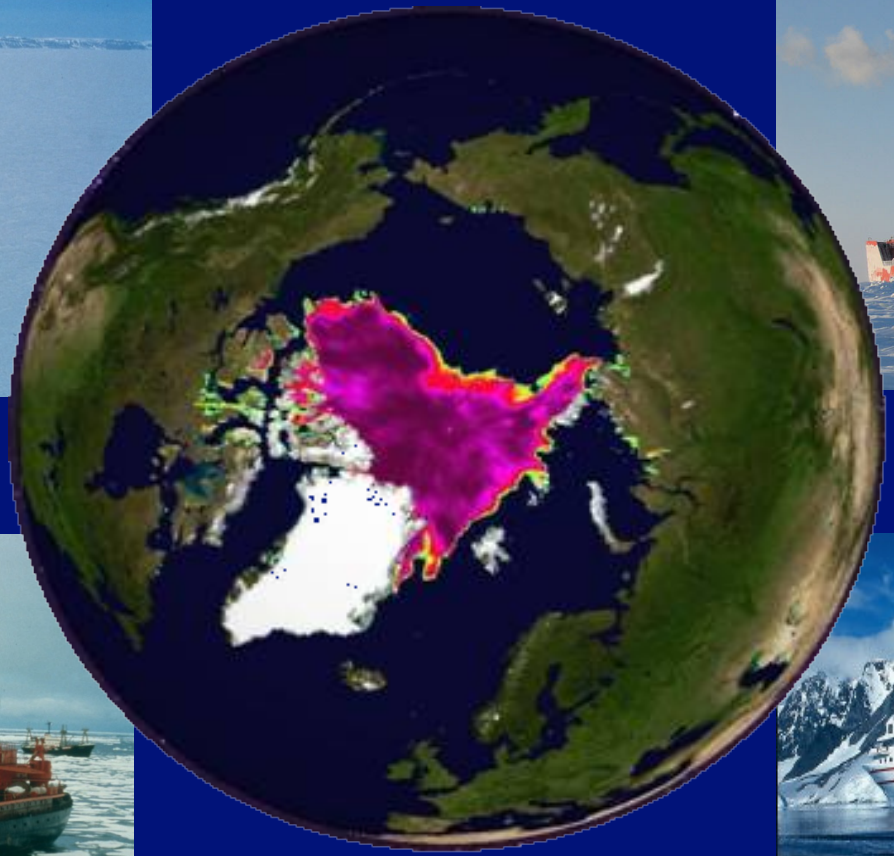
The Drivers of Arctic Shipping & Marine Operations

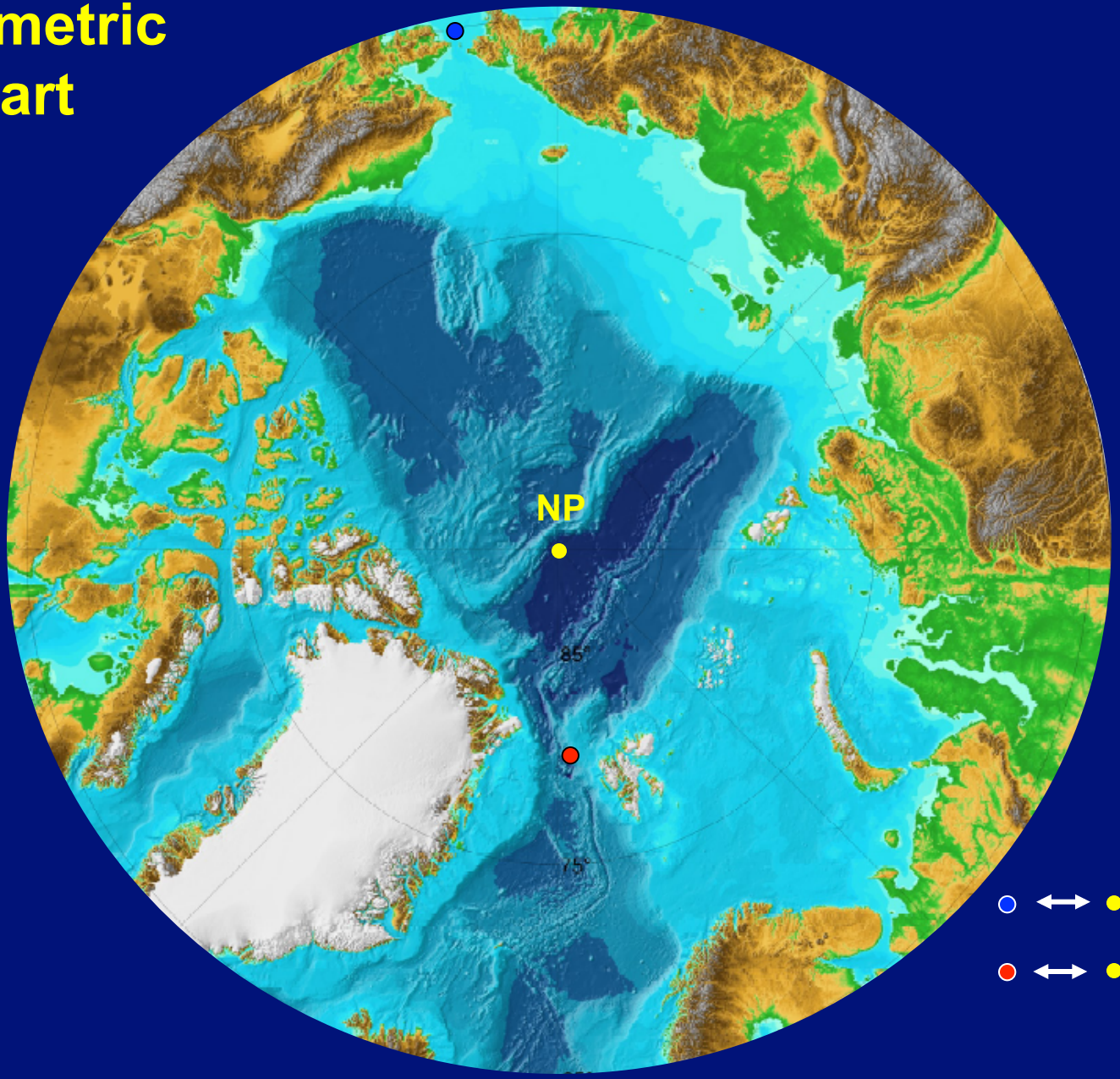
ShipArctic 2015: A Joint WMU-IMO-Arctic Council Conference

World Maritime University, Malmo, Sweden ~ 25-27 August 2015



Lawson W. Brigham, PhD
Professor, University of Alaska Fairbanks
Chair, Arctic Council Arctic Marine Shipping Assessment (2004-09)

Arctic Ocean Bathymetric Chart



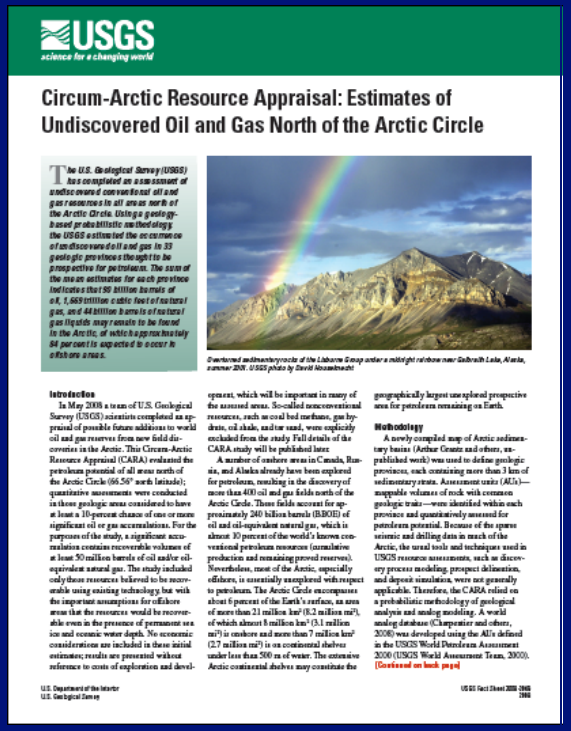
Topics ~ ShipArc Presentation:

- Arctic Perspectives & Global Links
- Changing Arctic Marine Access
- Current Arctic Marine Use
- Arctic Marine Shipping Assessment (AMSA) ~ Scenarios & Recommendations
- Summary Points & Challenges

The 21st Century Maritime Arctic

- Rapid & Profound Climate Change
- Globalization ~ Arctic Natural Resources
- Regional & Global Geopolitics
- Indigenous Peoples Challenges

U.S. Geological Survey Report ~ July 2008



USGS
science for a changing world

Circum-Arctic Resource Appraisal: Estimates of Undiscovered Oil and Gas North of the Arctic Circle

The U.S. Geological Survey (USGS) has completed an assessment of undiscovered conventional oil and gas resources in all areas north of the Arctic Circle. Using a geology-based probabilistic methodology, the USGS estimated the occurrence of undiscovered oil and gas in 33 geologic provinces thought to be prospective for petroleum. The sum of the mean estimates for each province indicates that 90 billion barrels of oil, 1,669 trillion cubic feet of natural gas, and 44 billion barrels of natural gas liquids may remain to be found in the Arctic, of which approximately 84 percent is expected to occur in offshore areas.

Overturned sedimentary rocks of the Lisburne Group under a midnight rainbow near Galbraith Lake, Alaska, summer 2008. USGS photo by David Houseknecht

Introduction

In May 2008 a team of U.S. Geological Survey (USGS) scientists completed an appraisal of possible future additions to world oil and gas reserves from new field discoveries in the Arctic. This Circum-Arctic Resource Appraisal (CARA) evaluated the petroleum potential of all areas north of the Arctic Circle (66.56° north latitude); quantitative assessments were conducted in those geologic areas considered to have at least a 10-percent chance of one or more significant oil or gas accumulations. For the purposes of the study, a significant accumulation contains recoverable volumes of at least 50 million barrels of oil and/or oil-equivalent natural gas. The study included only those resources believed to be recoverable using existing technology but with the important assumptions for offshore areas that the resources would be recoverable even in the presence of permanent sea ice and oceanic water depth. No economic considerations are included in these initial estimates; results are presented without reference to costs of exploration and development, which will be important in many of the assessed areas. So-called nonconventional resources, such as coal bed methane, gas hydrate, oil shale, and tar sand, were explicitly excluded from the study. Full details of the CARA study will be published later.

A number of onshore areas in Canada, Russia, and Alaska already have been explored for petroleum, resulting in the discovery of more than 400 oil and gas fields north of the Arctic Circle. These fields account for approximately 240 billion barrels (BBOE) of oil and oil-equivalent natural gas, which is almost 10 percent of the world's known conventional petroleum resources (cumulative production and remaining proved reserves). Nevertheless, most of the Arctic, especially offshore, is essentially unexplored with respect to petroleum. The Arctic Circle encompasses about 6 percent of the Earth's surface, an area of more than 21 million km² (8.2 million mi²), of which almost 8 million km² (3.1 million mi²) is onshore and more than 7 million km² (2.7 million mi²) is on continental shelves under less than 500 m of water. The extensive Arctic continental shelves may constitute the geographically largest unexplored prospective area for petroleum remaining on Earth.

Methodology

A newly compiled map of Arctic sedimentary basins (Arthur Grantz and others, unpublished work) was used to define geologic provinces, each containing more than 3 km of sedimentary strata. Assessment units (AUs)—mappable volumes of rock with common geologic traits—were identified within each province and quantitatively assessed for petroleum potential. Because of the sparse seismic and drilling data in much of the Arctic, the usual tools and techniques used in USGS resource assessments, such as discovery process modeling, prospect delineation, and deposit simulation, were not generally applicable. Therefore, the CARA relied on a probabilistic methodology of geological analysis and analog modeling. A world analog database (Charpentier and others, 2008) was developed using the AUs defined in the USGS World Petroleum Assessment 2000 (USGS World Assessment Team, 2000).

