ABS Consulting

Presented by
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ABS Group

Arctic Safety and Risk Management
History, Organization, & Management

Presentation Topics

- The American Bureau of Shipping
- Background: Establishing a baseline:
  - Environmental Conditions, Current Activities, and the IMO Polar Code
- Risk Approaches:
  - IMO Formal Safety Assessment
  - U.S. Coast Guard’s National Maritime Strategic Risk Assessment
- Risk Scenarios
- Enhanced Risk: Arctic Risk Factors

ABS in the Arctic: Our Commitment to Safety

Founded in the state of New York in 1862, to certify ship captains. ABS has been involved in development and improvement of safety standards.

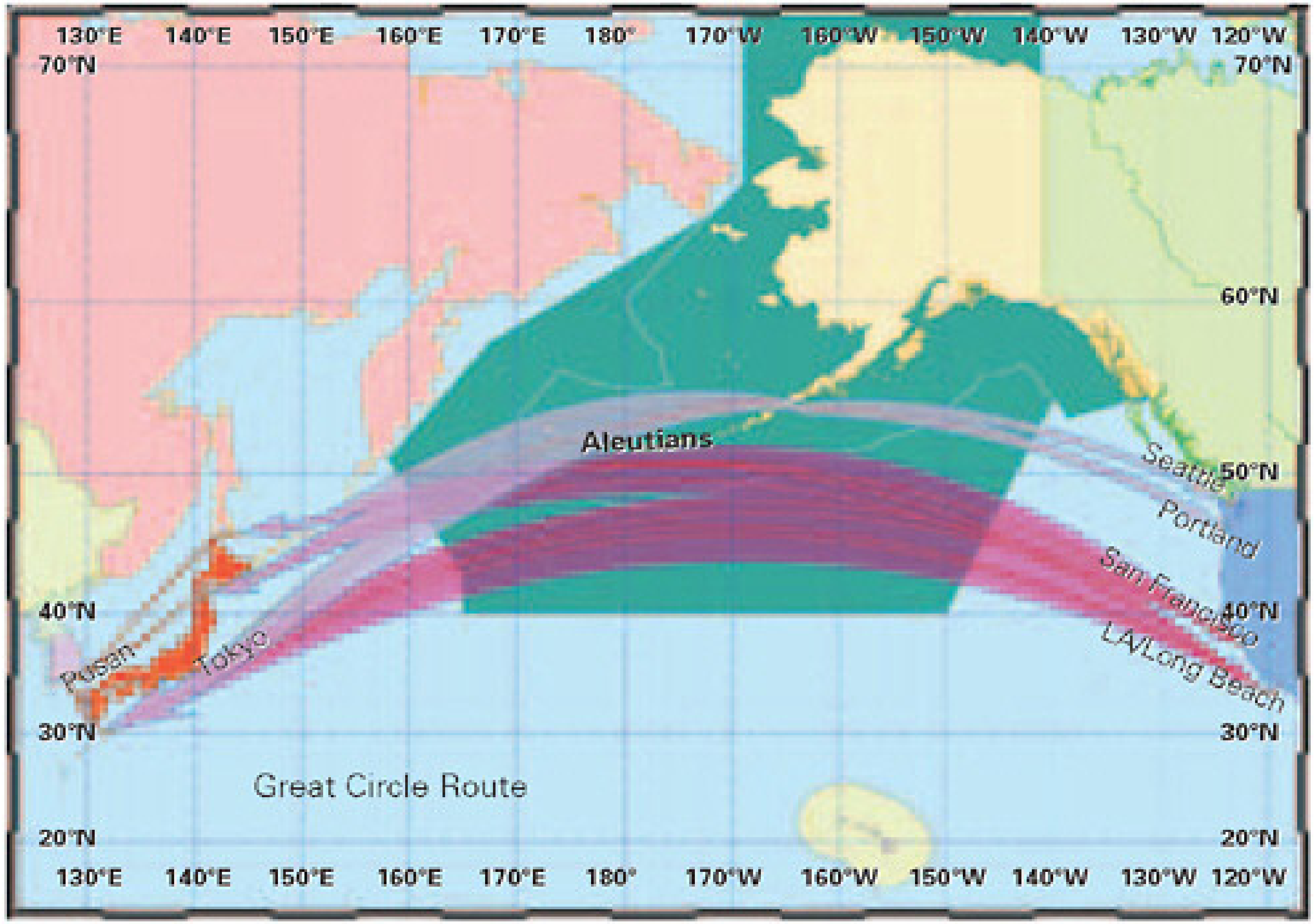
- 1958 – ABS certifies the first Mobile Offshore Drilling Unit (MODU)
- 1968 – ABS issues *Rules for Building and Classing Mobile Offshore Drilling Units*, the first classification Rules specifically for the offshore industry
- 1978 – ABS develops *Requirements for Verifying the Structural Integrity of Outer Continental Shelf Platforms*
  These requirements formed the basis of federal rules governing fixed offshore oil and gas platforms
- 1983 – Rules for MODUs in the Arctic and offshore Classifications
- 1984 – MOLIQPAK built to ABS Class for exploration in Beaufort Sea
- 1985 – Updated Rules for all MODUs to reflect increased safety standards
  Based on these standards, a MODU should be able to endure the severe multiyear ice of the North American Arctic
- 1999 – MOLIQPAK refitted under ABS Class for service in Russia’s Sakhalin I Field
- 2003 – ABS-Classed Glomar Beaufort Sea 1 refitted to ABS Class and moved offshore to Sakhalin Island, Russia
- 2006 – ABS publishes *Guide for Vessels Operating in Low Temperature Environments (*updated 2011, 2012, 2014 for industry input and technological advances)
- 2009 – ABS establishes the Harsh Environment Technology Centre at Memorial University of Newfoundland
- 2009 – ABS establishes Arctic Technical Advisory Committee
- 2011 – Developed the ABS Arctic Class
- 2011 – ABS publishes *Guide for Ice Loads Monitoring Systems*
- 2014 – ABS publishes *Advisory for Navigating Northern Sea Route*

ABS Arctic Teams: Technology & Policy

Policy Team: Works with regulators in Washington, D.C. to craft and evaluate new or proposed standards and their development

