Recent and Planned Oil & Gas Exploration, Development, Production and Transportation Activity in Arctic Regions

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3rd Symposium on the Impacts of an Ice-Diminishing Arctic on Naval and Maritime Operations

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Resources in the Arctic

17th Century Dutch Whalers

Svalbard
Coal Miners

Canadian Lead/Zinc Mine

- Development of the Arctic is not new
- Historically the Arctic Regions of our planet have attracted human activity in relation to resource development
  - Fishing and Whaling: Greenland, Canada, Alaska, Russia
  - Coal: Svalbard
  - Lead-Zinc: Greenland Canada and Alaska
  - Nickel: Russia
  - Iron Ore: Canada
  - Oil and Gas: Russia, Alaska, Canada, Norway

Overview

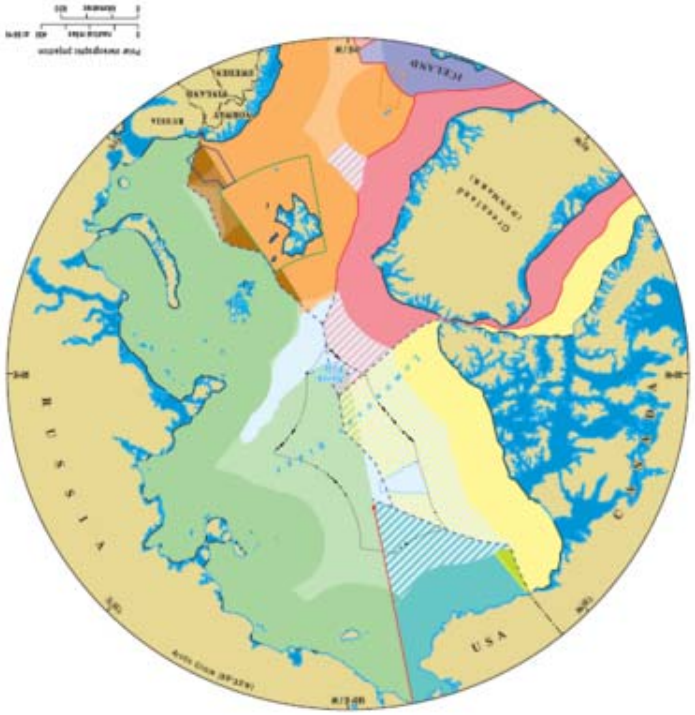
- **When assessing the issues associated with Arctic offshore development it is important to take a broad and holistic view. The problems cannot be stated only in technical terms. The issues also involve:**
  - **non-interference with traditional activities, such as whale and walrus hunting**
  - **logistics requirements**
  - **Infrastructure (or lack of it) problems**
  - **emergency evacuation and rescue**
  - **restrictions on activities which may interfere with marine mammal migration or season migratory bird populations**
  - **oil spill prevention and mitigation**
  - **radiated in water noise issues**
  - **ice-alert systems capabilities i.e. the ability to identify hazardous ice**
  - **air quality issues when dynamic positioning and/or aggressive ice management is applied**
  - **ice management systems capabilities i.e., the ability to actively mitigate potential loads from hazardous ice**
  - **and many more**

Areas of Interest in the Arctic Ocean

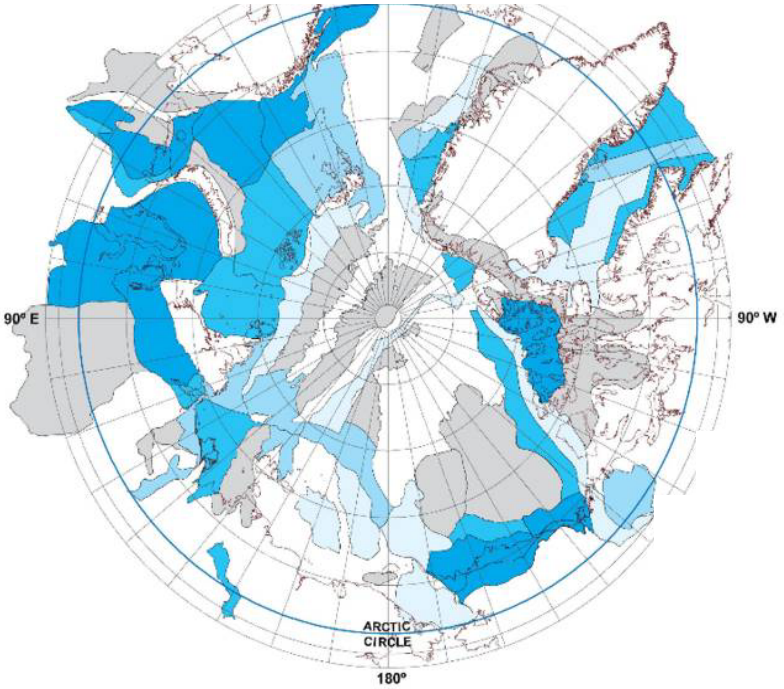
- Primary areas of interest for oil & gas exploration and production are in the shallower continental shelf areas off northern Russia, Canada and Alaska
- Current areas of interest are typically in water depths of less than 100m. in the Beaufort, Chukchi, Timan-Pechora Seas. Actually much of it in water-depths of less than 40m.
- A few deeper water areas have interest such as east and west Greenland and the northern Barents Sea (*Snohvit & Shtokman*)

