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Area Risk Assessment Project Overview

ARP Overview

- In 2014, the Government-appointed Tanker Safety Expert Panel made 45 recommendations on how oil spill preparedness and response could be enhanced in Canada.
- One of those recommendations was to develop and implement a regional risk-based planning model (ARP).

ARP Objectives

- To design a regional, risk-based planning approach that will:
 - reflect the risks and conditions specific to a geographic area,
 - incorporate scientific information to inform appropriate decision making, and
 - engage a broad range of stakeholders in the development of area response plans.
- One of the first steps was to design a risk assessment methodology for ship-source oil spills.

Area Risk Assessment (ARA) Objectives

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- Propose a framework to assess the existing spill prevention, preparedness and response activities to reduce the risk from ship-source oil spills.
- Determine the most probable locations within the four pilot areas for a ship-source & Oil Handling Facility (OHF) oil spill, taking into consideration:
 1. Marine safety measures;
 2. Local geography;
 3. Environmental sensitivities; and
 4. Ship traffic volumes.

Current Status

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- ARA methodology is still being developed by a consortium of companies including Dillon Consulting, two Dutch companies (Royal Haskoning DHV and MARIN) and RPS ASA.
- Methodology is being internally tested through four pilot projects and the estimated completion date is March 2017.
- Lessons learned from pilot project will result in improvements to the methodology.
- Once pilot project is completed, the Government of Canada will make a decision on whether to adopt risk-based planning nationally.

ARA Methodology

Introduction

Probability of Spill

Scenario

- Phase 1 – Probability of Spill
- Phase 2 – Scenario Selection
- Phase 3 – Risk Assessment

PHASE 1



PHASE 2

PHASE 3



APPLICATION OF ARA METHODOLOGY

ARA Methodology – Definition of Study Area

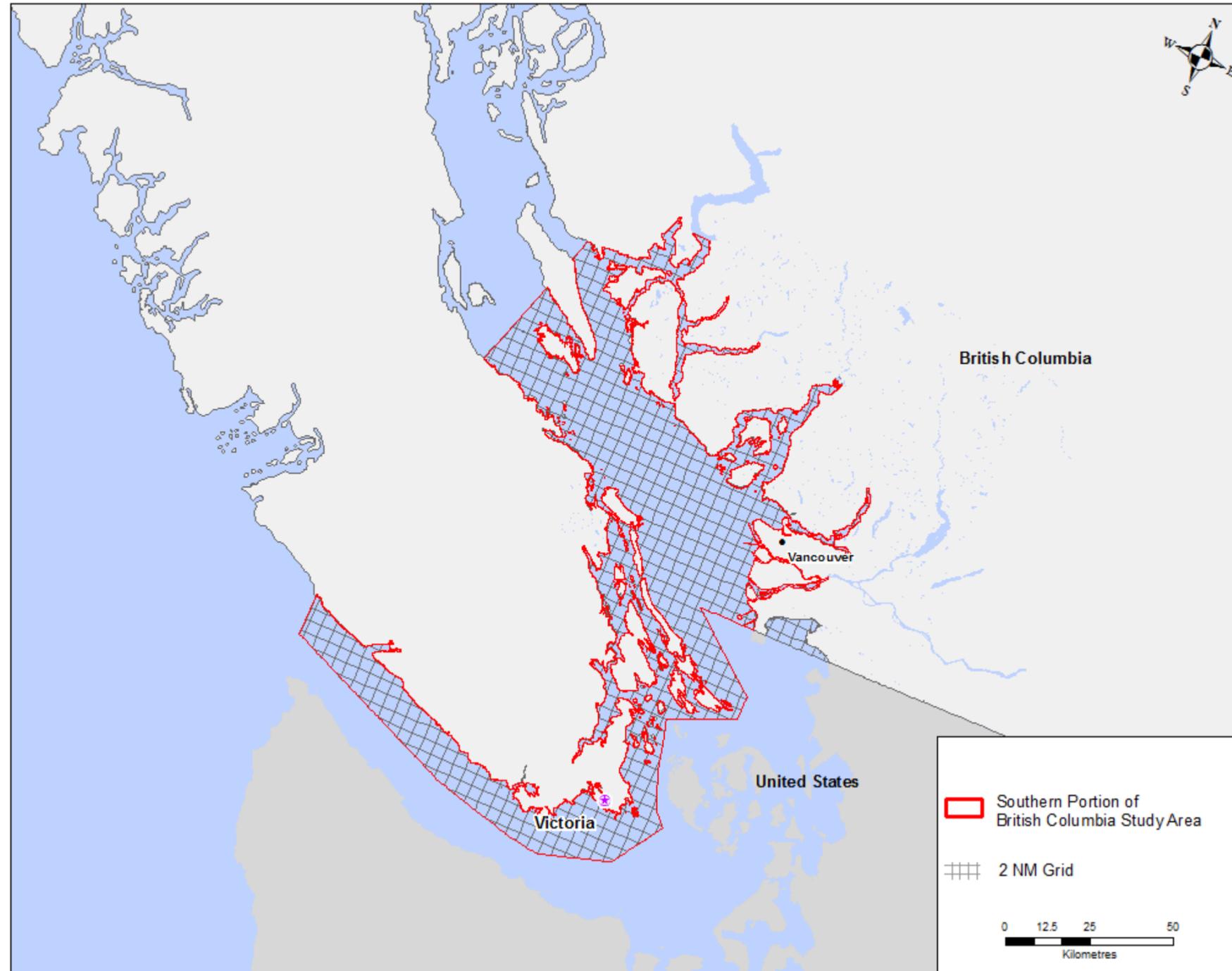
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ARA Methodology – Definition of Study Area

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Probability of Spill

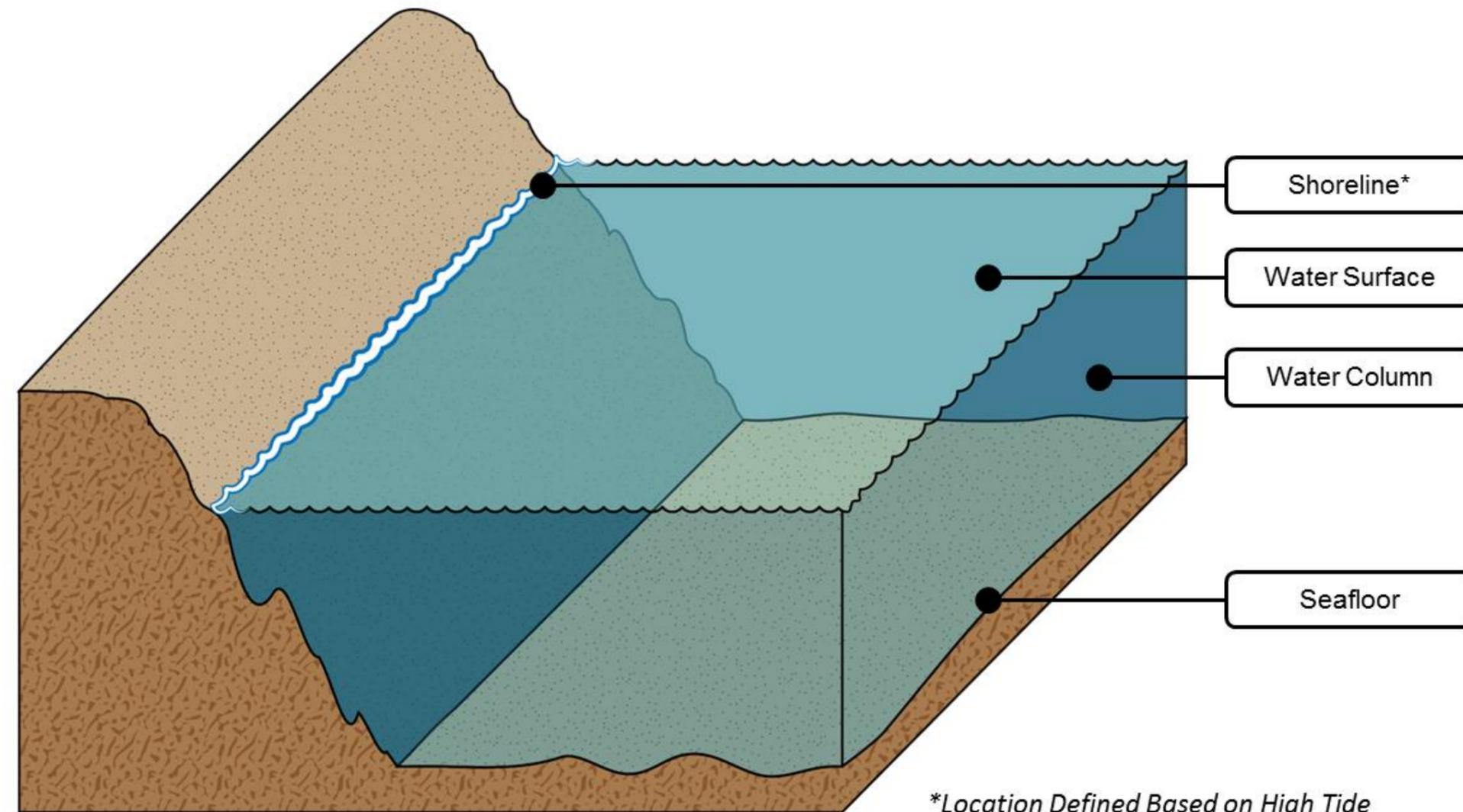
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- In order to examine the risks of ship-source spills, each Study Area is subdivided into a series of Grid Cells.
- Each Grid Cell consists of four layers called a Grid Layer.
- The Grid Layers allow the ARA Methodology to have sufficient spatial resolution to assess the risks of an oil spill.



