Building a Framework for Casualty Cat Modeling

2021 CAS Annual Meeting: San Diego

November 8, 2021

WillisRe

Agenda

- Background: Measuring casualty downside
- Willis Re eNTAIL: Conceptual Framework
- Willis Re eNTAIL: Demo
- Case Study #1: Modeling for a large global portfolio
- Case Study #2: Casualty industry modeling

Background

- **Understanding the likelihood and magnitude of future extreme downside events is crucial for insurance companies**

- In **property** lines of business, this need is filled by natural catastrophe (nat cat) models, which have been implemented broadly throughout the industry

- In **casualty** lines of business, there is currently not a widely adopted equivalent to nat cat models

Traditional methods for Casualty risk management – and where they fall short

Monitoring maximum policy limits for any one insured

Problems:

No true insight into tail risk

No consideration of systemic / clash / accumulation risk

Assigning volatility around the mean loss ratio for a line of business

Problems:

No true insight into tail risk

One loss engine to measure both body and tail of distribution can be inappropriate

Deterministic realistic disaster scenarios (RDS)

Problems:

Provide no information about event likelihood

Difficult to integrate into an economic capital model

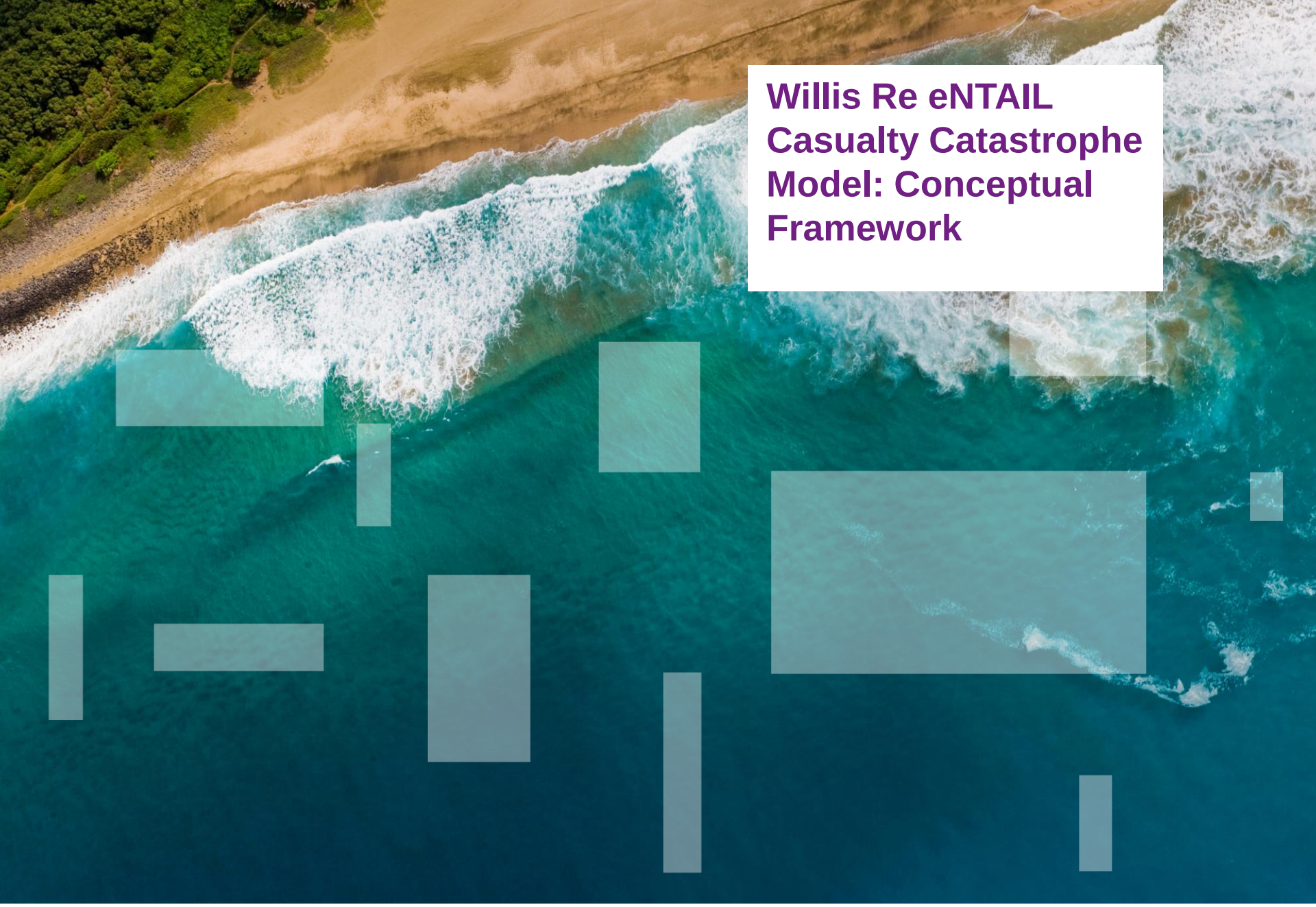
Articulating risk tolerance in a concrete way is a key goal for Casualty insurers

"Target an X% combined ratio for Casualty"	"Limit Casualty exposure in a given RDS to no more than $Y"	"Our 100 Year VaR for Casualty risk is Z% of capital"
▪ Reasonable profitability goal, but not a risk tolerance statement	▪ Getting close: based on exposure and downside ▪ But has no associated return period	✓ Ultimate goal ✓ Exposure-based framework focused on downside tail risk ✓ Tied to the capital that supports the business
A start	Better	Goal

Requirements for a better method for measuring Casualty downside risk

- ✓ Scientific exposure-based approach that can provide true insight into tail risk and future event likelihood
- ✓ Addresses unique behavior of the tail of the loss distribution by measuring cat risk distinctly and separate from non-cat
- ✓ Easy to integrate into wider economic capital model
- ✓ Produces a coherent narrative about what is driving severe outcomes
- ✓ Can measure risk at any level of granularity: by business unit or enterprise-wide
- ✓ Answers the fundamental question: “What is the 1 in [100/200/250] year downside for my Casualty portfolio?”