Arctic Boundaries and Yet To Find, YTF, Oil & Gas

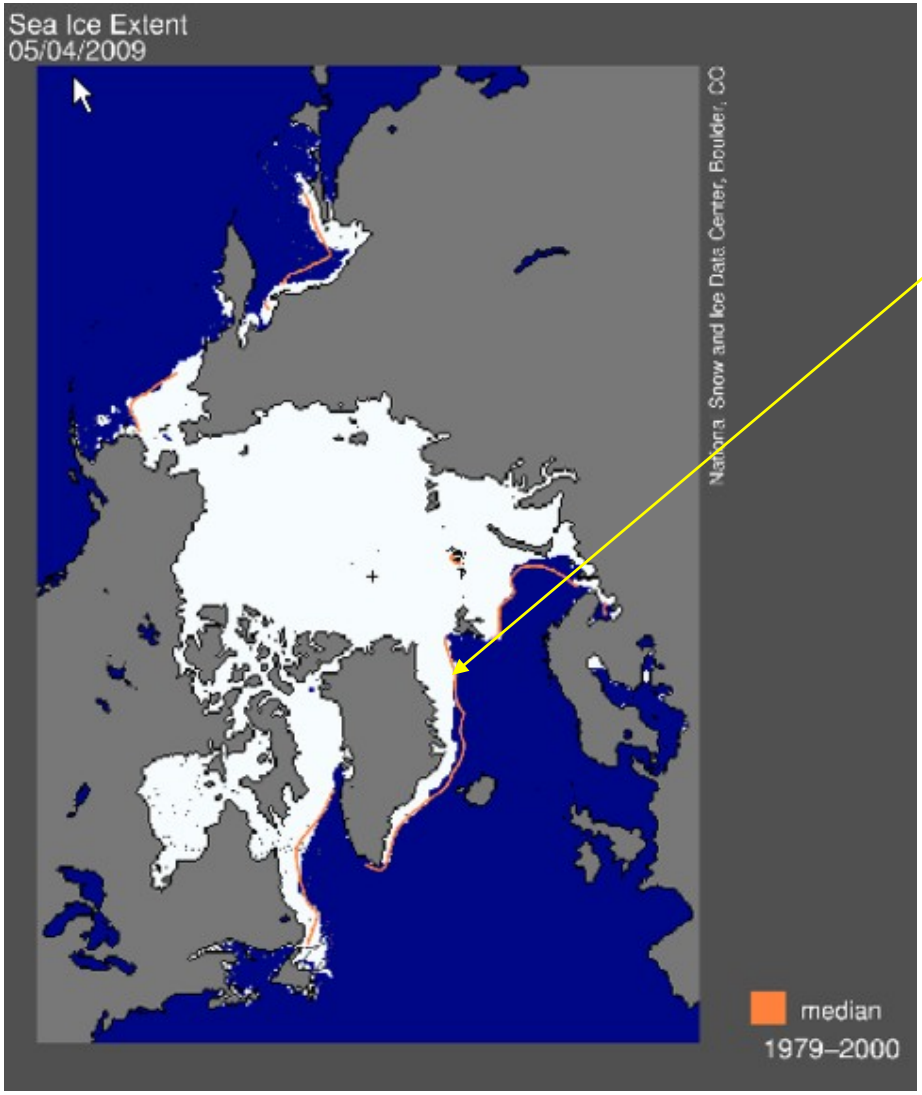
Arctic Boundaries



Arctic YTF Oil & Gas



Arctic Ice – May 4, 2009



Ice coverage approximately same as 1979-2000 average coverage

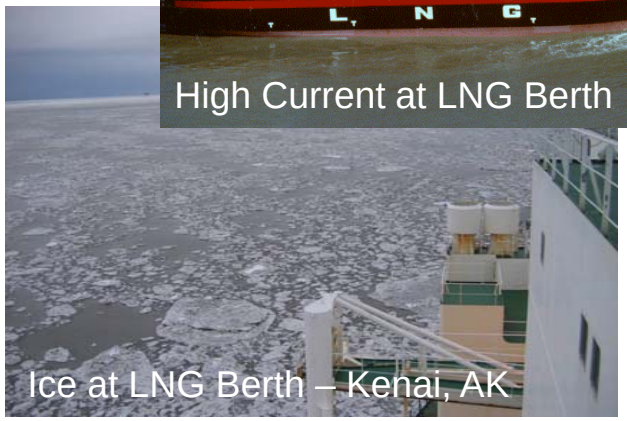
For year round operations – ice is still and will remain a major concern for marine and offshore activities well into the future

Overview of ConocoPhillips High Latitude Offshore Activities

Alaska LNG Export


LNG Tanker in Cook Inlet, AK


High Current at LNG Berth


Ice at LNG Berth – Kenai, AK

- Since 1969 ConocoPhillips has exported LNG from Kenai to Japan
- This is the first and only LNG Export facility in the US
- In 1995, the Kenai LNG project replaced the original Swedish built ships with two somewhat larger capacity ships, (89,880 cubic meters) built by IHI in Japan.
- The ships are steam turbine driven with and installed power of 21,000 h.p. giving a service speed of 18.5 knots
- The ships, the *Polar Eagle* and *Arctic Sun,* are unique in that they employ free-standing prismatic cargo tanks - so far the only ships in service with this arrangement.

Alaska North Slope Oil Export

Polar Tanker at Shipyard


Tanker Loading at Valdez, AK


Polar Tanker, Prince William Sound

Five (5) - 1 million bbl modern "Jones Act" tankers built in early 2000s to transport crude oil from TAPS terminal in Valdez to west coast refineries:

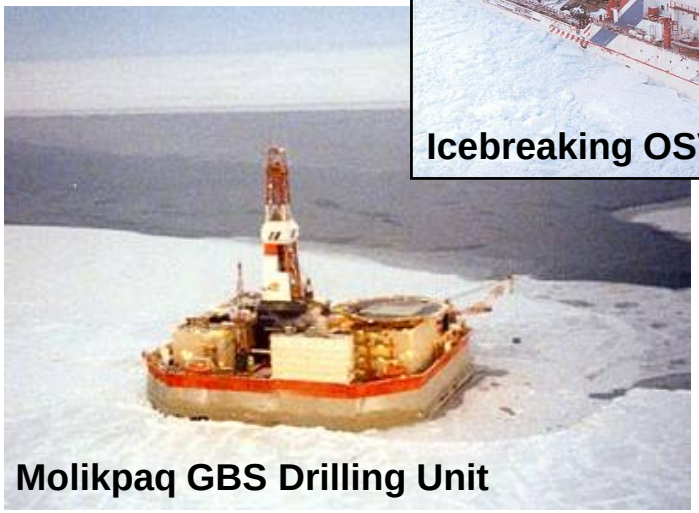
- Double-hulled
- Designed for high-latitude operations
- Highly redundant propulsion and steering systems
- Twin main engines, propellers and rudders with bow thruster
- Integrated bridge and engine controls
- State of the art navigation equipment

Canadian Beaufort Sea

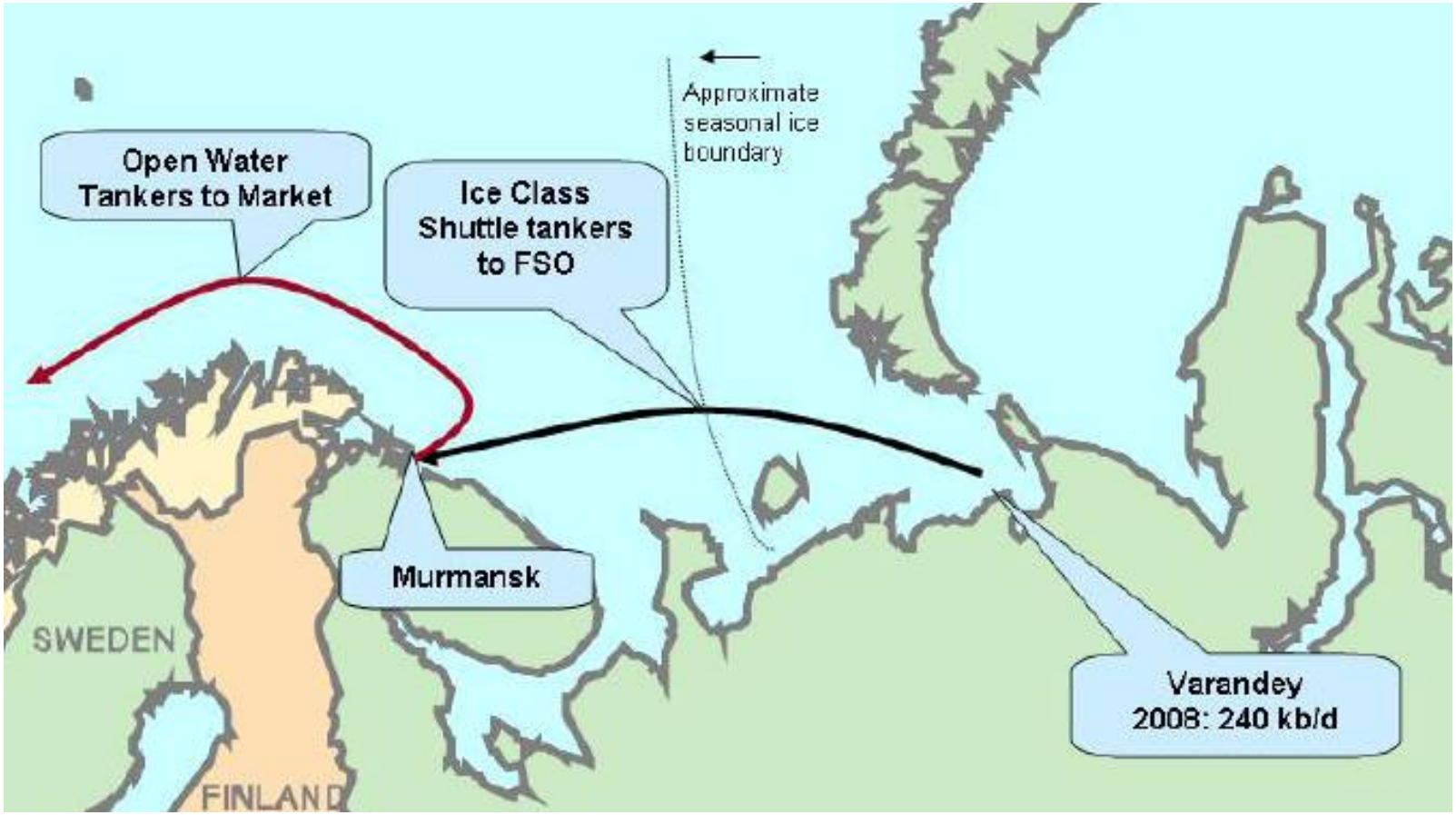
- Gulf Canada Resources which was later acquired by ConocoPhillips did a significant amount of exploration drilling in the Canadian Beaufort Sea in the late 1970s and early 1980s
- Two unique drilling units were designed and built
  - the Kulluk – a circular moored ice-worthy drill barge
  - the Molikpaq – a steel gravity based structure
- In addition 4 arctic capable icebreaking supply boats were built and deployed