[Continued on back page]

U.S. Department of the Interior
U.S. Geological Survey

USGS Fact Sheet 2008-3049
2008

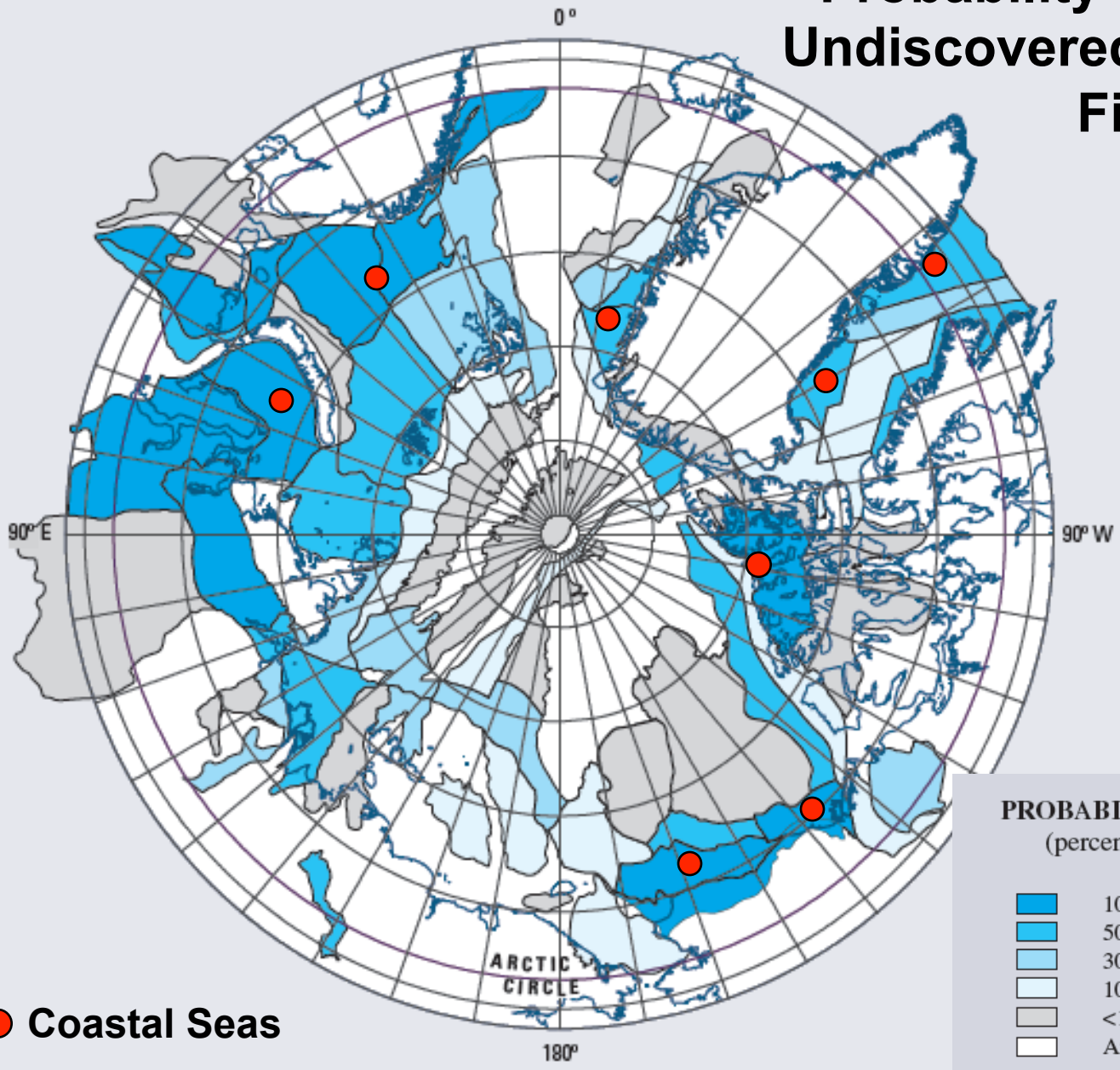
"Circum-Arctic Resource Appraisal: Estimates of Undiscovered Oil and Gas North of the Arctic Circle"

- –13% Undiscovered Oil
- –30% Undiscovered Natural Gas
- –20% Undiscovered Natural Gas Liquids

http://pubs.usgs.gov/fs/2008/3049/

New Arctic Resource Discoveries

Probability of Presence of Undiscovered Oil and/or Gas Fields



Coastal Seas

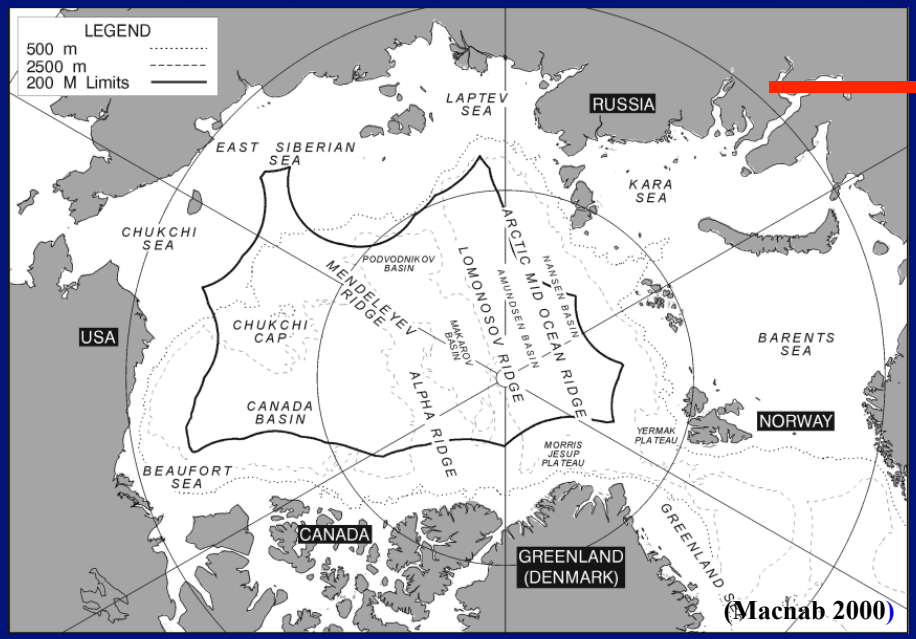
PROBABILITY
(percent)

- 100
- 50–100
- 30–50
- 10–30
- <10
- Area of low petroleum potential

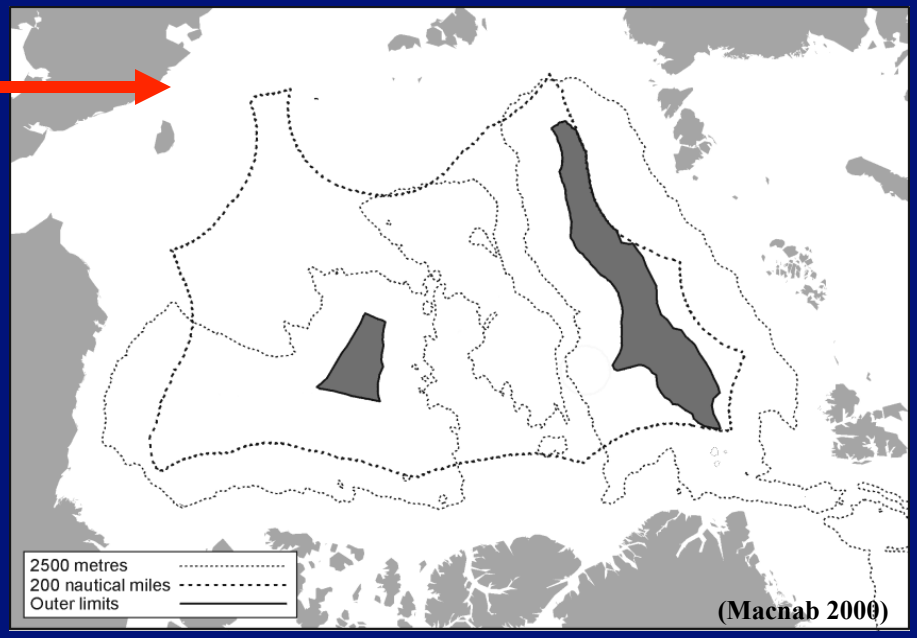
USGS (2008)

New Arctic Resource Discoveries

Today's Maritime Arctic (200 NM Exclusive Economic Zone)



Hypothetical - Future Maritime Arctic (After UNCLOS Article 76)



The ILULISSAT Declaration

- Conference of 5 Coastal States Bordering on the Arctic Ocean (Canada, Denmark & Greenland, Norway, Russia, USA)
  - 27-29 May 2008 ~ Ilulissat, Greenland
  - LOS/UNCLOS Provides 'Solid Foundation'
- 'We therefore see no need to develop a new comprehensive international legal regime to govern the Arctic Ocean.'

The ‘New’ Maritime Arctic

Lukoil (Russia) & ConocoPhillips (USA)

Operator ~ Sovcomflot (Russia)

Builder ~ Samsung (Korea)