It is possible to build a casualty cat model which satisfies all of these criteria



Willis Re eNTAIL Casualty Catastrophe Model: Conceptual Framework

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At a high level, Property cat and Casualty cat share similarities

Property Cat	
Scenario 	Event occurs generating widespread property damage
Exposure 	Insured properties in the path of the storm
Loss 	Individual claims frequency and severity

Casualty Cat	
Scenario 	Event occurs generating widespread liability
Exposure 	Insured entities vulnerable to liability from the event
Loss 	Individual claims frequency and severity

In reality, Casualty cat is much more uncertain and complex than Property

The nature of Casualty insurance creates challenges for creating a Casualty cat model that do not exist in Property cat modeling

	Property Cat	Casualty Cat
Event Definition	Events are generally easy to define, and we can easily observe similarity and regularity between events **Example:** Florida Hurricane	Events tend to be idiosyncratic and are often un-repeatable due to post-event changes in insurance contracts, societal change, etc. **Example:** Asbestos
Data	100+ years of weather and cat data is available. Events are known promptly after occurrence	Data is more limited, and risk is constantly evolving and shape-shifting. Events may be discovered many years after occurrence
Exposure Definition	Exposure is easily defined as the physical location of the property	Exposure is harder to define: LOB and industry can be subjective and unclear how granular to measure

Key concept: build a model that has a familiar high-level framework, but still addresses the idiosyncrasy of Casualty risk

Casualty risk is always changing, so it's crucial to focus on potential loss events in the future

Although the future is unknowable, we can use Realistic Disaster Scenarios (RDS) to map out possible future situations;
But because the future is unknowable, the RDS should not be focused too narrowly, but rather on **broad categories of future scenarios**

Broadly-defined RDS enable linking together new future scenarios to historical events that serve as "precedents" that "inspire" the future RDS.
Result: **forward-looking casualty scenarios that are supported by historical events, yet have enough freedom to not be straight jacketed by the past**

Construct RDS scenarios with stochasticity to obtain fully probabilistic output from a Monte Carlo simulation engine. These "Stochastic Realistic Disaster Scenarios" (SRDS) serve as the backbone of the model

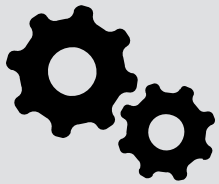
Willis Re's eNTAIL takes advantage of the high-level similarities between property cat and casualty cat to build a model that has a familiar framework, but still addresses the idiosyncrasy of Casualty risk

eNTAIL Casualty Cat Model Attributes

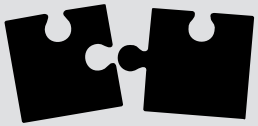
Goal: Measure extreme downside

Streamlined input data: bordereau of limits, attachments, LOB, industry

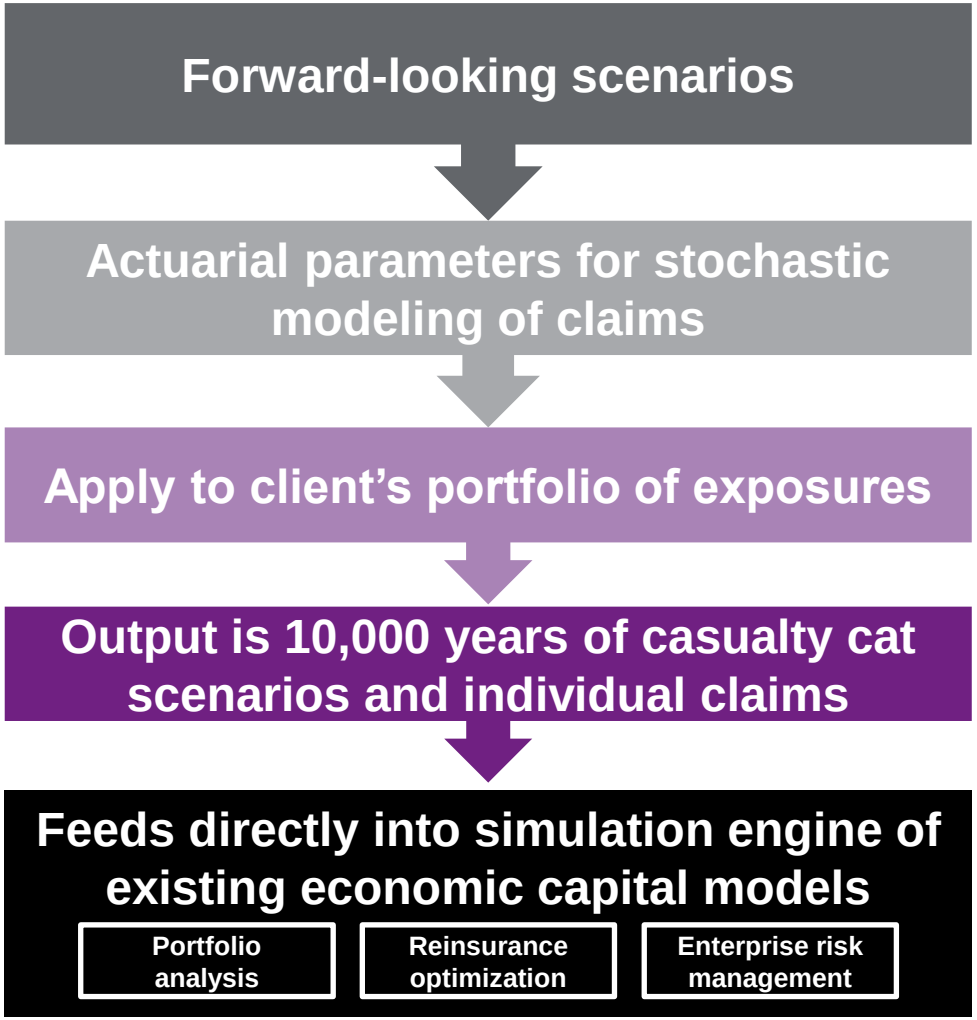
Exposure-based methodology driven by forward-looking scenarios