Kulluk Drill Barge


Icebreaking OSV


Molikpaq GBS Drilling Unit

Varandey Oil Export Project



Varandey Project Tankers

- **Three (3) icebreaking tankers**
  - 70,000 tdwt capacity –92,000 tons displacement.
  - Contracted with Samsung H.I.
  - Break 1.5m (5 ft.) of level ice continuously
  - 2 x 10MW (total ~27,000 h.p.) Tractor Azipod propulsion
  - Cost for 3 ships < $450 million
  - Construction Schedule – Contract to Delivery - 26 months
  - One ship instrumented to collect ice interaction data

Varandey Ice Operations – April 2009

Icebreaking Tanker preparing to connect

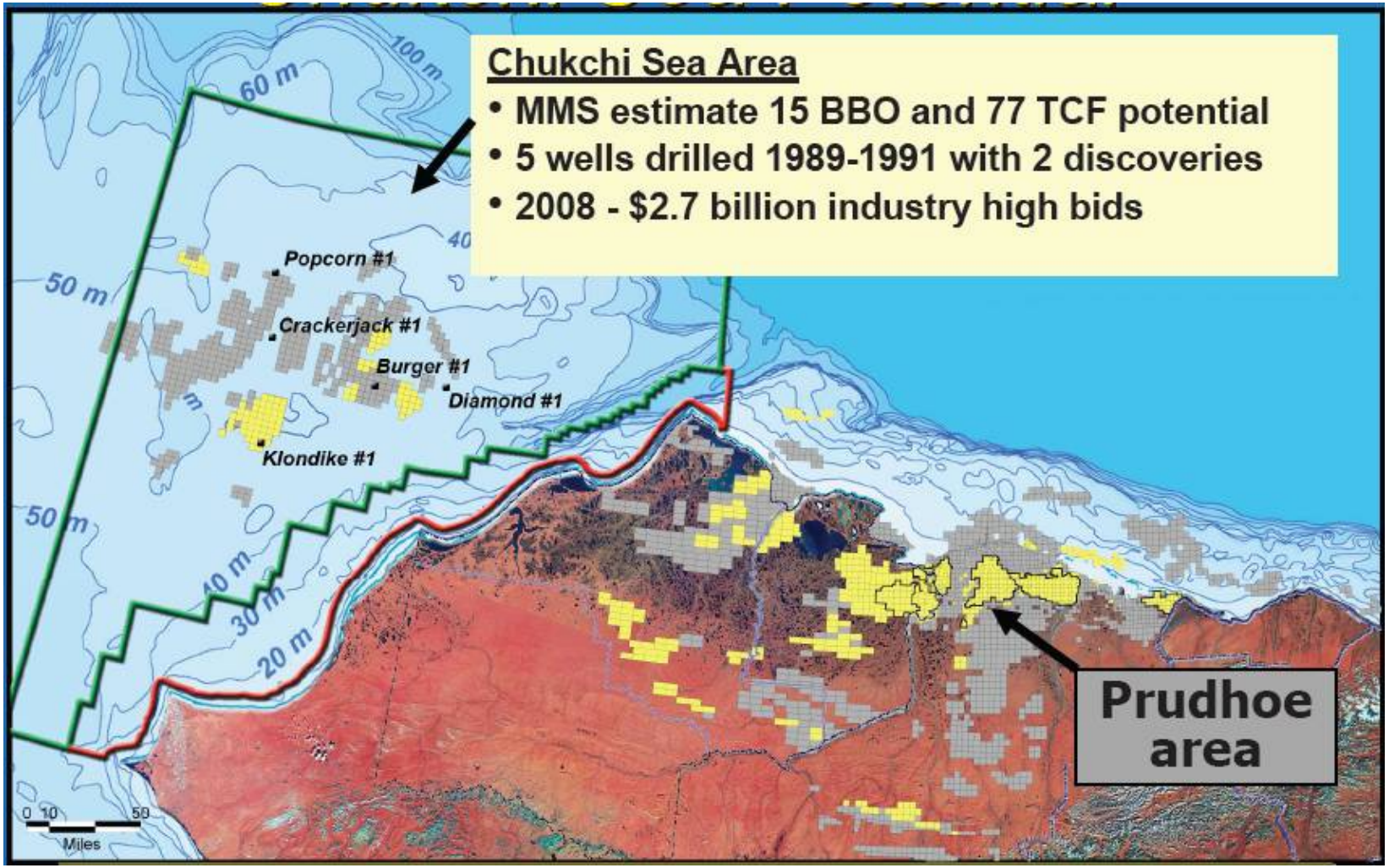
Ice Resistant Loading Structure

Icebreaking Support Vessel – 13,400 h.p.

Icebreaker – Ice Management Vessel – 22,500 h.p.

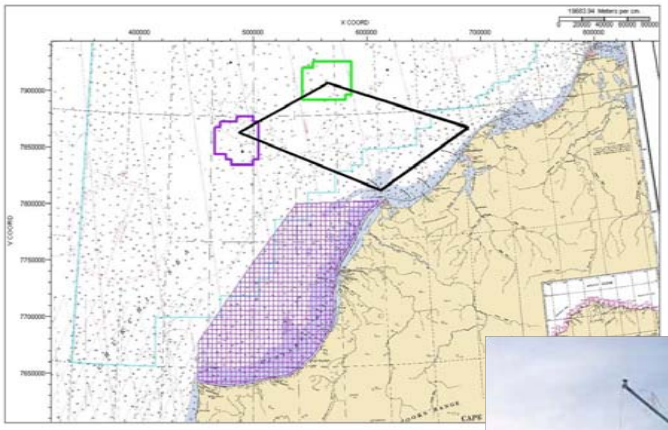
Description of Chukchi Sea Exploration Program in 2011