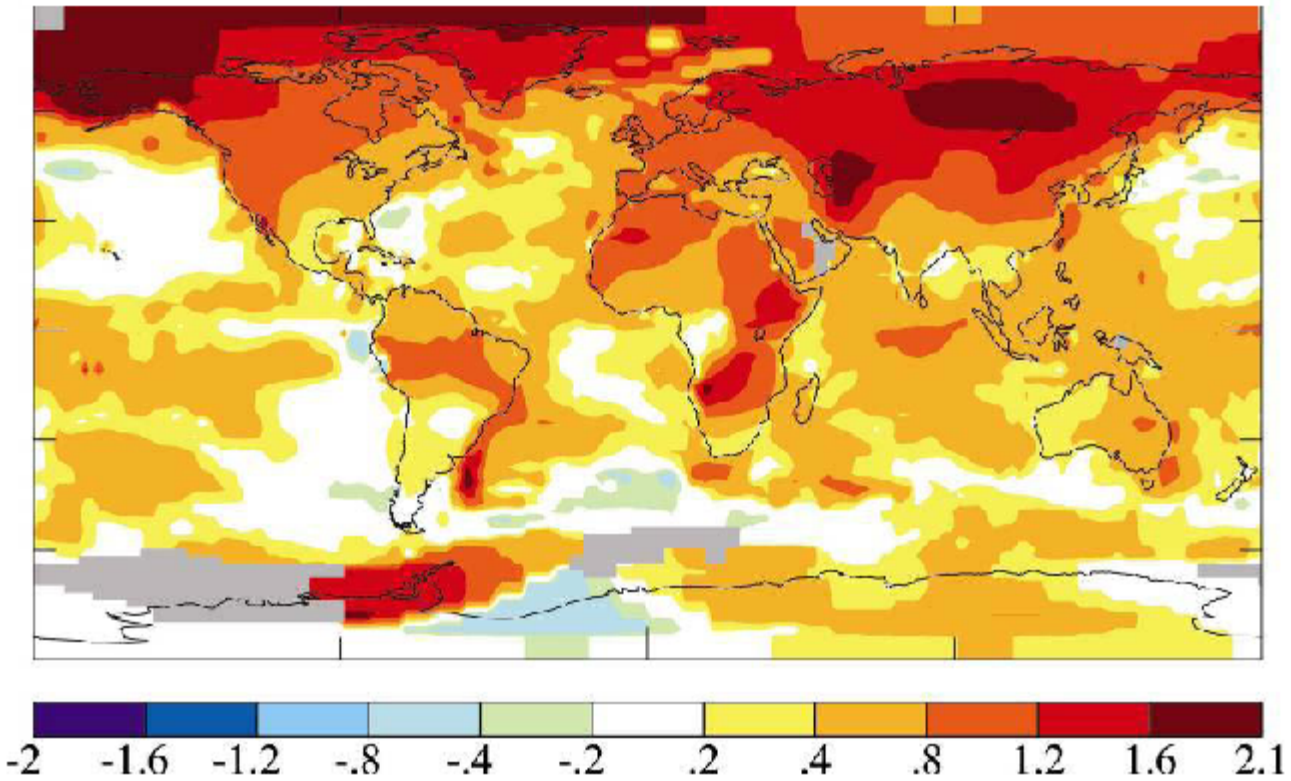
Technology ~ Finland, Canada & USA

Arctic Linkages to the Global Economic System

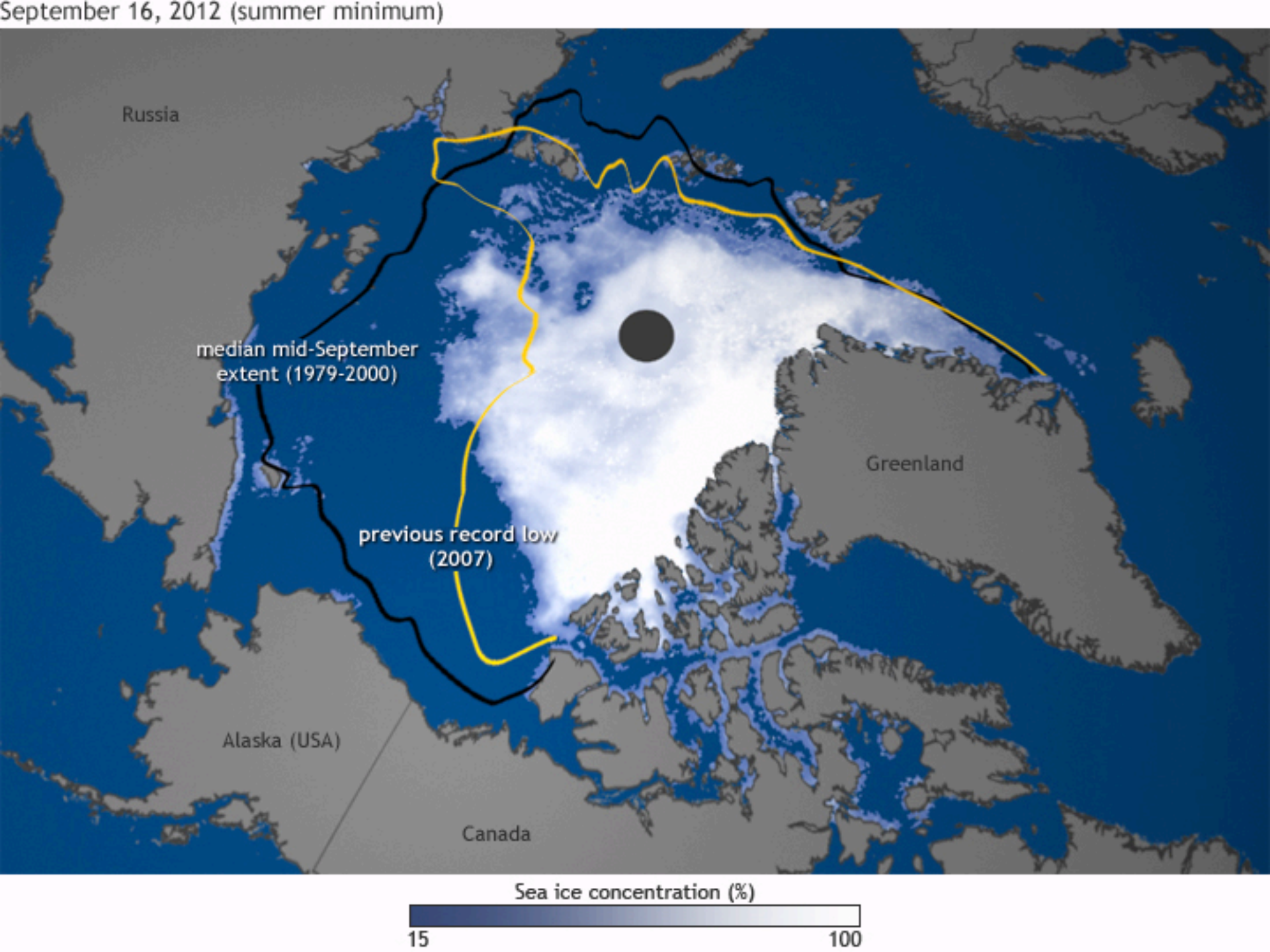
- International Fishing (10%)
- Global Marine Tourism Industry
- Hard Minerals ~ Palladium (40%), Nickel (22%), Diamonds (20%), Platinum (15%), Zinc (10%)
- Estimated Arctic Hydrocarbons ~ Undiscovered Natural Gas (30%) & Oil (13%)
- Potential: Rare Earths (25%), Coal & Fresh Water
- Regional Trade to Northern Communities & Infrastructure Development

The heating is not uniform geographically

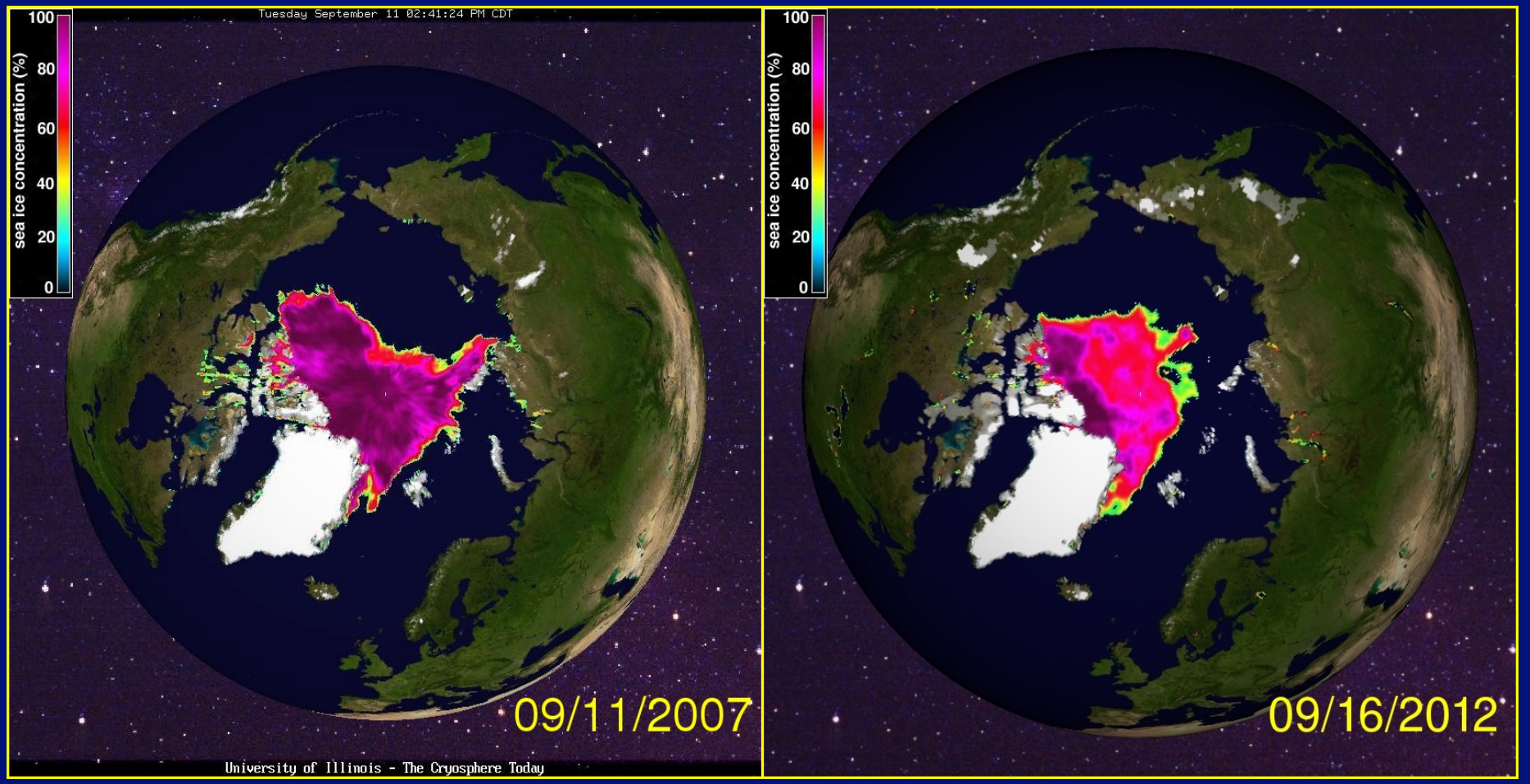
Surface T in 2001-2005 *vs* 1951-80, averaging 0.53°C increase



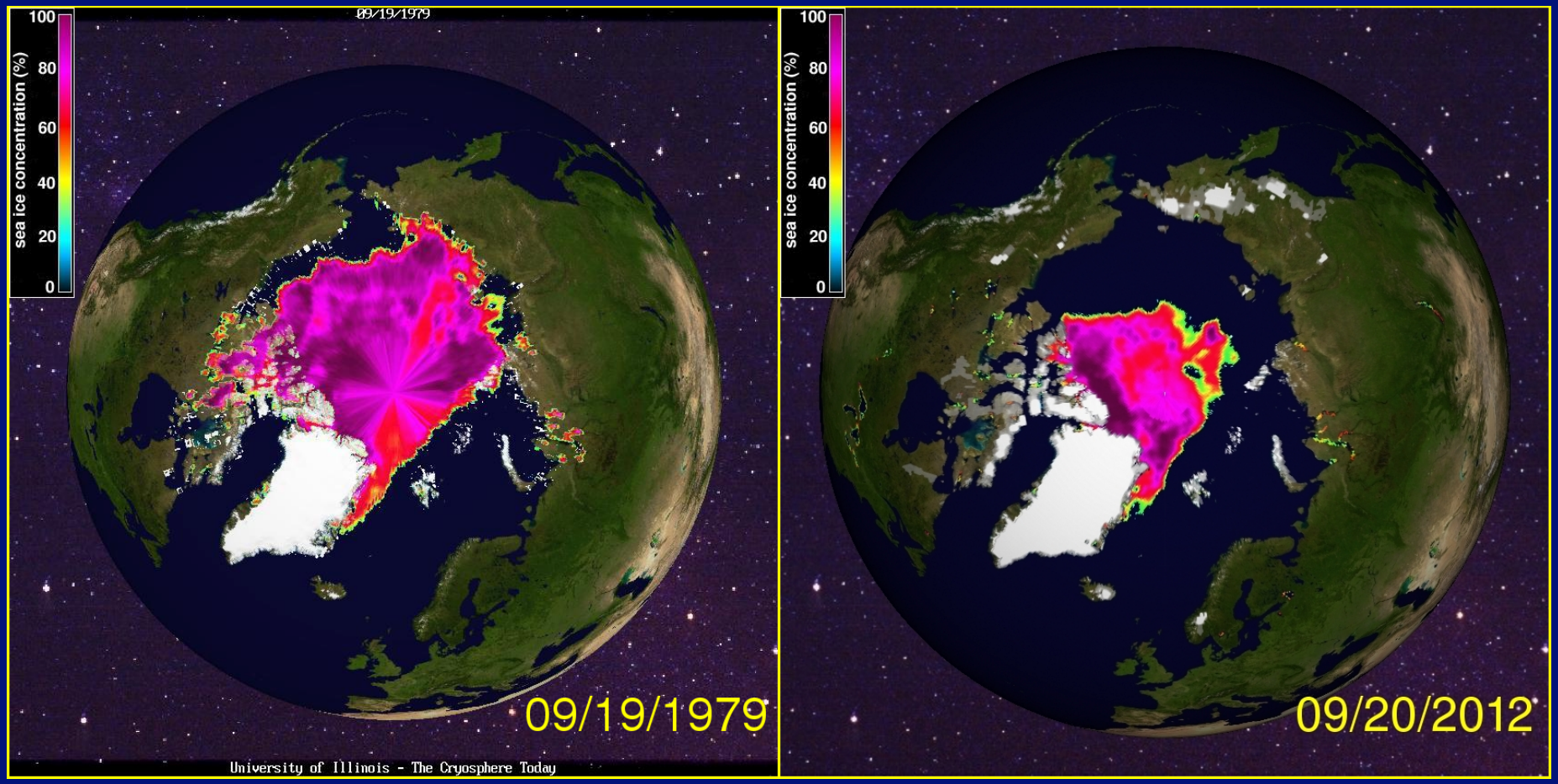
J. Hansen et al., *PNAS 103*: 14288-293 (2006)


September 16, 2012 (summer minimum)
Russia
median mid-September
extent (1979-2000)
previous record low
(2007)
Greenland
Alaska (USA)
Canada
Sea ice concentration (%)
15
100

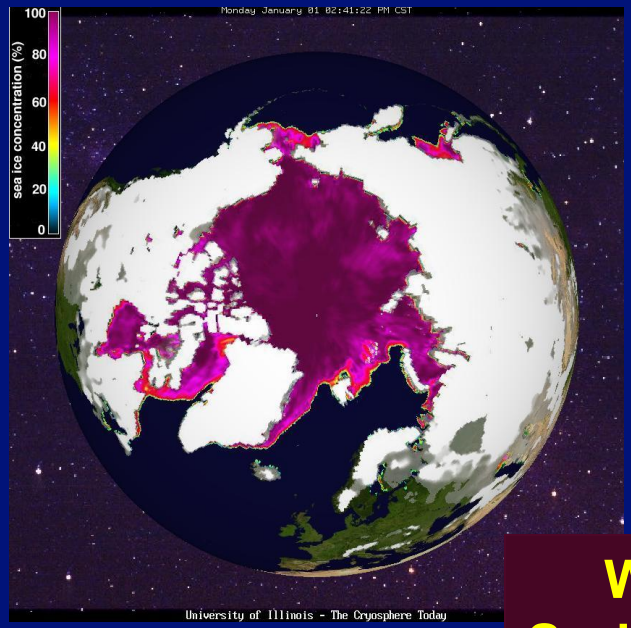
Arctic Sea Ice Minimum Extents ~ 2007 & 2012



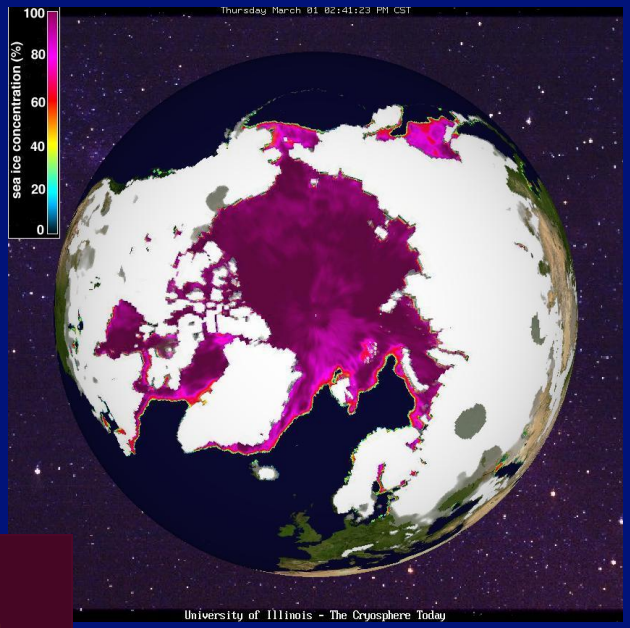
Changing Summer Arctic Sea Ice Coverage ~ 1979-2012



