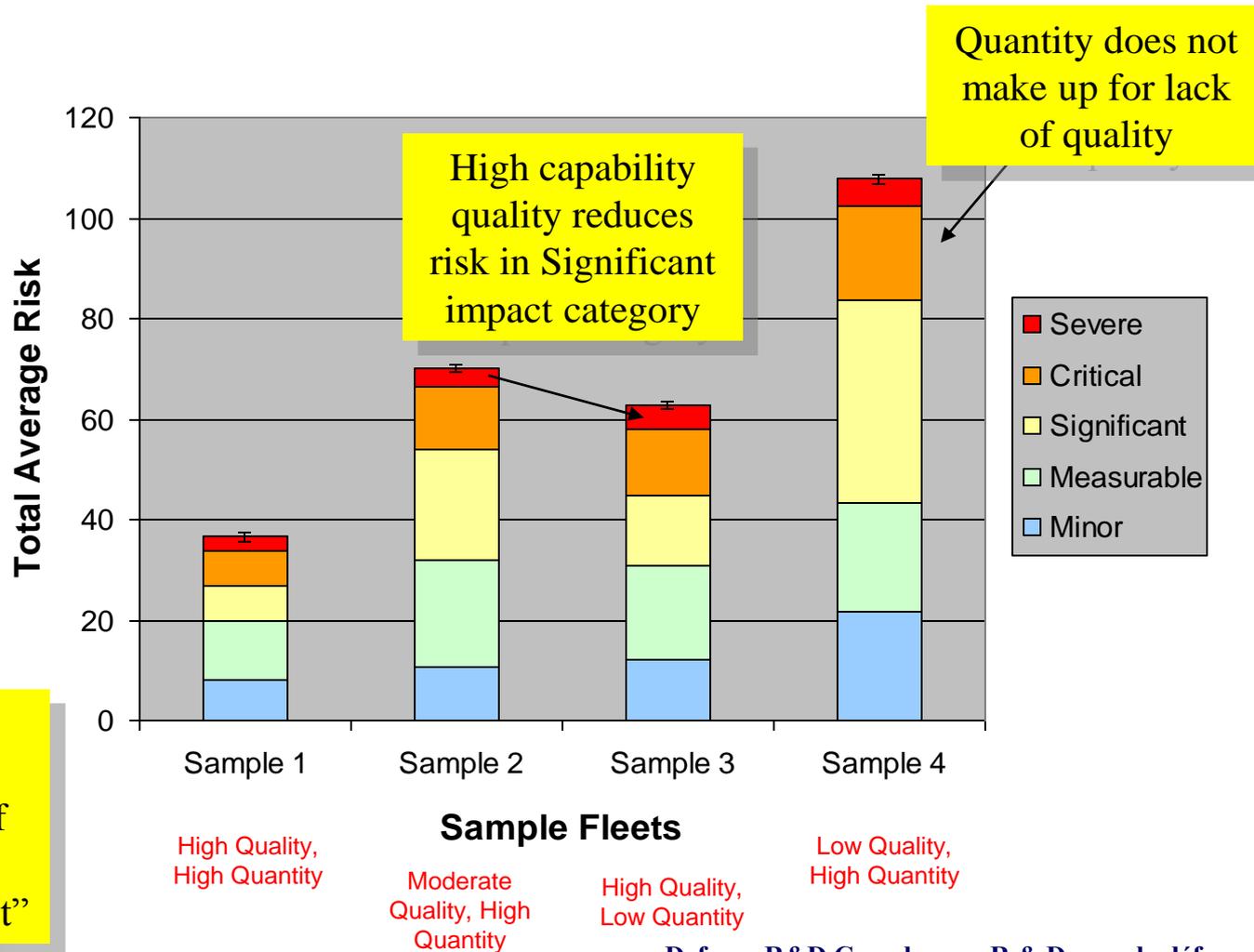


Trend anomalies due to scheduling offset (based on number of ships in fleet) overlap with scheduled events