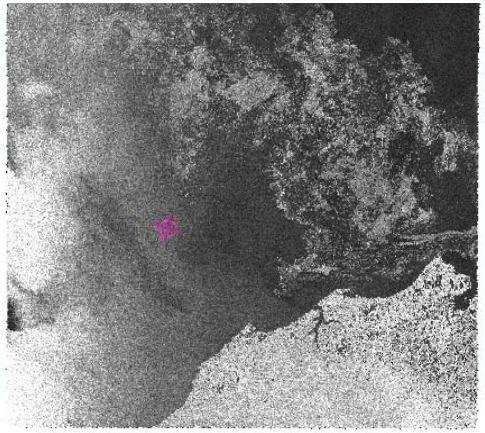
Chukchi Potential



Environmental Baseline & Other Studies

- ConocoPhillips has been and will continue to collect data to support its 2011 exploration program
- 2008
  - Site Survey at Klondike & seafloor imaging (Norseman 1)
  - Offshore environmental baseline studies (Bluefin)
  - Ice and open water studies
  - Air monitoring station in Wainwright
- 2009
  - Seabird Observations
  - Mammal Surveys
  - Physical Oceanography
  - Biological Oceanography
  - Acoustics Monitoring
  - Contaminants (not yet confirmed)
  - Coordinate with MMS COMIDA project to collect contaminants samples (sediment/biota) in a % of 2008 locations
- Ongoing work is being done with high resolution SAR satellites to characterize ice conditions





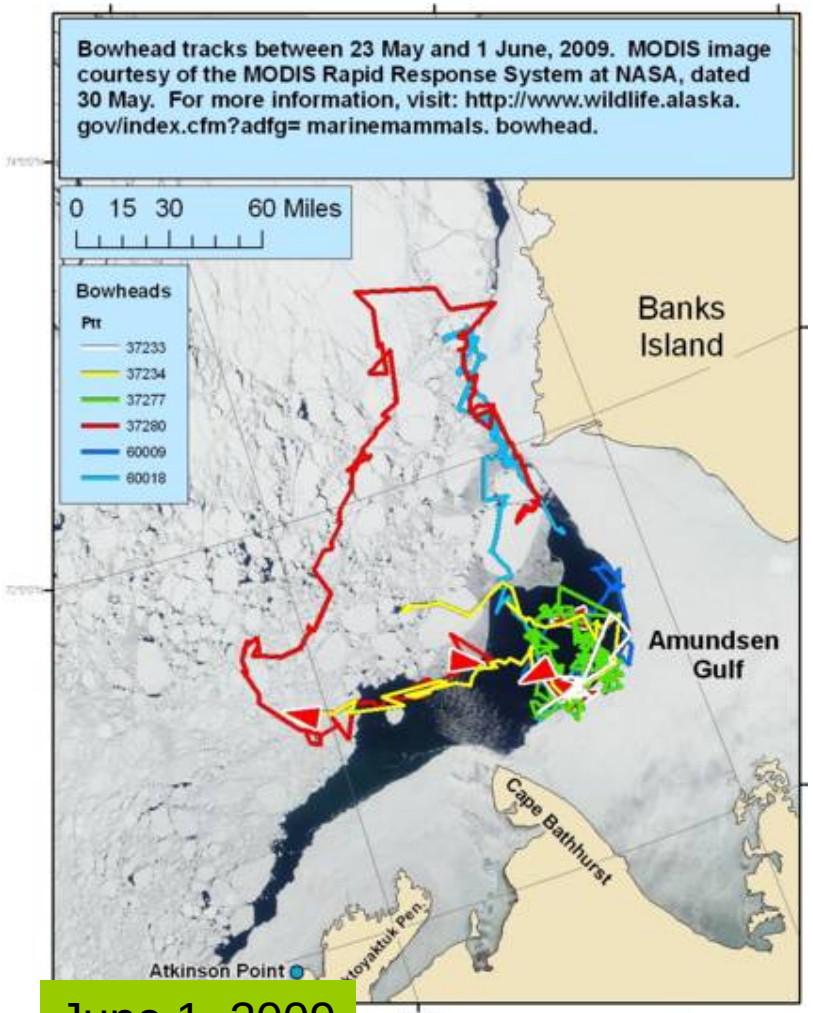
Unique Offshore Conditions

Whale Hunting – nutritional and cultural needs of local communities

Co-existence with Neighbors

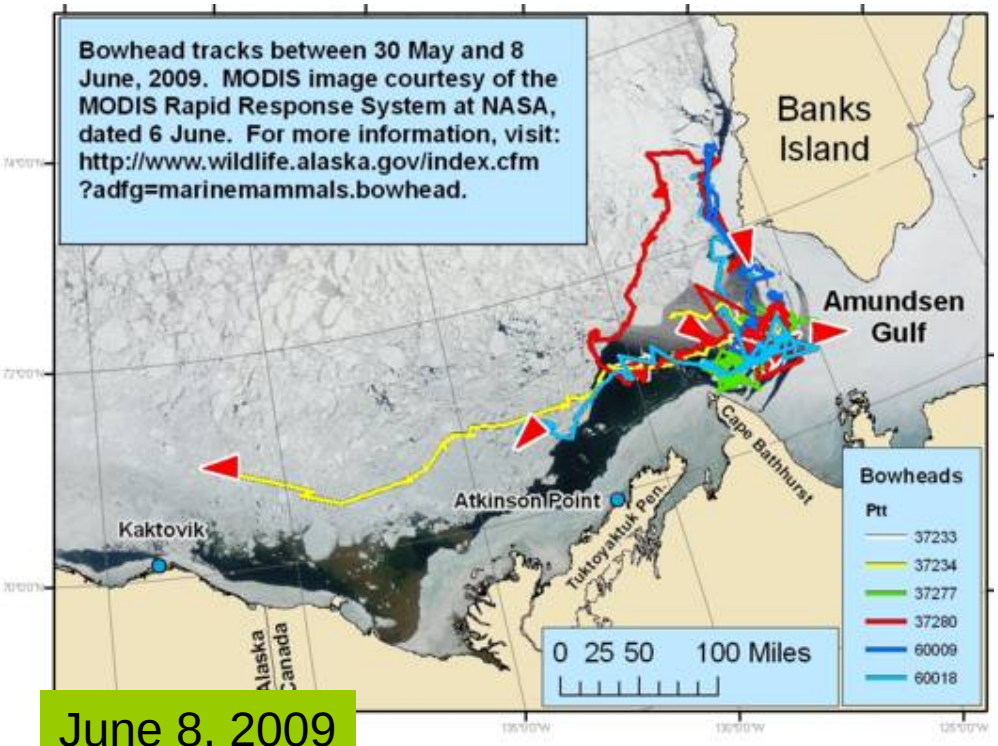
- Subsistence way of life
- Sensitive environment