1 January



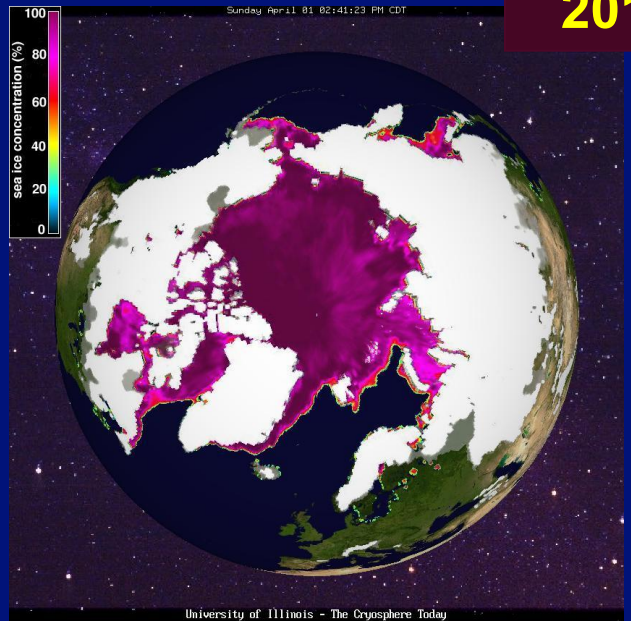
1 March



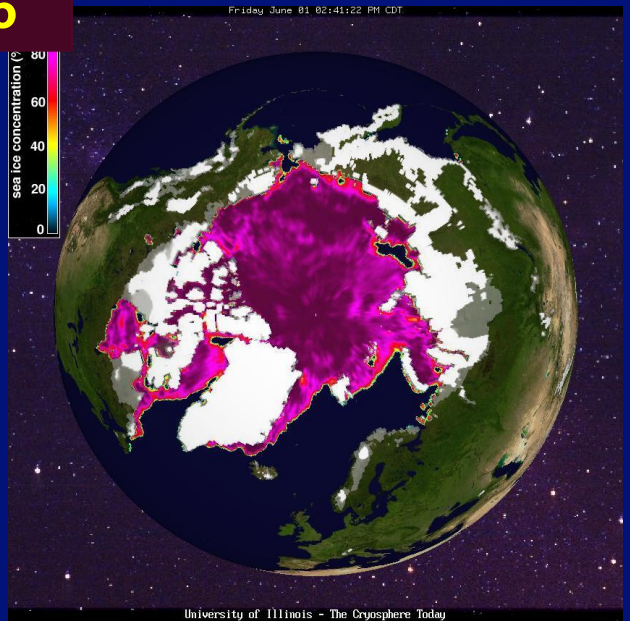
Winter & Spring Months

2014 & 2015

1 April



1 June



Septembers
2006-2015

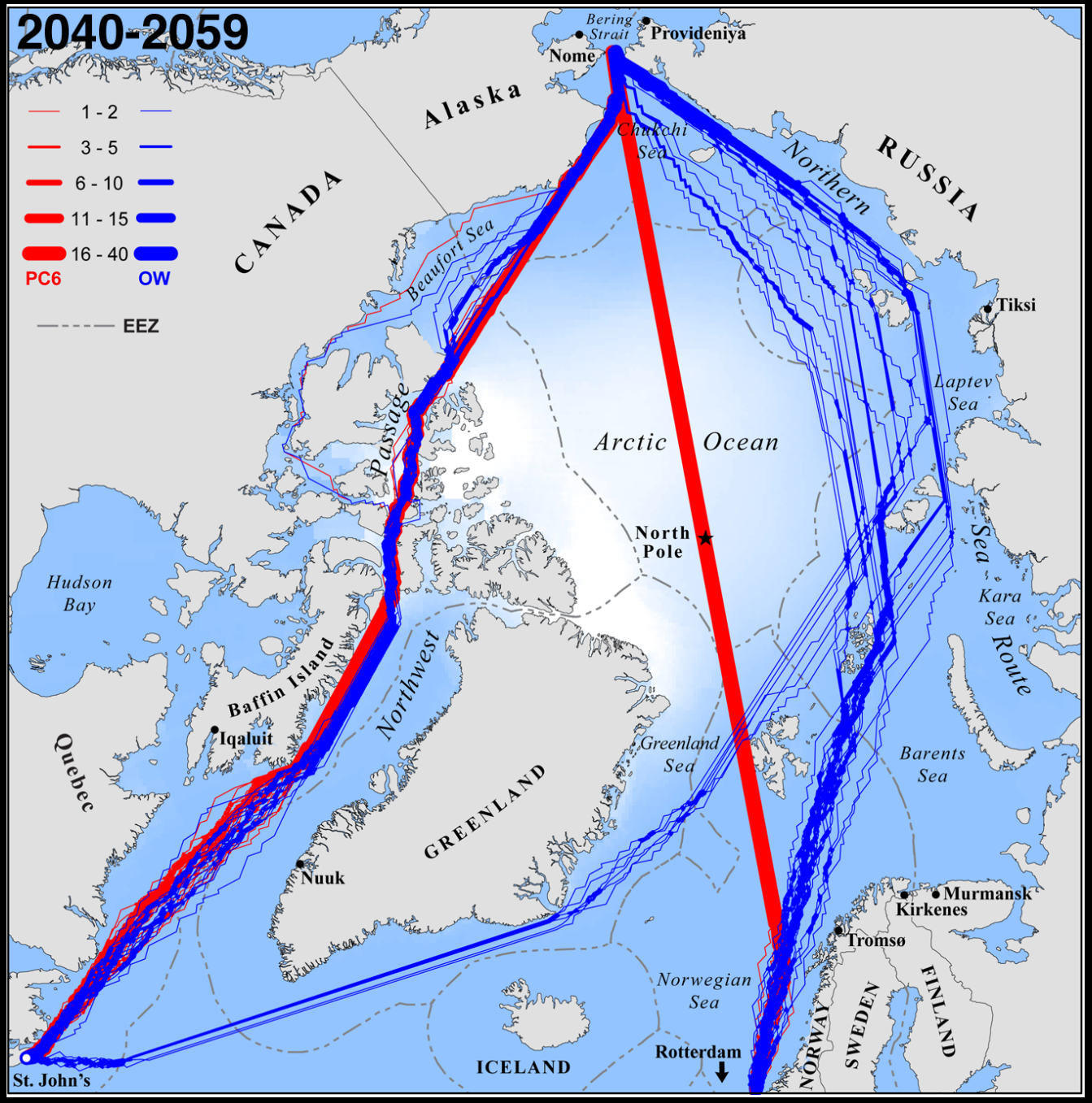
red lines=
Polar Class 6
(e.g. commercial
icebreaking ships)

blue lines=
common open-
water ships

Septembers
2040-2059

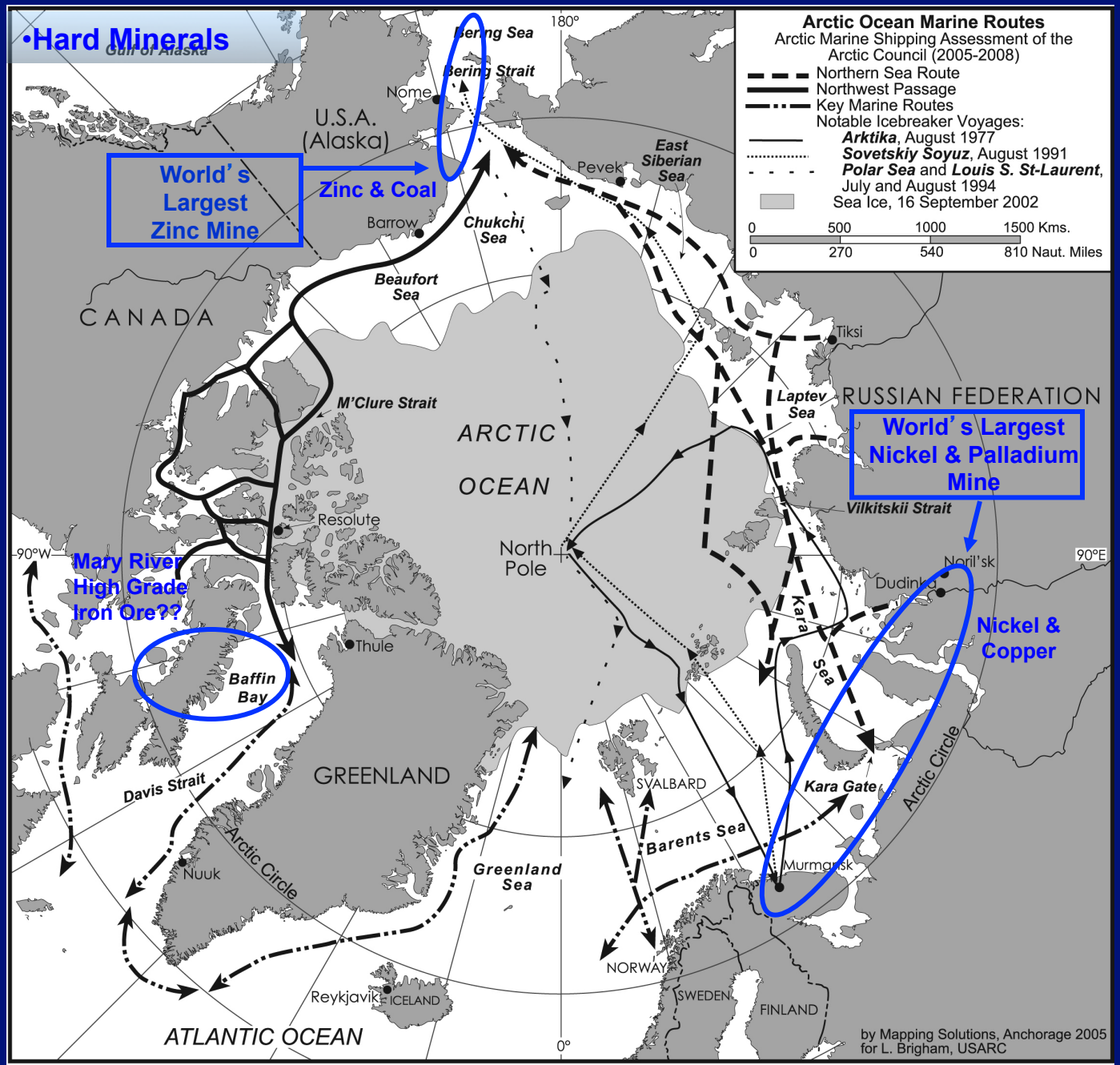
red lines=
Polar Class 6
(e.g. commercial
icebreaking ships)