Phase 1 – Probability of Spill

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Phase 1 – Probability of Spill determines:

- Probability and location of potential accidents
- Type of ship(s) involved in the accident
- Probability and volume of oil being spilled
- Type of oil being spilled
- A computer model called SAMSON is used to make these estimates, using:
 - Automated Identification System – AIS
 - Local Conditions (wind and currents, hydrographic charts)
 - Preventive Marine Safety Measures (e.g. pilotage, traffic separation, tugs)
 - Type and volume of oil being transported



Ship Traffic and Local Conditions

Introduction

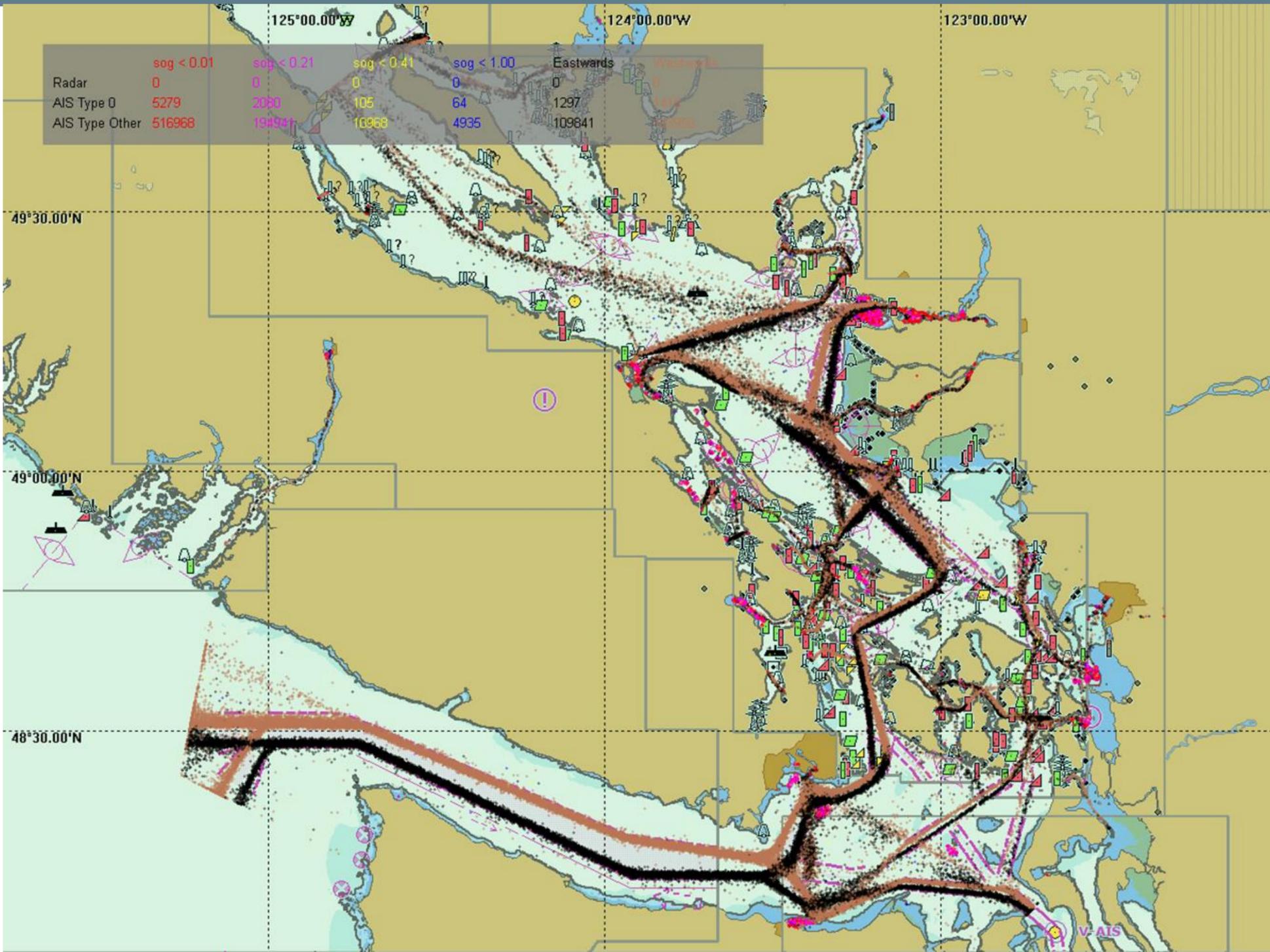
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- Traffic in area is approximately:
 - 50% tugs
 - 20% ferries
 - 18.5% commercial ships
 - 10% cruise ships
 - 1.5% oil tankers
- Local weather data obtained from EC/NOAA weather buoys
- Local current data obtained from a hydrodynamic model

AIS Demonstration

AIS Victoria Pilot Station

Preventative Marine Safety Measures

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The SAMSON model takes into account the following Preventative Marine Safety Measures:

- Admission Policy
- AIS and ECDIS
- Aids to Navigation
- Anchorage Areas
- Marine Safety Information
- Waterway Management
- Safety Distances
- Pilotage
- Traffic Separation Schemes
- Vessel Traffic Management Solutions
- Tugs (Tethered and Escort)

Accidents predicted by SAMSON

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Accident Type	Definition
Collision	The impact of two vessels that are both moving.
Allisions	The impact of one moving vessel into another vessel that is stationary (berthed or at anchor).
Wreck / Stranding	A wreck is a powered grounding of a vessel while a stranding is the vessel losing engine power and grounding from the force of the wind and current.
Hull Failure / Machinery Failure	Due to an equipment and/or mechanical failure inside the vessel, the vessel's hull is penetrated.
Foundering	The sinking of a vessel.
Fire/Explosion	A fire or explosion on the vessel, which does not necessarily lead to an oil spill.

