Assessment of Marine Oil Spill Risk and Environmental Vulnerability for the State of Alaska

NOAA FISHERIES

Restoration Center NW

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September, 2014

RPI

RPS asa

Environmental Research Consulting

THE Louis Berger Group, INC.

Why should we conduct a risk analysis?

- Prioritize our work.
- Use our limited resources well.
- NOAA's Strategic Plan and NMFS Strategic Plan mandate that we prioritize our work…

STRATEGIC PLANNING

Project Objectives

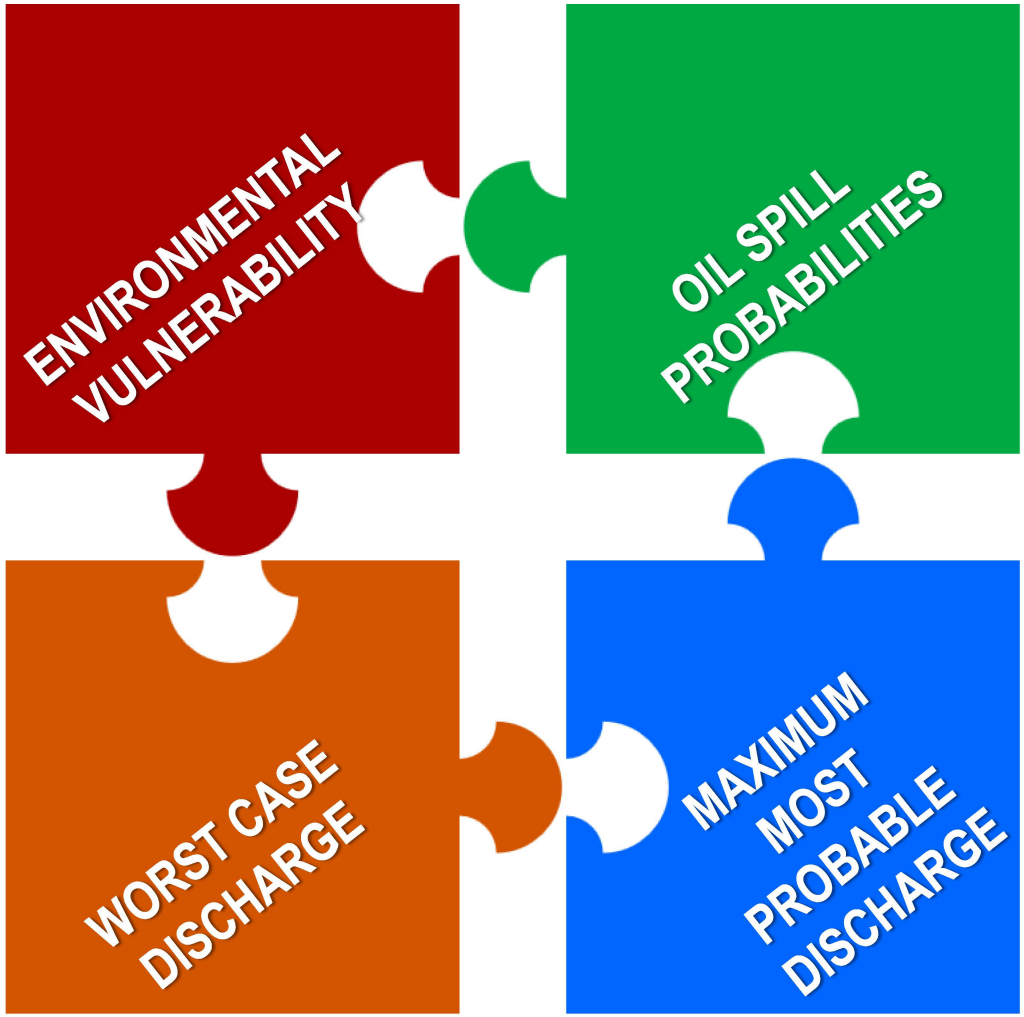
- Conduct a screening-level analysis of the relative risk of oil spills to the marine waters of Alaska
  - Study does not attempt to determine the exact size, location, transport, fate, and impacts of a particular future oil spill, nor the potential response technologies applied
- This information can be used to help guide strategic planning and prioritize future research activities

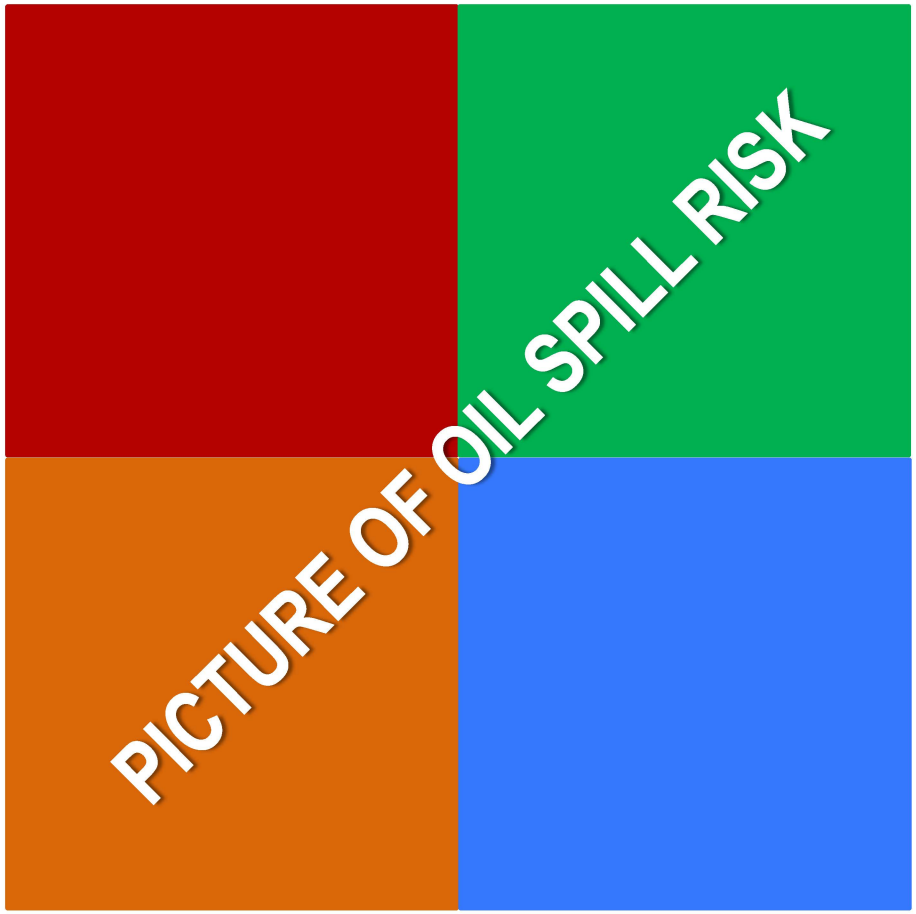
How do we calculate risk for this study?