Bowhead Whale Tracking



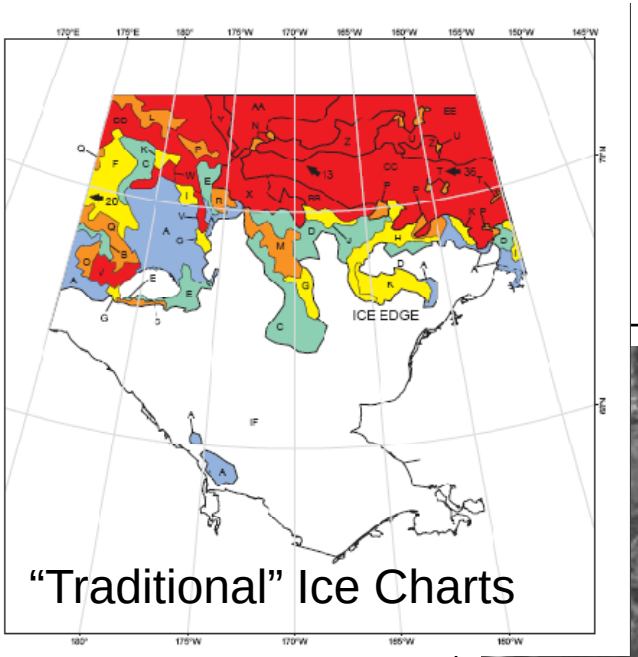
June 1, 2009

6 bowhead whales in Amundsen Gulf
May-June 2009

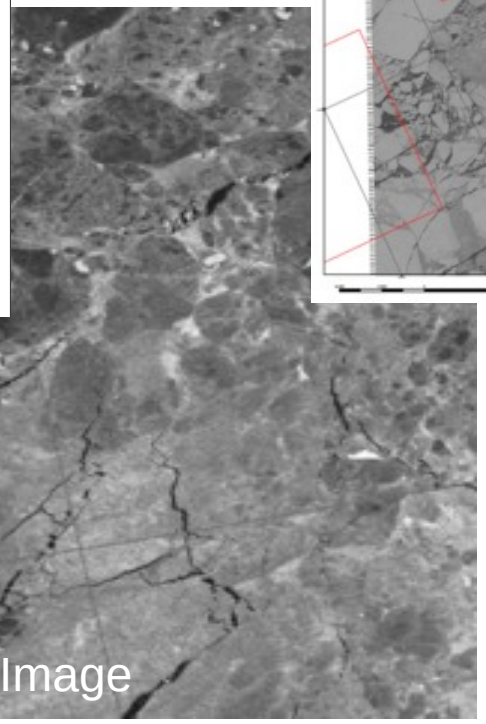


June 8, 2009

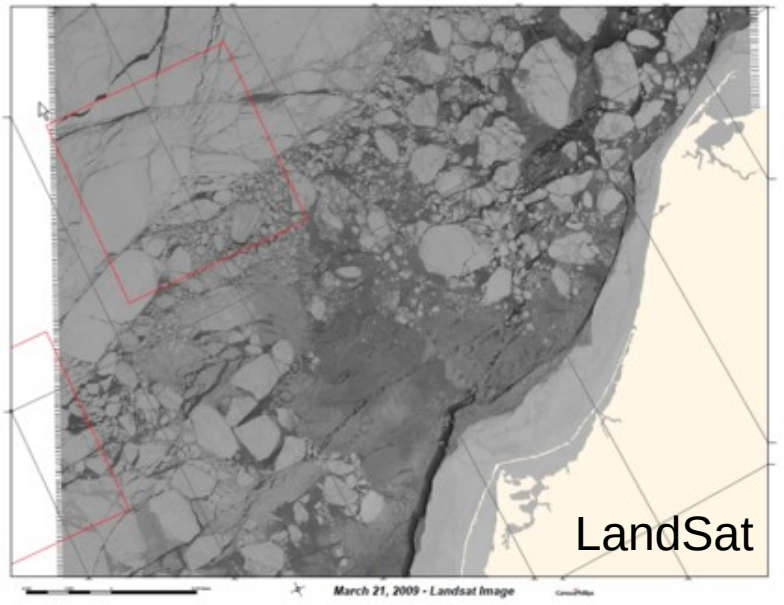
Arctic Ice Conditions



"Traditional" Ice Charts

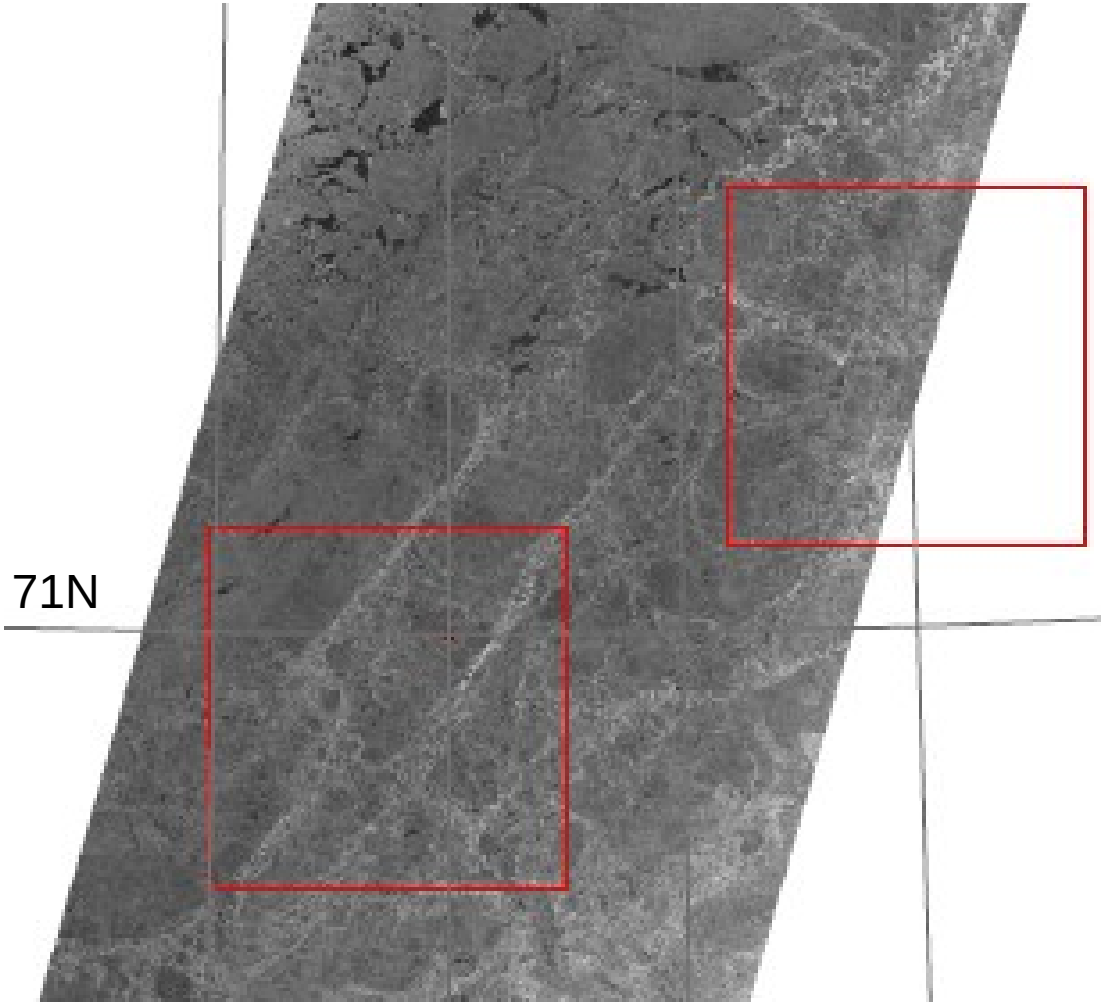


SAR Image



LandSat

TerraSAR-X Images –Chukchi Sea



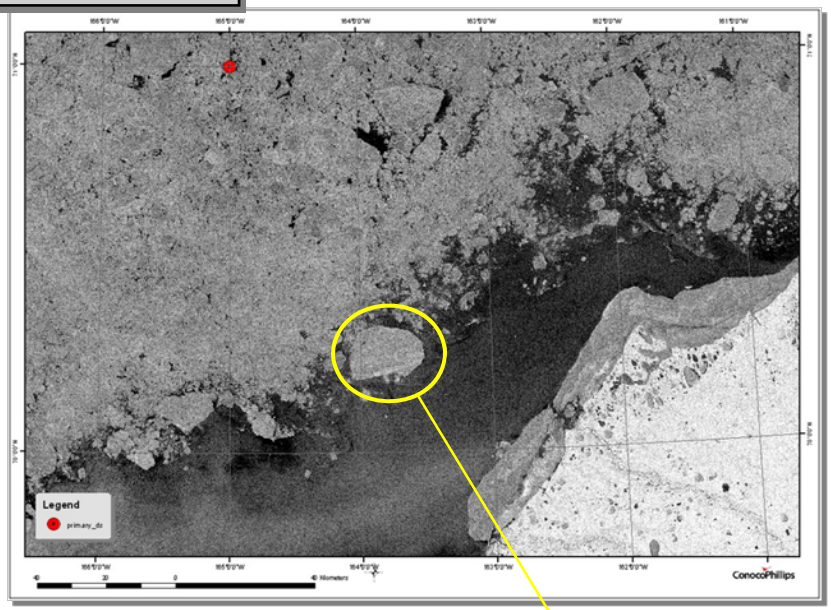
ScanSAR mode images over proposed drilling site at ~71N – 165W