blue lines=
common open-
water ships

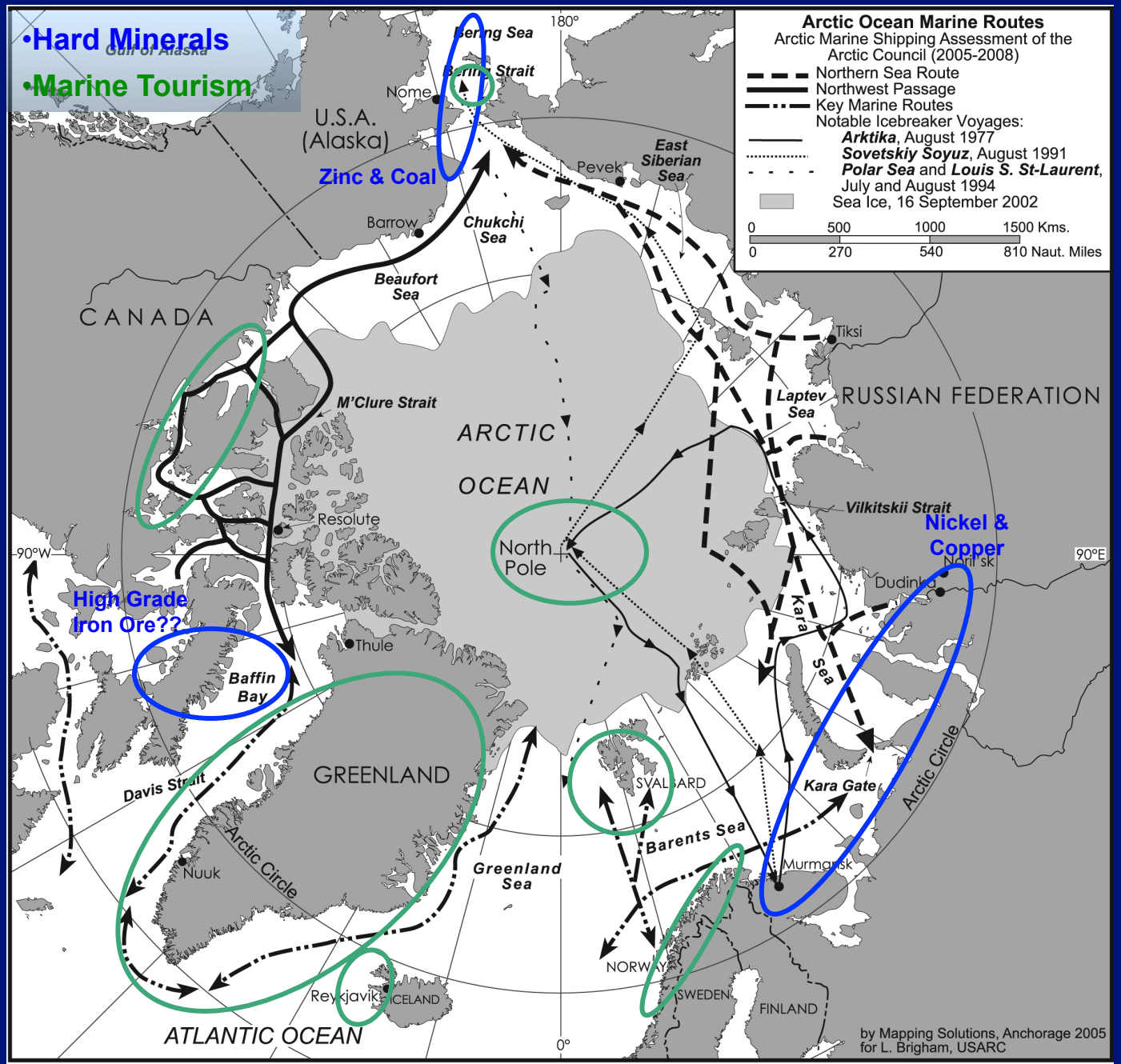


("New Trans-Arctic shipping routes navigable by midcentury", L.C. Smith and S.R. Stephenson, PNAS, 2013)