Casualty cat output integrates with broader economic capital modeling



eNTAIL Casualty Cat Model Framework



- Scenarios recognize that future events will be different than, yet structurally similar to, past events
- Granular parameters quantify likelihood of claims and amount of loss for all individual policies in portfolio
- Obtain the same PMLs and other return period metrics used in Property Cat
- Seamless entry into capital model

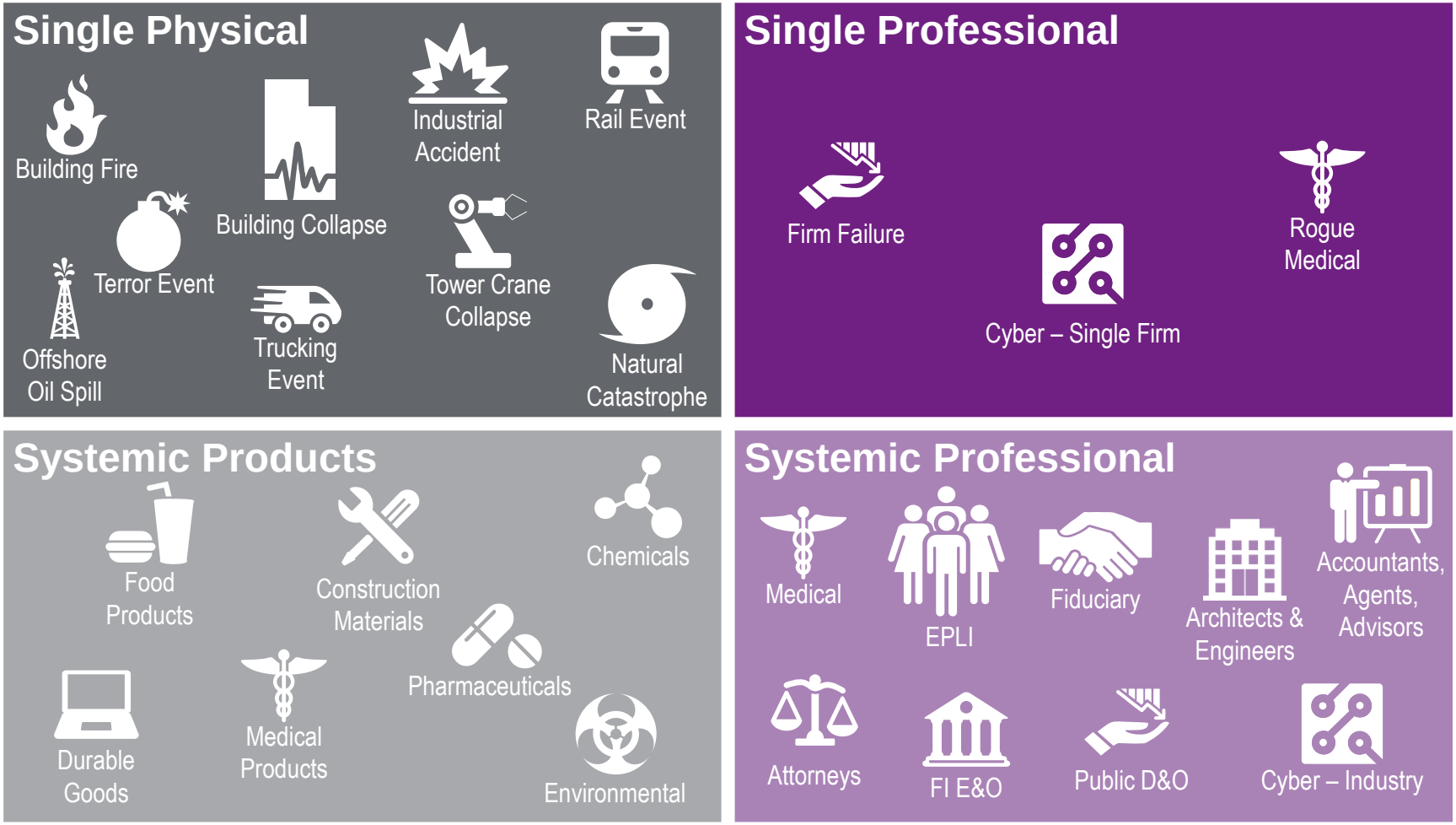
First step: Build scenarios by collecting historical data

- Willis Re conducted research into hundreds of events in the past 50 years to build a Casualty Cat historical event database

- Definition of Casualty Cat event follows two criteria:
  1. Historical event generated total insured casualty claims of more than $100M in today's dollars
  2. Historical event generated claims on more than one "tower" of insurance coverage

- Through this research, it became possible to take these historical events and slot them into broad, general categories that form the basis of the forward-looking scenarios in the final model