Saturation of demand



Example: Trading FFH Replacement Quality for Quantity

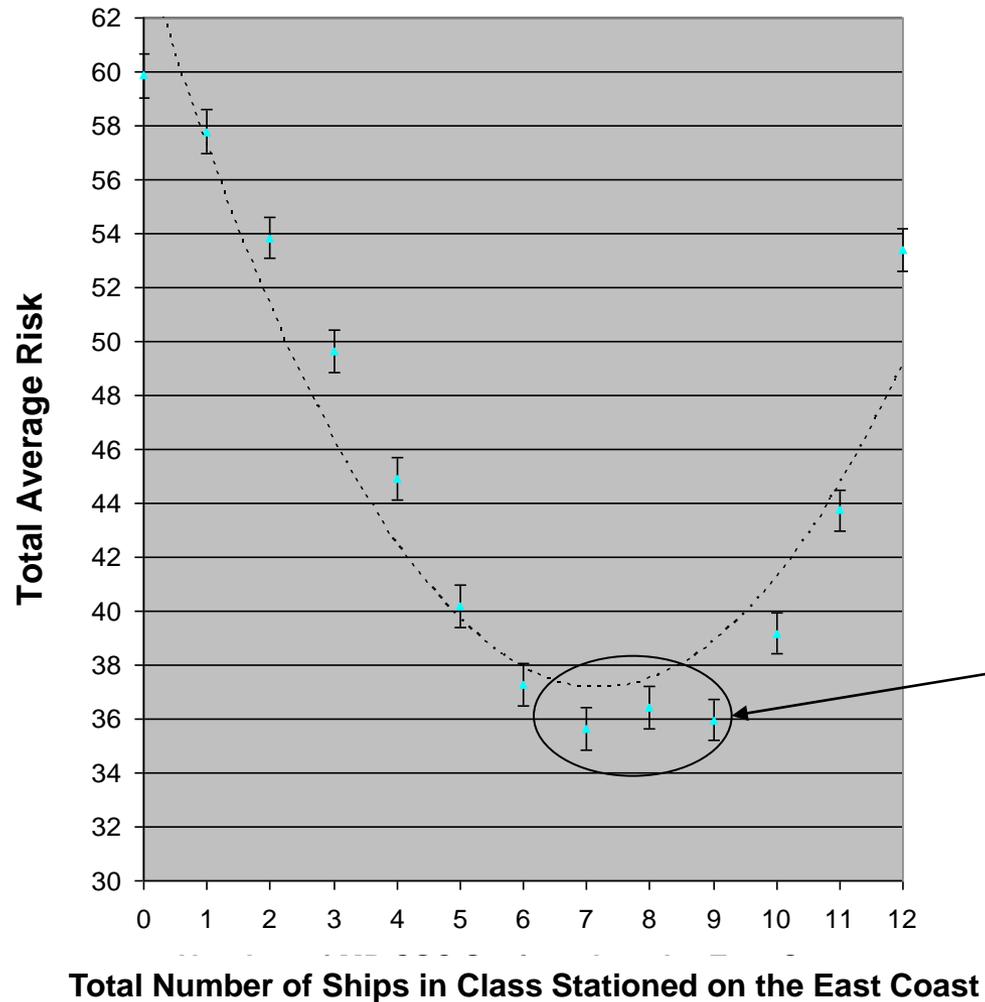


Performance related to construction of risk measure: “threshold effect”