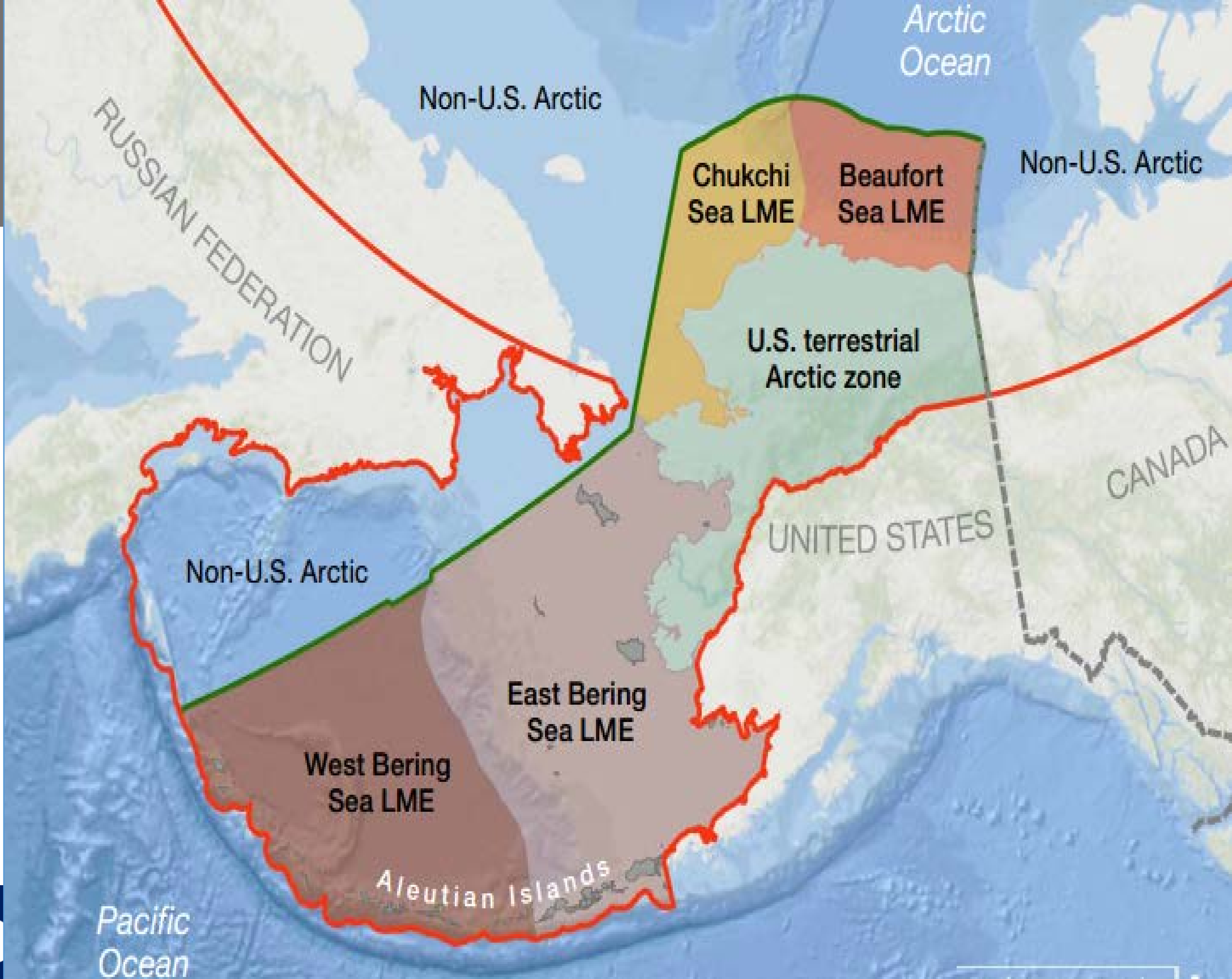
- 2008 – Signs a Memorandum of Understanding (MOU) between ABS, ABS Group, and USCG to develop Arctic research partnership
- 2010 – Conducts a High Latitude Mission Analysis for the USCG, including updating the existing “Polar Ice Operations” Mission Analysis Report (MAR)
- 2011 – Adapts and extends the CG Tactical Modeling Environment (CGTME) to include an Arctic Tactical Modeling Environment
- 2011 – Analyses the operational effectiveness and suitability of the TACSAT-4 UHF satellite to provide beyond line of site satellite communications to USCG land-, sea-, and air-based assets related to Arctic Shield 2012
- 2011 – Conducts a Hazard Identification for MODUs operating in the U.S. Arctic and risk-based scenario development
- 2012 – Develops a Business Case Analysis to determine acquiring Polar Presence Options in our 2012 Polar Icebreaker Business Case Analysis
- 2013 – Researches and reviews technologies for performance and readiness to support CG Arctic operations in the near future
- 2013 – Conducts a Formal Safety Assessment (IMO guidelines) to develop relevant accident scenarios and affected vessel populations to assess effectiveness and make recommendations for risk management decision makers.
- 2014 – Creates a present day baseline incident rates and environmental conditions in the Arctic
- 2014 – Creates a projected forecast of vessel activity in the Arctic and compares incident rates, environmental and safety impacts with our established baseline
- 2015 – Conducts a quantitative Risk Assessment and evaluation of the environmental benefits of the Draft Polar Code requirements.
- 2015 – Identifies data elements and processes for Arctic monitoring and risk-based decision making for Arctic drilling requirements for BSEE
- 2015 (Expected) – Conduct a Risk Assessment of Arctic drilling operations and the emergent technologies

Boundaries: The Lower U.S. Arctic



Nuka Research and Planning Group, 2006

Boundaries: NOAA's LME



NOAA's Arctic Action Plan, 2014

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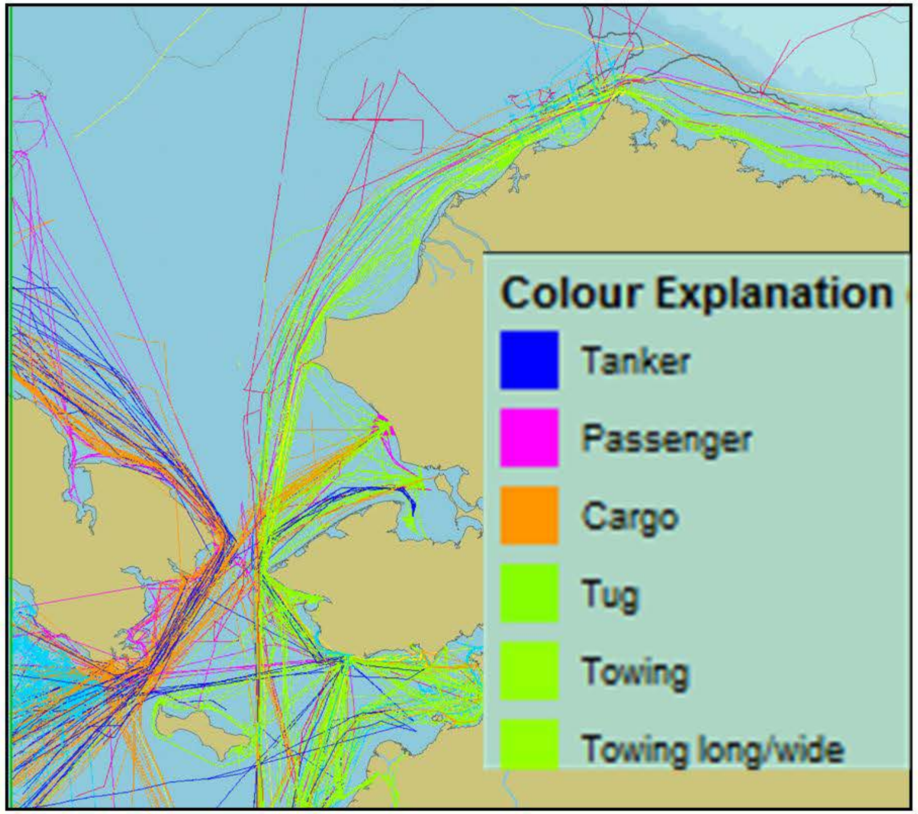
U.S. Arctic Vessel Traffic

Variations in Vessel Traffic

Bering Strait Arctic Vessel Traffic

01 JUN to 30 NOV 2013



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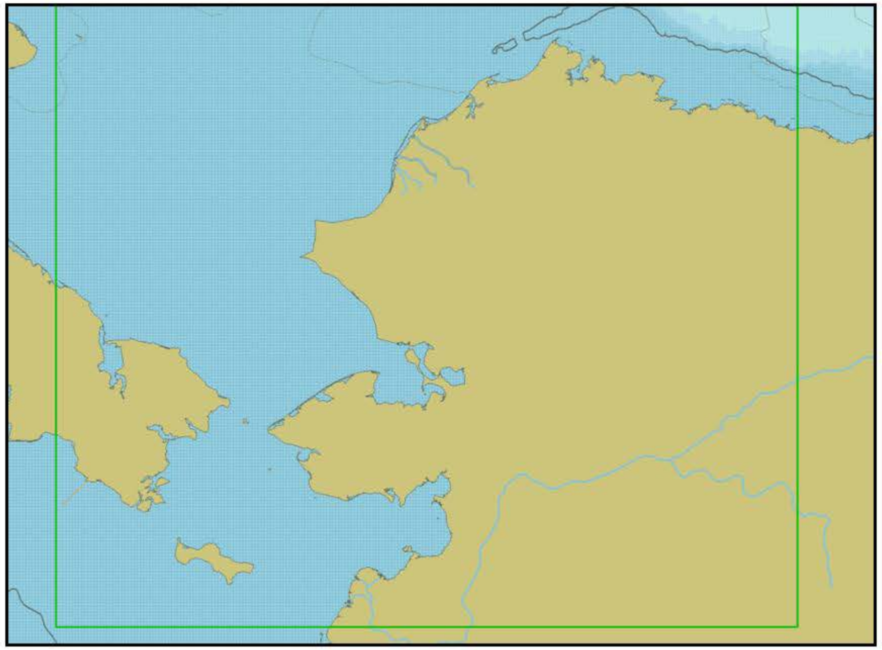


