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DNV GL OIL & GAS

Arctic Risk Map

Communicating Region's Complex Risk Picture

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Esri Petroleum GIS Conference. London, Nov. 6th. 2015

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DNV GL Global reach – local competence

150
years

400
offices

100
countries

16,000
employees


Addressing challenges in the oil and gas industry
Safety and environmental issues
Deepwater and harsh environment
Ageing assets and performance issues
Technology development
Cost pressure and standardization

The Arctic - taking a broader view

- **The Arctic** is not a uniform environment
- There are very different perceptions of risk [in the Arctic]
- We wanted to create an interactive map as a platform for transparent discussion and common understanding of risk drivers
- The map was to provide insight to the actual physical and biological environmental conditions of the Arctic

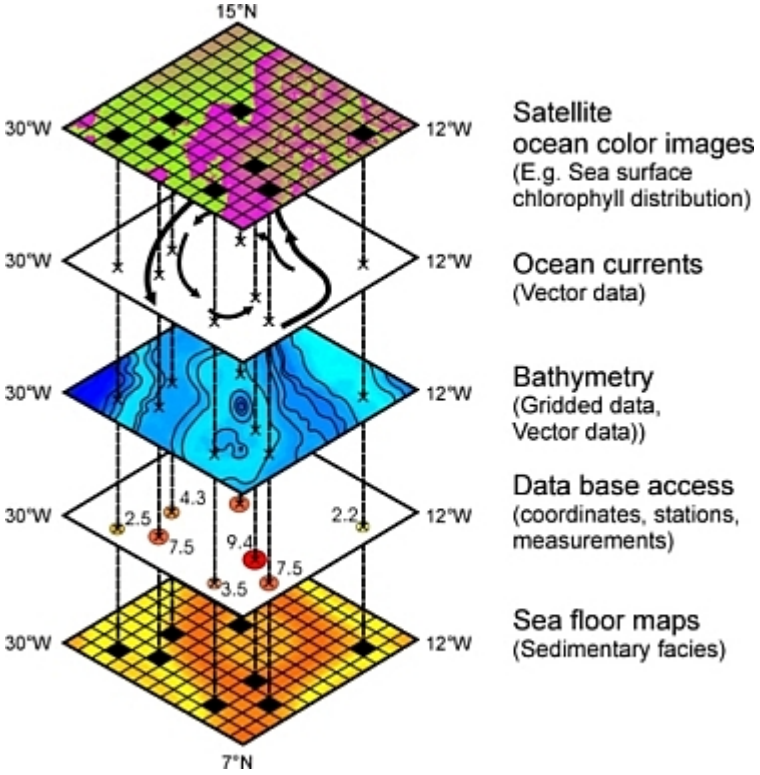
Operating in the Arctic requires adaptation to local conditions

- Low temperatures
- Sea ice and icebergs
- Marine icing
- Atmospheric icing
- Visibility & darkness
- Remoteness and lack of infrastructure

- Reduced satellite coverage
- Uncertainty in metocean data
- Polar lows
- Joint probabilities of loads
- Vulnerable ecosystems

Building the Arctic risk map – Approach and methodology

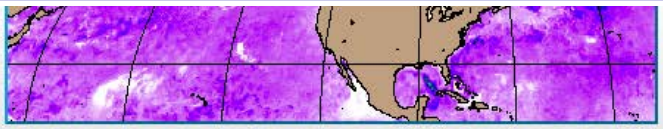
- Determine relevant data sources to our analysis
- Qualify data with respect to quality, consistency, and reliability
- Assemble and integrate data in ArcGIS
- Spatial analysis to derive statistics on phenomena and their covariation
  - Capture spatial and temporal variation
  - Location specific risk analysis



Screening of data sources

HYBRID COORDINATE OCEAN MODEL

HYCOM



Consortium for Data Assimilative Modeling

FOLLOW-ON

myOcean

OCEAN MONITORING AND FORECASTING

Providing PRODUCTS and SERVICES for all marine applications

CISL Research Data Archive

Managed by NCAR's Data Support Section
Data for Atmospheric and Geosciences Research