Today's Arctic Commercial Marine Use

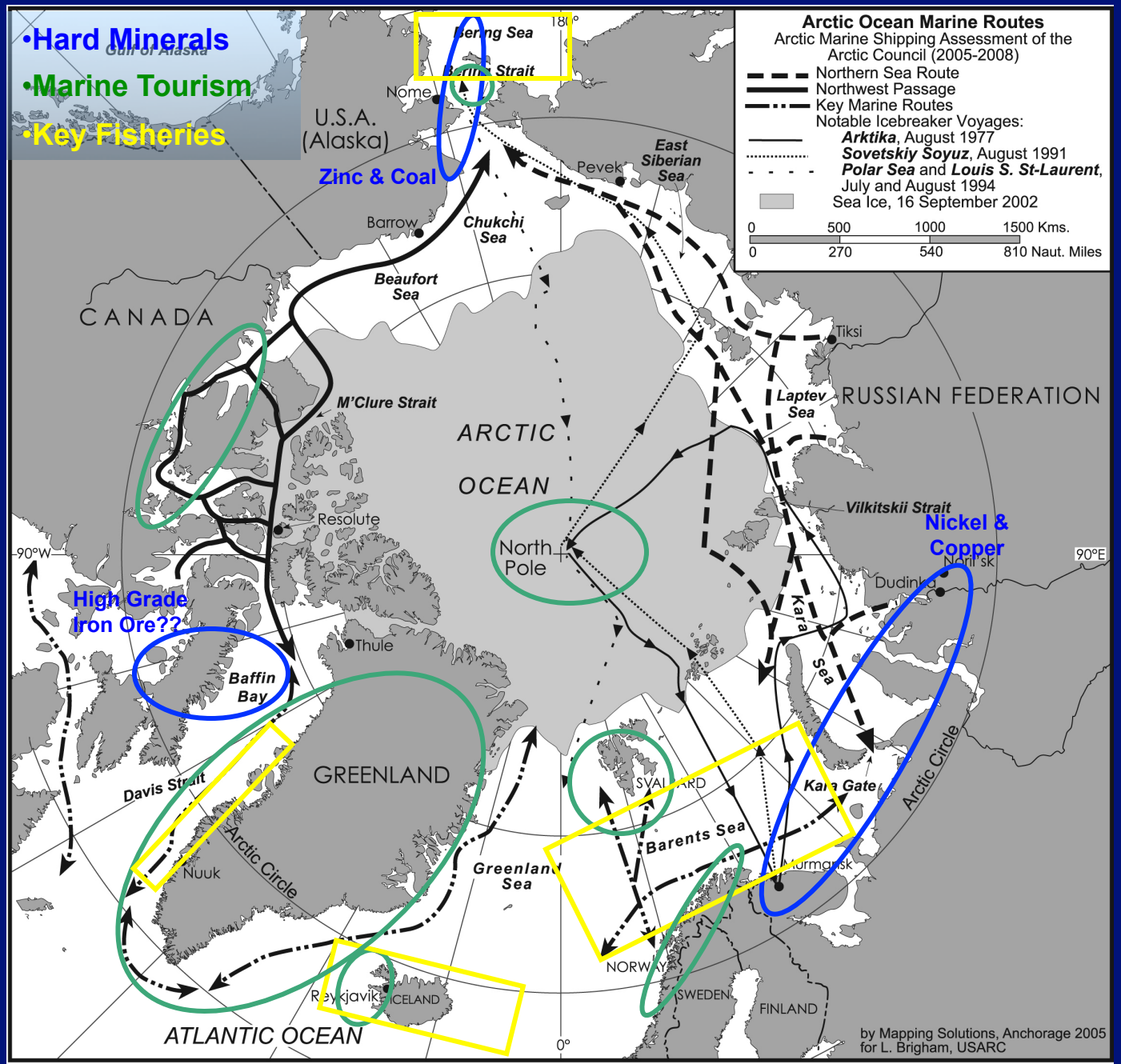


Today's Arctic Commercial Marine Use

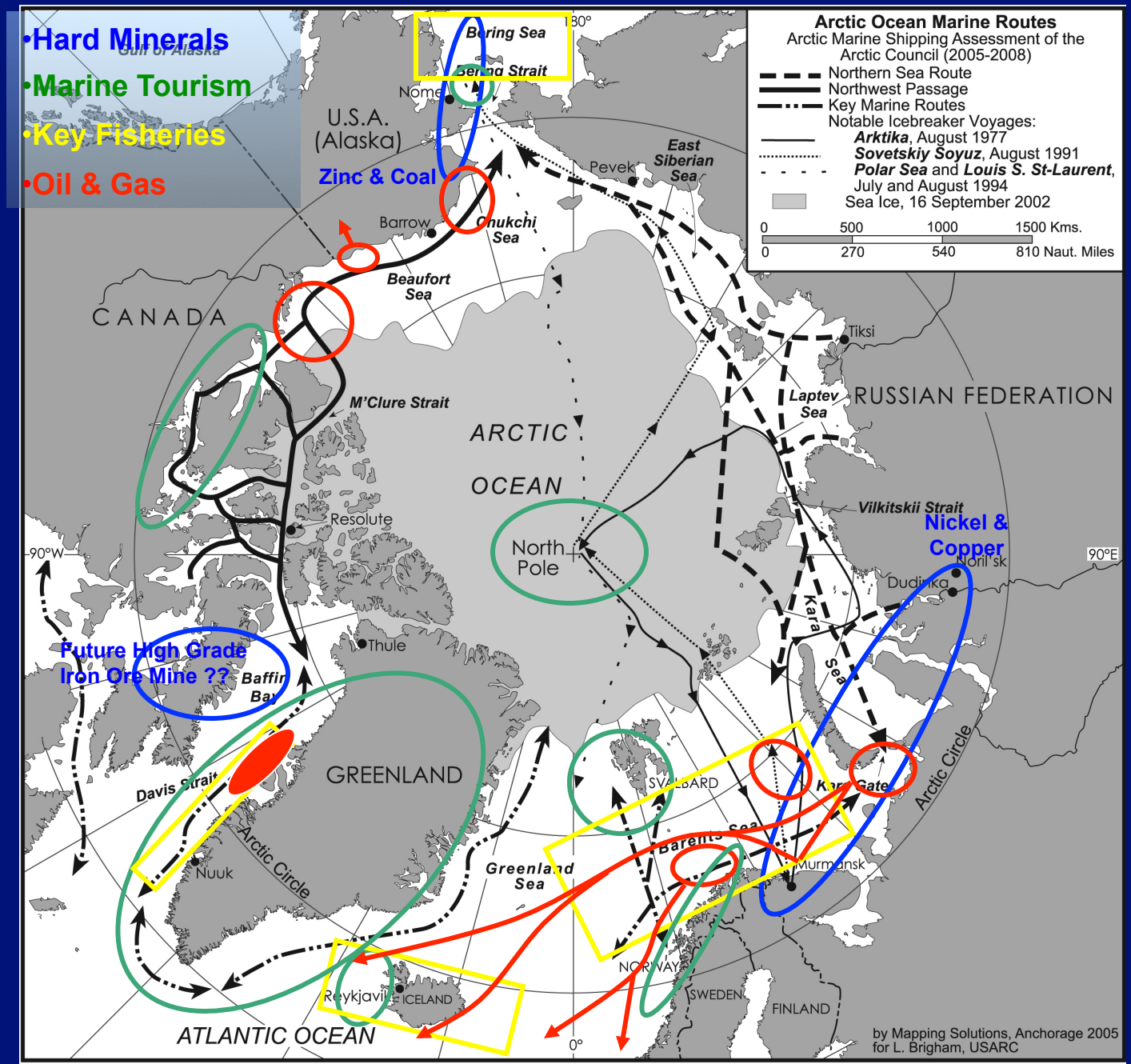


Arctic Cruising

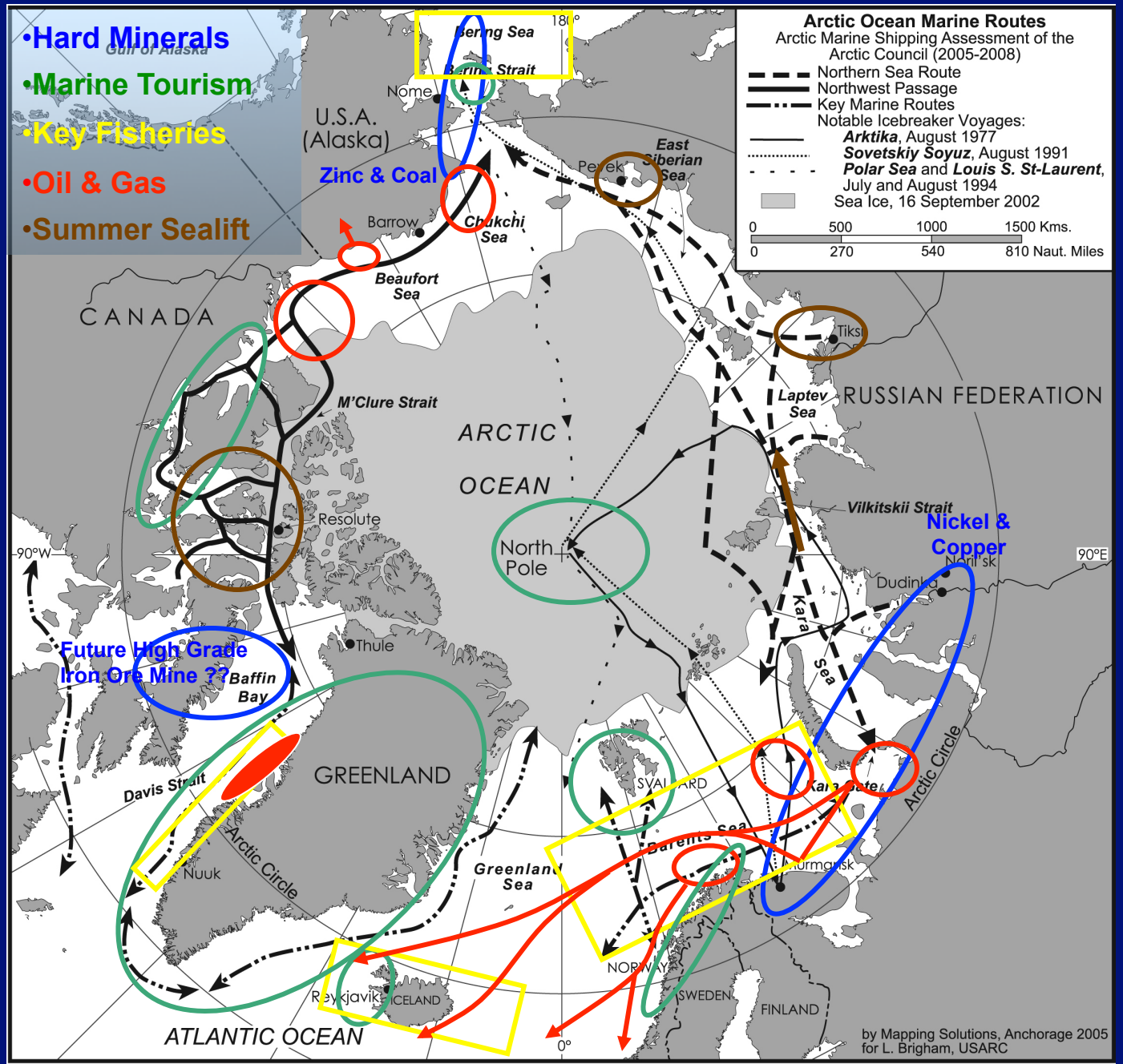
Today's Arctic Commercial Marine Use



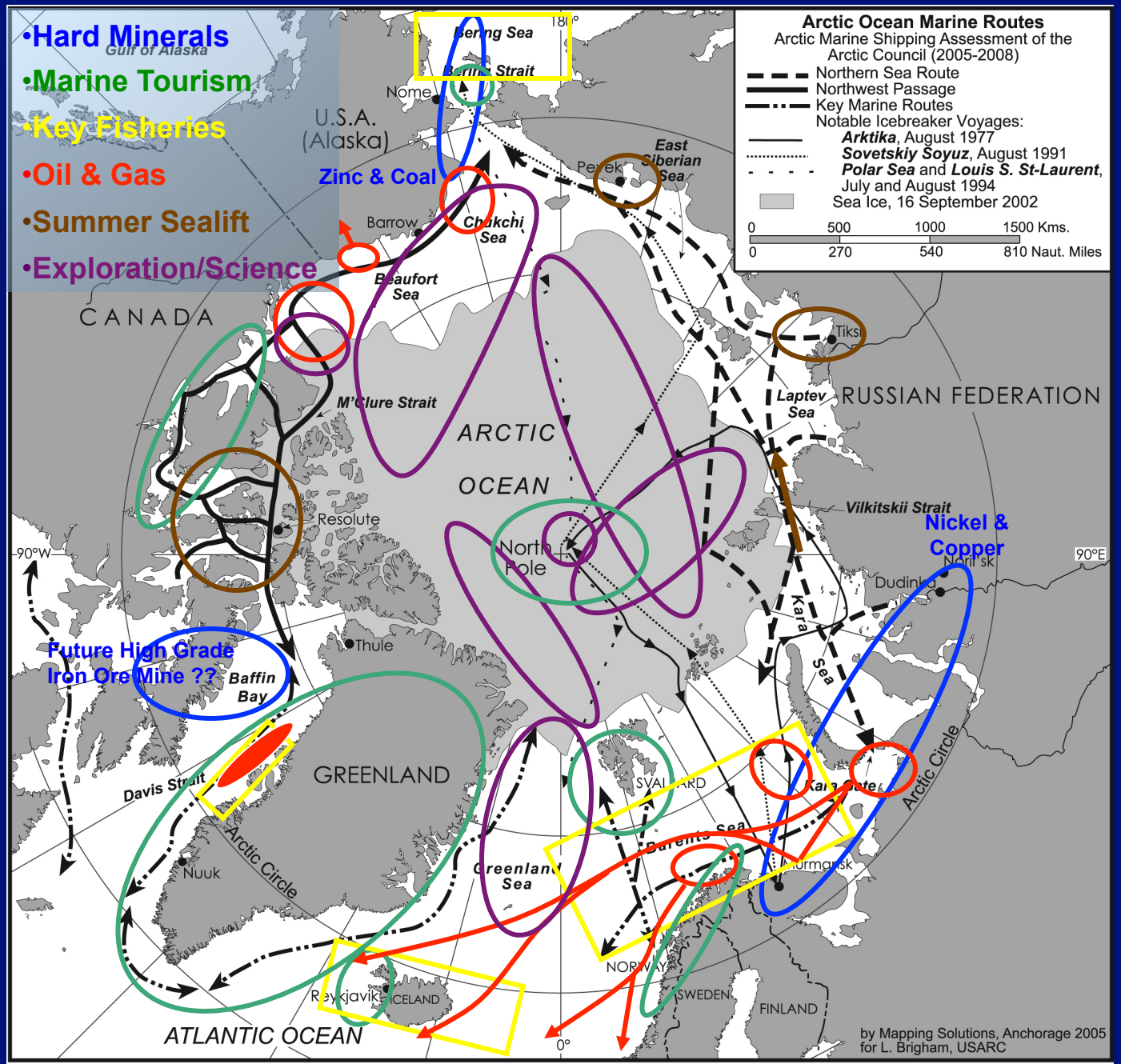
Today's Arctic Commercial Marine Use



Today's Arctic Commercial Marine Use



Today's Arctic Commercial Marine Use

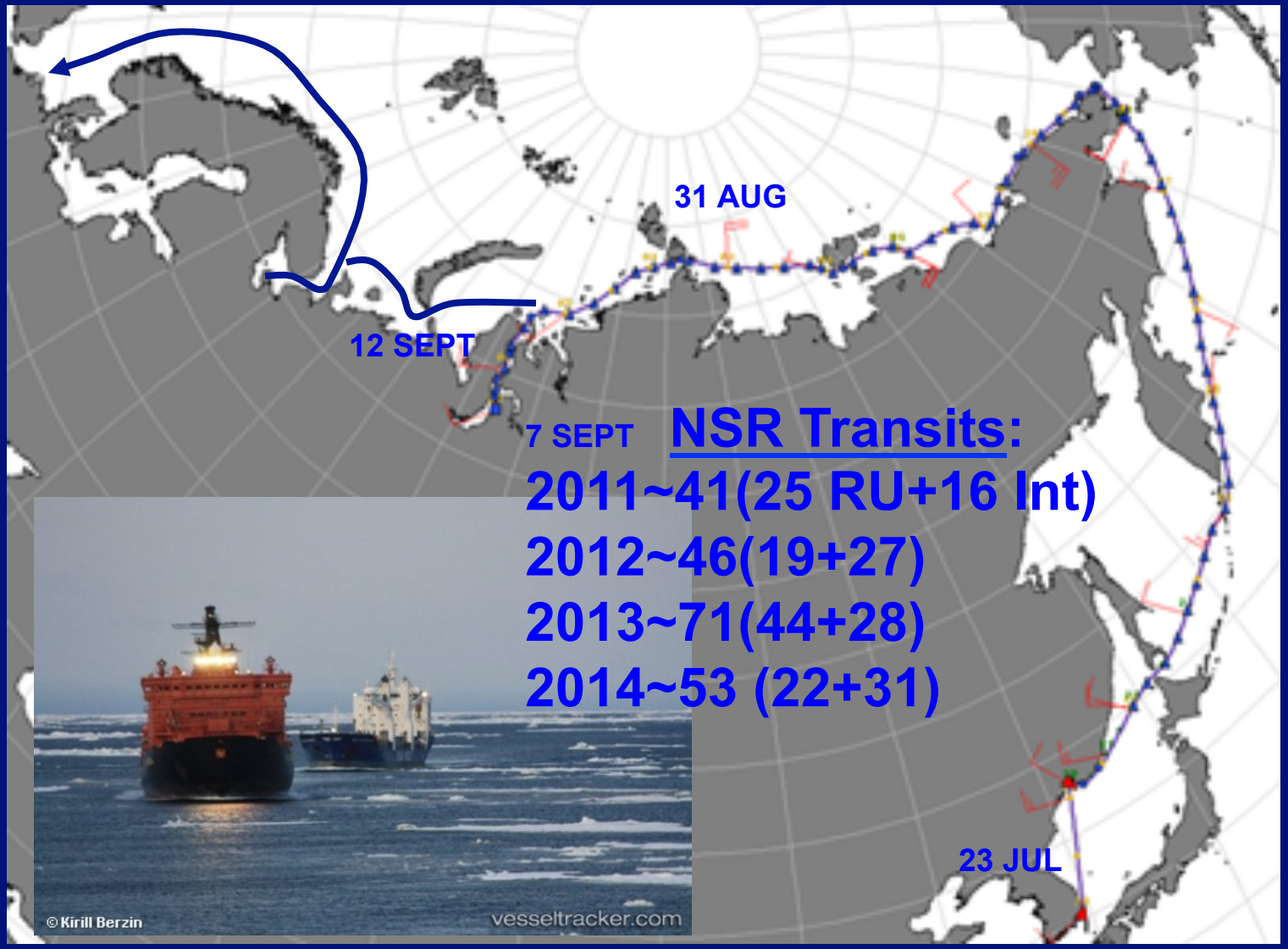


Icebreaker Transits to the North Pole & Trans-Arctic Voyages (1977-2014):

- 110 Transits to the North Pole (93 Russia, 7 Sweden, 3 USA, 3 Germany, 3 Canada, 1 Norway)
- Single Non-summer NP Voyage (*Sibir* Voyage May-June 1987)
- 66 Ship Transits to the NP in 2004-2014
- 7 Trans-Arctic Voyages Via the NP (1991, 1994, 1996, 2005)

‘Clear Evidence of Central Arctic Ocean Icebreaker Operations’

25 May 1987 ~ North Pole
Soviet Nuclear Icebreaker *Sibir*
‘A Walk Around the World!’

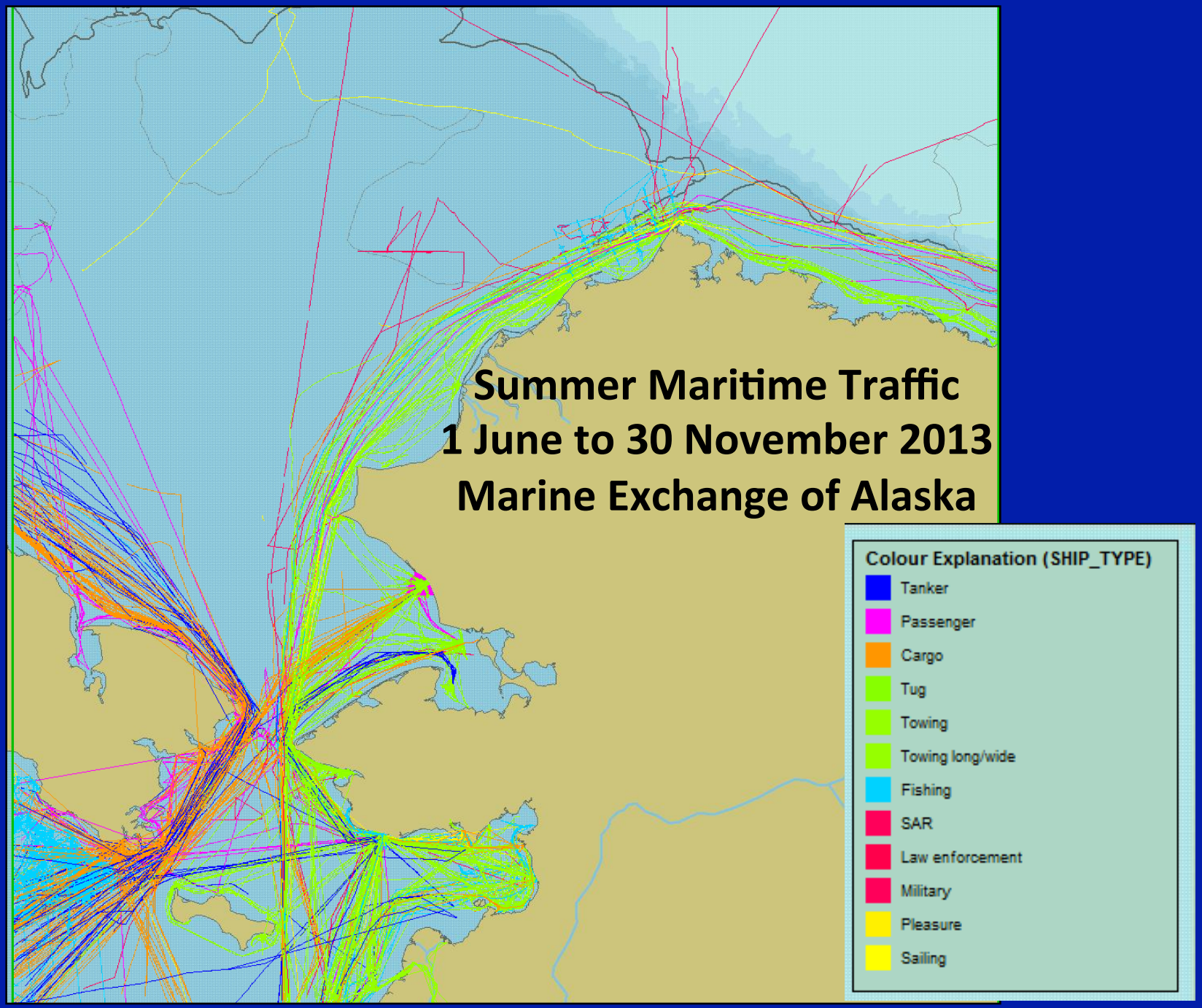


'Wild Card' Issue ~ Summer Northern Sea Route Voyages Linking Arctic Russia & Northern Europe to the Pacific