May 25, 2009 image

10/10 mostly “medium” first year ice with some “thick” first year ice and leads beginning to open north of the drilling site

Example of SAR Tracking of Ice

6/16/08



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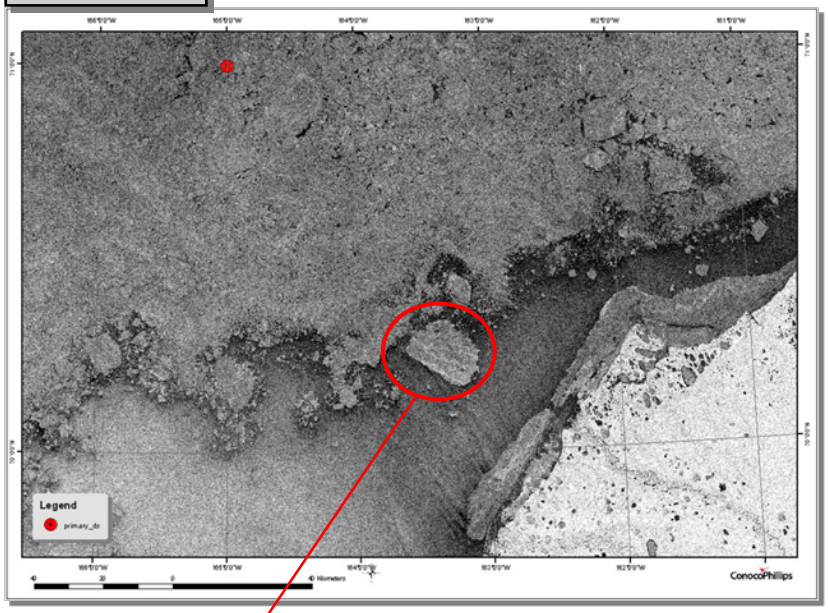
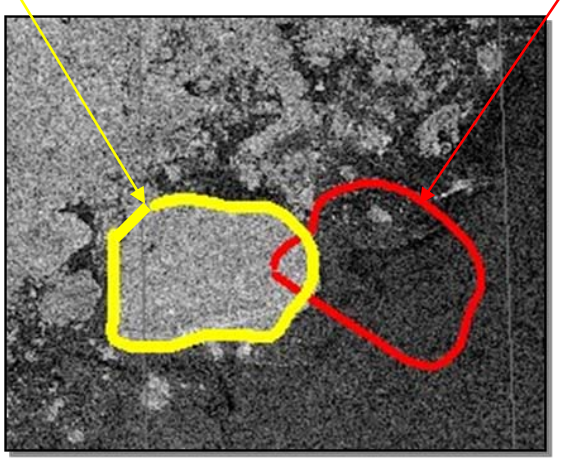
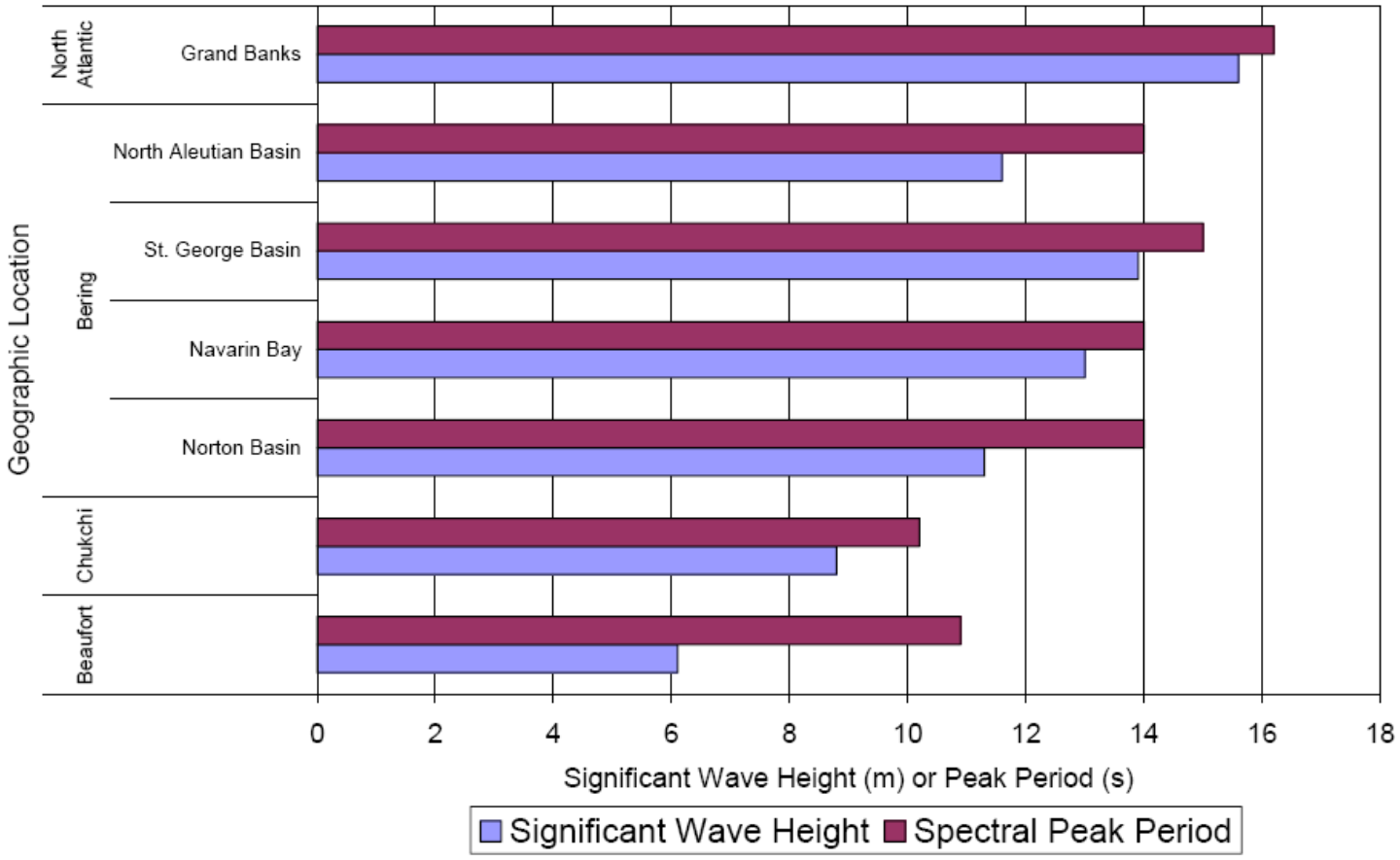