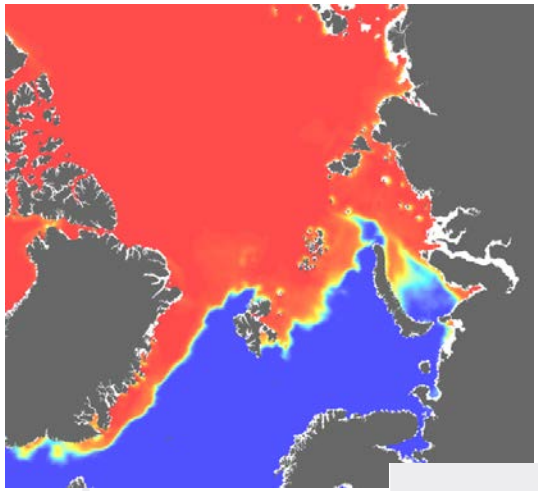
RDA

Norwegian Meteorological Institute

Catalog http://thredds.met.no/thredds/fou-hi/norkyst800m.html

MyOcean.eu : *Arctic Ocean Physics Analysis and Forecast*

- http://www.myocean.eu/web/69-myocean-interactive-catalogue.php/?option=com_csw&view=details&product_id=ARCTIC_ANALYSIS_FORECAST_PHYS_002_001_a



Variables:

barotropic_sea_water_x_velocity
barotropic_sea_water_y_velocity
depth
grid_latitude
grid_longitude
sea_ice_x_velocity
sea_ice_y_velocity
sea_water_salinity
sea_ice_area_fraction
sea_ice_thickness
sea_ice_albedo
surface_snow_thickness
sea_surface_height_above_geoid
sea_water_potential_temperature
sea_water_y_velocity
sea_water_x_velocity

Geographical coverage:

Areas:
arctic-ocean

Spatial resolution:	12.5 km
Vertical coverage:	from -5500m to 0m (CRS=EPSG:5714)
Temporal resolution:	daily mean
Temporal coverage[*]:	from 2011-10-19, still ongoing
Update Frequency:	daily

VARIABLES

Download	Name	Description	Standard name	Unit	Dimensions
☐	albedo		sea_ice_albedo	1	x,y,time
☐	bsfd		ocean_barotropic_streamfunction	m3 s-1	x,y,time
☐	fice		sea_ice_area_fraction	1	x,y,time
☐	fy_age	age_of_first_year_ice	???	day	x,y,time
☐	fy_frac	fraction_of_first_year_ice	???	1	x,y,time
☐	hice		sea_ice_thickness	m	x,y,time
☐	hsnow		surface_snow_thickness	m	x,y,time
☐	mlp		ocean_mixed_layer_thickness	m	x,y,time
☐	model_depth		sea_floor_depth_below_sea_level	meter	x,y
☐	salinity		sea_water_salinity	1e-3	x,y,depth,time
☐	ssh		sea_surface_elevation	m	x,y,time
☐	temperature		sea_water_potential_temperature	Celsius	x,y,depth,time
☐	u		x_sea_water_velocity	m s-1	x,y,depth,time
☐	uice		sea_ice_x_velocity	m s-1	x,y,time
☐	v		y_sea_water_velocity	m s-1	x,y,depth,time
☐	vice		sea_ice_y_velocity	m s-1	x,y,time