Global Media Coverage :

- ***Chinese Cargo Ship Sets Sail for Arctic Short-cut*** **(11 August 2013 ~ *Financial Times*) ~ [Notable: *Ob River* in Nov/Dec 2012 from Hammerfest to Tabeta, Japan]**
- ***100 Times to the North Pole***
  (2 August 2013 ~ *Barents Observer*)
- ***Northern Sea Route Slated for Massive Growth; A Seasonal Supplement to the Suez Canal*** **(4 June 2013 ~ *The Moscow Times*)**


Winter Maritime Traffic
1 January to 31 May 2013
Marine Exchange of Alaska


Summer Maritime Traffic
1 June to 30 November 2013
Marine Exchange of Alaska
Colour Explanation (SHIP_TYPE)
Tanker
Passenger
Cargo
Tug
Towing
Towing long/wide
Fishing
SAR
Law enforcement
Military
Pleasure
Sailing

Timeless Arctic Marine Transport: Indigenous Use of the Arctic Ocean

2004 – 2009

Arctic Council ~ Intergovernmental Forum

AMSA Lead Countries for PAME ~ Canada, Finland & USA

AMSA Focus ~ Marine Safety & Marine Environmental Protection

13 Major Workshops & 14 Town Hall Meetings

Key Challenge ~ Many Non-Arctic Stakeholders

Arctic Ministers' Approval 29 April 2009 ~ Negotiated Text

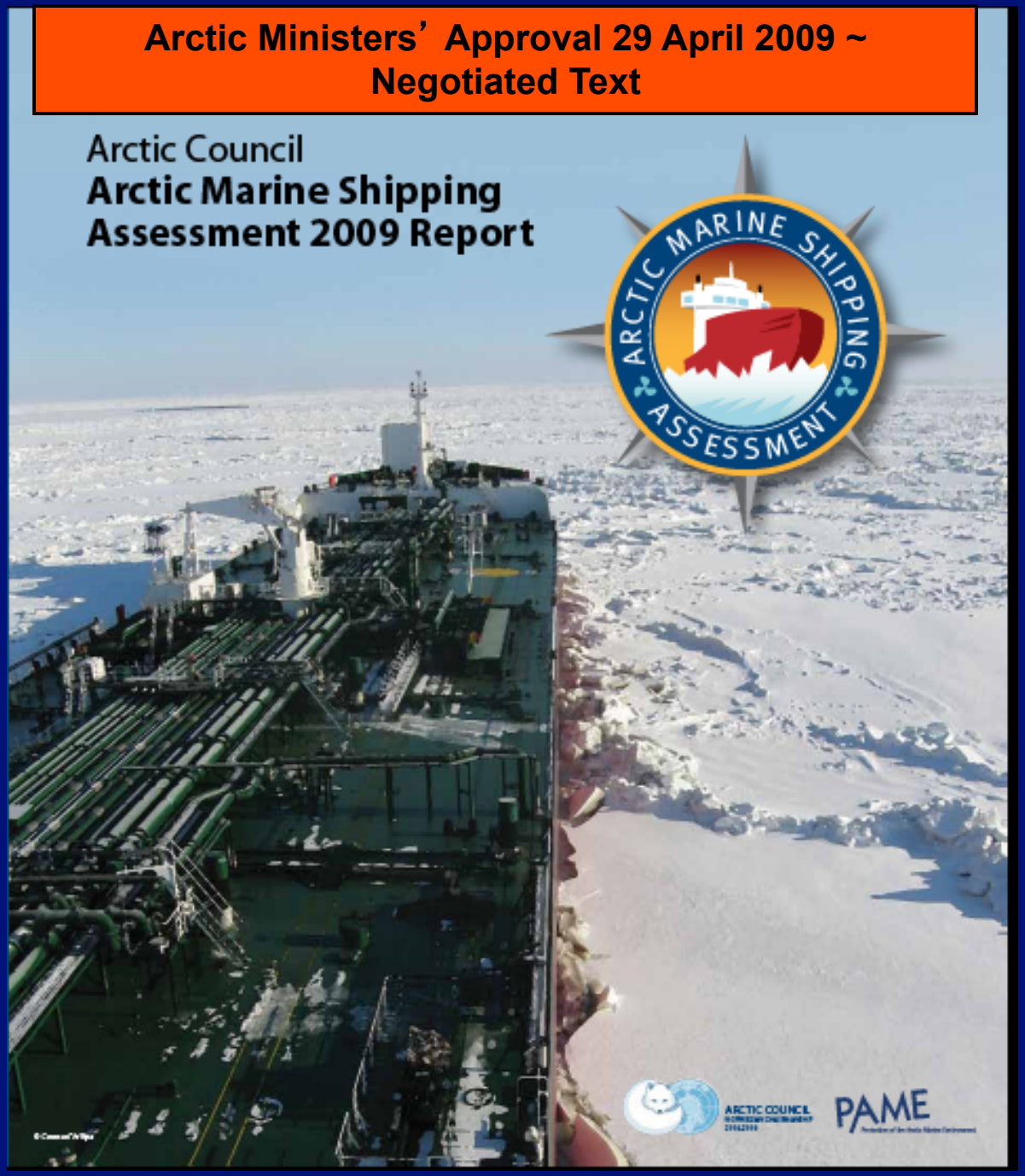


Table of Contents

- Executive Summary with Recommendations
- Arctic Marine Geography Climate & Sea Ice
- History
- Governance
- Current Use/Database
- Scenarios to 2020 & 2050
- Human Dimensions
- Environmental Impacts
- Infrastructure

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AMSA Key Uncertainties for Future Arctic Marine Transportation

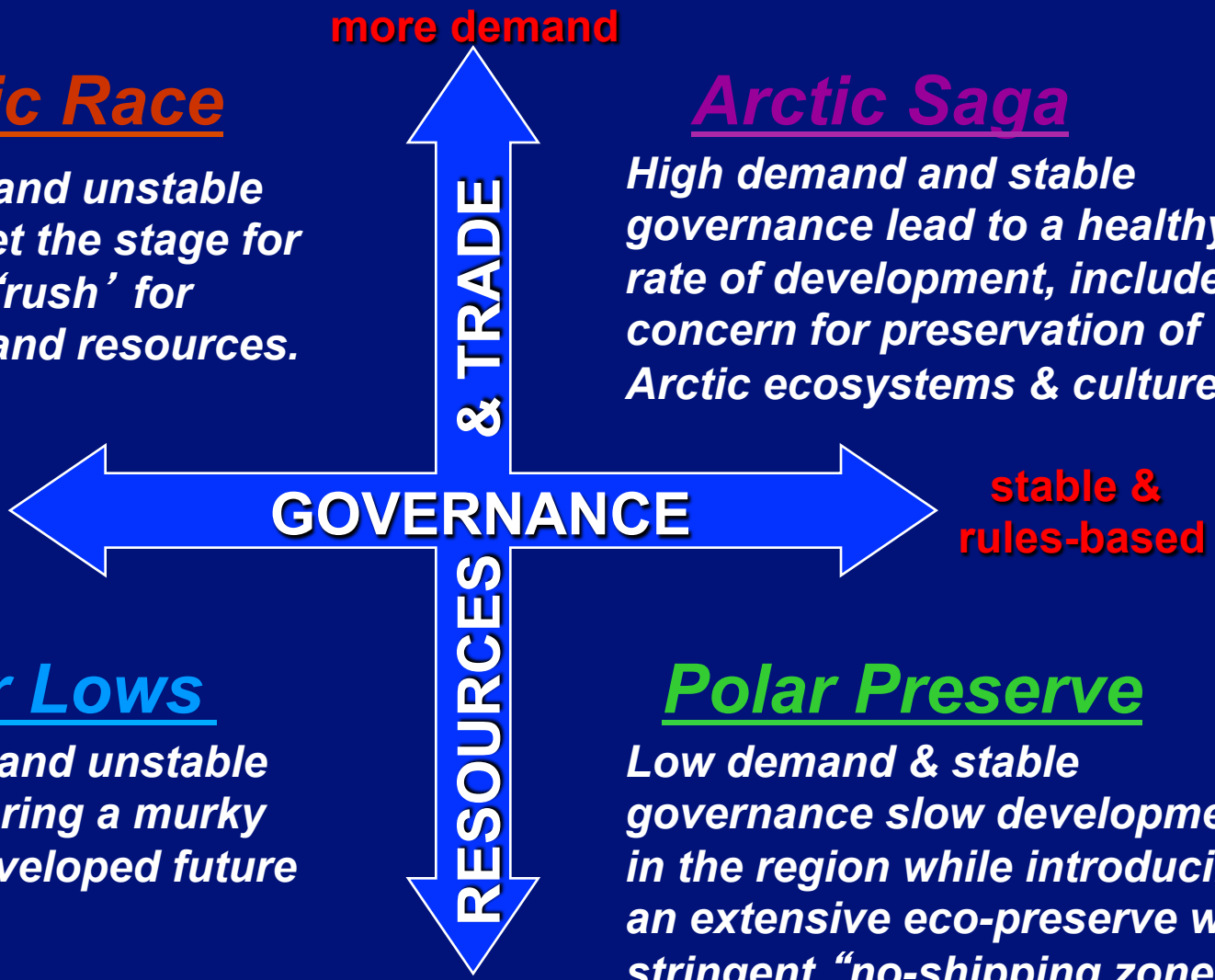
- Stable legal climate
- Radical change in global trade dynamics
- Climate change is more disruptive sooner
- Safety of other routes
- Socio-economic impact of global weather changes
- Oil prices (55-60 to 100-150 USD?)***
- Major Arctic shipping disasters***
- Limited windows of operation (economics)
- Rapid climate change
- Maritime insurance industry
- China, Japan & Korea become Arctic maritime nations
- Transit fees
- Conflict between indigenous & commercial use
- Arctic maritime enforcement
- Escalation of Arctic maritime disputes
- Shift to nuclear energy***
- New resource discovery
- World trade patterns
- Catastrophic loss or change in Suez or Panama Canals
- Global agreements on construction rules and standards

“Stricken cruise ship off Antarctic evacuated”

MSNBC- 11/23/07

M/V Explorer

Scenarios on the Future of Arctic Marine Navigation in 2050



Arctic Race

High demand and unstable governance set the stage for an economic 'rush' for Arctic wealth and resources.

Arctic Saga

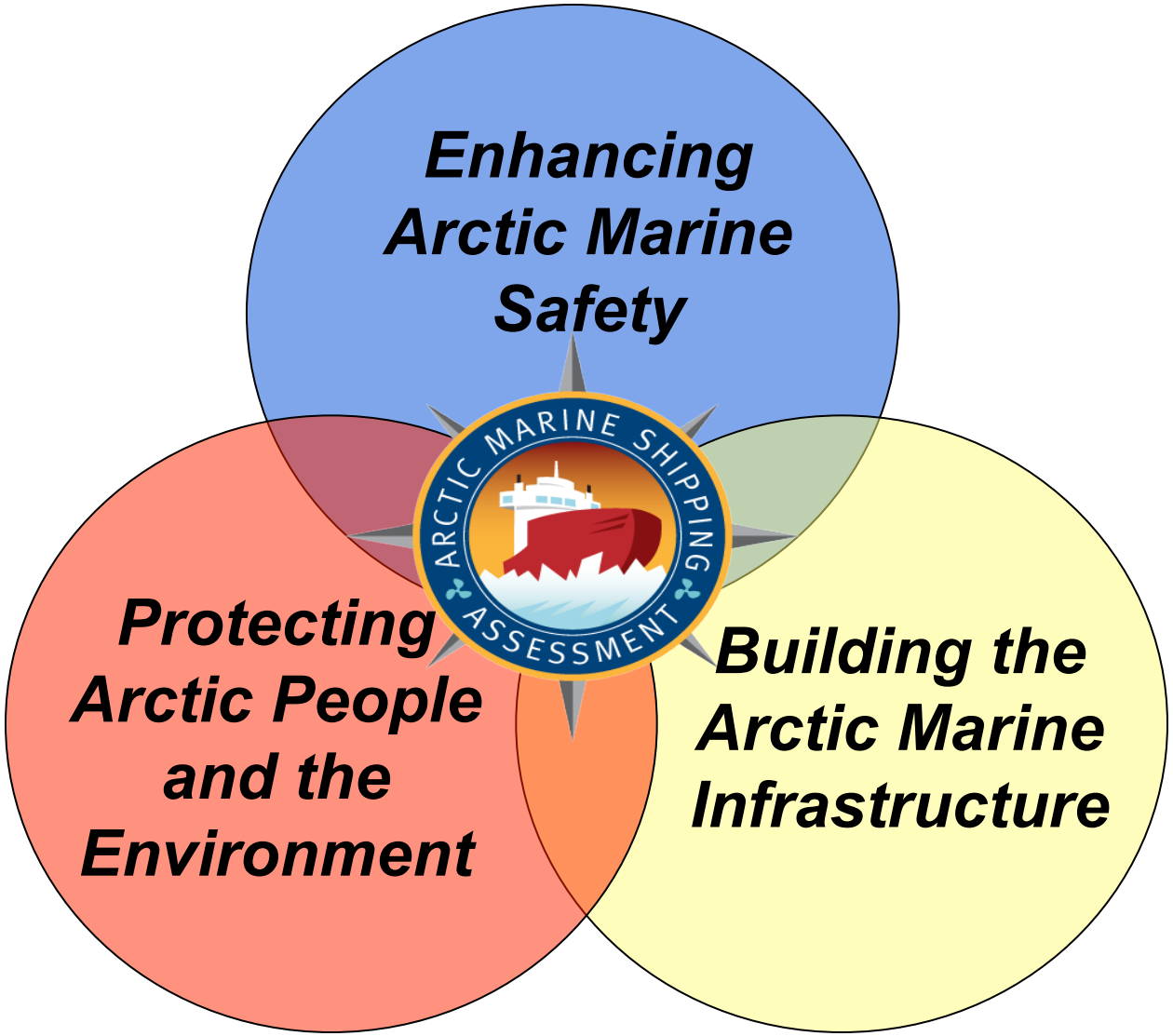
High demand and stable governance lead to a healthy rate of development, includes concern for preservation of Arctic ecosystems & cultures.