Phase 1 – Probability of Spill

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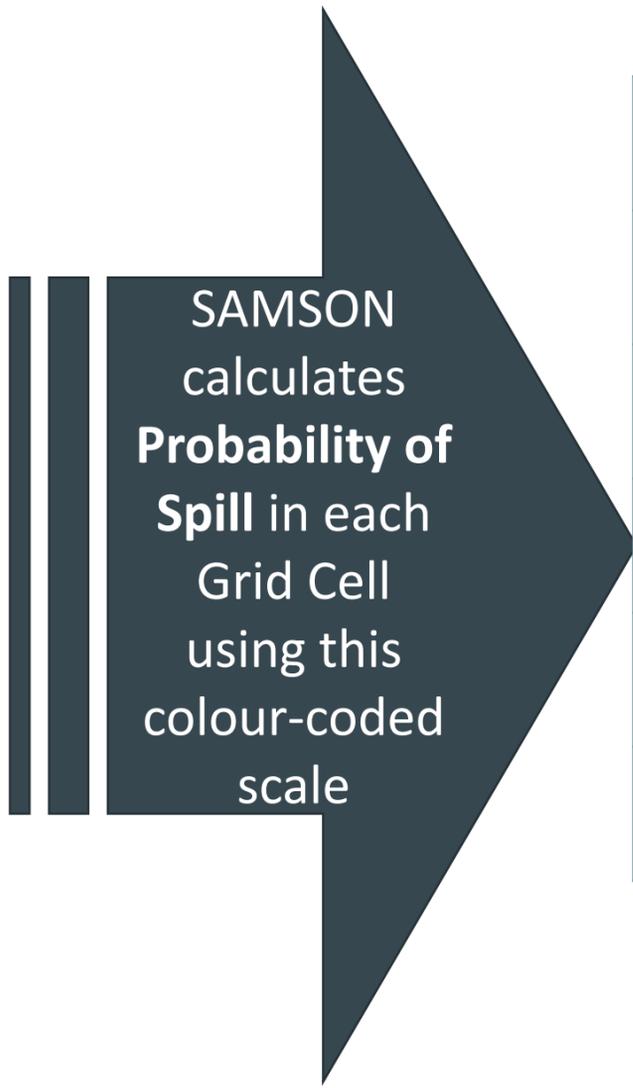
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SPILL CLASS	SPILL SIZE		VESSEL TYPE
	FROM (m ³)	TO (m ³)	
1	0.01	30	Fishing, Recreation
2	30	150	Small Commercial
3	150	1,000	Medium Commercial
4	1,000	5,000	General Purpose Med. Range Tanker
5	5,000	15,000	Long Range 1 Tanker Panamax
6	15,000	30,000	Aframax
7	30,000	100,000	New Panamax Suezmax
8	>100,000		VLCC ULCC



Phase 1 – Probability of Spill

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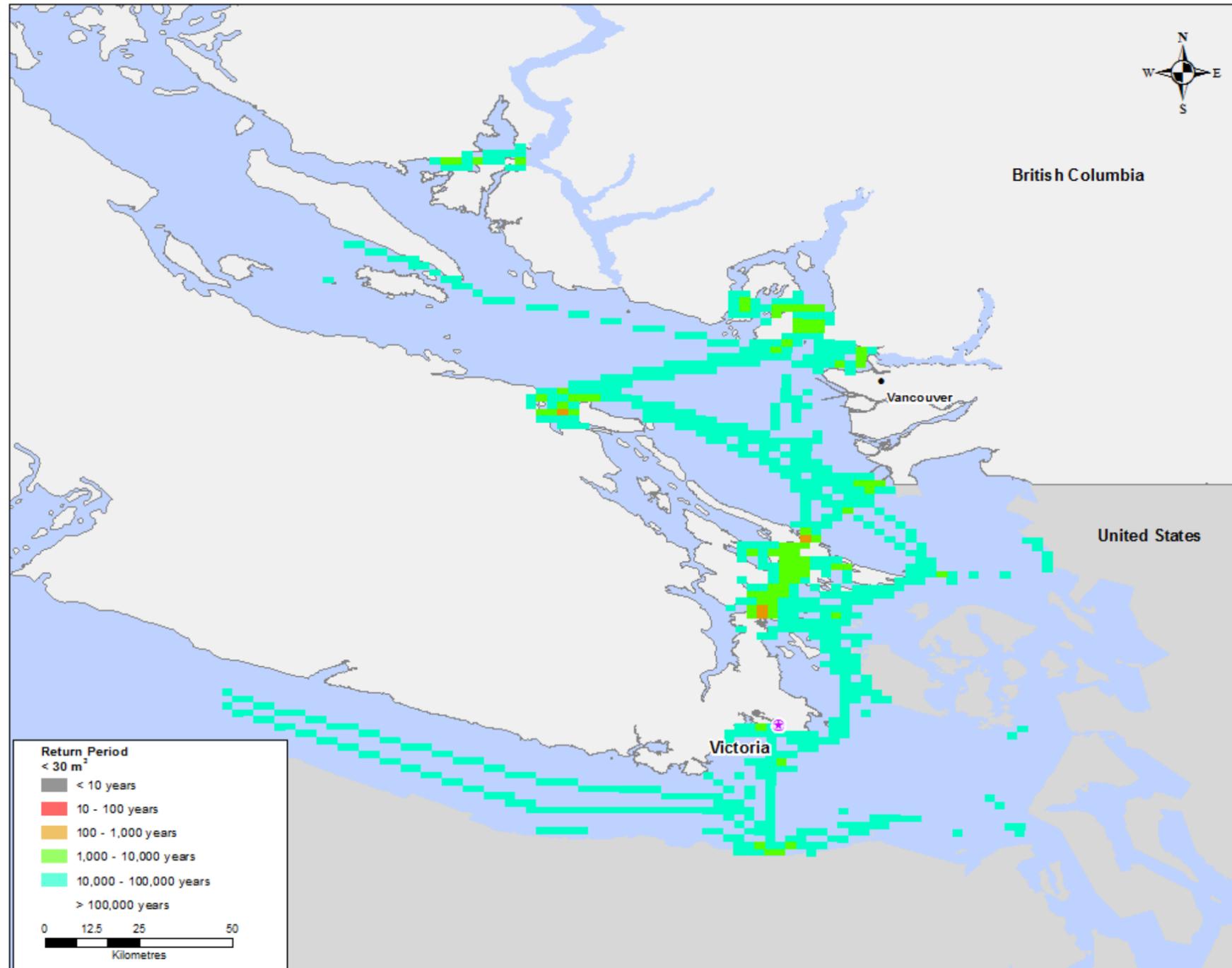
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- SAMSON generates a Probability of Spill heat map for each Spill Class
- Here is an example Probability of Spill map for Southern BC

Phase 2 – Scenario Selection

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- The probability of an oil spill is also commonly referred to as a “Return Period”.
- Return Period is commonly used to present probabilities of events such as floods and earthquakes, and for risk analysis purposes – designing structures to withstand events with certain Return Periods.