- Risk = Probability x Consequence
- Risk = (Probability of a Spill) x (Environmental Vulnerability) x (Volume Spilled)

	Low Probability	High Probability
Low Consequence	Low Risk	Medium Risk
High Consequence	Medium Risk	High Risk

- Volume Spilled = Maximum Most Probable Discharge and Worst Case Discharge
- Probability = Actual and Potential spills from Vessels and Facilities


ENVIRONMENTAL VULNERABILITY
OIL SPILL PROBABILITIES
WORST CASE DISCHARGE
MAXIMUM MOST PROBABLE DISCHARGE

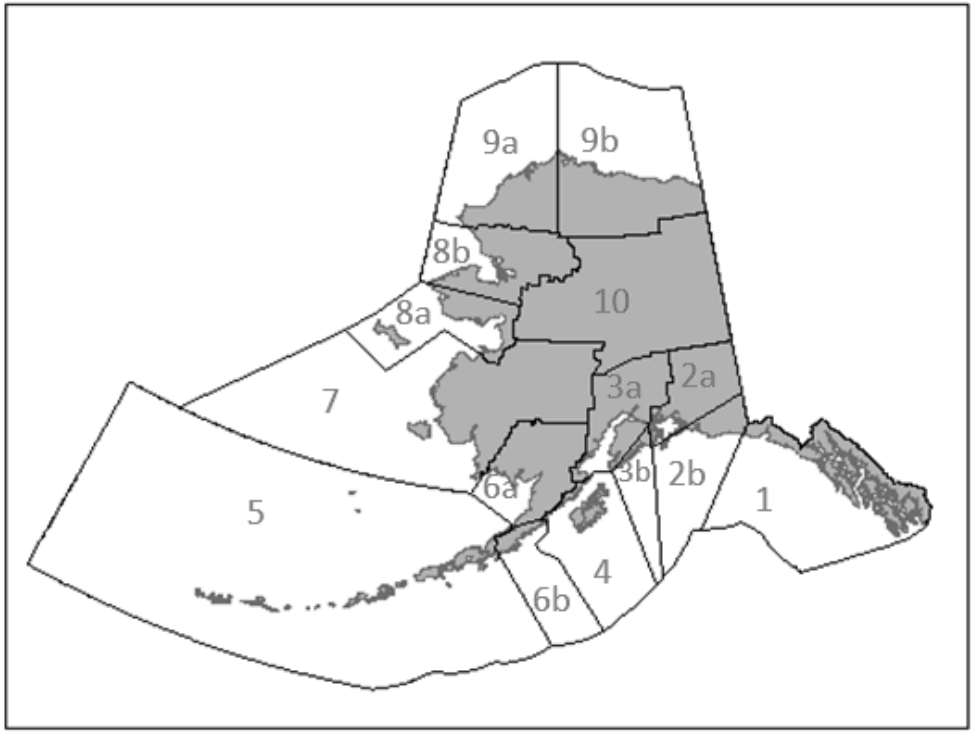

PICTURE OF OIL SPILL RISK

Over Arching Factors

- The analysis was done with regard to these three factors.
  - Area
  - Seasonality
  - Oil Type

How to Divide Alaska?

- Decided to use 10 SubAreas and subdivide.
- Maintains common nomenclature within the oil spill response community.