AIS Data Courtesy of Marine Exchange of Alaska

Capt. Mauger, USCG, CG-ENG, CMTS webinar, 24 Feb. 2015

Changes in the Arctic

Climate Change
- Warmer Waters
- Reduced Sea Ice Coverage
- Changing Ecosystem

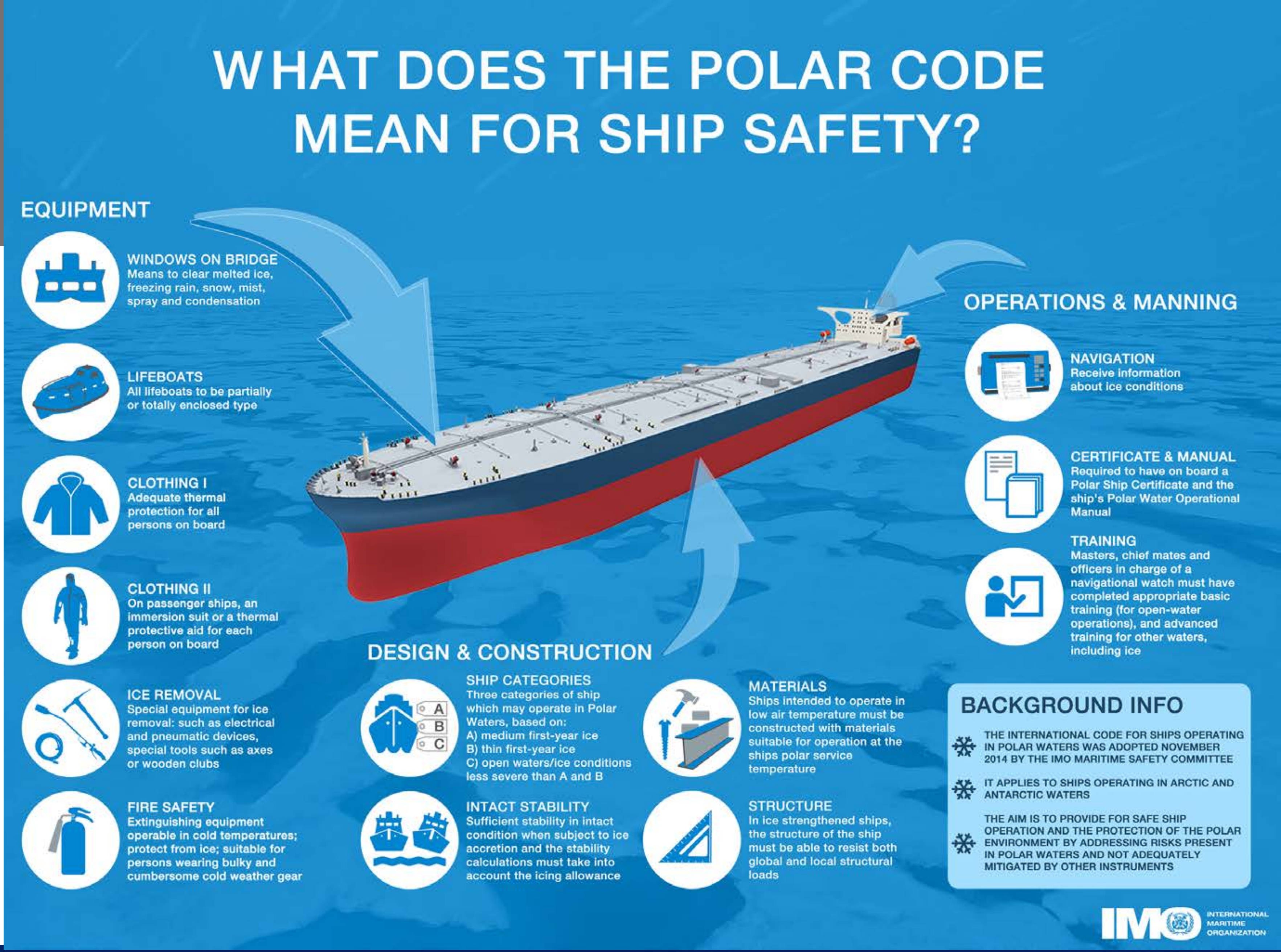
Increased Maritime Activities
- Increased Shipping (Cargo and Passenger)
- Oil, Gas and Mineral Exploration and Production
- Increased Commercial Fishing

Potential Impacts
- More Maritime Accidents
- More Water & Air Pollution
- More Response Needs (SAR & Pollution)
- Ecosystem Effects

The Polar Code

- Applies to ships travelling internationally above the 60^{th} parallel
- Collection of Amendments to:
  - The International Convention for the Prevention of Pollution From Ships (MARPOL)
    - Prevention of pollution by
    - Control of pollution by noxious liquid substances
    - Prevention of pollution by sewage from ships
    - Design and Construction
  - The International Convention for the Safety of Life at Sea (SOLAS)
    - Personnel Equipment
    - Operations & Manning
    - Navigation

The Polar Code



Creating a Baseline: Environmental Conditions

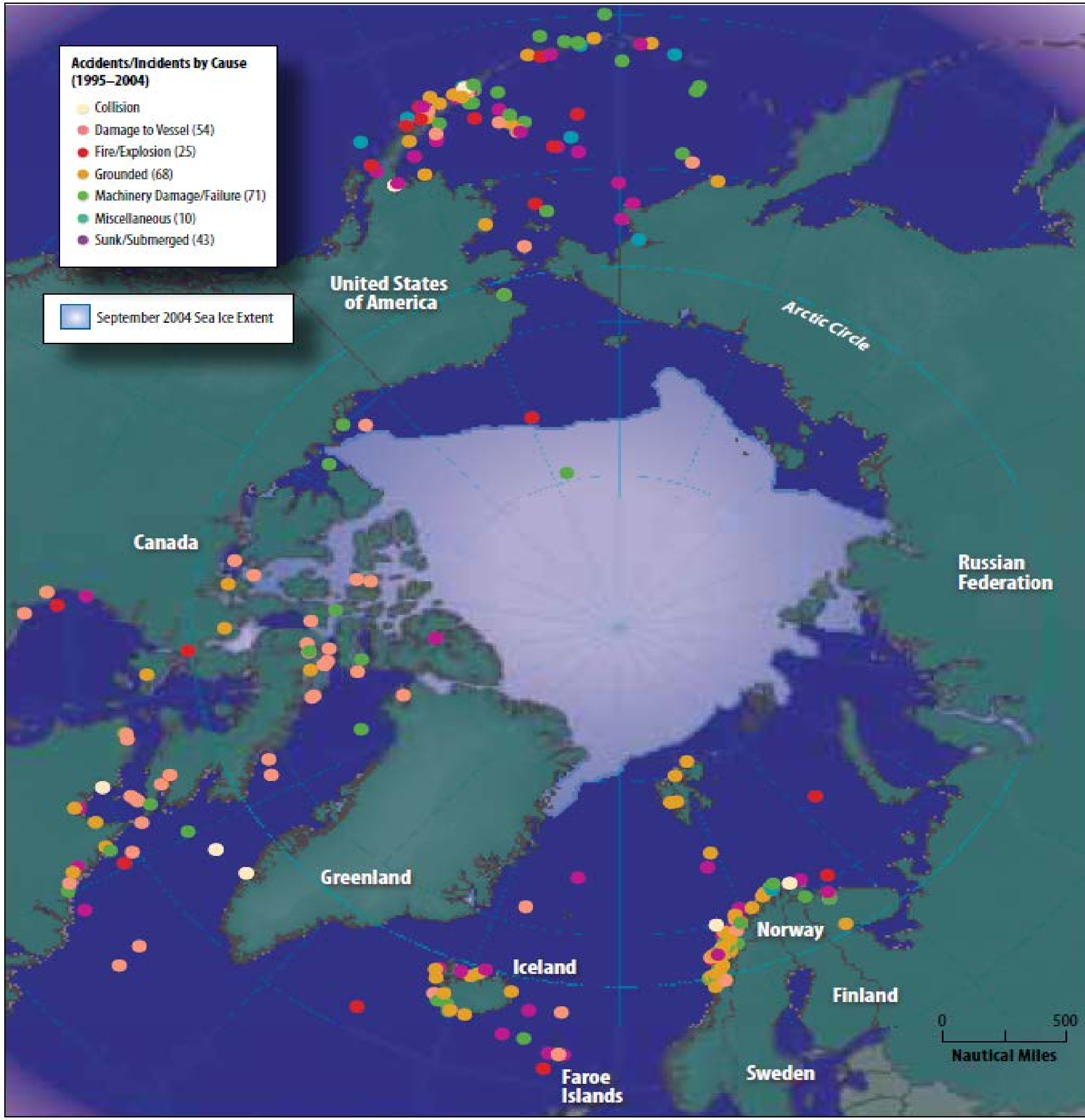
- *Wind/Sea-state*: The predominant summer winds in the U.S. Arctic Ocean are from the east and northeast, with speeds of 8 to 21 knots. There is a seasonal increase in wind speeds starts in June, and progresses northward from July to October.
- *Temperature*: The average surface air temperature will be assumed around 10°C (50°F). The average water temperature ranges between 2° to 5°C (35°F to 41°F).
- *Ice conditions*: During the summer, the Beaufort and Chukchi Seas experience a period of open water lasting approximately three months in the Beaufort Sea (August to October) and four months in the Chukchi Sea (July to October).