Chukchi Sea

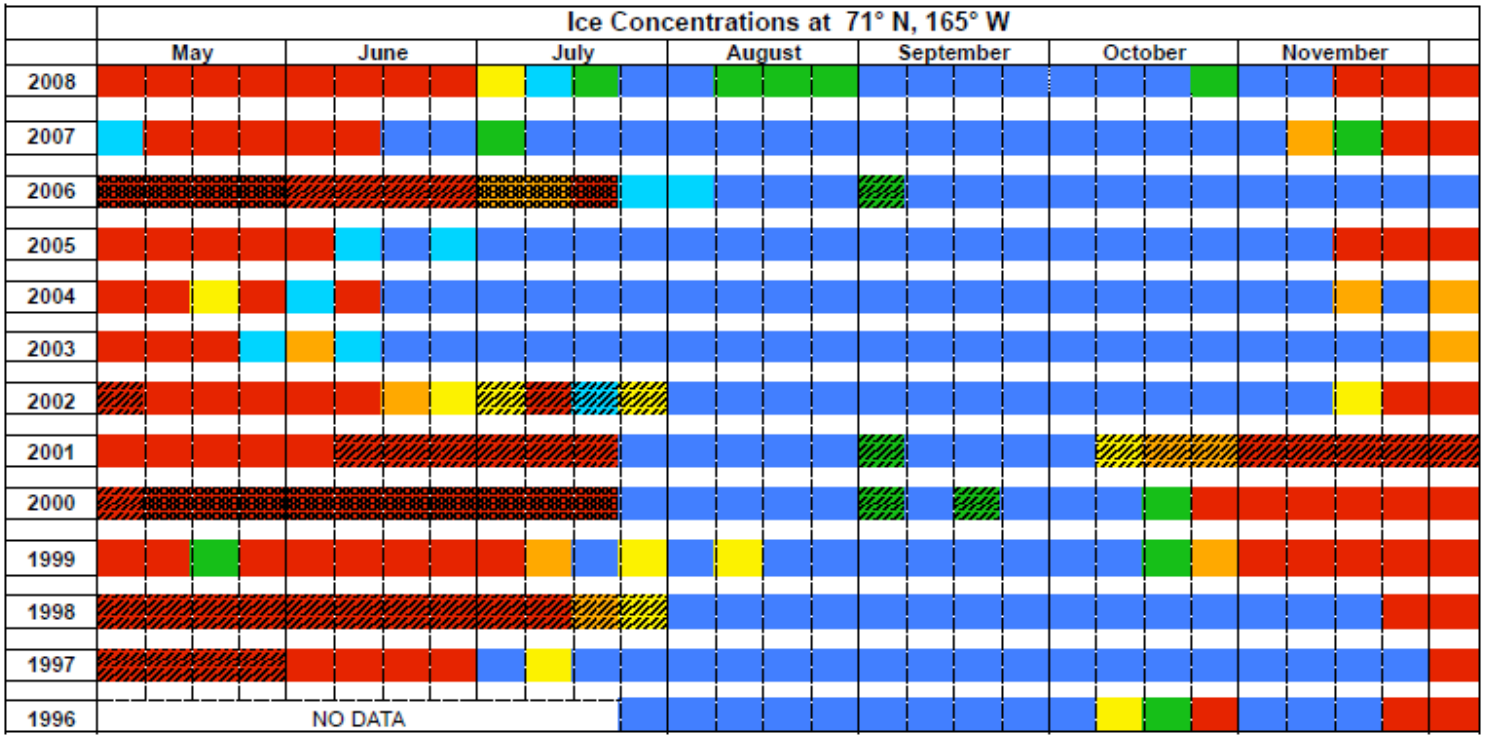
This large ice floe has moved 21 km in six days (roughly 0.15 km/hr)

100 Year Wave Conditions



Ice Free Seasons at Drill Site

Ice Conditions (blue = open water)



Total Ice Concentration Tenths		Multi-year Ice	
		1 to 3/10	>3/10
Ice Free			
Open Water	<1/0 ice		
1/3/10			
4 to 6/10			
7 to 8/10			
9 to 9+/10			

Data Source: US National Ice Center archived products

Why consider a jack-up rig?

- **Ideal water depth for JU drilling unit (~140 feet) and sufficient ice-free season at Devil's Paw**

- **Higher up-time due to insensitivity to wave action as compared to a drillship**

- **State of the art drilling**
  - **Increased mud system capabilities**
  - **Dual activity, drill and make up casing to run multiple joints**
  - **Able to drill and evaluate well much faster**

- **Improved HSE Performance**
  - **Pipe handling**
  - **Engines meet latest emissions requirements**
  - **Less noise in water, rig elevated**

- **Higher Operational Efficiency**
  - **Efficient drilling leads to less risk due to weather or ice events**

Jack-Ups in Ice Prone Waters

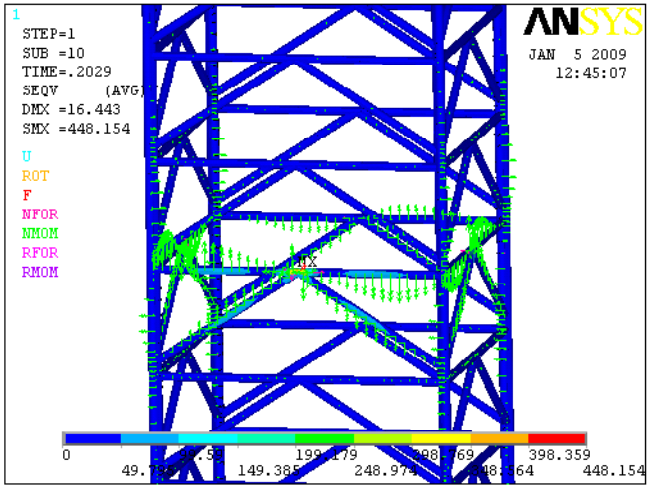
- Light seasonal ice East Coast since 1996
- Grand Banks Newfoundland 2005/2006 iceberg area
- 6 Wells Bering Sea/Norton Sound (1984/1985)
- Russia Pechora Sea 2004 & 2008

Rowan Gorilla Rig – Canada E. Coast

Rowan Gorilla Rig – Newfoundland

JU Leg Strength in Ice

- While no operations in ice are planned with the JU rig, it was deemed prudent to examine the potential strength limit for the legs of a JU unit to sustain ice loading.
- Ice model basin test have been carried out to ascertain this limit
- In addition two independent analytical studies have been completed by leading JU authorities – ABS and Keppel O&M