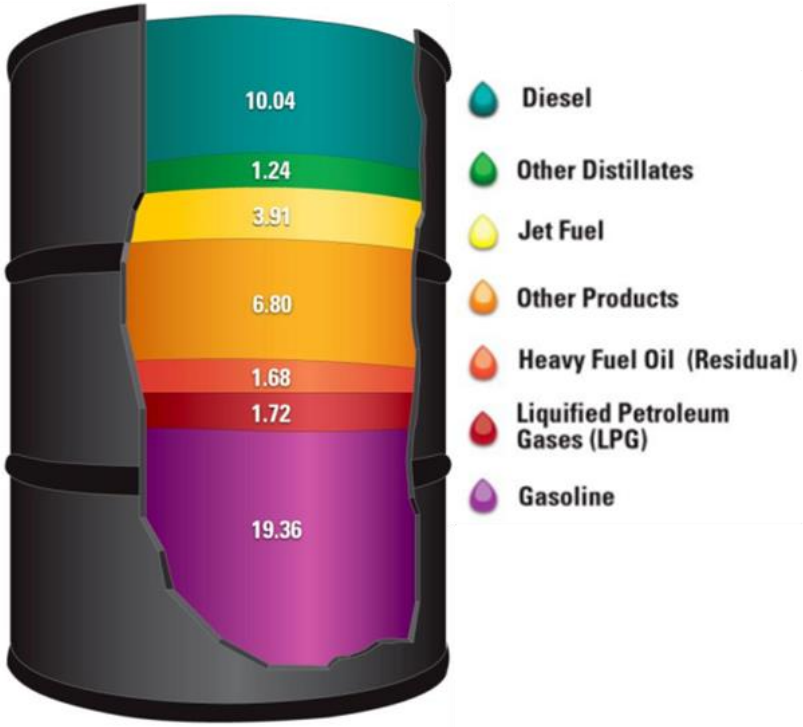


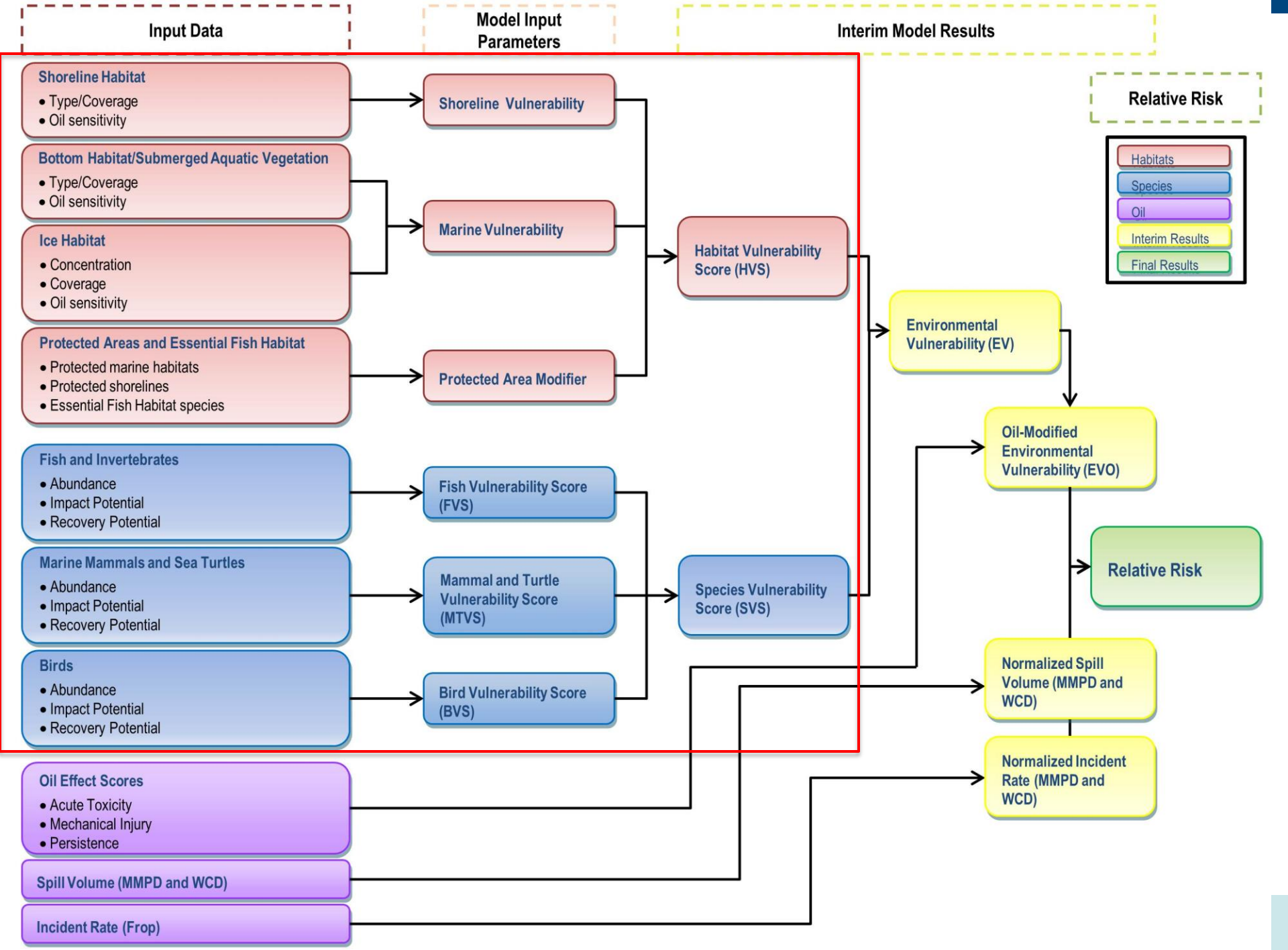
Seasonality

- The risk will change by the season because:
  - Habitat and species sensitivity changes
  - Vessel traffic and facility operations change.
- Six “seasons/periods”
  - December-January
  - February-March
  - April-May
  - June-July
  - August-September
  - October-November

Oil Type

- The analysis was done by oil type because it affects the consequence factor of the equation.
- These characteristics of oil affect the consequence factor:
  - Acute toxicity
  - Mechanical injury
  - Persistence
- Oil type categories:
  - Crude Oils
  - Distillates
  - Light Oils
  - Heavy Oils

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Relative Risk

Relative Environmental Vulnerability

- Based on habitats & species present and their vulnerability to oiling
- Includes terms for:
  - Habitat Vulnerability
  - Fish & Invertebrate Vulnerability
  - Marine Mammal Vulnerability
  - Marine Bird Vulnerability

Risk = (Probability of a Spill) x **(Environmental Vulnerability)** x (Volume Spilled)

What did we consider in our vulnerability analysis?

Vulnerability of Organisms

- Relative abundance
- Recovery potential
- Impact potential

Vulnerability of Habitat

- oil effects on habitat,
- Percent of habitat type in region,
- conservation status,
- Essential Fish Habitat (EFH),
- ice and submerged aquatic vegetation scores.

Species Selection: Species Group Sub-categories

Fish & Invertebrates

- Small pelagic fish
- Large pelagic fish
- Semi-demersal fish
- Demersal fish
- Anadromous fish
- Pelagic invertebrates
- Demersal invertebrates

Marine Mammals

- Baleen whales
- Toothed whales
- Fur-bearing pinnipeds
- Other pinnipeds (walrus, sea lion, phocids)
- Other fur-bearing marine mammals (polar bear, sea otter)

Birds

- Waterfowl
- Seabirds (aerial divers)
- Seabirds (surface divers)
- Shorebirds/wading birds
- Raptors

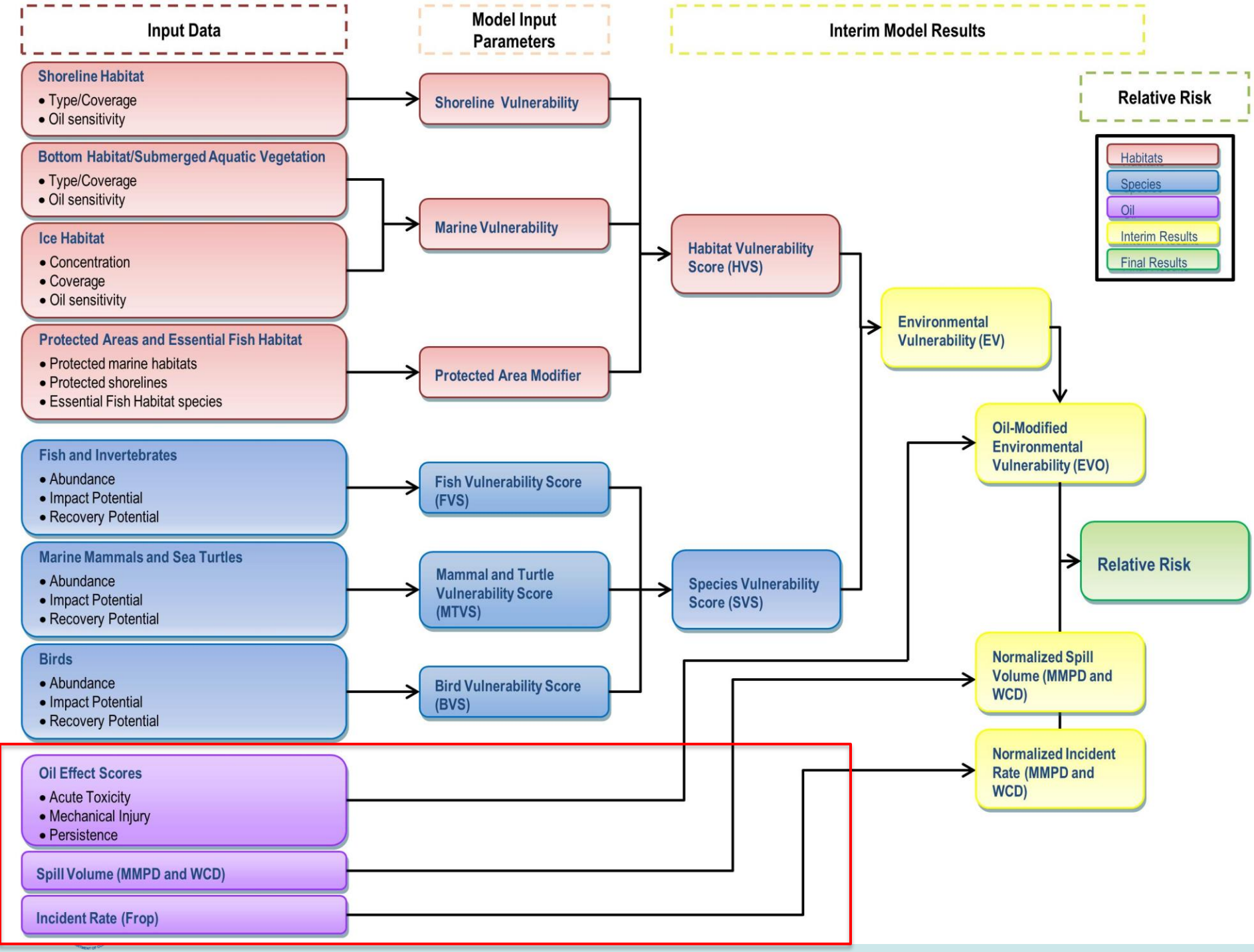
Environmental Vulnerability (EV) Results

