

ARCTIC OFFSHORE ENERGY RESOURCES: DISTRIBUTION ACROSS
INTERNATIONAL BOUNDARIES AND CLIMATIC IMPACT

by

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Abstract. The USGS estimates “that about 30% of the world’s undiscovered gas and 13% of the world’s undiscovered oil may be found [in the Arctic], mostly offshore.” While such large quantities of hydrocarbon resources hold out the promise of an Arctic energy future, this future is highly uncertain, implicating the interconnected issues of climate change, technological accessibility, sensitivity of the Arctic environment, and uncertainty of state jurisdiction over the resources under the international law of the sea.

This study explores some of these questions by examining the distribution of Arctic hydrocarbon resources across national jurisdictions and by evaluating their greenhouse-gas potential. The study 1) reviews sources of the law of the sea relevant to jurisdiction over Arctic hydrocarbon resources, 2) intersects geological maps of undiscovered resources with an Arctic maritime boundary map to estimate the amount of resources across various zones of national jurisdiction, and 3) calculates the amount of carbon dioxide (CO₂) that would be released from combustion of all undiscovered Arctic hydrocarbon resources.

I. Introduction.

Over the last decade, Arctic offshore energy has grabbed attention of the media, public, and policymakers. The interest is not unfounded—the U.S. Geological Survey (USGS) estimates “that about 30% of the world’s undiscovered gas and 13% of the world’s undiscovered oil,” amounting to more than 412 billion barrels of oil equivalent, “may be found [in the Arctic], mostly offshore.”¹ While such large quantities of oil and gas may hold out the promise of an Arctic energy future, this future is highly uncertain. Development of Arctic offshore energy

¹ Donald L. Gautier et al., *Assessment of Undiscovered Oil and Gas in the Arctic*, 324 SCIENCE 1175, 1175 (2008).

resources implicates the interconnected issues of climate change, technological accessibility, sensitivity of the Arctic environment, and uncertainty of state jurisdiction over the resources under the complex framework of international law of the sea. This study will explore some of these questions by examining the distribution of Arctic offshore hydrocarbon resources across zones of national jurisdiction and by calculating the amount of CO₂ that would be emitted by combustion of those resources.

1. Existing Arctic offshore energy projects. A number of hydrocarbon projects are already operational in the offshore Arctic,² mostly in nearshore Alaska, and exploratory drilling and development are underway in increasingly remote areas of the Arctic Ocean. The first producing Arctic offshore energy project outside the territorial seas is the Norwegian natural gas development Snøhvit. The first gas discovery was made at Snøhvit in 1984, and production began in 2007.³ The Snøhvit production unit is located entirely underwater—at a depth of 250 to 345 m⁴—to protect against the rough seas, and gas is transported to an onshore processing facility via a 143-km subsea pipeline.⁵ Another Norwegian offshore project, Goliat, is expected to be the first oil project in the Barents Sea. Goliat is located 50 km offshore in 360 to 420 m of water.⁶ Oil at Goliat will be extracted via subsea production templates attached to a floating

² For purposes of this study, “Arctic” is defined as all areas north of the Arctic Circle.

³ NORWEGIAN PETROLEUM DIRECTORATE, SNØHVIT (2011), *available at* <http://www.npd.no/Global/Engelsk/3-Publications/Facts/Facts2011/Figures/Chapter-10/Sn%C3%B8hvit.pdf>.

⁴ *Snøhvit*, STATOIL, <http://www.statoil.com/en/OurOperations/ExplorationProd/ncs/snoehvit/Pages/default.aspx> (last updated Feb. 28, 2013).

⁵ *Snøhvit—Unlocking Resources in the Frozen North*, STATOIL, <http://www.statoil.com/en/OurOperations/ExplorationProd/ncs/Pages/SnohvitNewEnergyHistoryInTheNorth.aspx> (last updated Nov. 23, 2009).

⁶ *Goliat*, NORWEGIAN PETROLEUM DIRECTORATE (Nov. 4, 2012), <http://www.npd.no/en/publications/facts/facts-2012/chapter-11/goliat>.

production platform and processing facility and will be transported onshore via shuttle tankers.⁷ Production is expected to begin in late 2014.⁸

Large and far-offshore hydrocarbon projects are also planned for the Russian Arctic. The Prirazlomnoye field in the Pechora Sea was discovered in 1989 and is located about 60 km offshore in 20 m of water.⁹ The field will be developed from a stationary platform connected to 40 slanted wells, and it may begin producing as early as 2013.¹⁰ The Shtokman natural gas field, discovered in 1989, is another large project underway in the Russian Arctic. Located in the Barents Sea, about 550 km offshore and in 320 to 340 m of water,¹¹ Shtokman is perhaps the most challenging Arctic offshore energy project to date. Shtokman will be developed via a floating production unit connected to subsea production templates and transported onshore via subsea pipeline.¹² As is generally the case with Arctic energy projects, development milestones have been delayed numerous times,¹³ and it is unclear when production will begin.

⁷ *Goliat: The Development Concept*, ENI NORGE, <http://www.eninorge.com/en/Field-development/Goliat/Development-solution> (last visited Apr. 24, 2013).

⁸ *Goliat: The Facts*, ENI NORGE, <http://www.eninorge.com/en/Field-development/Goliat/Facts> (last visited Apr. 24, 2013).

⁹ *Prirazlomnoye Oil Field*, GAZPROM, <http://www.gazprom.com/about/production/projects/deposits/pnm> (last visited Apr. 24, 2013).

¹⁰ Atle Staalesen, *Russian Industry Is Capable, Gazprom Says*, BARENTS OBSERVER (Dec. 18, 2012), <http://barentsobserver.com/en/energy/2012/12/russian-industry-capable-gazprom-says-18-12; Prirazlomnoye Oil Field, supra note 9>.

¹¹ *Offshore Facilities*, SHTOKMAN, <http://shtokman.ru/en/project/about/offshore> (last visited Apr. 24, 2013); *Shtokman*, GAZPROM, <http://www.gazprom.com/about/production/projects/deposits/shp> (last visited Apr. 24, 2013).

¹² *Offshore Facilities*, *supra* note 11.

¹³ *See, e.g., Russia's Shtokman Natural Gas Project*, REUTERS (Feb. 5, 2010, 4:04 PM GMT), <http://uk.reuters.com/article/2010/02/05/russia-gazprom-shtokman-idUSLDE6141PU20100205> (“If the [Shtokman] field is put on stream in 2016, this will be 16 years later than initially planned.”).

2. Arctic climate change. The Arctic has been warming more rapidly than the rest of the world over the past few decades,¹⁴ and climate models project that this trend will continue.¹⁵ The warming has led to dramatic observable changes in the Arctic environment. The Arctic ice cap thinned by one half between 2001 and 2007;¹⁶ in 2007, it was half the size it was in 1957.¹⁷ In summer 2007, the Arctic Ocean sea-ice cover reached its lowest extent since the beginning of satellite measurements in the late 1970s¹⁸—a record that was broken only five years later, in the summer of 2012.¹⁹ The disappearance of Arctic sea ice is particularly disconcerting because of the sea-ice albedo feedback, which magnifies the global consequences of Arctic warming.²⁰ However, decreasing sea-ice thickness and extent may also facilitate Arctic shipping and energy resource extraction. But, despite these developments, it is important to note that climatologists define “ice-free” ocean as ocean with less than a specified percentage of ice cover—for example,

¹⁴ E.g., Gordon McBean et al., *Arctic Climate: Past and Present*, in ARCTIC CLIMATE IMPACT ASSESSMENT 21, 39 (2005), available at http://www.acia.uaf.edu/PDFs/ACIA_Science_Chapters_Final/ACIA_Ch02_Final.pdf.

¹⁵ E.g., *id.* at 37.

¹⁶ Scott G. Borgerson, *The Great Game Moves North*, FOREIGN AFF. (Mar. 25, 2009), <http://www.foreignaffairs.com/articles/64905/scott-g-borgerson/the-great-game-moves-north>.

¹⁷ Scott G. Borgerson, *Arctic Meltdown: The Economic and Security Implications of Global Warming*, FOREIGN AFF., Mar./Apr. 2008, at 63, 63.

¹⁸ Press Release, Nat'l Snow & Ice Data Ctr., Arctic Sea Ice Shatters All Previous Record Lows: Diminished Summer Sea Ice Leads to Opening of the Fabled Northwest Passage (Oct. 1, 2007), http://nsidc.org/news/press/2007_seaiceminimum/20071001_pressrelease.html.

¹⁹ *Arctic Sea Ice Extent Breaks 2007 Record Low*, NAT'L SNOW & ICE DATA CTR. (Aug. 27, 2012), <http://nsidc.org/arcticseaicenews/2012/08/arctic-sea-ice-breaks-2007-record-extent>; *see also id.* (“[T]he six lowest ice extents in the satellite record have occurred in the last six years (2007 to 2012).”).

²⁰ The sea-ice albedo feedback operates because of the differences in albedo (reflectivity) of ocean water and overlying sea ice. As the highly reflective sea ice melts, it exposes the dark ocean water below, which absorbs more sunlight. The resultant positive radiative forcing warms the area, melting more ice in the process and closing the feedback loop. E.g., WILLIAM F. RUDDIMAN, *EARTH'S CLIMATE: PAST AND FUTURE* 16 (2d ed. 2008).

15%²¹—which still poses a significant impediment to shipping. Additionally, despite the rapid decline of the summer sea-ice cover, winter sea ice is expected to persist throughout this century²² and will thus continue to render the region inaccessible over much of the year.

3. Potential influence of climate change on Arctic energy resource development. It is yet unclear whether a causal connection exists between climate change and the growing interest in Arctic energy resources. Scarcity, rising energy resource prices, and technological advances have pushed the search for energy sources to increasingly remote and treacherous environments—be it the depths of Gulf of Mexico,²³ the “ultra-deep” deposits of offshore Brazil,²⁴ or the icy waters of the Arctic Ocean. Whether and how climate change has played or will play a causal role in this rush to the frontier, in the Arctic or elsewhere, remains to be seen.

However, the distribution of hydrocarbon exploration and extraction activity across the Arctic region suggests that changing climatic conditions may affect development of Arctic energy resources. Much more resource-related activity has taken place offshore Norway and Russia than offshore North America, perhaps because large parts of the Barents Sea are ice-free year-round²⁵ and because the Northern Sea Route (NSR) is generally much more passable than

²¹ *What Is the Difference Between Sea Ice Area and Extent*, NAT'L SNOW & ICE DATA CTR. (June 2008), <http://nsidc.org/arcticseaicenews/faq>.

²² ARCTIC COUNCIL, ARCTIC MARINE SHIPPING ASSESSMENT 2009 REPORT 25 (B. Ellis & L. Brigham eds., 2d prtg. 2009).

²³ *Shell Starts Production at Perdido*, SHELL (Mar. 31, 2010), <http://www.shell.com/global/aboutshell/media/news-and-media-releases/2010/perdido-31032010.html> (discussing the 2010 start of production at the Perdido platform in the Gulf of Mexico, which is moored in 2450 m of water and located 320 km offshore, making it the deepest oil platform in the world and the remotest in the Gulf of Mexico).

²⁴ *In Deep Waters: Brazil's Offshore Oil*, ECONOMIST (Feb. 3, 2011), <http://www.economist.com/node/18065645>.

²⁵ See, e.g., Norwegian Polar Inst., *Barents Sea-Lofoten Area*, STATE OF THE ENV'T NOR. (Feb. 26, 2013, 16:54 PM), <http://www.environment.no/Topics/Marine-areas/Barents-SeaLofoten-area> (“The inflow of warm Atlantic water ensures that the Norwegian coast and large parts of the Barents Sea are ice-free all year round.”); Thomas Nilsen, *Statoil Increases Barents-Drilling*,

the Northwest Passage (NWP), and ease of transport is a key consideration in the development of energy resources.

Commercial shipping along Arctic coasts has indeed increased over the last decade. As recently as 2004, no commercial vessels travelled all the way through the NSR or NWP.²⁶ In contrast, in the summer of 2012, forty-six vessels sailed across the entire NSR, up from thirty-four in 2011 and only four in 2010.²⁷ Petroleum products comprised more than 70% of their cargo.²⁸ In 2011, a fully laden 920-foot supertanker traversed the NSR with icebreaker escort; it is the largest ship to complete the voyage thus far.²⁹ In 2012, the first LNG tanker sailed through the NSR, also with icebreaker escort.³⁰ The tanker delivered gas to Japan from Statoil's Hammerfest plant, which processes natural gas extracted at Snøhvit.³¹ The more treacherous NWP opened for full-length crossings for the first time in the summer of 2007,³² coincident with the first recent sea-ice minimum. From 2009 through 2011, about twenty ships transited the

BARENTS OBSERVER (Aug. 29, 2012), <http://barentsobserver.com/en/energy/statoil-increases-barents-drilling-29-08> (“This is a less challenging area, as the Norwegian Barents is one of the only Arctic areas with a year-round ice-free zone.” (quoting Tim Dodson, Statoil Exploration executive vice president) (internal quotation mark omitted)).

²⁶ ARCTIC COUNCIL, *supra* note 22, at 89–90.

²⁷ Trude Pettersen, *46 Vessels Through Northern Sea Route*, BARENTS OBSERVER (Nov. 23, 2012), <http://barentsobserver.com/en/arctic/2012/11/46-vessels-through-northern-sea-route-23-11>.

²⁸ *Id.*

²⁹ Trude Pettersen, *First Supertanker Along Northern Sea Route*, BARENTS OBSERVER (Aug. 24, 2011), <http://www.barentsobserver.com/first-supertanker-along-northern-sea-route.4951370-16178.html>; *Tanker Vladimir Tikhonov Completes Successful Northern Sea Route Transit in a Week*, MAR. EXEC. (Sept. 1, 2011), <http://www.maritime-executive.com/article/tanker-vladimir-tikhonov-completes-successful-northern-sea-route-transit-in-a-week>.

³⁰ Press Release, Gazprom, *Gazprom Successfully Completes World's First LNG Supply via Northern Sea Route* (Dec. 5, 2012), <http://www.gazprom.com/press/news/2012/december/article150603>.

³¹ *Id.*; *Snøhvit*, *supra* note 4.

³² Borgerson, *supra* note 17, at 63.

NWP each year; however, most of them were government, passenger, and resupply vessels and not large cargo ships.³³

While the current role of climate change on Arctic energy resource development is uncertain, a warmer climate would likely make Arctic resource development cheaper and easier in the future. In turn, increasing consumption of those resources would further contribute to climate change, creating a feedback loop between Arctic energy resource extraction and the global climate.

4. Energy resources and the Arctic environment. Intensifying human activity in the Arctic also implicates a number of environmental issues beyond climate change. Activities related to hydrocarbon resource exploration and extraction can be very intrusive, including land- and sea-use disturbances, emissions from regular operations, and accidental leaks and spills.³⁴ Disasters such as the 1989 *Exxon Valdez* shipwreck have not been forgotten, and smaller incidents such as the 2013 detachment and grounding of a towed Shell Oil rig off the coast of Alaska serve as a stern reminder that resource extraction in the offshore Arctic is still far from safe for man and the environment.³⁵ Finally, the recent human intrusion into the Arctic is destroying the perception of the region as a frontier. As maritime policy expert Scott Borgerson noted, “The Alaskan coast might one day look like the shores of Louisiana, in the Gulf of

³³ See Nw. Territories Env’t & Natural Res., *Human Activities*, NW. TERRITORIES, http://www.enr.gov.nt.ca/_live/pages/wpPages/soe_human_activities.aspx#3 (last updated Aug. 19, 2011).

³⁴ For an overview of environmental impacts of Arctic oil and gas activities, see ARCTIC MONITORING & ASSESSMENT PROGRAMME, ARCTIC OIL AND GAS 2007 (2007).

³⁵ Henry Fountain, *Breakaway Oil Rig, Filled with Fuel, Runs Aground*, N.Y. TIMES (Jan. 1, 2013), <http://www.nytimes.com/2013/01/02/business/energy-environment/shell-oil-rig-runs-aground-in-alaska.html>.

Mexico, lit up at night by the millions of sparkling lights from offshore oil platforms³⁶—an image that is promising to some and repulsive to others.

5. Uncertainty of jurisdiction over Arctic offshore energy resources. Uncertainty of state jurisdiction over the Arctic Ocean is another important complication standing in the way of Arctic energy resource development. As described in more detail in Part II of this study, the legal regime of the Arctic Ocean and the Arctic seabed is a patchwork composed of the United Nations Convention on the Law of the Sea (UNCLOS) framework, a number of smaller treaties delineating specific maritime boundaries, and a series of unresolved disputes and unrecognized territorial claims. Certainty in Arctic maritime delimitation is of great importance for Arctic states and for oil companies interested in the region; neither is likely to invest significantly in the development of Arctic resources if they are not sure that they will be able to retain control over those resources.³⁷ For example, Norway claims that it started exploration in the Barents Sea near the Norway-Russia maritime boundary only after a 2010 agreement between the two states provided it with certainty about the location of the boundary.³⁸

6. Overview of the study. By examining the jurisdictional distribution and climatic impact of Arctic resources, this study will address some of the issues outlined above. The study has two principal aims: 1) to examine the distribution of Arctic offshore hydrocarbon resources across various zones of national jurisdiction, and 2) to evaluate the greenhouse-gas potential of those resources. The study has been inspired by and will build on two main strands of previous

³⁶ Borgerson, *supra* note 17, at 68.

