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Moratoria for Disruptive Socio-Technical Challenges: 1. Historical Cases and Conceptual Framework

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MORATORIA FOR DISRUPTIVE SOCIO-TECHNICAL CHALLENGES

I. CASES AND CONCEPTUAL FRAMEWORK

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ABSTRACT

We examine how moratoria can help manage high-stakes societal challenges at the boundaries of domestic and international law and policy, science, and technology. Moratoria are proposed as responses to a vast range of domestic and international issues, including the three highest-stakes current socio-technical disruptions: human germline editing; artificial intelligence; and intentional modification of the global environment (geoengineering). Despite extensive experience and many scholarly accounts of one or a few cases, basic questions about moratoria are weakly understood: Under what conditions can moratoria help manage such disruptive issues? What specific uses can they serve? How can they be designed and managed to most effectively realize their contributions?

We aim to inform the use of moratoria in the effective and equitable management of major current and coming socio-technical disruptions. Given limited current understanding, this first paper builds on historical experience, examining fifteen cases of moratoria on a wide range of international, scientific, and technical issues. From these we build a conceptual framework for the design and use of moratoria, starting with a taxonomy of three ideal types based on the main aims of actors adopting them: risk-management, bargaining, and principled-conflict moratoria. Risk-management moratoria suspend activities that pose uncertain, potentially severe, widely shared risks, to allow time for research, risk assessment, and development of responses. Bargaining moratoria suspend provocative or escalatory actions that threaten the achievement of potential joint gains, to allow time to negotiate management of the relevant issue or resource and allocation of the available gains. Principled conflict moratoria are interim benchmarks in the control of activities that raise categorical objections, independent of risk or bargaining concerns. These mostly occur as mixed cases, in which categorical opponents join with other actors whose opposition is based on risk or bargaining concerns and thus conditional, not categorical. In these cases, categorical opposition can be understood as risk concern with extreme precaution (including precaution toward indirect risks arising from potential future decisions or changes in behavior or attitudes), or as bargaining concern with extreme preferences and willingness to use aggressive tactics. In such mixed cases, the presence of categorical opposition generates predictable conflicts over moratorium design, including the scope of actions and actors covered and the conditions to end the moratorium. Even when categorical opposition prevents moratoria from realizing their narrow risk or bargaining aims, they may still help by merely delaying resolution of the contested activities, thus allowing reactions to the moratorium or other events to attenuate or deflect the initial conflicts, allowing time for perceptions and institutions to adjust, or spurring novel responses that raise less concern. A second companion paper extends the framework to apply it to potential contributions of moratoria to gene editing, AI, and geoengineering.

CONTENTS

INTRODUCTION

We examine the potential contributions of moratoria to managing high-stakes challenges that lie at the boundaries of domestic and international law and policy, science, and technology. Moratoria are frequently proposed as responses to a wide range of contentious legal and policy problems in diverse policy areas, both domestically and internationally. Yet despite ample and diverse experience with moratoria, they are weakly understood. The concept of a moratorium suffers from substantial definitional and analytic confusion in both scholarly and practical contexts, while the few analytic treatments of moratoria in relevant legal, policy, and social-science literatures are conceptually thin and limited in empirical basis.¹ There are thus basic questions about the aims, design, mechanisms of effect, and outcomes of moratoria that are crucial for both practical decisions and general understanding, on which present research and analysis offer little guidance.

The stakes in understanding these questions are rising. While the wide range of issues on which moratoria are proposed or adopted includes many long-standing, entrenched conflicts and many issues with relatively low stakes,² moratoria are also among the leading proposals to address some of the highest-stakes, most potentially disruptive issues facing human societies – including the three current areas of disruptive technological change often identified as leading sources of existential risks: human germline modification,³ artificial intelligence,⁴ and large-scale manipulation of the environment.⁵

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- ¹ Most prior works on moratoria are descriptive accounts of one case, while two have made inferences from comparison of two cases. (See Sarah Lieberman et al., *Moratoria in International Politics: A Comparative Analysis of the Moratoria on Genetically Modified Products and Commercial Whaling*, 14 BRIT. J. POL. & INT'L REL. 518 (2012); Wenqiang Yin, *Moratorium in International Law*, 11 CHINESE J. INT'L L. 321 (2012)); and two have surveyed four to six US moratoria in biomedical research. Spivak et al., *Moratoria and Innovation: of pretext, permanence, transparency, and time limits*, J Health and Biomed Law 14:5-26 (2018), argued that some of these were pretexts, adopted by actors whose aim was prohibition. V. Bonham, *Moratoria in Scientific Research: A Review*, J. Health Care Law and Policy 24:2, 223-248 (2022), examined the effect of alternative enactment processes (administrative, regulatory, or legislative) on the persistence and adaptability of moratoria.
 - ² See, for example, recurrent calls for moratoria on GMOs, e.g., *Conservation Group Calls for GMO Moratorium*, WORLDWATCH INST. (Jan. 3, 2007), <http://www.worldwatch.org/node/4821> (Director-General of IUCN re-affirming IUCN's call for moratorium); on capital punishment, e.g., UN General Assembly resolutions 65/206 (Dec 20, 2010) and 71/187 (Dec 19, 2016); and moratoria on siting and extraction methods for energy production, particularly fracking and related drilling technologies, e.g., updated list of fracking moratoria at <https://keeptapwatersafe.org/global-bans-on-fracking/>.
 - ³ Proposed moratoria on these followed the 2014 announcement of the CRISPR-Cas9 method, which advanced precise targeting of genetic manipulation. See Jennifer A. Doudna & Emmanuelle Charpentier, *The New Frontier of Genome Engineering with CRISPR-Cas9*, 346 SCIENCE 1077 (2014); See also, e.g., David Baltimore et al., *A Prudent Path Forward for Genomic Engineering and Germline Gene Modification*, 348 SCIENCE 36 (2015); Eric Lander et al., *Adopt a Moratorium on Heritable Genome Editing*, 567 NATURE 165, 165-68 (2019).
 - ⁴ *Autonomous Weapons: An Open Letter from AI and Robotics Researchers*, FUTURE OF LIFE INST. (July 2015), <http://futureoflife.org/open-letter-autonomous-weapons/>. FUTURE OF LIFE INST. *Pause Giant AI Experiments*. Future of Life Inst. March, 2023, <https://futureoflife.org/open-letter/pause-giant-ai-experiments/>
 - ⁵ Climate engineering technologies involve intentional, global-scale intervention in the climate system aiming to offset some of the harms caused by human-driven elevation of atmospheric greenhouse gases. See COMM. ON GEOENG'G CLIMATE, NAT'L RES. COUNCIL, CLIMATE INTERVENTION: CARBON DIOXIDE REMOVAL AND RELIABLE SEQUESTRATION (2015); COMM. ON GEOENG'G CLIMATE, NAT'L RES. COUNCIL, CLIMATE

These issues present two dimensions of challenge. First, they are marked by deep uncertainties, both about rapidly advancing scientific knowledge and technical capability and about how these advances will influence and interact with law, policy, and human behavior. Second, they lack effective legal authorities and capabilities to manage them – either because mechanisms of influence and risk are unknown or operate at scales misaligned with jurisdictional authority, or because relevant authorities even within jurisdictions are absent, underdeveloped, ambiguous, or contested.

Our project aims to advance understanding on how moratoria can contribute to managing disruptive socio-technical challenges like these, and how they might be enacted, designed, and managed to best realize these contributions. To investigate these issues in the absence of prior theory or well founded empirical generalizations, in this first paper we draw on relevant historical experience. We present summaries of fifteen case studies of past or current moratoria, providing an empirical foundation larger and more diverse than in previous scholarship on moratoria.

Even with this broader scope, the set of historical parallels that matches both dimensions of challenge in current socio-technical disruptions – deep uncertainty and weak legal and policy capacity – is thin. To maximize relevance to current challenges, we thus include two groups of historical cases, each primarily aligned with one of the two dimensions of challenge: International diplomatic conflicts, whether or not they exhibit deep scientific and technological uncertainties; and management of disruptive scientific and technical advances, whether or not they have significant cross-jurisdictional aspects.

Based on these cases, we develop a preliminary analytic framework that we aim to apply to both historical and current cases. Because the historical cases sit in diverse institutional and legal contexts, this framework abstracts from jurisdiction-specific matters such as specific statutory sources of authority, institutional mandates, or decision and procedural rules that have been the main focus of prior scholarship.⁶ Instead, the framework highlights strategic factors likely to generalize across both subject matter and jurisdictional setting, such as the identity of relevant actors, their aims and resources, the choices they make in adopting a moratorium, and how these factors interact to shape moratorium outcomes. With this perspective, we consider the following high-level questions about moratoria:

- In what contexts, and under what conditions, are moratoria proposed or adopted?
- For what purposes are moratoria adopted? What problems do they aim to solve, for whom?
- What are the major dimensions of design choice in enacting a moratorium?
- How do context, intended purposes, and design choices interact to determine moratorium outcomes, including how effectively they realize their intended purposes?

The paper is organized as follows. Part I defines moratoria, specifies how moratoria are distinguished from other similar actions, and identifies three primary design characteristics that vary across moratoria. Part II summarizes fifteen historical cases of moratoria, grouped in two subject-

INTERVENTION: REFLECTING SUNLIGHT TO COOL EARTH (2015). A CE moratorium was first proposed in Cicerone 2006 (Cited FN8, pg. 138 in Gernot Wagner book). Subsequent proposals in Biermann et al (2022), and the Report of the Climate Overshoot Commission (2023).

⁶ See, e.g., Bonham; Yin; Spivak et al

matter areas where moratoria are frequently proposed: international diplomacy, and controversial fields of science and technology. Based on these cases, Part III develops a conceptual framework for analysis and assessment of moratoria, based on a taxonomy of three ideal types of moratoria that differ in their context and purpose, with additional discussion of mixed or intermediate cases. Part IV provides tentative conclusions, reflections on the scope and limits of our analysis, and preliminary exploration of what guidance our framework offers for new issues, including the three current areas of disruptive socio-technical change – AI, human genome editing, and geoengineering – that motivate our project. A companion paper in preparation will apply the framework to these new cases and examine how it might be extended to address these and other coming major socio-technical disruptions.

I. MORATORIA AND THEIR CHARACTERISTICS

This section presents our definition of moratoria and identifies the major characteristics that define and differentiate among moratoria, including how these vary across moratoria. In discussing these characteristics, we also state some background assumptions about moratoria and their uses that bound our project and frame the questions that guide our analysis of the cases in Part II.

A. Defining and Characterizing Moratoria

We define a moratorium as a temporary or conditional suspension of some specified activity, which is adopted under uncertainty about the activity's subsequent disposition.⁷ The term comes from the *praescripta moratoria* of Roman law, “a deferment of payment granted by imperial edict.”⁸ Use of the term broadened over time to encompass suspensions of any activity, whether adopted voluntarily or under domestic or international law.⁹ The three elements of this definition each inform our analysis and case selection: (1) a moratorium is a prohibition of some activity; (2) the prohibition is temporary or conditional; and (3) the subsequent disposition of the activity is uncertain.

First, a moratorium is a prohibition. This distinguishes moratoria from other temporary or provisional acts that are not prohibitory, including various treaties, agreements, statutes, regulations, and other actions that include expiry dates, sunset clauses, or other provisions for future rescission or revision.¹⁰

Second, a moratorium's prohibition is conditional or time-limited.¹¹ Moratoria are thus intermediate between full authorization and full prohibition, but intermediate in a particular way that is distinct from other partial restrictions such as regulation of an activity's methods, scale, or impacts. Even if this temporary or conditional character is not explicitly stated, it must be understood

⁷ Our definition is standard except for the condition that subsequent disposition must be uncertain. *See, e.g., Moratorium*, BLACK'S LAW DICTIONARY (9th ed. 2009); Lieberman et al., *supra* note 1, at 518; COOK-DEEGAN, *supra* note 1, at 4; Yin, *supra* note 1, at 321.

⁸ Alexander Riedel, *Moratorium*, in *ENCYCLOPEDIA OF PUBLIC INTERNATIONAL LAW* 409, 409-10 (Ezio Biglieri & G. Prati eds., 2014).

⁹ Yin, *supra* note 1, at 321-24; COOK-DEEGAN, *supra* note 1, at 4.

¹⁰ *See* Barbara Koremenos, *Loosening the Ties that Bind: A Learning Model of Agreement Flexibility*, 55 INT'L ORG. 289 (2001); Jason Oh, *The Pivotal Politics of Temporary Legislation*, 100 IOWA L. REV. 1055 (2014).

¹¹ Yin, *supra* note 1, at 333.

by adopters, in a stronger sense than merely recognizing that no decision is truly permanent. At adoption, a moratorium carries a shared expectation that the suspended activity will be reconsidered at some future time and its disposition potentially changed. This future disposition might be full authorization or prohibition, specific limitations or regulations, or extension of the moratorium on the original or revised terms. For example, a frequent time trajectory for moratoria is initial enactment with broad scope, followed by a later decision to continue it with narrower scope.

Third, when a moratorium is adopted, the activity's future disposition must be uncertain, not explicitly or implicitly pre-determined. This element distinguishes and narrows our definition relative to many in popular usage and prior scholarship. In particular, it excludes temporary suspensions that merely limit an activity's rate via periodic stopping and starting, or that delay it until some confidently expected resumption. In those cases there is no uncertainty about the future disposition of the activity, only about its timing. For example, we do not regard a local government's suspension of new building permits to clear a backlog of administrative processing or allow infrastructure buildout as meeting our definition of a moratorium; nor a hiring freeze to wait out a period of budget restriction; nor a suspension of new admissions to an organization to keep total membership at a target level. Nor in all cases do deferments of debt payments meet our definition of a moratorium, despite their resemblance to the original meaning in Roman law.¹² This uncertainty about future disposition, which is central to the strategic conditions for adoption and fate of a moratorium, pertains to collective knowledge about future disposition, not the preferences of individual actors. Some actors may know what they want the future treatment of the activity to be, or even confidently expect this preferred outcome, but this does not violate our requirement that future disposition be uncertain. Rather, our definition only requires that no group with such fixed expectations or preferences has full control over the moratorium's terms of adoption or future disposition.

Moratoria are not all alike. Adopting a moratorium requires specifying various characteristics, of which we identify three as most basic: the associated actors, the scope of covered activities, and the conditions for termination.

Actors associated with a moratorium may include individuals, firms, or other organizations, but our focus on issues with significant legal and policy stakes favors cases with some state actors.¹³ Although some single-actor decisions such as self-commitment efforts can resemble moratoria,¹⁴ we consider only bilateral and multilateral cases. Actors associated with a moratorium include both those who adopt it and those bound – those who, absent the moratorium, might have engaged in the suspended activity. Those adopting and bound by a moratorium can be distinct groups, or may partly or fully overlap. At one extreme, a group of adopters may seek to collectively bind themselves. At the other, adopters may seek to restrain some group entirely separate from themselves, via some form of legal or normative authority or by withholding some essential resource. Intermediate cases may include those in which the actors adopting and bound by a moratorium partly overlap, or in which a moratorium aims to influence behavior of more actors than are expressly bound by it. Variation in the configuration of participating actors is likely to be associated with variation in available mechanisms of control, with collectively adopted moratoria

¹² See, e.g., Yin's enumeration of multiple instances of debt payment deferment going back 150 years, para 2.

¹³ This bias may also arise from terminology, since the term "moratorium" is generally viewed as law-like, more likely to be applied to authoritative state action than, e.g., to mutual restraint agreements among firms.

¹⁴ Thomas C. Schelling, *The Intimate Contest for Self-command*, 60 PUB. INT. 94 (1980).

often limited to voluntary agreement and normative suasion, while external adopters may be able to deploy stronger authority or control over essential resources to impose a binding moratorium.

We assume that actors adopt moratoria not merely for expressive or symbolic reasons, but to advance relevant interests – which may include selfish material interests, judgements of aggregate social benefit or harm, preferences over procedures or forums, or expected spillovers to other issues. For a moratorium to be adopted, a group numerous and powerful enough – a forcing coalition – must prefer it to available alternative treatments of the targeted activity, which may include fully authorizing or prohibiting it, limiting or regulating it, or continued disagreement how to treat it. For a moratorium to be preferred to these alternatives, actors’ interests must partly favor and partly oppose the activity. Such a mix of favorable and opposed interests may arise in various ways: For example, some actors may on balance favor the activity while others on balance oppose it; or individual actors may hold mixed or conditional views, supporting or opposing the activity depending on facts or preferences not known, or actions not determined, at the time of adoption. For a moratorium to be enacted, enough participating actors must expect that at its termination they will be better able to identify or achieve a preferred treatment of the activity than at its adoption.

A moratorium’s scope specifies what activities fall under it. In some cases the activity of concern will be so salient and clearly bounded that the appropriate scope for a moratorium is clear and uncontested. In other cases, divergent information or preferences among actors may make the appropriate scope unclear or contested. Actors may seek to include or exclude specific activities in which they have strong interests, or may support a moratorium on some activities to deflect opposition from related activities that they favor. Uncertainty and dissent over the precise scope of a moratorium may persist even after adoption, if adoption language is imprecise and there is no authority able to resolve interpretive ambiguities or disagreements.

A moratorium’s termination conditions describe when, or under what conditions, it will end. Termination conditions can be defined by duration (“after 10 years”), external conditions (“if observed increase in global-average temperature exceeds 2.5 degrees Celsius”), procedural decision rules (“if a majority of parties so decide at their annual meeting”), or some combination of these. Although the existence of some termination conditions must be widely understood for a moratorium to meet our definitional requirement of being temporary or provisional, specific terms for termination need not be explicit: they may be intentionally ambiguous or even unstated, reflecting some implicit shared understanding. As with many instances of intentional ambiguity in negotiated agreements,¹⁵ such ambiguity may be necessary for adoption, insofar as actors do not know, or are unwilling to commit to, specific future conditions under which they would accept either full authorization or prohibition of the activity; or alternatively, if actors expect their future preferences to depend on knowledge, events, or actions not known at the time of adoption.

In some cases, interim parallel activities are conducted during a moratorium, which aim to inform its termination conditions or support effective outcomes. Depending on the issue, parallel activities might include related research and development, assessment, negotiations, exploration or development of relevant legal authority or administrative capacity, or other activities to support the moratorium. We treat these parallel activities as conceptually distinct from the moratorium, but because they may be linked in various ways and may influence outcomes, we track them in our case summaries and consider them in our analysis.

¹⁵ FRED C. IKLÉ, *HOW NATIONS NEGOTIATE* 7, 15 (1967).

II. HISTORICAL EXPERIENCE WITH MORATORIA

This section presents the empirical component of our project, via brief summaries of historical and current cases of moratoria. We selected cases that address significant matters of law or policy, at the US national level or internationally; that were actually enacted, either formally or *de facto*, rather than merely proposed; that are prominent enough to have generated a secondary literature; and that are recent, occurring since the mid-twentieth century. The set of cases meeting these criteria is not precisely bounded, so we make no claim that our set is exhaustive or statistically representative of some clearly defined universe of potential cases. The set is, however, larger and more diverse than previously considered in studies of moratoria, and includes the instances typically proposed as relevant to current high-stakes moratorium decisions.

This selection yields fifteen cases, in two broad subject-matter areas. Part A reviews ten cases of moratoria in international diplomacy. Part B covers five cases of moratoria adopted in controversial areas of scientific research or technology, mostly within the United States but with significant international linkages. Each case briefly reviews the context in which a moratorium was proposed, its scope and form, the aims of its proponents, and its outcome and current status.

A. *Moratoria in International Diplomacy*

We review ten cases of moratoria used to manage conflicts in international diplomacy. The cases are diverse in issue-area, covering fields of sovereign claims, natural-resource allocation and management, environmental protection, international security, and trade. They are also diverse in structure: three are bilateral, concerning allocation and management of trans-boundary resources, while the seven multilateral cases range from 3 to 76 initial adopters.¹⁶ In their structure of interests, some are best understood as distributive or constant-sum issues, others as various forms of collective-action problem.¹⁷

1. Antarctic Territorial Claims

A moratorium on territorial claims has anchored Antarctica's governance system for more than sixty years.¹⁸ The system developed over a decade, in response to growing tension over contending claims in the 1940s. Seven states made claims—the United Kingdom, New Zealand, France, Norway, Australia, Chile, and Argentina—with overlaps between those of Argentina, Chile, and the United Kingdom.¹⁹ The United States and Soviet Union neither made nor recognized claims, but both maintained a basis of claim through exploration and scientific research.²⁰ The United States

¹⁶ 3 = initial participants in nuclear testing moratoria (US, UK, USSR); 76 = parties to TRIPS when moratorium on non-violation complaints first adopted.

¹⁷ For a review of these alternative structures of interests, see THOMAS C. SCHELLING, *STRATEGY OF CONFLICT* (1960); Add Schelling *Micromotives and Macrobehavior*; HOWARD RAIFFA, *THE ART AND SCIENCE OF NEGOTIATION* (1982).

¹⁸ See generally GOVERNING THE ANTARCTIC: THE EFFECTIVENESS AND LEGITIMACY OF THE ANTARCTIC TREATY SYSTEM (Olav S. Stokke & Davor Vidas eds., 1996).

¹⁹ See *Territories Claimed by Sovereign States in the Antarctic*, 10 POLAR REC. 163, 163 (1960).

²⁰ See Boleslaw A. Boczek, *The Soviet Union and the Antarctic Regime*, 78 AM. J. INT'L L. 834, 840-46 (1984); U.S. ANTARCTIC PROGRAM EXTERNAL PANEL, *Antarctica-Past and Present*, in THE UNITED STATES IN ANTARCTICA 17, 21 (1997).

considered making a territorial claim, but on balance judged its interests in free access and limiting Soviet reach to outweigh the benefits of asserting its own claim.²¹

Conflict over claims and broader Cold-War tensions moved several states to seek international resolution. In 1948, the United States proposed two governance arrangements: a U.N. trusteeship, or a condominium that would merge all claims and establish a governing commission.²² Under either approach the United States would make a claim to join other claimants in governing arrangements. When only two states supported this proposal, Chile instead proposed a *modus vivendi* arrangement, which would freeze claims and objections for five to ten years.²³ By separating claims from Antarctic activities, the proposal would let states conduct research anywhere on the continent, but would eliminate incentives for new bases or expeditions merely to assert claims.²⁴ The United States found the proposal offered benefits similar to its prior stance of neither making nor recognizing claims,²⁵ and began working with Chile on a modified proposal.²⁶

After a few years delay, interest in the initiative revived in planning the 1957-58 International Geophysical Year (IGY), a collaboration among twelve national science agencies.²⁷ The first IGY planning conference adopted a “Gentlemen’s Agreement,” similar to the prior *modus vivendi* proposal, that IGY activities “do not modify the existing status of the Antarctic regarding the relations of the participating countries.”²⁸ IGY’s success showed the value of Antarctic research cooperation, the need to resolve claim conflicts, and the practicality of the *modus vivendi* approach.²⁹

States began negotiating an Antarctic governance treaty soon after IGY. Although initial positions on claims were far apart,³⁰ states agreed on a subtly crafted moratorium that sharpened the approach of the *modus vivendi* and Gentleman’s Agreement.³¹ Crucially, the moratorium did not change the status of any existing claims or rights: claimants retained their claims; non-claimants retained all bases for unasserted claims; and states retained rights to recognize or reject others’ claims. Rather, while the Treaty was in force the moratorium applied to new or enlarged claims, and to bases for claims from new activities, thus removing incentives for activities to bolster

²¹ See generally Jason Kendall Moore, *A ‘Sort’ of Self-Denial: United States Policy Toward the Antarctic, 1950-59*, 37 POLAR REC. 13 (2001).