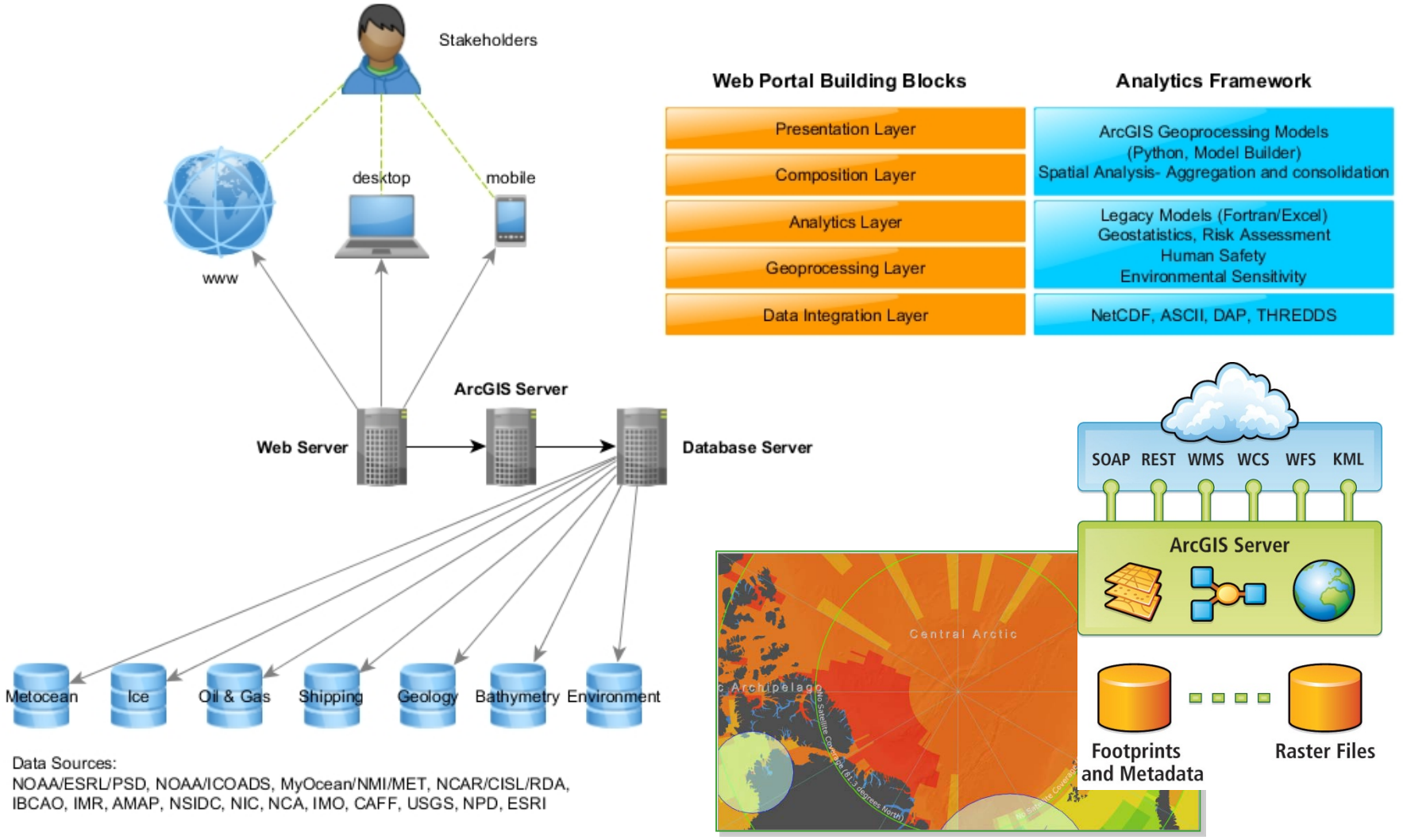
DIMENSIONS

Name	Description	Standard name	Unit	Dimensions
depth	depth	depth	m	depth
latitude		latitude	degrees_north	x,y
longitude		longitude	degrees_east	x,y
time	forecast time	time	hour since 1950-1-1T00:00:00Z	time
x		projection_x_coordinate	100 km	x
y		projection_y_coordinate	100 km	y

Methodology

- Raster Processing from source NetCDF files
  - Multidimensional Tools
    - Make NetCDF Raster Layer
  - Multidimensional Supplementary Tools
  - NetCDF viewers (Panoply)
- Spatial Analysis using Spatial Analyst suite of tools
  - Local Toolset (Cell Statistics)
  - Conditional Toolset (Con)
  - Map Algebra (Raster Calculator)
- ArcMap for map authoring
- ArcGIS Server Advanced for publishing
  - Spatial Server
  - Image Extension for Server
    - Processing and publishing mosaic datasets

Arctic Risk Map – Architecture



A short video (5 minutes)

Arctic Risk Map video

Risk Indices – Environmental Vulnerability Index (EVI)

Environmental Vulnerability Index

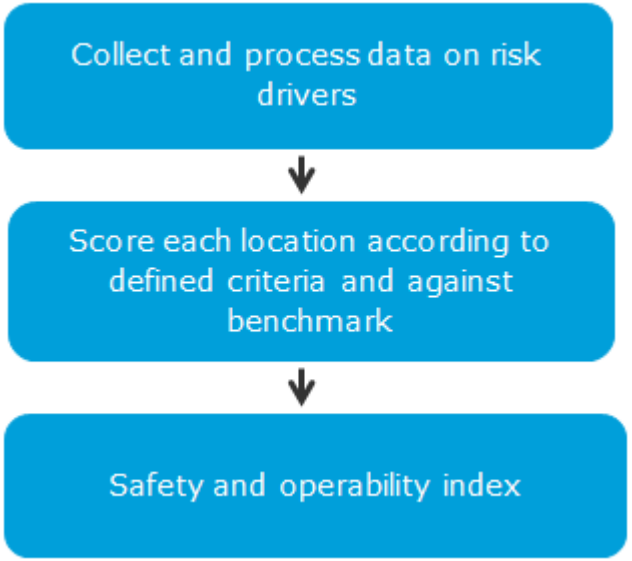
Vulnerability towards oil

Calculated score for each EBSA area to reflect:

- Species distribution and abundance
- Population size and ratio
- Red List status (IUCN)
- Species sensitivity to oil
- Habitat preference and specificity
- Ecosystem significance
- Activity/life stage
- Season

Risk Indices - Safety and Operability Index

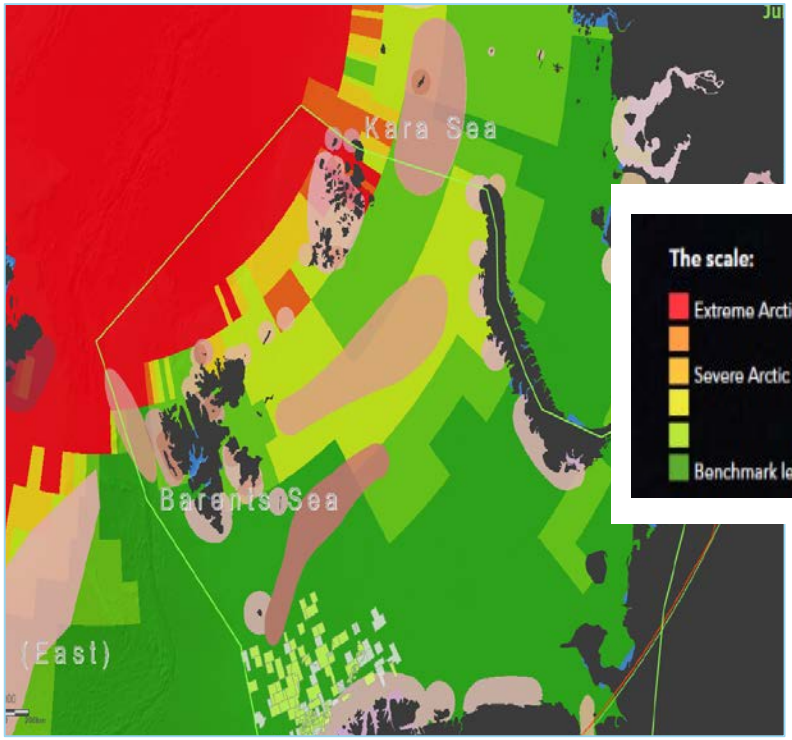
- The SOI is based on risk influencing factors such as sea ice, visibility, temperature, distance from SAR resources, etc.
- Expressed as an aggregated score for each Arctic region by Month
- The principal factors are known to affect safety and operability in these regions
- Benchmarked against recognized standards [NORSOK] and risk-level of operations in the Norwegian Sea



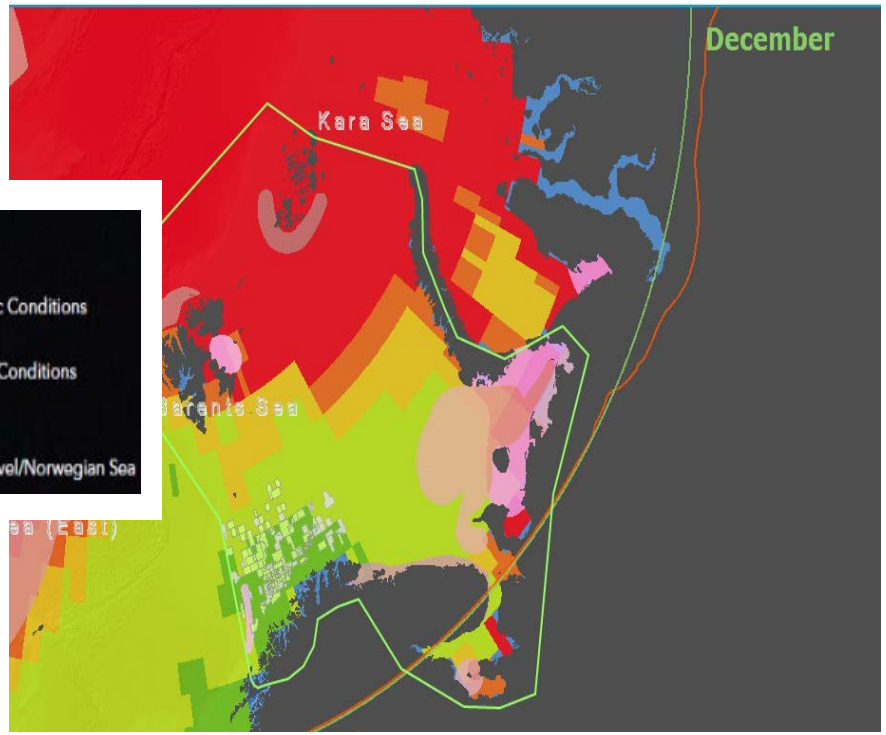
Physical factors included in Safety and operability index