³⁷ See, e.g., John B. Bellinger III, *Arctic Treasure*, FOREIGN POL'Y (Aug. 19, 2011), http://shadow.foreignpolicy.com/posts/2011/05/19/arctic_treasure (“U.S. oil and gas companies simply will not invest in these areas [beyond the EEZ] unless the U.S. has clear legal title.”).

³⁸ Thomas Nilsen, *Stoltenberg Looks North for More Oil*, BARENTS OBSERVER (Feb. 14, 2012), <http://barentsobserver.com/en/articles/stoltenberg-looks-north-more-oil>; see also *infra* notes 172–181 and accompanying text.

research: First, in 2008, the USGS conducted an extensive survey of undiscovered Arctic hydrocarbon resources, the “Circum-Arctic Resource Appraisal: Estimates of Undiscovered Oil and Gas North of the Arctic Circle (CARA).”³⁹ CARA is the first comprehensive, large-scale, region-specific assessment of the Arctic’s hydrocarbon resource potential. Second, researchers at the International Boundary Research Unit (IBRU) at Durham University in the United Kingdom have assembled the first comprehensive map of states’ legal claims over the Arctic Ocean.⁴⁰ This project will build on the two seminal studies by combining international maritime boundary data with geological data about the distribution of hydrocarbon resources across the Arctic Ocean. The study will be limited to areas north of the Arctic Circle, which span across six jurisdictions: Canada, Denmark, Iceland, Norway, Russia, and the United States.

II. Law of the sea overview.

1. The UNCLOS ocean-zoning regime. UNCLOS sets the basic international legal framework for ocean governance. UNCLOS divides ocean space into zones of different levels of permissible coastal-state jurisdiction. For example, a state has full sovereignty over its internal waters⁴¹—the innermost (coastal-most) UNCLOS zone—but slightly less sovereignty over its territorial sea, out to 12 nautical miles (nm) of its coastal baselines, where it fully controls the seabed⁴² but where innocent passage of foreign vessels must be permitted.⁴³ The coastal state has

³⁹ *Circum-Arctic Resource Appraisal: Overview*, U.S. GEOLOGICAL SURVEY, <http://energy.usgs.gov/RegionalStudies/Arctic.aspx> (last updated Oct. 5, 2012).

⁴⁰ INT’L BOUNDARIES RESEARCH UNIT, MARITIME JURISDICTION AND BOUNDARIES IN THE ARCTIC REGION (2010), *available at* <http://www.dur.ac.uk/resources/ibru/arctic.pdf>.

⁴¹ *See* United Nations Convention on the Law of the Sea art. 2(1), Dec. 10, 1982 [hereinafter UNCLOS] (“[W]aters on the landward side of the baseline of the territorial sea form part of the internal waters of the State”).

⁴² *Id.* art. 2(2).

⁴³ *Id.* art. 17.

even less sovereignty over its exclusive economic zone (EEZ).⁴⁴ For purposes of control over offshore hydrocarbon resources, the extent and scope of a state’s jurisdiction over its EEZ and extended continental shelf are especially important.

Five of the six Arctic states considered in this study have ratified UNCLOS.⁴⁵ The United States is the only exception,⁴⁶ but even it generally accepts UNCLOS as customary international law (CIL).⁴⁷ However, there is disagreement over the CIL status of certain provisions of UNCLOS, including those governing the EEZ and the seabed,⁴⁸ which are of particular significance to this study. The extent to which the United States is bound by UNCLOS—for purposes of jurisdiction over Arctic Ocean energy resources and otherwise—is thus far from clear.

2. The EEZ. In its EEZ, a coastal state has “sovereign rights” to exploitation of living and nonliving resources of the seabed and the water column,⁴⁹ but it is greatly restricted in its ability to regulate international navigation.⁵⁰ In addition, the state has “the exclusive right to construct and to authorize and regulate the construction, operation and use of” artificial islands

⁴⁴ See *infra* notes 49–52 and accompanying text.

⁴⁵ Div. for Ocean Affairs & the Law of the Sea, *Chronological Lists of Ratifications of, Accessions and Successions to the Convention and the Related Agreements as at 23 January 2013*, UNITED NATIONS, http://www.un.org/Depts/los/reference_files/chronological_lists_of_ratifications.htm (last updated Jan. 23, 2013).

⁴⁶ *Id.* Eventual ratification of the treaty by the United States is more than a theoretical possibility. See, e.g., *The Law of the Sea Convention (Treaty Doc. 103-39): The U.S. National Security and Strategic Imperatives for Ratification* (May 23, 2012) (statement of then-Secretary of State Hillary Rodham Clinton before the Senate Committee on Foreign Relations), available at <http://www.state.gov/secretary/rm/2012/05/190685.htm>.

⁴⁷ RESTATEMENT (THIRD) OF FOREIGN RELATIONS LAW OF THE UNITED STATES, at pt. V introductory note (1987).

⁴⁸ *Id.*

⁴⁹ UNCLOS, *supra* note 41, art. 56(1)(a).

⁵⁰ See *id.* art. 58(1) (“In the exclusive economic zone, all States . . . enjoy, subject to the relevant provisions of this Convention, the freedoms [of navigation] . . .”).

and structures for, *inter alia*, exploration and exploitation of natural resources,⁵¹ such as oil rigs. However, all states—and not just the coastal state—may lay subsea cables and pipelines on the seabed of the EEZ, but the coastal state must consent to the proposed course of the installations.⁵²

A coastal state's EEZ may extend up to 200 nm from its territorial-sea baselines.⁵³ In addition, UNCLOS demands that EEZ delimitation for states “with opposite or adjacent coasts shall be effected by agreement on the basis of international law . . . to achieve an equitable solution”; if such agreement cannot be reached in a reasonable time, the states must resort to UNCLOS dispute-resolution procedures.⁵⁴ While this provision is rather vague and seems to give states much discretion in the delimitation process, state practice suggests that the median or equidistant line between the two coasts is generally selected as a starting point toward achieving an equitable solution.⁵⁵

3. The continental shelf. A state may lay claim to the continental shelf up to 200 nm from its territorial-sea baselines.⁵⁶ In some cases—based on the distance from the shoreline and

⁵¹ *Id.* art. 60(1).

⁵² *Id.* art. 58.

⁵³ *Id.* art. 57. As defined in UNCLOS, territorial-sea baselines are the baselines establishing the landward boundary of a state's territorial sea. *See id.* art. 5 (“[T]he normal baseline for measuring the breadth of the territorial sea is the low-water line along the coast as marked on large-scale charts officially recognized by the coastal State.”).

⁵⁴ *Id.* art. 74. Contrast the EEZ-delimitation process with the more formulaic approach to delimitation of territorial seas of states with adjacent or opposite coasts, according to which, absent historic title or other special circumstances, “neither of the two States is entitled, failing agreement between them to the contrary, to extend its territorial sea beyond the median line” between the states' territorial-sea baselines. *Id.* art. 15.

⁵⁵ *See, e.g.,* Hong Zeng Zhang, *The Adjacent Sea*, in *INTERNATIONAL LAW: ACHIEVEMENTS AND PROSPECTS* 849, 864–65 (Mohammed Bedjaoui ed., 1991).

⁵⁶ *See* UNCLOS, *supra* note 41, art. 76(1) (“The continental shelf of a coastal State comprises . . . submarine areas that extend beyond its territorial sea throughout the natural prolongation of its land territory to the outer edge of the continental margin, or to a distance of 200 nautical miles from the [territorial-sea] baselines . . . where the outer edge of the continental margin does not

on geologic characteristics of the seabed specified in UNCLOS article 76(4)⁵⁷—a state may lay claim to the continental shelf beyond 200 nm from its territorial-sea baselines.⁵⁸ However, the claimed continental shelf cannot reach beyond the further of 1) 350 nm from the territorial-sea baselines or 2) 100 nm from the 2500-m isobath.⁵⁹ If the continental shelf extends between states with adjacent or opposite coasts, these delimitation provisions are superseded⁶⁰ by a rule analogous to the rule for division of such areas in the EEZ—the shelf is to be divided equitably according to an agreement between the states on the basis of international law, or through UNCLOS’s dispute-resolution mechanism if such agreement cannot be reached in reasonable time.⁶¹

On its continental shelf, a state can exercise “sovereign rights for the purpose of exploring [the shelf] and exploiting its natural resources,”⁶² including the “exclusive right to authorize and regulate drilling . . . for all purposes.”⁶³ However, “[t]he rights of the coastal State over the continental shelf do not affect the legal status of the superjacent waters,” meaning that the coastal state lacks jurisdiction over the water column above its continental shelf beyond the

extend up to that distance.”); *see also id.* art. 56(1)(a) (stating that in its EEZ, the coastal state has jurisdiction over natural resources “of the waters superjacent to the seabed and of the seabed and its subsoil”).

⁵⁷ *See id.* art. 76(4) (describing the two ways a state can delineate its extended continental shelf, one based on the “outermost fixed points at each of which the thickness of sedimentary rocks is at least 1 per cent” and the other based on the location of the foot of the continental slope, which is generally “determined as the point of maximum change in [the slope’s] gradient”); *id.* art. 76(3) (“The continental margin comprises the submerged prolongation of the land mass of the coastal State, and consists of the seabed and subsoil of the shelf, the slope and the rise. It does not include the deep ocean floor with its oceanic ridges . . .”).

⁵⁸ *Id.* art. 76(4)–(5).

⁵⁹ *Id.* art. 76(5).

⁶⁰ *Id.* art. 76(10).

⁶¹ *Id.* art. 83; *supra* note 54 and accompanying text.

⁶² UNCLOS, *supra* note 41, art. 77(1). These natural resources include “mineral and other non-living resources of the seabed and subsoil” as well as sedentary organisms living on the seabed or in the subsoil. *Id.* art. 77(4).

⁶³ *Id.* art. 81.

EEZ.⁶⁴ As in the EEZ, the coastal state has exclusive control over construction and regulation of artificial islands and other structures on the continental shelf, but all states may lay subsea cables and pipelines.⁶⁵

Under UNCLOS, a state wishing to obtain control over the continental shelf beyond 200 nm from its territorial-sea baselines must make a public declaration and submit geophysical and other specified information to the United Nations Commission on the Limits of the Continental Shelf (CLCS).⁶⁶ The state must make its submission to the CLCS within ten years of entry into force of UNCLOS for that state.⁶⁷ The CLCS will review the submission and make recommendations about it “in accordance with [UNCLOS] article 76.”⁶⁸ If the coastal state disagrees with CLCS’s recommendations, the state “shall, within a reasonable time, make a revised or new submission to the Commission.”⁶⁹ However, the CLCS is considered by some to be only a legitimating body, and the final decision about the extension of the shelf is made by the submitting state and neighboring states affected by the claim.⁷⁰

⁶⁴ *Id.* art. 78(1).

⁶⁵ *Id.* arts. 58, 60, 79(1), (3), 80; *supra* notes 51–52 and accompanying text.

⁶⁶ UNCLOS, *supra* note 41, art. 76(8).

⁶⁷ *Id.* annex II, art. 4.

⁶⁸ *Id.* annex II, art. 3(1)(a).

⁶⁹ *Id.* annex II, art. 8; *see also* CLCS R.P. annex VII (presenting a flowchart which suggests that if a state does not accept CLCS’s recommendations about the outer limits of its continental shelf, the state should prepare a “[n]ew or revised submission,” thus restarting the CLCS review process).

⁷⁰ *See* UNCLOS, *supra* note 41, art. 76(8) (“The Commission shall make recommendations to coastal States on matters related to the establishment of the outer limits of their continental shelf. The limits of the shelf established by a coastal State on the basis of these recommendations shall be final and binding.”); Ted L. McDorman, *The Role of the Commission on the Limits of the Continental Shelf: A Technical Body in a Political World*, 17 INT’L J. MARINE & COASTAL L. 301, 313–17 (2002) (discussing the various interpretations of the CLCS’s role in the claim process).

The state delimitation decisions should conform to UNCLOS provisions for delineation of the extended continental shelf;⁷¹ however, compliance with UNCLOS does not necessarily prevent states from making overlapping claims,⁷² and the consequences of a state's failure to conform to CLCS recommendations are undefined. The CLCS's role in delimitation of overlapping or disputed areas is unclear as well.⁷³ According to UNCLOS, CLCS's actions "shall not prejudice matters relating to delimitation of boundaries between States with opposite or adjacent coasts."⁷⁴ Similarly, in its Rules of Procedure—a legal document "subordinate" to UNCLOS⁷⁵—the CLCS claims to recognize that "competence" with respect to disputes arising from delimitation of the extended continental shelf "rests with the States."⁷⁶ If a CLCS submission involves an interstate dispute, the CLCS Rules of Procedure require submitting states to inform the CLCS of the controversy and to assure it "to the extent possible that the submission will not prejudice matters relating to the delimitation of boundaries between States."⁷⁷ If a dispute indeed exists, the CLCS "shall not consider and qualify a submission" made by a

⁷¹ UNCLOS, *supra* note 41, art. 76(2), (4)–(6).

⁷² Cf. Alex G. Oude Elferink & Constance Johnson, *Outer Limits of the Continental Shelf and "Disputed Areas": State Practice Concerning Article 76(10) of the LOS Convention**, 21 INT'L J. MARINE & COASTAL L. 461, 467 (2006) ("[T]wo States making a submission for the same [continental-shelf] area may include different outer limit lines. For instance, two States may rely on different data or have different views on the interpretation or application of Article 76.").

⁷³ For an overview of the many issues arising from this muddled area of law, see *id.* at 464–68.

⁷⁴ UNCLOS, *supra* note 41, annex II, art. 9; see also Elferink & Johnson, *supra* note 72, at 467 ("[T]he result of Article 76(10) of the Convention is that the provisions in Article 76(8) and 76(9) concerning the final and binding and permanent nature of outer limits of the continental shelf cannot be invoked against another State where the delimitation of the continental shelf is concerned.").

⁷⁵ Elferink & Johnson, *supra* note 72, at 467.

⁷⁶ CLCS R.P. annex I, art. 1. In cases of "dispute in the delimitation of the continental shelf between opposite or adjacent States or in other cases of unresolved land or maritime disputes," the CLCS Rules of Procedure provide that "submissions may be made and shall be considered in accordance with Annex I to these Rules." *Id.* R. 46(1). The Annex I procedure is outlined above.

⁷⁷ *Id.* annex I, art. 2.

disputing state without “prior consent given by all States that are parties to such a dispute.”⁷⁸ In disputed or potentially disputed cases, a state may first make a partial submission that does not prejudice the outcome of the dispute and may make any remaining submissions at a later date, notwithstanding the usual ten-year time limit for CLCS submissions.⁷⁹

UNCLOS also sets up a separate regime for “the seabed and ocean floor and subsoil . . . beyond the limits of national jurisdiction”⁸⁰—that is, in areas not claimable as extended continental shelf by any state pursuant to UNCLOS article 76. These areas are collectively known as “the Area.”⁸¹ According to UNCLOS, “[t]he Area and its resources are the common heritage of mankind,”⁸² and “[n]o State shall claim or exercise sovereignty or sovereign rights over [them].”⁸³ Instead, these resources may only be exploited under the auspices of the International Seabed Authority, as provided in the UNCLOS Area regime.⁸⁴

4. Arctic maritime boundary claims, disputes, and treaties. Within the international law of the sea framework outlined above, the Arctic states have asserted a number of territorial claims over the Arctic Ocean, some of which compete with each other. While some of the major Arctic maritime-jurisdiction controversies concern coastal-state control over navigation,⁸⁵ such disputes do not affect state jurisdiction over resources of the seabed and subsoil and will thus not be further explored in this study. However, the study will review the major disputes,

⁷⁸ *Id.* annex I, art. 5.

⁷⁹ *Id.* annex I, art. 3.

⁸⁰ UNCLOS, *supra* note 41, art. 1(1).

⁸¹ *Id.*

⁸² *Id.* art. 136.

⁸³ *Id.* art. 137(1).

⁸⁴ *Id.* pt. XI, §§ 3–4.