²² See OFFICE OF THE HISTORIAN, U.S. DEP’T OF STATE, FOREIGN RELATIONS OF THE UNITED STATES 1948, GENERAL: THE UNITED NATIONS, VOL. I, PART 2, 977 (1948).

²³ Rip Bulkeley, *The Political Origins of the Antarctic Treaty*, 46 POLAR REC. 9, 10 (2010).

²⁴ See OFFICE OF THE HISTORIAN, U.S. DEP’T OF STATE, *supra* note 22, at 1009. (same comment as note 22)

²⁵ Bulkeley, *supra* note 23.

²⁶ OFFICE OF THE HISTORIAN, U.S. DEP’T OF STATE, FOREIGN RELATIONS OF THE UNITED STATES 1949, NATIONAL SECURITY AFFAIRS, FOREIGN ECONOMIC POLICY, VOL. I, 800-02, 807-09 (1949).

²⁷ The seven claimants plus the United States, Soviet Union, and three others. See generally Moore, *supra* note 21.

²⁸ Gillian Triggs, *The Antarctic Treaty System: A Model of Legal Creativity and Cooperation*, in SCIENCE DIPLOMACY: ANTARCTICA, SCIENCE, AND THE GOVERNANCE OF INTERNATIONAL SPACES 39, 42 (Paul Arthur Berkman et al. eds., 2011); M.J. PETERSON, *MANAGING THE FROZEN SOUTH: THE CREATION AND EVOLUTION OF THE ANTARCTIC TREATY SYSTEM* (1988).

²⁹ Bulkeley, *supra* note 23, at 10.

³⁰ See PETERSON, *supra* note 28, at 40; KLAUS DODDS, *PINK ICE: BRITAIN AND THE SOUTH ATLANTIC EMPIRE* 75-95 (2002).

³¹ Antarctic Treaty art. IV, Dec. 1, 1959, 12 U.S.T. 794, 402 U.N.T.S. 71.

claims. These terms, as well as the Treaty's provisions for scientific access and international control, also weakened the force of prior claims in practice, although these remained formally in effect.

The claims moratorium was crucial to subsequent growth of Antarctic governance, including the several agreements that now comprise the Antarctic Treaty System (ATS).³² It achieved this partly by barring certain activities and claims, but more importantly by changing the meaning of other activities, deeming activities that would generally support or contest claims not to do so. This innovation allowed research and other beneficial activities to proceed that would otherwise have been hindered by rival interests, whether due to distorted incentives, access restrictions, or mutual suspicion of militarization or maneuvering for advantage. It also provided the foundation to support negotiation of other cooperative Antarctic agreements.

The moratorium is not perfectly durable. The suspensions only last while the Treaty remains in force, and while the Treaty defines clear (if cumbersome) procedures by which it might cease to be in force,³³ it is silent regarding the status of claims if this should occur. Anxiety persists about the future status of claims and recent scholarship suggests the regime will come under increasing stress from climate change, rising value of Antarctic resources, and calls for more equitable global control.³⁴ There have been no overt challenges to the regime thus far,³⁵ however, not even via requests for the review conference that the Treaty authorized after 30 years.³⁶

2. Antarctic Mineral Activity

Mineral issues were not discussed in the Antarctic Treaty negotiations because they were deemed controversial and premature.³⁷ Although the continent's mineral potential remains largely unexplored, research suggests it could be large, including both fossil fuels and precious metals.³⁸ Technical advances in the 1970s suggested viable commercial opportunities, but the lack of a legal regime for access and rights discouraged investment.³⁹ In 1976, parties agreed to negotiate a minerals treaty and adopted a voluntary moratorium in the interim.⁴⁰ The result of these negotiations,

³² See generally *Key Documents of the Antarctic Treaty System*, SECRETARIAT OF THE ANTARCTIC TREATY, http://www.ats.aq/e/ats_keydocs.htm; See also *The Antarctic Treaty Explained*, BRITISH ANTARCTIC SURVEY, http://www.antarctica.ac.uk/about_antarctica/geopolitical/treaty/explained.php (last visited May 22, 2014)..

³³ Antarctic Treaty, Art. XII.1, XII.2.

³⁴ Daniela Liggett et al., *Is it all going south? Four future scenarios for Antarctica*, 53 POLAR REC. 459 (2017); Doaa Abdel-Motaal, *Averting the Battle for Antarctica*, 12 YALE J. INT'L AFF. 1 (2017); Ottavio Quirico, *Climate Change, Regionalism, and Universalism: Elegy for the Arctic and the Antarctic?* 35 AM. U. INT'L L. REV. 487 (2020); Elizabeth Buchanan, *Antarctica in the Gray Zone*, 76 AUST'LJ. INT'L AFFS. 324 (2022); Charles R. Corbett and E.A. Parson, *Radical Climate Adaptation in Antarctica*, ECOL. L. Q. 49:1 (2022).

³⁵ SECRETARIAT OF THE ANTARCTIC TREATY, FINAL REPORT OF THE 45TH ANTARCTIC TREATY CONSULTATIVE MEETING (May 29 – June 8, 2023, https://documents.ats.aq/ATCM45/fr/ATCM45_fr001_e.pdf

³⁶ Id., Art. XII.2; See also Barbara Koremenos, *Loosening the Ties That Bind: A Learning Model of Agreement Flexibility*, 55 INT'L ORG. 289, 312-315 (2001).

³⁷ Brian Roberts, *International Co-operation for Antarctic Development: The Test for the Antarctic Treaty*, 19 POLAR REC. 107, 111 (1978).

³⁸ See, e.g., H. COMM. ON SCI. & TECH., 94TH CONG., POLAR ENERGY RESOURCES POTENTIAL (Comm. Print 1976).

³⁹ OFF. TECH. ASSESSMENT, 101ST CONG., POLAR PROSPECTS: A MINERALS TREATY FOR ANTARCTICA 37 (1989).

⁴⁰ Christopher C. Joyner, *The Antarctic Minerals Negotiating Process*, 81 AM. J. INTL. L. 888, 890-91 (1987);

the Convention on Regulation of Antarctic Mineral Resource Activities (CRAMRA), was unanimously adopted in 1988.⁴¹ CRAMRA allowed mineral development under tight restrictions, including extensive off-limits protected areas, strict environmental assessment, and consensus that proposed projects would not do significant environmental harm.⁴² Political conditions had changed sharply over the decade of negotiation, however, particularly in the growth of an international environmental movement.⁴³ NGOs calling to ban mining and declare Antarctica a “world park” gained two significant victories in 1989:⁴⁴ a General Assembly resolution,⁴⁵ and statements by Australia and France that they would not ratify CRAMRA.⁴⁶ Since the treaty required ratification by all original Antarctic Parties, this meant it could not enter into force.⁴⁷

With mineral demand expected to grow, Parties agreed a new Treaty was needed but differed over what it should contain. Although mining opponents were in the stronger position, supporters sought to avoid a permanent ban and retain options for future development.⁴⁸ After two years of negotiation, Parties adopted the Madrid Protocol on Environmental Protection in 1991.⁴⁹ The Protocol includes a moratorium on mineral exploration and development, although disagreement over its terms delayed adoption by a year and left some ambiguity in the adopted text. While the relevant language appears to establish an unconditional ban – Article VII prohibits “any activity relating to mineral resources, other than scientific research”⁵⁰ – other provisions weaken that ban to a moratorium. After 2048, any Consultative Party may request a review conference, at which amendments may be adopted by qualified majority.⁵¹ Although the United States sought a fairly permissive process to allow mineral activities thereafter,⁵² the text narrows the procedural routes to allowing these without fully foreclosing them – and remains somewhat ambiguous.⁵³

Antarctic Treaty Consultative Party, *Final Report on Its Ninth Meeting*, recommendation IX-1, para. 8 (Sept. 19-Oct 7, 1977).

⁴¹ The Convention for the Regulation of Antarctic Mineral Resource Activities, June 2, 1988, 27 I.L.M. 859 [hereinafter CRAMRA].

⁴² *Id.* at arts. 4, 18, 21-22, 41.

⁴³ See CHRISTOPHER C. JOYNER, GOVERNING THE FROZEN COMMONS: THE ANTARCTIC REGIME AND ENVIRONMENTAL PROTECTION 38, 50, 193-94, 245 (1998).

⁴⁴ F.M. AUBURN, ANTARCTIC LAW AND POLITICS 124, 259 (1982). See generally J.M. Spectar, *Saving the Ice Princess: NGOs, Antarctica & International Law in the New Millennium*, 23 SUFFOLK TRANSNAT'L L. REV. 57 (1999).

⁴⁵ G.A. Res. 44/124, at 92 (Dec. 15, 1989).

⁴⁶ Malcolm W. Browne, *France and Australia Kill Pact on Limited Antarctic Mining and Oil Drilling*, N.Y. TIMES, Sept. 25, 1989, at A10.

⁴⁷ CRAMRA, *supra* note 41, at art. 62.

⁴⁸ Spectar, *supra* note 44, at 90; See also Antarctic Protection Act of 1990, Pub. L. No. 101-594, 104 Stat. 2975 (1990); See *U.S. Raises Objections to Antarctica Pact*, N.Y. TIMES, June 18, 1991, at C6.

⁴⁹ Protocol on Environmental Protection to the Antarctic Treaty, Oct. 4, 1991, 30 I.L.M. 1455, 1461.

⁵⁰ *Id.* at art. 7.

⁵¹ Proposed revisions would be adopted by a majority of Parties, including three-quarters of 1991 Consultative Parties, and enter into force by three-quarter majority of Parties including all 1991 CPs. *Id.* at art. 25(3).

⁵² Anthony Luke, “America backtracks on Antarctic mining ban”, New Scientist 28 June 1991, <https://www.newscientist.com/article/mg13017751-600-america-backtracks-on-antarctic-mining-ban/>

⁵³ The US proposed that if a mining regime is proposed but does not enter into force within three years, any party

This case thus includes two moratoria. The initial ten-year moratorium successfully facilitated negotiation of CRAMRA, but changes in the political context over that time prevented the treaty from gaining the ratifications needed to enter into force. The subsequent moratorium, which combines a clear ban on mining for 50 years with substantial – but not insurmountable – procedural barriers thereafter, is still in force.⁵⁴ At a minimum, the moratorium has stabilized the regime by delaying exploitative activity, which could threaten the treaty’s scientific and environmental aims and also draw attention to broader problems of property rights and regulatory authority that have been left ambiguous. Attempts to clarify or resolve these could readily revive sovereign ambitions and threaten the delicate balance on which the ATS depends.⁵⁵

Parties re-affirmed their commitment to the Madrid Protocol in 2019,⁵⁶ but its continued durability remains uncertain. Although the commercial viability of Antarctic mineral production remains uncertain, technological advances and resource scarcities are increasing interest.⁵⁷ There is growing speculation that some nations are looking ahead to post-2048 development, by allowing prospecting under the guise of scientific research as allowed by Article 7.⁵⁸ At the same time, Antarctica is experiencing profound environmental transformation from climate change.⁵⁹ These changes weaken the view of Antarctica as a pristine wilderness beyond human influence, and strengthen Antarctica’s linkage to global climate risks via destabilization of ice sheets.⁶⁰ Thus, while the moratorium remains as a stabilizing force for the ATS, it faces future threats of unclear timing and character, with no clear path evident for its potential future change or termination.

may withdraw from the moratorium and start mining after two more years. The adopted text states that the moratorium continues unless an amendment includes a binding resource regime meeting specified conditions; changes the withdrawal time to three years after adoption rather than proposal; and only lets parties withdraw from the entire Protocol, not just the moratorium (Art 25.V(b)). The text does not state whether these limits on amendments can themselves be amended, or what happens if a proposed regime does not meet the high threshold for adoption.

⁵⁴ See Mohamed Haron, *The Ability of the Antarctic Treaty System to Adapt to External Challenges*, in *ANTARCTIC TREATY SYSTEM IN WORLD POLITICS* 299, 303 (A.J. Dahl & W. Ostreng eds., 1991).

⁵⁵ PETER J BECK, *THE INTERNATIONAL POLITICS OF ANTARCTICA* 244 (1986). See also Catherine Redgwell, *Environmental Protection in Antarctica: the 1991 Protocol*, *International and Comparative Law Quarterly* 43:3 (July 1994), 599-634. (Noting that Australia’s rejection of CRAMRA partly reflected concern that a regulatory and revenue regime for mining would take Australian interests associated with its large sovereign claim.)

⁵⁶ See Secretariat of the Antarctic Treaty, *Final Report of the Forty-Second Antarctic Treaty Consultative Meeting* 209 (July 1-11, 2019), https://documents.ats.aq/ATCM42/fr/ATCM42_fr001_e.pdf, p.209; See also Secretariat of the Antarctic Treaty, *30 Years of the Environmental Protocol*, Oct. 4, 2021, <https://www.ats.aq/devph/en/news/199>.

⁵⁷ See Alan D. Hemmings, *Antarctic Politics in a Transforming Global Geopolitics*, in *HANDBOOK ON THE POLITICS OF ANTARCTICA* 507, 507-22 (Klaus Dodds et al, eds. 2017); see also Mark P. Nevitt & Robert V. Percival, *Polar Opposites: Assessing the State of Environmental Law in the World's Polar Regions*, 59 *B.C. L. REV.* 1655, 1678-82 (2018); see also Leah Feiger & Mara Wilson, *The Countries Taking Advantage of Antarctica During the Pandemic*, *The Atlantic* (May 15, 2020).

⁵⁸ See Brady, Anne-Marie. “China’s Expanding Antarctic Interests: Implications for Australia.” Australian Strategic Policy Institute, 2017, <http://www.jstor.org/stable/resrep04257>; Elizabeth Buchanan, *Antarctica in the Gray Zone*, 76 *Aust’l J. Int’l Affs.* 324 (2022); Nasih Sarp Ergüven, Burcu Özsoy, Sinan Yirmibeşoğlu & Özgün Oktar, *Regulation of Mineral Resource Activities in Antarctica*, 9 *Int’l J. Env’t & Geoinformatics* 81 (2022).

⁵⁹ Luis Valentin Ferrada, “Five factors that will decide the future of Antarctica,” *Polar Journal* 8:1, 2018, 84-109.

⁶⁰ See Corbett and Parson, *Radical Climate Adaptation in Antarctica*, *supra* Note 35.

3. Nuclear Weapons Testing

Hundreds of atmospheric nuclear weapons tests conducted in the 1950s by the United States, Soviet Union, and United Kingdom prompted global demands to ban testing.⁶¹ When negotiations for a test ban began in 1958, all three states adopted temporary testing moratoria.⁶² Tests resumed in 1961 in response to rising US-Soviet tensions and France's first test,⁶³ but states were still able to adopt the Limited Test Ban Treaty in 1963.⁶⁴ The next fifteen years saw modest further progress, including several agreements to limit tests by location or size.⁶⁵ By the late 1980s, declining Cold-War tensions reduced the perceived need to develop new weapons and prompted renewed calls for a comprehensive test ban.⁶⁶ A growing Soviet anti-nuclear movement⁶⁷ led to a 1991 decision to close the main test site and adopt a moratorium.⁶⁸ France announced a moratorium one year later, spurred by anti-nuclear protests and the growing political power of the Green Party.⁶⁹ The U.S. Congress then adopted a moratorium for one year (until July 1, 1993), with the option to resume testing thereafter by Presidential decision under specified conditions.⁷⁰ With negotiations for a full test ban treaty then underway, President Clinton extended the moratorium until the treaty entered into force.⁷¹

The Comprehensive Nuclear-Test-Ban Treaty (CTBT), adopted in 1996, obliges parties “not to carry out any nuclear weapon test explosion or any other nuclear explosion.”⁷² The Treaty has not yet achieved the required ratification by all 44 nuclear-capable states, so has not entered into force.⁷³ Even without a binding obligation, however, further tests have mostly been blocked by the

⁶¹ JONATHAN E. MEDALIA, CONG. RESEARCH SERV., RL33548, COMPREHENSIVE NUCLEAR-TEST-BAN TREATY: BACKGROUND AND CURRENT DEVELOPMENTS 1 (2014).

⁶² Pierce S. Corden, *Historical Context and Steps to Implement the CTBT*, in BANNING THE BANG OR THE BOMB? NEGOTIATING THE NUCLEAR TEST BAN REGIME 17, 19 (Mordechai Melamud et al. eds., 2014).

⁶³ Fen Osler Hampson, *The Importance of Coupling: The Limited Test Ban Negotiations*, in BANNING THE BANG OR THE BOMB? NEGOTIATING THE NUCLEAR TEST BAN REGIME 87 (Mordechai Melamud et al. eds., 2014).

⁶⁴ Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water, Aug. 5, 1963, 14 U.S.T. 1313, 480 U.N.T.S. 43.

⁶⁵ Hampson, *supra* note 63, at 89; MEDALIA, *supra* note 61; Treaty on the Limitation of Underground Nuclear Weapon Tests, U.S.-U.S.S.R., July 3, 1974, 13 I.L.M. 906; Treaty on Underground Nuclear Explosions for Peaceful Purposes, U.S.-U.S.S.R., May 28, 1976, 15 I.L.M. 891, 1714 U.N.T.S. 387.

⁶⁶ MEDALIA, *supra* note 61.

⁶⁷ Rebecca Johnson, *The Role of Civil Society in Negotiating the CTBT*, in BANNING THE BANG OR THE BOMB? NEGOTIATING THE NUCLEAR TEST BAN REGIME 96, 106 (Mordechai Melamud et al. eds., 2014).

⁶⁸ Japp Ramaker, *The Negotiating Process, 1994-1996: A View from the Chair*, in BANNING THE BANG OR THE BOMB? NEGOTIATING THE NUCLEAR TEST BAN REGIME 58, 64 (Mordechai Melamud et al. eds., 2014).

⁶⁹ Johnson, *supra* note 67, at 102.

⁷⁰ *See id.*; Energy and Water Development Appropriations Act of 1993, Pub. L. No. 102-377, §507, 106 Stat. 1315, 1343-44 (1992).

⁷¹ Johnson, *supra* note 67.

⁷² Comprehensive Nuclear Test Ban Treaty, art. I, Sept. 24, 1996, 35 I.L.M. 1439 [hereinafter CTBT]; *but see* David S. Jonas, *The Comprehensive Nuclear Test Ban Treaty: Current Legal Status in the United States and the Implications of a Nuclear Test Explosion*, 39 N.Y.U J. INT'L. L. & POL. 1007, 1016 (2007).

⁷³ *See* Status of Signature and Ratification, <https://www.ctbto.org/our-mission/states-signatories>. India, N. Korea, and Pakistan have not signed. China, Egypt, Iran, Israel, and the United States have not ratified. Russia revoked its ratification (but not signature), Nov 2, 2023, to align with the US (Andrew Osborn, Reuters, Nov 2, 2023).

ongoing unilateral moratoria. France resumed testing in 1995 but met intense international protests and soon reinstated its moratorium.⁷⁴ Russia has continued low-yield experiments, but claims (against widespread objections) that these comply with the treaty.⁷⁵ The United States reserves its right to resume testing if needed to “diagnose or remedy a problem in a warhead critical to the U.S. nuclear deterrent . . .,” but has not done so.⁷⁶ Even while proposals for broader restrictions on nuclear weapons fail,⁷⁷ support for the test moratorium was affirmed by a Security Council resolution as recently as 2016.⁷⁸ States’ interests in testing may be declining as stockpile stewardship technologies let them maintain their capacity without testing.⁷⁹

As on many arms-control issues, states’ testing decisions present two strategic considerations: a collective interest in limiting shared risk by reducing testing, while avoiding disadvantage from unilateral restraint. The moratoria sought to balance these interests. Although formally unilateral, their clear intent was to elicit reciprocal restraint in pursuit of collective de-escalation. They signaled willingness to make concessions and accept small risks to support mutually beneficial restraint. Through this signaling, and by providing time for negotiation, they eased adoption of formal limits in the 1963 and 1996 treaties.⁸⁰ More recently, they have helped build a *de facto* international norm against testing, even without a binding obligation.⁸¹ Nearly all states remain committed to these unilateral moratoria, despite continuing tests by the one state with no moratorium, North Korea.⁸² Indeed, the global outcries that met North Korea’s tests and France’s brief retreat

⁷⁴ See Ramaker, *supra* note 68; *Fifteenth Anniversary of France’s Last Nuclear Test*, CTBTO PREPARATORY COMM’N, <https://www.ctbto.org/news-and-events/news/fifteenth-anniversary-frances-last-nuclear-test> (last visited June 29, 2024).

⁷⁵ See, e.g., Paul Sonne, *U.S. military intelligence steps up accusation against Russia over nuclear testing*, WASH. POST (June 13, 2019, 4:23 PM), https://www.washingtonpost.com/world/national-security/us-military-intelligence-steps-up-accusation-against-russia-over-nuclear-testing/2019/06/13/2dadf2e2-8e26-11e9-b162-8f6f41ec3c04_story.html.

⁷⁶ See U.S. Dept of Defense, 2022 National Defense Strategy, <https://media.defense.gov/2022/Oct/27/2003103845/-1/-1/2022-NATIONAL-DEFENSE-STRATEGY-NPR-MDR.PDF>; But see Robert C. O’Brien, *The Return of Peace Through Strength: Making the Case for Trump’s Foreign Policy*, FOREIGN AFFS., July/Aug. 2024, at 24 (arguing for resuming US testing). See also MEDALIA, *supra* note 61, at 4 (quoting Letter from Sec. Rice to Senator Domenici, June 25, 2007).

⁷⁷ See United Nations, Treaty on the Prohibition of Nuclear Weapons (2017), https://treaties.un.org/doc/Treaties/2017/07/20170707%2003-42%20PM/Ch_XXVI_9.pdf; see also Bill Chappell, *U.N. Treaty Banning Nuclear Weapons Takes Effect, Without the U.S. and Other Powers*, NPR (Jan. 22, 2021), <https://www.npr.org/2021/01/22/959583731/u-n-treaty-banning-nuclear-weapons-takes-effect-without-the-u-s-and-others>.

⁷⁸ Valentina Pop & Paul Sonne, *U.N. Security Council Approves Nuclear Test Ban Resolution; Egypt’s objections linked to absence of any commitments to cut down nuclear warhead numbers*, WALL ST. J. (Sept. 23, 2016).