Example: FFH Replacement Coastal Distribution

Total number of ships in class held constant at 12



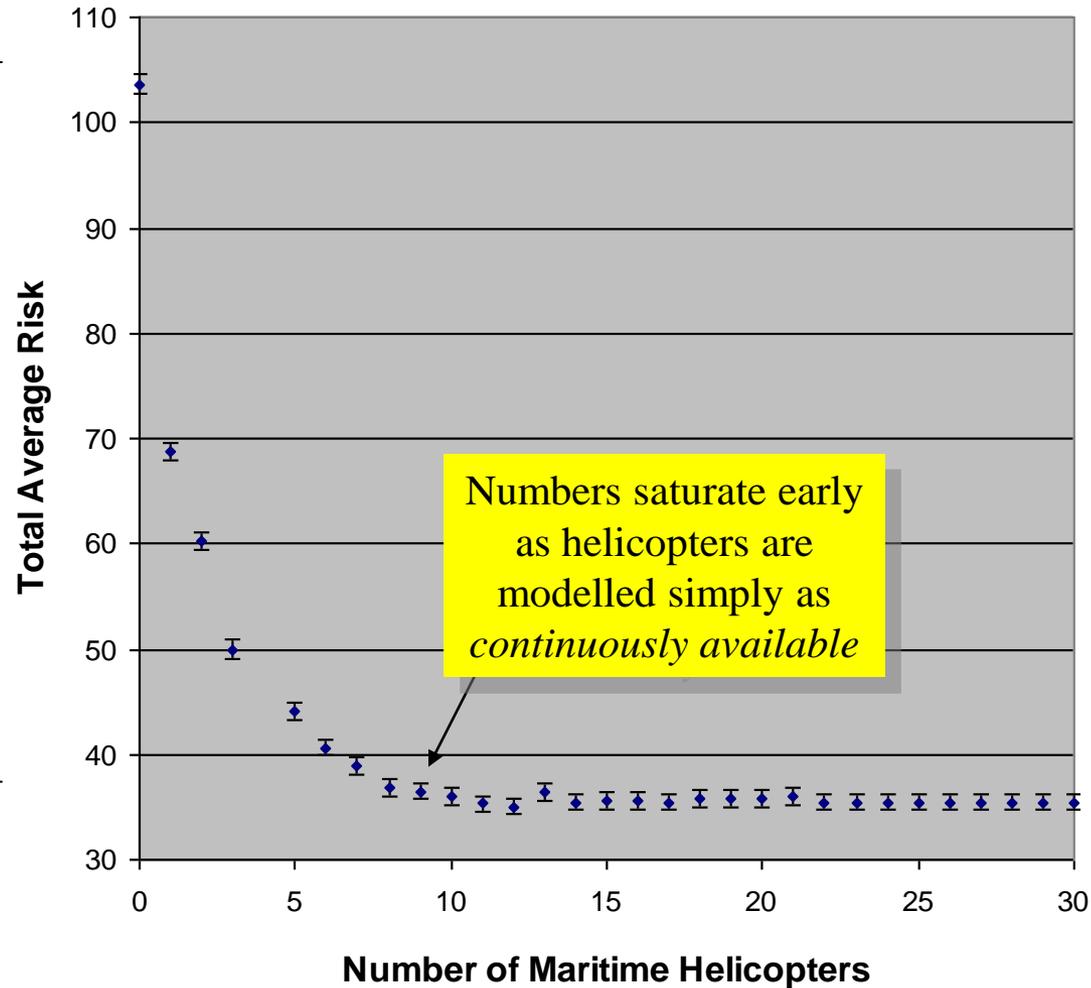
Bias towards East Coast related to vignette locations and frequency of occurrence

Difference between fleets is not statistically significant



Example: Maritime Helicopters

Significant portion of demand satisfied by Maritime Helicopters, highlighting role as force multiplier





Conclusions

- Usage of Tyche for naval force structure analysis
 - Flexibility to handle wide variety of asset types (not just naval) and behaviours
 - Focus on capabilities and alternative asset assignments
 - Large data sets = long run times
- Political Risk as a measure of performance
 - Allows comparison of disparate events
 - Susceptible to large variation in output due to small variation in input based on “threshold effect”
 - Elements of subjectivity
 - Folds in unique requirements of Canadian military perspective

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Questions?