Polar Lows

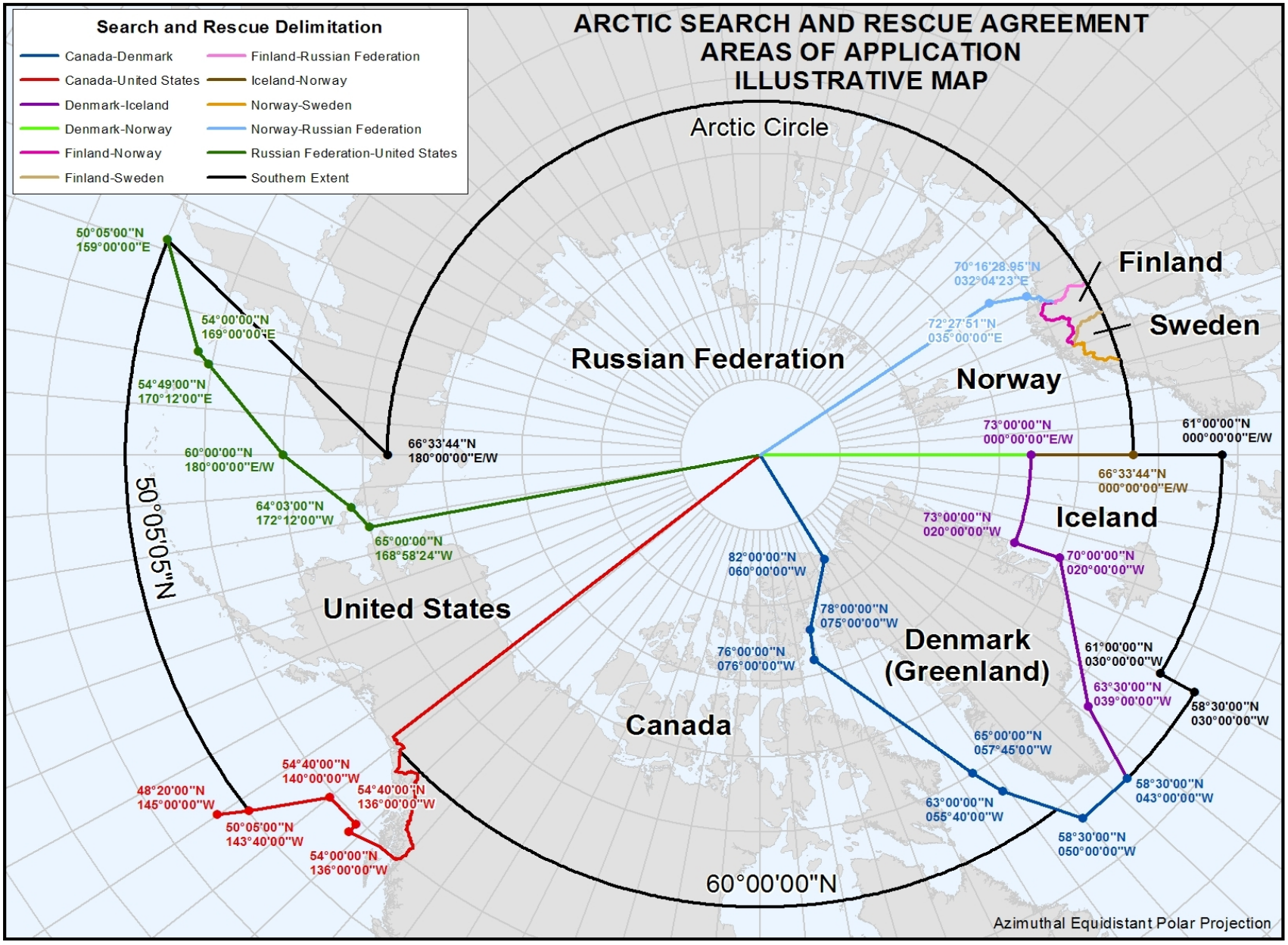
Low demand and unstable governance bring a murky and under-developed future for the Arctic.

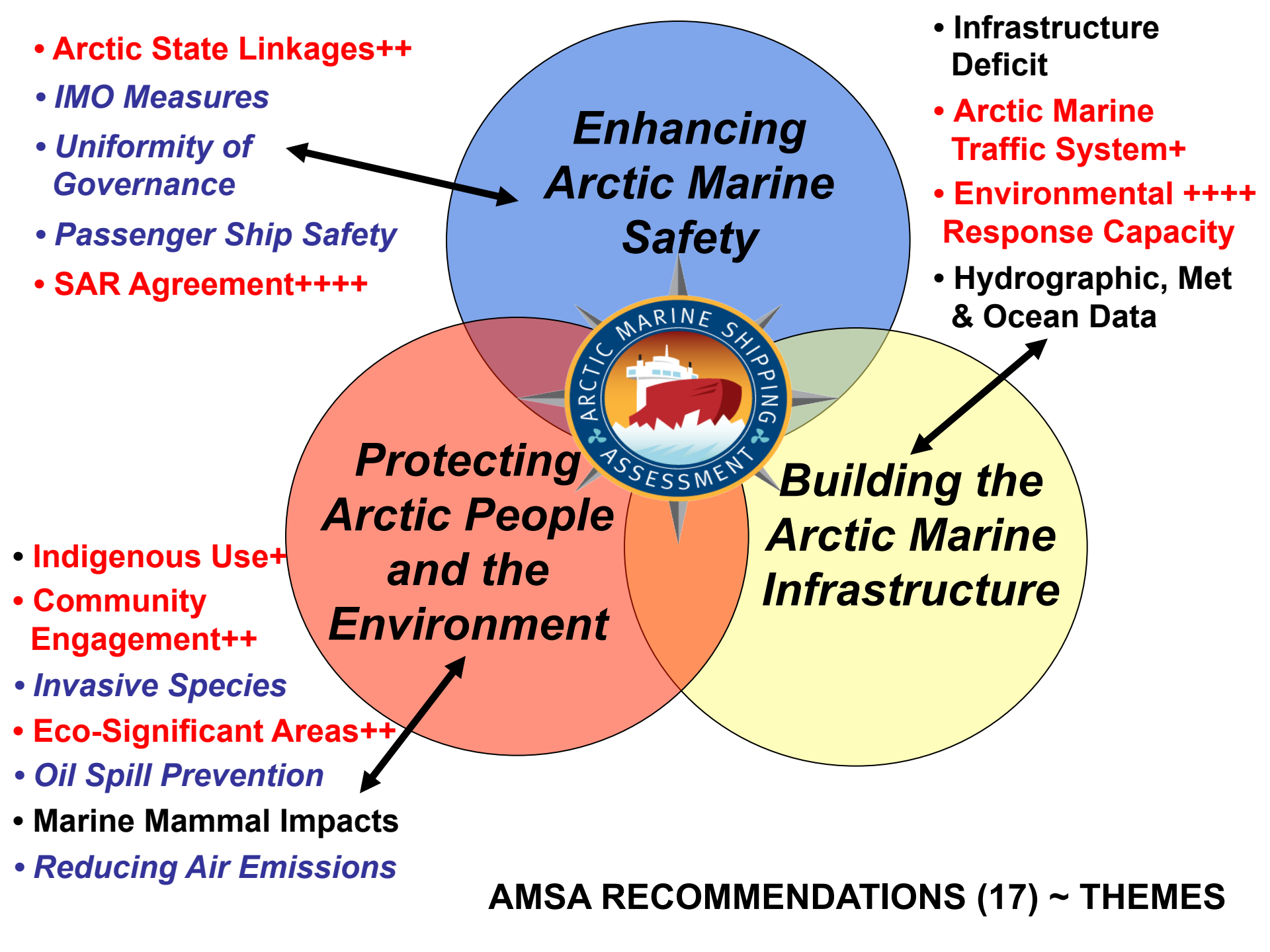
Polar Preserve

Low demand & stable governance slow development in the region while introducing an extensive eco-preserve with stringent "no-shipping zones".



AMSA RECOMMENDATIONS (17) ~ THEMES


ARCTIC SEARCH AND RESCUE AGREEMENT
AREAS OF APPLICATION
ILLUSTRATIVE MAP
Search and Rescue Delimitation
Canada-Denmark
Canada-United States
Denmark-Iceland
Denmark-Norway
Finland-Norway
Finland-Sweden
Finland-Russian Federation
Iceland-Norway
Norway-Sweden
Norway-Russian Federation
Russian Federation-United States
Southern Extent
Arctic Circle
Russian Federation
Norway
Finland
Sweden
Iceland
Denmark
(Greenland)
Canada
United States
50°05'00"N
159°00'00"E
54°00'00"N
169°00'00"E
54°49'00"N
170°12'00"E
60°00'00"N
180°00'00"E/W
64°03'00"N
172°12'00"W
65°00'00"N
168°58'24"W
66°33'44"N
180°00'00"E/W
50°05'05"N
48°20'00"N
145°00'00"W
54°40'00"N
140°00'00"W
50°05'00"N
143°40'00"W
54°40'00"N
136°00'00"W
54°00'00"N
136°00'00"W
70°16'28.95"N
032°04'23"E
72°27'51"N
035°00'00"E
73°00'00"N
000°00'00"E/W
66°33'44"N
000°00'00"E/W
61°00'00"N
000°00'00"E/W
73°00'00"N
020°00'00"W
70°00'00"N
020°00'00"W
82°00'00"N
060°00'00"W
78°00'00"N
075°00'00"W
76°00'00"N
076°00'00"W
61°00'00"N
030°00'00"W
63°30'00"N
039°00'00"W
58°30'00"N
030°00'00"W
65°00'00"N
057°45'00"W
58°30'00"N
043°00'00"W
63°00'00"N
055°40'00"W
58°30'00"N
050°00'00"W
60°00'00"N
Azimuthal Equidistant Polar Projection


• Arctic State Linkages++
• IMO Measures
• Uniformity of Governance
• Passenger Ship Safety
• SAR Agreement++++
Enhancing Arctic Marine Safety
• Infrastructure Deficit
• Arctic Marine Traffic System+
• Environmental ++++ Response Capacity
• Hydrographic, Met & Ocean Data
ARCTIC MARINE SHIPPING ASSESSMENT
Protecting Arctic People and the Environment
Building the Arctic Marine Infrastructure
• Indigenous Use+
• Community Engagement++
• Invasive Species
• Eco-Significant Areas++
• Oil Spill Prevention
• Marine Mammal Impacts
• Reducing Air Emissions
AMSA RECOMMENDATIONS (17) ~ THEMES

AMSA 2009:

- **Baseline Assessment**
- **Arctic Council Policy Document**

~ Negotiated Text Approved 29 April 2009 ~

- **Strategic Guide**

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Summary Points & Challenges

- Arctic Natural Resource Development ~ Main Driver
- Greater Marine Access & Potentially Longer Navigation Seasons
- NSR ~ Seasonal Supplement to the Suez Canal Route ~ Opportunities for Seasonal Trans-Arctic Voyages
- 'New' Suez & Panama Canals Add Capacity to Global Routes
- Four Challenges:

(1) Defining/Maintaining the Ice Navigation Season Length

(2) Addressing the Huge Arctic Marine Infrastructure Gap

(3) Implementing the IMO Polar Code & Uniformity

(4) Projecting Plausible Ship Traffic Patterns/Trends

The Maritime Arctic of the Future ~ Complexity