Creating a Baseline: In Case of an Emergency

- Lack of infrastructure
  - Lack of deepwater ports
  - Lack of places of refuge
  - Lack of marine salvage
  - No adequate port reception facilities for ship-generated waste and towing services
- Limitation of Operational Assets (Icebreaking, SAR, and pollution response);
- Remoteness/high latitude and evacuation;
- Lack of charting and hydrographic data;
- Limitations of navigation aids; and
- Difficulty of detecting ice using radar.

Accidents in the Arctic (1995 – 2004, Lloyd’s)

- Accident History in the Arctic is a small sample size
- ABS Consulting developed the following incident rates:
  - CONUS
  - Alaska
  - U.S. Arctic
  - High Arctic
- Comparing the rates, we extrapolate what a likely increase in the future may be.



Map 5.7 Arctic shipping accidents and incidents causes, 1995-2004. *Source: Lloyd's Marine Intelligence Unit Sea Searcher Database, Canadian Transportation Safety Board (Marine), Canadian Hydraulics Centre- Arctic Ice Regime System Database.*

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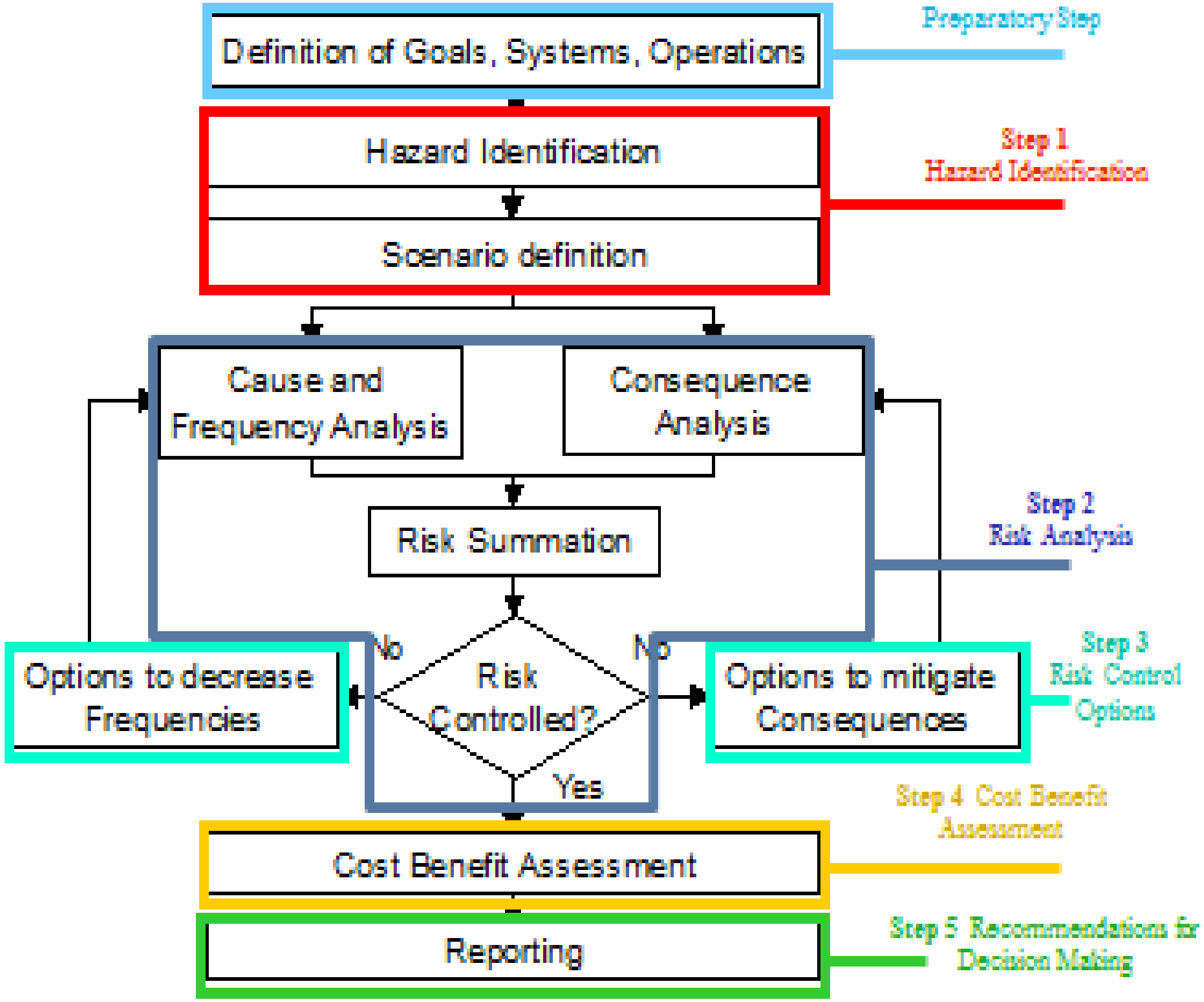
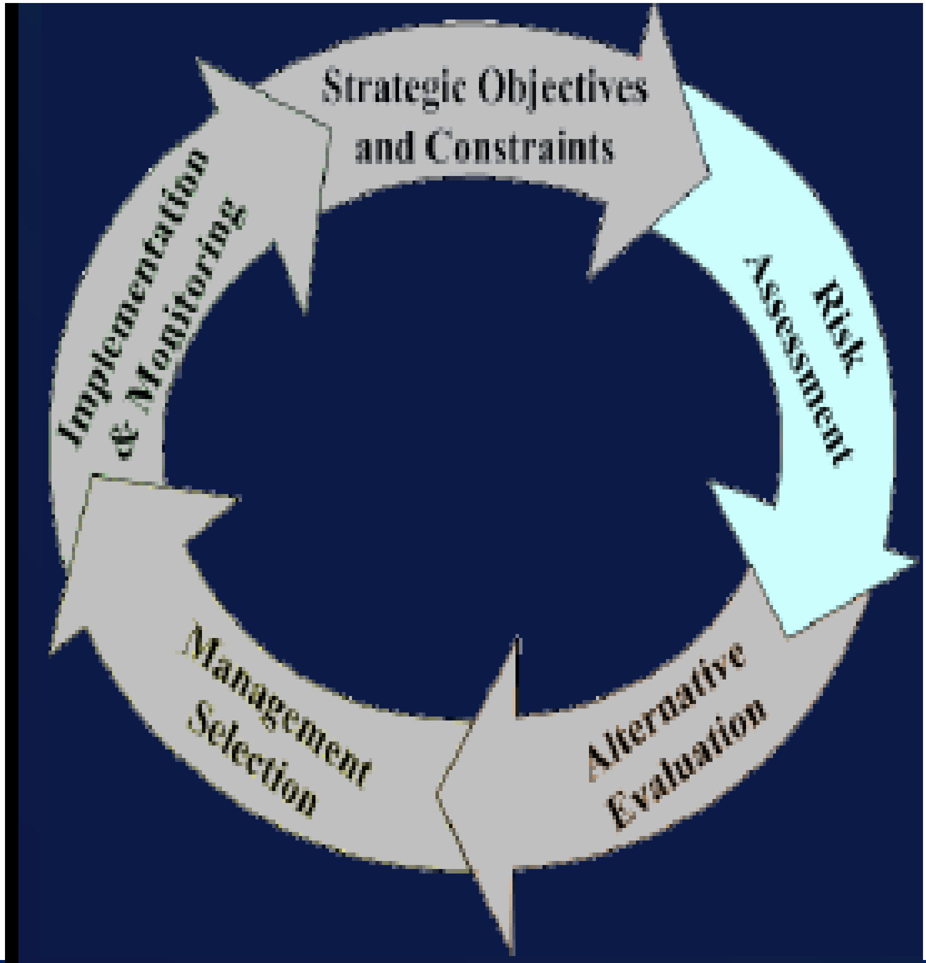
Risk Approaches: IMO FSA

- IMO FSA
  - 5 Step Process:
    - Hazard Identification
    - Risk Analysis
    - Risk Control Options
    - Cost Benefit Assessment
    - Recommendations for Decision-making