⁷⁹ See Chris McIntosh, *Framing the CTBT Debate Over the US Ratification of the Treaty*, in BANNING THE BANG OR THE BOMB? NEGOTIATING THE NUCLEAR TEST BAN REGIME 146, 153-54 (Mordechai Melamud et al. eds., 2014). There is controversy over whether all stockpile stewardship activities are consistent with the Treaty. See MEDALIA, *supra* note 61, at 8, 23, 34, 42-43, 48.

⁸⁰ See Johnson, *supra* note 67; Mordechai Melamud, Paul Meerts & I. William Zartman, *Lessons from the CTBTO Negotiation Processes*, in BANNING THE BANG OR THE BOMB? NEGOTIATING THE NUCLEAR TEST BAN REGIME 341, 342 (Mordechai Melamud et al. eds., 2014).

⁸¹ See *Joint Ministerial Statement on the CTBT*, MINISTRY OF FOREIGN AFFAIRS OF JAPAN (Sept. 27, 2012), http://www.mofa.go.jp/policy/un/disarmament/ctbt/friends_minstate1209.html.

⁸² *Joint Statement to the 2010 Non-Proliferation Treaty Review Conference by the Five Permanent Members of*

from its moratorium demonstrate states' political incentives to maintain their commitments.⁸³

4. Ocean Dumping of Low-Level Radioactive Waste

From the 1940s to the early 1980s, countries routinely disposed of radioactive wastes at sea.⁸⁴ Although dumping initially included used reactor fuel and other high-level wastes, this was banned by the 1972 London Convention.⁸⁵ The Convention did not, however, ban dumping low-level wastes, which are less hazardous but are produced in much larger volumes, and so are costly to process on land.⁸⁶ Several nations continued to dump low-level waste after the Convention,⁸⁷ which was generally judged by scientists to have minimal environmental risk.⁸⁸

Claiming health and environmental risks, Greenpeace launched a campaign in 1978 against all radioactive dumping.⁸⁹ Several non-dumping nations with concerns about coastal and marine environments supported the campaign, including Spain, the Nordic states, and several Pacific islands.⁹⁰ In response, Convention parties adopted a voluntary moratorium in 1983 on dumping all radioactive material, to be re-assessed based on an expert risk assessment.⁹¹ Environmental groups expressed suspicion about the assessment, arguing both that dumping nations would simply ignore it, and that scientific assessment could not address the moral concerns raised by dumping.⁹² The UK and Russia continued dumping during the moratorium,⁹³ while Japan—which had previously

the United Nations Security Council, U.S. DEP'T OF ST. (May 5, 2010), <https://2009-2017.state.gov/r/pa/prs/ps/2010/05/141547.htm>.

⁸³ Patricia Lewis, World Leaders Must Curb Nuclear Proliferation in the Middle East and Beyond, *Chatham House* (May 3, 2024), <https://www.chathamhouse.org/2024/05/world-leaders-must-curb-nuclear-proliferation-middle-east-and-beyond>.

⁸⁴ See John Warren Kindt, *Radioactive Wastes*, 24 NAT. RESOURCES J. 967, 974-76 (1984).

⁸⁵ Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter art. IV, annex I ¶ 6, Dec. 29, 1972, 26 U.S.T. 2403 [hereinafter London Convention].

⁸⁶ See NUCLEAR ENERGY AGENCY, ORG. ECON. COOPERATION & DEV., LOW-LEVEL RADIOACTIVE WASTE REPOSITORIES: AN ANALYSIS OF COSTS (1999), <https://www.oecd-nea.org/rwm/reports/1999/low-level-waste-repository-costs.pdf>; Kindt, *supra* note 84, at 972-73.

⁸⁷ See Alan Sielen, *The New International Rules on Ocean Dumping: Promise and Performance*, 21 GEO. INT'L ENVTL. L. REV. 295, 317 (2009).

⁸⁸ See IAEA, SAFETY SER. 5, RADIOACTIVE WASTE DISPOSAL INTO THE SEA 77 (1961); NOAA, *The Assimilative Capacity of U.S. Coastal Waters for Pollutants*, Workshop Proceedings, Washington DC (Jul 29-Aug. 4, 1979).

⁸⁹ Remi Parmentier, *Greenpeace and the Dumping of Wastes at Sea: A Case of Non-State Actors' Intervention in International Affairs*, 4 INT'L NEGOT. 1 (1999); IMO, Report of 7th Meeting of Parties to the London Convention, LDC 7/12 (1983), http://www.imo.org/en/KnowledgeCentre/ReferencesAnd-Archives/IMO_Conferences_and_Meetings/London_Convention/LCandLDCReports/Documents/Report%20of%20LDC%2012%20November%201989.pdf.

⁹⁰ Edward L. Miles, *Sea Dumping of Low-Level Radioactive Waste, 1964 to 1982*, in ENVIRONMENTAL REGIME EFFECTIVENESS: CONFRONTING THEORY WITH EVIDENCE 87, 105-06 (E.L. Miles et al. eds., 2002).

⁹¹ Res. LDC 14(7), Disposal of Radioactive Wastes and Other Radioactive Matter at Sea, annex 3, LDC 7/12 (Mar. 9, 1983); Mechanism for the Preparation of an Expert Meeting on Radio-Active Matters Related to the London Dumping Convention, annex 6, LDC 7/12 (Mar. 9, 1983).

⁹² Report of the Seventh Consultative Meeting of Contracting Parties to the London Convention, *supra* note 89.

⁹³ See generally Alexey V. Yablokov, *Radioactive Waste Disposal in Seas Adjacent to Territory of the Russian Federation*, 43 MARINE POLLUTION BULL. 8 (2001); Ursula Wasserman, *Disposal of Radioactive Waste*, 19 J. WORLD TRADE 425, 427 (1985).

moved disposal to rivers in 1969—sought to resume dumping in the Pacific.⁹⁴ The US observed the moratorium, having decided in 1970 that other disposal methods were cheaper.⁹⁵

When the 1985 assessment failed to reach a conclusion on the risks of low-level dumping, Parties adopted a resolution to extend the moratorium indefinitely and create a new expert panel, charged to provide further information on “scientific, political, legal, economic, and social dimensions” of dumping by 1993.⁹⁶ States were divided on the extended moratorium. The United States and UK signed the moratorium but stressed its voluntary character, while Russia and Japan did not sign.⁹⁷ While these disagreements persisted, opinion gradually shifted against dumping. The UK and France continued to oppose hardening the moratorium into a ban, while Japan and the United States changed positions to support a ban.⁹⁸ In some cases, countries were forced to change disposal methods by public pressure. In the UK, for example, plans to continue violating the moratorium were thwarted when dockworkers’ unions refused to handle the waste material.⁹⁹

Russia blatantly violated the moratorium. A 1993 report disclosed that the Soviet Union and Russia had both dumped routinely and that Russia planned to continue.¹⁰⁰ In October 1993, Russia dumped hundreds of tons in the Sea of Japan with no attempt at concealment.¹⁰¹ When denounced by Greenpeace for violating international law, Russia’s Environment Minister replied (correctly) that there was no violation because there was no ban in the Convention, the moratorium was voluntary, and in any case, Russia had not joined it.¹⁰²

The new expert panel did little to resolve the dispute. Its 1993 report found no evidence of significant harm from dumping but paired this finding with general statements on the need to protect the marine environment, so it could be interpreted either to support or oppose dumping.¹⁰³ By

⁹⁴ See Steven D. Lavine, *Russian Dumping in the Sea of Japan*, 24 DENV. J. INT’L L. & POL’Y 417, 435 (1996); Japan also made two land-based releases of treated but detectably radioactive wastewater from the Fukushima accident (not covered by the LC or LP), most recently in 2023. Victoria Cruz-De Jesus, *Preserving the Sea in a Radioactive World: How Japan’s Plan to Release Treated Nuclear Wastewater into the Pacific Ocean Violates UNCLOS*, 37 Am. U. Int’l L. Rev. 1005 (2022).

⁹⁵ See OFF. OF RADIATION PROGRAMS, U.S. ENVTL. PROT. AGENCY, FACT SHEET ON OCEAN DUMPING OF RADIOACTIVE WASTE MATERIALS 3 (1980). *But see Oceans Suggested as Dumps*, N.Y. TIMES, July 24, 1984, at B20.

⁹⁶ Res. LDC.21(9), *Dumping of Radioactive Wastes at Sea*, annex 4, LDC 9/12 (Oct. 18, 1985), [http://www.imo.org/en/KnowledgeCentre/IndexofIMOResolutions/London-Convention-London-Protocol-\(LDC-LC-LP\)/Documents/LDC.21\(9\).pdf](http://www.imo.org/en/KnowledgeCentre/IndexofIMOResolutions/London-Convention-London-Protocol-(LDC-LC-LP)/Documents/LDC.21(9).pdf); Res. LDC.28(10), *Studies and Assessments Pursuant to Resolution LDC 21(9)*, annex 11, LDC 10/15 (Nov. 5, 1986), [http://www.imo.org/en/KnowledgeCentre/IndexofIMOResolutions/London-Convention-London-Protocol-\(LDC-LC-LP\)/Documents/LDC.28\(10\).pdf](http://www.imo.org/en/KnowledgeCentre/IndexofIMOResolutions/London-Convention-London-Protocol-(LDC-LC-LP)/Documents/LDC.28(10).pdf).

⁹⁷ See Lavine, *supra* note 94, at 427.

⁹⁸ See *id.* at 435, 437, 448; David E. Pitt, *Nations Back Ban on Atomic Dumping*, N.Y. TIMES, Nov. 13, 1993, at 7.

⁹⁹ See *Ban is Extended on Dumping of Hazardous Waste at Sea*, N.Y. TIMES, Feb. 26, 1984, at 18.

¹⁰⁰ See Yablokov, *supra* note 93.

¹⁰¹ David E. Sanger, *Nuclear Material Dumped Off Japan*, N.Y. TIMES, Oct. 19, 1993, at A1.

¹⁰² Lavine, *supra* note 94, at 427 (quoting *Press Conference by Viktor Danilov-Danilyan and Yuri Yarov, Candidates for the State Duma from the Political Bloc Vybor Rossii (Russia’s Choice) on Russian Federation Environmental Problems*, Official Kremlin International News Broadcast, Nov. 22, 1993).

¹⁰³ Kirsti-Liisa Sjöblom & Gordon Linsley, *Sea Disposal of Radioactive Wastes: The London Convention 1972*, 2 IAEA BULL. 12, 15 (1994).

that time, however, most parties had moved against dumping, allowing adoption of a 1993 amendment that banned all radioactive dumping, subject to review at 25-year intervals.¹⁰⁴ Five countries abstained—Russia, China, the United Kingdom, France, and Belgium—but none voted against the ban,¹⁰⁵ which was subsequently incorporated into the 1996 London Protocol.¹⁰⁶ Although they observed the moratorium, the United Kingdom, France, and Japan continued to argue that it was a needless concession to public fears and ocean dumping was the most environmentally sound disposal method.¹⁰⁷ Russia planned to keep dumping,¹⁰⁸ but accepted the ban in 2005 upon being promised Japanese aid to build a waste processing facility.¹⁰⁹

The initial moratorium was ostensibly a response to uncertain environmental risk, to be resolved based on risk assessment. But while the limited evidence suggested the risk was low, multiple assessments were unable to resolve the uncertainty and reach clear conclusions on risk. Opponents of dumping were able to make it costlier by broad political mobilization, while most countries had access to other disposal options of similar cost. Under continued pressure and without strong advantages for ocean dumping, even the strongest proponents eventually succumbed, despite the lack of progress in assessing risks. The moratorium thus hardened into a ban.

5. Commercial Whaling

In 1946, with uncontrolled whaling threatening the collapse of commercially important stocks, fifteen nations adopted the International Convention for the Regulation of Whaling (ICRW), which established the International Whaling Commission (IWC).¹¹⁰ The IWC's task was to ensure orderly management of whaling by setting catch limits, which were adopted or revised by three-quarters majority vote based on advice from a Scientific Committee.¹¹¹

Over subsequent decades whaling faced increasing challenges both from declining demand and from opposition by environmental groups, whose highly effective “Save the Whales” campaigns reflected concerns about both species survival and the ethics of whaling.¹¹² In the IWC, conflict was evident in both catch limit decisions and shifts in membership. Through the 1960s the

¹⁰⁴ Res. LC.51(16), Amendments to the Annexes to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 Concerning Disposal at Sea of Radioactive Wastes and Other Radioactive Matter, annex 5, LC 16/14 (Nov. 12, 1993); [http://www.imo.org/en/KnowledgeCentre/IndexofIMOResolutions/London-Convention-London-Protocol-\(LDC-LC-LP\)/Documents/LC.51\(16\).pdf](http://www.imo.org/en/KnowledgeCentre/IndexofIMOResolutions/London-Convention-London-Protocol-(LDC-LC-LP)/Documents/LC.51(16).pdf).

¹⁰⁵ Int'l Maritime Org. [IMO], Report of the Sixteenth Consultative Meeting of Contracting Parties to the London Convention, at ¶ 4.41, LC 16/14 (Dec. 15, 1993), http://www.imo.org/en/KnowledgeCentre/ReferencesAndArchives/IMO_Conferences_and_Meetings/London_Convention/LCandLDCReports/Documents/Report%20of%20LC%2016%20November%201993.pdf.

¹⁰⁶ 1996 Protocol to the 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, art. 4, Nov. 8, 1196, 36 I.L.M. 1 (1997).

¹⁰⁷ See Lavine, *supra* note 94, at 441-42.

¹⁰⁸ See Pitt, *supra* note 98.

¹⁰⁹ See Lavine, *supra* note 94, at 443-48.

¹¹⁰ International Convention for the Regulation of Whaling [hereinafter ICRW], Preamble, Dec. 2, 1946, 62 Stat. 1716, 161 U.N.T.S. 72.

¹¹¹ *Id.* at art. III(2).

¹¹² See PATRICIA W. BIRNIE, INTERNATIONAL REGULATION OF WHALING: FROM CONSERVATION OF WHALING TO CONSERVATION OF WHALES AND REGULATION OF WHALE-WATCHING (1985); see also Anthony D'Amato & Sudhir K. Chopra, *Whales: Their Emerging Right to Life*, 85 AM J. INT'L L. 21, 40-48 (1991).

IWC set limits far above Scientific Committee advice, even as whale populations declined and opposition strengthened.¹¹³ In 1972, the UN Conference on the Human Environment recommended a ten-year moratorium on whaling,¹¹⁴ and the United States banned trade in whale products.¹¹⁵ Although the IWC had been created by whaling states for their mutual benefit, their control of the body declined through the 1970s as anti-whaling states joined and the United States and Australia promoted a moratorium on commercial whaling.¹¹⁶

In 1982, anti-whaling members reached a three-quarters majority and set all commercial catch limits to zero.¹¹⁷ This *de facto* moratorium took effect in 1986, to be re-assessed in 1990 based on a Scientific Committee report on sustainable catch levels.¹¹⁸ But while the Treaty text and moratorium decision both state that catch limits should be based on scientific advice,¹¹⁹ the Scientific Committee had little influence on parties.¹²⁰ Although their 1990 report concluded that some stocks could be sustainably harvested,¹²¹ parties declined to lift the moratorium until new management procedures were adopted to ensure compliance with catch limits.¹²² This decision outraged whaling states and prompted the Scientific Committee's chair to resign.¹²³ Debate on these procedures has stalled since, as anti-whaling parties continue to block attempts to lift the moratorium.¹²⁴

The moratorium falls short of a full prohibition due to several exceptions, most importantly that it covers only commercial whaling, not research or aboriginal subsistence.¹²⁵ Moreover, parties may opt out of an IWC decision by objecting within ninety days.¹²⁶ Japan, Norway, the Soviet Union, and Peru filed objections to the moratorium, although Japan and Peru later withdrew theirs.¹²⁷ Iceland left the IWC in 1992, then rejoined in 2002 with a reservation to the moratorium

¹¹³ William C. Burns, *The International Whaling Commission and the Future of Cetaceans: Problems and Prospects*, 8 COLO. J. INT'L ENVTL. L. & POL'Y 31, 35-42 (1997).

¹¹⁴ Rep. of the United Nations Conference on the Human Environment, U.N. Doc. A/Conf. 48/14, Recommendation 33 at 12, (1972).

¹¹⁵ See, e.g., 50 C.F.R. § 17.11; Marine Mammal Protection Act of 1972, Pub. L. No. 92-522, 86 Stat. 1027 (1972) (codified as amended at 16 U.S.C. §§ 1361-1421).

¹¹⁶ See Lieberman et al., *supra* note 1, at 525.

¹¹⁷ See INT'L WHALING COMM'N, Schedule 2018 –as amended by the Commission at the 67th Meeting, September 2018 [hereinafter IWC Schedule], ¶ 6, The resolution passed by a vote of 25 to 7, with 5 abstentions. THIRTY-THIRD REPORT OF THE INTERNATIONAL WHALING COMMISSION 21 (1983).

¹¹⁸ IWC Schedule, *supra* note 117, at ¶ 10(d)-(e).

¹¹⁹ THIRTY-THIRD REPORT OF THE INTERNATIONAL WHALING COMMISSION, *supra* note 117, at 20-21; ICRW, *supra* note 110, at art. V(2).

¹²⁰ See A.W. Harris, *The Best Scientific Evidence Available: The Whaling Moratorium and Divergent Interpretations of Science*, 29 WM. & MARY ENVT. L. & POL'Y REV. 375, 377 (2005).

¹²¹ See *Report of the Scientific Committee*, 41 REP. INT'L WHALING COMM'N 51, 62-63 (1991), <https://archive.iwc.int/?r=2106>.

¹²² See *generally Revised Management Procedure (RMP)*, INT'L WHALING COMM'N, <https://iwc.int/rmp> (last visited Mar. 8, 2019).

¹²³ See David D. Caron, *The International Whaling Commission and the North Atlantic Marine Mammal Commission: The Institutional Risks of Coercion in Consensual Structures*, 89 AM. J. INT'L L. 154, 162-67 (1995).

¹²⁴ See *Revised Management Procedure (RMP)*, *supra* note 122.

¹²⁵ ICRW, *supra* note 110, at art. VIII; IWC Schedule, *supra* note 117, at ¶ 10(d)-(e).

¹²⁶ ICRW, *supra* note 110, at art. V(3)(a).

¹²⁷ IWC Schedule, *supra* note 117, ¶ 10(e) (accompanying note).

whose legality is disputed.¹²⁸ Norway resumed whaling in 1993, as its objection allowed. Norway also joined Iceland, Greenland, and the Faroe Islands in an effort to establish a new international whaling institution separate from the IWC.¹²⁹

Japan continued whaling under the moratorium, initially based on its objection then later at lower catch levels under the scientific research exception.¹³⁰ Japan continued this scientific program despite a 2014 loss in an ICJ case brought by Australia¹³¹ and repeated statements by the Scientific Committee that the catch had no scientific justification, although the Committee also noted that the Minke whales Japan proposed to catch were not at risk of extinction.¹³² After years of conflict, Japan announced in December 2018 that it would withdraw from the IWC and stop whaling in international waters, while continuing to hunt in Japanese waters.¹³³

The moratorium thus remains in place, while the most determined opponents continue whaling via several legal pathways – including objection, reservation, the research exemption, or withdrawal from the treaty — although with much lower catch than before the moratorium.¹³⁴ This standoff reflects ongoing conflict over whether limits must be based only on extinction risk or may also reflect broader environmental and moral concerns. The intensity of conflict, including occasional violent confrontations at sea,¹³⁵ has spurred speculation that the regime is not sustainable.¹³⁶ It has also been proposed that the withdrawal of Japan, the strongest objector, may strengthen support among remaining parties to continue the moratorium or harden it into a full ban.¹³⁷

This moratorium reflects a shift over time in the aims of the Convention and IWC. Their initial

¹²⁸ See *Iceland and Commercial Whaling*, INT’L WHALING COMM’N, <https://iwc.int/Iceland>.

¹²⁹ See Agreement on Cooperation in Research, Conservation and Management of Marine Mammals in the North Atlantic, Apr. 9, 1992, 1945 U.N.T.S. 3.

¹³⁰ See Burns, *supra* note 113, at 45, 49, 80; see also Whaling in the Antarctic (Austl. v. Japan: N.Z. Intervening), Judgment, 2014 I.C.J. Rep. 226 (March 31); ASSOC. PRESS IN TOKYO, *Japan Plans Unilateral Restart to Antarctic Whaling in 2015, Says Official*, GUARDIAN (June 20, 2015, 1:12 PM), <http://www.theguardian.com/environment/2015/jun/20/japan-plans-unilateral-restart-to-antarctic-whaling-in-2015-says-official>.

¹³¹ Austl. v. Japan: N.Z. Intervening, 2014 I.C.J. at 299-300.

¹³² See Phillip J. Clapham, *Japan Disregards Whaling Review Again*, 547 NATURE 32, 32 (2017); Dennis Normile, *Japan’s Exit From Whaling Group May Benefit Whales*, 363 SCIENCE 110, 110 (2019).

¹³³ *Statement on Government of Japan Withdrawal from the IWC*, INT’L WHALING COMM’N (Jan. 14, 2019), <https://iwc.int/statement-on-government-of-japan-withdrawal-from-t>. In 2021, Japanese vessels took a total of about 400 Minke, Bride’s, and Sei whales in Japanese waters. See Whale and Dolphin Conservation: Whaling in Japan, <https://us.whales.org/our-4-goals/stop-whaling/whaling-in-japan/>.

¹³⁴ See *Catches taken: under objection or under reservation, Catches under objection or under reservation since 1985*, INT’L WHALING COMM’N, https://iwc.int/table_objection (last visited Mar. 10, 2019); *Icelandic Company to Resume Commercial Hunting of Fin Whales*, PRESS HERALD (Apr. 17, 2018), <https://www.pressherald.com/2018/04/17/icelandic-company-to-resume-commercial-hunting-of-fin-whales/>; Henry Samuel, *Norway Sparks Outcry by Raising Whaling Quota*, TELEGRAPH (Mar. 7, 2018), <https://www.telegraph.co.uk/news/2018/03/07/norway-sparks-outcry-raising-whaling-quota/>.

¹³⁵ See, e.g., *Wars over Whaling*, JAPAN TIMES (Jan. 15, 2012), <https://www.japantimes.co.jp/opinion/2012/01/15/editorials/wars-over-whaling/#.XIL67y3MzVo>; *Sea Shepherd Accuses Japanese Whalers of ‘Aggressive’, ‘Ruthless’ Confrontation*, GUARDIAN (Feb. 2, 2014), <https://www.theguardian.com/environment/2014/feb/02/sea-shepherd-accuses-japanese-confrontation-whaling>.

¹³⁶ See, e.g., Lieberman et al., *supra* note 1, at 528; Oran R. Young et al., *Subsistence, Sustainability, and Sea Mammals: Reconstructing the International Whaling Regime*, 23 OCEAN & COASTAL MGMT. 117, 124 (1994).