Region	Period						Yearly Mean
	Dec-Jan	Feb-Mar	Apr-May	Jun-Jul	Aug-Sep	Oct-Nov	
Aleutians	1.48	1.44	1.51	1.55	1.49	1.53	1.50
Norton Sound/St. Lawrence Is.	1.38	1.39	1.46	1.44	1.21	1.27	1.36
Kodiak/Shelikof Strait	1.27	1.24	1.37	1.36	1.33	1.27	1.31
Western Alaska	1.24	1.31	1.38	1.36	1.17	1.18	1.27
Kotzebue Sound/Hope Basin	1.09	1.08	1.30	1.27	1.14	1.10	1.17
Cook Inlet	1.20	1.21	1.32	1.14	1.09	1.02	1.16
Aniakchak	1.09	1.10	1.19	1.22	1.17	1.13	1.15
Chukchi Sea	0.99	0.98	1.19	1.31	1.16	1.06	1.12
Offshore Kenai Peninsula	1.09	1.04	1.14	1.14	1.11	1.03	1.09
Prince William Sound	1.02	1.03	1.16	1.05	1.00	0.91	1.03
Beaufort Sea	0.87	0.87	1.05	1.24	1.13	0.98	1.02
Southeast Alaska	0.94	0.93	1.08	1.09	1.07	0.98	1.01
Bristol Bay	1.01	1.05	1.05	0.95	0.88	0.98	0.99
South-Central Alaska	0.94	0.88	1.03	1.06	1.03	0.92	0.98
Seasonal Average	1.12	1.11	1.23	1.23	1.14	1.10	

Environmental Vulnerability (EV) Results

- Values for each component of the EV score: habitat vulnerability (HVS), marine mammal & sea turtle vulnerability (MTVS), bird vulnerability (BVS), and fish & invertebrate vulnerability (FVS)

Region	Mean HVS	Mean MTVS	Mean BVS	Mean FVS	Mean EV
Aleutians	0.63	0.90	0.74	0.97	1.50
Norton Sound/St. Lawrence Is.	0.89	0.42	0.43	0.56	1.36
Kodiak/Shelikof Strait	0.62	0.53	0.81	0.73	1.31
Western Alaska	0.71	0.47	0.47	0.75	1.27
Kotzebue Sound/Hope Basin	0.83	0.31	0.31	0.39	1.17
Cook Inlet	0.71	0.25	0.75	0.35	1.16
Aniakchak	0.58	0.34	0.75	0.63	1.15
Chukchi Sea	0.79	0.40	0.32	0.26	1.12
Offshore Kenai Peninsula	0.57	0.34	0.79	0.42	1.09
Prince William Sound	0.65	0.22	0.58	0.34	1.03
Beaufort Sea	0.73	0.34	0.30	0.24	1.02
Southeast Alaska	0.43	0.59	0.68	0.48	1.01
Bristol Bay	0.56	0.33	0.49	0.45	0.99
South-Central Alaska	0.51	0.34	0.63	0.42	0.98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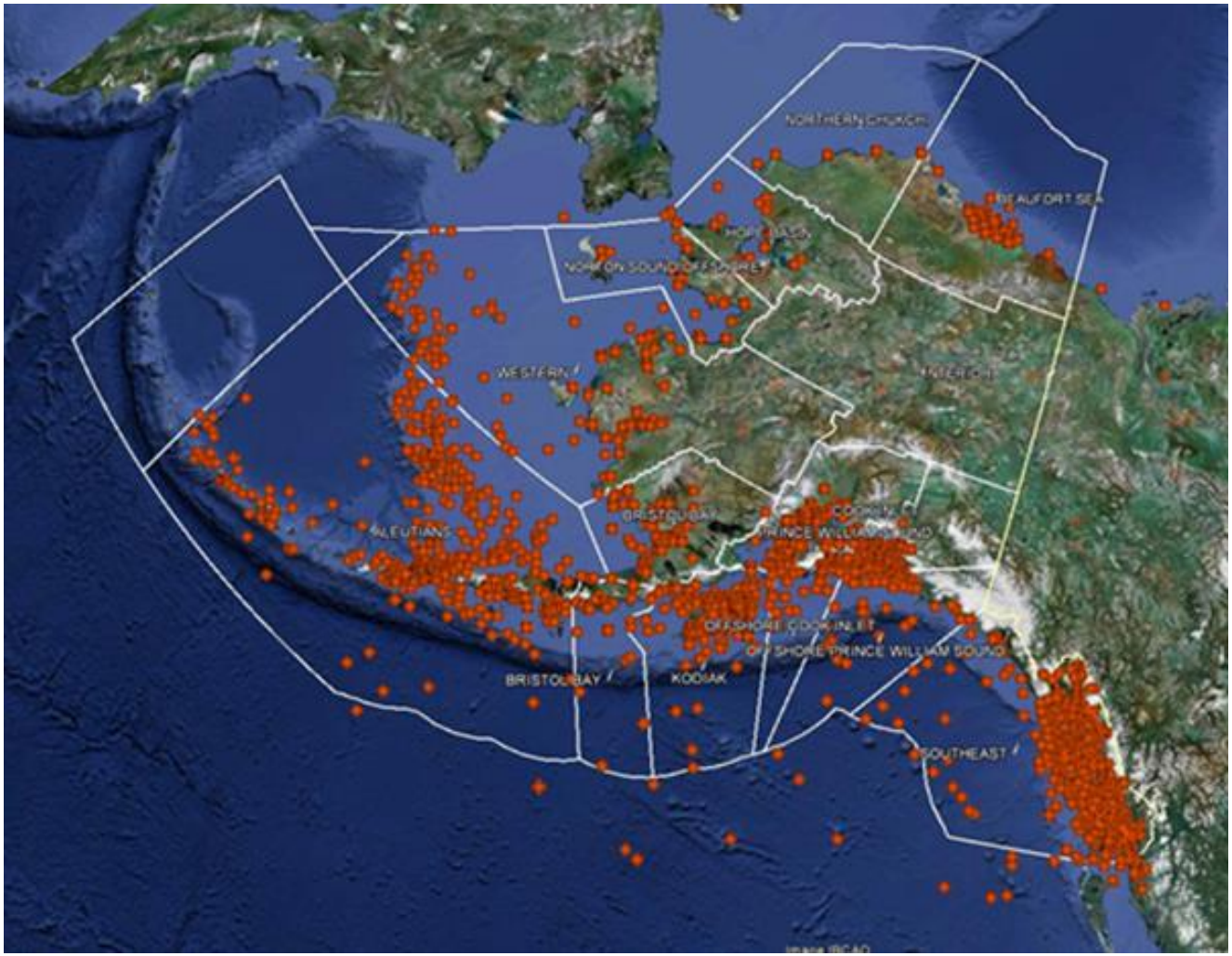
Historical Incident Database