Four Perils Used in eNTAIL



Second step: Determine which policies in the portfolio are exposed to scenarios

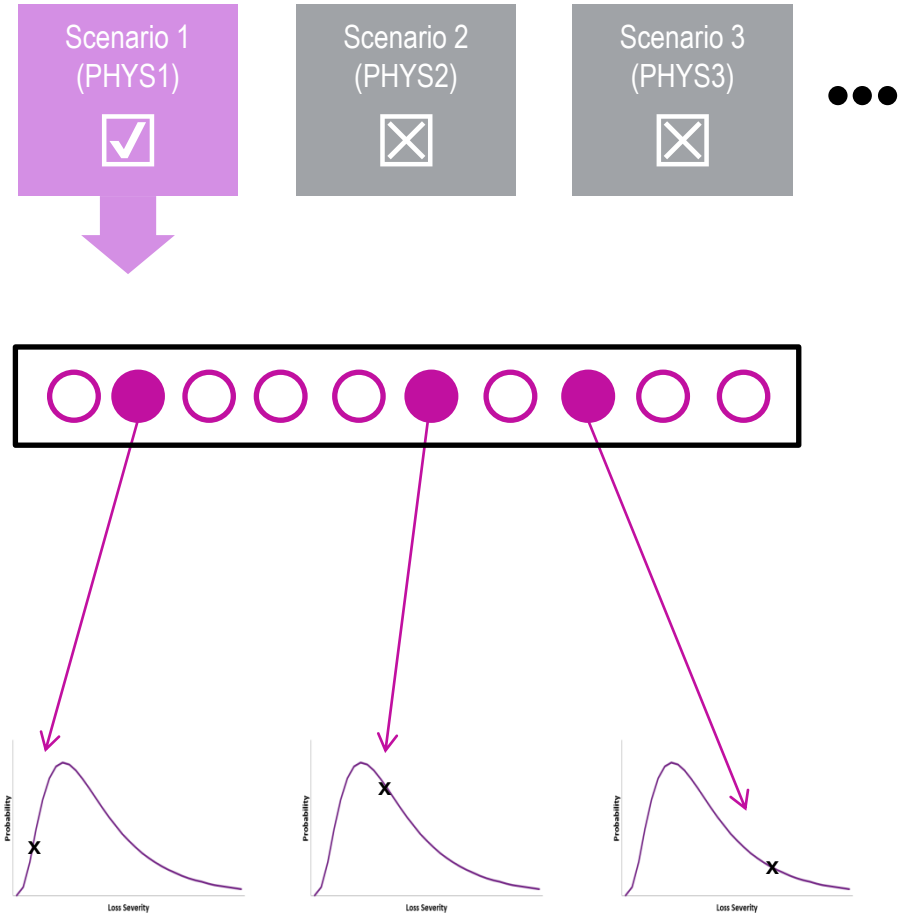
Willis Re has created a mapping system within the framework of the eNTAIL model for allocating exposure to policies based on commonly collected attributes

Collect key attributes of the insured (LOB/Industry, size, etc.)

Use standardized criteria based on these key attributes to assign policies in the portfolio to "Exposure Categories"

These categories help determine which forward-looking scenarios in the model the policy will be exposed to

eNTAIL Model Logic



1. Each scenario has a probability of occurring in a given year

2. Each individual policy in the portfolio has a probability of having a claim, given a scenario has occurred

3. Each resulting claim has a probability curve for the severity (dollar amount) of the claim

Framework requires three primary sets of parameters, all of which can be estimated based on empirical historical data

Parameter #1: Annual scenario frequency

- The likelihood of a given scenario occurring in a given year
- Based on empirical historical frequency of events in dataset

Parameter #2: Conditional claim frequency

- Given a scenario has occurred, the likelihood of a claim on a given policy
- Based on empirical likelihoods in historical events and key attributes of policy insured

Parameter #3: Conditional claim severity

- Given a claim has been incurred, the dollar amount of the loss for that policy
- Estimated based on trended historical severities of claims in casualty cat events

Willis Re eNTAIL: Implementation / Software

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eNTAIL Modeling Workflow

Input file:

Excel input template feeds into R-shiny app-based user interface

Simple input data based on data insurers already collect

Calculation engine:

User presses a button and R code runs in background

Model calculations completed in seconds

Output files:

Excel/CSV file with fully granular simulation output of individual claims

Output designed to be easily integrated into economic capital models

Software Demo

- Demo: https://rconnect.wre.willistowerswatson.com/eNTAIL/

Case Study: Modeling for a large global portfolio

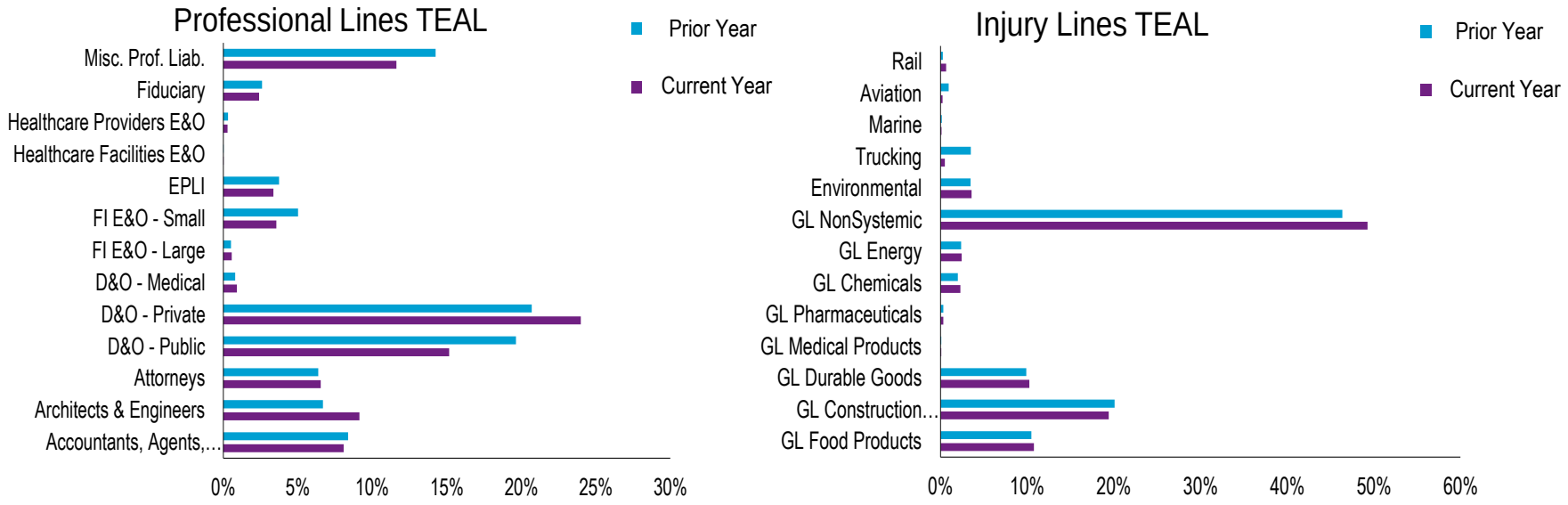
Modeling a Global Casualty Portfolio

- Annual review to assess extreme downside of client's global casualty and professional lines portfolio

- Two main tracks for the eNTAIL project:
  1. **Exposure tracking / management**
  2. **Modeling cat downside results / return periods / PMLs**

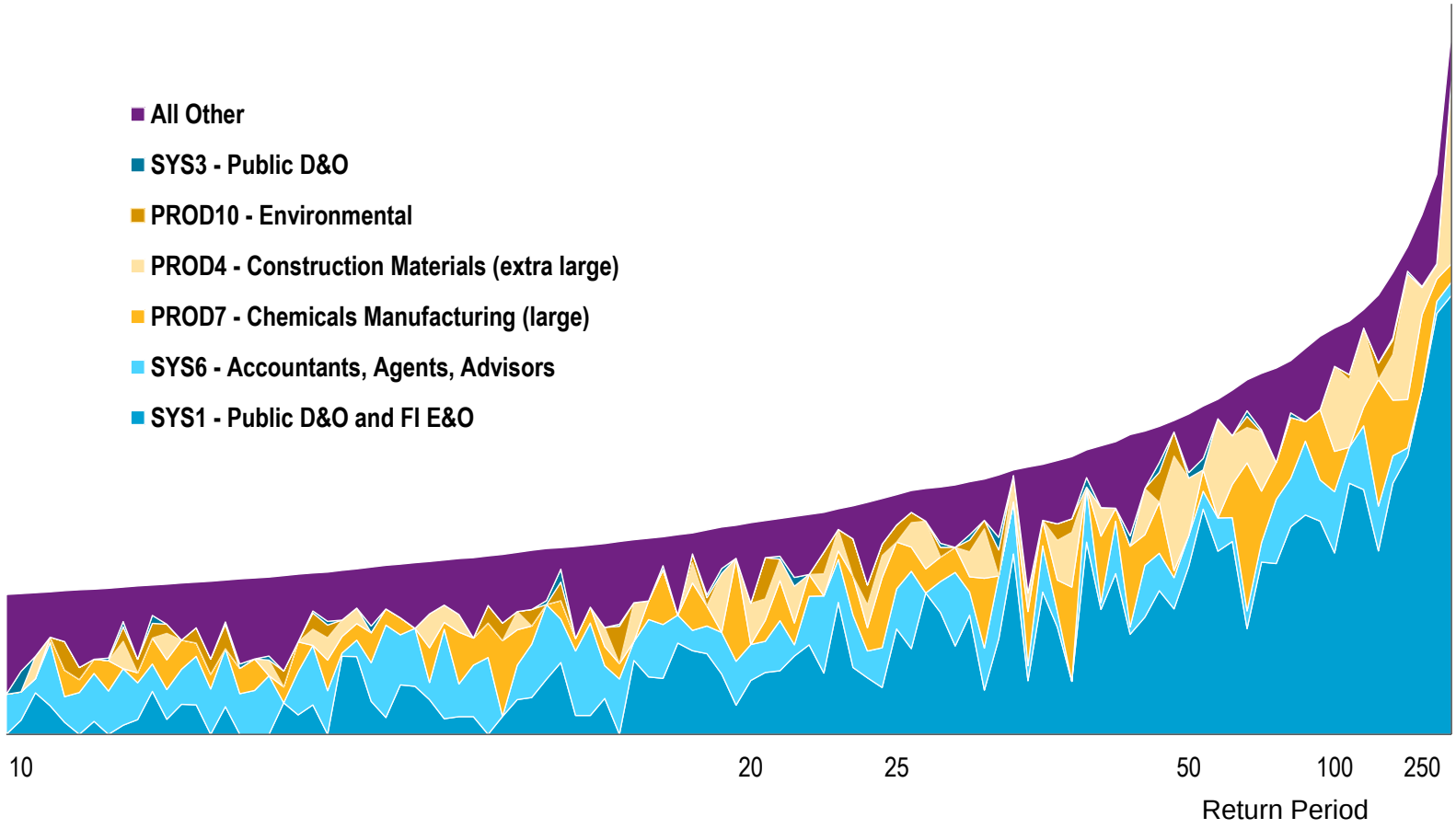
- Goals:
  - Review significant changes in exposure year over year
    - Policy counts, limit usage, business mix
  - Understand key threats to portfolio
    - Use modeling results to identify events driving the downside
  - Combine eNTAIL cat modeling with typical non-cat actuarial model for a total view
    - Total non-cat + cat model can be used for capital modeling, evaluating reinsurance options, etc.

