

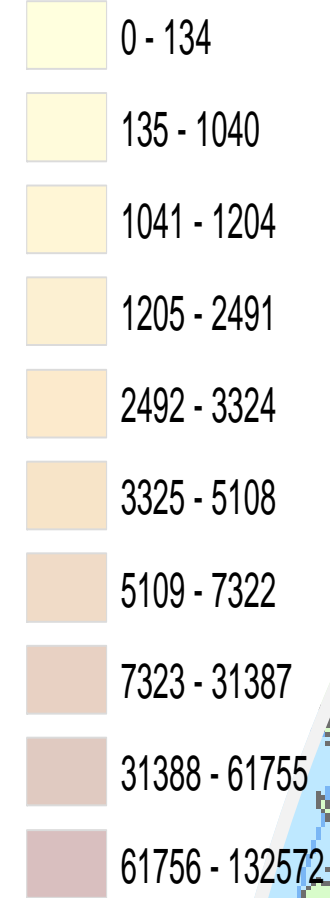
# Hydrocarbon Reserves and Retreating Ice in the Arctic Ocean

**PROJECT CONTEXT** It has perhaps become axiomatic that ours will be a “Pacific” century—not a period of *pax*, but one fashioned largely by activity along the rims of our greatest ocean. Yet, in shifting our map and cognition laterally from their traditional North Atlantic focus, we might also envision the globe rolled on its side. As climatic change in the Arctic augurs a new era of oceanic affairs in global development, our Arctic age will present both phenomenal possibility and hazard. Not for the first time, we turn our gaze to the stranded riches and potential of the North. Not for the first time, it reveals the limits of human capacity. The United States Geological Survey’s 2008 Circum-Arctic Resource Appraisal estimated that within the Arctic Circle (66° 33’ 44” 90 north of the Equator) lay “90 billion barrels of oil, 1,669 trillion cubic feet of natural gas, and 44 billion barrels of natural gas liquids,” of which 84 percent was submarine. This potential coincides with the technology and willingness to begin exploration. Though sensationalist perspectives have forecast an “Arctic scramble” or “gold rush,” development is slow. Extreme cold, climatic volatility, darkness, winds and currents in the North, and fluctuation of interest and capacity from the South limit hydrocarbon exploitation. This project explores the relationship between sea ice cover—the dominant natural factor in any offshore development—and hydrocarbon availability, as well as the relationship between the availability of hydrocarbons and development.

## Hydrocarbon accessibility by sea ice coverage/ Oil and gas licenses

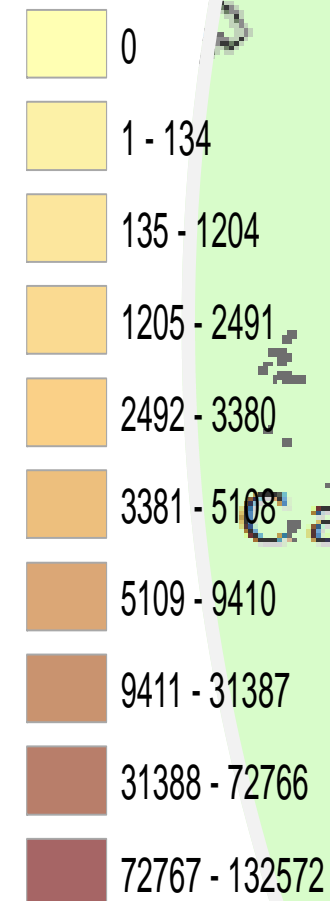
### Year round full coverage

Est. Oil/Oil equivalent (mil. barrels)



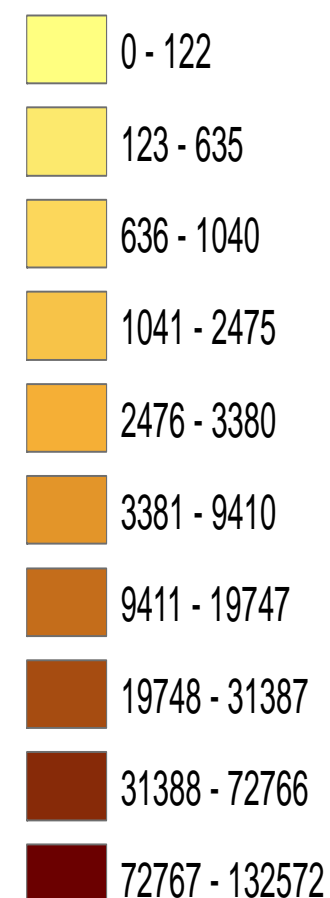
### Seasonal non-coverage

Est. Oil/Oil equivalent (mil. barrels)