Parameter	Description	Temporal resolution
Open Water Season	Duration of open water season (consecutive days)	Annual
Ice Coverage	Ice concentration	Monthly
Ceiling	Limits for helicopter operation vertical - % of time < 200 m cloud height	Monthly
Visibility	Limits for helicopter operation horizontal - % of time < 500 m horizontal	Monthly
SAR	Search and Rescue – operational radius, 180 min criteria	Fixed
Temperature	Design temperature	Annual
Days below -20° C	Number of days per year below -20°C	Monthly
Daylight	Hours of daylight per day	Monthly
Wind speed	Monthly max	Monthly
Marine icing	Overland algorithm	Monthly
Wind Chill Index	NORSOK	Monthly

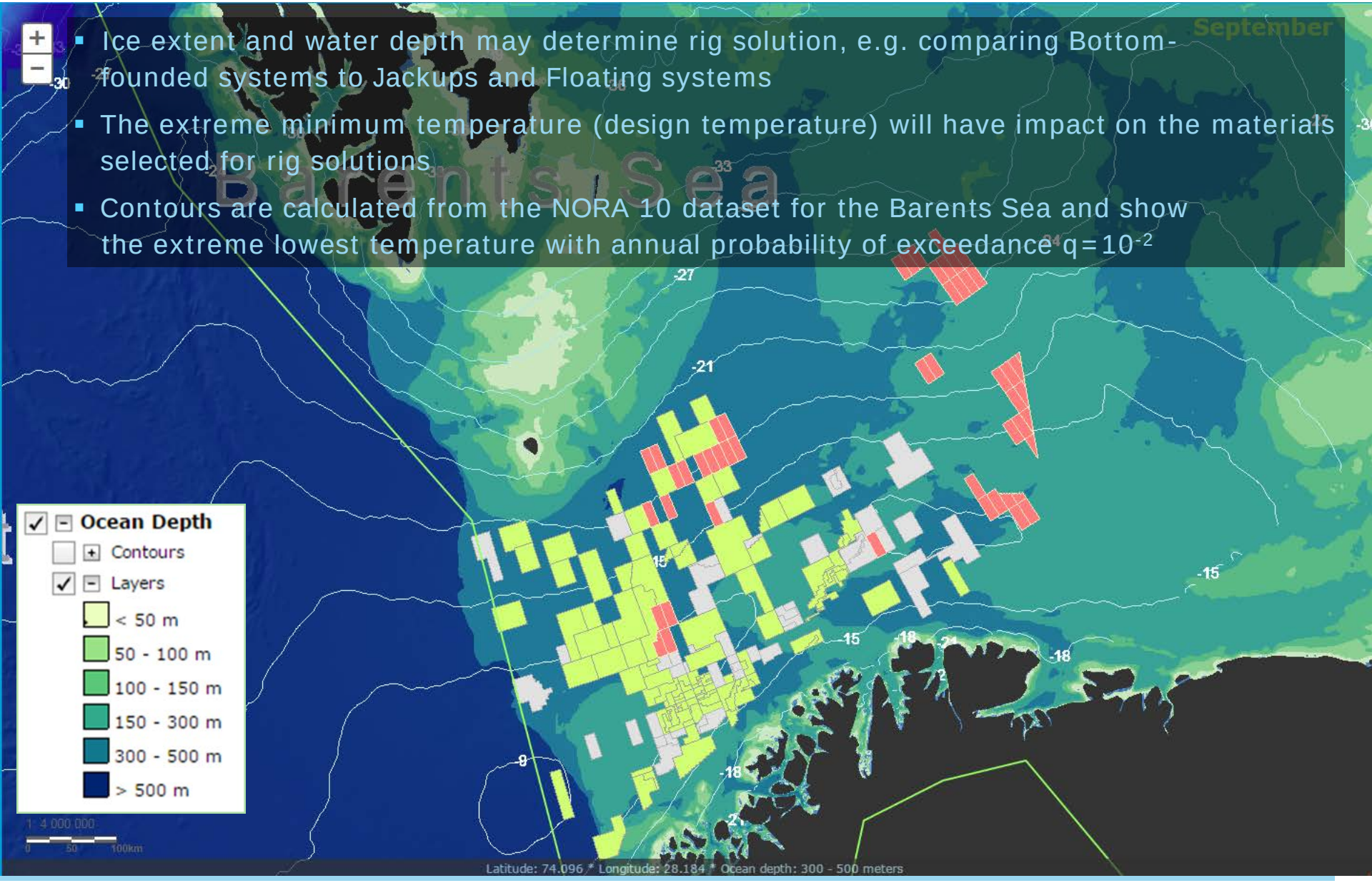
Barents Sea – Petroleum licenses, SOI and environmental vulnerability index for July and December