Phase 2 – Scenario Selection

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Scenario Selection

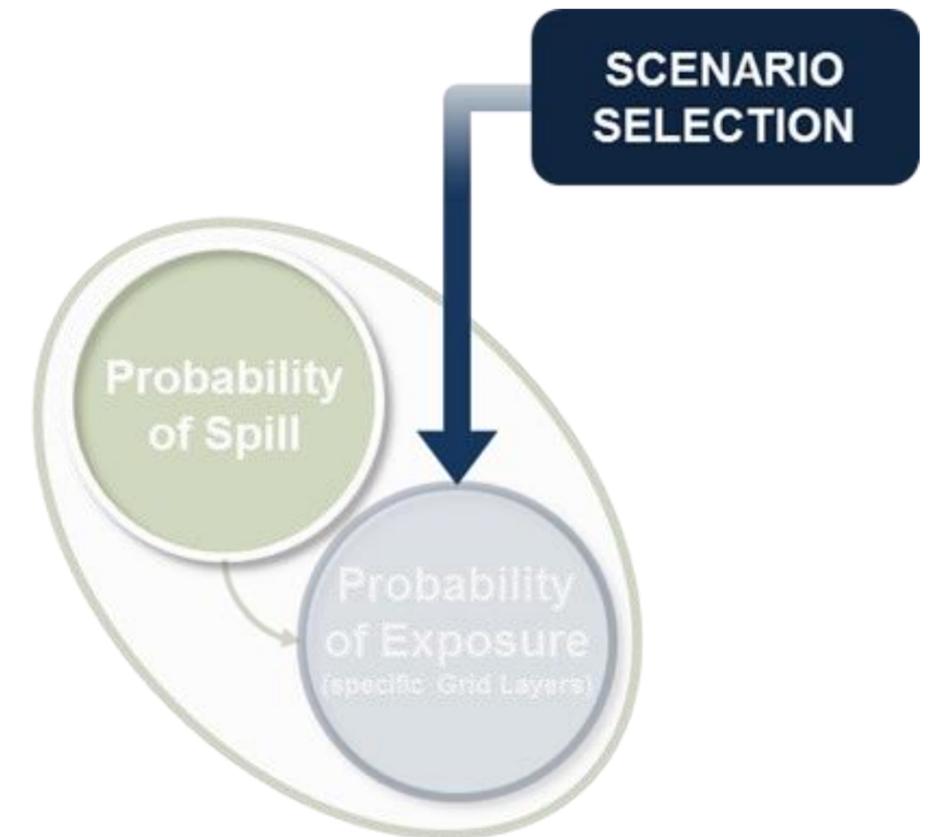
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Phase 2 – Scenario Selection:

- Prioritizes the locations with the highest probability of an oil spill for further study in Phase 3
- Utilizes the Probability of Spill results generated by SAMSON in Phase 1.



Phase 2 – Scenario Selection

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Two types of scenarios are selected:

- Level 1 Scenarios

- Spills with a Return Period of 1 in 1,000 years (or a 0.1% chance in any given year of the scenario occurring at a specific grid cell)

- Level 2 Scenarios

- Spills with a Return Period of 1 in 5,000 years (or a 0.02% chance in any given year of the scenario occurring at a specific grid cell)

For the ARA Methodology, a standardized Return Period allows for a consistent means of selecting spill scenarios in a Study Area.

Phase 2 – Scenario Selection

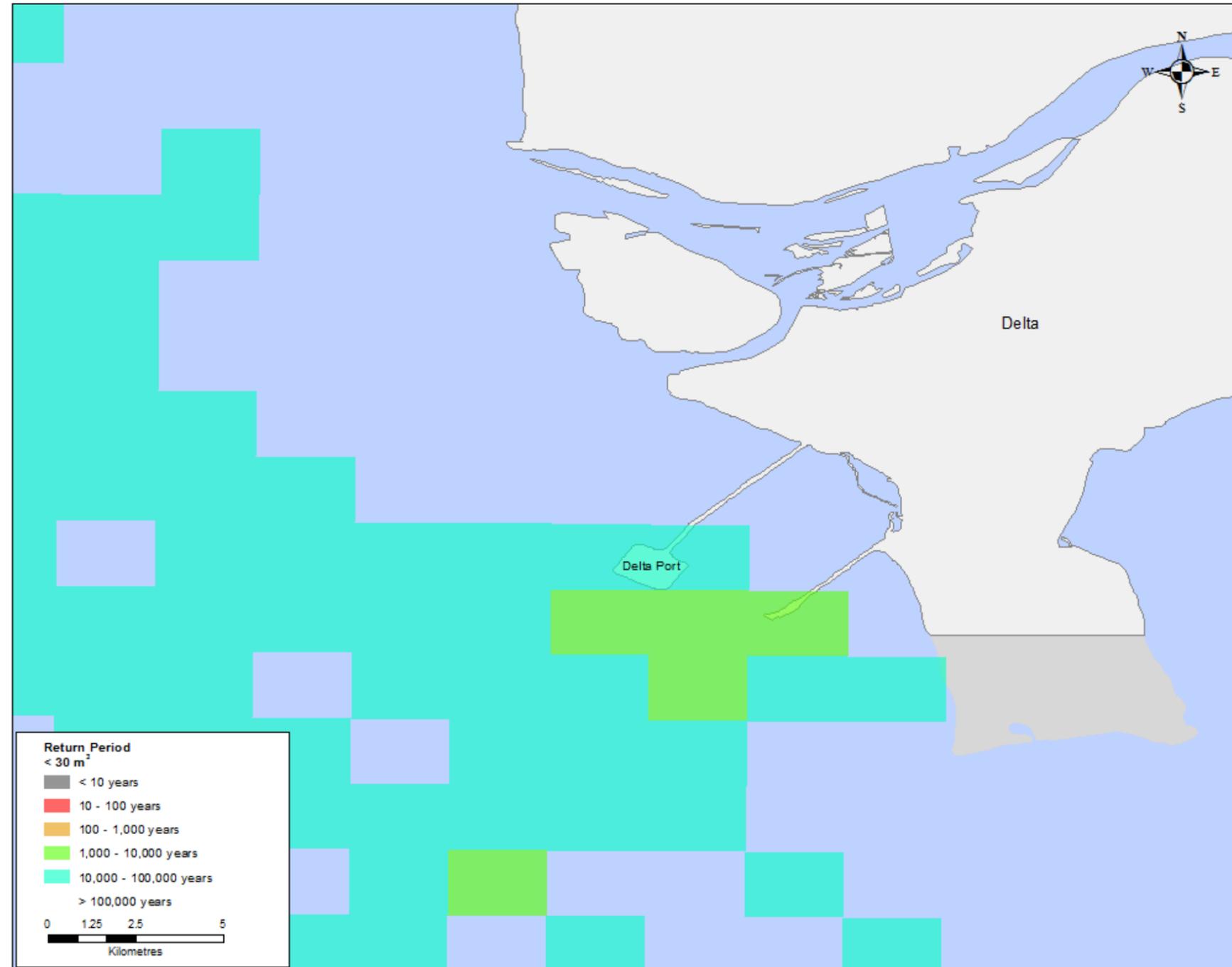
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Phase 3 – Risk Assessment