⁸⁵ One notable example is the U.S.-Canada dispute over waters of the Canadian Arctic Archipelago, which Canada has declared as its internal waters but which the United States considers to be straits used for international navigation. *See, e.g.,* Kathryn Isted, Note, *Sovereignty in the Arctic: An Analysis of Territorial Disputes & Environmental Policy Considerations*, 18 J. TRANSNAT’L L. & POL’Y 343, 354–55 (2009).

unacknowledged claims, and treaties that may today affect state control over Arctic offshore hydrocarbon resources. This review will update previous research on the subject⁸⁶ and will provide context for the maps of zones of Arctic maritime jurisdiction in Part III of the study.

a. 1973 Canada-Denmark agreement. In 1973, Canada and Denmark signed an agreement on the Delimitation of the Continental Shelf Between Greenland and Canada,⁸⁷ which set out “to establish in the area between Greenland and the Canadian Arctic Islands a dividing line beyond which neither Party . . . will extend its sovereign rights for the purpose of exploration and exploitation of the natural resources of the continental shelf.”⁸⁸ The agreed-upon boundary was the median line between the states, as “determined and adjusted by mutual agreement.”⁸⁹ In addition, the parties agreed that

[i]f any single geological petroleum structure or field . . . extended across the dividing line and the part of such structure or field which is situated on one side of the dividing line is exploitable, wholly or in part, from the other side of the dividing line, the Parties shall seek to reach an agreement as to the exploitation of such structure.⁹⁰

Finally, citing mapping difficulties, the states agreed not to issue resource-exploration licenses “in areas bordering the dividing line” without the other state’s consent to the exact delineation of the agreed-upon boundary near the relevant area.⁹¹

⁸⁶ See generally, e.g., INT’L BOUNDARIES RESEARCH UNIT, *supra* note 40, at 2–3; Isted, *supra* note 85.

⁸⁷ Agreement Between the Government of the Kingdom of Denmark and the Government of Canada Relating to the Delimitation of the Continental Shelf Between Greenland and Canada, Dec. 17, 1973, *available at* <http://www.un.org/depts/los/LEGISLATIONANDTREATIES/PDFFILES/TREATIES/DNK-CAN1973CS.PDF>.

⁸⁸ *Id.* pmb.; *accord id.* art. 1.

⁸⁹ *Id.* art. 1.

⁹⁰ *Id.* art. 5.

⁹¹ *Id.* art. 3.

b. 1981 Iceland-Norway Jan Mayen agreement. In the 1981 agreement on the Continental Shelf in the Area Between Iceland and Jan Mayen,⁹² Iceland and Norway agreed to extension of the Icelandic EEZ to 200 nm, to division of areas where the distance between the two states' territorial-sea baselines was less than 400 nm,⁹³ and to sharing of certain hydrocarbon resources. The agreement provided that the continental-shelf and EEZ boundaries between the two states would coincide⁹⁴ and established a 45,020 km² joint-development zone that overlaps the two states' EEZs⁹⁵—the Norwegian EEZ in the north and the Icelandic EEZ in the south.

In the joint-development zone, the states agreed to conduct joint geological exploration⁹⁶ and to grant exclusive exploration or production licenses only pursuant to joint-venture contracts or other agreement between the states.⁹⁷ Where the joint-development zone overlaps with the Norwegian EEZ (a 32,750 km² area), Iceland would “be entitled to participate with a share of 25 percent” in hydrocarbon exploration and production.⁹⁸ When negotiating with outside oil companies,⁹⁹ Norway would have to seek an arrangement that would require the companies to carry the two states' costs until “commercial finds have been declared.”¹⁰⁰ If such an arrangement could not be achieved, the states would discuss the “possibility of conducting the

⁹² Agreement Between Iceland and Norway on the Continental Shelf in the Area Between Iceland and Jan Mayen, Oct. 22, 1981, *available at* http://www.nea.is/media/olia/JM_agreement_Iceland_Norway_1981.pdf.

⁹³ *Id.* p.mbl.

⁹⁴ *Id.* art. 1.

⁹⁵ *See id.* art. 2 (laying out the coordinates of the joint-development zone); *id.* arts. 3–9 (specifying the procedures for joint exploitation of hydrocarbon deposits).

⁹⁶ *Id.* art. 3. Plans for exploration would be drafted by both Norwegian and Icelandic experts, but the practical implementation and cost of exploration would be borne by the Norwegian Petroleum Directorate (NPD), unless the states agreed otherwise. *Id.* art. 4.

⁹⁷ *Id.* art. 4.

⁹⁸ *Id.* art. 5.

⁹⁹ The agreement refers to “outside governmental or non-governmental petroleum companies,” *id.* arts. 5–6; in other words, oil companies not owned by either of the two states.

¹⁰⁰ *Id.* art. 5.

operations as a joint venture where each of them carries its own costs, or where they share the costs.”¹⁰¹ If Iceland declined to participate in such an arrangement, Norway could proceed on its own.¹⁰² However, if commercial finds were declared, Iceland could still enter into the venture at that point, provided that it reimbursed Norway for its portion of the already incurred costs.¹⁰³ Conversely, in the smaller (12,270 km²) area where the joint-development zone overlapped with the Icelandic EEZ, Norway would be entitled to participate with a 25% share, but Iceland would not be required to seek a cost-carrying arrangement with outside oil companies.¹⁰⁴ In both areas, after commercial finds were declared, the states would be required to carry their own costs proportional to their participation in the contract.¹⁰⁵

Finally, the agreement provided for shared exploitation of deposits that cross the EEZ boundary between the states or that are at least partially located within the joint-development zone. If the deposit crossed the EEZ boundary or lay south of the boundary but extended into the joint-development zone, “the usual unitization principles,” to be worked out in more detail by agreement between the two states, would apply.¹⁰⁶ But if the deposit lay north of the EEZ boundary but extended into the joint-development zone, the deposit would be treated as if it lay entirely in the joint-development zone.¹⁰⁷ The first production licenses in the joint-development zone—which were also the first-ever production licenses in Icelandic waters—were granted in

¹⁰¹ *Id.*

¹⁰² *Id.*

¹⁰³ *Id.*

¹⁰⁴ *Id.* art. 6.

¹⁰⁵ *Id.* art. 7.

¹⁰⁶ *Id.* art. 8.

¹⁰⁷ *Id.*

January 2013.¹⁰⁸ As specified in the 1981 agreement, Norway received a 25% participation in the licenses.¹⁰⁹

c. 1990 U.S.-Soviet agreement. The 1990 agreement between United States and the former Soviet Union chose a line established by the 1867 Convention Ceding Alaska as the maritime boundary between the states' EEZs as well as any potential continental shelf beyond them.¹¹⁰ The agreement provided that any areas east of the agreed-upon boundary that were within the Soviet EEZ ("eastern special areas") would belong to the United States, even though they were otherwise outside the U.S. EEZ.¹¹¹ Conversely, any areas west of the boundary that were within the U.S. EEZ ("western special areas") would belong to the Soviet Union, even though they were otherwise outside the Soviet EEZ.¹¹² The states clarified that any jurisdictional rights over those special areas would originate from the agreement and not from unilateral extension of the states' EEZs beyond the 200-nm limit.¹¹³ The agreement also purported to "define the limits of [the states'] respective maritime jurisdictions" that may be subject to

¹⁰⁸ Trude Pettersen, *License To Drill*, BARENTS OBSERVER (Jan. 8, 2013), <http://barentsobserver.com/en/energy/2013/01/license-drill-08-01>.

¹⁰⁹ *Id.*

¹¹⁰ Message from the President of the United States Transmitting the Agreement Between the United States of America and the Union of Soviet Socialist Republics on the Maritime Boundary, with Annex (1990) [hereinafter Message from the President on 1990 U.S.-Soviet Agreement], *available at* <http://www.state.gov/documents/organization/125431.pdf>; Agreement Between the United States of America and the Union of Soviet Socialist Republics on the Maritime Boundary art. 1, June 1, 1990 [hereinafter 1990 U.S.-Soviet Agreement], *available at* <http://www.state.gov/documents/organization/125431.pdf>. International law of the sea would determine the scope and extent of the states' jurisdiction over the seabed and the superjacent water column in areas affected by the agreement. *Id.* art. 5.

¹¹¹ 1990 U.S.-Soviet Agreement, *supra* note 110, art. 3(1).

¹¹² *Id.* art. 3(2).

¹¹³ *Id.* art. 3(3); Message from the President on 1990 U.S.-Soviet Agreement, *supra* note 110, at vii.

“continental shelf, but not exclusive economic zone claims”¹¹⁴ by extending the agreed-upon boundary “as far [north] as permitted under international law.”¹¹⁵ In other words, the two states would delimit any potential extended continental shelf as between each other, but whether and how far offshore the claimed continental shelf extended would be determined by international law. As Russia has not ratified this agreement, it has not yet entered into force.¹¹⁶

d. Denmark-Norway boundary dispute and resolution. Meanwhile, on the European side of the Arctic Ocean, in August 1988, Denmark submitted an application to the International Court of Justice (ICJ) to decide a dispute between Denmark and Norway regarding the states’ maritime boundary between Greenland and Jan Mayen.¹¹⁷ Norway argued that as previous maritime delimitation agreements involving the two states used median lines between the states’ coastlines as boundaries, the median-line principle should also extend to other maritime boundaries between the two states, including the Greenland-Jan Mayen boundary.¹¹⁸ In June 1993, the ICJ held that, *inter alia*, the previous agreements did not determine the boundary in question and that it would thus have to be determined independently.¹¹⁹ However, basing its decision on the 1958 Geneva Convention and CIL, the ICJ still used the median line as the provisional boundary between the two states, subject to equitable adjustment.¹²⁰ The ICJ did not

¹¹⁴ Message from the President on 1990 U.S.-Soviet Agreement, *supra* note 110, at vi. As noted above, such areas are located more than 200 nm from a state’s territorial-sea baselines but within the limits defined by UNCLOS article 76. See *supra* notes 57–59 and accompanying text.

¹¹⁵ 1990 U.S.-Soviet Agreement, *supra* note 110, art. 2(1).

¹¹⁶ Bureau of European & Eurasian Affairs, *Status of Wrangel and Other Arctic Islands*, U.S. DEP’T OF STATE (Sept. 8, 2009), <http://www.state.gov/p/eur/rls/fs/128740.htm>.

¹¹⁷ Application Instituting Proceedings, Maritime Boundary in the Area Between Greenland and Jan Mayen (Den. v. Nor.) (Aug. 16, 1988), <http://www.icj-cij.org/docket/files/78/6613.pdf>.

¹¹⁸ Maritime Delimitation in the Area Between Greenland and Jan Mayen (Den. v. Nor.), 1993 I.C.J. 38, para. 22 (June 14).

¹¹⁹ *Id.* para. 40.

¹²⁰ *Id.* paras. 48–50.

apply UNCLOS, as the two states had not yet ratified it at the time.¹²¹ Then, in pursuit of the equitable delimitation solution required by CIL,¹²² the ICJ shifted the provisional, median-line boundary eastward to allocate a larger portion of the shelf area to Denmark.¹²³ In support of its decision, the ICJ cited the disparity in the lengths of the relevant coastlines (the relevant coastline of Greenland was much longer than the relevant coastline of Jan Mayen)¹²⁴ and access to fishery resources in the area.¹²⁵ The ICJ noted that access to the area's mineral resources could also be relevant to the delimitation, but it did not further address the issue, as the states did not provide it with sufficient information.¹²⁶

Based on the ICJ's 1993 judgment, in December 1995 Denmark and Norway concluded an agreement on the boundary between Greenland and Jan Mayen.¹²⁷ The two states also agreed that if one state opines that the natural resources on the continental shelf of the other state extend onto the first state's continental shelf, the first state may submit this opinion and supporting evidence to the other state.¹²⁸ The two states shall then discuss "the extent of the resources and the possibility of exploitation," and if they establish 1) that the resources do extend across both states' continental shelves and also 2) that the resources on one state's shelf "can be exploited wholly or in part from the area of the other . . . or that the exploitation of the resources in the area

¹²¹ *Id.* para. 48.

¹²² *Id.*

¹²³ *Id.* paras. 48–50, 90.

¹²⁴ *Id.* paras. 68–69.

¹²⁵ *Id.* paras. 75–80. Interestingly, the ICJ also discussed the presence of sea ice in the area and its impact on accessibility of the region, and it left open the possibility that this factor may affect maritime delimitation. *Id.* paras. 77–78.

¹²⁶ *Id.* para. 72.

¹²⁷ Agreement Between the Kingdom of Denmark and the Kingdom of Norway Concerning the Delimitation of the Continental Shelf in the Area Between Jan Mayen and Greenland and Concerning the Boundary Between the Fishery Zones in the Area pmb., Dec. 18, 1995, available at <http://www.marineregions.org/documents/DNK-NOR1995CS.pdf>.

¹²⁸ *Id.* art. 2.

of one Party would affect the possibility of exploitation of the resources in the area of the other Party,” then “an agreement concerning the exploitation of the resources shall be made at the request of one of the Parties.”¹²⁹ The states also noted “that a final determination of the further [southerly] course of the delimitation line . . . must be effected in consultation with Iceland,”¹³⁰ as Iceland would also be affected.¹³¹

Iceland and Denmark then concluded an analogous agreement with respect to their continental-shelf boundary, just south of the 1995 Denmark-Norway boundary, in November 1997.¹³² In accordance with the 1995 Denmark-Norway agreement, the Denmark-Iceland treaty noted that the northernmost boundary point was established in cooperation with Norway and will need to be confirmed through an agreement with it.¹³³ The agreement also included a natural-resource provision nearly identical to the provision in the 1995 treaty.¹³⁴

e. Russian 2001 CLCS submission. In December 2001, Russia made its initial CLCS submission regarding the Arctic Ocean, Barents Sea, Bering Sea, and the Sea of Okhotsk.¹³⁵

¹²⁹ *Id.*

¹³⁰ *Id.* pmb1.

¹³¹ This situation is an early example of the need for multilateral cooperation in determining maritime boundaries between Arctic states, as delimitation will often implicate more than just two states. *See infra* notes 151–156 and accompanying text.

¹³² Agreement Between the Government of the Kingdom of Denmark Along with the Local Government of Greenland on the One Hand, and the Government of the Republic of Iceland on the Other Hand on the Delimitation of the Continental Shelf and the Fishery Zone in the Area Between Greenland and Iceland art. 1, Nov. 11, 1997, *available at* <http://www.un.org/Depts/los/LEGISLATIONANDTREATIES/PDFFILES/TREATIES/DNK-ISL1997CS.PDF>.

¹³³ *Id.*

¹³⁴ *Id.*; *supra* notes 128–129 and accompanying text.

¹³⁵ Div. for Ocean Affairs & Law of the Sea, *Submission by the Russian Federation*, UNITED NATIONS [hereinafter Div. for Ocean Affairs & the Law of the Sea, *Submission by the Russian Federation*], http://www.un.org/Depts/los/clcs_new/submissions_files/submission_rus.htm (last updated June 30, 2009). Russia was the first state to ever make a CLCS submission. Div. for Ocean Affairs & the Law of the Sea, *Submissions, Through the Secretary-General of the United Nations, to the Commission on the Limits of the Continental Shelf, Pursuant to Article 76*,

Portions of Russia’s proposed continental-shelf boundary in the Arctic Ocean were comprised of provisional boundaries with other states, to be further outlined through negotiations with those states.¹³⁶ Conversely, the Bering Sea boundary with the United States was not deemed provisional, perhaps because of the 1990 U.S.-Soviet Agreement.¹³⁷ Canada and Denmark, which could both potentially claim areas of the Arctic seabed claimed in the Russian submission,¹³⁸ argued that the submission did not contain enough data and that any determinations by the CLCS would be without prejudice to any subsequent bilateral negotiations.¹³⁹ Norway commented—with Russia’s agreement—that the Russian claim constituted a “maritime dispute” between the two states but consented to CLCS’s consideration of the submission, provided that it does not prejudice subsequent bilateral delimitation.¹⁴⁰

Paragraph 8, of the United Nations Convention on the Law of the Sea of 10 December 1982, UNITED NATIONS [hereinafter Div. for Ocean Affairs & the Law of the Sea, Submissions], http://www.un.org/Depts/los/clcs_new/commission_submissions.htm (last updated Mar. 1, 2013).

¹³⁶ Elferink & Johnson, *supra* note 72, at 468–69.

¹³⁷ *See supra* notes 110–116 and accompanying text. Russia has not yet ratified this agreement but did refer to it in its CLCS submission. United States of America: Notification Regarding the Submission Made by the Russian Federation to the Commission on the Limits of the Continental Shelf 2 (Feb. 28, 2002) [hereinafter U.S. Notification to Russian CLCS Submission], http://www.un.org/Depts/los/clcs_new/submissions_files/rus01/CLCS_01_2001_LOS__USAtext.pdf.

¹³⁸ *See infra* Map 1.

¹³⁹ Elferink & Johnson, *supra* note 72, at 470 & n.28; Canada: Notification Regarding the Submission Made by the Russian Federation to the Commission on the Limits of the Continental Shelf (Jan. 18, 2002), http://www.un.org/Depts/los/clcs_new/submissions_files/rus01/CLCS_01_2001_LOS__CANtext.pdf; Denmark: Notification Regarding the Submission Made by the Russian Federation to the Commission on the Limits of the Continental Shelf (Feb. 4, 2001), http://www.un.org/Depts/los/clcs_new/submissions_files/rus01/CLCS_01_2001_LOS__DNKtext.pdf.