Safety and operability index - July

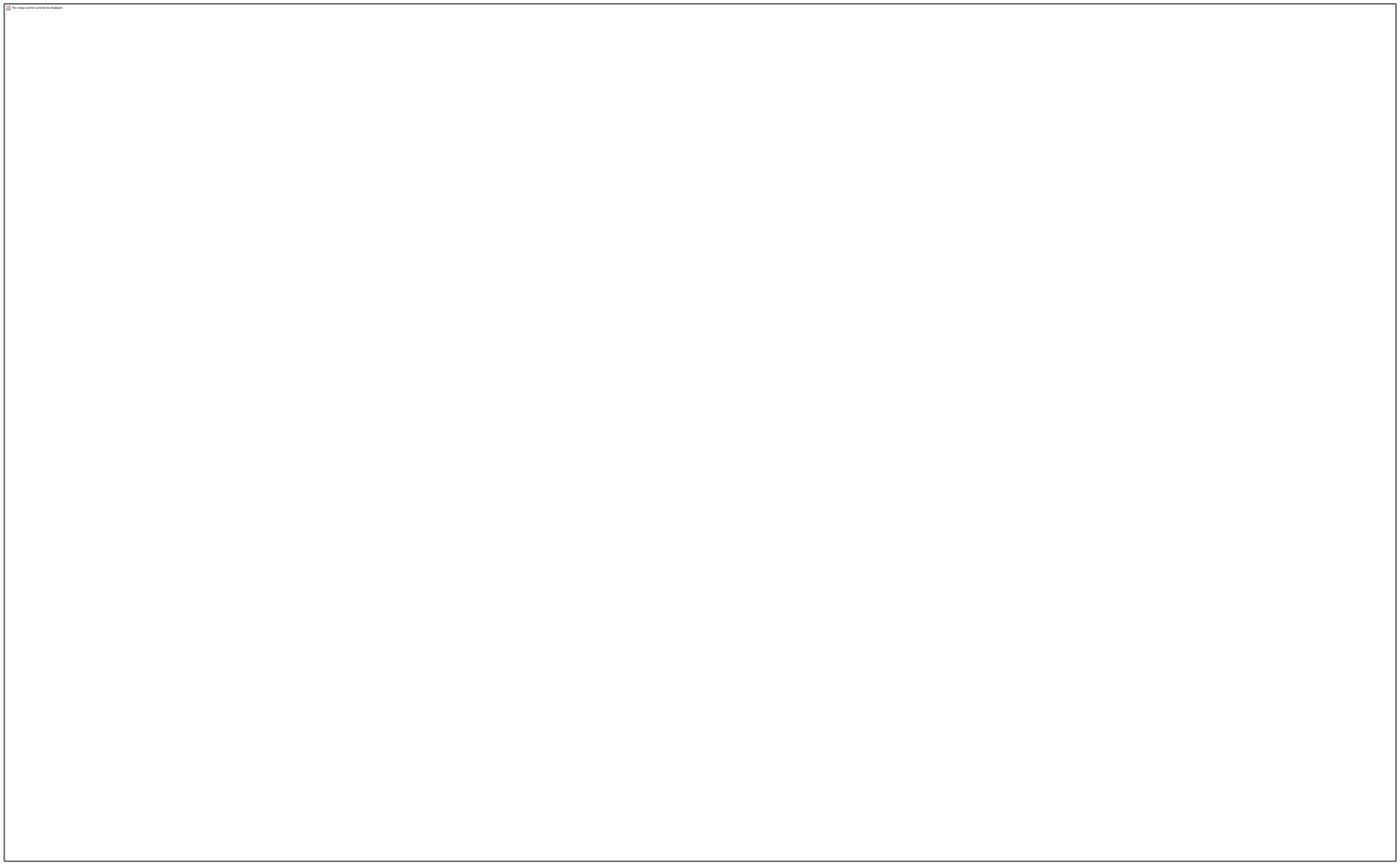


Safety and operability index - December



- Ice extent and water depth may determine rig solution, e.g. comparing Bottom-founded systems to Jackups and Floating systems
- The extreme minimum temperature (design temperature) will have impact on the materials selected for rig solutions