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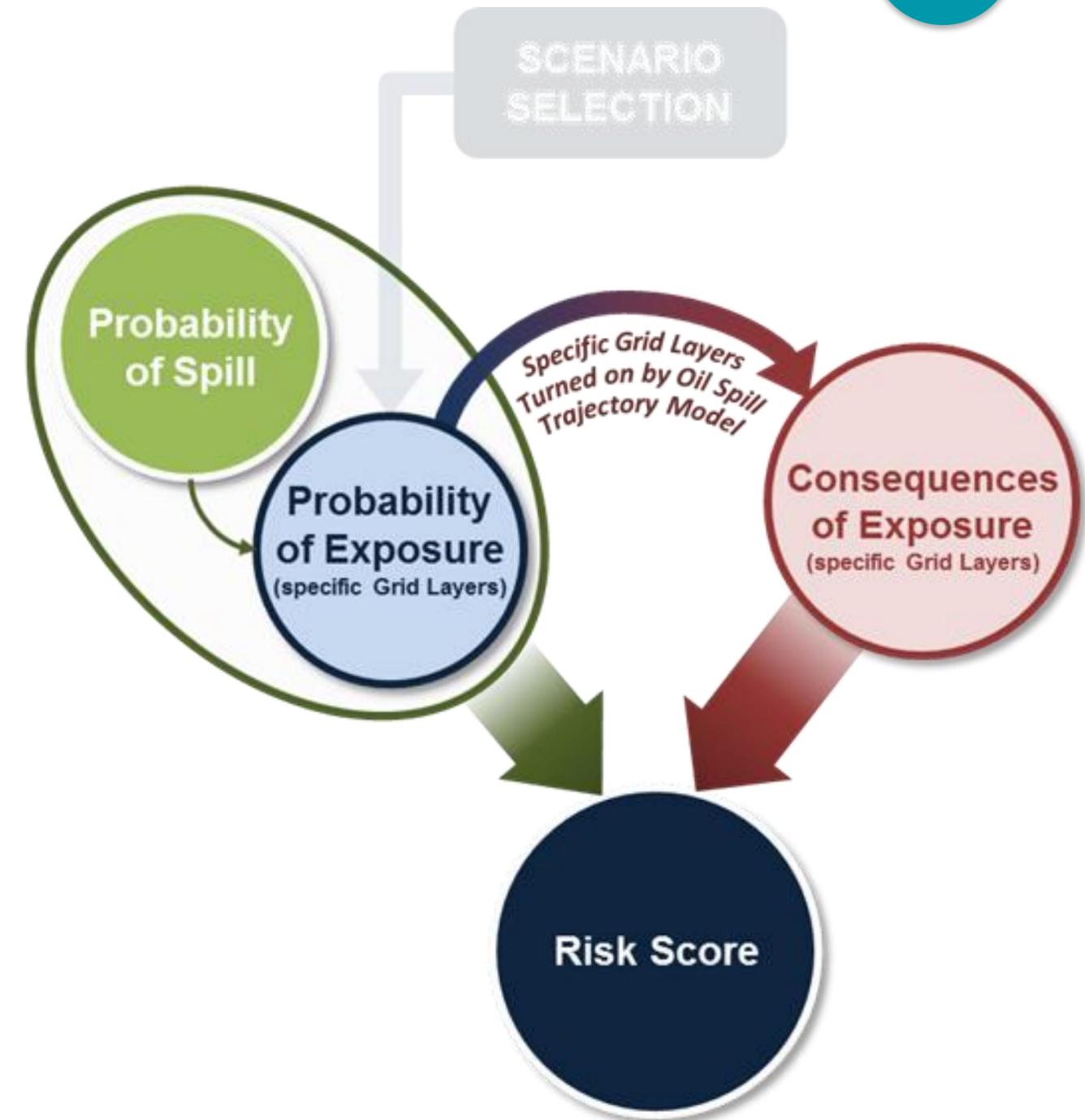
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- Phase 1 of the ARA Methodology determines “Probability of Spill”.
- Phase 2 selects the oil spill scenarios that includes the:
 - Location of oil spill
 - Type of oil that is released
 - Volume of oil that is released
- The risk assessment of each scenario that is identified in Phase 2 is then completed in Phase 3.



Phase 3 – Risk Assessment

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The risk assessment is a three step process:

- Step One:
 - Fate and trajectory analysis is conducted using a computer model to determine where the oil spill will go.
- Step Two:
 - Consequence score is calculated based on environmental sensitivities in contact with oil (based on the trajectory analysis).
- Step Three:
 - Results of Steps 1 and 2 are combined with the Probability of Spill to generate the Risk Scores within each grid cell.

Step 1 – Trajectory Analysis

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- All spill scenarios are first modeled using RPS ASA's SIMAP (Spill Impact Model Application Package) oil spill modeling system.
- SIMAP quantifies the following, in all 3 dimensions within a Grid Cell and over time, for each individual model run/scenario:
 - Oil mass, volume and thickness on the water surface
 - Oil mass, volume and thickness on shorelines
 - Oil concentrations in the water column
 - Oil concentrations in the sediments
- Inputs to SIMAP include local wind conditions, currents, suspended sediments, and other water parameters (such as temperature and density), and spill response measures.
- Modelled in Stochastic Mode

Step 1 – Trajectory Analysis

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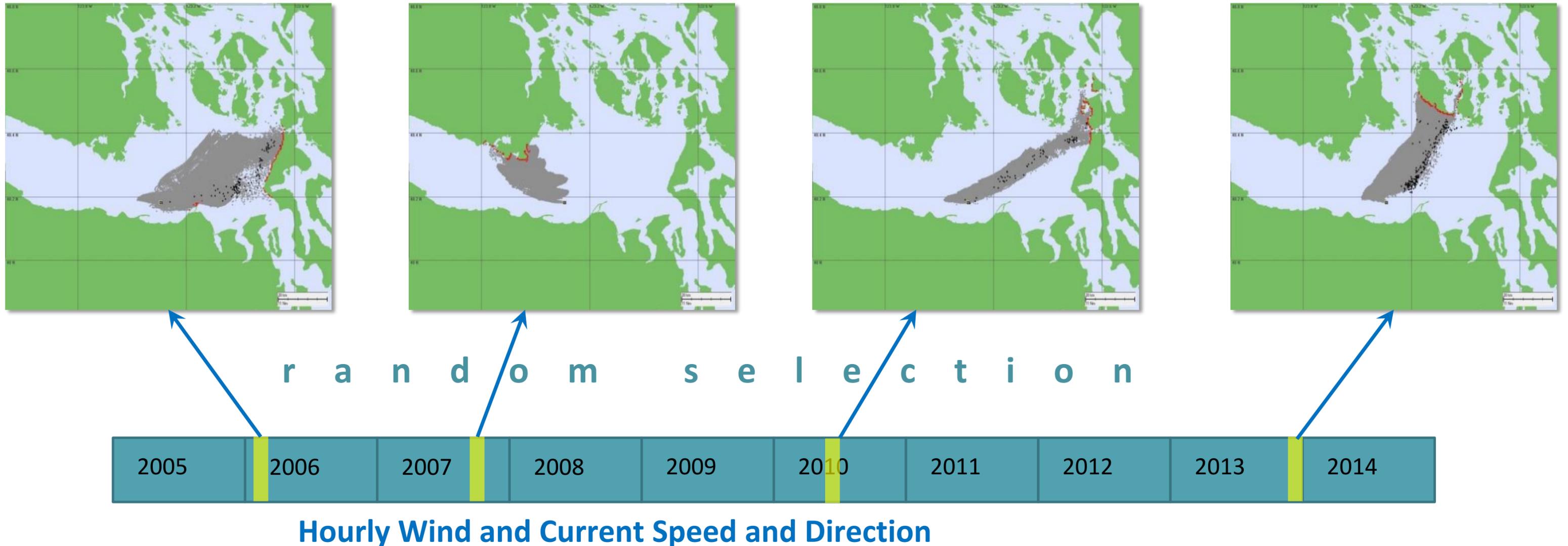
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Run trajectory model hundreds of times, randomizing spill date/time