¹⁴⁰ Norway: Notification Regarding the Submission Made by the Russian Federation to the Commission on the Limits of the Continental Shelf 3 (Mar. 20, 2002) (internal quotation marks omitted), *available at* http://www.un.org/depts/los/clcs_new/submissions_files/rus01/CLCS_01_2001_LOS__NORtext

(Norway and Russia subsequently resolved their controversy in a 2010 bilateral agreement on their maritime boundary in the Barents Sea and Arctic Ocean, described below.)¹⁴¹ Finally, the United States challenged Russia's claim to the Alpha-Mendeleev ridge, arguing that it was formed by a volcanic hotspot emanating from "the deep Arctic Ocean Basin" and is thus "not part of any State's continental shelf."¹⁴² Similarly, the United States challenged Russia's claim to the Lomonosov Ridge, arguing that "[t]he ridge is a freestanding feature in the deep, oceanic part of the Arctic Ocean Basin, and not a natural component of the continental margins of either Russia or any other State."¹⁴³ Like Canada and Denmark, the United States also noted the insufficiency of data provided in the Russian submission.¹⁴⁴ In June 2002,¹⁴⁵ CLCS recommended that Russia submit the results of finalized bilateral delimitations with Norway and the United States as the limits of its outer continental shelf in those regions, and that it revise its claim to the Central Arctic Ocean as provided in CLCS's recommendations.¹⁴⁶ As of April 2013, Russia has yet to make a revised submission to the CLCS with respect to those areas.¹⁴⁷

f. 2006 Denmark-Norway Greenland-Svalbard agreement. In February 2006, Denmark and Norway concluded an agreement about their continental-shelf boundary between Svalbard and Greenland. The boundary was established "on the basis of the median line between relevant

.pdf. Norway also argued that the claimed area was clearly part of the Eurasian continental shelf and only needed to be delimited as between the two states. *Id.*

¹⁴¹ See *infra* notes 172–181 and accompanying text.

¹⁴² See U.S. Notification to Russian CLCS Submission, *supra* note 137, at 2 ("[The continental margin] does not include the deep ocean floor with its oceanic ridges" (quoting UNCLOS, *supra* note 41, art. 76(3)) (internal quotation marks omitted)).

¹⁴³ *Id.* at 3.

¹⁴⁴ *Id.* at 2–3.

¹⁴⁵ Div. for Ocean Affairs & the Law of the Sea, *Submission by the Russian Federation*, *supra* note 135.

¹⁴⁶ OCEANS AND THE LAW OF THE SEA: REPORT OF THE SECRETARY-GENERAL: ADDENDUM paras. 38, 40, UN Doc. A/57/57/Add.1 (Oct. 8, 2002), <http://daccess-dds-ny.un.org/doc/UNDOC/GEN/N02/629/28/PDF/N0262928.pdf?OpenElement>.

¹⁴⁷ Div. for Ocean Affairs & the Law of the Sea, *Submissions*, *supra* note 135.

coastlines of Greenland and Svalbard and on the basis of negotiations between the Parties.”¹⁴⁸

The areas addressed in the agreement are all within 200 nm of one of the states’ territorial-sea baselines.¹⁴⁹ The 2006 Denmark-Norway treaty included a natural-resource provision similar to the provision in the 1997 Denmark-Iceland treaty; however, the 2006 treaty also specified that any resource-exploitation agreement reached by the states would address how “any such deposit shall be most effectively exploited and [how] the proceeds relating thereto shall be apportioned.”¹⁵⁰

g. 2006 Denmark-Iceland-Norway Agreed Minutes. In September 2006, Denmark, Iceland, and Norway signed the Agreed Minutes on the Delimitation of the Continental Shelf Beyond 200 Nautical Miles Between the Faroe Islands, Iceland and Norway in the Southern Part of the Banana Hole of the Northeast Atlantic (“Agreed Minutes”).¹⁵¹ The Agreed Minutes addressed the delimitation of the extended continental shelf between the three states, subject to UNCLOS requirements.¹⁵² The latter stipulation meant that if any area covered in the agreement was not part of the continuous continental shelf of the three states, the outer limit of the continental shelf would be delineated in accordance with UNCLOS article 76, without affecting

¹⁴⁸ Agreement Between the Government of the Kingdom of Norway on the One Hand, and the Government of the Kingdom of Denmark Together with the Home Rule Government of Greenland on the Other Hand Concerning the Delimitation of the Continental Shelf and the Fisheries Zones in the Area Between Greenland and Svalbard art. 1, Feb. 20, 2006 [hereinafter 2006 Denmark-Norway Agreement], *translated in* Alex G. Oude Elferink, *Maritime Delimitation Between Denmark/Greenland and Norway*, 38 OCEAN DEV. & INT’L L. 375, 378 app. 1 (2007).

¹⁴⁹ Elferink, *supra* note 148, at 375.

¹⁵⁰ 2006 Denmark-Norway Agreement, *supra* note 148, art. 2.

¹⁵¹ Agreed Minutes on the Delimitation of the Continental Shelf Beyond 200 Nautical Miles Between the Faroe Islands, Iceland and Norway in the Southern Part of the Banana Hole of the Northeast Atlantic, Sept. 20, 2006, *available at* <http://www.regjeringen.no/en/dep/ud/documents/Laws-and-rules/retningslinjer/2006/Agreed-Minutes.html?id=446839>.

¹⁵² *Id.* art. 1.

other agreed-upon boundaries.¹⁵³ The three states agreed to submit their continental-shelf claims to the CLCS in the near future, and they further agreed to declare that they do not object to CLCS's consideration of each other's claims in the area, provided that such consideration does not prejudice subsequent CLCS submissions from the three states or delimitations negotiated among the three states.¹⁵⁴ The provisionally delineated continental-shelf boundaries among the three states would first be adjusted based on each state's ability to support its claims in front of the CLCS,¹⁵⁵ and then final boundaries would be established by subsequent bilateral agreements among the three states.¹⁵⁶

h. Norwegian 2006 CLCS submission. Norway made its CLCS submission in November 2006.¹⁵⁷ The partial submission comprised three claims: the "Banana Hole" in the Greenland Sea between mainland Norway and Jan Mayen; a claim in the Western Nansen Basin (a small strip of sea extending poleward from the northernmost part of Norway's EEZ, above Svalbard); and the "Loop Hole" in the Barents Sea, extending eastward from the Norwegian EEZ toward Russia.¹⁵⁸ Denmark, Iceland, and Russia could have been potentially affected by the Norwegian claim. Pursuant to the Agreed Minutes, Denmark and Iceland, which could have been affected by the Banana Hole claim, responded that they did not object to CLCS's consideration of the Norwegian submission for the area, provided that any determination made by the CLCS would

¹⁵³ *Id.* art. 4; *see also id.* ("These Agreed Minutes are based on the shared view that the whole area concerned consists of continuous continental shelf.").

¹⁵⁴ *Id.* arts. 6–8.

¹⁵⁵ *Id.* arts. 2, 8.

¹⁵⁶ *Id.* arts. 9–10.

¹⁵⁷ Div. for Ocean Affairs & the Law of the Sea, *Submissions*, *supra* note 135.

¹⁵⁸ OLJEDIREKTORATET, CONTINENTAL SHELF SUBMISSION OF NORWAY IN RESPECT OF AREAS IN THE ARCTIC OCEAN, THE BARENTS SEA AND THE NORWEGIAN SEA: EXECUTIVE SUMMARY 6 (2006), *available at* http://www.un.org/Depts/los/clcs_new/submissions_files/nor06/nor_exec_sum.pdf.

not prejudice subsequent bilateral delimitations.¹⁵⁹ Russia—not a party to the Agreed Minutes—claimed that the Norwegian submission involved an unresolved boundary dispute between Russia and Norway but did not object to CLCS’s consideration of the Norwegian claim, again provided that it does not prejudice bilateral resolution of the dispute.¹⁶⁰

In the meantime, in March 2009, the CLCS responded to the Norwegian claim with its recommendations. The CLCS found that the entire Loop Hole area was part of the Eurasian continental shelf, and that “[o]nly a bilateral delimitation between Norway and the Russian Federation remains to be carried out to delineate the extent of each coastal State’s continental shelf” in the area.¹⁶¹ The CLCS also agreed with Norway’s submission for the Western Nansen Basin,¹⁶² and it almost entirely agreed with the Banana Hole submission but noted that it may be affected by delimitation with the neighboring two states.¹⁶³

¹⁵⁹ Denmark: Notification Regarding the Submission Made by Norway to the Commission on the Limits of the Continental Shelf (Jan. 24, 2007), *available at* http://www.un.org/Depts/los/clcs_new/submissions_files/nor06/dnk07_00218.pdf; Iceland: Notification Regarding the Submission Made by Norway to the Commission on the Limits of the Continental Shelf (Jan. 29, 2007), *available at* http://www.un.org/Depts/los/clcs_new/submissions_files/nor06/isl07_00223.pdf.

¹⁶⁰ Russian Federation: Notification Regarding the Submission Made by Norway to the Commission on the Limits of the Continental Shelf (Feb. 21, 2007), *available at* http://www.un.org/Depts/los/clcs_new/submissions_files/nor06/rus_07_00325.pdf. The dispute was eventually settled by the 2010 Norway-Russia agreement. *See infra* notes 172–181 and accompanying text.

¹⁶¹ COMM’N ON THE LIMITS OF THE CONT’L SHELF, SUMMARY OF THE RECOMMENDATIONS OF THE COMMISSION ON THE LIMITS OF THE CONTINENTAL SHELF IN REGARD TO THE SUBMISSION MADE BY NORWAY IN RESPECT OF AREAS IN THE ARCTIC OCEAN, THE BARENTS SEA AND THE NORWEGIAN SEA ON 27 NOVEMBER 2006*, at 9 (2009), *available at* http://www.un.org/Depts/los/clcs_new/submissions_files/nor06/nor_rec_summ.pdf.

¹⁶² *Id.* at 15–16.

¹⁶³ *Id.* at 30.

i. Iceland's 2009 CLCS submission. Iceland made a partial submission to the CLCS in April 2009.¹⁶⁴ The submission discussed, *inter alia*, the Ægir Basin area, which has been provisionally addressed in the Agreed Minutes.¹⁶⁵ Norway and Iceland filed their responses in accordance with the Agreed Minutes.¹⁶⁶

j. Denmark's 2009 CLCS submission. In April 2009, Denmark made a submission for a small area north of the Faroe Islands, bordering on the Norwegian Banana Hole claim¹⁶⁷ and just within the geographic scope of this study. Per the Agreed Minutes, Iceland and Norway responded that they did not object to CLCS's consideration of the Danish claim, provided that it did not prejudice subsequent delimitation discussions among the three states.¹⁶⁸ In 2012, Denmark also made a partial submission for delineation of the continental shelf of southern

¹⁶⁴ THE ICELANDIC CONTINENTAL SHELF: PARTIAL SUBMISSION TO THE COMMISSION ON THE LIMITS OF THE CONTINENTAL SHELF PURSUANT TO ARTICLE 76, PARAGRAPH 8 OF THE UNITED NATIONS CONVENTION ON THE LAW OF THE SEA IN RESPECT OF THE ÆGIR BASIN AREA AND REYKJANES RIDGE: PART I. EXECUTIVE SUMMARY (2009), *available at* http://www.un.org/Depts/los/clcs_new/submissions_files/isl27_09/isl2009executivesummary.pdf.

¹⁶⁵ *Id.* at 5. Other parts of the Icelandic claim are outside the geographic area of this study.

¹⁶⁶ Denmark: Notification Regarding the Submission Made by Iceland to the Commission on the Limits of the Continental Shelf (June 15, 2009), http://www.un.org/Depts/los/clcs_new/submissions_files/isl27_09/dnk_15jun09.pdf; Norway: Notification Regarding the Submission Made by Iceland to the Commission on the Limits of the Continental Shelf (July 7, 2009), *available at* http://www.un.org/Depts/los/clcs_new/submissions_files/isl27_09/nor_7jul09.pdf.

¹⁶⁷ GEOLOGICAL SURVEY OF DEN. & GREEN., PARTIAL SUBMISSION OF THE GOVERNMENT OF THE KINGDOM OF DENMARK TOGETHER WITH THE GOVERNMENT OF THE FAROES TO THE COMMISSION ON THE LIMITS OF THE CONTINENTAL SHELF: THE CONTINENTAL SHELF NORTH OF THE FAROE ISLANDS 7 fig.1, 13 (2010), *available at* http://www.un.org/Depts/los/clcs_new/submissions_files/dnk28_09/dnk2009executivesummary.pdf.

¹⁶⁸ Norway: Notification Regarding the Submission Made by Denmark to the Commission on the Limits of the Continental Shelf (July 7, 2009), *available at* http://www.un.org/Depts/los/clcs_new/submissions_files/dnk28_09/nor_7jul09.pdf; Iceland: Notification Regarding the Submission Made by Denmark to the Commission on the Limits of the Continental Shelf (June 15, 2009), *available at* http://www.un.org/Depts/los/clcs_new/submissions_files/dnk28_09/isl_15jun09.pdf.

Greenland, below the Arctic Circle and thus outside this study's area.¹⁶⁹ Denmark intends to make a submission for the continental shelf of northern and northeastern Greenland—potentially including the Lomonosov Ridge, Morris Jessup Rise, Amundsen Basin, and East Greenland Ridge¹⁷⁰—at a later date.¹⁷¹

k. *2010 Norway-Russia agreement.* The most recent ratified bilateral agreement on boundary delimitation in Arctic waters is the 2010 Norway-Russia Treaty Concerning Maritime Delimitation and Cooperation in the Barents Sea and the Arctic Ocean.¹⁷² The agreement, a culmination of more than forty years of negotiations between the two states,¹⁷³ set out the

¹⁶⁹ GEOLOGICAL SURVEY OF DEN. & GREEN., PARTIAL SUBMISSION OF THE GOVERNMENT OF THE KINGDOM OF DENMARK TOGETHER WITH THE GOVERNMENT OF GREENLAND TO THE COMMISSION ON THE LIMITS OF THE CONTINENTAL SHELF: THE SOUTHERN CONTINENTAL SHELF OF GREENLAND 8 fig.1 (2012), *available at* http://www.un.org/Depts/los/clcs_new/submissions_files/dnk61_12/DNK2012_EX_SUM_S_GREENLAND.pdf. Canada noted that the claimed area may potentially overlap with the Canadian continental shelf but also stated that it did not object to CLCS's consideration of the Danish submission, provided that it is without prejudice to any subsequent bilateral delimitation. Canada: Notification Regarding the Submission Made by Denmark to the Commission on the Limits of the Continental Shelf (June 15, 2012), *available at* http://www.un.org/Depts/los/clcs_new/submissions_files/dnk61_12/clcs61_2012_can.pdf; *see also* GEOLOGICAL SURVEY OF DEN. & GREEN., *supra*, at 15 (“The final delimitation will, as appropriate, be determined through a bilateral agreement.”). Pursuant to the Agreed Minutes, Iceland also did not object to CLCS's consideration of the Danish submission, provided that it did not prejudice any subsequent bilateral delimitation. Iceland: Notification Regarding the Submission Made by Denmark to the Commission on the Limits of the Continental Shelf (Jan. 17, 2013), *available at* http://www.un.org/Depts/los/clcs_new/submissions_files/dnk61_12/ISL_NV_UN_001_17_01_13.pdf.

¹⁷⁰ Christian Marcussen & Martin V. Heinesen, *The Continental Shelf Project of the Kingdom of Denmark—Status at the Beginning of 2010*, 20 GEOLOGICAL SURV. DEN. & GREEN. BULL. 51, 53 (2010).

¹⁷¹ GEOLOGICAL SURVEY OF DEN. & GREEN., *supra* note 169, at 5.

¹⁷² Treaty Between the Kingdom of Norway and the Russian Federation Concerning Maritime Delimitation and Cooperation in the Barents Sea and the Arctic Ocean, Sept. 15, 2010 [hereinafter 2010 Norway-Russia Agreement], *available at* http://www.regjeringen.no/upload/SMK/Vedlegg/2010/avtale_engelsk.pdf.

¹⁷³ *See* Elferink & Johnson, *supra* note 72, at 472 (“In this area both States have been negotiating the delimitation of a continental shelf boundary since 1969.”).

coordinates of the states' maritime boundary in the Barents Sea and Arctic Ocean.¹⁷⁴ Analogous to the 1990 U.S.-Soviet Agreement, the treaty specified that Russia could exercise EEZ jurisdiction over an area east of the agreed-upon boundary that lay outside Russia's but within Norway's EEZ.¹⁷⁵

The 2010 Norway-Russia Agreement also addressed the allocation of hydrocarbon resources between the two states. First, “[i]f a hydrocarbon deposit extends across” the agreed-upon boundary between the two states, Annex II of the agreement would apply,¹⁷⁶ requiring the parties to negotiate a Unitisation Agreement to govern exploitation of the deposit.¹⁷⁷ Second, “[i]f the existence of a hydrocarbon deposit on the continental shelf of one of the Parties is established and the other Party is of the opinion that the said deposit extends to its continental shelf, the latter Party may notify the former Party” and provide data in support of its claim.¹⁷⁸ Then, the parties should discuss the extent of the deposit “and the possibility for exploitation of the deposit as a unit.”¹⁷⁹ If a deposit extends across the continental shelves of both parties and 1) the part of the deposit on the shelf of one party can be exploited from the shelf of the other, or 2) exploitation of the part of the deposit on the shelf of one party would affect exploitation of the part on the shelf of the other, a unitization agreement “shall be reached at the request of one of the Parties . . . in accordance with Annex II.”¹⁸⁰ Exploitation of a deposit that extends across the

¹⁷⁴ 2010 Norway-Russia Agreement, *supra* note 172.