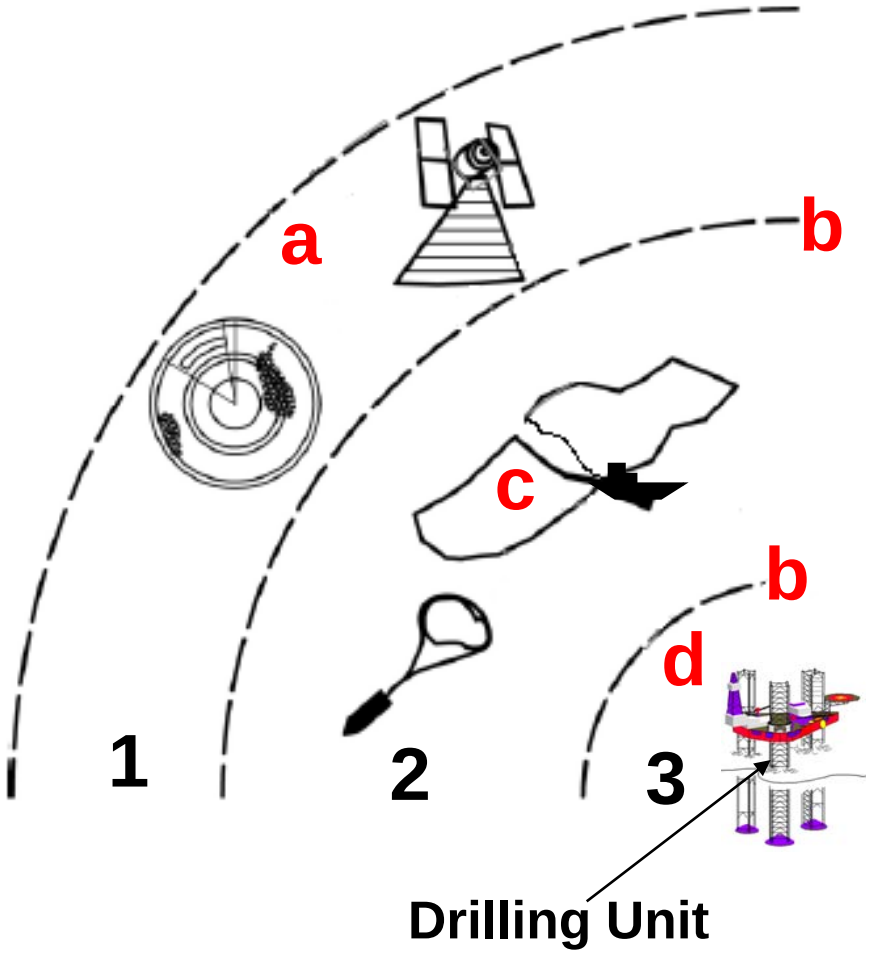


Structural Analysis under Ice Load

What are Ice Alert and Ice Management Systems?

- Mobile offshore drilling units deployed in ice-covered waters are often supported by highly capable ice management vessels, with the intended role of modifying the local ice environment, reducing ice actions on the structure, and enhancing ice clearance.
- The types of ice management systems that are employed can have a significant influence on the design approach taken for any particular offshore system.
- This depends upon expected levels of ice management reliability, for example, the ability to consistently detect potentially hazardous ice conditions and in turn, successfully manage them before they interact with the structure.
- The major components of an ice management system used for mobile facilities in ice prone regions are illustrated on the following slide.

Ice Alert & Ice Management System



ZONES:

1. Observation Zone
2. Management Zone
3. Critical Zone

ACTIONS:

a. Detection

b. Threat Evaluation

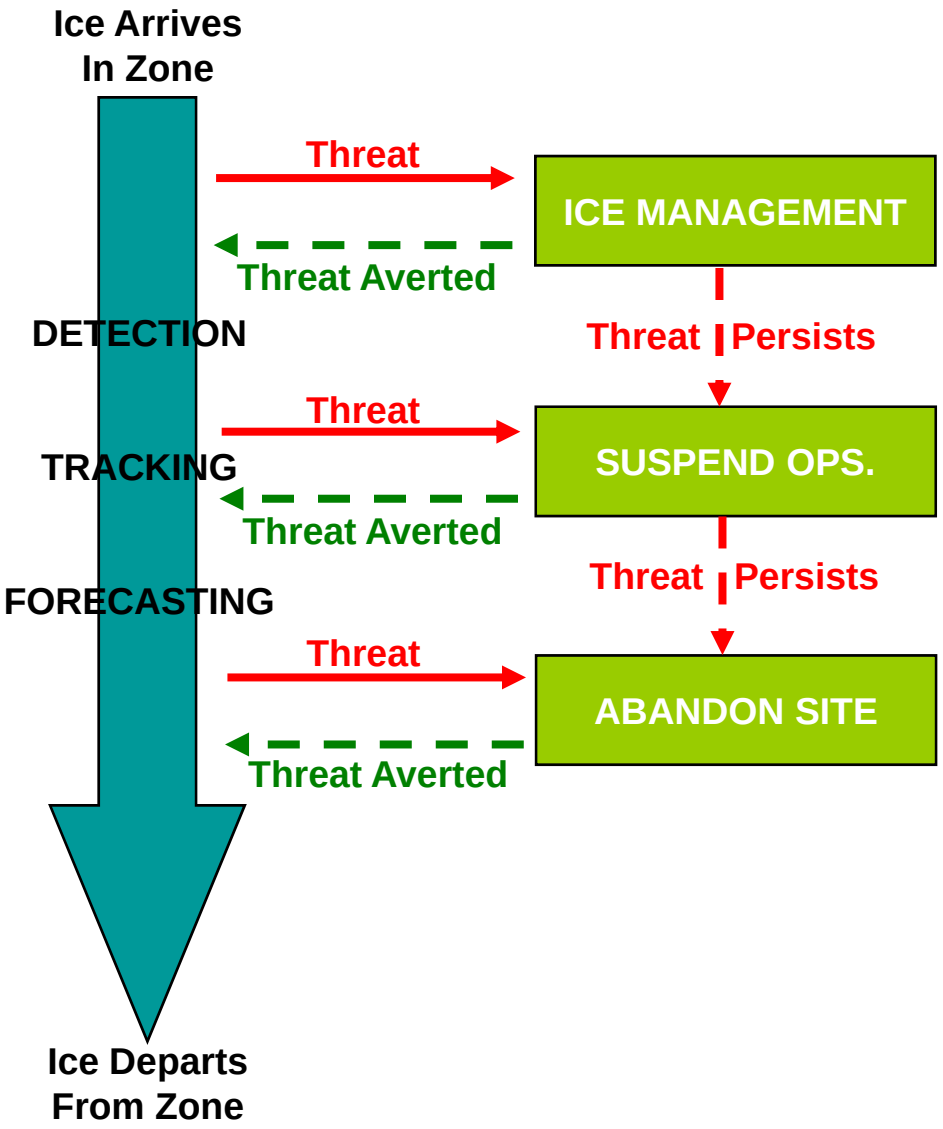
c. Physical Management

d. Secure & Prepare to Abandon

After - ISO/DIS 19906 – Arctic Offshore Structures

Ice Management Strategy

- The ice management strategy for Chukchi summer-fall sea ice conditions is illustrated in the flow diagram
- Detection, tracking and forecasting continue throughout the time when the potentially hazardous ice features are present.
- Once a threat is perceived and the feature is within prescribed time and/or distance limits as specified in the ice management plan, the appropriate ice management resources will be deployed.
- If the threat is averted, detection, tracking and forecasting will continue until there is assurance that the feature can no longer approach the JU unit.
- Drilling operations may be suspended and ultimately, if the threat persists, the well may be secured and JU unit jacked-down onto its hull and towed clear disconnected.



Potential Ice Management Vessels


Fennica - Finland


Varandey - Russia


Atle - Sweden

- Typical ice breakers currently available for duties in the Chukchi Sea are shown on the left.
- Baltic Sea and Russian vessels may be available for summer/fall operations in Chukchi Sea, as permitted by their normal operating seasonal duties
- Ice management vessels will be used to continuously observe ice conditions and take action to manage hazardous ice features

Ice breakers

Source: TransViking

Ice data

Source: FIMR

Ice Management Plan

AHTS

Source:
TransViking

Drill Site @ 71°N & 165°W

Wet-tow

Supply Vessels

Source:
Resolvemarine

Dry-tow

Source:Dockwise

Point Barrow

Wainwright

Ware Vessel

Source:
Universal Logistics

Oil Spill Response

Sources: APPSCI & DavidCMartin

CHUKCHI PROJECT FLEET

Arctic ~~Challenges~~ Opportunities

- Resource potential–World-class opportunity
- Arctic history–Met challenges, built facilities in difficult environments
- Opportunity–Industry can deliver technology–Must foster stakeholder confidence