10, 985 incidents
1995 - 2012

Spills/potential spills

- Vessels
- Facilities
- Geographic location (lat/lon and ADEC region)
- Source type
- Incident cause
- Oil type
- Spill volume

Risk = **(Probability of a Spill)** x (Environmental Vulnerability) x **(Volume Spilled)**

Incident Rate Results

Region	Yearly Mean Current/Historical Incident Rate (# per year)				
	Crude	Distillate	Heavy	Light	Sum of All Oil Types
Southeast Alaska	0.03	2.6	0.5	30.5	33.6
Aleutians	0	0.3	0.5	14.1	14.9
Beaufort Sea	3.1	0.04	0.05	10.5	13.7
Cook Inlet	2.1	0.7	0.4	9.3	12.4
Prince William Sound	0.6	0.6	0.1	7.5	8.8
Kodiak/Shelikof Strait	0.05	0.2	0.2	7.3	7.8
Western Alaska	0	0.4	0.05	2.7	3.1
Offshore Kenai Peninsula	0.01	0.1	0.06	2.1	2.4
Bristol Bay	0	0.2	0.1	1.8	2.1
South-Central Alaska	0.07	0.07	0.07	0.7	1.0
Norton Sound/St. Lawrence Is.	0	0.1	0.03	0.7	0.9
Aniakchak	0.02	0.03	0.04	0.5	0.6
Kotzebue Sound/Hope Basin	0	0.06	0.02	0.3	0.4
Chukchi Sea	0.01	0.07	0.01	0.2	0.3

MMPD Volume

- "Maximum Most Probable Discharge"
- Based on USCG definitions:
  - Facility MMPD = the lesser of 1,200 bbl or 10% of the WCD
  - Vessel (<25,000 deadweight tonnage) MMPD = 10% of the WCD
  - Vessel (≥25,000 deadweight tonnage) MMPD = 2,500 bbl
- For each region/period/oil type, the MMPD volumes for all source types were weight-averaged
  - Volumes represented in proportion to their occurrence (i.e., incident rate)

MMPD Spill Volume - Results

Region	Current Theoretical MMPD (bbl)				
	Crude	Distillate	Heavy	Light	Sum of All Oil Types
Beaufort Sea	1,200	800	800	1,200	4,000
Cook Inlet	830	830	830	830	3,320
South-Central Alaska	670	670	670	670	2,680
Aniakchak	560	560	560	560	2,240
Chukchi Sea	560	560	560	560	2,240
Prince William Sound	520	520	520	520	2,080
Kotzebue Sound/Hope Basin	0	527	527	790	1,843
Norton Sound/St. Lawrence Is.	0	650	433	650	1,733
Western Alaska	0	510	340	510	1,360
Bristol Bay	0	280	420	420	1,120
Southeast Alaska	230	230	230	230	920
Aleutians	0	250	250	250	750
Kodiak/Shelikof Strait	150	150	150	150	600
Offshore Kenai Peninsula	150	150	150	150	600

WCD Volume

- "Worst Case Discharge"
- Based on USCG/EPA definitions:
  - For onshore/offshore facilities: "the largest foreseeable discharge in adverse weather conditions." WCDs for facilities are based on the types of facilities present in each region and the known capacities of the facilities (for AK, range from 100 bbl to 200,000 bbl)
  - For offshore wells: defined as 30 days of flow at the daily production rate for wells <10,000 ft, and 45 days of flow at the daily production rate for wells that are >10,000 ft
  - For vessels: total capacity of the cargo and/or bunker fuel tanks of the vessel (for AK, range from 10 bbl to 1.9 million bbl)