¹⁷⁵ *Id.* art. 3(1). In addition, like the 1990 U.S.-Soviet Agreement, the 2010 Norway-Russia Agreement provided that “exercise of sovereign rights or jurisdiction [in the special area] derives from the agreement of the Parties and does not constitute an extension of [Russia's] exclusive economic zone.” *Id.* art. 3(2); *supra* note 113 and accompanying text.

¹⁷⁶ 2010 Norway-Russia Agreement, *supra* note 172, art. 5(1).

¹⁷⁷ *Id.* annex II, art. 1. The unitization agreement must include certain provisions specified in the annex. *Id.*

¹⁷⁸ *Id.* art. 5(2).

¹⁷⁹ *Id.*

¹⁸⁰ *Id.*

continental shelves of both parties “may only begin as provided for in the Unitisation Agreement.”¹⁸¹

l. The tentative Canada-Denmark Lincoln Sea agreement. In late November 2012, Canada and Denmark reached a tentative agreement regarding the remainder of their EEZ boundary between eastern Canada and Greenland.¹⁸² The agreement will also provide an opportunity to update the states’ 1973 agreement on the existing maritime boundary between East Greenland and Canada south of the Lincoln Sea.¹⁸³

m. The ongoing U.S.-Canada dispute over the Beaufort Sea. The U.S.-Canada dispute over the Beaufort Sea is still ongoing and may be of strategic importance. According to Canada, the maritime border between the two states in the Beaufort Sea is “an extension of the land border”; according to the United States, the border “is at right angles to the coast.”¹⁸⁴ This discrepancy has muddled the legal status of a 26,100 km² portion of the Beaufort Sea north of Alaska and the Yukon. The region is thought to be rich in hydrocarbon resources, and leasing and exploration are already underway in nearby areas,¹⁸⁵ but the uncertainty over the legal status of the region has resulted in a de facto moratorium on hydrocarbon activity.¹⁸⁶

¹⁸¹ *Id.* art. 5(3); *id.* annex II, art. 1(8).

¹⁸² *Canada and Kingdom of Denmark Reach Tentative Agreement on Lincoln Sea Boundary*, FOREIGN AFFAIRS & INT’L TRADE CAN. (Nov. 28, 2012), <http://www.international.gc.ca/media/aff/news-communiqués/2012/11/28a.aspx>.

¹⁸³ *Id.*; see also *supra* notes 87–91 and accompanying text.

¹⁸⁴ Rob Huebert, *Security in the Canadian North: Changing Concerns and Options*, FRASER F., May 2004, at 10, 11.

¹⁸⁵ See, e.g., *Shell 2012 Exploration Plan—Beaufort Sea*, BUREAU OF OCEAN ENERGY MGMT., <http://www.boem.gov/About-BOEM/BOEM-Regions/Alaska-Region/Leasing-and-Plans/Plans/2012-Shell-Beaufort-EP/Index.aspx> (last visited Mar. 16, 2013). For an explanation of this study’s treatment of the Beaufort Sea area, see *infra* note 230 and accompanying text.

¹⁸⁶ James S. Baker & Michael Byers, *Crossed Lines: The Curious Case of the Beaufort Sea Maritime Boundary Dispute*, 43 OCEAN DEV. & INT’L L. 70, 74 (2012); Betsy Baker, *Filling an Arctic Gap*, 34 VT. L. REV. 57, 69 (2009).

The United States has not ratified UNCLOS; it is thus unclear if it may take advantage of the CLCS process¹⁸⁷ and, conversely, whether it is bound by it. However, the United States seems to accept most of UNCLOS as CIL (though its position on UNCLOS's seabed and EEZ provisions is unclear) and may eventually ratify the convention.¹⁸⁸ The United States has been actively surveying its potential extended continental shelf and will likely delineate it in the coming years.¹⁸⁹

Canada, however, has ratified UNCLOS but is still preparing its CLCS submission. Surveying for the submission—including multiple joint efforts with the United States, Denmark, and Sweden—has been in progress since 2006.¹⁹⁰ Under the UNCLOS ten-year time limit, the submission must be completed by December 2013.¹⁹¹ As Canada's continental shelf could potentially overlap with Denmark's and Russia's, Canada could also be implicated in those states' pending CLCS claims.¹⁹²

III. Distribution of Arctic resources across international boundaries.

1. Methods. *a. Overview.* Part III of the study consisted of three basic steps: 1) assembly of the international boundary GIS data, 2) intersection of the international boundary data with the CARA geological data, and 3) analysis of the resulting maps.

b. CARA resource data. All Arctic hydrocarbon resource data used in this study were obtained from USGS's 2008 CARA study, a "geologically based assessment" of oil and gas

¹⁸⁷ McDorman, *supra* note 70, at 303–04.

¹⁸⁸ See *supra* notes 46–48 and accompanying text.

¹⁸⁹ See U.S. EXTENDED CONT'L SHELF PROJECT, <http://continentalshelf.gov> (last updated Oct. 9, 2012) ("The mission of the U.S. Extended Continental Shelf Project is to establish the full extent of the continental shelf of the United States, consistent with international law.").

¹⁹⁰ *Canada's Program*, FOREIGN AFFAIRS & INT'L TRADE CAN., <http://www.international.gc.ca/continental/program-canada-programme.aspx?view=d> (last updated Aug. 15, 2012).

¹⁹¹ *Id.*

¹⁹² See *infra* Map 1.

potential of the Arctic.¹⁹³ The CARA project released a series of papers on province-by-province assessments of oil, gas, and natural gas liquid (NGL) resources north of the Arctic Circle. CARA GIS data on geological provinces and assessment units (AUs) are available in the public domain.

CARA is based on a compilation of geological data from published literature, from public organizations, such as the former U.S. Minerals Management Service (MMS), the Geological Survey of Canada, and the Norwegian Petroleum Directorate (NPD), as well as from information contributions from the industry.¹⁹⁴ The assessment only considered recoverable conventional hydrocarbon accumulations of more than 50 million barrels oil equivalent (MBOE).¹⁹⁵ Recoverable resources were defined based on existing technology, but other economic factors were not considered. Additionally, the assumption was made that the resources would be recoverable regardless of water depth or sea-ice cover.¹⁹⁶

The CARA project first assembled a map of Arctic sedimentary formations that was used to define AUs—“mappable volumes of sedimentary rocks that share similar geological properties” and contain sediment accumulations that are thick enough to have meaningful hydrocarbon-bearing potential.¹⁹⁷ Due to the lack of wellbore and seismic data,¹⁹⁸ hydrocarbon resources in each AU were assessed using “a probabilistic methodology of geological analysis and analog modeling.”¹⁹⁹ Two hundred and forty-six AUs from across the world that have been

¹⁹³ Gautier et al., *supra* note 1, at 1175.

¹⁹⁴ *Id.* at 1176.

¹⁹⁵ *Id.* at 1175.

¹⁹⁶ KENNETH J. BIRD ET AL., U.S. GEOLOGICAL SURVEY, CIRCUM-ARCTIC RESOURCE APPRAISAL: ESTIMATES OF UNDISCOVERED OIL AND GAS NORTH OF THE ARCTIC CIRCLE 1 (2008), *available at* <http://pubs.usgs.gov/fs/2008/3049/fs2008-3049.pdf>; Gautier et al., *supra* note 1, at 1176.

¹⁹⁷ BIRD ET AL., *supra* note 195, at 1.

¹⁹⁸ Gautier et al., *supra* note 1, at 1176.

¹⁹⁹ BIRD ET AL., *supra* note 195, at 2.

²⁰⁰ Gautier et al., *supra* note 1, at 1176.

previously assessed by the USGS were used as analogs to the Arctic AUs.²⁰⁰ Based on those analogs, CARA then assessed the probability of the presence of a 50 MBOE accumulation for each Arctic AU; AUs with a probability of less than 0.1 were excluded.²⁰¹ The remaining 49 AUs were further quantitatively assessed in a Monte Carlo simulation that included conditional distributions of “the number of undiscovered accumulations, the size frequency of undiscovered accumulations, and the likelihood of oil versus gas in each accumulation.”²⁰² These AUs then provided the basis for quantitative assessment of twenty-five geological provinces with requisite hydrocarbon potential.²⁰³ These provinces are the basic analytic units used in this study.

c. Description of IBRU maritime boundary data. The second principal dataset—the Arctic Ocean international boundary data—is not publicly available but was obtained by personal request from researchers at IBRU. The data were previously used to construct IBRU’s “Maritime Jurisdiction and Boundaries in the Arctic Region” map.²⁰⁴ The IBRU shapefiles included: 1) lines of 250 nm and 350 nm from territorial-sea baselines; 2) certain agreed international boundaries, consisting of Denmark-Canada, Denmark-Norway, and Norway-Russia boundaries, as well as part of the U.S.-Canada boundary (but excluding certain boundaries of the Russian and Norwegian areas and of the U.S.-Russian Special Area); 3) median lines, with the exception of the line connecting the Russia-Canada median to the Denmark-Norway agreed boundary and the line connecting the U.S.-Canada median to the Russian claimed boundary; 4) straight baselines; 5) the Norway-Iceland joint zone; 6) the U.S.-Canada zone in the Beaufort Sea; 7) the Norway-Russia Special Area; and 8) the Svalbard area.

²⁰⁰ *Id.* at 1176–77. The 246 analogs in aggregate accounted for more than 95% of known hydrocarbons outside the United States. *Id.*

²⁰¹ *Id.* at 1177.

²⁰² *Id.*

²⁰³ BIRD ET AL., *supra* note 195, at 3.

²⁰⁴ INT’L BOUNDARIES RESEARCH UNIT, *supra* note 40.

d. Additional data sources. To complete the Arctic international boundary map, the IBRU data had to be supplemented with outside data sources, most of which were referenced by the IBRU.²⁰⁵ The Norwegian CLCS submission was used to construct boundaries for claimed Norwegian areas in the Norwegian Sea, Barents Sea, and Western Nansen Basin.²⁰⁶ The submission consisted of a set of 94 coordinates specifying the boundaries of the Norwegian Banana Hole claim; a set of 14 coordinates specifying the boundaries of the state's claim in the Western Nansen Basin; and instructions for construction of the Loop Hole claim.²⁰⁷ The Russian CLCS submission, consisting of 32 coordinates and a demonstration map, was used to construct boundaries for Russia's claimed area in the Arctic Ocean.²⁰⁸

The ETOPO1 bathymetry dataset²⁰⁹ from NOAA's National Geophysical Data Center (NGDC) was used to obtain the 2500-m isobath, which is part of the definition of unclaimable ocean areas pursuant to UNCLOS article 76(4).²¹⁰ ETOPO1 is a 1-arc-minute raster global relief model, and it is publicly available from NGDC's website.²¹¹ ETOPO1 updates NGDC's ETOPO2 2-arc-minute dataset, which was used in IBRU's analysis.²¹² This study extracted isobaths from both ETOPO1 and ETOPO2; when they were used in boundary analysis, they yielded very similar results. The final analysis is based on the newer ETOPO1 dataset.

²⁰⁵ *Id.* at 2–3.

²⁰⁶ OLJEDIREKTORATET, *supra* note 158.

²⁰⁷ *Id.* app. 1.

²⁰⁸ Div. for Ocean Affairs & Law of the Sea, *Submission by the Russian Federation*, *supra* note 135.

²⁰⁹ *ETOPO1 Global Relief Model*, NAT'L GEOPHYSICAL DATA CTR., NAT'L OCEANIC & ATMOSPHERIC ADMIN., <http://www.ngdc.noaa.gov/mgg/global/global.html> (last visited Feb. 23, 2013).

²¹⁰ See UNCLOS art. 76(4) (limiting the continental shelf to areas that “either [do] not exceed 350 nautical miles from the baselines . . . or [do] not exceed 100 nautical miles from the 2,500 metre isobaths”).

²¹¹ *ETOPO1 Global Relief Model*, *supra* note 209.

²¹² INT'L BOUNDARIES RESEARCH UNIT, *supra* note 40, at 3.

Finally, shapefiles with basic geographic data—the continental base map and the Arctic Circle—were obtained from the Natural Earth (NE) database.²¹³ Datasets used were 1:10,000,000 Land polygons and Geographic Lines.²¹⁴

e. Basic processing and assembly of the international boundary dataset. CARA and IBRU data were first transformed to the GCS_WGS_1984 datum, projected using the North Pole Stereographic projection, and clipped to extend only within the Arctic Circle. Then, the partial IBRU data were compared to the final IBRU map to identify the abovementioned missing information.

Next, to create the territorial-sea polygons, NE land polygons were buffered 12 nm seaward from the coastline to obtain the seaward territorial-sea boundary,²¹⁵ without taking into account straight baselines. Then, IBRU straight baselines were buffered by 12 miles to account for states' extension of their territorial seas via the straight baselines. The 12-nm and straight-baseline buffers were then dissolved to obtain the full seaward boundary of the states' territorial seas. As straight baselines occasionally extended across coastal indentations, thus leaving a space between the coast and the straight baseline, the polygons were edited by tracing the shape remaining between the coast and the straight baseline and merging it with the main territorial-sea polygon.

EEZ polygons were constructed next. Additional data (as described above) were obtained and processed to supply the missing boundaries. Boundary coordinates listed in the Russian

²¹³ *1:10m Physical Vectors*, NATURAL EARTH, <http://www.naturalearthdata.com/downloads/10m-physical-vectors> (last visited Feb. 23, 2013).

²¹⁴ *See id.*

²¹⁵ *See* UNCLOS, *supra* note 41, art. 3 (“Every State has the right to establish the breadth of its territorial sea up to a limit not exceeding 12 nautical miles . . .”).

CLCS submission²¹⁶ were plotted and connected with straight lines; the partial U.S.-Russia boundary supplied by IBRU was then extended to connect with those points, as described in the Russian CLCS submission. Then, the two sets of Norwegian CLCS coordinates were plotted. To construct the remaining Norwegian claim, the Loop Hole, Norway's coast was buffered to 200 nm and intersected with the Norway-Russia agreed boundary.²¹⁷ To supply the missing median line north of Greenland, the northern edges of Danish and Norwegian EEZs were buffered in 5-mile increments, and the resultant vertices were connected by straight lines. Analogously, to supply the missing median extending from the IBRU-provided U.S.-Canada median, the 350-nm line north of Canada and the United States was buffered to the intersection with the Russian claimed boundary. The boundary lines were then used to construct polygons representing the various zones of jurisdiction for each state. Lastly, to define the unclaimable areas of the Arctic Ocean, the 2500-m contour was extracted from ETOPO1, buffered to 100 nm, and intersected with existing boundary lines.²¹⁸ The resulting dataset was then compared for consistency with the finished IBRU map.

f. Classification of zones of jurisdiction. Map 1, the international boundary map, was used to classify the Arctic Ocean into undisputed areas, claimed areas, potential areas, and treaty areas, as defined in this study.²¹⁹ The study defines undisputed areas as all areas within a state's 1) territorial sea and 2) EEZ that 3) are not challenged by another state. Claimed areas are all areas within a state's 1) territorial sea, 2) EEZ, and 3) beyond 200 nm of its territorial-sea

²¹⁶ Div. for Ocean Affairs & the Law of the Sea, *Submission by the Russian Federation*, *supra* note 135.

²¹⁷ *See supra* notes 172–175 and accompanying text.

²¹⁸ The same procedure was also repeated for the older ETOPO2 dataset; for purposes of this study, there was little relevant difference between the resultant isobaths.

²¹⁹ Labels “undisputed” and “treaty” are used for convenient reference; they are used only as defined above, and they do not necessarily represent the legal status of each area beyond that definition.

baselines that have been claimed by that state through a submission to the CLCS and that are not currently challenged by another state. However, it is important to keep in mind that some of the areas currently classified as claimed are subject to change based on the outcome of final bilateral negotiations—for example, the final determination of boundaries between Denmark, Iceland, and Norway outlined in the Agreed Minutes²²⁰—or subsequently submitted claims, such as the pending Danish submission for the continental shelf north of Greenland, which may overlap with the 2001 Russian claim.²²¹ If a state has not claimed any continental shelf beyond 200 nm of its territorial-sea baselines, its undisputed and claimed areas are coextensive.²²²

Potential areas as defined in this study include all areas beyond 200 nm of a state's territorial-sea baselines that have not yet been claimed by that state but could be, pursuant to the UNCLOS condition that they “either [do] not exceed 350 nautical miles from the baselines . . . or . . . 100 nautical miles from the 2,500 metre isobath.”²²³ This definition describes the maximum claimable area under UNCLOS, which may far exceed the UNCLOS article 76 definition based on geological characteristics of the seafloor.²²⁴ In addition, where potential areas of two states are adjacent to each other, they were divided by a median-line boundary—an approach adopted by the IBRU.²²⁵ The median-line approach is consistent with the UNCLOS requirement that states with adjacent continental shelves determine the boundary “by agreement on the basis of

²²⁰ See *supra* notes 151–156 and accompanying text.

²²¹ See *supra* notes 135–147 and accompanying text.