Monitoring Exposures

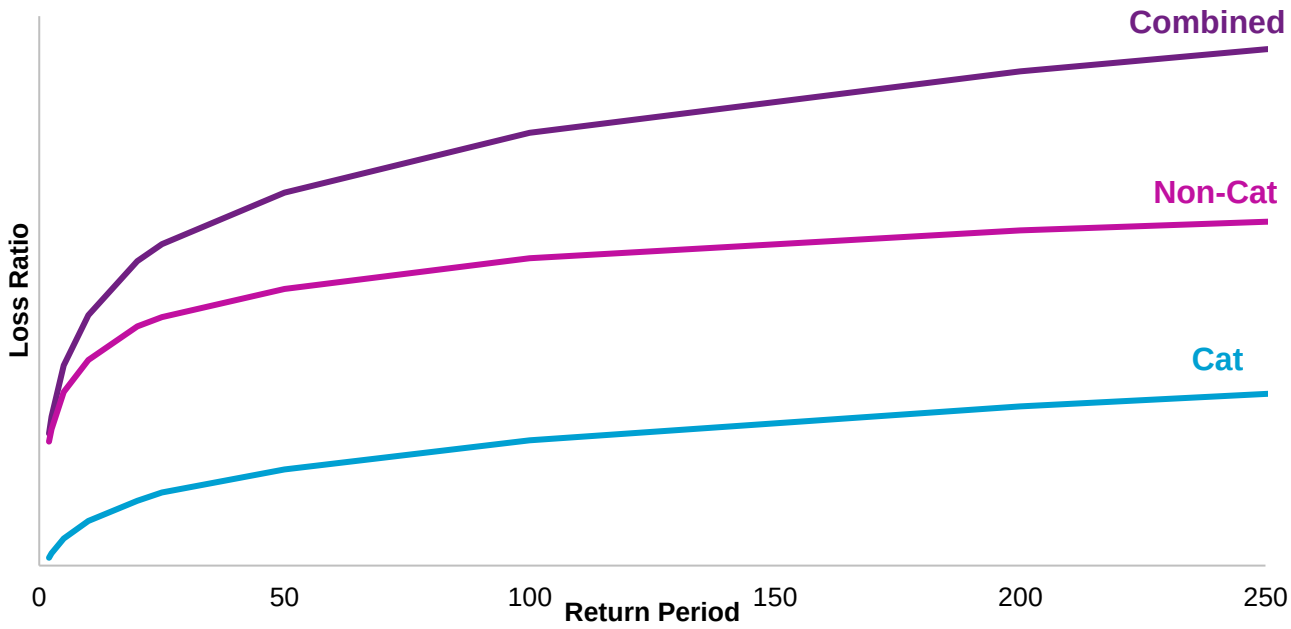


- For property portfolios, tracking TIV concentrations helpful in assessing largest threats
- **Total Exposed Aggregate Limit (TEAL)** provides a view on limit usage and aggregate exposure similar to TIV
- Casualty & professional lines not as susceptible to geographic accumulations, but instead accumulation within LOBs or industries

What's in the tail: Ground Up Loss



Creating a Combined View of the Portfolio



- Can combine eNTAIL modeled results with a traditional non-cat actuarial model of the portfolio
- Provides complete view of the modeled portfolio which can then be used for:
  - Capital modeling
  - ERM
  - Evaluating reinsurance options
  - etc.

Case Study: Industry Portfolio

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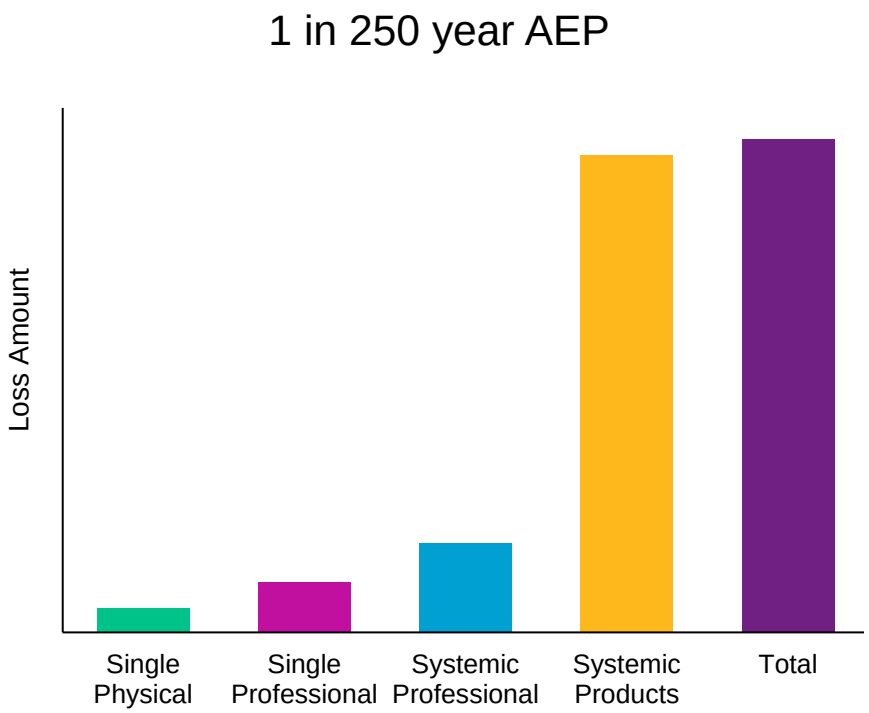
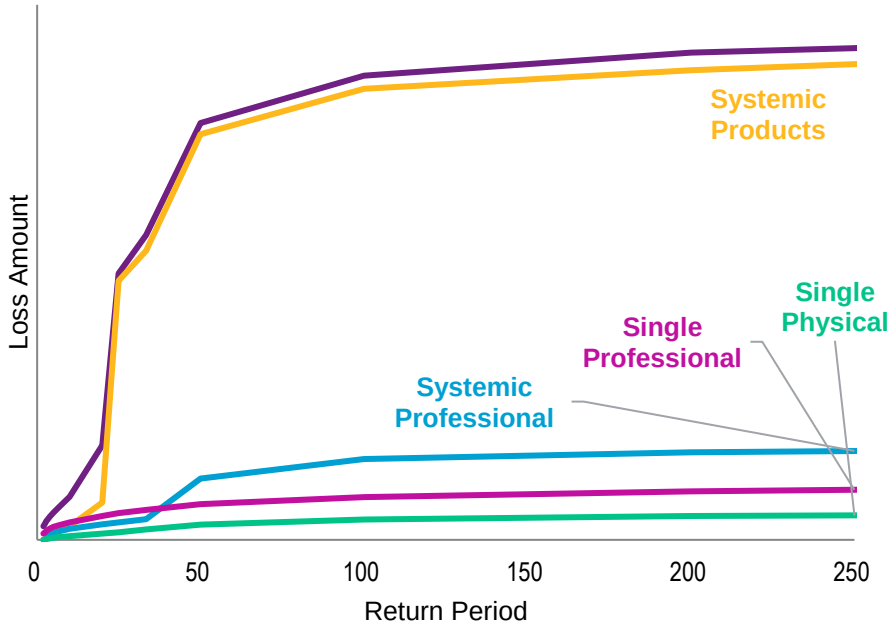
Casualty Industry Modeling: Overview