Step 1 – Trajectory Analysis

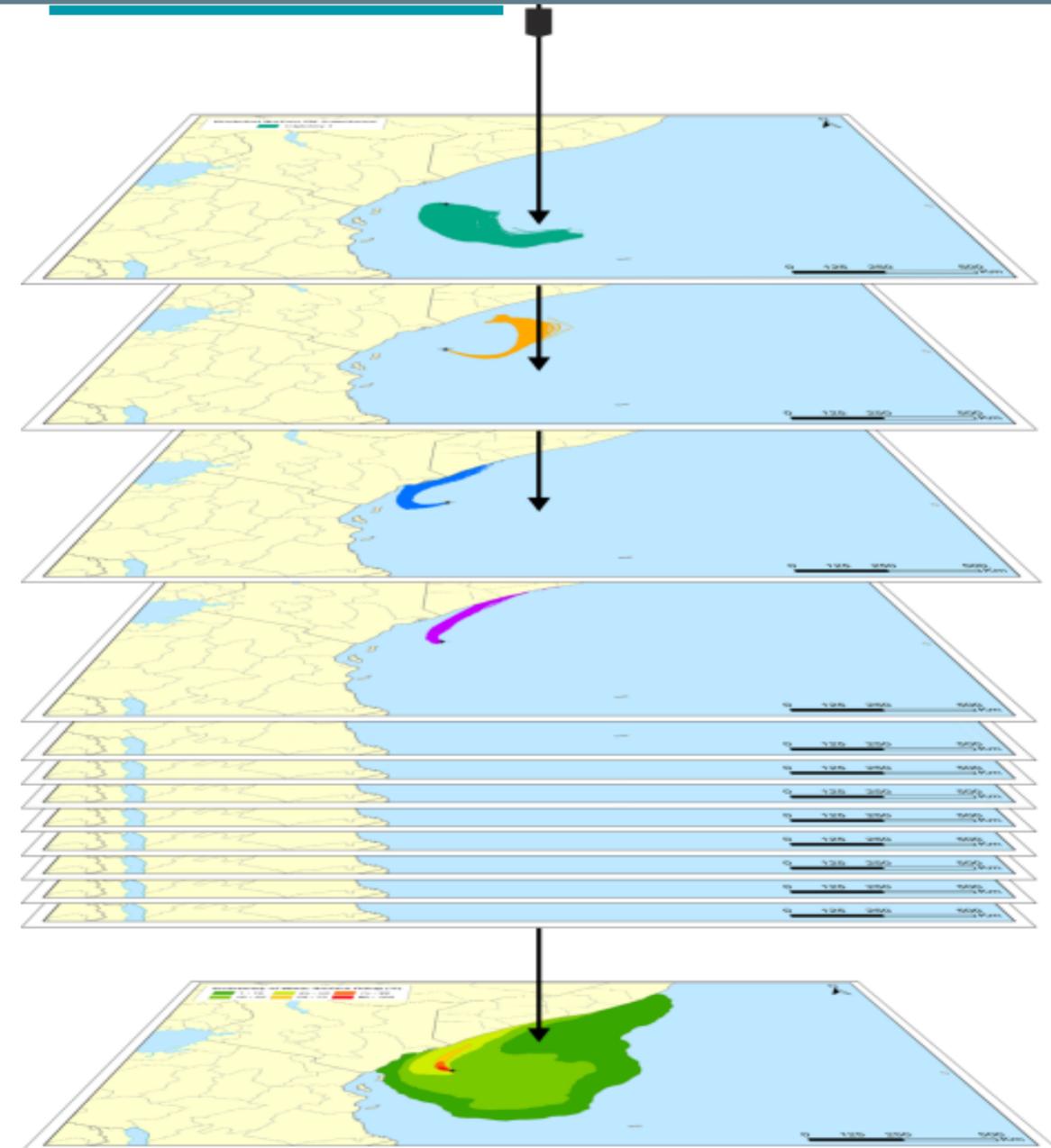
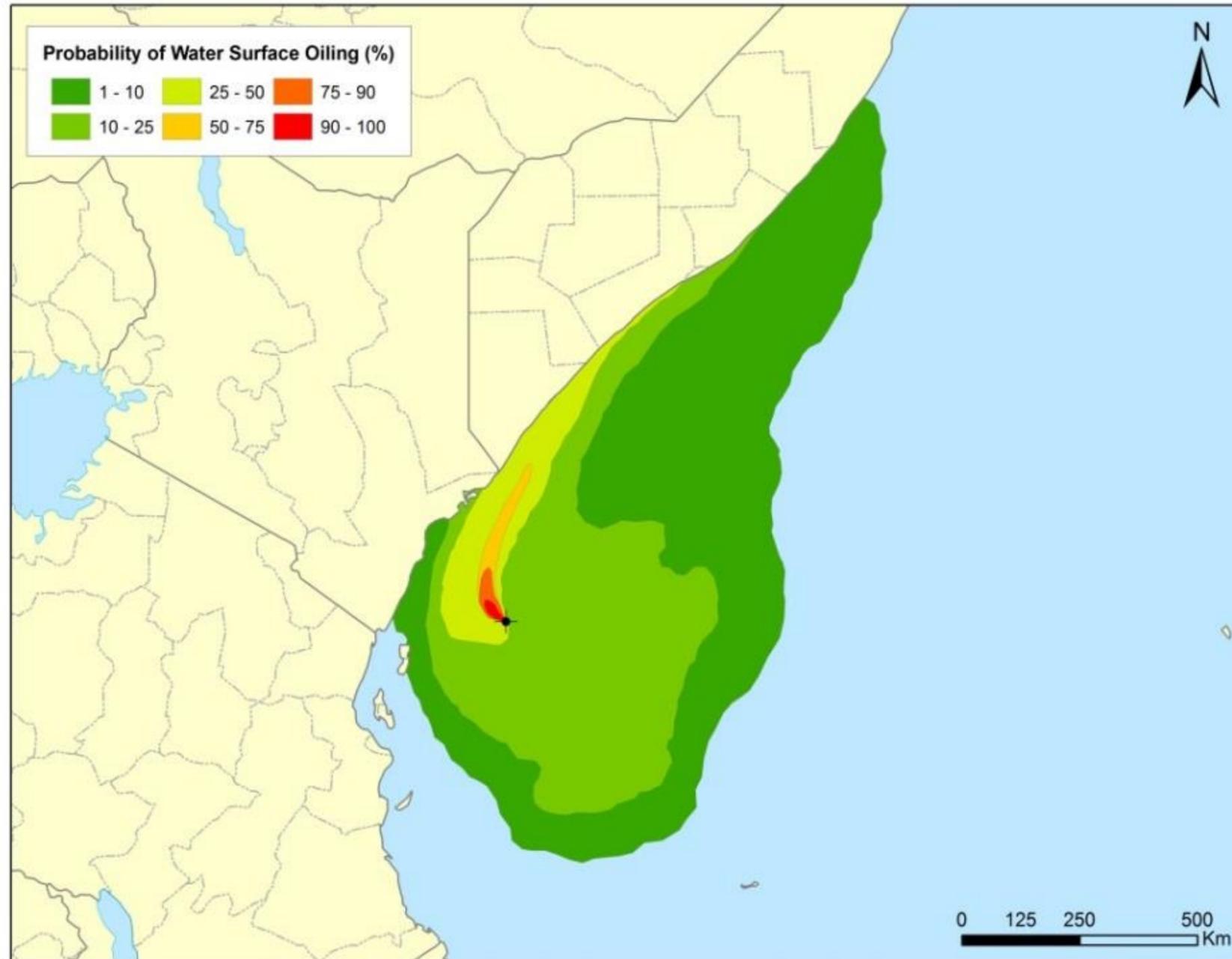
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Step 1 – Trajectory Analysis