WCD Spill Volume - Results

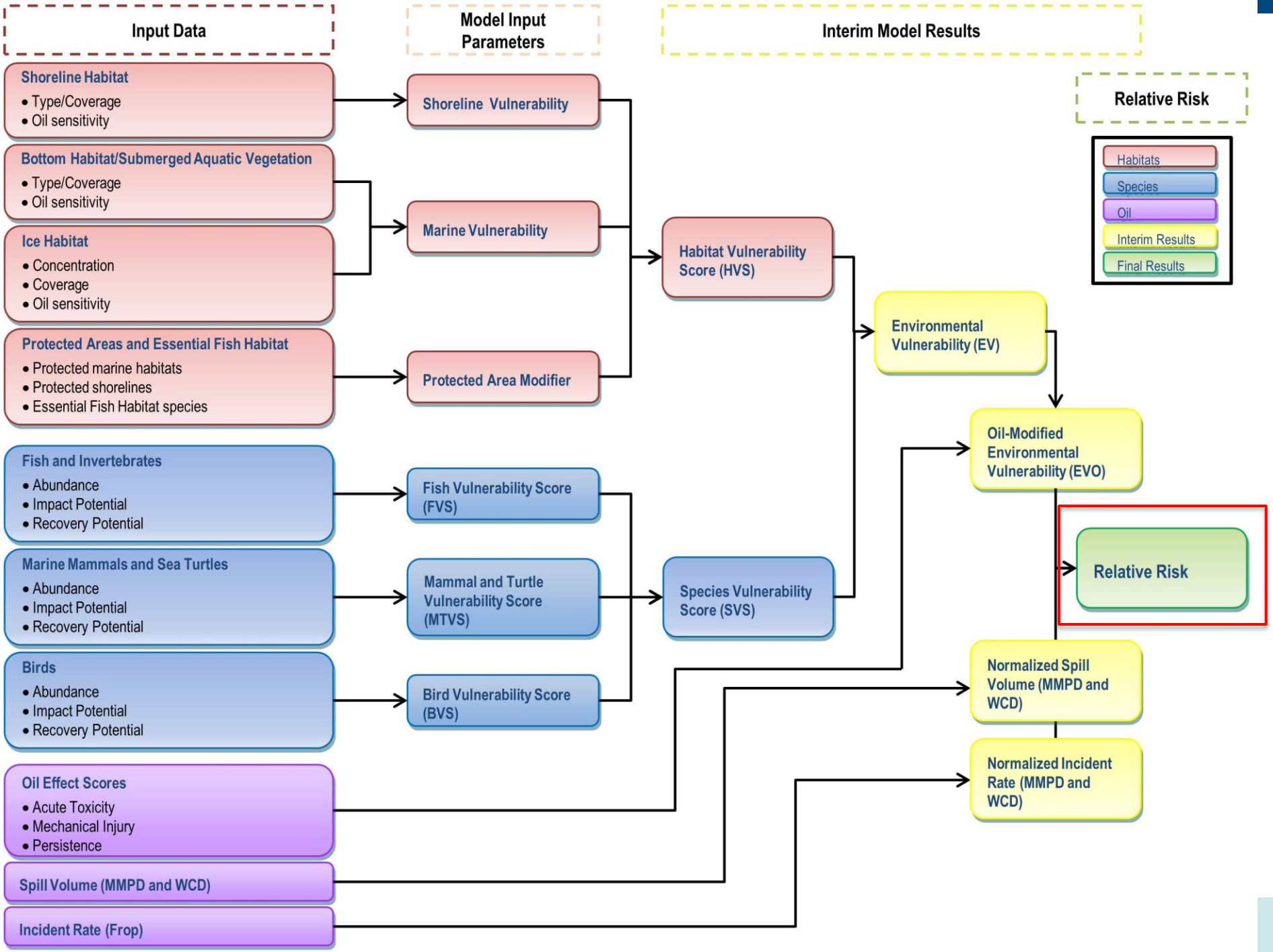
Region	Current Theoretical WCD (bbl)				
	Crude	Distillate	Heavy	Light	Sum of All Oil Types
Cook Inlet	1,900,000	523,000	1,900,000	1,900,000	6,223,000
Kodiak/Shelikof Strait	1,900,000	523,000	1,900,000	1,900,000	6,223,000
Prince William Sound	1,900,000	523,000	1,900,000	1,900,000	6,223,000
Southeast Alaska	1,900,000	523,000	1,900,000	1,900,000	6,223,000
South-Central Alaska	1,900,000	348,667	1,900,000	1,900,000	6,048,667
Beaufort Sea	3,900,000	348,667	348,667	523,000	5,120,333
Chukchi Sea	2,200,000	50,000	20,000	50,000	2,320,000
Aniakchak	523,000	523,000	523,000	523,000	2,092,000
Offshore Kenai Peninsula	523,000	523,000	523,000	523,000	2,092,000
Aleutians	0	523,000	523,000	523,000	1,569,000
Bristol Bay	0	108,667	163,000	163,000	434,667
Norton Sound/St. Lawrence Is.	0	163,000	108,667	163,000	434,667
Western Alaska	0	163,000	108,667	163,000	434,667
Kotzebue Sound/Hope Basin	0	108,667	108,667	163,000	380,333

Modeling Approach: 2025 Projections

- Study also included an assessment of future relative risk for the year 2025, based on expected changes in vessel traffic, oil exploration/production, and the regional economy
- Only incidents rates and MMPD/WCD spill volumes were projected into the future
- No future projections of environmental vulnerability were calculated for this project