Risk Approaches: USCG NMSRA

- USCG National Maritime Strategic Risk Assessment (NMSRA)
  - Risk Assessment
    - Threat x Vulnerability x Consequence = Risk
  - Alternative Evaluation
  - Management Selection
  - Implementation and Monitoring
  - Strategic Objectives and Constraints



Frequency * Consequence = Risk

Frequency Index			
FI	Frequency	Definition	F (per ship year)
7	High	Likely to occur once per month on one ship	10
5	Medium	Likely to occur once per year in a fleet of 10 ships, i.e. likely to occur a few times during the ship's life	0.1
3	Low	Likely to occur once per year in a fleet of 1,000 ships	10^{-3}
1	Remote	Likely to occur once in 10 years in a fleet of 1,000 ships	10^{-5}

Severity Index				
SI	Severity	Effects on Human Safety	Effects on Ship	S (Equiv. fatalities)
1	Minor	Single or minor injuries	Local equipment damage	0.01
2	Signifi-cant	Multiple or severe injuries	Non-severe ship damage	0.1
3	Severe	Single fatality or multiple severe injuries	Severe damage	1
4	Cata-strophic	Multiple fatalities	Total Loss	10

Risk Matrix					
		Severity			
		1	2	3	4
Frequency		Minor	Significant	Severe	Catastrophic
7	High	8	9	10	11
6		7	8	9	10
5	Medium	6	7	8	9
4		5	6	7	8
3	Low	4	5	6	7
2		3	4	5	6
1	Remote	2	3	4	5

NMSRA Frequency

Frequency Category	Description	Value
Continuously	> 550 events per year	730
Daily	210 to 550 events per year	365
Weekly	32 to 210 events per year	52
Monthly	8 to 32 events per year	12
Quarterly	3 to 8 events per year	4
Annually	1 to 3 events per year	1
Decade	1 event every 2 to 20 years	0.1
Half-century	1 event every 20 to 70 years	0.02
Century	1 event every 70 to 180 years	0.01
Millennium	1 event every 180 or more years	0.001

Incident Types

- Allision/Grounding
- Collision
- Crane Accident
- Diving Accident
- Electrical Failure
- Explosion
- Fire
- Helicopter Accident
- Loss of Position
- Loss of Stability
- Man Over-Board
- Mechanical Failure
- Work-related Injury

Hazards of the Arctic

- Survivability
  - Lack of Infrastructure
  - Difficulty of Evacuation
  - High Latitude and Remoteness
  - Lack of Charting and Hydrographic Data
  - Limitations of Navigation Aids
  - Limitations of Communications Systems
  - Difficulty of Detecting Ice using Radar
- Environmental Conditions
  - Surface Air Temperature
  - Low Temperature (Air and Water)
  - Weather
  - Polar Lows
  - Winds
  - Hurricanes and Storms
  - Wave Heights
  - Sea Ice
  - Ice Load Considerations
  - Changing Nature of Sea Ice
  - Icebergs/Growlers/Ice Islands
  - Optical Phenomena and Fog
- Wildlife
- Explosive Sources

Scenario Development:

Arctic Hazards

Hazard Type	Definition and/or Meaning
Sea Ice	Ice That Floats On The Ocean's Surface. Ice Volume (I.E. Thickness) Is Often A Function Of The Age Of The Ice.
Wind/Waves	Severe Wind And Waves Formed As A Result Of The Unique Arctic Climate.
Ice Accretion	Ice That Builds Up On Exposed Surfaces As A Result Of Extremely Cold Temperatures And High Moisture Content Or Wind-driven Ocean Spray.
Limited Mobility	Inhibited Mobility And Dexterity As A Result Of Additional Layers Of Clothing Being Worn By Personnel In The Extreme Arctic Climate.
Extreme Cold	Arctic Temperatures That Occasionally Drop So Low That Ship Crews And Equipment Have Operational And Mechanical Difficulties, Respectively.
Extreme Motion	Severe Rolling And Pitching On Vessels As A Result Of High Winds And Waves In The Arctic.
Data And Charts	The Lack Of Arctic Navigational Documentation Such As Depth Charts And Accurate Maps As Well As Limited Bathymetric Data.
Crew Fatigue	Sleep Deprivation And Muscle Soreness That Develops Over Erratic Crew Shifts From Long Days And Nights Associated With Certain Arctic Seasons.
Poor Visibility	Inhibited Visibility As A Result Of Common Arctic Weather Conditions Such As Fog.

Arctic Conditions

- Arctic Species
- Cold Flow
- High Latitude - Human Factors
- High Latitude - Remoteness
- High Latitude - Weather
- Ice Accretion
- Low Air Temperature
- Low Water Temperature
- Rapidly Changing Weather Conditions
- Sea Ice
- Vessel Congestion
- Vessel Remoteness

ABS Consulting Arctic Vessel Types

- Commercial Fishing Vessels
  - Defined by IMO as any vessel used commercially for catching fish, whales, seals, walrus of any other living resource of the sea.
- Commercial Freight Vessels
  - Defined by IMO as a vessel intended primarily to carry dry cargo in bulk, including types such as ore carriers and combination carriers.
- Passenger Vessels
  - Defined by IMO as a vessel that carries more than twelve passengers.
- Mobile Offshore Drilling Unit (MODU)/Drillship and Support Vessels
  - Defined by IMO as a vessel that is capable of engaging in drilling operations for the exploration or exploitation of resources beneath the sea-bed such as liquid or gaseous hydrocarbons, sulfur or salt.
  - Included are any ships dedicated to supporting drilling operations.

NMSRA Modeling: Consequence Equivalency Matrix

NMSRA Impact Types				
Civil Order	Direct Economic Impact	Impacts of Maritime Security	Maritime Mobility, Recovery and Commerce	Secondary Economic Impact
Death and Injury	Environmental	Law Enforcement-Related Impacts	National Security	Symbolic

Impact Types	Category 0	Category 1	Category 2	Category 3	Category 4	Category 5	Category 6	Category 7	Category 8	Category 9
	0	1.729	5.188	6.3	22.05	47.25	343	3,462	34,647	346,497
Death and Injury	No deaths; Injuries that are not life-threatening	No deaths; 1 life-threatening injury	No deaths (for non-PWCS incidents: 1-5 life threatening injuries)	1 death and others with life-threatening injuries	2 to 5 deaths and others with life-threatening injuries	6 to 9 deaths and others with life-threatening injuries	10 to 99 deaths and others with life-threatening injuries	100 to 999 deaths and others with life-threatening injuries	1000 to 9,999 deaths and others with life-threatening injuries	10,000 to 99,999 deaths and others with life-threatening injuries
	Category 0	Category 1	Category 2	Category 3	Category 4	Category 5	Category 6	Category 7	Category 8	
	0	0.155	1.65	16.5	165	1,650	16,500	165,000	1,650,000	
Direct Economic Loss (Including Property Damage)	<$10,000 in damage/loss	$10,000 to $299,999 in damage/loss	$300,000 to $2.9 million in damage/loss	$3 million to $29 million in damage/loss	$30 million to $299 million in damage/loss	$300 million to $3 billion in damage/loss	$3 billion to $29 billion in damage/loss	$30 billion to $299 billion in damage/loss	≥$300 billion in damage/loss	
Secondary Economic Loss			Minimal impact on local economy	Minor impact on local economy	Moderate impact on local economy	Major impact on local economy				
	No impact on economy				Minor impact on regional economy	Moderate impact on regional economy	Major impact on regional economy			
							Minor impact on national economy	Moderate impact on national economy	Major impact on national economy	

ARMF NMSRA Consequence Categories

- **Death and Injury**: the number of life-threatening injuries and deaths associated with an incident.
- **Primary Economic:** direct economic loss(es) associated with an incident, such as vessel damage.
- **Secondary Economic:** the impact on the local, regional, and/or national economy.
- **Marine Mobility**: the impact of an incident on vessel traffic and/or port commerce.
- **Environmental**: the impact of an incident on marine species and/or the release of Hazardous Materials (HAZMAT) and/or oil.
- **National Security**: the impact of an incident on tactical assets, National Security Strategy, and/or military outload.
- **Maritime Security:** Exclusive Economic Zone (EEZ) encroachment.