¹³⁷ *Save the Whales, Again*, 565 NATURE 133, 133 (2019).

and official purpose was to limit catch to sustainable levels based on scientific assessments, but differently motivated, more categorical opposition emerged over time. Moratorium supporters were outraged at prior catch levels set far above scientific recommendations. Yet in continuing the moratorium they also ignore Scientific Committee advice that some species are not endangered, since their objections to whaling are not based on extinction risk. The result has been escalating conflict from contending efforts to use the institution to advance incompatible values. Scientific risk assessment, which addresses only one of those contending values, is largely ignored.

6. Moratoria under Trade Treaties in the World Trade Organization (WTO)

Treaty negotiators must often deal with contentious issues on the boundary of their negotiations, matters relevant to a treaty or its expected benefits but not yet ripe for explicit inclusion in its provisions. Such issues typically arise in fast-changing areas marked by high uncertainty, including negotiation of trade treaties, where they may jeopardize negotiations on related matters but not yet be fully resolvable. Moratoria are often proposed as responses to such issues, either explicitly within a treaty being negotiated or enacted in parallel. We summarize two prominent examples: non-violation complaints under the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS),¹³⁸ and customs duties on electronic commerce.

a. Intellectual Property Non-Violation Complaints

Several world trade treaties, including the foundational General Agreement on Tariffs and Trade (GATT), allow states to make “non-violation complaints.” Such complaints address state actions that impair a reasonably expected benefit of the treaty but do not violate an explicit treaty obligation.¹³⁹ Trade treaties generally allow such complaints, recognizing that a wide range of policies not explicitly included in a treaty can distort competition between domestic and imported goods and frustrate the treaty’s goals.¹⁴⁰ Such complaints are especially controversial for intellectual property (IP) rights, for which the 1994 Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) aims to set minimum international standards for protection of IP rights.¹⁴¹

Some large technology exporters, including the United States and Switzerland, view non-violation complaints as necessary to prevent parties from undermining TRIPS by narrow interpretations of its scope.¹⁴² Others argue that non-violation complaints violate the principle that a state

¹³⁸ U.N. CONF. ON TRADE & DEVELOPMENT & INT’L CTR. FOR TRADE & SUSTAINABLE DEVELOPMENT [hereinafter UCTAD-ICTSD], RESOURCE BOOK ON TRIPS AND DEVELOPMENT 674-75, 680-82 (2005).

¹³⁹ See, e.g., General Agreement on Tariffs and Trade, arts. XXII & XXIII, Oct. 30, 1947, 61 Stat. A-11, 55 U.N.T.S. 194; Marrakesh Agreement Establishing the World Trade Organization, Annex 1A, Apr. 15, 1994, 1867 U.N.T.S. 187; General Agreement on Trade in Services, art. XXIII(3), Apr. 15, 1994, Marrakesh Agreement Establishing the World Trade Organization, Annex 1B, 1869 U.N.T.S. 183.

¹⁴⁰ Frieder Roessler & Petina Gappah, *A Re-Appraisal of Non-Violation Complaints Under the WTO Dispute Settlement Procedures*, in THE WORLD TRADE ORGANIZATION: LEGAL, ECONOMIC AND POLITICAL ANALYSIS 1371, 1374 (Patrick F. J. et al. eds., 2005).

¹⁴¹ See Agreement on Trade-Related Aspects of Intellectual Property Rights, art. 64.2, Apr. 15, 1994, 33 I.L.M. 1125 [hereinafter TRIPS]; UCTAD-ICTSD, *supra* note 138, at 663-64. See also Peter K. Yu, *The Objectives and Principles of the Trips Agreement*, 46 Hous. L. Rev. 979, 980 (2009).

¹⁴² UCTAD-ICTSD, *supra* note 138, at 663; TRIPS: ‘Non-Violation’ Complaints (Article 64.2) Background and Current Situation, WORLD TRADE ORG., http://www.wto.org/english/tratop_e/trips_e/nonviolation_background_e.htm (last visited Nov. 20, 2015).

cannot be legally bound without its consent, by creating *de facto* standards stricter than states have accepted in negotiations.¹⁴³ For example, some EU states feared the United States might use non-violation complaints to demand access to their markets, when TRIPS only provides protection of IP rights within foreign markets, not market access.¹⁴⁴ Developing countries feared complaints against their drug pricing policies, even though TRIPS does not restrict price controls.¹⁴⁵

After long debate on non-violation complaints made little progress and threatened to derail adoption of the treaty, TRIPS negotiators deferred the conflict by subjecting the complaints to a five-year moratorium.¹⁴⁶ Since then parties have simply extended the moratorium without discussion at each biennial Ministerial Conference, most recently in 2024.¹⁴⁷ Although the underlying conflict thus remains unresolved, the moratorium's provisional character made it more acceptable to the IP-rich minority than either an outright concession or continued conflict, in part because it provided evidence on how costly the concession would be, without long-term commitment. Although the moratorium represents an ongoing partial victory for opponents of non-violation complaints, its repeated pro forma renewal suggests that the NVC opponents are finding the cost acceptable and the moratorium may thus gradually harden into a prohibition.¹⁴⁸

b. Customs Duties on Electronic Commerce

The WTO began developing trade rules for electronic commerce at its second ministerial conference in 1998.¹⁴⁹ To promote growth and innovation in this rapidly expanding field, Ministers adopted a moratorium on customs duties on electronic transactions.¹⁵⁰ The United States supported the moratorium along with the EU and other industrialized countries, despite emerging EU-US disagreements on broader issues in e-commerce trade law. The moratorium's impact was unclear, due to uncertainty about both the administrative feasibility of levying duties on e-commerce and the scope of the moratorium.¹⁵¹ While it clearly did not bar duties on physical goods traded via e-commerce, whether it covered only transmission services or also trade in digital content or services rendered through e-commerce was ambiguous and contested.

The moratorium has been repeatedly extended, even while disagreement over the treatment

¹⁴³ See UCTAD-ICTSD, *supra* note 138, at 663-64, 674-75.

¹⁴⁴ Frederick M. Abbott, *TRIPS in Seattle: The Not-So-Surprising Failure and the Future of the TRIPS Agenda*, 18 BERKELEY J. INT'L L. 165, 172-73 (2000).

¹⁴⁵ *Id.* at 172.

¹⁴⁶ UCTAD-ICTSD, *supra* note 138, at 663-64; see TRIPS, *supra* note 141, at art. 64.2.

¹⁴⁷ Ministerial Decision, "TRIPS Non-Violation and Situation Complaints," 2 March 2024, WT/L/1194, at https://www.wto.org/english/tratop_e/trips_e/nonviolation_e.htm.

¹⁴⁸ Nirmalya Syam, Non-Violation and Situation Complaints under the TRIPS Agreement: Implications for Developing Countries, South Centre Research Paper No. 109 (May 2020), <https://www.southcentre.int/wp-content/uploads/2020/05/Rp-109.pdf>; Catherine Saez, *Buenos Aires Ministerial Not the End of the Road*, WTO Director Tells Reporters, INTELL. PROP. WATCH (Nov. 11, 2017), <http://www.ip-watch.org/2017/11/28/buenos-aires-ministerial-not-end-road-wto-director-tells-reporters/>.

¹⁴⁹ SACHA WUNSCH-VINCENT, *THE WTO, THE INTERNET AND TRADE IN DIGITAL PRODUCTS: EC-US PERSPECTIVES* 37-43 (2006).

¹⁵⁰ World Trade Organization, Geneva Ministerial Declaration on Global Electronic Commerce of 20 May 1998, WTO Doc. WT/MIN(98)/DEC/2, https://www.wto.org/english/tratop_e/ecom_e/mindecl_e.htm.

¹⁵¹ See WUNSCH-VINCENT, *supra* note 149, at 36, Table 2.1.

of duties on e-commerce has deepened.¹⁵² The US and Japan have proposed converting the moratorium to a permanent ban, with broad scope in the trade and policies it covers.¹⁵³ The EU has argued for keeping it temporary pending broad agreement on the treatment of e-commerce.¹⁵⁴ Developing countries, which initially took no strong view on the moratorium, have more recently called to abolish it because it denies them a potential revenue source with no offsetting benefits.¹⁵⁵ In a contentious discussion at the 13th Ministerial Conference in 2024, it was agreed to extend the moratorium once more, now with an explicit deadline at which it will expire unless renewed.¹⁵⁶

Both these moratoria allowed negotiating an agreement when one disputed area threatened the whole deal or associated benefits. In each case parties had views about whether the disputed actions would benefit or harm them, but there was substantial uncertainty about how the actions would be used and the magnitude of their effects. The moratoria deferred resolution of the contested issues, but even as provisional suspensions they represented partial victories for those who opposed the contested actions – IP importers in the TRIPS case, e-commerce exporters in the duties case. Over time, parties took no explicit steps to advance knowledge or agreement under the moratorium but gained experience of the effects of barring the contested activity, which were not extreme. Passage of time has strengthened the opponents of NVCs, as repeated *pro forma* extensions have brought the moratorium closer to a *de facto* prohibition; but has strengthened supporters of e-commerce duties as states learn about the scale of revenues foregone, culminating in the 2024 decision to shift the default outcome to expiry by 2026 absent explicit further extension.

7. Bilateral Resource Exploitation Moratoria

Although most international land boundaries are long settled, disputes over offshore boundaries still occur periodically. The stakes can be high when disputed areas contain high-value fisheries or sub-seabed resources, particularly as new resources are discovered, scarcity of substitutes increases their value, and technical ability to exploit them advances. Negotiating agreements on such disputes takes time, raising concerns that some state or private actor may rush in to take the resources while ownership and control remain ambiguous. Moratoria on resource exploitation in contested areas are frequently proposed to ease these concerns and support negotiated agreement over resource allocation and management. Of many similar examples, we note highlights of three cases.

¹⁵² World Trade Organization, Work Programme on Electronic Commerce, General Council Decision (adopted Dec. 10, 2019), <https://docs.wto.org/dol2fe/Pages/SS/directdoc.aspx?filename=q:/WT/L/1079.pdf&Open=True>. Disagreements have included the legal status of the moratorium. Between the failure to explicitly renew the moratorium at the 1999 Seattle conference and its explicit renewal at Doha in 2001 (and every conference since), the EU and several developing countries claimed the moratorium had lapsed while the US argued it remained in force. See WUNSCH-VINCENT, *supra* note 149, at 41.

¹⁵³ Submission by the United States, *Work Programme on Electronic Commerce*, WTO Doc. WT/COMTD/17 (Feb. 12, 1999).

¹⁵⁴ European Commission (2000e), 3-4 and 10-11, cited note 36 Wunsch-Vincent, p. 42.

¹⁵⁵ Committee on Trade and Development, Participation of the Developing Countries in the Global Trading System, WTO Doc. WT/COMTD/W/100 (June 19, 2002).

¹⁵⁶ Expiry will be at the next Ministerial Conference or on 31 March 2026, whichever comes first. WTO, Ministerial Decision 2 Mar. 2024, *Work Programme on Electronic Commerce*, WT/MIN(24)/38; WT/L/1193, <https://docs.wto.org/dol2fe/Pages/SS/directdoc.aspx?filename=q:/WT/MIN24/38.pdf&Open=True>

a. Barents Sea Mineral Resources

After a long-standing dispute, Norway and the Soviet Union began negotiations in the 1980s to resolve their maritime boundary in the Barents Sea. As they started negotiation, they put a moratorium on mineral and energy development in the disputed area.¹⁵⁷ An agreement on the boundary, now between Norway and Russia, was achieved in 2010, at which point the moratorium was lifted.¹⁵⁸

b. Torres Strait Mining and Drilling

A treaty between Australia and Papua New Guinea (PNG) to define maritime boundaries in the Torres Strait was signed in 1978 and entered into force in 1985.¹⁵⁹ The treaty created a trans-boundary protected area where Strait inhabitants' free movement and fishing were protected but mining and drilling were subject to a ten-year moratorium.¹⁶⁰ The moratorium affected the allocation and management of all Strait resources, but Parties' interests differed in their relative valuation of different resources: PNG and Straits inhabitants prioritized fisheries and marine ecosystems, while Australia put higher value on mineral and energy resources and sought to preserve options for their future development. Since the moratorium delayed development of one type of resource to protect the other, parties differed over what to do when the initial 10-year period ended: Australia proposed a 5-year extension, PNG an indefinite one.¹⁶¹ They agreed on three successive short-term extensions while continuing to negotiate a conservation plan for Strait resources, then extended the moratorium to an indefinite ban when this plan was completed in 2008.¹⁶²

c. U.S.-Mexico Transboundary Oil and Gas Reservoirs

When the United States and Mexico adopted a maritime boundary Treaty in 1978,¹⁶³ two high-seas areas in the Gulf of Mexico were enclosed by the two nations' exclusive economic zones.

¹⁵⁷ Valery Konyshchev & Alexander Sergunin, *Russia's Policies on the Territorial Disputes in the Arctic*, 2 J. INT'L REL. & FOREIGN POL'Y 55, 66 (2014); *Delimitation Agreement: A New Era In the Barents Sea and the Arctic?*, ARTIC FORUM FOUND., <http://eu-arctic-forum.org/allgemein/delimitation-agreement-a-new-era-in-the-barents-sea-and-the-arctic/> (last visited Mar. 14, 2019).

¹⁵⁸ *Norway and Russia officially split Barents Sea*, WORLD OIL (Feb. 2, 2011).

¹⁵⁹ Henry Burmester, *The Torres Strait Treaty: Ocean Boundary Delimitation by Agreement*, 76 AM. J. INT'L L. 321, 322 (1982).

¹⁶⁰ Treaty Between Australia and the Independent State of Papua New Guinea Concerning Sovereignty and Maritime Boundaries in the Area Between the Two Countries, Including the Area Known as Torres Strait, and Related Matters, Austl.-Papua N.G., Dec. 18, 1978, [1985] A.T.S. 4 (entered into force Feb. 15, 1985) [hereinafter *Torres Strait Treaty*]; *The Torres Strait Treaty*, AUSTRALIAN GOVERNMENT: DEPARTMENT OF FOREIGN AFFAIRS AND TRADE, <https://dfat.gov.au/geo/torres-strait/Pages/the-torres-strait-treaty.aspx> (last visited July 9, 2018); See also Burmester, *supra* note 158, at 331.

¹⁶¹ Kym Seebohm & Gerry Morvell, *Towards an Integrated Sustainable Development Management Strategy for Torres Strait*, 36 AUSTL. GEOGRAPHICAL STUD. 82, 89 (1998).

¹⁶² *18th Papua New Guinea-Australia Ministerial Forum Joint Statement*, AUSTL. GOV'T: DEP'T OF FOREIGN AFF. & TRADE (April 23, 2008), http://dfat.gov.au/news/news/Documents/18_forum_joint_statement.pdf.

¹⁶³ Treaty on Maritime Boundaries between the United States of America and the United Mexican States, Mex.-U.S., May 4, 1978, 17 I.L.M. 1073 (1978).

One of these, the “Western Gap,” appeared to hold large oil and gas resources.¹⁶⁴ While these were initially not feasible to exploit, advances in deep-water drilling by the 1990s raised U.S. producers’ interest in developing sites in the gap.¹⁶⁵ At that time Mexico’s state oil company Pemex lacked technology and capital for deep-water exploration but was legally barred from partnering with foreign firms to gain these resources.¹⁶⁶ With treatment of transboundary resources unresolved, Mexico feared U.S. companies would drain reservoirs in the gap by drilling from the U.S. side.¹⁶⁷

In 1997, the United States announced it would not lease tracts in the Western Gap until the two countries reached agreement on its resources. Negotiations began soon after and produced the Western Gap Treaty in 2000. The Treaty created a framework for cooperative resource development and put a ten-year moratorium on drilling in a buffer zone on each side of the boundary, later extended to 2014.¹⁶⁸ A second treaty, adopted in 2012, established a more specific resource development regime and ended the moratorium.¹⁶⁹ The two moratoria helped support negotiated agreement over the trans-boundary resources. The first US unilateral moratorium eased Mexican concerns about cross-border drilling and so facilitated its ratification of the 2000 treaty,¹⁷⁰ while both moratoria allowed time to build support for letting Pemex enter foreign partnerships.¹⁷¹

In these three cases, parties sought to agree on allocation and management of cross-boundary resources, but exploitative activities threatened to obstruct negotiated agreement and potentially harm the resources. Moratoria muted these threats and allowed negotiated agreement on how to divide and manage the resources. The subsequent dispositions differed, reflecting the distinct conditions of each case: in Barents, an end to the moratorium when resources were fully allocated with no remaining trans-boundary issues; in Torres Strait, an indefinite extension of the moratorium based on parties’ agreement to prioritize biological resources over minerals; and in the Western Gap, replacement of the moratorium by a joint regime allocating and regulating the resource when significant trans-boundary interdependencies remained.

¹⁶⁴ S. Exec. Rep. No. 105-4 (1997).

¹⁶⁵ See Miriam Grunstein, Richard McLaughlin & Luis Anastacio Gutiérrez, *Gulf of Mexico Offshore Transboundary Hydrocarbon Development: Legal Issues Between Mexico & the U.S.*, HOUS. LAW. MAG., Nov.-Dec. 2012, at 22.

¹⁶⁶ CLARE RIBANDO SEELKE ET AL., CONG. RESEARCH SERV., R43313, MEXICO’S OIL AND GAS SECTOR: BACKGROUND, REFORM EFFORTS, AND IMPLICATIONS FOR THE UNITED STATES, CONG. RESEARCH 2-3 (2015).

¹⁶⁷ Jose A. Vargas, *The 2012 U.S.-Mexico Agreement on Transboundary Hydrocarbon Reservoirs in the Gulf of Mexico: A Blueprint for Progress or a Recipe for Conflict?*, 14 SAN DIEGO INT’L L. J. 3, 37 (2012).

¹⁶⁸ Treaty on the Delimitation of the Continental Shelf in the Western Gulf of Mexico Beyond 200 Nautical Miles, Mex.-U.S., art. 1, June 9, 2000, 2143 U.N.T.S. 417 [hereinafter Western Gap Treaty]. See also Dabney Welsh, *Access to Our Backyard Reserves: A Final Resolution of the Western Gulf of Mexico’s Maritime Boundaries*, 23 HOUS. J. INT’L L. 609, 651-52 (2001).

¹⁶⁹ Agreement between the United States of America and the United Mexican States Concerning Transboundary Hydrocarbon Aquifers in the Gulf of Mexico, Mex.-U.S., Feb. 20, 2012 [hereinafter 2012 Transboundary Agreement], <https://www.boem.gov/US-Mexico-Transboundary-Reservoirs-Agreement/>; Resolution Making Continuing Appropriations, Pub. L. No. 113-67, §303, 127 Stat. 1165, 1181 (2013) (approving the 2012 Transboundary Agreement).

¹⁷⁰ Vargas, *supra* note 167, at 41.

¹⁷¹ SEELKE ET AL., *supra* note 166, at 68-69.

B. Moratoria for Controversial Science and Technology

This section reviews five cases of moratoria in another area where moratoria are frequently proposed: controversial scientific research or technology development. Where the cases discussed in the previous section were all diplomatic conflicts with national governments as the principal actors, these involve more diverse actors: governments in their roles as research funders, plus various national and trans-national organizations, and sometimes significant roles for individuals. While our cases all pertain to biomedical research and applications, this reflects the concentration of research controversies in recent decades, which is presently broadening as other various areas of life, physical, earth, computational science increase in disruptive potential and controversy.

1. Recombinant DNA Research

By the early 1970s, advances in understanding the molecular basis of genetics and associated experimental methods made it possible to combine genetic material from different species, in so-called “recombinant DNA” (rDNA) research.¹⁷² The methods promised great advances in research and medicine, but raised concerns about altered organisms escaping the lab, as well as potential misuse of the new ability to manipulate the genetic basis of life.¹⁷³ After discussions at a June 1973 scientific conference, a group of leaders in the field asked the National Academy of Sciences (NAS) to form a committee to assess risks of rDNA research and recommend control measures.¹⁷⁴ The committee’s July 1974 report called on the National Institutes of Health (NIH) to develop operational guidelines to control research risks.¹⁷⁵ It also called for a voluntary moratorium, proposing that:

until potential hazards of [rDNA] molecules have been better evaluated or until adequate methods are developed for preventing their spread, scientists throughout the world join with the members of this committee in voluntarily deferring [two] types of experiments [judged most hazardous].¹⁷⁶

The moratorium’s aim was to allow time to convene an international meeting to further consider risks and responses.¹⁷⁷ Although some researchers believed the risks did not warrant the moratorium, it was universally observed.¹⁷⁸ The proposed meeting took place at Asilomar, California in February 1975 and included international scientists, lawyers, officials, and journalists.¹⁷⁹ The meeting report recommended a tiered set of lab safety measures for different types of experiment

¹⁷² See, e.g., D.A. Jackson, R.H. Symons & P. Berg, *Biochemical Method for Inserting New Genetic Information into DNA of Simian Virus 40: Circular SV40 DNA Molecules Containing Lambda Phage Genes and the Galactose Operon of Escherichia coli*, 69 PROC. NAT’L ACAD. SCI. 2904 (1972); J.E. Mertz & R.W. Davis, *Cleavage of DNA by R1 Restriction Endonuclease Generates Cohesive Ends*, 69 PROC. NAT’L ACAD. SCI. 3370 (1972).

¹⁷³ See *id.*; Paul Berg & Maxine F. Singer, *The Recombinant DNA Controversy: Twenty Years Later*, 92 PROC. NAT’L ACAD. SCI. 9011, 9011 (1995); Paul Berg & Janet E. Mertz, *Personal Reflections on the Origins and Emergence of Recombinant DNA Technology*, 184 GENETICS 9 (2010).

¹⁷⁴ Maxine Singer & Dieter Soll, *Guidelines for DNA Hybrid Molecules*, 181 SCIENCE 1114 (1973).

¹⁷⁵ *Id.*

¹⁷⁶ The committee’s letter report was simultaneously published as Paul Berg et al., *Potential Biohazards of Recombinant DNA Molecules*, 185 SCIENCE 303 (1974).

¹⁷⁷ *Id.*

¹⁷⁸ Berg & Singer, *supra* note 173.