Modeling Approach: 2025 Incident Rates

- Assumptions based on a literature review of studies related to future spillage risk
- Assumptions relate to:
  - Factors that reduce the probability of an incident becoming a spill event (e.g., risk mitigation practices, use of double-hulled tanks)
  - Changes in vessel traffic patterns
  - Marine engineering advances and ice coverage reductions, allowing for year-round activity
  - Changes in the distribution of oil types
  - Increases in oil exploration/production activities
  - Economic growth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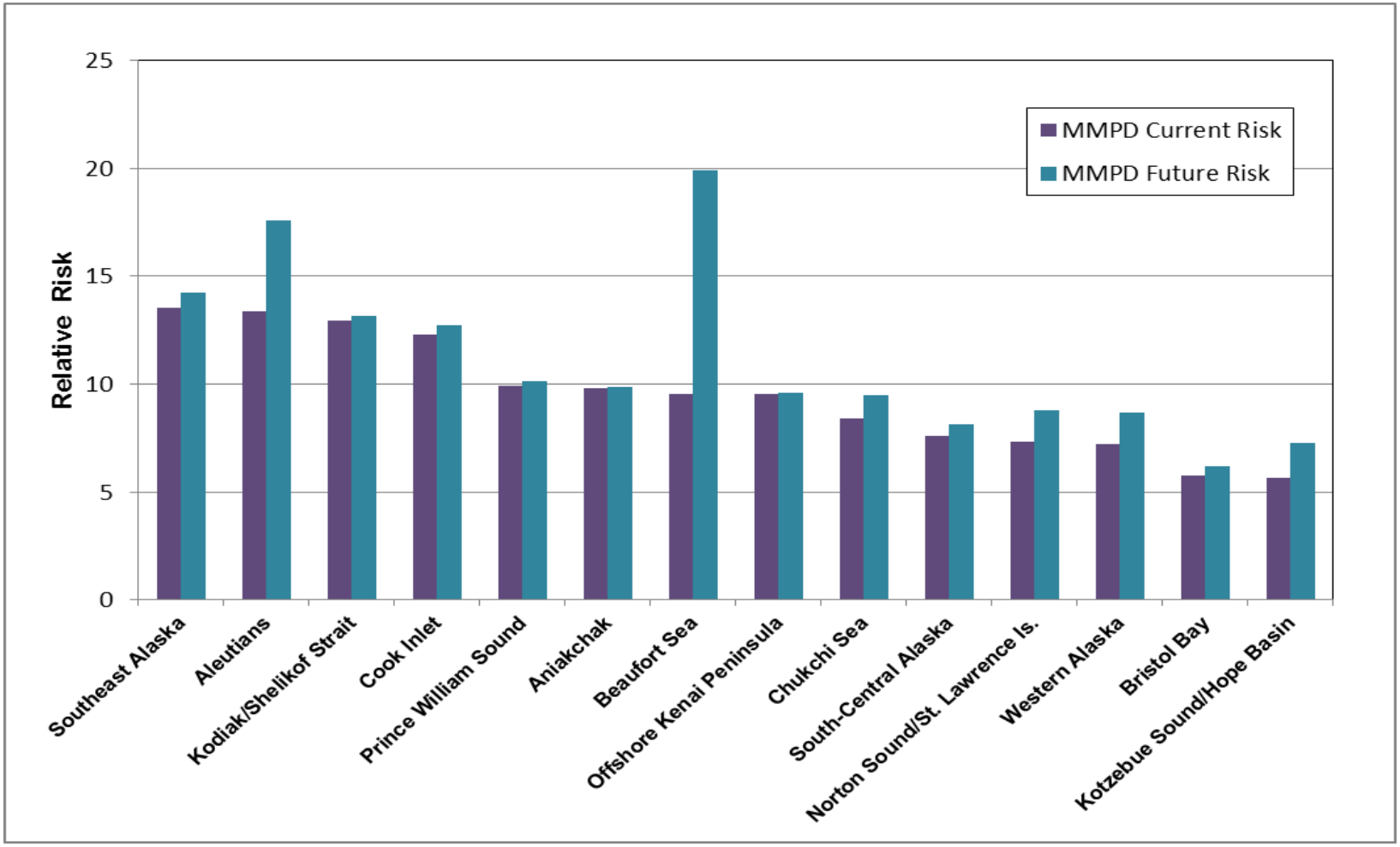
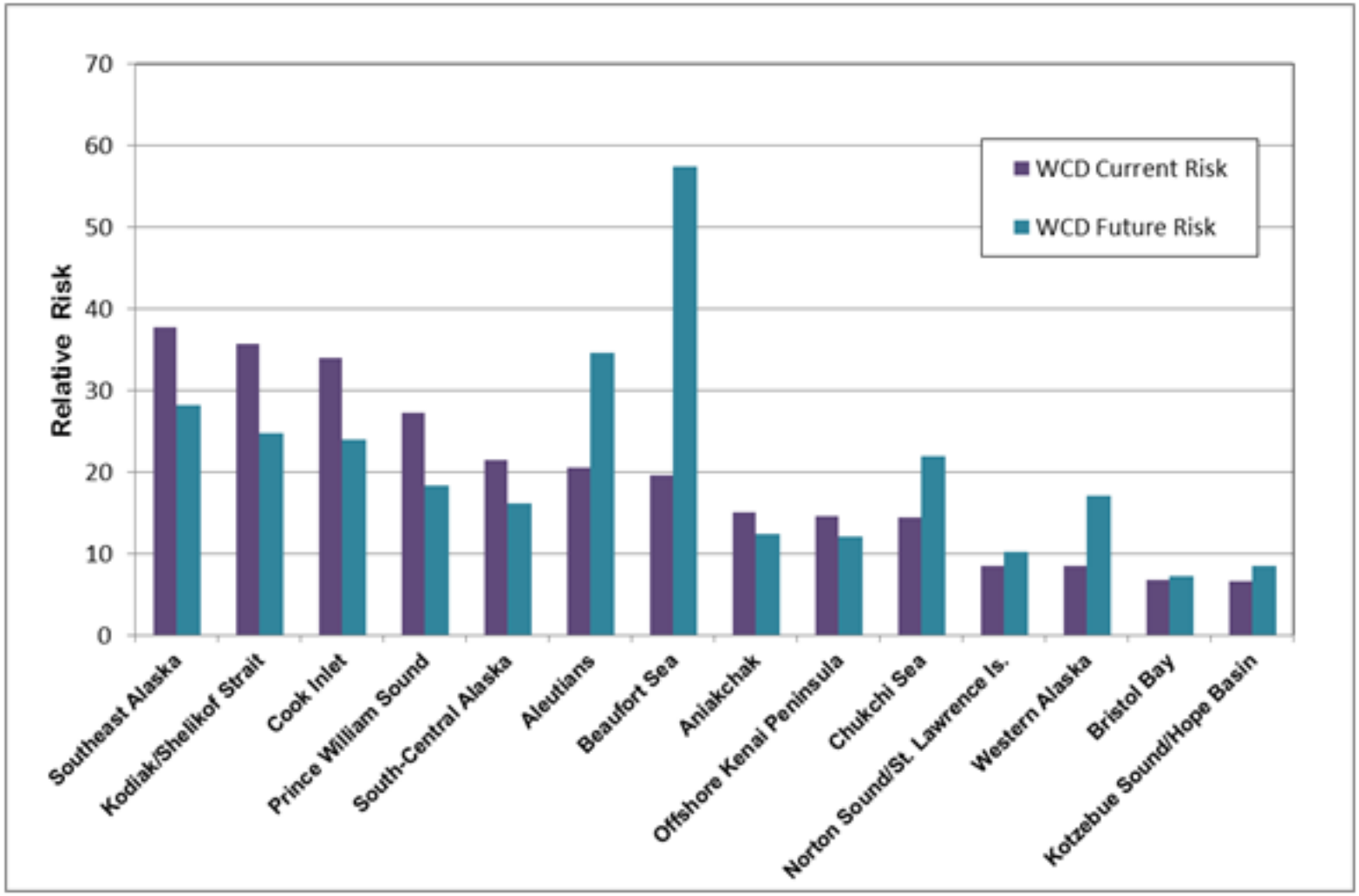
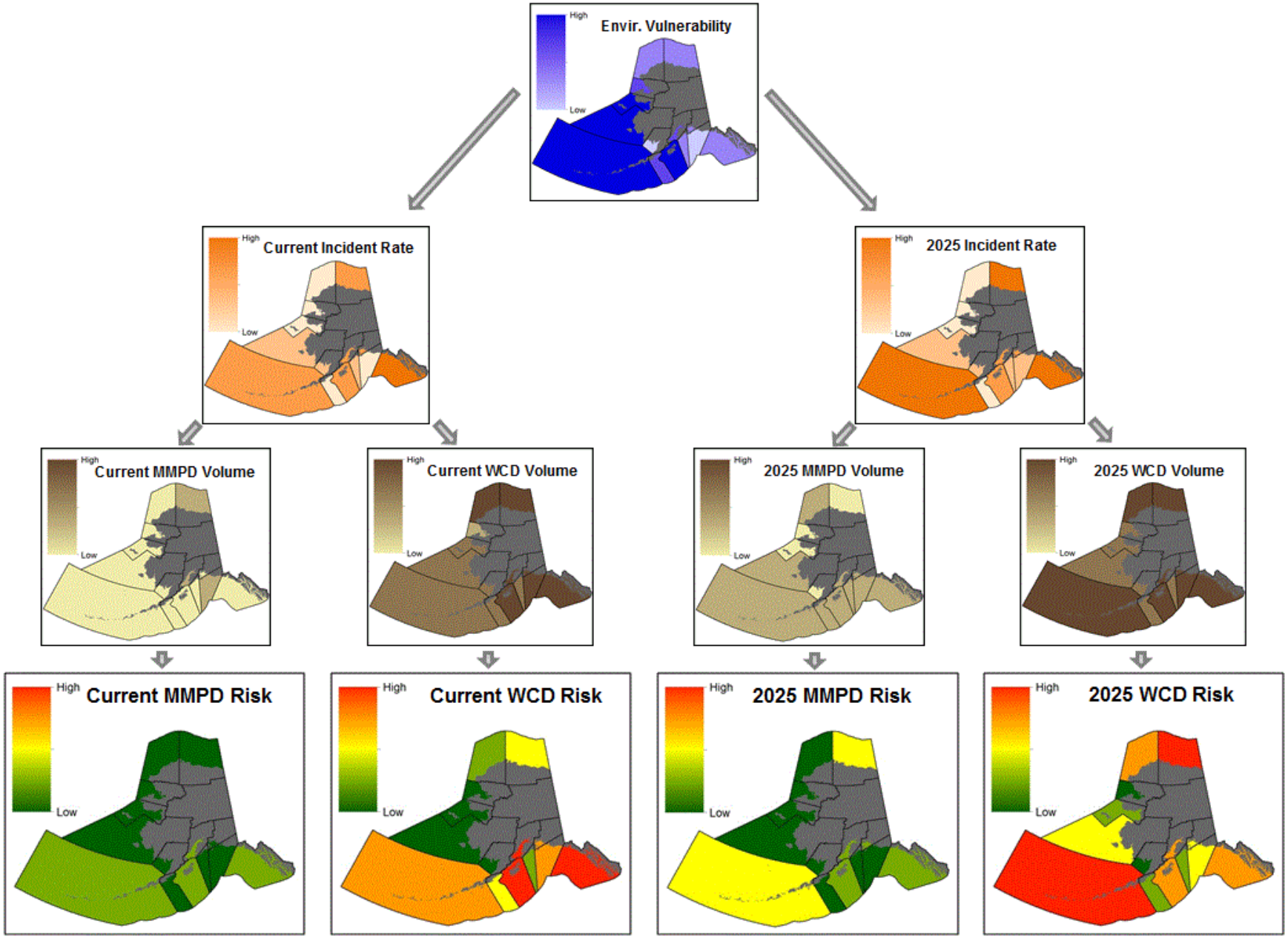
MMPD Risk Results