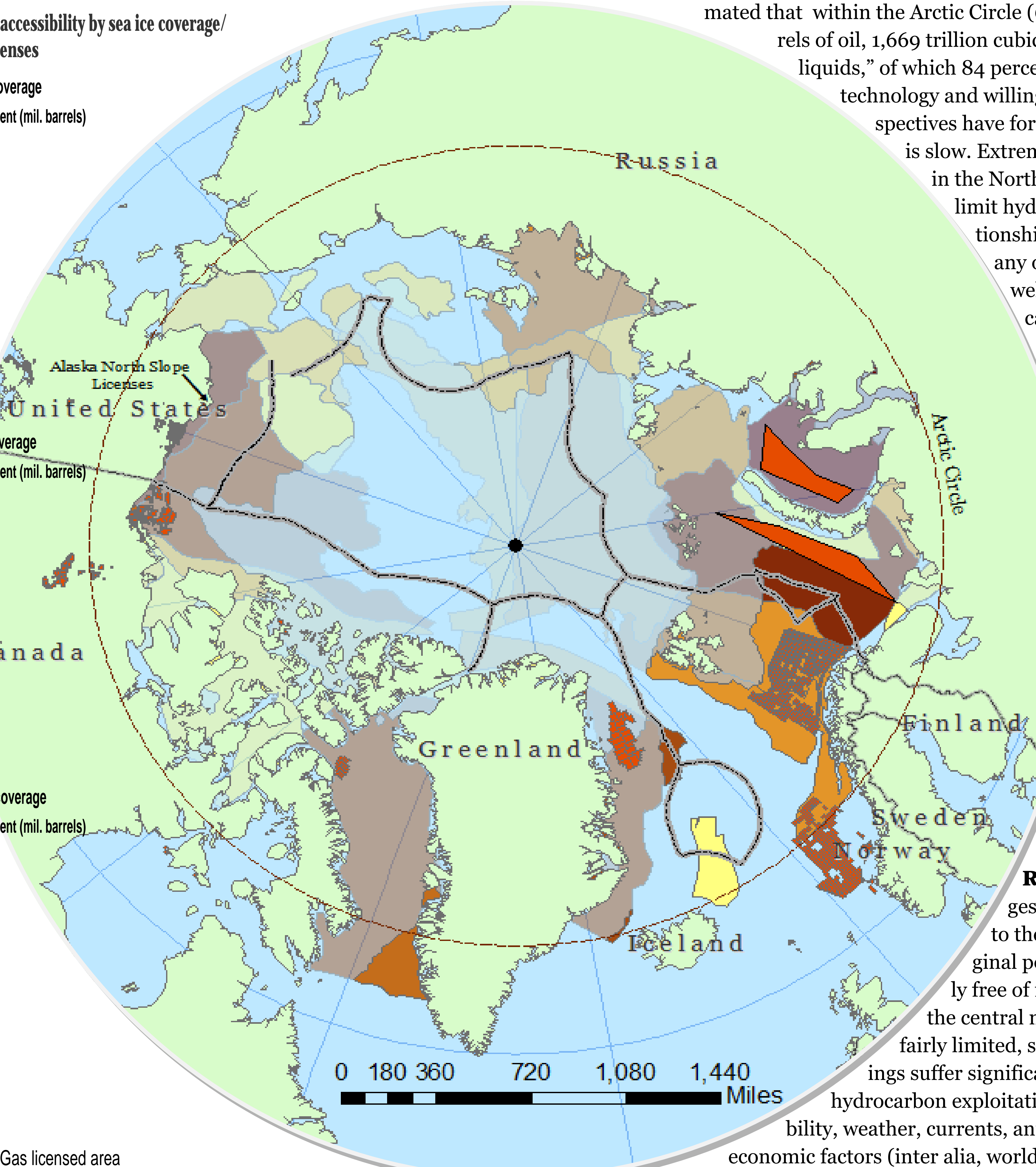


### Year round non-coverage

Est. Oil/Oil equivalent (mil. barrels)