²²² For mapping purposes, claimed areas include both claimed and undisputed and claimed and potentially disputed areas; however, the two sets of areas are disaggregated in Tables 1 through 3.

²²³ UNCLOS, *supra* note 41, art. 76(4).

²²⁴ INT'L BOUNDARIES RESEARCH UNIT, *supra* note 40, at 2; *supra* notes 57–59 and accompanying text.

²²⁵ INT'L BOUNDARIES RESEARCH UNIT, *supra* note 40, at 1.

international law . . . to achieve an equitable solution;”²²⁶ however, the equitable solution may be adjusted to deviate from the median line.²²⁷

As defined in this study, treaty areas—the Norway-Russia Special Area, the Eastern Special Area, and the U.S.-Canada Beaufort Sea zone—are areas divided between two states pursuant to an international agreement or subject to a manifest international dispute. Potential and treaty areas as defined in this study do not overlap with each other or with claimed or undisputed areas. According to the 1990 U.S.-Soviet Agreement, the United States may exercise EEZ jurisdiction in an area that would fall within the Soviet EEZ in the absence of such agreement.²²⁸ Russia and Norway have in 2010 concluded an analogous agreement, which grants Russia EEZ jurisdiction over the Norway-Russia Special Area, although the area would otherwise fall within the Norwegian EEZ.²²⁹ Accordingly, in state-aggregate calculations, resources in the two special areas are allocated to the United States and Russia, although the areas are mapped separately from U.S. and Russian claimed areas; this approach is also consistent with the IBRU map. The third treaty area comprises the overlapping U.S. and Canadian claims to a 26,100 km² area of the Beaufort Sea. Jurisdiction over resources in the region is yet to be resolved by the two states, and there is a de facto moratorium on exploration and exploitation in the disputed area.²³⁰ As no clear solution to the dispute is in sight, the area and its resources were divided evenly between the two states in Tables 1 through 3. In contrast, the Jan Mayen joint-development zone was not classified as a treaty area for purposes of this study, as it did not involve a transfer of jurisdiction over a given area of the continental shelf

²²⁶ UNCLOS, *supra* note 41, art. 83(1).

²²⁷ *See supra* note 123 and accompanying text.

²²⁸ *See supra* notes 110–113 and accompanying text.

²²⁹ *See supra* notes 172–175 and accompanying text.

²³⁰ *See supra* notes 184–186 and accompanying text.

from one state to another but only provided for sharing of resources.²³¹ Moreover, because the CARA data did not quantitatively assess the only AU in the Jan Mayen joint-development zone due to its presumed low hydrocarbon potential,²³² this classification does not impact the results of the study.

Finally, unclaimed areas are defined as areas that are unclaimable according to UNCLOS provisions and have not yet been claimed by any state. According to UNCLOS article 76(5), unclaimable areas are areas that are both 1) 350 nm beyond the coastal state's territorial-sea baselines and 2) 100 nm beyond the 2500-m isobath.²³³

g. Intersection of geological and boundary data. After the international boundary dataset was fully assembled and interpreted, it was intersected with the CARA geological data. As the CARA data do not describe the distribution of Arctic resources within geological provinces, the distribution was assumed to be uniform within each province; thus, the allocation of resources from a single province spanning multiple jurisdictions would be proportional to the fraction of the area of that province within each jurisdiction. To enable this analysis, new feature layers using ratio policy had to be constructed for the CARA data. CARA data was first clipped using the land polygons to include only offshore resources. The geologic and boundary data were then intersected using the Intersect tool. For some aggregate maps, the resulting polygons within each jurisdiction were dissolved to obtain the total amount of resources in that jurisdiction. Intersected

²³¹ See *supra* notes 96–107 and accompanying text.

²³² BIRD ET AL., *supra* note 195, at 4.

²³³ This definition of unclaimable areas, which minimizes the extent of unclaimable areas and thus maximizes the extent of potentially claimable ones, was adopted from the IBRU and complies with the UNCLOS article 76(5) limitation on the maximum extent of a state's extended continental shelf. See *supra* note 59 and accompanying text.

polygons were then mapped in various configurations to show the distribution of resources in the different zones of jurisdiction of the six states.²³⁴

2. Results. *a. Aggregate data.* According to CARA, the Arctic—including onshore and offshore areas—contains a total of 412,157 MBOE; 89,983 MBO; 1,668,658 billion cubic feet gas (BCFG; amounting to 278,110 MBOE); and 44,064 MBNGL of undiscovered resources.²³⁵ Offshore resources—the focus of this study—comprised about 66% of the total CARA resources, amounting to 273,508 MBOE; 61,223 MBO; 1,110,276 BCFG (or 185,046 MBOE); and 27,238 MBNGL. Gas comprised 67.7% of the offshore resources, oil 22.4%, and NGL 10%.²³⁶

b. Map 1: Overview of zones of jurisdiction. Map 1, the basic map that serves as a template for all others in the study, demonstrates the maximum extent of state jurisdiction across the Arctic Ocean. The map displays all agreed-upon international boundaries, potential boundaries, and claimed boundaries, as well as all undisputed, claimed, potential, and unclaimable areas. The map itself is available in the Appendix.

As evident from Map 1, most of the Arctic Ocean—97.4 % by area—has been or can be claimed by a state.²³⁷ Iceland has claimed a small shelf area east of its EEZ and cannot potentially claim any other areas. Norway has claimed three areas beyond its EEZ: the Banana Hole, the Loop Hole, and the Western Nansen Basin area. Russia has claimed an extensive area beyond its EEZ—by far the largest of all claimed areas—spanning from the U.S.-Russia agreed boundary to the North Pole, and then extending diagonally toward the Russian EEZ, past the New Siberian Islands. Canada has not claimed any areas beyond its EEZ, though it could

²³⁴ See *infra* Maps 2–5.

²³⁵ Analysis of the data used in this study matched that result.

²³⁶ See *infra* Table 3.

²³⁷ See *infra* Table 1.

potentially claim an extensive area bounded by the 250-nm and Russia-Canada median lines in the north and the south, and by the Denmark-Canada and U.S.-Canada lines in the east and west. Likewise, Denmark has claimed no areas beyond its EEZ, though it could potentially claim 1) a triangular area extending across the North Pole, bounded by the Norway-Denmark, Denmark-Canada, and Denmark-Russia median lines, as well as by an unclaimable area; 2) and a smaller area north of Norway's EEZ and Banana Hole claim around Svalbard. The United States has not claimed any areas beyond its EEZ, though it could potentially claim a triangular area bounded by the U.S.-Canada median line and the agreed boundary between the United States and Russia.²³⁸ The two unclaimable areas consist of a strip of ocean stretching between the 250- and 350-nm lines, roughly from north of the New Siberian Islands in the east to north of Svalbard in the west, and of an area seaward of the 350-nm line north of the Canadian Arctic archipelago.

Assuming that median lines are agreed upon as the boundaries on continental shelves of adjacent states—a significant assumption—the majority of claimed and potential areas may be under the jurisdiction of only a single state. Under this assumption, the sole overlapping areas are a 26,600 km² overlap between the Russian claim and Denmark's potential area near the North Pole, a 46,200 km² area between the Russian claim and Canada's potential area in the central Arctic Ocean, and the 26,100 km² area of overlap between Canada and the United States in the Beaufort Sea.

c. Division of the Arctic Ocean seabed across zones of jurisdiction. Based on the total of undisputed, claimed, potential, and treaty areas, the largest portion of the Arctic Ocean seabed (5,683,300 km², or 41.2% of total Arctic Ocean area) belongs to Russia, followed by Canada

²³⁸ See 1990 U.S.-Soviet Agreement, *supra* note 110, art. 3(1).

(3,122,000 km², or 22.6%); Norway (1,920,800 km², or 13.9%); Denmark (1,695,000 km², or 12.3%); United States (859,200 km², or 6.2%); and Iceland (236,500 km², or 1.7%).

Jurisdiction over most (76.4 %) of the Arctic Ocean seabed is undisputed.²³⁹ Undisputed areas represent from 57.5% (for United States) to 89.6% (for Iceland) of each state's maximum seabed area, and the size order of the six states' undisputed areas is the same as the order of their total areas.

Only Denmark, Iceland, Norway, and Russia have claimed areas of the seabed beyond the EEZ; those areas represent, respectively, 10.4%, less than 0.1%, 10.9%, and 22.3% of each state's total seabed area (including all undisputed, claimed, and potential areas). Claimable, currently unoccupied potential areas under UNCLOS article 76 are still available only to Canada, Denmark, and the United States; if those areas were claimed in their entirety, they would represent 26%, 16%, and 41%, respectively, of those states' total areas. Finally, treaty areas represent 0.4% of the total area for Canada, 0.1% for Russia, and 1.5% for the United States.

Table 1. Areas of Arctic Ocean across zones of jurisdiction. “% state total” refers to the share of that state's maximum claimable area represented by the cell. “% Arctic Ocean total” refers to the share of the total Arctic Ocean area represented by the cell.

State	Area (km ²)	% state total	% Arctic Ocean total
Arctic Ocean total	13,805,200	--	100
Canada	3,122,097	100	22.6
Claimed and undisputed	2,297,999	73.6	16.6
Potential	811,065	26.0	5.9
Treaty	13,033	0.4	0.1
Denmark	1,695,011	100	12.3
Undisputed	1,422,499	83.9	10.3
Claimed	999	0.1	0.0
Potential	271,513	16.0	2.0
Iceland	236,514	100	1.7
Undisputed	211,949	89.6	1.5
Claimed	24,565	10.4	0.2

²³⁹ As defined in this study, undisputed areas are located either in the territorial sea or in the EEZ, and they do not overlap with other states' claims. *See supra* notes 219–228 and accompanying text.

Norway	1,920,762	100	13.9
Undisputed	1,710,532	89.1	12.4
Claimed	210,230	10.9	1.5
Russia	5,683,348	100	41.2
Undisputed	4,413,775	77.7	32.0
Claimed	1,266,001	22.3	9.2
Treaty	3,572	0.1	0.0
USA	859,233	100	6.2
Claimed and undisputed	494,093	57.5	3.6
Potential	352,107	41.0	2.6
Treaty	13,033	2.2	0.1
Unclaimable	355,285	--	2.6

d. Distribution of Arctic offshore hydrocarbon resources across Arctic states. If all undisputed, claimed, and potential areas are taken into account, Russia accounts for the largest share—56%—of the undiscovered hydrocarbon resources, followed by Denmark and the United States (13.9% each), Canada (9.3%), Norway (5.8%), and Iceland (0.2%). Only 0.5% of the resources are located in unclaimable areas. The certainty of the states’ claims, however, depends on the distribution of resources across zones of jurisdiction as defined by UNCLOS.

Table 2. Distribution of Arctic offshore hydrocarbon resources across states and zones of jurisdiction. All resources are in units of MBOE. “% Arctic total” refers to the share of the total Arctic offshore hydrocarbons represented by the cell. “% state total” refers to the share of that state’s maximum total offshore hydrocarbons represented by the cell. The “Claimed and undisputed” designation is used for states with claimed areas that are coextensive with undisputed areas. Only zones of jurisdiction that contain hydrocarbon resources are displayed (for example, according to the CARA data, Iceland’s claimed area does not contain any hydrocarbons and is thus not included in the table). All resources are in units of MBOE.

State	Oil	Gas	NGL	Total
Arctic total	61,223.9	185,046.0	27,238.3	273,508.2
% Arctic total	22.4	67.7	10.0	
Canada				
Total	11,534.3	12,629.1	1246.1	25,409.5
% Arctic total	18.8	6.8	4.6	9.3
Claimed and undisputed	9030.8	10,165.8	1087.3	20,284.0
% state total	78.3	80.5	87.3	79.8
% Arctic total	14.8	5.5	4.0	7.4
Potential	2360.9	2314.2	145.3	4820.3
% state total	20.5	18.3	11.7	19.0
% Arctic total	3.9	1.3	0.5	1.8
Treaty	142.6	149.1	13.5	305.2

% state total	1.2	1.2	1.1	1.2
% Arctic total	0.2	0.1	0	0.1
Denmark				
Total	12,345.3	18,130.5	7632.2	38,108.0
% Arctic total	20.2	9.8	28.0	13.9
Undisputed	11,879.8	17,292.3	7334.2	36,506.3
% state total	96.2	95.4	96.1	95.8
% Arctic total	19.4	9.3	26.9	13.3
Potential	465.5	838.2	298.0	1601.7
% state total	3.8	4.6	3.9	4.2
% Arctic total	0.8	0.5	1.1	0.6
Iceland				
Total	193.8	312.7	176.8	683.3
% Arctic total	0.3	0.2	0.6	0.2
Undisputed	193.8	312.7	176.8	683.3
% state total	100	100	100	100
% Arctic total	0.3	0.2	0.6	0.2
Norway				
Total	3645.0	11,303.9	872.0	15,820.9
% Arctic total	6.0	6.1	3.2	5.8
Undisputed	3565.6	11,269.2	853.5	15,688.3
% state total	97.8	97.5	97.9	99.2
% Arctic total	5.8	6.0	3.1	5.7
Claimed	79.4	34.7	18.5	132.6
% state total	2.2	2.5	2.1	0.8
% Arctic total	0.1	0	0.1	0
Russia				
Total	17,025.9	122,766.3	14,452.7	154,244.9
% Arctic total	27.8	66.3	53.1	56.4
Undisputed	15,358.5	116,470.4	14,048.4	145,877.3
% state total	90.2	94.9	97.2	94.6
% Arctic total	25.1	62.9	51.6	53.3
Claimed	1638.2	6086.8	398.7	8123.7
% state total	9.6	5.0	2.8	5.3
% Arctic total	2.7	3.3	1.5	3.0
Treaty	29.3	209.1	5.6	243.9
% state total	0.2	0.2	0	0.2
% Arctic total	0	0.1	0	0.1
USA				
Total	16,108.6	19,211.7	2767.4	38,087.8
% Arctic total	26.3	10.4	10.2	13.9
Claimed and undisputed	14,988.8	18,085.3	2696.8	35,770.9
% state total	93	94.1	97.4	93.9
% Arctic total	24.5	9.8	9.9	13.1
Potential	975.2	954.0	54.7	1983.8
% state total	6.1	5	2	5.2

% Arctic total	1.6	0.5	0.2	0.7
Treaty	144.6	172.5	16.0	333.1
% state total	0.9	0.9	0.6	0.9
% Arctic total	0.2	0.1	0.1	0.1
Unclaimable	446.5	796.5	107.9	1350.9
% Arctic total	0.7	0.4	0.4	0.5

e. Distribution of resources across zones of jurisdiction. Consistent with the area analysis, the vast majority of Arctic states’ hydrocarbon resources—ranging from 80.8% for Canada to 100% for Iceland, and 93% in aggregate—are located in areas of undisputed jurisdiction (that is, either in the territorial sea or in the EEZ).²⁴⁰ If only undisputed areas are taken into account, most hydrocarbon resources—53.3%—still belong to Russia; 13.3% belong to Denmark, 13.1% to the United States, 7.4% to Canada, 5.7% to Norway, and 0.2% to Iceland. For all states except Canada, claimed²⁴¹ and disputed areas comprise less than 10% of the total state hydrocarbon stock. Areas claimed by Norway and Russia increase each state’s total hydrocarbon stock by 0.8% and 5.3%, respectively; Iceland’s and Denmark’s claims do not overlap with any quantified AUs and thus do not add any resources to the states’ stocks. In contrast, if Denmark, the United States, and Canada claimed all the areas they potentially could claim under the UNCLOS regime (but excluding treaty areas), their hydrocarbon stocks would increase by 4.2%, 5.2%, and 19.0%, respectively. Treaty areas increase the total hydrocarbon stock by 1.8% for Canada, 0.2% for Russia, and 0.9% for the United States. In total, 1) Iceland and Denmark added no resources by claiming land beyond its undisputed area; 2) Norway added 0.8% and Russia 5.5% to its total hydrocarbon stocks with their claimed areas (and, for Russia, also with its treaty area); 3) Denmark would add 4.2% if it claimed its potential areas; and 4) United States would add 6.1% and Canada 20.2% with their potential and treaty areas.

²⁴⁰ Table 2.

²⁴¹ For the remainder of this Section, “claimed” refers to claimed but not undisputed areas.

f. Distribution of resources by resource type. Natural gas comprises a majority (66.7%) of Arctic offshore hydrocarbon resources. Oil comprises 22.4%, with the remaining 10% made up by NGL. Regions under Norwegian and Russian jurisdiction are predominantly gas-rich (79.6% and 71.4% gas, respectively), whereas the Canadian and U.S. areas contain significant oil resources (49.7% and 50.4% of each state's total, respectively). In Denmark, an unusually high fraction (20%) of total resources is composed of NGL. Resource composition was relatively constant across zones of jurisdiction within each state. Table 3 displays the distribution of resources by resource type.

Table 3. Distribution of Arctic offshore hydrocarbon resources across states and zones of jurisdiction by resource type. All resources are expressed as percentages of the state total, by energy value.