WCD Risk Results




Envir. Vulnerability
High
Low
Current Incident Rate
2025 Incident Rate
Current MMPD Volume
Current WCD Volume
2025 MMPD Volume
2025 WCD Volume
Current MMPD Risk
Current WCD Risk
2025 MMPD Risk
2025 WCD Risk

Conclusions

- Environmental vulnerability, incident rate, and relative risk scores are typically higher in the summer months than during the winter
  - Due to presence of migratory species and greater vessel traffic activities during the warmer months
- Light and heavy oils are the biggest contributors to risk for the current MMPD, current WCD, 2025 MMPD, and 2025 WCD scenarios on average

Conclusions

- Top 3 highest relative risk regions for each model scenario:

Relative Risk Rank	MMPD Current Risk	WCD Current Risk	MMPD 2025 Risk	WCD 2025 Risk
1	Southeast Alaska	Southeast Alaska	Beaufort Sea	Beaufort Sea
2	Aleutians	Kodiak/Shelikof Strait	Aleutians	Aleutians
3	Kodiak/Shelikof Strait	Cook Inlet	Southeast Alaska	Southeast Alaska

- These regions are recommended for further study to investigate various aspects of the factors constituting risk:
  - spill volume and location
  - location of species and habitats within a region
  - fate and transport of spilled oil

Conclusions

- Benefits of the risk model approach:
  - The various inputs, assessment criteria, and assumptions are explicitly stated and analyzed in a quantitative manner
  - Transparent
  - Objective, repeatable results

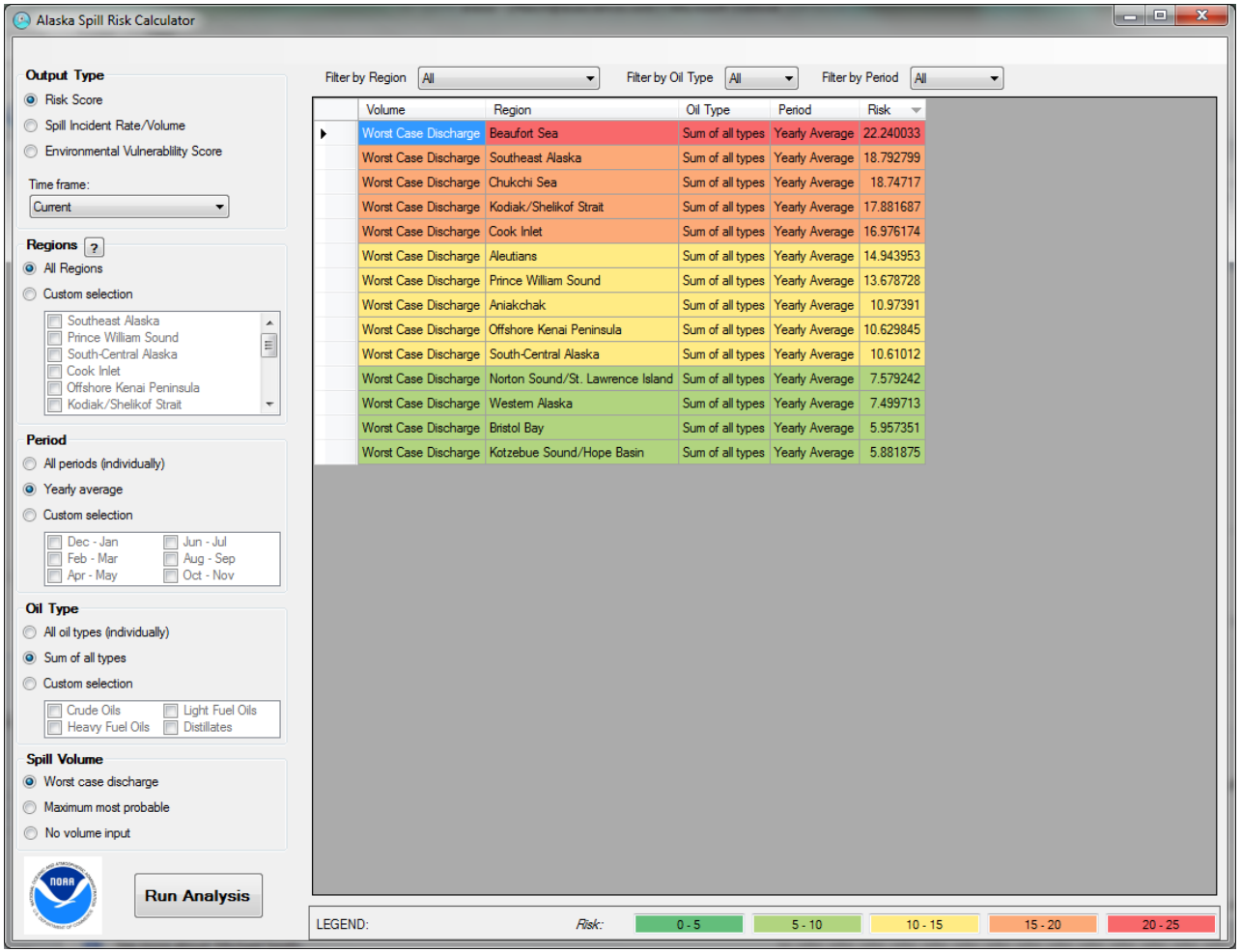
- Despite the inherent limitations of such a broad-scale assessment effort, this study provides valuable information to guide the prioritization of risk planning and further study in Alaska

What next?

- The report, appendices, database and query tool should be available in November 2014.
- If funding were available, it would be ideal to determine trajectories in high risk areas.

Alaska Spill Risk Calculator

- Simple interface to allow user to generate tables of various results
- Can export to text, shapefile, or kml



Questions?

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