- The eNTAIL model is primarily designed to produce tailored output as applied to a specific insurer's set of exposures
- However, it can also be used to measure downside at the industry level
- Industry modeling can be useful as:
  - A benchmark comparison to company-level results
  - A starting point for those who do not have the company-specific data required to run the model readily available
- Willis Re has created a version of the model input designed to replicate the US Casualty industry as a whole

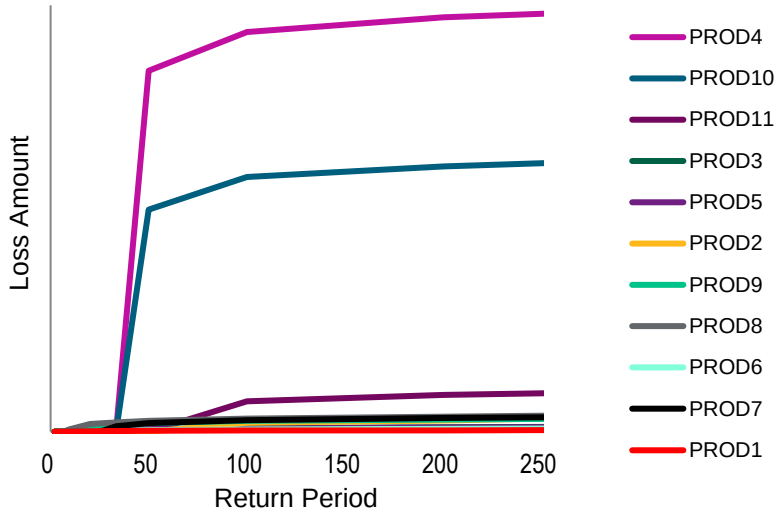
Industry Modeling Output by Peril



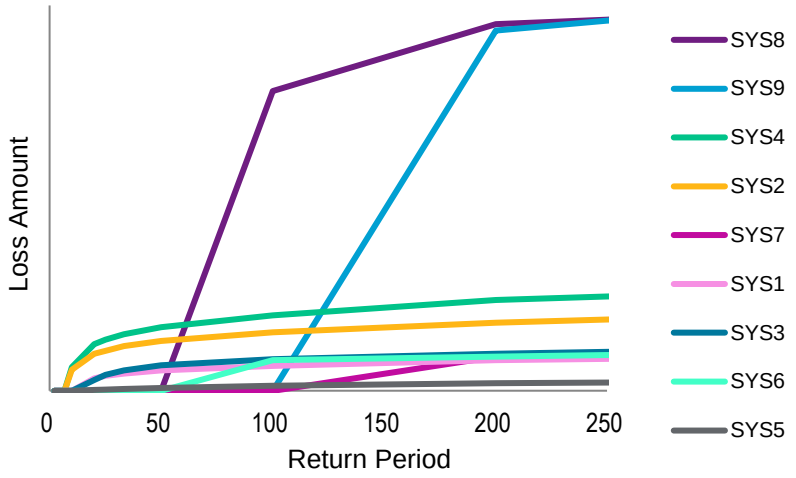


Industry AEP Curves by Scenario