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Probability of Spill

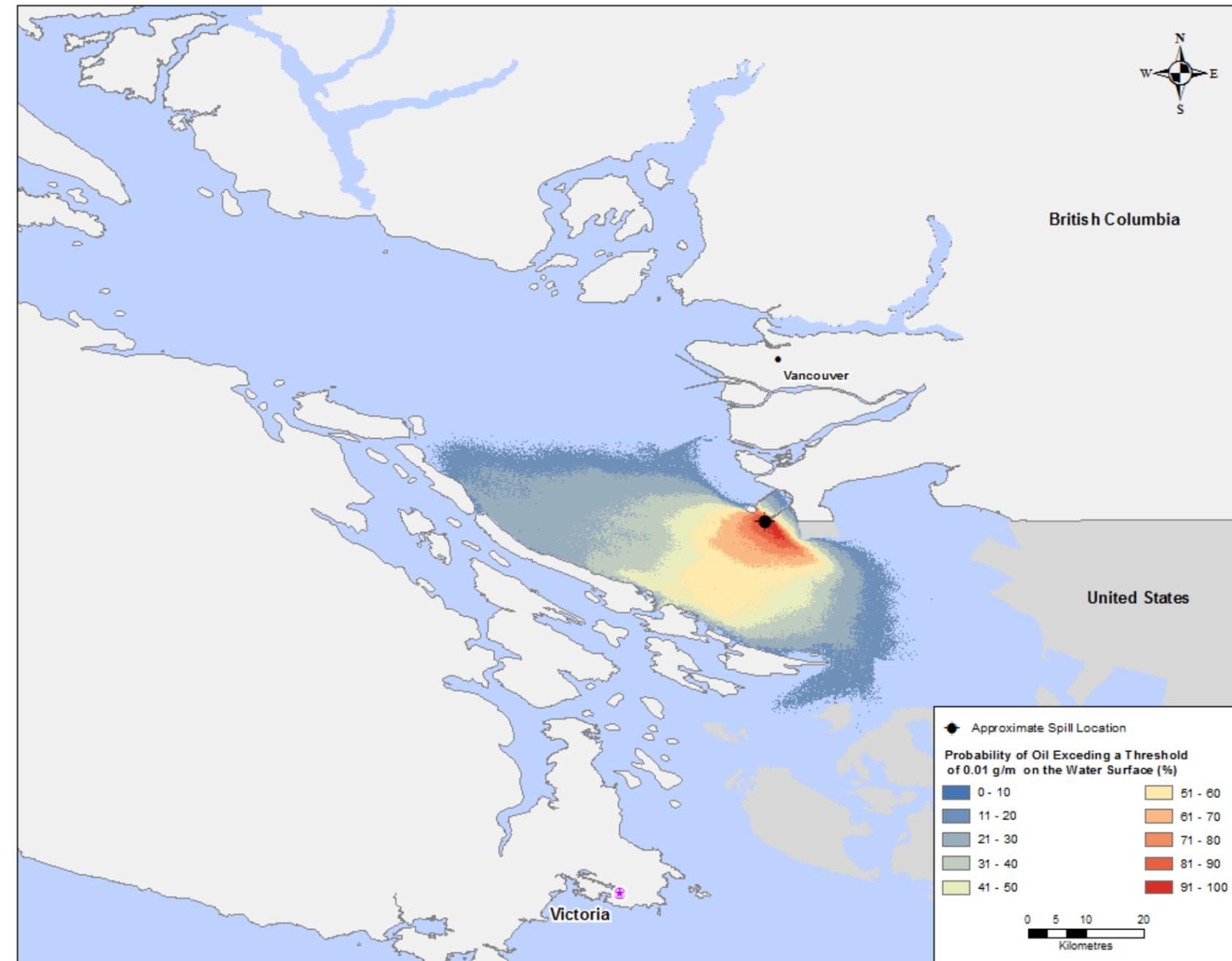
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- Outputs from SIMAP for each scenario show the probability of oil being present in:
 - Water Surface
 - Water Column
 - Seafloor
 - Shoreline
- This map represents an example of the SIMAP results showing the probability of the presence of oil on the water surface.



Step 2 – Consequence of Exposure

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Three types of sensitivity information is used in the ARA Methodology:

1. Biological

- Protected Areas and Important Habitat – Protected Areas through legislation and regulations, and important for certain species
- Species at Risk – Mammals, birds, reptiles, fish, invertebrates and marine plants

2. Physical

- 11 different types of shorelines ranging from bedrock cliffs to marsh
- 3 different seafloor types based on geological features and sediment type

3. Socio-Economic

- Human use of resources for social and economic benefit
- 7 different socio-economic factors – commercial fishing, tourism, parks, First Nations communities and cultural sites, water use facilities, freight movement, population density

Step 2 – Consequence of Exposure

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Probability of Spill

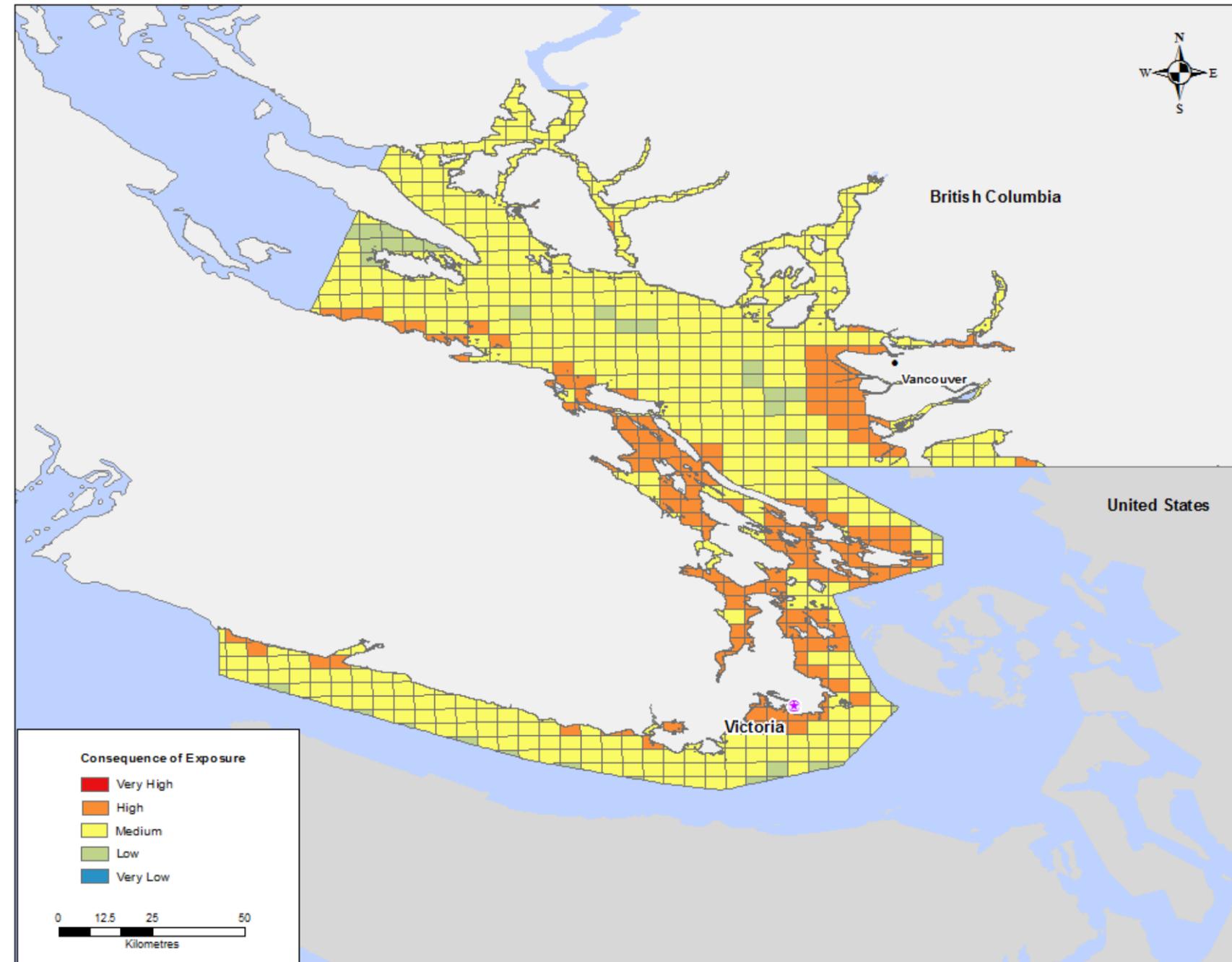
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- The three consequence elements are combined to calculate the *Consequence of Exposure* within each grid cell.
- Here is a map of that shows an example of the Consequence of Exposure scores within each grid cell.