¹⁷⁹ *Id.*

based on estimated risks,¹⁸⁰ with two types remaining under a moratorium that were judged too risky given existing control capabilities.¹⁸¹ With these measures in place, rDNA research other than these two types could resume. Like the initial moratorium, this narrowing of its scope was adopted over strong minority objections.¹⁸² Berg recounts, “[s]ome scientists, and public officials . . . were certain that recombinant DNA research was flirting with disaster and lifting the moratorium was a blunder. . . .”¹⁸³

NIH had already formed an rDNA Advisory Committee (RAC) to develop controls for US federally funded research, which began work on the last day of the Asilomar meeting.¹⁸⁴ Although NIH only had authority over federally funded research, the RAC expected that other funders and researchers would follow its guidance. To move quickly while the voluntary Asilomar measures still had strong support, and to maintain future flexibility,¹⁸⁵ NIH issued guidelines rather than binding regulations, initially in June 1976.¹⁸⁶ As expected, all federal agencies adopted the guidelines, as did most private biotechnology firms – who were eager to signal responsible conduct to avoid tighter controls being proposed in Congress.¹⁸⁷

The moratorium was a voluntary response by researchers to uncertain, high-stakes risks, adopted to gain time to assess risks and develop management practices. Despite disagreement over the need for a moratorium, all researchers observed it.¹⁸⁸ This response reflected both a precautionary stance toward potentially severe risks,¹⁸⁹ and an effort to avoid more burdensome externally imposed controls by managing risks proactively.¹⁹⁰ As it became clear that direct risks of research were less than initially thought, NIH revised the guidelines in 1978 and several times since, until concluding in 2019 that rDNA research no longer required specific controls beyond general research safety practices.¹⁹¹ These processes of risk assessment and control did not, however, address broader concerns initially raised about rDNA research, about societal disruption, or

¹⁸⁰ Paul Berg et al., *Summary Statement of the Asilomar Conference on Recombinant DNA Molecules*, 72 PROC. NAT’L ACAD. SCI. 1981, 1982 (1975).

¹⁸¹ The exceptions were rDNA from highly pathogenic organisms and experiments using more than 10 liters of culture. *Id.* at 1983.

¹⁸² Berg & Singer, *supra* note 173, at 9011.

¹⁸³ *Id.*

¹⁸⁴ D.S. Fredrickson, *A History of the Recombinant DNA Guidelines in the United States*, in RECOMBINANT DNA AND GENETIC EXPERIMENTATION 151, 152 (W. J. Whelan & Joan Morgan eds., 1979).

¹⁸⁵ H. DeWitt Stetten, *The Early History of the Recombinant DNA Molecule Program Advisory Committee of NIH*, in RECOMBINANT DNA AND GENETIC EXPERIMENTATION 157, 157-60 (Joan Morgan & W. J. Whelan eds., 1979).

¹⁸⁶ Fredrickson, *supra* note 184, at 152. See NIH Guidelines for Research Involving Recombinant DNA Molecules, 41 FED. REG. 27,902, 27,943 (July 7, 1976).

¹⁸⁷ See STAFF OF SUBCOMM. ON INVESTIGATIONS AND OVERSIGHT OF THE HOUSE COMM. ON SCI. & TECH., 98TH CONG., REP. ON THE ENVIRONMENTAL IMPLICATIONS OF GENETIC ENGINEERING 10 (Comm. Print 1984).

¹⁸⁸ Paul Berg, *Reflections on Asilomar 2 at Asilomar 3: Twenty-five Years Later*, 44 PERSP. IN BIO. & MED. 183, 184 (2001).

¹⁸⁹ Accord Fredrickson, *supra* note 184, at 156.

¹⁹⁰ *Id.*

¹⁹¹ National Institutes of Health, Notice of the Publication of Revised NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules, 2019.

other indirect effects of the knowledge and capabilities emerging from the research.¹⁹²

2. Human Fetal Research

Although medical research had been conducted since the 1920s on tissues from human fetuses following abortions or miscarriages, that research became controversial in the early 1970s in the United States after early elective abortions were legalized by *Roe v. Wade*.¹⁹³ Over the five decades since, a confused series of multiple moratoria, similar in aims but variable in scope, terms, and means of enactment, have sought to limit fetal, embryonic, and related research via restrictions on US research funding.¹⁹⁴

In response to post-*Roe* protests, the Department of Health, Education, and Welfare (HEW) suspended funding for research on living fetuses.¹⁹⁵ Congress codified this suspension as a four-month moratorium in 1974, to be reviewed following a report from the new National Commission for Protection of Human Subjects.¹⁹⁶ Based on this report, HEW enacted comprehensive human subjects regulations in August 1975. These kept the moratorium for research on living fetuses in utero, even immediately prior to abortion (with a waiver provision that was in practice virtually unusable), but lifted it for research on aborted non-viable fetuses.¹⁹⁷ After several failed efforts to enact tighter restrictions, Congress in 1985 suspended the waiver process for fetal research *in utero* for three years – turning the prior *de facto* moratorium into an explicit one – while leaving the treatment of post-abortion research on fetuses or fetal tissues unchanged.¹⁹⁸

This uneasily stable situation was disrupted by two developments in the early 1980s. First, advances in fertility treatment after the first human in-vitro fertilization (IVF) in 1978 weakened

¹⁹² See Paul Berg, *Asilomar and Recombinant DNA*, NOBEL PRIZE (Aug. 26, 2004), http://www.nobelprize.org/nobel_prizes/chemistry/laureates/1980/berg-article.html; See also Wivel NA. Historical perspectives on the NIH Recombinant DNA Advisory Committee. *Hum Gene Ther.* 2014;25(1):19-24. doi:10.1089/hum.2013.2524; Stefan Schafer and Sean Low, Asilomar moments: Formative framings in recombinant DNA and solar climate engineering research. *Phil Trans Royal Soc* 372 (2031), Dec 2014. DOI:10.1098/rsta.2014.0064

¹⁹³ *Roe v. Wade*, 410 U.S. 113 (Jan 22, 1973); D.C. Wertz, *Embryo and Stem Cell Research in the United States: History and Politics*, 9 *GENE THERAPY* 674, 674 (2002); see also John C. Fletcher, *The Stem Cell Debate in Historical Context*, in *THE HUMAN EMBRYONIC STEM CELL DEBATE: SCIENCE, ETHICS, AND PUBLIC POLICY* 27, 27 (Suzanne Holland et al. eds., 2001).

¹⁹⁴ Although medicine uses distinct names for different prenatal stages -- *embryo* up to eight weeks after fertilization, *fetus* thereafter -- most legal writing uses “fetus” for all prenatal stages. Fetal tissue from spontaneous abortions (miscarriages) is generally less useful for research because the abortions are often caused by genetic abnormalities and they often occur outside medical-care settings. V. Bonham, *Moratoria in Scientific Research: A Review*, *J. Health Care Law and Policy* 24:2, 223-248 (2022)

¹⁹⁵ Victor Cohn, “NIH vows not to fund fetus work,” *Washington Post* (April 13, 1973), p. A1. The National Institutes of Health (NIH), the main US government funder of biomedical research, was then part of the Department of Health, Education, and Welfare (HEW), which became the Department of Health and Human Services (HHS) after the creation of a separate Department of Education in 1979.

¹⁹⁶ National Research Act, Pub. L. No. 93–348, 88 Stat. 342 (1974); Regulations implementing the moratorium in FR 39:30962, 1974.

¹⁹⁷ 45 CFR 46:201-200; A controversial change from the Commission report was to let researchers maintain vital functions of non-viable fetuses post-abortion. See Barbara J. Culliton, “Fetal Research,” *Science* 190, 17 October 1975. See also Rachel Benson Gold and Dorothy Lehrman, Fetal research under fire: the influence of abortion politics. *Family Planning Perspectives* 21:1, Jan/Feb 1989, p. 6-11; Bonham, p. 233.

¹⁹⁸ Health Research Extension Act of 1985, Pub. L. No. 99-158, § 498, 99 Stat. 820, 877 (1985).

the moratorium’s practical effect.¹⁹⁹ IVF treatments, often done in private clinics with no Federal funding, created large numbers of leftover embryos of unclear legal status that were potentially available for research. Second, transplants of fetal tissue for treatment of diseases, which had been occasionally and unsuccessfully attempted since the 1920s, showed promise for treating Parkinson’s disease following 1988 studies in Mexico and Sweden.²⁰⁰ Potential clinical demand for fetal tissue if these benefits were confirmed raised the prospect, at least in theory, of planned pregnancy and abortion with the intent of providing tissue for transplant.

When NIH researchers proposed a study similar to those in Mexico and Sweden, HHS stopped all federal funding for fetal tissue transplant research from induced abortions. Abortion opponents sought to broaden this to all research using fetal tissue, but 1988 legislation merely extended the 1985 moratorium on *in utero* research two more years with no mention of fetal transplants – thereby leaving in place HHS’s administrative moratorium on transplant research. Although a NIH Advisory Panel recommended resuming this research to the incoming Bush administration, the new HHS Secretary extended the moratorium indefinitely in November 1989.²⁰¹

As one of its first acts, the Clinton Administration rescinded the HHS moratorium and proposed legislation that would allow funding research with fetal tissue from any abortion, subject to strict consent and documentation requirements similar to those in place since the 1975 regulations.²⁰² After this legislation passed in June 1993, Clinton partly reversed course with a December 1994 announcement, against the advice of another NIH Panel, that federal funds could not be used for research that creates embryos.²⁰³ The new Republican Congress took this further in 1995 via an appropriations rider, the Dickey-Wicker amendment, which barred federal funding for “the creation of a human embryo or embryos for research purposes; or research in which a human embryo or embryos are destroyed, discarded, or knowingly subjected to risk of injury or death greater than that allowed for research on fetuses in utero.”²⁰⁴ Congress has attached similar language to every subsequent HHS appropriation, continually renewing this funding moratorium.²⁰⁵

Scientific advances continued to shift the ground under the moratoria. In 1998, privately funded researchers at the University of Wisconsin isolated human embryonic stem cells (hESCs),

¹⁹⁹ Walter Sullivan, *Woman Gives Birth to Baby Conceived Outside the Body*, N.Y. TIMES, July 26, 1978, at 19.

²⁰⁰ Madrazo I, León V, Torres C, Aguilera MC, Varela G, Alvarez F, Fraga A, Drucker-Colín R, Ostrosky F, Skurovich M. Transplantation of fetal substantia nigra and adrenal medulla to the caudate nucleus in two patients with Parkinson’s disease. *N Engl J Med*. 1988;318:51; Lindvall O, Brundin P, Widner H, Rehnström S, Gustavii B, Frackowiak R, Leenders KL, Sawle G, Rothwell JC, Marsden CD. Grafts of fetal dopamine neurons survive and improve motor function in Parkinson’s disease. *Science*. 1990;247:574–577.

²⁰¹ Letter by HHS Secretary Louis Sullivan, Nov 2, 1989, to acting NIH Director William F. Raub. See James F. Childress, *Deliberations of the Human Fetal Tissue Transplantation Research Panel*, Biomedical Politics Institute of Medicine (US) Committee to Study Decision Making; Hanna KE, editor. Washington (DC): National Academies Press (US); 1991

²⁰² Federal Funding of Fetal Tissue Transplantation Research, 58 Fed. Reg. 7,457 (Jan. 22, 1993); *see also* NIH Revitalization Act of 1993, Pub. L. No. 103-43, § 121(c), 107 Stat. 122, 133 (1993). The law also criminalized commercial exchange of such fetal tissue or designating a specific recipient.

²⁰³ Warren E. Leary, Clinton rules out federal money for research on human embryos created for that purpose”, *NYT* Dec 3, 1994, pg. 8. *See also* Harold Varmus, *The Art and Politics of Science* (2009), 197-198.

²⁰⁴ Balanced Budget Down Payment Act, Pub. L. No. 104-99, § 128, 110 Stat. 26, 34 (1996).

²⁰⁵ *See* 42 U.S.C. § 289g (2019).

undifferentiated cells from early-stage embryos that can develop into any cell type.²⁰⁶ Stem cells' clinical promise drove another spike of interest in embryonic research,²⁰⁷ but because collecting the cells usually destroyed an embryo, most stem-cell research was ineligible for federal funding under Dickey-Wicker.²⁰⁸ NIH's first hESC guidelines, released in August 2000, loosened the moratorium by allowing funding for research on pre-existing cell lines created without Federal funds (in practice, embryos from IVF), while research producing or using new cell lines remained ineligible.²⁰⁹ The guidelines did not settle the matter, however, because they left the task of specifying which cell lines qualified to another committee and because the distinction they drew between new and pre-existing lines relied on a disputed interpretation of Dickey-Wicker language.²¹⁰

The 2000 election brought another change of course. In a 2001 rule the new Bush administration listed specific eligible pre-existing cell lines, but there were so few of these that pressure to weaken or work around the limits persisted.²¹¹ Bills to loosen the restrictions passed Congress but were vetoed by President Bush, while some states adopted separate measures to support research, including a 3 billion dollar program in California.²¹² Conflict persisted despite three advances that offered new ways to gain stem cells without violating the moratorium: the 2006 discovery of induced pluripotent stem cells (iPSC), which are formed from somatic cells without using embryos; the 2007 isolation of stem cells from amniotic fluid; and the 2008 announcement of a non-destructive method to extract stem cells from an embryo.²¹³

Further reversals followed each change of Administration. At the request of President Obama, NIH revised its guidelines in 2009 to allow funding for cell lines derived from previously donated

²⁰⁶ James A. Thomson et al., Embryonic Stem Cell Lines Derived from Human Blastocysts, 282 SCI. 1145 (1998); *See generally*, Michael J. Shamblott et al., *Derivation of Pluripotent Stem Cells from Cultured Human Primordial Germ Cells*, 95 PROC. NAT'L ACAD. SCI. 13726 (1998).

²⁰⁷ A majority of the U.S. public supported hESC research (*See Stem Cell Research*, GALLUP, <http://www.gallup.com/poll/21676/stem-cell-research.aspx> (last visited Mar. 14, 2019)), but religious groups were forcefully opposed (*See, e.g.*, CONGREGATION FOR THE DOCTRINE OF THE FAITH, INSTRUCTION DIGNITAS PERSONAE ON CERTAIN BIOETHICAL QUESTIONS (2008)).

²⁰⁸ J.C. Mountford, *Human Embryonic Stem Cells: Origins, Characteristics and Potential for Regenerative Therapy*, 18 TRANSFUSION MED. 1, 3-4 (2008).

²⁰⁹ NIH, Guidelines for Research Using Human Pluripotent Stem Cells, 65 Fed. Reg. 51976 (2000); David G. Zacharias et al., Impedance of Novel Therapeutics Technologies: The Case of Stem Cells, 5 C LINICAL & TRANSLATIONAL SCI. 422, 423-24 (2012)

²¹⁰ David Kennedy, "Two cheers for New Stem Cell Rules," Science 289:5484, p. 1469, 1 Sept, 2000; David Korn, "The NIH Guidelines on Stem Cell Research," Science 289:5486, p. 1877, 15 Sept, 2000; Paul Smaglik, "Embryo stem-cell work gets NIH go-ahead," Nature 406:p. 925, 2000;

²¹¹ President Bush's announcement claimed that 60 cell lines were available, but at that point fewer than a dozen had been described in scientific publications. *See Address to the Nation on Stem Cell Research*, 2 PUB. PAPERS 953-56 (Aug. 9, 2001); Exec. Order No. 13,435, 72 Fed. Reg. 34,591 (June 22, 2007); *See also* Gretchen Vogel, "US to Fund limited stem cell research", Science, 10 Aug, 2001.

²¹² *Proposition 71: California Stem Cell Research and Cures Initiative*, CAL. INST. REGENERATIVE MED., https://www.cirm.ca.gov/sites/default/files/files/about_cirm/prop71.pdf.

²¹³ *See* Kazutoshi Takahashi & Shinya Yamanaka, *Induction of Pluripotent Stem Cells from Mouse Embryonic and Adult Fibroblast Cultures by Defined Factors*, 126 CELL 663 (2006); *see also* Junying Yu et al., *Induced Pluripotent Stem Cell Lines Derived from Human Somatic Cells*, 318 SCIENCE 1917 (2007); De Coppi, P, Bartsch G, Jr, Siddiqui MM, et al. Isolation of amniotic stem cell lines with potential for therapy. Nat Biotech 2007;25(1):100-106; Young Chung et al., *Human Embryonic Stem Cell Lines Generated without Embryo Destruction*, 2 CELL STEM CELL 113 (2008).

IVF embryos, subject to strict requirements for donor consent and no reproductive use of the cells.²¹⁴ These looser guidelines survived several challenges, ending with a 2011 DC Circuit decision upholding the guidelines and the interpretation of Dickey-Wicker on which they relied.²¹⁵ The Trump administration adopted a series of explicit funding restrictions and procedural barriers in 2019 and 2020, whose scope was so broad and unclear as to threaten several previously uncontroversial research areas, such as studies on modified mice containing human-derived fetal tissue.²¹⁶ The Biden administration in turn reversed these in April 2021, largely restoring the rules in place under Obama.²¹⁷ Dickey-Wicker thus remains in place, significantly weakened, with little pressure for repeal or significant further change. Current federal funding rules are similar to those of 2009, with stronger consent procedures and bars on payment to embryo donors. NIH still only funds stem-cell research on approved lines, but these have grown rapidly and now number nearly 500.²¹⁸

This confused series of on-again, off-again moratoria targeted activities linked to intensely contested moral issues but did so indirectly, through restrictions on federal research funding. The main grounds for opposition were categorical moral or religious objections to creation, harm, or instrumental use of human embryos, which were deemed to merit moral consideration even immediately after fertilization or with no possibility of surviving. Other concerns related to consent, induced incentives, or commercial interests were advanced, but cannot account for the intensity of opposition, nor for opponents' disinterest in policy adjustments to address those concerns. These categorical objections limited the ability to mitigate conflict through compromise, so the moratorium was subject to multiple reversals as one side or the other gained political advantage.

Yet the moratorium's effectiveness was limited. It was clear throughout that federal funding restrictions cannot stop all research, but the moratorium's effects were also limited by confusion and dissent over its precise scope, and scientific advances.²¹⁹ Scope was repeatedly re-drawn in ways that appeared arbitrary and remained vulnerable to further advances. The resultant burdens on research were substantial and unevenly distributed, falling hardest on research too far from clinical use to attract private funding, although burdens have declined as the number of eligible

²¹⁴ See Exec. Order No. 13,505, 74 Fed. Reg. 10,667 (Mar. 11, 2009); National Institutes of Health Guidelines for Human Stem Cell Research, 74 Fed. Reg. 32,170 (July 7, 2009).

²¹⁵ See *Sherley v. Sebelius*, 689 F.3d 776 (D.C. Cir. 2012), *cert. denied*, 568 U.S. 1087 (2013); See also Jocelyn Kaiser, "NIH Wins Appeal of Stem Cell Injunction," *Science*, 29 April 2011, at <https://www.science.org/content/article/nih-wins-appeal-stem-cell-injunction>. The Circuit's decision relied on Chevron deference, deeming the operative text of the amendment ambiguous.

²¹⁶ Meredith Wadman and Jocelyn Kaiser, "Trump clamps down on fetal tissue research", *Science* 364:6445, 14 June 2019, 1016; *Science* 26 July 2019; Sara Reardon, "Trump administration halts fetal-tissue research by government scientists," *Nature* 570, 148 (5 July, 2019); Sheryl Gay Stolberg, "Trump ethics panel urges rejection of fetal tissue research," *New York Times*, Aug 18, 2020; Meredith Wadman, *New U.S. Ethics Board Rejects Most Human Fetal Tissue Research Proposals*, *Science* (Aug. 18, 2020),

²¹⁷ Kelly Servick, "NIH lifts restrictions on fetal tissue research", *Science* 23 April 2021, 372:6540, p. 329; Nidhi Subbaraman, "NIH reverses Trump-era restrictions on fetal-tissue research", *Nature* 16 April 2021; Apoorva Mandavilli, "Biden admin ends limits on use of fetal tissue for research," *NYT* April 17, 2021.

²¹⁸ See *NIH Human Embryonic Stem Cell Registry: Research Using These Lines is Eligible for NIH funding*, NAT'L INST. HEALTH, https://grants.nih.gov/stem_cells/registry/current.htm (last visited March 29, 2022).

²¹⁹ See Debora Spar & Anna Harrington, *Selling Stem Cell Science: How Markets Drive Law Along the Technological Frontier*, 33 AM. J. L. & MED. 541, 562 (2007).

cell lines has increased.²²⁰ The current form may represent a stable compromise, putting limited burdens on research while re-focusing on widely shared moral principles of informed consent and non-coercion.

3. Human-Animal Chimera Research

Like human embryonic research, research on human-animal chimeras has attracted persistent controversy and been subject to a federal funding moratorium. Chimeras are formed by grafting human cells or tissues into other species. This is a long-standing research practice, aimed at developing animal models, such as humanized mice, on which to conduct human clinical research.²²¹ The 1998 isolation of hESCs empowered this research by making it possible to do these grafts with human stem cells, promising greatly improved animal models, new stem-cell therapies, or ways to develop human organs for transplant.

Because chimera embryos are not human, research on them avoids some objections and restrictions that apply to human embryos. They fall outside the Dickey-Wicker amendment and the worldwide soft-law 14-day limit on growing human embryos for research.²²² NIH's 2000 stem-cell guidelines included a bar on funding "research in which human pluripotent stem cells are combined with an animal embryo."²²³ But the 2001 rule identifying eligible cell lines revoked the 2000 guidelines without mentioning chimeras, so they regained funding eligibility. Debate over the scope of acceptable chimera research raged for several years. A 2005 NAS report concluded chimera research was acceptable with limits,²²⁴ but President Bush's 2006 State of the Union Address included it in a list of moral abuses in research that he urged Congress to prohibit. Despite several subsequent attempts, most recently in 2021, Congress has not enacted such a prohibition.²²⁵

In addition to religious concerns about blurring the line between humans and other animals, the main objections to chimera research were the potential suffering of the created being, including

²²⁰ *Id*; See also, Aaron D. Levine, *Policy Uncertainty and the Conduct of Stem Cell Research*, 8 CELL STEM CELL 132, 132-33 (2011).

²²¹ Shultz LD, Ishikawa F, Greiner DL. Humanized mice in translational biomedical research. *Nat Rev Immunol.* 2007;7:118–30; Richard R. Behringer, Human-animal chimeras in biomedical research, *Cell Stem Cell* 1:3, 13 Sept 2007, 259-262. The reverse practice, xenotransplantation of animal tissues or organs into human patients, was the object of a few grisly early experiments, but abandoned as knowledge of immunological rejection advanced until recent revival of interest. See David K C Cooper, a brief history of cross-species organ transplantation. *Proc Bayl Univ Med Cent* 25(1), 49-57, Jan 2012; See also Dooldeniya, M D; Warrens, AN (2003). "Xenotransplantation: where are we today?". *Journal of the Royal Society of Medicine.* 96 (3): 111–117.

²²² See Insoo Hyun et al, "Human embryo research beyond the primitive streak," *Science* 371;6533, 998-1000 (5 Mar 2021); Kelly Servick, "Door opened to more permissive research on human embryos," *Science* 372;6545, 894, 28 May, 2021.

²²³ NIH Guidelines for Research Using Human Pluripotent Stem Cells, 65 Fed. Reg. 51,979 (Aug. 25, 2000).

²²⁴ See NAT'L RES. COUNCIL & INST. OF MED., GUIDELINES FOR HUMAN EMBRYONIC STEM CELL RESEARCH 6, 105-06 (2005).