- Contours are calculated from the NORA 10 dataset for the Barents Sea and show the extreme lowest temperature with annual probability of exceedance $q = 10^{-2}$

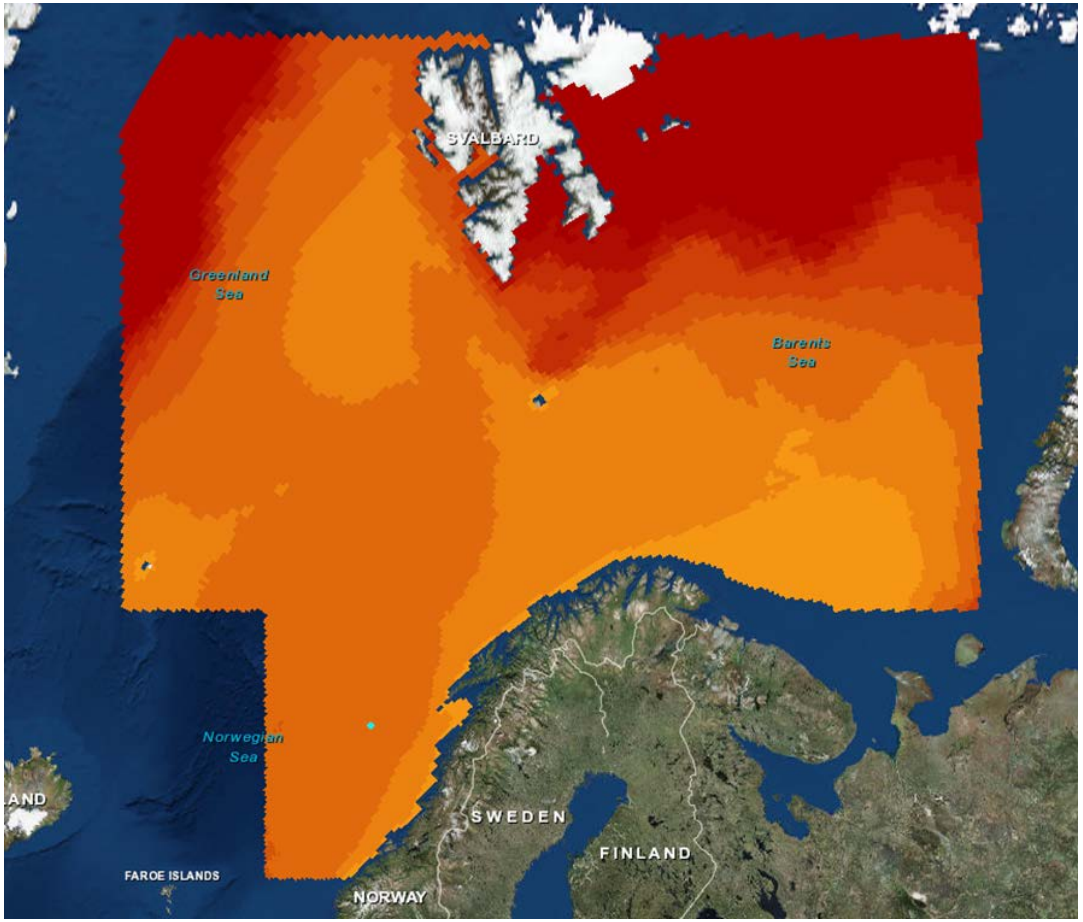
Arctic challenges:
Spotlight on technology: Oil spill response