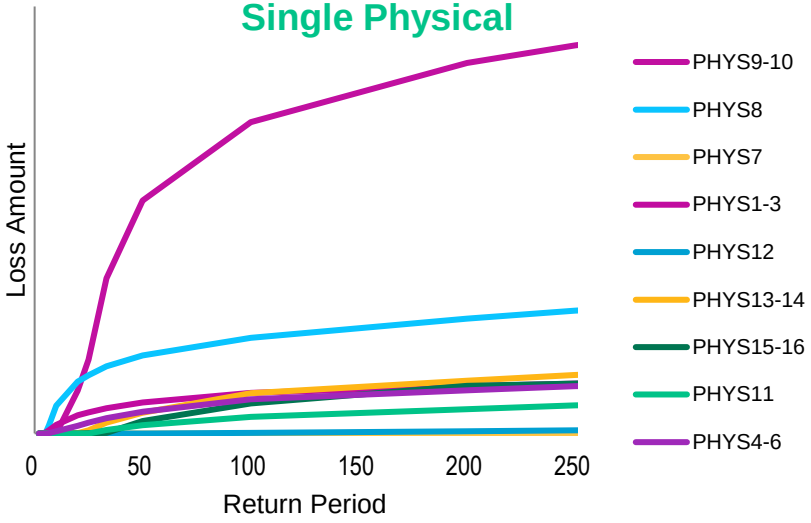
Systemic Products



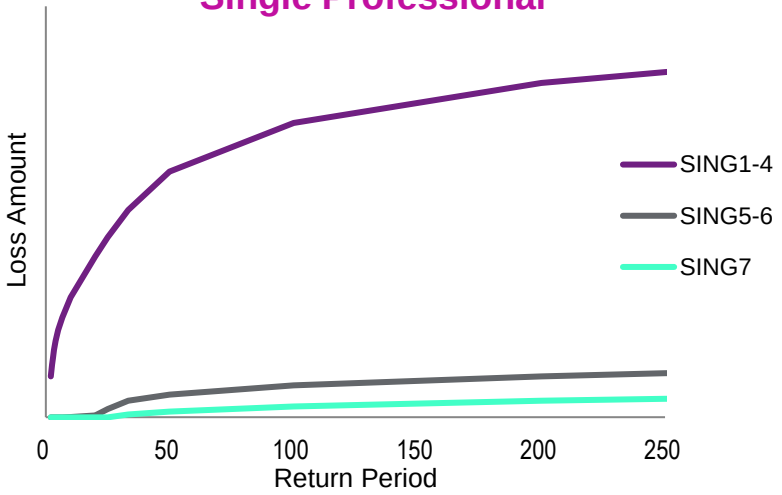
Systemic Professional



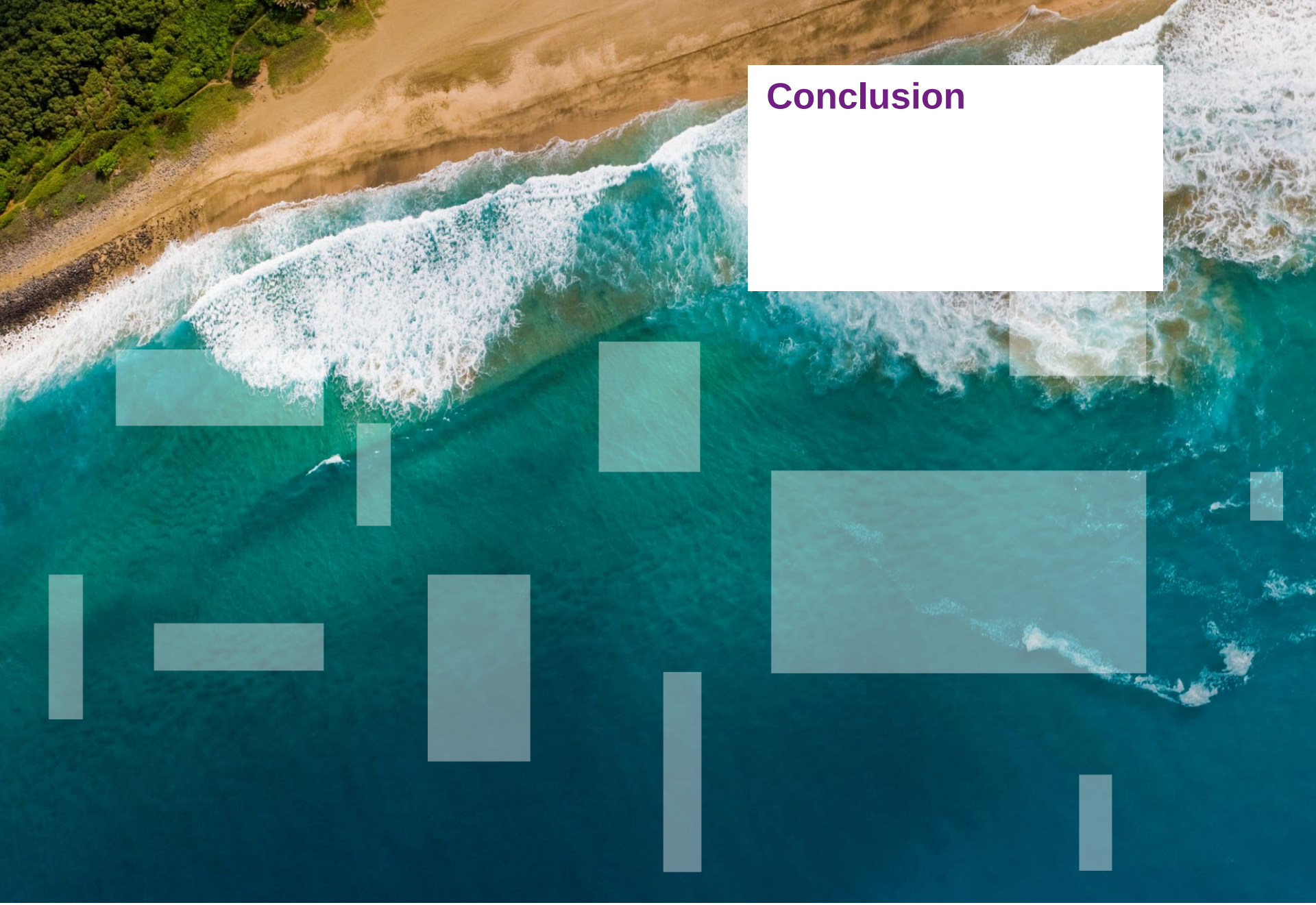
Single Physical



Single Professional



Conclusion



Final Points

- There is a need in the Casualty industry for better tools to quantify downside risk

- It is possible to build a Casualty cat model which:
  - Fulfills this industry-wide need
  - Is based on a scientific exposure-based methodology and empirical data
  - Functions in a similar way to a property cat model while addressing the unique aspects of casualty business

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