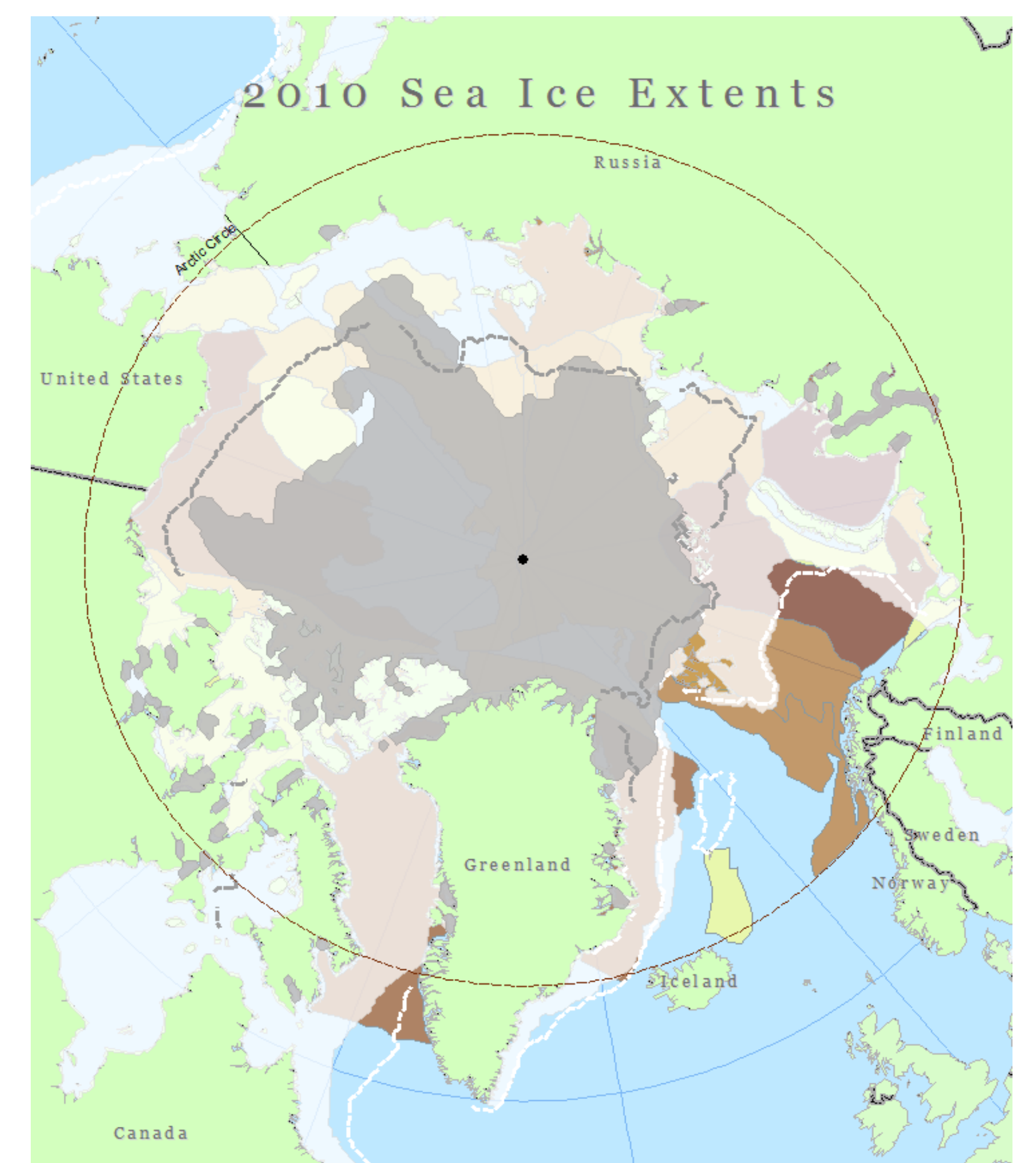
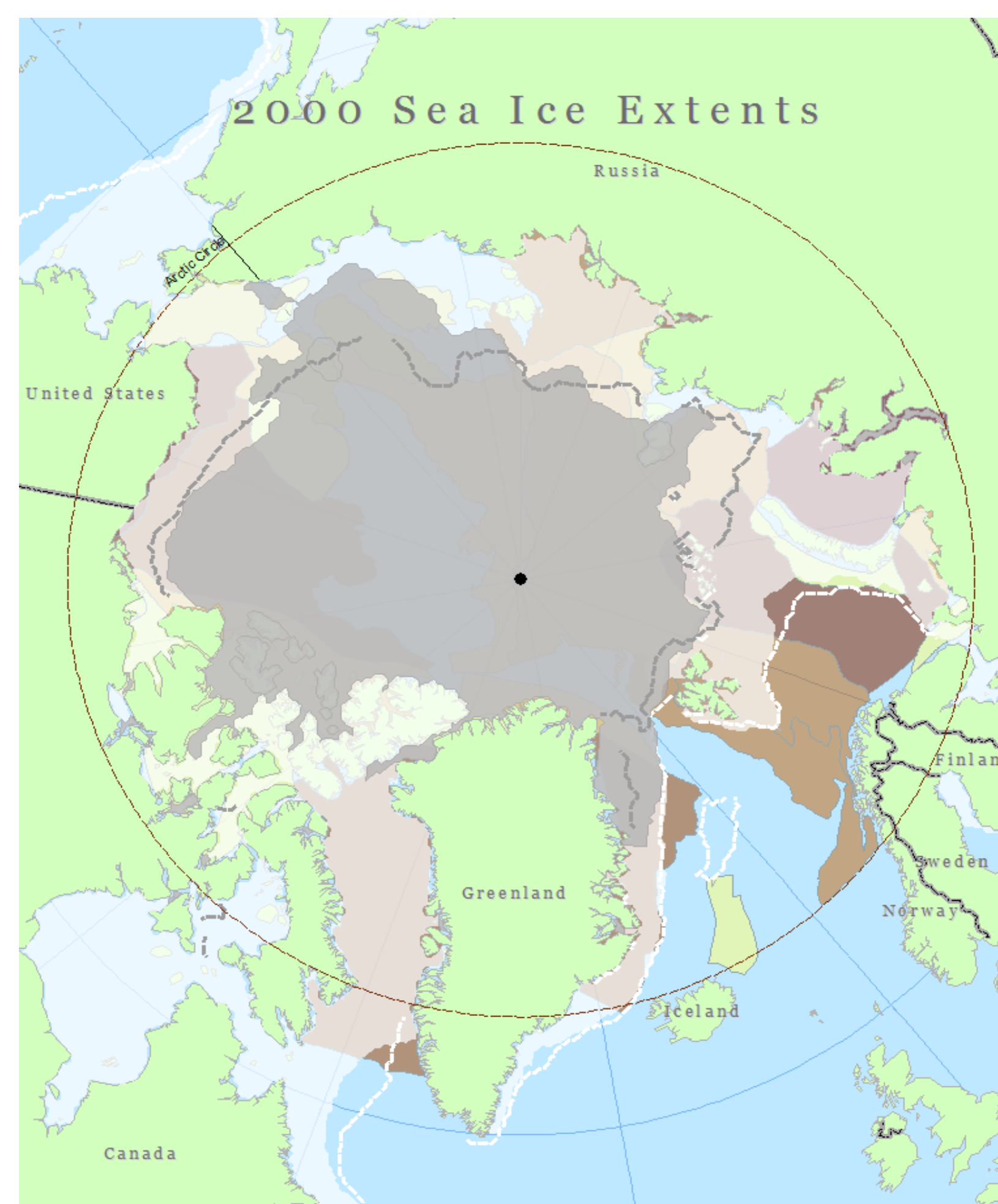