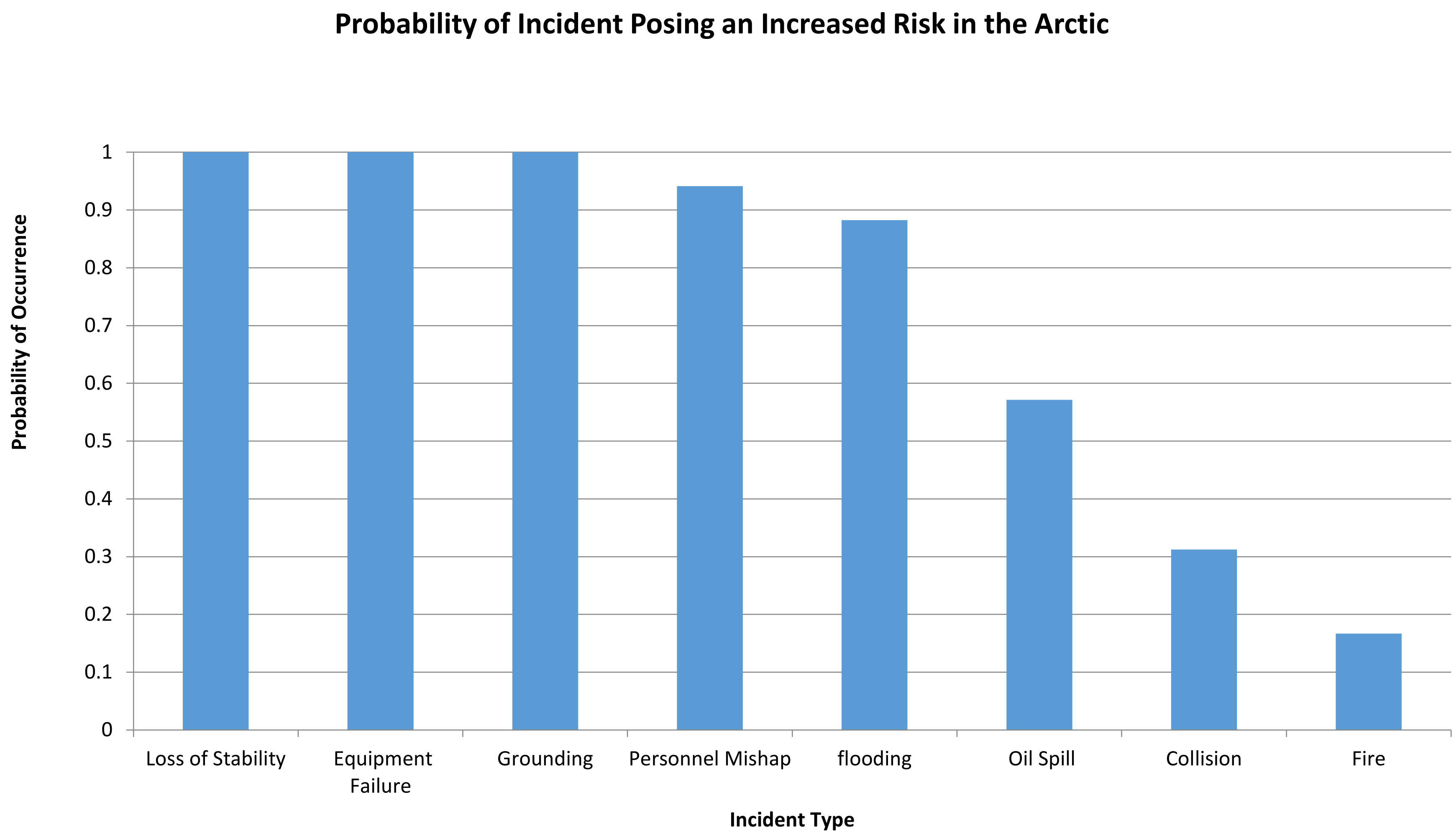
Arctic Hazard Scenario Development

Sector	Sub-Sector	Causal Factor	Incidents	Leading to
		Cold	Explosion	Pollution
Fishing	Commercial Fisherman	Ice Accretion - Topsides	Fires	Injuries
	Subsistance Fisherman (Tribal)	Sea Ice	Flooding	Deaths
	Recreational Fisherman	Wind/Waves	Capsize	Property Damage
		Fatigue	Collision	Environmental Impact
Shipping	Petroleum	Maintenance	Allision	Economic Effects
	Bulk	Design	Spills	
	Break-bulk	Congestion/Restricted Seaway	Falls	
	Container	Navigation	injuries	
	RO-RO	Hydrology/Bathymetry	Loss of Propulsion	
			Mammal Strike	
Mineral Extration	Oil/Gas Fixed		Blow-out	
	Oil/Gas Floating		Mechanical Failure	
	Dredge			
Passenger Tourism	Recreational (<30 PAX)			
	Small			
	Large			

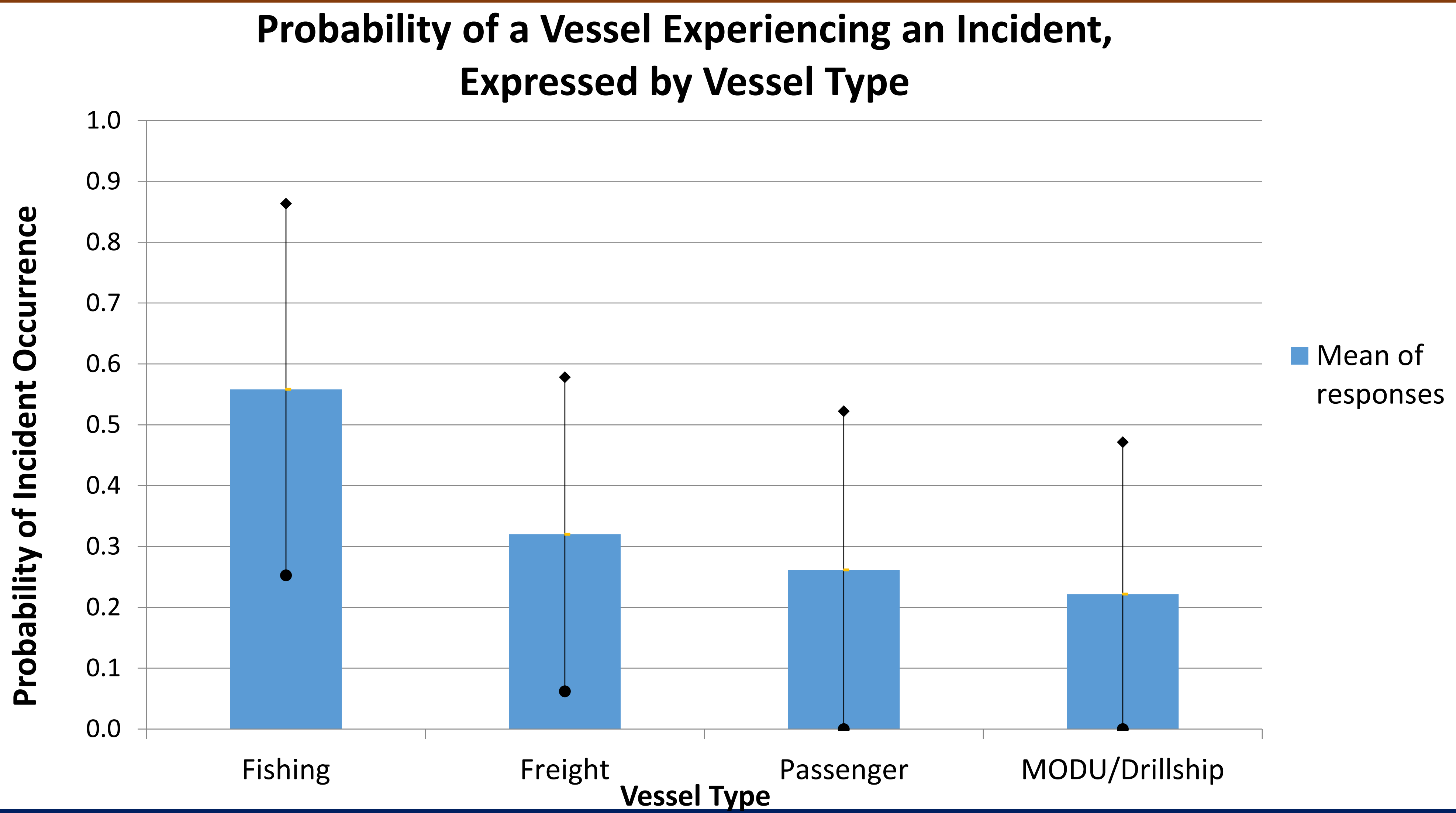
IMO FSA Arctic Hazard Scenarios Examples