²²⁵ First attempt, Sen Brownback, Hum Chimera Prohibition Act, 11 July 2005, prohibited creation of non-human life forms with brains derived wholly or mostly from human neural tissue. The bill died in Congress, but similar prohibitions were enacted in Arizona and Louisiana. (Jennifer L. Brown et al., "A technological and regulatory review on human-animal chimera research," *Cell Transplantation*, Aug 20, 2023, DOI <https://doi.org/10.1177/09636897231183112>. Second attempt, Human-animal chimera prohibition act of 2016, intro HR by Christopher Smith.

isolation, and the risk of creating something having more moral status than recognized.²²⁶ Because these concerns were most salient for species closer to humans, NIH's revised 2009 guidelines barred human-primate chimeras but allowed chimeras with other species.²²⁷ During preparation of further revisions in 2015 a new concern arose, that human cells might affect off-target organs, particularly the central nervous system or gametes – suggesting risk of creating human-like brains in animals, or heritable changes. This led NIH to reinstate the moratorium on all chimera research pending more consultation.²²⁸ One year later they proposed further revisions, which would lift the moratorium for rodent chimeras, replace it with an extra review stage for other non-primates, and broaden it for primates to include the earliest, pre-gastrulation stage embryos.²²⁹ They announced plans to complete new guidelines in 2017, but have taken no further action since. The moratorium thus remains in place, criticized by both religious groups seeking a ban,²³⁰ and scientists seeking resumed funding and pointing out arbitrary differences between eligible and ineligible research.²³¹

The chimera funding moratorium has several points in common with that on embryonic research. Both aim to balance incommensurable opposing interests, categorical concerns about sanctity of life against interests in advancing scientific knowledge and medical treatment. Both cover only US federal research funding, not all research, so research has continued with private and State funding, and in nations with looser restrictions. The international landscape is highly variable, with some jurisdictions supporting research such as human-primate chimeras that would be barred even under NIH's proposed 2016 relaxation.²³² Meanwhile, the prospect of transplant organs unconstrained by the tiny supply of donated human organs has driven rapid advancement in international

²²⁶ Julian J. Koplin and Julian Savulescu, “time to rethink the law on part-human chimeras,” *J Law and the Biosciences* 6:1, Oct 2019, 37-50.

²²⁷ National Institutes of Health 2009. Guidelines on Human Stem Cell Research. <https://stemcells.nih.gov/policy/2009-guidelines.htm>.

²²⁸ *See NIH Research Involving Introduction of Human Pluripotent Cells into Non-Human Vertebrate Animal Pre-Gastrulation Embryos*, NAT'L INST. OF HEALTH (Sept. 23, 2015), <https://grants.nih.gov/grants/guide/notice-files/NOT-OD-15-158.html>; *see also* Arun Sharma et al., *Lift NIH Restrictions on Chimera Research*, 350 *SCIENCE* 640 (2015).

²²⁹ *Request for Public Comment on Proposed Changes to the NIH Guidelines for Human Stem Cell Research and Proposed Scope of an NIH Steering Committee's Consideration of Certain Human-Animal Chimera Research*, NAT'L INST. OF HEALTH (Aug. 4, 2016), <https://grants.nih.gov/grants/guide/notice-files/NOT-OD-16-128.html>; Wu J, Greely HT, Jaenisch R, Nakauchi H, et al. Stem cells and interspecies chimeras. *Nature*. 2016;540:51–9; Jocelyn Kaiser, “NIH moves to lift moratorium on animal-human chimera research,” *Science* Aug 4, 2016.

²³⁰ See, e.g., National Catholic Bioethics Center, “We should be concerned about chimeras,” June 18, 2021, at <https://www.ncbcenter.org/messages-from-presidents/chimeras>; See also Family Research Council, “Human-animal chimeras are a bioethical nightmare,” June 16, 2021, at <https://www.frc.org/blog/2021/06/human-animal-chimeras-are-bioethical-nightmare>

²³¹ Insoo Hyun, “what’s wrong with human-nonhuman chimera research?” *Plos Biology* 14(8), 2016, e1002535, pointing out the moratorium excludes other methods of mixing human and nonhuman species, such as genetic humanization of mice and transplant of human glial progenitor cells into mouse brains; International Society for Stem Cell Research, *Guidelines for Stem Cell Research and Regenerative Medicine, 2021 Update*. At <https://www.isscr.org/policy/guidelines-for-stem-cell-research-and-clinical-translation>

²³² Tsutomu Sawai, Taiichi Hatta, Misao Fujita, “Japan Significantly Relaxes Its Human-Animal Chimeric Embryo Research Regulations,” *Cell Stem Cell* 24:4, 513-514, April 04, 2019; David Cyranoski, “Japan approves first human-animal embryo experiments,” *Nature* 26 July, 2019, <https://www.nature.com/articles/d41586-019-02275-3>; Nicola Davis, *First Human-Monkey Chimera Raises Concern Among Scientists*, *The Guardian* (Aug. 3, 2019), <https://www.theguardian.com/science/2019/aug/03/first-human-monkey-chimera-raises-concern-among-scientists>.

chimera research, including the first human-pig chimera in 2017 and the first human-monkey chimera in 2020.²³³ On the concern about off-target effects, one recent review reported no evidence of humanization of animal hosts in 150 studies.²³⁴

4. Human Cloning

The possibility of cloning animals – producing new individuals genetically identical to an existing one without germ-cell fertilization – has been recognized since the early 20th Century.²³⁵ A key advance occurred in 1996, when a Scottish team first cloned a mammal: Dolly the sheep was cloned by somatic-cell nuclear transfer (SCNT), transfer of the nucleus from a somatic (body) cell into an egg cell with its nucleus removed.²³⁶

Therapeutic cloning – producing cloned cells or tissues for medical treatment – presented a mix of scientific and therapeutic benefits and moral concerns similar to other embryonic research.²³⁷ Reproductive cloning, however – creating human embryos from somatic cells and implanting them for gestation and birth – raised more serious concerns. Early reports that clones may suffer deformities or premature aging were soon found to be unique to the first attempt, and not general risks of cloning.²³⁸ But reproductive cloning also raised objections related to creating people for instrumental purposes or with pre-selected traits, including the specter of repugnant societies practicing widespread genetic manipulation, as in Huxley’s dystopic novel, *BRAVE NEW WORLD*.²³⁹

Although the ability to clone humans appeared remote, fears of misuse prompted rapid federal action. The Dickey-Wicker amendment already arguably covered cloning, but President Clinton made that explicit ten days after the Dolly announcement with a moratorium on federal funding

²³³ Jun Wu et al, Interspecies Chimerism with Mammalian Pluripotent Stem Cells, *Cell* 168, 3, P473-486.e15, January 26, 2017. [https://www.cell.com/cell/fulltext/S0092-8674\(16\)31752-4](https://www.cell.com/cell/fulltext/S0092-8674(16)31752-4); (reporting first viable pig embryo with human cells); Sara Reardon, *Hybrid Human-Chicken Embryos Illuminate Key Developmental Milestone*, *NATURE NEWS* (May 23, 2018), <https://www.nature.com/articles/d41586-018-05202-0> (study using human-chicken chimera embryos to study early development and differentiation); Tao Tan et al, Chimeric contribution of human extended pluripotent stem cells to monkey embryos ex vivo, *Cell* 184:8, P2020-2032.E14, Apr 15, 2021. [https://www.cell.com/cell/fulltext/S0092-8674\(21\)00305-6](https://www.cell.com/cell/fulltext/S0092-8674(21)00305-6).

²³⁴ Andrew T. Crane, Joseph P. Voth, Francis X. Shen, Walter C. Low, Concise Review: Human-Animal Neurological Chimeras: Humanized Animals or Human Cells in an Animal? *Stem Cells* 37:4, 444-452, April 2019. <https://doi.org/10.1002/stem.2971>

²³⁵ See Edward M. De Robertis, *Spemann’s Organizer and Self-Regulation in Amphibian Embryos*, 7 *NATURE REV.: MOLECULAR CELL BIOLOGY* 296 (2006). For a general description of cloning, see PRESIDENT’S COUNCIL ON BIOETHICS, *HUMAN CLONING AND HUMAN DIGNITY: AN ETHICAL INQUIRY* xxiv (2002), https://repository.library.georgetown.edu/bitstream/handle/10822/559368/pcbe_cloning_report.pdf?sequence=1&isAllowed=y.

²³⁶ See Ian Wilmut et al., *Viable Offspring Derived from Fetal and Adult Mammalian Cells*, 385 *NATURE* 810 (1997).

²³⁷ NAT’L BIOETHICS ADVISORY COMM., *CLONING HUMAN BEINGS: REPORT AND RECOMMENDATIONS OF THE NATIONAL BIOETHICS AND ADVISORY COMMISSION* 24-33 (1997) [hereinafter NBAC REPORT].

²³⁸ See T. Monmaney, *Prospect of Human Cloning Gives Birth to Volatile Issues*, *L.A. TIMES*, Mar. 2, 1997, at A1; See also Joanna Klein, *Dolly the Sheep’s Fellow Clones, Enjoying Their Golden Years*, *N.Y. TIMES* (Jul. 26, 2016), *US MAJOR DAILIES*, <https://search.proquest.com/usmajor-dailies/docview/1806660169/C148E2BB5E348C1PQ/2?accountid=14512>.

²³⁹ ALDOUS HUXLEY, *BRAVE NEW WORLD* (1932); see NBAC REPORT, *supra* note 237, at 2-4.

for cloning with exemptions for cells, tissues, and non-human animals.²⁴⁰ At the same time, Clinton asked the new National Bioethics Advisory Commission (NBAC) to advise within 90 days on the moral and legal implications of human cloning,²⁴¹ and asked researchers to observe a voluntary moratorium in the interim.²⁴² The Biotechnology Industry Organization announced it would do so, while also stressing the great value of cell and tissue cloning and urging the administration to oppose “any hastily drafted laws . . . that may, however well intentioned, inadvertently also ban this valuable research.”²⁴³

Given its tight deadline, the NBAC only examined reproductive cloning via SCNT to create a human child and concluded that this is morally unacceptable.²⁴⁴ They could not, however, agree on the ethical reasoning to reach this conclusion, relying instead mainly on potential health risks to the cloned child.²⁴⁵ They recommended continuing the moratoria until a 3 – 5 year legislative moratorium could be enacted, drawn with narrow scope to avoid stifling valuable but lower-risk research.²⁴⁶ On receiving the report, Clinton sent draft legislation to Congress for a five-year moratorium on private or public reproductive cloning by SCNT.²⁴⁷ Several scientific bodies announced parallel voluntary moratoria with the same five-year duration and narrow scope.²⁴⁸ While the bill was pending, however, one scientist announced he planned to clone a human before Congress could enact the moratorium.²⁴⁹ The FDA responded quickly with a statement that its jurisdiction already covered human cloning so any experiment done without its approval would be illegal.²⁵⁰

Federal and state legislators, not convinced FDA’s statement eliminated risk of rogue cloning, proposed several cloning bills, including one (S. 1601) that would criminalize any use of SCNT to

²⁴⁰ Memorandum on Prohibition of Federal Funding for Cloning Human Beings, 1 PUB. PAPERS 233 (Mar. 4, 1997).

²⁴¹ Letter to National Bioethics Advisory Commission Chair Harold Shapiro on Cloning Technology Issues, 1 PUB. PAPERS 196 (Feb. 24, 1997).

²⁴² Remarks Announcing the Prohibition on Federal Funding for Cloning of Human Beings and an Exchange with Reporters, 1 PUB. PAPERS 230 (Mar. 4, 1997).

²⁴³ See, e.g., Henri A. Termeer & Charl B. Fedlbaum, *Support of Voluntary Moratorium*, BIOTECHNOLOGY INDUSTRY ORG. (Mar. 27, 1997), <https://www.bio.org/advocacy/letters/support-voluntary-moratorium>.

²⁴⁴ NBAC REPORT, *supra* note 237, at 3-4.

²⁴⁵ See *id.* at 107-08; Gina Kolata, *Clinton’s Advisory Panel Backs Moratorium on Human Clones*, N.Y. TIMES, May 18, 1997, at 21; Science News Staff, *President Proposes Human Cloning Ban*, SCIENCE (June 9, 1997), <https://www.sciencemag.org/news/1997/06/president-proposes-human-cloning-ban>.

²⁴⁶ NBAC REPORT, *supra* note 237, at 109.

²⁴⁷ “Cloning Prohibition Act of 1997,” H.R. DOC. NO. 105-97 (1997); <https://clintonwhitehouse4.archives.gov/textonly/WH/Work/060997.html>. The bill barred cloning “for the purposes of creating a child,” but was silent on reproductive cloning through embryonic stage for therapy or research purposes. “Clinton seeks to ban human cloning but not all experiments,” AP, June 10, 1997, at <https://www.nytimes.com/1997/06/10/science/clinton-seeks-to-ban-human-cloning-but-not-all-experiments.html>

²⁴⁸ See 144 CONG. REC. S427-28 (daily ed. Feb. 5, 1998); Meredith Wadman, *US Biologists Adopt Cloning Moratorium*, 389 NATURE 319 (1997).

²⁴⁹ ANDREA L. BONNICKSEN, CRAFTING A CLONING POLICY: FROM DOLLY TO STEM CELLS 55-56 (2002).

²⁵⁰ See Stuart L. Nightingale, *Letter About Human Cloning*, FDA (Oct. 26, 1998), <https://www.fda.gov/ScienceResearch/SpecialTopics/RunningClinicalTrials/ucm150508.htm>. Although FDA’s jurisdictional claim is weak, it has not been challenged. See generally Richard A. Merrill & Bryan J. Rose, *FDA Regulation of Human Cloning: Usurpation or Statesmanship?*, 15 HARV. J.L. & TECH. 85 (2001).

create human embryos.²⁵¹ In response, a large medical and scientific coalition argued that the voluntary moratoria plus FDA jurisdiction provided enough protection and succeeded in blocking the bill by filibuster.²⁵² Several later attempts to enact broad cloning prohibitions as US legislation or an international treaty also failed.²⁵³ Similar restrictions were successfully adopted, however, in several U.S. states and other nations, and as non-binding international resolutions.²⁵⁴ A few laws, notably in the UK, cover only reproductive cloning,²⁵⁵ but most also include cloning for research or treatment, based on slippery-slope arguments that any effective cloning capability would generate irresistible demand for reproductive use.²⁵⁶

None of these laws covers non-human species, where cloning has seen rapid advances. There are now substantial industries using SCNT to clone pets, livestock, and other commercially important animals,²⁵⁷ as well as early efforts to support survival of endangered species by cloning.²⁵⁸ Cloning of primates has consistently been more challenging, with the first successful cloning to embryo stage announced in 2007,²⁵⁹ to live birth in 2018,²⁶⁰ and to survival to adulthood in 2024.²⁶¹

²⁵¹ Human Cloning Prohibition Act, S. 1601, 105th Cong. (1998).

²⁵² 144 CONG. REC. S322-23 (daily ed. Feb. 3, 1998). *See also* BONNICKSEN, *supra* note 249, at 61. *See, e.g., Cloning: Legal, Medical, Ethical, and Social Issues Before the Subcomm. on Health & Env't, H. Comm. on Commerce*, 105th Cong. (Feb. 12, 1998) (statement of David Korn, Senior Vice President, Division of Biomedical and Health Sciences Research, Assoc. Am. Med. Colleges); Times Wire Reports, *AMA Seeks 5-Year Cloning Moratorium*, L.A. TIMES (Feb. 13, 1998), <http://articles.latimes.com/1998/feb/13/news/mn-18778>.

²⁵³ *See, e.g.*, H.R. 2505, 107th Cong. (2001); H.R. 534, 108th Cong. (2003); S. 303, 108th Cong. (2003); S. 658, 109th Cong. (2005); *see also* Alexander Morgan Capron, *Placing a Moratorium on Research Cloning to Ensure Effective Control over Reproductive Cloning*, 53 HASTINGS L.J. 1057 (2002). *See* U.N. AD HOC COMM. ON AN INT'L CONVENTION AGAINST THE REPRODUCTIVE CLONING OF HUMAN BEINGS (2015), <http://legal.un.org/cloning/>; *see also* G.A. Res. 59-280, U.N. Doc. A/Res/59/280 (Mar. 23, 2005).

²⁵⁴ *See* R. Korobkin, *Stem Cell Research and the Cloning Wars*, 18 STAN. L. & POL'Y REV. 169 (2007).

²⁵⁵ Helen Pilcher, *UK Gives Go-Ahead to Therapeutic Cloning*, NATURE NEWS (Aug. 11, 2004), <https://www.nature.com/news/2004/040809/full/040809-11.html>.

²⁵⁶ Susan Mayor, *UK Royal Society Report Proposes Ban on Reproductive Cloning*, The Scientist (June 26, 2001), <https://www.the-scientist.com/news-analysis/royal-society-calls-for-moratorium-on-human-reproductive-cloning-54527>; *Frequently Asked Questions About Human Cloning and the Council's Report*, President's Council on Bioethics, https://bioethicsarchive.georgetown.edu/pcbe/topics/cloning_faq.html (last visited Mar. 17, 2019).

²⁵⁷ *See, e.g.*, Carol L. Keefer, *Artificial Cloning of Domestic Animals*, 112 PNAS 8874 (2015), <https://www.pnas.org/content/112/29/8874>; T. Wakayama *et al.*, "Full-term development of mice from enucleated oocytes injected with cumulus cell nuclei," *Nature* 394:369-374, 23 July 1998; I.A. Polejaeva *et al.*, "Cloned pigs produced by nuclear transfer from adult somatic cells," *Nature* 407:86-90, 7 Sept 2000; G.L. Woods *et al.*, "A Mule Cloned from Fetal Cells by Nuclear Transfer," *Science* 301:5636, 1063-, 22 August 2003, DOI: 10.1126/science.1086743.

²⁵⁸ Sabrina Imbler, *Meet Elizabeth Ann, the First Cloned Black-Footed Ferret*, NY Times (Feb. 18, 2021), <https://www.nytimes.com/2021/02/18/science/black-footed-ferret-clone.html>

²⁵⁹ J A Byrne *et al.*, "Producing primate embryonic stem cells by somatic cell nuclear transfer," *Nature* 450(7169):497-502, 22 Nov 2007, DOI: 10.1038/nature06357.

²⁶⁰ Zhen Liu *et al.*, "Cloning of Macaque Monkeys by Somatic Cell Nuclear Transfer," *Cell* 172:4, 881-887, 8 Feb 2018.

²⁶¹ Liao, Z., Zhang, J., Sun, S. *et al.* Reprogramming mechanism dissection and trophoblast replacement application in monkey somatic cell nuclear transfer. *Nat Comm* 15, 5 (2024). <https://doi.org/10.1038/s41467-023-43985-7>

Since the 1998 alarm that prompted FDA’s assertion of jurisdiction, a few individuals and cults have claimed to have cloned humans, but the claims are unverified and generally disbelieved.²⁶² Research on human therapeutic cloning has proceeded through the patchwork of bans and funding moratoria, more slowly and with more difficulty than for other species. Results over the past decade – including production of cloned human embryos in 2013²⁶³ and a method to generate germ cells from somatic cells in 2017,²⁶⁴ as well as the cloning of primates noted above – suggest that human reproductive cloning capability is close, perhaps even realized, but there have been no publicly announced efforts to do so.

As in the fetal research and chimera cases, demands for cloning moratoria were driven by strong moral concerns, but here these were triggered by symbolic events and implausible claims long before the most alarming prospect, human reproductive cloning, appeared possible. Quickly enacted but narrowly targeted moratoria helped calm public fear, broader bans were avoided in research-heavy jurisdictions by highly mobilized scientific and medical interests. In addition to these narrow moratoria, opposition to tighter restrictions also benefited from lack of clarity about the precise grounds for concern and the boundary of morally permissible research and therapeutic cloning. Advisory bodies have also struggled to adequately address the moral concerns, focusing instead on more tractable issues such as health risks to cloned individuals, which are peripheral to the main objections and virtually certain to decline with scientific progress.

The case illustrates the challenge of defining the scope of restrictions under rapid scientific and technological progress: too broad, and they may restrict research that does not raise the concerns or is necessary to inform understanding of risks; too specific, and they risk losing effectiveness as research and methods advance, eroding to mere symbolic commitment or bureaucratic burden that fails to address the motivating concerns. Attempts to enact the broadest restrictions were ineffective, because there were too many ways to make advances while avoiding specifically drawn restrictions, particularly when these vary across jurisdictions. Yet the most serious concern, human reproductive cloning, appears to represent a persistent normative barrier, despite the evident incentives, the advances in capability, and the lack of restrictions in many jurisdictions.²⁶⁵

5. Viral Gain-of-Function Research

In 2011, two research groups announced they had modified the avian influenza virus H5N1 to be transmissible between mammals.²⁶⁶ If released, the modified viruses could potentially trigger a

²⁶² See, e.g., J. Borger, “Cult scientists claim first human cloning,” *The Guardian* 28 Dec 2002; See also Young, Emma. “First Cloned Baby.” *New Scientist*, 27 Dec 2002,

²⁶³ M. Tachibana, et al., *Human Embryonic Stem Cells Derived by Somatic Cell Nuclear Transfer*, 153 *Cell* 1228 (2013), [https://www.cell.com/fulltext/S0092-8674\(13\)00571-0](https://www.cell.com/fulltext/S0092-8674(13)00571-0); David Cyranoski, *Human Stem Cells Created by Cloning*, 497 *Nature* 295 (2013), <https://www.nature.com/news/human-stem-cells-created-by-cloning-1.12983>; A. Trounson & N.D. DeWitt, *Pluripotent Stem Cells from Cloned Human Embryos: Success at Long Last*, 12 *Cell Stem Cell* 636 (2013), [https://www.cell.com/cell-stem-cell/pdf/S1934-5909\(13\)00215-4.pdf](https://www.cell.com/cell-stem-cell/pdf/S1934-5909(13)00215-4.pdf)

²⁶⁴ K. Hayashi *et al.*, “Reconstitution of mouse oogenesis in a dish from pluripotent stem cells,” *Nature Protocols* 12, 1733–1744 (2017).

²⁶⁵ Henry T. Greely, “Human reproductive cloning: The curious incident of the dog in the night-time,” *STAT*, Feb 21, 2020, at <https://www.statnews.com/2020/02/21/human-reproductive-cloning-curious-incident-of-the-dog-in-the-night-time/>

²⁶⁶ David Malakoff, *Proposed H5N1 Research Reviews Raise Concerns*, 338 *SCIENCE* 1271 (2012).

global pandemic.²⁶⁷ These “gain-of-function” studies were so alarming that regulators first tried to limit publication of results,²⁶⁸ although both studies were published a few months later.²⁶⁹ Some scientists and citizen groups argued that risks of the modified viruses being used for biological war or terrorism were so great that the research should not be published, or done at all.²⁷⁰ Influenza researchers replied that the research was essential to prevent and manage future outbreaks, and that they were adequately managing the risks.