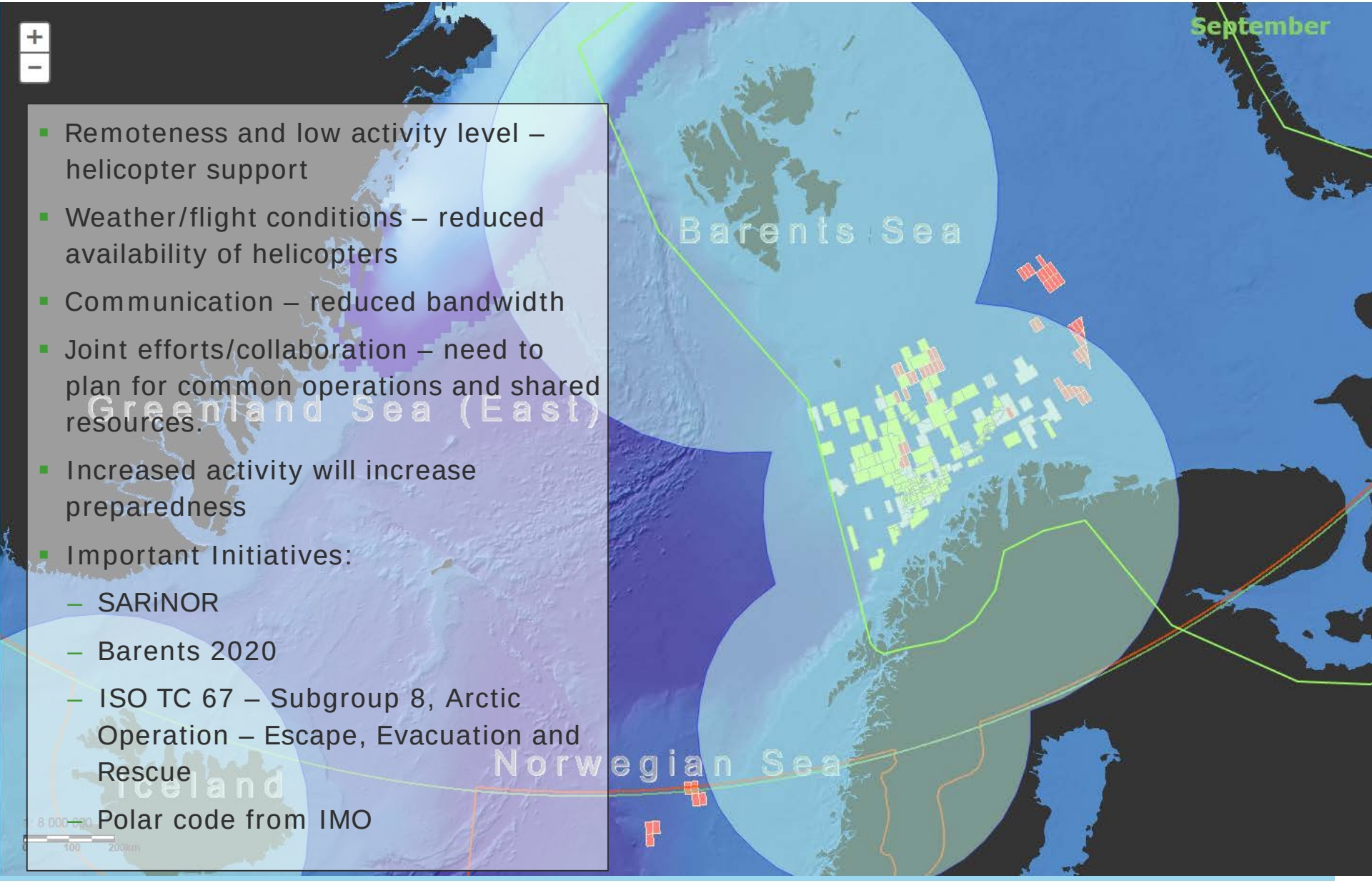
Operational window for oil spill response efficiency and capability

Limited and ineffective oil spill response capability in the Barents Sea in February using conventional methods

Oil spill recovery is greatly impaired due to sea-ice, low temperatures, winds and rough seas.



Maintain adequate level of emergency response



- Remoteness and low activity level – helicopter support
- Weather/flight conditions – reduced availability of helicopters
- Communication – reduced bandwidth
- Joint efforts/collaboration – need to plan for common operations and shared resources.
- Increased activity will increase preparedness
- Important Initiatives:
  - SARiNOR
  - Barents 2020
  - ISO TC 67 – Subgroup 8, Arctic Operation – Escape, Evacuation and Rescue
  - Polar code from IMO

Strategies for risk mitigation should include a stepwise approach

https://maps.dnvgl.com/arcticriskmap

Thank you for your attention

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SAFER, SMARTER, GREENER

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