Accident Class	Accident Scenario	Arctic Condition	Arctic Influencing Factor	Influencing Factor	Initiating Event	Scenario Example
Collision	Detection system failure associated with Unchartered waters due to High Latitude - Human factors leads to Collision	High Latitude – Weather	Heavy Seas	Vessel Congestion	Detection System Failure	Lack of navigation experience in unknown waters and heavy vessels congestion leads to a collision.
Crane Accident	Structural failure from Overloading the crane from Ice accretion due to Low temperature leads to Crane accident	Low temperature	Ice accretion	Cold Flow	Structural failure (Overload)	The crane attempts to lift a payload marked as one weight but due to ice accretion, has exceeded the safety requirement of 75% of the crane weight or less and causes the structural failure of the crane.
Diving Accident	Attack on diver/system by Arctic Species leads to Diving accident	Arctic Species			Attack on diver/system	While on a dive, the diver is attacked by a polar bear.
Electrical Failure (Systems/ Components)	Material Embrittlement associated with improper material selection and prolonged cold exposure due to low temperature leads to Electrical failure (Systems/Components)	low temperature	improper material selection and prolonged cold exposure	Cold Flow	Material Embrittlement	Use of plastics or other materials not adequate for use in cold temperatures leads to electrical casing shrinking and cracking, leading to electrical short
Explosion	Explosive vapor build up associated with Increased enclosed areas due to Low temperature leads to Explosion	Low temperature	Increased enclosed areas	Reduced Ventilation	Explosive vapor build up	Due to increased enclosed space, the resulting decreased ability to vent and circulate, allows explosive vapors to build up in larger areas, increasing the likelihood of being near a spark, resulting in an explosion.
Fire	Overheating associated with Freezing due to Low temperature leads to Fire	Low temperature	Freezing	Workplace hazard	Overheating	A portable heater is used near a flammable source (i.e. blanket), which catches on fire.
Helicopter Accident	Loss of aircraft stability associated with Rapidly changing weather due to High latitude - Weather leads to Helicopter Accident	High latitude - Weather	Rapidly changing weather		Loss of helicopter stability	Due to high levels of particulate fragmentation of air parcels and creation of localized Hadley cells, the turbulence creates unsafe conditions to fly a helicopter resulting in the inoperability of the helicopter or an accident while in operation.

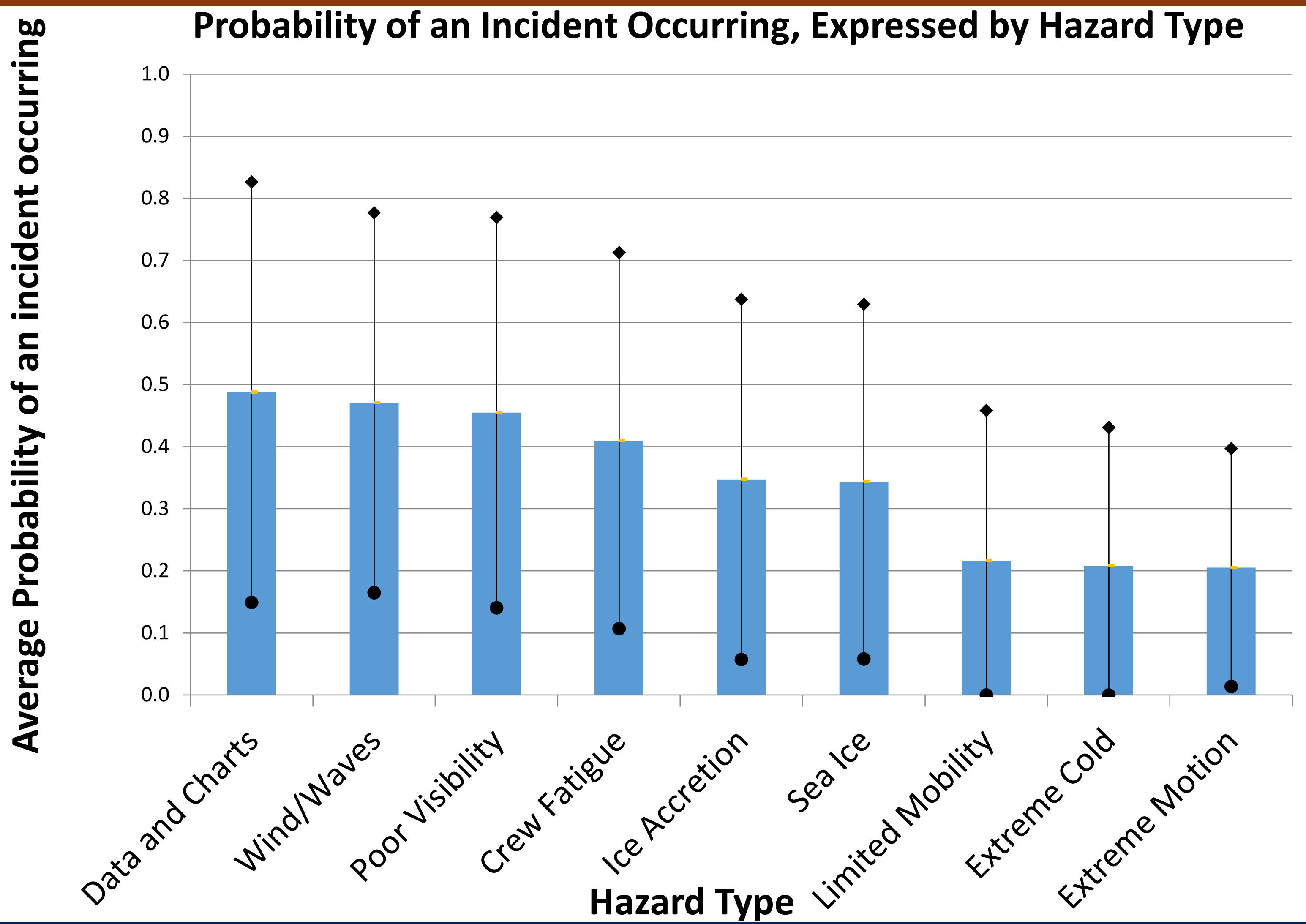
ARMF SME Results: Probability of Incident – Baseline Comparison



ARMF SME Results: Probability of Incident - by Vessel Type



ARMF SME Results: Probability of Incident – by Hazard



The range is one standard deviation from the mean probability to show the regularity of the distribution