State	Oil as % of total	Gas as % of total	NGL as % of total
Arctic total	22.4	67.7	10.0
Canada			
Total	45.4	49.7	3.1
Claimed and undisputed	44.5	50.1	5.4
Potential	49.0	48.9	3.0
Treaty	46.7	48.0	4.4
Denmark			
Total	32.4	47.6	20.0
Claimed and undisputed	32.5	47.4	20.1
Potential	29.1	52.3	18.6
Iceland			
Total	28.4	45.8	25.9
Claimed and undisputed	28.4	45.8	25.9
Norway			
Total	23.0	71.4	5.5
Undisputed	23.1	71.4	5.5
Claimed	20.7	74.5	4.8
Russia			
Total	11.0	79.6	9.4
Undisputed	10.5	79.8	9.6
Claimed	20.2	74.9	4.9
Treaty	12.0	85.7	2.3
USA			
Total	42.3	50.4	7.3
Claimed and undisputed	41.9	50.6	7.5

Potential	49.2	48.1	5.2
Treaty	43.4	51.8	4.8
Unclaimable	33.1	59.0	8.0

g. Resource distribution maps (in Appendix).

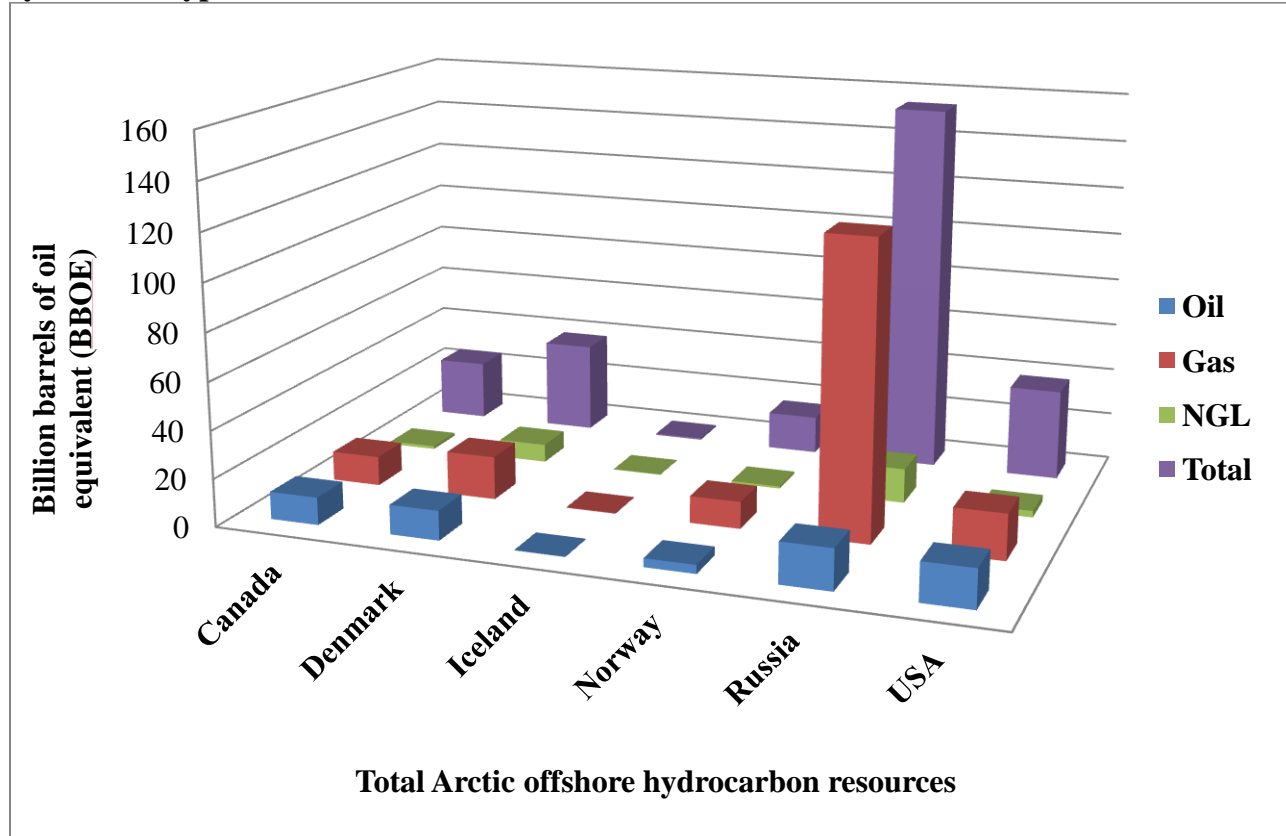
Map 2: Total hydrocarbons in undisputed and claimed areas. This map displays the total amount of hydrocarbons in undisputed and claimed areas, by jurisdiction. In this and all the following maps, 1) hydrocarbon resources are displayed by geological province; 2) colors indicate distribution of resources across state jurisdictions; 3) pie charts display the distribution of resources across resource type; 4) size of pie chart indicates the total amount of resources in each jurisdiction; and 5) only provinces that CARA assessed to have a significant hydrocarbon potential are displayed.

Map 3: Total hydrocarbons in undisputed areas. This map displays the total amount of hydrocarbons in undisputed areas only, by jurisdiction.

Map 4: Total hydrocarbons in potential areas. This map displays the total amount of hydrocarbons in potential areas only, by jurisdiction.

Map 5: Total hydrocarbons across jurisdictions. This map displays the total amount of hydrocarbons in the offshore Arctic, including undisputed areas, claimed areas, and potential areas, by jurisdiction.

Graph 1. Distribution of total Arctic offshore hydrocarbon resources across jurisdictions, by resource type.



3. Key assumptions. The most important assumption made in the study was that resources are distributed evenly across AUs and that the fraction of a resource under a state’s jurisdiction is thus proportional to the fraction of the relevant AU’s area under that state’s jurisdiction. This assumption was required because CARA did not assess the distribution of resources across each AU. However, hydrocarbon resources are in reality likely unevenly distributed, and within a single AU, large fields under the jurisdiction of one state coupled with dry areas under the jurisdiction of another could severely affect the accuracy of the results. However, analogous assumptions have been made in other studies,²⁴² and until additional

²⁴² See, e.g., KENNETH J. DRUMMOND, DRUMMOND CONSULTING, NORTHERN CANADA DISTRIBUTION OF ULTIMATE OIL AND GAS RESOURCES 20 (2009), available at <http://www.drummondconsulting.com/NCAN09Report.pdf>.

geological data on the distribution of Arctic resources become available, there are few alternatives.

The study also adopted a significant assumption already made by the IBRU—that the states’ potentially claimable areas extended to the maximum permissible under the UNCLOS framework.²⁴³ This maximum extent was in turn determined using simple geometry and remotely sensed bathymetry data. Detailed geological data, on which the UNCLOS definition of the continental shelf is based²⁴⁴ but which are unavailable for most of the Arctic, could reveal that the claimable areas fall far short of these theoretical maxima.²⁴⁵

A related assumption is the use of median lines as the boundary between states’ adjacent potential areas. UNCLOS requires states with adjacent areas of the continental shelf to agree upon an equitable solution grounded in international law.²⁴⁶ While the median line is often chosen as the equitable solution,²⁴⁷ it is also subject to subsequent adjustment for special circumstances before the solution is finalized.²⁴⁸ Boundaries of adjacent potential areas may thus shift as a result of bilateral delimitations.

4. Comparison with other estimates. This Section compares this study’s estimate of hydrocarbon resources under each state’s jurisdiction with official estimates conducted by that state, or, where such official estimates are not available, to independent scientific estimates cited by the state. The availability of relevant data varies widely—for example, the Norwegian continental shelf is well explored and much of the data is publicly available, whereas the Icelandic and Canadian continental shelves are largely unexplored, and limited data is accessible

²⁴³ See *supra* notes 223–224 and accompanying text.

²⁴⁴ See *supra* note 57 and accompanying text.

²⁴⁵ INT’L BOUNDARIES RESEARCH UNIT, *supra* note 40, at 3.

²⁴⁶ UNCLOS, *supra* note 41, art. 83(1).

²⁴⁷ See *supra* note 55 and accompanying text.

²⁴⁸ See *supra* notes 120–126 and accompanying text.

for the Russian shelf. In addition, it must be kept in mind that not all of the cited estimates are directly comparable to the estimates in this study, which focuses on undiscovered offshore resources north of the Arctic Circle and may differ from other estimates in terms of both geographical coverage and geological risk. The most closely comparable estimate was chosen in each case, and the discrepancies between the chosen estimate and this study’s estimate are noted. With the exception of Russia, this study’s results matched well (within 50%, and often much closer) with the official estimates. Table 5 presents the comparison of this study’s results with other estimates.

Table 5. Comparison of hydrocarbon resources calculated for each jurisdiction in this study with governmental estimates. For each state, the most comparable estimate in terms of risk and geological extent was selected for the comparison. Iceland is not included in the table, as a meaningful comparison with the results of this study cannot be made (for more discussion, see Part III.4.c–d below).

Jurisdiction	Total (MBOE)		
	Study	Estimate	Study as % of estimate
Canada	20,589	21,312	97
Denmark	36,506	39,903	92
Norway	15,821	10,944/12,831	145/123
Russia	154,245	557,000	27
United States	36,104	43,000	84

a. Canada. A 2009 study prepared for the Canadian government estimated Canada’s undiscovered offshore oil resources above 60°N to be 8441 MBO and its gas resources to be 12,871 MBOE, for a total of 21,312 MBOE.²⁴⁹ This estimate’s definition of resources by geographic area and geologic risk²⁵⁰ matches the definition chosen in this study, except that the southernmost boundary for the resources in this study is the Arctic Circle (66°33’N) instead of 60°N. The Canadian study does not describe the northern boundary of its assessment area; however, as Canada has not claimed any continental shelf beyond its EEZ, the study likely does

²⁴⁹ DRUMMOND, *supra* note 244, at 34–35 tbls.17 & 18.

²⁵⁰ Both CARA and the Canadian study include estimates for undiscovered resources.

not include hydrocarbons in areas that could potentially be claimed by Canada. Thus, the Canadian government's estimate is most directly comparable to the sum of hydrocarbon resources of undisputed and treaty areas estimated in this study, which amounts to 9173 MBO, 10,315 MBOE gas, and 1101 MBNGL, for a total of 20,589 MBOE. In relative terms, the estimate from my study is 108% of the Canadian government's estimate for oil resources, 80% for gas resources, and 97% for total hydrocarbons.

b. Denmark. A 2007 USGS estimate of undiscovered resources of northeastern Greenland, which served as the "prototype" for CARA, posited that the region contains 8901 MBO, 14,363 MBOE gas, and 8121 MBNGL of undiscovered resources, for a total of 31,385 MBOE.²⁵¹ In 2008, the USGS completed an analogous estimate for the West Greenland-East Canada province, where 7275 MBO, 8636 MBOE gas, and 1152 MBNGL of undiscovered resources are expected, for a total of 17,036 MBOE.²⁵² However, as the West Greenland-East Canada assessment extends from the Greenland coastline all the way to the Canadian coastline, it includes resources under both Danish and Canadian jurisdictions,²⁵³ but the maritime boundary between the two states is approximately the median line between their coastlines. Thus, the geographic scope of that assessment could be matched more closely to the scope of my study by dividing the West Greenland assessment by two before adding it to the northeast Greenland assessment; this operation yields 12,539 MBO, 18,681 MBOE gas, and 8697 MBNGL, for a total of 39,903 MBOE. For comparison, my study estimates the total resources in areas under undisputed Danish jurisdiction at 11,880 MBO, 17,292 MBOE gas, 7334 MBNGL, for a total of

²⁵¹ Donald L. Gautier, *Oil and Gas Resources of Northeast Greenland*, GEO EXPRO, Oct. 2007, 56, 58, 60.

²⁵² U.S. GEOLOGICAL SURVEY, FACT SHEET 2008–3014, ASSESSMENT OF UNDISCOVERED OIL AND GAS RESOURCES OF THE WEST GREENLAND–EAST CANADA PROVINCE, 2008 (2008), *available at* http://pubs.usgs.gov/fs/2008/3014/pdf/FS08-3014_508.pdf.

²⁵³ *Id.*

36,506 MBOE—or 95%, 93%, 84%, and 92% respectively, of the adjusted USGS Greenland estimate. As these estimates were carried out by the USGS as part of the CARA project, they do not provide independent verification of the data in this study; however, they also appear to be the only available comprehensive estimates for the region and have been cited widely by Danish and Greenland authorities.²⁵⁴

c. Norway. According to the Norwegian Petroleum Directorate's (NPD's) most recent (December 2012) hydrocarbon-resource estimate, Norway's Barents Sea continental shelf (entirely within the area of this study) contains a total of 6038 MBOE of undiscovered resources.²⁵⁵ The Norwegian Sea shelf (largely outside the area of this study) contains a total of 4906 MBOE.²⁵⁶ However, these NPD estimates do not include new data on undiscovered resources in the southeastern Barents Sea and around Jan Mayen that were only published in late February 2013.²⁵⁷ The recent project mapped a triangular area extending along the Norway-Russia border in the Barents Sea—again pointing to the importance of clear delimitation of jurisdictional boundaries under the 2010 Russia-Norway treaty²⁵⁸—and around Jan Mayen, in an area partially covered by the 1981 Iceland-Norway agreement.²⁵⁹ The two recently mapped areas

²⁵⁴ See, e.g., BUREAU OF MINERALS & PETROLEUM, GREEN. SELF GOV'T, EXPLORATION AND EXPLOITATION OF HYDROCARBONS IN GREENLAND: STRATEGY FOR LICENCE POLICY 2009, at 14–15 (2009), available at http://uk.nanoq.gl/Emner/Government/Departments/ministry_of_industry_and_mineral_resources/~media/1F66073BE1E54C66A499D38C8846F101.ashx.

²⁵⁵ *The Petroleum Resource Account as of Dec. 31, 2012*, NORWEGIAN PETROLEUM DIRECTORATE (Jan. 3, 2013), <http://www.npd.no/en/Topics/Resource-accounts-and--analysis/Temaartikler/Resource-accounts/2012>.

²⁵⁶ *Id.*

²⁵⁷ *New Resource Figures for the Southeastern Barents Sea and Jan Mayen*, NORWEGIAN PETROLEUM DIRECTORATE (Feb. 27, 2013), <http://www.npd.no/en/news/News/2013/New-resource-figures-for-the-southeastern-Barents-Sea-and-Jan-Mayen>.

²⁵⁸ See *supra* notes 37, 172–174 and accompanying text.

²⁵⁹ See *supra* notes 92–109 and accompanying text.

are estimated to contain a total of about 2453 MBOE, which would increase undiscovered resources of the Norwegian shelf by 15%.²⁶⁰ The 44,000 km² mapped area in the southeastern Barents Sea is expected to contain 1887 MBOE (with a large uncertainty, ranging from 346 MBOE to 3554 MBOE).²⁶¹ Gas is estimated to comprise 85% of the resources (1604 MBOE) and oil 15% (283 MBO).²⁶² The 100,000 km² area around Jan Mayen is expected to contain 566 MBOE, with an uncertainty ranging from 0 MBOE to 2893 MBOE. For comparison, this study estimates that the Norwegian continental shelf north of the Arctic Circle contains a total of 15,821 MBOE, comprising 145% of the sum of the NPD Barents and Norwegian Sea estimates without the new discoveries (10,944 MBOE). However, the difference between NPD's estimate and the estimate from this study is likely even greater, as much of the Norwegian Sea shelf is outside this study's area. But if the February 2013 Barents Sea results are added to the NPD December 2012 estimate—summing up to 12,831 MBOE—this study's results would represent 123% of the NPD estimate. Notably, the Jan Mayen Microcontinent AU, which largely overlaps the Jan Mayen area explored by Norway, was not quantitatively assessed by the USGS in the CARA project because of its presumed low hydrocarbon potential and is thus not included in this comparison.²⁶³

d. Iceland. NPD's Jan Mayen estimate is also an estimate for the Icelandic continental shelf, as the mapped area partially overlaps with the Norway-Iceland joint-development zone,

²⁶⁰ *New Resource Figures for the Southeastern Barents Sea and Jan Mayen*, *supra* note 257.

²⁶¹ *Id.*

²⁶² *Id.* If a discovery is made in the area, the best estimate will increase to 1258 MBOE, with uncertainty ranging from 126 MBOE to 4026 MBOE. *Id.*

²⁶³ *See supra* note 232 and accompanying text.

including the part of the joint-development zone that extends into the Icelandic EEZ.²⁶⁴

However, a meaningful comparison cannot be made with the results of this study, as the Jan Mayen AU was not quantitatively assessed. Older estimates for the Icelandic continental shelf did not make conclusions about the presence of exploitable hydrocarbons.²⁶⁵

e. Russia. The Russian government estimates that its Arctic shelf holds about 557,000 MBOE,²⁶⁶ which greatly (by 35%) exceeds the total amount of Arctic resources calculated by CARA or the total amount of offshore resources estimated by this study (by 103%). The Russian estimate thus also greatly exceeds this study's estimate of the amount of offshore resources under Russian jurisdiction—154,245 MBOE, or only 27% of the Russian estimate.

f. United States. MMS estimates that the undiscovered resources in federal waters of the Chukchi Sea, Beaufort Sea, and Hope Basin amount to 23,750 MBO and 108,190 BCFG (18,032 MBOE), or 43,000 MBOE in total.²⁶⁷ This geographic area is comparable to the geographic area

²⁶⁴ *Iceland Continental Shelf Portal*, NAT'L ENERGY AUTH., <http://www.nea.is/the-national-energy-authority/map-servers/iceland-continental-shelf-portal> (last visited Mar. 16, 2013); *New Resource Figures for the Southeastern Barents Sea and Jan Mayen*, *supra* note 257.