Oil and Gas licensed area



**METHODOLOGY** The lower series of maps displays the relationship between sea ice extent highs (March) and lows (September) over two decades (1990, 2000, 2010). In the latter two maps, polylines representing high and low extents from 1990 reveal the aggregate decrease in year-round and seasonal sea ice. Estimated offshore oil and gas reserves, depicted with graduated colors, appear as ice retreats. The central map shows relative accessibility of resources as a function of ice retreat, from year-round ice-free to seasonally ice-free to year-round ice-bound. Oil and gas exploration and exploitation licenses reflect the extent to which national governments have accorded the right to begin exploitation of less ice-bound areas.

**RESULTS AND LIMITATIONS** The lower series suggests that ice continues to present considerable impediment to the exploitation of off-shore Arctic hydrocarbons. A marginal portion of total undiscovered reserves is fully or seasonally free of ice, concentrated in the Norwegian and Barents Seas. As the central map elaborates, exploration/exploitation licenses are fairly limited, similarly concentrated in Northwest Eurasia. These findings suffer significant limitations. Sea ice is the primary natural factor of hydrocarbon exploitation, but they do not consider intra-seasonal sea-ice variability, weather, currents, animal habitats, transportation networks, or political-economic factors (inter alia, world energy prices, political interest, international cooperation). A more complex suitability study incorporating these various elements could better explain why some areas are exploited and suggest areas that would be suitable for exploitation.



## Offshore Hydrocarbons and Arctic Ocean ice extent