In January 2012, in response to mounting criticism, thirty-nine researchers announced a voluntary 60-day moratorium on H5N1 gain-of-function studies, with stated purpose:

to provide time to explain the public health benefits of this work, to describe the measures in place to minimize possible risks, and to enable organizations and governments around the world to review their policies . . . regarding these experiments.²⁷¹

When controversy persisted after the 60-day period, researchers announced an indefinite extension to the moratorium. One commented that “... the public needed reassurance and justification about these experiments.”²⁷² Researchers and regulators discussed risks and safety practices at several meetings through 2012,²⁷³ while a few national governments and the World Health Organization worked on new research guidelines.²⁷⁴

In February 2013, the group that had adopted the moratorium announced plans to resume research in countries that had implemented guidelines, but controversy persisted, including objections that a few insiders had dominated debate.²⁷⁵ At that point most jurisdictions had not adopted

²⁶⁷ A FRAMEWORK FOR GUIDING U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES FUNDING DECISIONS ABOUT RESEARCH PROPOSALS WITH THE POTENTIAL FOR GENERATING HIGHLY PATHOGENIC AVIAN INFLUENZA H5N1 VIRUSES THAT ARE TRANSMISSIBLE AMONG MAMMALS BY RESPIRATORY DROPLETS 1 (2013), <http://www.phe.gov/s3/dualuse/Documents/funding-hpai-h5n1.pdf> [hereinafter U.S. FUNDING FRAMEWORK].

²⁶⁸ See A. Casadevall & T. Shenk, *The H5N1 Manuscript Redaction Controversy*, MBIO, Jan-Feb 2012, at 1; D. Butler, *Court Upholds Need for Export Permits for Risky Flu Research*, NATURE NEWS (Sept. 26, 2013, 7:10 PM), <http://blogs.nature.com/news/2013/09/court-upholds-need-for-export-permits-for-risky-flu-research.html>.

²⁶⁹ See Sander Herfst et al., *Airborne Transmission of Influenza A/H5N1 Virus Between Ferrets*, 336 SCIENCE 1534 (2012); Masaki Imai et al., *Experimental Adaptation of an Influenza H5 HA Confers Respiratory Droplet Transmission to a Reassortant H5 HA/H1N1 Virus in Ferrets*, 486 NATURE 420 (2012).

²⁷⁰ D. Grady & D.G. McNeil Jr., *Debate Persists on Deadly Flu Made Airborne*, N.Y. TIMES, Dec. 26, 2011, at A1.

²⁷¹ Ron A. M. Fouchier et al., *Transmission Studies Resume for Avian Flu*, 339 SCIENCE 520 (2013).

²⁷² David Malakoff, *H5N1 Researchers Announce End of Research Moratorium*, SCIENCE (Jan. 23, 2013), <https://www.sciencemag.org/news/2013/01/h5n1-researchers-announce-end-research-moratorium>.

²⁷³ *Id.*; see *Gain-Of-Function Research on Highly Pathogenic Avian Influenza H5N1 Viruses: An International Consultative Workshop*, NAT’L INST. OF HEALTH, <http://osp.od.nih.gov/office-biotechnology-activities/event/2014/gain-function-research-highly-pathogenic-avian-influenza-h5n1-viruses-international-consultative> (last visited Nov. 25, 2015).

²⁷⁴ See, e.g., *Guidance for Adoption of Appropriate Risk Control Measures to Conduct Safe Research on H5N1 Transmission*, WORLD HEALTH ORG. (July 2012), https://www.who.int/influenza/human_animal_interface/biosafety_summary/en/ (proposing laboratory safety guidelines for H5N1 research); U.S. FUNDING FRAMEWORK, *supra* note 267.

²⁷⁵ See Fouchier et al., *supra* note 272 (announcing the end of the voluntary moratorium); Declan Butler, *Work Resumes on Lethal Flu Strains*, 493 NATURE 460 (2013); Steve Connor, *Leading Scientists Condemn Decision to Continue Controversial Research into Deadly H5N1 Bird-flu Virus*, INDEPENDENT (Jan. 23, 2013).

new guidelines and a risk assessment requested by NIH had not been completed.²⁷⁶ A NATURE commentary observed that, “Rather than use the avian flu moratorium to seek advice, listen and foster debate, many influenza scientists engaged in an academic exercise of self-justification.”²⁷⁷

Several prominent biosafety failures at supposedly secure U.S. labs in 2014 bolstered the opposition, even though they were unrelated to the specific research at issue.²⁷⁸ In response, the Obama Administration in October 2014 announced a new moratorium (labeled a “pause”) on federal funding for gain-of-function studies on influenza and the respiratory viruses MERS and SARS, “until a ... broad deliberative process is completed that results in the adoption of a new gain-of-function research policy.”²⁷⁹ They also asked privately funded researchers to join the pause voluntarily, until completion of a risk assessment by the National Science Advisory Board for Biosecurity (NSABB). The pause generated divergent views, including strong opposition from virology researchers who argued it was too broad and did not adequately consider benefits of the paused research in supporting development of vaccines and treatments.²⁸⁰

Following the NSABB report, NIH lifted the funding moratorium in December 2017 and replaced it with a new layer of review for research on “enhanced pandemic potential pathogens,”²⁸¹ overseen by an advisory panel with broad scientific, security, and legal expertise.²⁸² Objections persisted, however, including both claims that the process was over-restrictive in covering broad classes of research rather than individual projects, and that it was not protective enough.²⁸³ Belated

²⁷⁶ *Vigilance Needed: Experiments That Make Deadly Pathogens More Dangerous Demand the Utmost Scrutiny*, Editorial, 493 NATURE 451, 452 (2013).

²⁷⁷ Simon Wain-Hobson, *H5N1 Viral-Engineering Dangers Will Not Go Away*, 495 NATURE 411 (2013).

²⁷⁸ Jocelyn Kaiser, *Lab Incidents Lead to Safety Crackdown at CDC*, SCIENCE (July 11, 2014, 4:15 PM), <http://news.sciencemag.org/biology/2014/07/lab-incidents-lead-safety-crackdown-cdc>.

²⁷⁹ U.S. GOVERNMENT GAIN-OF-FUNCTION DELIBERATIVE PROCESS AND RESEARCH FUNDING PAUSE ON SELECTED GAIN-OF-FUNCTION RESEARCH INVOLVING INFLUENZA, MERS, AND SARS VIRUSES 1 (2014), <http://www.phe.gov/s3/dualuse/Documents/gain-of-function.pdf> [hereinafter FUNDING PAUSE]; see also FRANCIS S. COLLINS, STATEMENT ON FUNDING PAUSE ON CERTAIN TYPES OF GAIN-OF-FUNCTION RESEARCH (2014), www.nih.gov/about/director/10172014_statement_gof.htm.

²⁸⁰ See Jocelyn Kaiser, *Researchers Rail Against Moratorium on Risky Virus Experiments*, SCIENCE (Oct. 22, 2014), <http://news.sciencemag.org/biology/2014/10/researchers-rail-against-moratorium-risky-virus-experiments>; Compare, e.g., Marc Lipstich & Thomas V. Inglesby, *Moratorium on Research Intended to Create Novel Potential Pandemic Pathogens*, MBIO, Nov.-Dec. 2014, at 1, 1-5, with Michael J. Imperiale & Arturo Casadevall, *Vagueness and Costs of the Pause on Gain-of-Function (GOF) Experiments on Pathogens with Pandemic Potential, Including Influenza Virus*, MBIO, Nov.-Dec. 2014, at 1, 1-3.

²⁸¹ *NIH Lifts Funding Pause on Gain-of-Function Research*, NIH (Dec. 19, 2017), <https://www.nih.gov/about-nih/who-we-are/nih-director/statements/nih-lifts-funding-pause-gain-function-research>; See also Sara Reardon, *US government lifts ban on risky pathogen research*, Nature 19 Dec, 2017.

²⁸² Jocelyn Kaiser, “NIH lifts 3-year ban on funding risky virus studies,” Science Dec 19, 2017; See also US Dept of HHS, “Framework for guiding funding decisions about proposed research involving enhanced potential pandemic pathogens,” 2017, at <https://www.phe.gov/s3/dualuse/Documents/p3co.pdf>.

²⁸³ Michael J. Imperiale & Arturo Casadevall, *A New Approach to Evaluating the Risk–Benefit Equation for Dual-Use and Gain-of-Function Research of Concern*, FRONTIERS BIOENG’G & BIOTECH., Mar. 2018, at 1, 1-6; Karen Feldscher, *Ban on Deadly Pathogen Research Lifts, but Controversy Remains*, HARV. SCH. PUB. HEALTH NEWS (Jan. 8, 2018), <https://www.hsph.harvard.edu/news/features/deadly-pathogen-research-controversy/>.

disclosure that the panel approved two experiments similar to those that sparked the initial controversy raised further objections to the secrecy of the process.²⁸⁴ NIH announced it would reconsider the new procedures, while also noting the process could not operate fully openly, due to security concerns and their obligation to keep grant applications confidential.²⁸⁵ The review became entangled with controversy over the origin of COVID-19 and whether NIH had funded gain-of-function research in China.²⁸⁶ Controversy over the stringency and transparency of the process persists through 2024, along with periodic federal and state proposals to ban the research.²⁸⁷

As in the rDNA research case, this moratorium was initially adopted voluntarily by researchers. While both direct and indirect risks – lab accidents and intentional creation or release of dangerous agents – were present in both cases, indirect risks were more salient here due to the potential lethality and obvious potential for misuse of the viruses. Researchers in these cases were less willing to subject their research to outside scrutiny and control, however, particularly regarding indirect risks. They described the moratorium’s aims as explaining safety practices and managing unwarranted public fears, rather than seriously reviewing and strengthening risk management – a stance whose limits became clear when they announced the end of the moratorium. The attempt led to charges that the moratorium was a sham and prompted the broader federal moratorium.

This funding moratorium provided time and resources to assess and develop responses to both direct and indirect risks. The resultant review framework involves a degree of scrutiny and breadth of expertise that suggest a credible attempt to address both direct and indirect risks. Controversy persists, but at a lower level that reflects the challenge of managing two tensions inherent in the Panel’s job: reconciling the need to keep grant applications confidential with assessing risks transparently enough to be judged credible; and making individual risk-benefit judgments for each experiment that are consistent across experiments. Efforts to balance these remain a work in progress.

²⁸⁴ J. Kaiser, “Experiments that could make bird flu more risky poised to resume,” *Science* Feb 8, 2019; Mark Lipsitch and Tom Inglesby, “The US is funding dangerous experiments it doesn’t want you to know about,” *Washington Post* Feb 27, 2019; Francis Collins, “NIH commitment to transparency on research involving potential pandemic pathogens,” March 5, 2019, at <https://www.nih.gov/about-nih/who-we-are/nih-director/statements/nih-commitment-transparency-research-involving-potential-pandemic-pathogens>.

²⁸⁵ Jocelyn Kaiser, “After criticism, federal officials to revisit policy for reviewing risky virus experiments,” *Science* Jan 24, 2020; Nidhi Subbaraman, “US officials revisit rules for disclosing risky disease experiments,” *Nature* 27 Jan, 2020.

²⁸⁶ Minutes, National Science Advisory Board for Biosecurity, Feb 28, 2022, at https://osp.od.nih.gov/wp-content/uploads/NSABB_February_28_2022-Minutes_052522.pdf; L.A. Tabak and L.A. Jorgenson, “2022 Charge to NASBB,” slides from of NSABB meeting, Feb 28, 2022, at https://osp.od.nih.gov/wp-content/uploads/Tabak_and_Jorgenson-2022_Charge_to_the_NSABB.pdf; See also, U.S. Department of Health and Human Services, *Statement on misinformation about SARS-COV-2 origins*. NIH, (Oct 20, 2021), <https://www.nih.gov/about-nih/who-we-are/nih-director/statements/statement-misinformation-about-sars-cov-2-origins>.

²⁸⁷ Max Kozlov, “Risky gain-of-function studies need stricter guidance, say US researchers,” *Nature* 3 May, 2022; Felicia Goodrum et al, “Virology under the microscope – A call for rational discourse” *J of Virology* 97:2, 26 January, 2023; NSABB, Proposed biosecurity oversight framework for the future of science, March 2023, at: <https://osp.od.nih.gov/wp-content/uploads/2023/03/NSABB-Final-Report-Proposed-Biosecurity-Oversight-Framework-for-the-Future-of-Science.pdf>; American Soc for Microbiology, *Impact Assessment of Research on Infections Agents*, September 2023; Max Kozlov, “first global survey reveals who is doing gain-of-function research and why,” *Nature*, 15 September 2023; Jocelyn Kaiser, “House approves ban on gain-of-function pathogen research,” *Science* 15 November, 2023; Jocelyn Kaiser, “Wisconsin bill would restrict pathogen studies,” *Science* 19 January 2024.

III. A FRAMEWORK FOR ANALYZING MORATORIA

A. Overview and Recap of Cases

Table 1 provides a summary of the cases discussed in Section II, showing the associated actors, scope, termination conditions, mechanism of adoption, and present status of each. Based on these cases, this section presents a preliminary framework to analyze the contexts, purposes, characteristics, and outcomes of moratoria. In addition to advancing conceptual understanding and providing guidance for further research, the framework aims to provide practical guidance on when and under what conditions it is useful to adopt a moratorium, and how to design and implement them for maximum effectiveness for a given issue context.

B. Guiding Questions and a Taxonomy

As the first step in our analysis, we propose a categorization of three types of moratoria, based on distinct purposes in adopting them, which provides a more consistent and conceptually fruitful basis for analysis than categorizing moratoria by subject-matter, institutional setting, or type of legal authority by which they are adopted.

- 1) *Risk-management moratoria*, to support risk assessment and management for activities that present uncertain but potentially serious shared risks;
- 2) *Bargaining moratoria*, to support bargaining to advance shared interests or limit conflict in situations where parties have well understood material interests.
- 3) *Principled-conflict moratoria*, to demarcate landmarks or temporary resolutions of conflict over activities that some parties oppose categorically, independent of risks, material interests, or other consequences.

These types are defined by the objectives that motivate actors to adopt the moratorium. Objectives and underlying interests can be ambiguous or mixed, however, between actors, over time, or internally within actors. These are thus ideal types, which provide analytic clarity but which real cases approach to varying degrees, depending on commonality or divergence of interests involved.

Sections C through E analyze each type separately. For each type, we discuss the conditions in which moratoria are proposed, their intended purposes, and resultant requirements for participating actors, scope, and termination conditions, drawing on the cases in Part II. We also consider the implications of each type for parallel activities conducted while the moratorium is in force aiming to aid its resolution. Section F considers moratoria of mixed or intermediate type.

C. Risk-Management Moratoria

Risk-management moratoria are proposed in situations that adopting actors perceive to exhibit three characteristics: threat of harm; infeasibility of immediate control; and urgency. First, the targeted activity is believed to present a threat of harm, collectively to the actors proposing the moratorium or things they value. The risk is widely shared and potentially severe, but uncertain in important characteristics such as its specific manifestations, causal mechanisms, realized severity, or distribution. As we discuss below, the boundary between risk-management and principled-conflict motivations can be subtle, the principal distinction being that risk-management moratoria prioritize material risks – e.g., environmental, health, safety, economic, or political risks – over those

that are moral, aesthetic, symbolic, or spiritual in character. Second, immediate control of the risk is not feasible, due to lack of knowledge or lack of response capability – which may in turn reflect weakness of legal authority, administrative capacity, or political support. Third, the situation is urgent, in that continuing the activity threatens to unacceptably or irreversibly increase risks or impair control capability. These conditions most often arise for new activities such as new research areas or technologies, but can also apply to current, even long-practiced activities, through such factors as rapid expansion in scale, identification of new risk mechanisms via advancing knowledge, recognition of cumulative effects, or changes in how consequences are valued.

Of our cases, the moratoria on rDNA and viral gain-of-function research fall cleanly into this type, while those on Antarctic mining, nuclear testing, ocean dumping, and whaling exhibit prominent risk-management characteristics with other aims also present. In such cases, a moratorium suspends the risky activities, to stop the immediate threat and allow time to advance related knowledge, assess the character and severity of risks, and develop and implement measures to manage risks. Achieving these aims implies certain requirements for a moratorium's associated actors, scope, and termination conditions.

The actors bound by a risk-management moratorium must include most or all those likely to conduct the risky activity being controlled, whom we call its “insiders.” Whether the requirement is most insiders or all – i.e., how close to full participation is required – will depend on how the ability to impose risks is distributed. As the ability of a few actors to impose severe risks increases, it becomes more important that the moratorium bind all insiders. The actors adopting the moratorium need not be identical to the group bound by it. Adopters may be outsiders who are able to restrict the activity, through formal legal or political authority, control over required resources, or ability to deploy effective norms and associated public or peer pressure. The relative roles of insiders and outsiders in adopting the moratorium can vary widely, from adoption by mutual agreement among insiders to imposition by some outside authority.

Even full insider support for adopting a moratorium need not imply insiders all agree on the severity of risks or the need for a moratorium. Insiders may support a moratorium based on sincere risk judgments, or may do so for tactical reasons – e.g., to signal responsibility and calm public fears, and so avoid uninformed or burdensome restrictions imposed by outsiders. Whatever the strength and distribution of insider support, moratorium proponents face a collective-action problem, since uncoordinated individual decisions to suspend the activity will be ineffective. A proposed moratorium helps surmount this collective-action problem by providing a salient proposal to coordinate choices and channel normative pressure, even if advanced by only a subset of insiders – particularly if its proponents include highly respected or influential insiders.

For a risk-management moratorium to achieve its aims, its scope must adequately cover the activities judged to cause the risks of concern, but not restrict the parallel activities needed to understand and control the risks – typically research, risk assessment, and development of control measures. In some cases the risky actions and these parallel activities will be clearly separated, so defining the moratorium scope is straightforward; in other cases actors may disagree on specific activities' relative contributions to imposing risk and informing its control, so scope can be contested. Although the moratorium is conceptually distinct from these parallel activities, it provides the envelope within which they take place and can fail if its scope obstructs them or its termination ignores them, such that there is not sufficient confidence that risks are adequately controlled.

Our two pure risk-management cases, rDNA and viral gain-of-function research, illustrate the

importance and delicacy of this consensus, including the possibility of breakdown up to the point of proposed termination. Both were insider-led moratoria, one highly effective and one less so. Risk assessment and management advanced rapidly under the rDNA moratorium, based on distinguishing experiments by expected risk and strengthening pre-existing laboratory containment strategies. The moratorium did not hinder these activities, and both it and the new controls gained sufficient support for partial resumption, albeit over some dissent. The subsequent enforceable guidelines allowed research to flourish but were nonetheless conservative, allowing later relaxation with no mishaps. The viral research moratorium was also first adopted by insiders, but subsequent risk-management and the proposed termination were so insider-controlled and permissive that outsider concern and opposition increased – albeit also heightened by unrelated lab-safety failures. Outsider opposition concerned a broader set of risk mechanisms than insiders wanted to consider, including not just lab safety but also intentional development and release of dangerous viruses. In response, federal funding agencies imposed a broader moratorium, now partly relaxed but with continuing controversy over the transparency of research-approval procedures.

D. Bargaining Moratoria

Moratoria can support bargaining in situations where a group perceives an opportunity for collective benefit through negotiated agreement on joint action, but these joint benefits are threatened by provocative actions that may appear individually advantageous and hence tempting. Examples of such provocative actions include pre-emptive seizure of shared or contested resources whose allocation is being negotiated, or escalatory actions in a situation of potential conflict. While situations suitable for bargaining moratoria require actors to have some broad mix of shared and rival interests, specific interests and resultant issue structure can vary widely. Substantive interests may be those of a Prisoner's Dilemma or other collective-action problem.²⁸⁸ Alternatively, even if actors' substantive interests are purely distributive, as in the case of a fixed resource to be divided or divergent preferences on a policy decision, all may prefer a wide range of negotiated outcomes to continued conflict or delay.²⁸⁹ These structures can be further complicated by escalation dynamics, by which aggressive or provocative acts by some parties elicit reciprocal escalation by others, hardening opposition and increasing costs and barriers to agreement.²⁹⁰

Of our cases, the moratoria on Antarctic claims, the initial 10-year moratorium on Antarctic mining, trade treaties, and bilateral resource disputes fall cleanly into the bargaining type, while those on nuclear testing, whaling, and the subsequent Antarctic mining moratorium in the Madrid protocol exhibit bargaining characteristics with other aims also present. A bargaining moratorium suspends the provocative or destabilizing individual actions judged likely to trigger escalation or

²⁸⁸ Variants of these structures of interest in which the mutually harmful actions are individually advantageous under only low levels of collective cooperation, high levels, or any levels, make the well-known variants of collective-action situations called Chicken, Assurance, and Prisoner's Dilemma. *See generally* RUSSELL HARDIN, *COLLECTIVE ACTION* (1982); THOMAS SCHELLING, *MICROMOTIVES AND MACROBEHAVIOR* (1978).

²⁸⁹ Distributive issues are often analogized to dividing a fixed resource among claimants. Such situations are sometimes called "zero-sum," or more accurately, "fixed-sum" decisions. They are "distributive" in that a fixed value is divided such that giving more to one party gives less to others. Even purely distributive decisions can offer mutual benefit, if there exist resolutions that all parties prefer to continued conflict. *See generally* SCHELLING, *supra* note 136; RAIFFA, *supra* note 136.

²⁹⁰ *Barriers to Conflict Resolution*, ed., Kenneth J. Arrow, Robert H. Mnookin, Lee Ross, Amos Tversky, Robert Wilson. Norton, 1995.

obstruct agreement, to allow time to pursue a jointly beneficial agreement. If actors' relationships implicate other issues beyond those being explicitly negotiated, a moratorium may also bring broader benefits by signaling cooperative intent and building mutual understanding and trust. Uncertainty may be present in bargaining moratoria, but unlike risk-management moratoria uncertainty is not essential. Actors may or may not be uncertain on the consequences of the targeted actions or their preferences about these: they need only be confident that they prefer a negotiated outcome to uncoordinated individual actions.

To achieve its aims, a bargaining moratorium must adequately control threats to joint gains while in force, allow or encourage the needed negotiations, and transition to a regime of stable agreement on termination. Bargaining moratoria are often embedded in broad, multi-issue relations among parties, so requirements for effectiveness can be complex and case-specific. Yet a few generalizations about associated actors, scope, and termination conditions are possible.

Because bargaining moratoria are embedded in negotiations, they are usually collectively adopted by the same actors as are bound by them, those we called "insiders" for risk management moratoria. To be effective, a bargaining moratorium must bind all those whose actions threaten joint gains, but the restrictions need not be fully symmetric. The targeted provocative acts may be available to all actors or only to some, in which case the moratorium restrains some actors more than others, as in the Antarctic claims, Western Gap, and TRIPS non-violation complaints cases. Such asymmetry must merely be viewed, especially by those most constrained, as sufficiently even-handed in balancing costly restraint and anticipated benefit. The scope must be broad enough to include the potential individual acts that are judged provocative or destabilizing; and it may be further broadened to include related actions that promote or incentivize the targeted acts. Termination conditions must allow enough time for parties to negotiate an agreement they judge acceptable, whether drawn narrowly on the provocative actions of concern or more broadly.