²⁶⁵ *See, e.g.,* ICELAND MINISTRY OF INDUS., OIL EXPLORATION IN THE DREKI AREA ON THE JAN MAYEN RIDGE 45 (2007), *available at* http://eng.atvinnuvegaraduneyti.is/media/Rafraen_afgreidsla/Report_on_oil_exploration-KK.PDF (“Even though there are indications of hydrocarbons in the Jan Mayen area, it must be kept in mind that they are not conclusive. Absolute outcome is not to be expected until one or more drillings have taken place.”).

²⁶⁶ <http://government.ru/eng/docs/22397>. The estimate matches studies that stated that the Russian Arctic shelf comprises about 74% to 80% of the total Russian offshore hydrocarbon resources, for which an oft-cited estimate is 723,500 MBOE. *See, e.g., Oil and Gas Raw Material Base on the Russia's Arctic Shelf*, BELLONA, <http://www.bellona.org/reports/report/1197291722.54> (last visited Mar. 17, 2013); V.D. Kaminsky, O.I. Suprunenko & V.V. Suslova, *Oil and Gas Potential of the Russian Arctic Shelf and Palaeogeographical Mapping of the Barents Sea*, in *ARCTIC PETROLEUM GEOLOGY* 345, 346 fig.22.2 (A.M. Spencer et al. eds., 2011) (stating that the Arctic shelf represents 74% to 80% of all Russian shelf resources but providing no estimate for the overall amount of those resources).

²⁶⁷ MINERALS MGMT. SERV., U.S. DEP'T OF THE INTERIOR, UNDISCOVERED OIL AND GAS RESOURCES, ALASKA FEDERAL OFFSHORE AS OF 2006, at 6 (2006), *available at*

of this study, except that part of the Hope Basin also extends south of the Arctic Circle. As the United States has not claimed any of its potential areas, this estimate is most closely comparable to the sum of the resources in undisputed and treaty areas—15,133 MBO (64% of MMS’s estimate), 18,258 MBOE gas (101% of MMS’s estimate), and 2713 MBNGL (not separately estimated by MMS), for a total of 36,104 MBOE (84% of MMS’s estimate).

IV. CO₂ released by combustion of undiscovered Arctic hydrocarbon resources.

1. Introduction. Questions of state jurisdiction over the Arctic seabed and questions of environmental protection—including climate change—are inextricably linked. Only states with jurisdiction over the resources can license development of those resources, thus regulating how much will be developed and how the development will proceed, which will in turn influence the impact of those resources on the global climate.

2. Methods. *a. CO₂ stock calculations.* EPA’s standard method was used as a model for calculating the amount of CO₂ that would be released if Arctic hydrocarbon resources were consumed in their entirety.²⁶⁸ The energy content per volume of each resource was first calculated, and then the result was multiplied by the carbon coefficient for that resource (in kg C/MBtu). Equation 1²⁶⁹ shows the full calculation for the amount of CO₂ released by combustion of a barrel of oil; analogous calculations were conducted for natural gas and NGL.

Equation 1.
$$5.80 \frac{\text{MBtu}}{\text{bbl}} \times 20.31 \frac{\text{kg C}}{\text{MBtu}} \times 3.67 \frac{\text{g CO}_2}{\text{g C}} = 0.43 \frac{\text{ton CO}_2}{\text{bbl}}$$

http://www.boem.gov/uploadedFiles/BOEM/Oil_and_Gas_Energy_Program/Resource_Evaluation/Resource_Assessment/2006AlaskaUndiscoveredOilandGasResources.pdf.

²⁶⁸ U.S. ENVTL. PROT. AGENCY, ANNEX 2: METHODOLOGY AND DATA FOR ESTIMATING CO₂ EMISSIONS FROM FOSSIL FUEL COMBUSTION (2012), *available at* <http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html>; *Calculations and References*, U.S. ENVTL. PROT. AGENCY, <http://www.epa.gov/cleanenergy/energy-resources/refs.html> (last updated Dec. 6, 2012).

²⁶⁹ *Calculations and References*, *supra* note 268.

The aggregate amount of resources was obtained from the CARA data,²⁷⁰ and the aggregate amount of offshore resources was calculated as discussed in Part III. The energy coefficients were obtained from EPA data and are listed in Table 6. For oil, EPA's standard coefficient was used.²⁷¹ The median EPA 2012 value was chosen for the natural gas coefficient;²⁷² however, the chosen coefficient describes pipeline natural gas, the chemical composition of which may differ from natural gas in the ground.²⁷³ This assumption was made because composition of natural gas extracted from different fields may vary,²⁷⁴ and the relevant information is not yet available for undiscovered Arctic resources. As CARA treats NGL as oil-equivalent, the same carbon coefficient was used for a barrel of NGL as for a barrel of oil.²⁷⁵ Carbon in all three fuels was assumed to be oxidized in its entirety.²⁷⁶

To calculate the effect of CO₂ released from combustion of all Arctic resources on global atmospheric CO₂ concentrations, the mass of the total CO₂ was compared to the mass of the atmosphere, 5.137 x 10¹⁸ kg.²⁷⁷ Oak Ridge National Laboratory's Carbon Dioxide Information Analysis Center' (CDIAC's) calculation was used, according to which 1 ppmv of CO₂ equates to

²⁷⁰ BIRD ET AL., *supra* note 195, at 4.

²⁷¹ U.S. ENVTL. PROT. AGENCY, *supra* note 268, at A-86 tbl.A-55; *Calculations and References*, *supra* note 268.

²⁷² See U.S. ENVTL. PROT. AGENCY, *supra* note 268, at A-55 tbl.A-35 (listing average annual pipeline gas coefficients for the United States).

²⁷³ *Id.* at A-62 to -64.

²⁷⁴ See *id.* at A-63.

²⁷⁵ Oak Ridge National Laboratory's Carbon Dioxide Information Analysis Center (CDIAC) also takes this approach. *Factors and Units for Calculating CO₂ Emissions from Fuel Production and Trade Data*, CARBON DIOXIDE INFO. ANALYSIS CTR., OAK RIDGE NAT'L LAB., <http://cdiac.esd.ornl.gov/trends/emis/factors.html> (last updated Sept. 26, 2012).

²⁷⁶ *Calculations and References*, *supra* note 268.

²⁷⁷ Kevin E. Trenberth, *Seasonal Variations in Global Sea Level Pressure and the Total Mass of the Atmosphere*, 86 J. GEOPHYSICAL RES. 5238, 5238 (1981).

2.13 Gt C.²⁷⁸ All of the CO₂ was assumed to remain in the atmosphere instead of being absorbed by marine or terrestrial sinks. Results of these calculations are presented in Table 6.

3. Results. Combustion of all undiscovered Arctic hydrocarbon resources would increase global atmospheric CO₂ concentrations by 19 ppm; this figure decreases to 13 ppm if only offshore resources are considered. Compared to the 394 ppm global CO₂ concentration as measured at Mauna Loa in November 2012,²⁷⁹ burning all undiscovered Arctic fossil fuel resources would represent a 4.8% increase in total atmospheric CO₂ levels, or 16.7% of the total increase from the pre-industrial level of 280 ppm.²⁸⁰ For offshore resources, these percentages would be 3.2% and 11.1%, respectively.

Table 6. Mass of CO₂ released by complete combustion of undiscovered Arctic hydrocarbon resources.

Fuel type	Carbon coefficient (kg/MBtu)	Amount of resource (MBO and MBNGL; BCF gas)		Mass of CO ₂ released (Gt)		Atmospheric CO ₂ increase (ppmv)	
		Total	Offshore	Total	Offshore	Total	Offshore
Oil	20.31	89,983.2	61,223.9	38.87	26.44	4.98	3.39
Gas	14.46	1,668,657,840	1,110,276,100	91.21	60.69	11.68	7.77
NGL	20.31	44,064.24	27,238.29	19.03	11.76	2.44	1.51
Total	--	412,157.09	273,508.21	149.11	98.90	19.09	12.66

While these numbers are large, they represent an estimate of CO₂ emissions from undiscovered hydrocarbon resources, a significant fraction of which may never developed. In addition, much of the CO₂ emitted from combustion of Arctic energy resources may be removed from the atmosphere by various Earth processes. About 55% of the 350 Gt of anthropogenic CO₂

²⁷⁸ *Frequently Asked Questions*, CARBON DIOXIDE INFO. ANALYSIS CTR., OAK RIDGE NAT'L LAB., <http://cdiac.ornl.gov/pns/faq.html> (last visited Feb. 23, 2013).

²⁷⁹ *Trends in Atmospheric Carbon Dioxide*, EARTH SYS. RESEARCH LAB., NAT'L OCEANIC & ATMOSPHERIC ADMIN., http://www.esrl.noaa.gov/gmd/ccgg/trends/#mlo_full (last visited Dec. 23, 2012).

²⁸⁰ INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: SYNTHESIS REPORT 37 (2007), available at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf.

that have been emitted into the atmosphere since 1959 have been absorbed by various terrestrial and oceanic sinks, and recent research suggests that the uptake of those sinks has been increasing over time.²⁸¹

V. Summary.

1. Arctic resources in the global context. Undiscovered offshore Arctic hydrocarbon resources are significant in the global context. According to a 2012 USGS estimate, a total of 1,666,237 MBOE of conventional hydrocarbon resources remain undiscovered in the world.²⁸² Undiscovered Arctic resources, estimated at 412,157 MBOE, thus represent about 25% of the world total; undiscovered Arctic offshore resources, estimated at 273,508 MBOE, represent about 17%. These quantities are significant; however, serious concerns about the viability of Arctic offshore resources remain,²⁸³ and it is far from clear whether, when, and how the resources that are actually in the ground will be developed.

2. Division of the Arctic Ocean seabed across zones of jurisdiction. The geospatial analysis in Part III indicates that the vast majority of the Arctic seabed (97.4%) could be subject to state jurisdiction pursuant to the UNCLOS zonal regime. Most of the Arctic seabed (76.4%) is already subject to undisputed state jurisdiction. In addition, some states—Russia, Norway, Iceland, and, to a lesser extent, Denmark—have officially laid claim to the continental shelf

²⁸¹ A.P. Ballantyne et al., *Increase in Observed Net Carbon Dioxide Uptake by Land and Oceans During the Past 50 years*, 488 NATURE 70 (2012).

²⁸² U.S. GEOLOGICAL SURVEY, AN ESTIMATE OF UNDISCOVERED CONVENTIONAL OIL AND GAS RESOURCES OF THE WORLD, 2012, at 3 tbl.1 (2012), available at <http://pubs.usgs.gov/fs/2012/3042/fs2012-3042.pdf>.

²⁸³ See, e.g., *Russian Retreat Is About Gas Prices, Not Greenpeace*, GUARDIAN THE OBSERVER BLOG (Sept. 1, 2012), <http://www.guardian.co.uk/business/2012/sep/02/barclays-should-be-bold-get-smaller> (“The Arctic might hold nearly a quarter of the world’s remaining hydrocarbon reserves but the Shtokman retreat, coming after Cairn Energy’s drilling failures off Greenland, is a reminder that for the time being at least, the financial, as well as the environmental, costs may be too high.”); Introduction, *supra*.

beyond their EEZs and have thus expanded areas under their ostensible jurisdiction (by 22.3%, 10.9%, 10.4%, and 0.1% respectively).²⁸⁴ Russia's claim has also increased the hydrocarbon resources under the state's jurisdiction by 5.3% (or 8124 MBOE), and Norway has increased them by 0.8% (133 MBOE). Iceland's and Denmark's claims, according to the CARA estimates, did not increase the states' hydrocarbon resource bases.

But a sizable area (11%) of the Arctic Ocean seabed is yet to be claimed, and claiming it could significantly increase the remaining eligible states' shelf areas (by 26% for Canada, 16% for Denmark, and 41% for the United States) as well as the hydrocarbon resources under their jurisdiction (by 19.0% or 4820 MBOE for Canada; 4.2% or 1602 MBOE for Denmark; and 5.2% or 1984 MBOE for the United States). Treaty areas represent less than 2.5% of each state's seabed area or resources. Unclaimable areas represent the remaining 2.6% of the Arctic Ocean and contain only 0.5% of the resource base.

Whether total or only undisputed areas are considered, Russia controls the largest portion of the Arctic seabed (41.2% in total or 32% for undisputed areas only), as well as the majority of Arctic offshore hydrocarbon resources (56.4%, or 154,245 MBOE in total; 53.3%, or 145,877 MBOE for undisputed areas only).²⁸⁵ Russia has also been most assertive in its jurisdictional claims—it has claimed by far the largest portion of the seabed beyond its undisputed area (representing 22.3% of Russia's total shelf area, 28.7% of its undisputed area, and 9.2% of the total Arctic Ocean area). Russia's claim also overlaps with areas potentially claimable by other states, including Denmark and Canada. The United States, though currently a relatively minor

²⁸⁴ All percentages are expressed relative to each state's maximum claimable area—that is, including the state's undisputed, claimed, claimable, and treaty areas.

²⁸⁵ *See supra* Tables 1 & 2; *see also* Gautier et al., *supra* note 1, at 1178 (“Although substantial amounts of gas may be found in Alaska, Canada, and Greenland, the undiscovered gas resource is concentrated in Russian territory, and its development would reinforce the preeminent strategic resource position of that country.”).

player in the region, has the most potential for area expansion—by claiming potential areas, it could increase the area of the continental shelf under its jurisdiction by 41.0%. Canada, however, has the most potential to increase its resource base by claiming additional areas of the Arctic Ocean—by up to 19.0%.

3. Importance of jurisdictional certainty. The remaining uncertainty about state jurisdiction over the Arctic seabed is an impediment to potential development of Arctic hydrocarbon resources. Neither states nor private parties are willing to invest in exploration and development if they are unsure whether they will be able to retain control over the resources. Although jurisdiction over the majority (76.4%) of the Arctic Ocean is undisputed, another 5% of the ocean area have not been claimed at all. Furthermore, some areas have only been claimed unilaterally, without CLCS approval or consent of other potentially affected states; others, such as the Beaufort Sea, have been claimed by multiple states; and yet others, such as the area around the North Pole, may be subject to overlapping claims if states decide to pursue them. The total amount of resources under such uncertain jurisdiction is significant, amounting to 18,700 MBOE or 7% of the Arctic total.²⁸⁶

4. Expected developments and future research. However, delimitation efforts are underway to resolve the remaining uncertainties, and they may significantly affect the Arctic Ocean maritime boundary map in the near future. The map used in this study is based on claims that were submitted to the CLCS by the end of 2012. However, significant submissions are anticipated in the coming years—Canada, Denmark, and the United States (provided that it ratifies UNCLOS or that it may otherwise proceed within or parallel to the CLCS framework)

²⁸⁶ See *supra* Table 2.

are actively preparing their claims to areas of the Arctic Ocean,²⁸⁷ and Russia is still revising its initial 2001 submission.²⁸⁸ In addition to making their CLCS submissions, these states will also need to engage in bilateral delimitation negotiations with their neighbors to delimit the continental shelf in adjacent areas. Even states that have already made what are likely their final CLCS submissions—for example, Norway and Iceland—may need to respond to their neighbors' claims and finalize other bilateral delimitations.²⁸⁹ The Arctic jurisdiction map should be updated over the next few years to reflect these developments.

Additionally, future research should incorporate more detailed information on sedimentary geology of the Arctic Ocean as such information becomes available. More detailed geological data will allow for more accurate assessment of both the distribution of hydrocarbon resources across the Arctic Ocean, as well as for determination of the outer limits of the continental shelf pursuant to UNCLOS's geological definition.²⁹⁰ At the time of this study, only province-level hydrocarbon data was available for most of the Arctic Ocean, which required the significant assumption that hydrocarbon resources were uniformly distributed across each geological province.²⁹¹ In addition, due to a lack of more detailed information on Arctic Ocean sedimentology, each state's continental shelf was assumed to extend all the way to the UNCLOS theoretical maximum, although the claimable continental shelf may in reality fall far short of that under the geological definition of UNCLOS article 76.²⁹²

5. Conclusion. To some, the large quantities of hydrocarbons thought to be located north of the Arctic Circle hold out the promise of an Arctic energy future. However, significant risks

²⁸⁷ See *supra* notes 170–171, 189–190 and accompanying text.

²⁸⁸ See *supra* note 147 and accompanying text.

²⁸⁹ See *supra* notes 151–171 and accompanying text.

²⁹⁰ See *supra* note 57 and accompanying text.

²⁹¹ See *supra* notes 242 and accompanying text.

²⁹² See *supra* notes 243–245 and accompanying text.

stand in the way in development of those resources, including geological uncertainty, the muddled international legal environment, and the fragile and inhospitable Arctic environment. While the final outcome remains unclear, we can expect significant developments in the area over the next few decades.