Step 3 – Calculation of the Risk Scores

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Probability of Spill

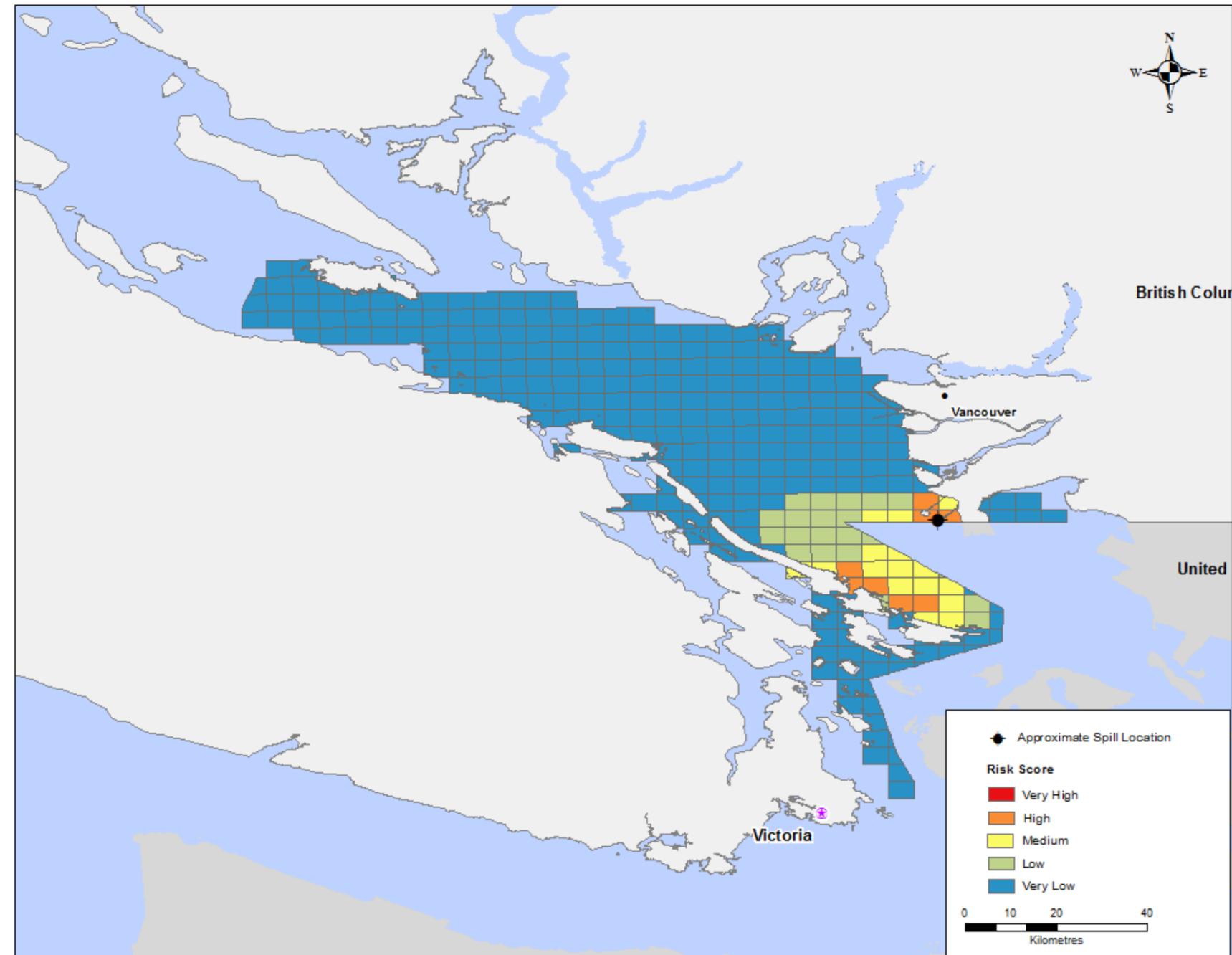
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- Risk Score is calculated per Grid Cell.
- Here is a Risk Score map for a hypothetical scenario.



Summary

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Phase 1 – Probability of Spill

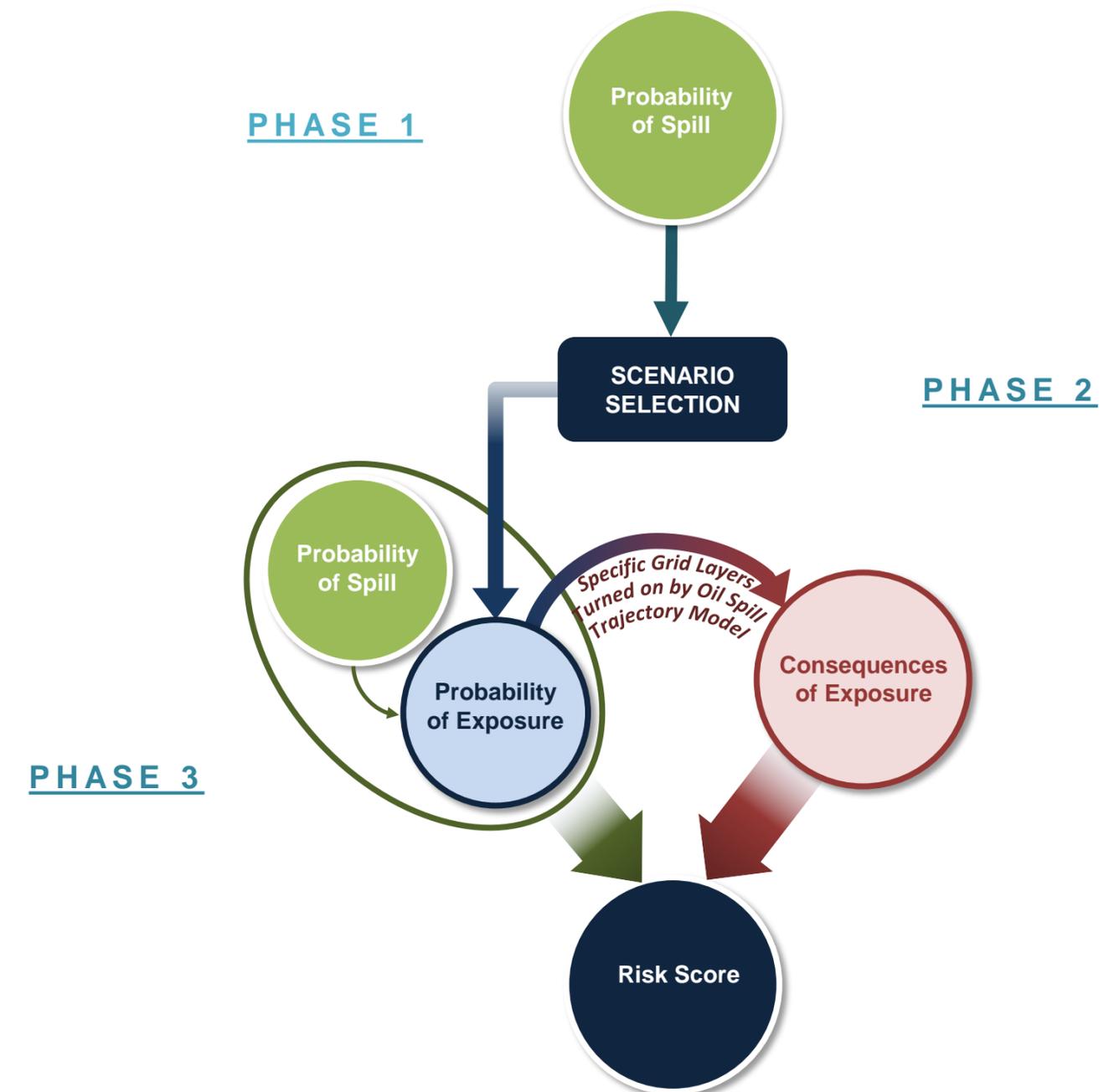
- Probability and location of an accident that involves one or more ships or at an OHF

Phase 2 – Scenario Selection

- Determines highest risk locations for a ship-source oil spill

Phase 3 – Risk Assessment

- Step 1 – Trajectory Analysis
- Step 2 – Consequence of Exposure
- Step 3 – Determine the Risk Scores



Next Steps

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Probability of Spill

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- The consortium of companies responsible for the ARA contract will continue testing the methodology and deliver final results in late 2016.
- Following the ARP initiative's completion in March 2017, the Government of Canada will make a decision on whether to adopt risk-based response planning nationally.



Questions?

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