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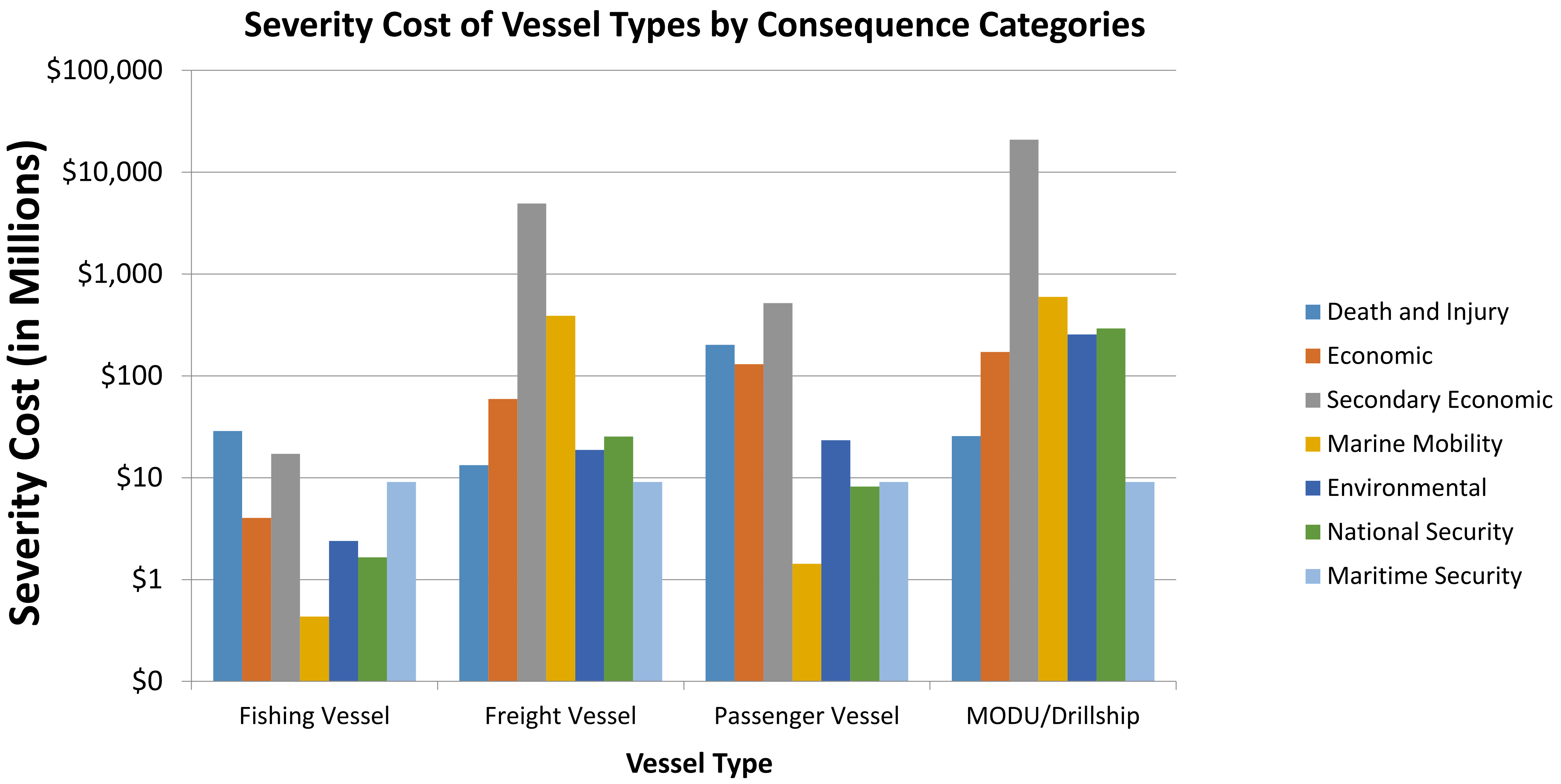
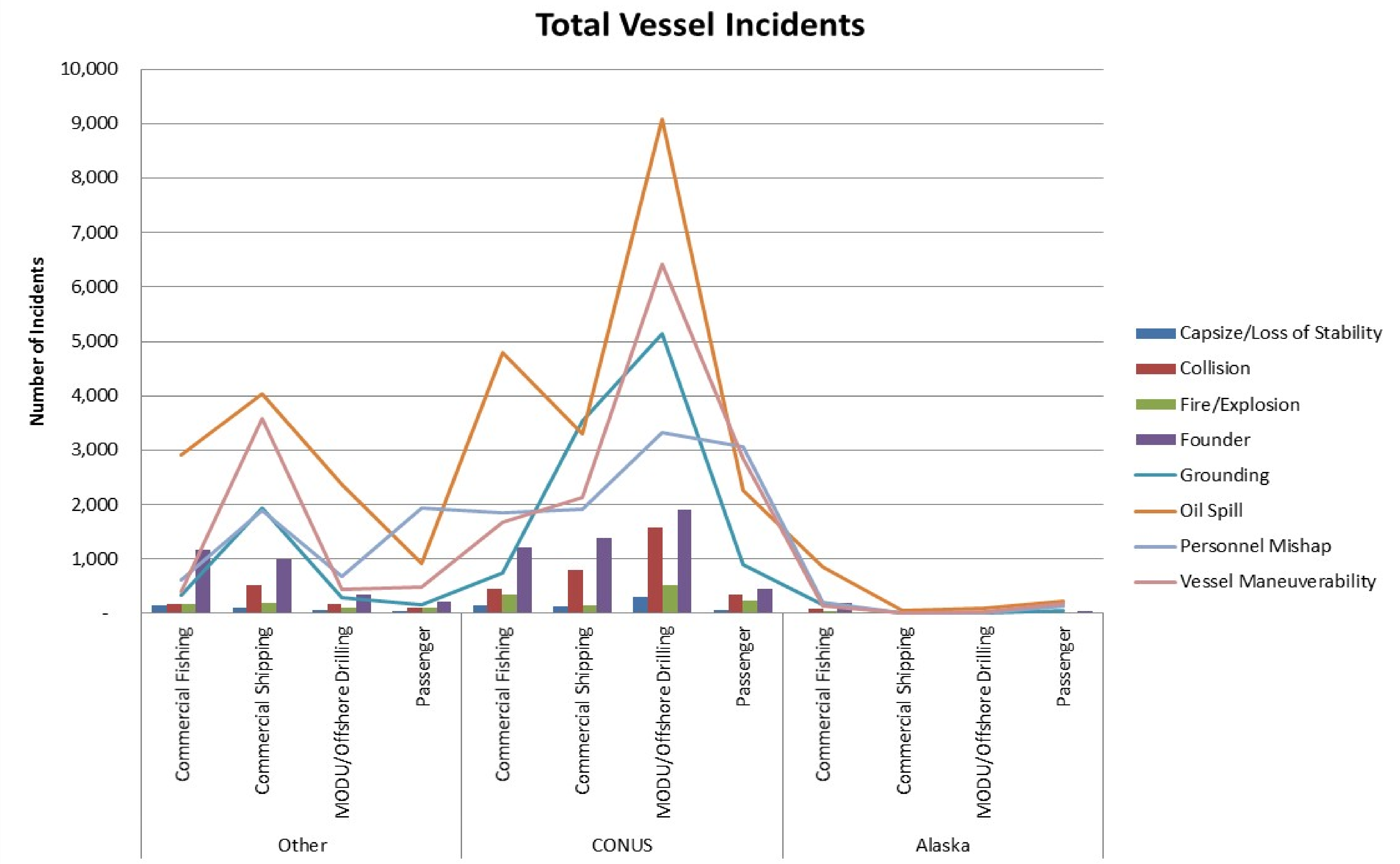
ARMF SME Results: Severity of Incident – Vessel Types



ARMF Incidents



ARMF Approach SME Findings: General

- Arctic Maritime Activities were believed to present an increased likelihood of incidents occurring compared to a non-Arctic baseline in all incident types except for collision and fire.
- Incidents most likely occur: loss of stability, equipment failure and groundings.
  - Groundings had a significantly higher mean probability of posing an increased risk in the Arctic relative to a non-Arctic baseline relative to other incident types.
- Inadequate data and charts may be main cause of an incident than other Arctic hazards
  - Other hazards of concern were wind and waves, poor visibility and crew fatigue.
- Fishing vessels most likely to experience an incident among the four vessel types considered.
  - Predicted to experience the least severe consequences per incident, although deaths and injuries are expected to be more likely to occur on these vessels than any other vessel type.
- Passenger Vessel consequences (costs) of incidents are driven by the potential for deaths and injuries.
  - A catastrophic incident for a Passenger Vessel may result in significant loss of life. This severity category exhibited the widest variance among the expert's estimates.
- MODUs/Drillships consequences are significantly greater than those associated with incidents on any other vessel type.
  - The consequences (costs) are driven by the potential secondary economic effects. Presumably this estimate reflects the potential ramifications of an incident on the entire offshore industry.
- Secondary Economic Effects are significant contributors of impact costs associated with Freight Vessels.

ARMF Approach Findings: By Vessel Types

- **Fishing vessels** had a higher estimated mean probability of incident occurrence in every incident type category. This result was reasonable considering the high quantity of fishing vessels potentially operating in the Arctic relative to freight, passenger, and MODU vessels. Moreover, SMEs likely perceived fishing vessels as more vulnerable compared to other vessel types because of their size and relatively lenient personnel experience requirements. However, the consequences associated with incidents on fishing vessels were typically rated lower than other incidents. This is likely due to the smaller exposures related to crew sizes and fuel capacities on fishing vessels compared to other vessel types.
- **MODUs/Drillships** had the second-highest estimated mean probability of being involved in a personnel mishap-related incident caused by limited mobility (mean of 0.194) or wind/waves (mean of .381). MODUs/drillships had a lower estimated mean probability of being involved in an ice accretion-related incident than being involved in a limited mobility-related incident since crew members aboard MODUs frequent the deck space and would presumably be exposed to ice accretion on a regular basis in the Arctic.
- MODUs generally had a lower probability of incident occurrence than the other vessel types due to the stable nature of the structure and strict requirements associated with the vessel type and oil exploration operations in the Arctic. Lack of vessel travel likely impacted MODU/drillship probabilities involving "Loss of stability/capsize," "Groundings," and (to a lesser extent) "Flooding."
- **Freight vessels** had the highest estimated mean probability of a personnel mishap-related incident occurring related to wind/waves. Conversely, these vessels had the lowest estimated mean probability of a personnel mishap-related incident occurring related to ice accretion.
- **Inadequate data & charts** had the highest estimated mean probability of occurrence relative to other hazard types for freight vessels and passenger vessels.