E. Principled-Conflict Moratoria

In both risk-management and bargaining moratoria, actors' views on the suspended activity are contingent, depending on knowledge of risks and responses or potential future actions that are uncertain at the time of adoption. In both types, adopting parties recognize the possibility of future conditions in which they would judge a decision to resume the suspended activity acceptable.

In some cases, however, actors' opposition to the targeted activity may be categorical or unconditional. Actors may hold such categorical views based on religious, moral, ideological, or other principled commitments. These actors confidently expect that nothing that happens during the moratorium – not knowledge advances, risk control, or agreement on related actions – will soften their opposition. Such categorical opposition is present in our cases on human-development research (fetal research, chimeras, and cloning), and ocean dumping, whaling, and the second Antarctic mining moratorium. In each of these cases, some actors judged the targeted activity to be wrong in ways that cannot be mitigated by effective control of associated material risks or favorable commitments on related issues.

The presence of categorical opponents changes conditions for adopting a moratorium in a few ways. Categorical opponents cannot be insiders to the contested activity, but rather aim to stop it by mobilizing outside legal, political, or other resources. Because they would prefer a full prohibition to a moratorium, categorical opponents view a moratorium as a limited gain, which they support because they cannot secure their preferred outcome. Because achieving even this limited

gain requires cooperation with other, differently motivated actors, pure principled-conflict moratoria – in contrast to the other two types – are likely to be rare. The closest example to such a pure type would be a moratorium adopted between categorical opponents and equally fixed supporters of a contested activity. Although these groups' intractably opposed interests would mean such a moratorium could not offer any substantive joint gains, it might still serve two secondary purposes. It could advance immediate interests that are less starkly opposed than those in the activity itself, analogous to a battlefield truce to let both sides recover their casualties. Or if both sides expect conditions to shift in their favor during the moratorium, whether through their own efforts or independent external events, a moratorium might provide a salient benchmark to help rally support, and a delay that both sides expect to benefit them.²⁹¹ Both sides cannot be correct in this expectation, of course, yet such conflicting confidence is a frequent characteristic of conflicts.²⁹²

Our examples do not include such a pure principled-conflict case, and we expect such cases to be uncommon. Rather, all our cases involving categorical opposition are mixed. We discuss mixed cases in the next section.

F. Mixed Cases, Precaution, and Indirect Risk Mechanisms

While many moratoria align closely with the risk management or bargaining types, in which understandings of the risk the contested activity poses and the reason for a moratorium are widely shared, there are also cases intermediate between types. These reflect mixed objectives for the moratorium, arising from different views among participating actors, mixed or conflicted interests within individual actors, or interests that change over time. Such mixed aims affect both the design of moratoria, and the parallel activities conducted during a moratorium to inform decisions about its termination. In this section we consider the various possible combinations of motivations for moratoria and their implications for moratorium design and outcomes.

Risk Management and Bargaining:

Motivations for a moratorium can reflect a combination of risk-management and bargaining types. Although the two types are conceptually distinct and more often occur separately, they can occur together if the actions proposed for suspension present both uncertain shared risks (as in risk-management types), and impairment of potential joint gains (as in bargaining types). In some cases the implications of such mixed motives for moratorium design may be straightforward. If the actions and actors raising the two concerns overlap closely, a moratorium can cover all that are viewed as either risky or provocative. Parallel activities and termination conditions may present subtler challenges, however. The parallel activities needed to characterize and manage risks and to restrain provocative actions may involve different participants, follow different processes, or draw on different bodies of expertise. Interim activities for one aim may bias outcomes on the other, e.g., if processes of risk assessment and control tend to favor some interests in a resource over others. Mixed aims may also present challenges for design of termination conditions, if the two concerns resolve at different times or in response to different conditions. Challenges to a moratorium and the likelihood of conflict or breakdown may be greater if distinct groups of actors are

²⁹¹ See Lieberman, Gray & Groom, *supra* note 99, at 530. If the targeted activity is long practiced but has come to be contested, a moratorium can hold particular symbolic value for categorical opponents, who can portray it as a *de facto* ban. See COOK-DEEGAN, *supra* note 99, at 4.

²⁹² Cite Ikke again.

mainly concerned with each aim, or the relative prominence of the concerns changes over time.

Risk-management and bargaining interests can be present simultaneously or shift over time. Our cases illustrate various interactions of these interests, in the nuclear testing, whaling, and Antarctic mining cases. Nuclear testing was first viewed as a bargaining problem among nuclear powers, but awareness of environmental risks from testing – affecting many more actors than those doing the bargaining – emerged over time. Via this interaction, risk-motivated external pressure helped promote a moratorium that advanced both aims. The moratorium did, however, represent part of a nuclear regime that maintained a disparity favoring the initial nuclear powers, together with the more explicit two-class system in the Non-Proliferation Treaty.

In whaling, both bargaining and risk concerns were present from the start, as catch allocations and extinction risk, but the regime initially prioritized the former in awarding catch limits far above those based on scientific advice. Changes in membership over time gradually raised the priority of extinction risk, with an increasingly precautionary stance that overlapped with moral objection to killing whales. The moratorium adopted in response to this shift has since been sustained under highly precautionary rationales, including decisions to ignore scientific advice on extinction risk in the opposite direction from the early days of the regime. The result has been a near-breakdown of the regime, as the states most committed to whaling left the regime or found ways to evade the moratorium within it under various exemption provisions.

In Antarctic mining, the initial 10-year moratorium addressed both bargaining and risk-management concerns, but the latter became dominant in the rejection of CRAMRA and adoption of the Madrid Protocol. This priority is especially clear in the moratorium's broad scope, including activities that hold minimal threat but would help characterize mineral resources and so might promote emergence of commercial interests. The regime increasingly appears brittle – not just in its inability to address the profound environmental changes underway in Antarctica, but also in its inability to shift function to manage nascent emergence of rival commercial interests. While this shift would require a full reconstruction of the current regime, the prior rejected treaty CRAMRA did address both concerns – prioritizing environmental protection while also including procedures for review and potential approval of commercial projects. We speculate that if this stress becomes too strong, parties might respond by returning to the prior unadopted provisions as a starting point.

A particularly high-stakes interaction between bargaining and risk-management can arise in the development and control of new types of weapons. In our cases this interaction appears only marginally in nuclear testing, but it can be more clearly seen in early debates over nuclear and biological weapons and current debates over autonomous or AI-enabled weapons. In these cases parties may take actions that intentionally raise shared risk to compel concessions in a bid for rival advantage, as analyzed in Schelling's classic treatment of brinksmanship.²⁹³ In such situations, moratoria targeting these actions could advance both risk-management and bargaining aims.

Mixed Types Including Principled Conflict:

Mixed cases in which principled, categorical opposition is present together with either risk-management or bargaining motives present more opportunities for sustained conflict, both at initial adoption and later. In these cases, actors who support the moratorium for risk-management or bargaining reasons envision possible outcomes of the moratorium and parallel activities that may

²⁹³ Thomas C. Schelling, *Arms and Influence*.

lead to a future decision to resume the suspended activity, to some degree or in some form. Categorical opponents would prefer to fully prohibit the suspended activity but are unable to do so. In supporting the moratorium they join others whose concerns about the activity are contingent, related to shared risks or bargaining. They may do so for reasons similar to those in the hypothetical pure principled-conflict case above, including the expectation that conditions during the moratorium will shift in their favor and so help them eventually achieve a full prohibition. They expect their opposition to be unaffected by advances in knowledge or control capability, or agreement on related activities, and thus foresee no benefit from risk-management or bargaining activities, although they may participate in these for tactical reasons. Mixed motives including principled conflict are present in the dumping, whaling, and Antarctic minerals cases, and in the cluster of cases on research in human reproduction and development.

This mix of interests among participants affects both the initial adoption of a moratorium, and the operation of interim processes under the moratorium. In initial adoption, categorical opponents are likely to favor design choices that bring the moratorium as close as possible to a full prohibition. They may thus favor moratoria that bind more actors and cover broader scope, including actions that others deem affirmatively helpful – e.g., research, risk assessment, regulatory development, or negotiations over access and allocation for contested resources – precisely because these may lead to subsequent decisions to resume the contested activity.

For termination conditions, categorical opponents will favor conditions that create a strong presumption against narrowing or ending the moratorium, while others foresee possible conditions when they would support this outcome, and thus favor termination conditions that do not preclude it. In this regard, the fact of having adopted a moratorium gives an advantage to categorical opponents: since there were serious enough concerns to establish the moratorium in the first place, continuing it will become the implicit default or status-quo position in the absence of clearly stated conditions to end it. This advantage can be strengthened by adopting termination conditions that make this burden-shifting explicit, requiring some affirmative finding to authorize resumption. It can be strengthened still more by requiring a high standard of proof, perhaps invoking analogies to other decision domains that use high standards, such as the 5% or 1% standard for statistical significance in empirical research or the “beyond a reasonable doubt” standard of criminal law.²⁹⁴ High standards can also be imposed implicitly, as the outcome of supermajority or consensus decision rules or by requiring observed conditions that are unlikely to occur or are expressed in ambiguous or aspirational terms prone to unbounded contestation. Conversely, other participants will tend to favor termination conditions that impose lower barriers to resumption, such as fixed time-limits, relatively permissive decision rules well short of unanimity, or external conditions that are clearly observable and not subject to unlimited contestation. Leaving termination conditions undefined or ambiguous, as in several of our cases, might appear broadly appealing, since uncertainty at adoption may make it difficult for any adopters to agree on codifying specific conditions that would lead them to support narrowing or ending the moratorium. Such ambiguity may especially favor categorical opponents, however, since a lack of explicit conditions for termination may create the most expansive implicit presumption against resumption.²⁹⁵

Differences between categorical opponents and other adopters will also arise in the parallel

²⁹⁴ Dessler and Parson Ch 4 (importing burden/standard arguments to envt decisions from other domains)

²⁹⁵ Cf. Bodansky, *supra* note __, at 547 (“As the whaling case illustrates, unless moratoriums are time limited, they can be very difficult to lift, even after scientific uncertainties are resolved and management is feasible.”).

activities during the moratorium to inform its resolution, particularly over whether these have met the conditions for resumption. On this, interactions will differ depending whether categorical opponents are interacting primarily with others motivated by bargaining or risk-management concerns. In bargaining moratoria – as in whaling and Antarctic mining – categorical opponents are likely to oppose any prospect that negotiations lead to resumption. They can advance this aim through extreme demands on terms of resumption likely to be unacceptable to others, or through procedural obstruction. These actions will resemble the hard-bargaining tactics parties sometimes use to seek favorable resolution in distributive negotiations. These can be highly effective, but are limited if other parties can agree on resumption without including the parties using them.

In risk-management moratoria, categorical opponents will similarly seek to ensure that interim activities to characterize and control the risks of concern do not lead to resumption. With a moratorium in place, proposals to resume already bear some degree of burden to show that risks are adequately understood and controlled. In this context, categorical opponents' aim can be further advanced by either establishing a high standard of proof or weakening the interim activities to ensure they cannot meet that standard. To this end, opponents may seek to assign questions to risk assessment bodies that are beyond their capability: either questions that are scientific in form but practically unanswerable due to data or observational limits, or questions that embed normative judgments and are thus not subject to scientific resolution.²⁹⁶ They may invoke democratic legitimacy to refuse full autonomy to a non-political expert body, instead demanding ongoing political control over the assessment process so as to preserve the ability to reject its results if they disagree. Or they may simply starve or undermine the process, because with non-resumption established as the default or status-quo position, inconclusive or failed assessments meet their aims as well as those that give their preferred answers.

Our cases show diverse examples of such marginalized or obstructed assessment processes. The ocean dumping moratorium required an affirmative finding of safety to allow resumption, but repeated assessments – first by an expert body, then under partial political control – struggled to reach clear conclusions in the face of severe knowledge limits. The resultant ambiguous assessments let both sides entrench their positions, until dumping eventually became unattractive even to its former proponents, who gave up. In whaling, a Scientific Committee charged with assessing extinction risk could not effectively rebut methodological criticisms and precautionary arguments advanced by categorical opponents of whaling. Repeated scientific findings that some species could be hunted without extinction risk, which opponents judged irrelevant to their concerns, failed to mitigate disagreement and may have contributed to heightened conflict and reduced legitimacy of the institution. In cloning, an expert panel given a broad charge including both health risks and ethical concerns was unable to address the latter, so instead recommended continuing the moratorium based on health risks to cloned individuals – thus both relying on suspect results that were unlikely to persist, and missing the point about the actual grounds for opposition.

This discussion may suggest that categorical opponents' stances toward moratoria are purely pretextual,²⁹⁷ but we regard this conclusion as too strong. We have posited categorical opposition as a hypothetical extreme case, but actors' preferences in practice are unlikely to be known with certainty or fixed over time. The boundary between categorical opposition and risk-management or bargaining concerns is thus diffuse – uncertain, subject to misrepresentation, context-dependent,

²⁹⁶ See generally ALVIN WEINBERG, *SCIENCE AND TRANS-SCIENCE* (1973).

²⁹⁷ Spivak and Cohen.

and changeable over time. When categorical opposition co-exists with bargaining interests, the boundary is mediated by intensity of preferences over benefits related to resumption, and by aggressive bargaining tactics. While true categorical opposition precludes full agreement on resumption, negotiations to resume can also fail due to extreme demands and tactics, even without categorical opposition. Ironically, if agreement to resume is reached, parties who are near-categorical opponents – or who persuade others that they are – are likely to gain highly favorable terms.

When categorical opposition co-exists with risk-management motives, the boundary is mediated by precautionary attitudes toward risk. Because fully confident characterizations of risks and responses are never available, parties' interpretation of assessment outputs will always reflect their risk attitudes and framing, which can vary widely even among non-categorical opponents. Highly precautionary actors may seek to avoid risks that are low-probability or weakly characterized, or may consider a broader range of risk mechanisms and potential outcomes, resulting in a stance toward material risks that in practice is difficult to distinguish from categorical opposition.

An important interaction between risk management and categorical opposition, which is often prominent for new areas of scientific research or technology, concerns risk mechanisms that depend on how policy-makers or others use advances in knowledge or capability or adjust behavior or attitudes in response to them. The clearest and most direct concerns from such interactions arise in research or technology with implications for weapons, when new knowledge or capability may be used maliciously. Such concerns were expressed in both lab-safety cases and the review process now operating for viral gain-of-function research attempts to address them. Less direct concerns about socio-politically mediated risk mechanisms were raised in all cases on human reproduction and development, from relatively concrete speculation that clinical use of fetal tissue might lead to an increase in elective abortions, to diffuse concerns about broad changes in human behavior or attitudes that were advanced in all these cases. These concerns are generally expressed as material risks rather than moral objections, but they blur this boundary because they depend on speculations about future behavioral change. They are ill suited to scientific risk assessment or technical responses, which rarely consider human behavior as a determinant of risk except in military and strategic planning domains. Other than viral gain-of-function, in none of our cases did the response address such concerns, and organizers of the rDNA moratorium explicitly rejected them. These concerns are prominent, however, in current debate over the socio-technical disruptions that we address in the next paper, where we will consider their implications in detail.

In practice, it may not be possible to establish confidently whether opposition to an activity is categorical or contingent, or whether support for a moratorium is pretextual or sincere. This is partly because states of mind including motivations are not observable, and may even be uncertain to the actors holding them. It is also because moratoria on strongly contested issues may remain in place a long time, either through repeated extensions or a lack of clear termination conditions – during which all relevant conditions may change. In such cases, in addition to the specific functions we ascribe to them, moratoria also serve as tools of delay – and under conditions of uncertainty and conflict, mere delay can bring substantial benefits. If conflict on one issue is obstructing a broader agreement that parties want, delaying resolution of the difficult point can let the broader negotiations proceed. Simply agreeing on mutually acceptable terms of delay in adopting a moratorium can provide an experience of agreement that is lower-stakes and easier to reach than a full resolution. These interim, lower-stakes negotiations may help parties build communication and

trust, reduce tension, or explore creative resolutions to their conflicts.²⁹⁸

A moratorium-induced delay can also allow external conditions to change, either in reaction to the moratorium or independently. A moratorium on an activity for which there is high demand will create strong incentives to identify and develop substitutes for the activity. If the substitutes do not raise the same objections as the suspended activity, their development may weaken support for it. Our cases showed such developments in dumping, via development of non-ocean disposal methods; in nuclear testing, via development of underground, sub-scale, and model-based alternatives; and to a limited extent in fetal research, via developing sources of research materials whose production does not destroy embryos. Through such processes, a moratorium can help give supporters of the contested activity the benefits they sought through other means while gradually hardening into a narrow prohibition, letting conflict over the contested activity fade away.

Conditions for disposition of a contested activity can also change due to independent trends or events that occur during a moratorium. Changes in relevant knowledge or capabilities, or shifts in political alignments, may either strengthen opponents so they can achieve a full prohibition, or weaken them so they accept narrowing or ending the moratorium. Events or passage of time during a moratorium can also change actors' knowledge, perceptions, or preferences, strengthening support or opposition or changing the terms of both. Initially categorical opponents may come to recognize that certain actions or events may make the activity less unacceptable to them, blurring the boundary between categorical opposition and other motivations. Indeed, what initially appears as categorical opposition may be revealed over time to be a proxy or shorthand, a precautionary initial stance of rejection toward something on which actors have not developed well informed or confident views. Any of these trends may move the activity into less contested space, or otherwise make the conflict more tractable. In these various ways, a moratorium long in place may ease conflict even without explicit subsequent agreement, by throwing sand in the gears of change so perceptions, expectations, preferences, and institutions can adapt to changes in knowledge or capabilities that may be profoundly disruptive on shorter time-scales, eventually allowing new acceptable and stable resolutions of the contested activity to emerge. We conjecture that such diffuse longer-term contributions of moratoria may be especially important in addressing contested activities that are new and dissimilar to familiar issues or decisions, on which actors' initial perceptions and judgments may be preliminary, based on limited evidence, and unstable.

IV. CONCLUDING OBSERVATIONS

To understand the potential contribution of moratoria to managing high-stakes socio-technical disruptions, we have examined fifteen past and current cases of moratoria, adopted in diverse international, scientific, and technological areas. We describe moratoria by three principal design characteristics – the actors adopting and bound by them, the scope of activities they suspend, and their conditions for termination – and have also noted the parallel activities conducted during moratoria to promote agreed disposition of the suspended activity at the end of the moratorium.

Of our fifteen cases, four ended with decisions to resume the suspended activities: the two laboratory safety cases and two of the three transboundary resource management issues. Three

²⁹⁸ J.K. Sebenius & David Lax, *Thinking Coalitionally: Party Arithmetic, Process Opportunism, and Strategic Sequencing*, in *NEGOTIATION ANALYSIS* 153, (H. Peyton Young ed., 1992).

hardened into prohibitions: nuclear testing, ocean dumping of low-level radioactive waste, and energy and minerals development in the Torres Strait. Three persist but have but have had their impact changed or weakened by exemptions or innovation around their scope: commercial whaling, fetal research, and chimera research. And five remain in force relatively unchanged – Antarctic territorial claims and mining, human cloning, and the two policy moratoria under the WTO – although one of these, the e-commerce duties moratorium, is now scheduled to lapse and the suspended activities resume absent action to the contrary.

From these cases, we have proposed a preliminary analytic framework for examining design, purposes, and outcomes of moratoria, based on a taxonomy of three ideal types distinguished by actors' principal aims in adopting them. Risk management moratoria suspend activities believed to present serious shared risks, to allow research, assessment, and development of controls to understand and manage the risk. They may be adopted by coalitions including both insiders – those who might otherwise engage in the suspended activity – and others. To achieve the aim of a risk-management moratorium, the actors bound and substantive scope must suspend the activities judged to present risks, without restricting the parallel activities of research, assessment, or development of control measures needed to characterize and manage risks. Termination conditions must be related to successful completion of these activities. Bargaining moratoria suspend provocative or escalatory actions that threaten potential joint benefits, to allow negotiations to realize and allocate those gains. Their scope covers those actions perceived as provocative or escalatory, while relevant actors include those who might share in the joint gains but be tempted to engage in the suspended actions. Their termination conditions are related to achieving the desired agreement.

These two types occur in nearly pure cases, where adopting actors broadly agree on the nature of threat posed by the suspended activity and the conditions necessary to decide its subsequent disposition. The third type, principled conflict moratoria, suspends an activity that some actors oppose categorically, their opposition not mitigated by advancing knowledge or control of material risks or negotiated agreement on related decisions. Unlike risk-management and bargaining moratoria, these do not admit consensual resolution and are more likely to appear in mixed-type moratoria along with other interests than in pure forms.

Mixed-type moratoria are those whose adoption is motivated by more than one of the three types of interest we have identified. When moratoria are motivated by both risk-management and bargaining interests, the two interests may have different implications for scope, actors bound, and termination conditions that require compromise or adjustment, particularly if the two types of interest are primarily represented by different actor groups or shift in relative prominence over time.

Mixed-type moratoria in which principled or categorical opposition is present with other motivations may exhibit recalcitrant conflict. Categorical opponents would prefer to fully prohibit the targeted activity, so adopting a moratorium is a compromise in which they must cooperate with other actors whose opposition is contingent, motivated by risk or bargaining concerns. Predictable differences follow in moratorium design and management, with categorical opponents favoring covered actors and scope broader than warranted by risk or bargaining considerations, possibly including benign activities intended to inform future disposition. Categorical opponents will also favor strong barriers against future contraction or termination of the moratorium, via termination conditions that are ambiguous, contestable, or not explicitly stated at all. Interaction of categorical opponents in mixed types can lead to recalcitrant conflict, under which moratoria fail to resolve through either risk-management or bargaining processes and may persist a long time. Even in such cases, however, moratoria can be helpful merely by delaying or re-directing conflict. Moratoria

may create incentives to develop alternatives to the contested activity that avoid the original concerns, clarify the interests favoring or opposing the activity, or allow time for external events to change relevant actors' knowledge, preferences, or resources, thus shifting the original conflict to allow clearer resolution, or reducing its saliency.

Our second companion paper will apply and extend this analytic framework to consider the potential contributions of moratoria to managing the three most prominent socio-technical disruptions now on legal and policy agendas in the US and internationally: gene editing, artificial intelligence, and geoengineering. We will critically review existing moratorium proposals, characterize the range of objections and concerns that motivate the proposals, and offer practical guidance regarding what contributions moratoria can make on each issue and how they might be designed to most effectively realize those contributions. To do this, we will extend the conceptual framework presented in this paper to address the most salient differences between these issues and the cases upon which we developed the framework. Debate over these issues exhibits strong concerns related to risk management, bargaining, and principled conflict that align substantially with the parallel concerns in our historical cases. But addressing these issues requires a more extensive and explicit treatment of risk mechanisms mediated by hypothesized behavior changes in response to new knowledge or capabilities, and a more detailed examination of the interactions between these mechanisms of concern and the three concerns that organize our initial conceptual framework in this paper. We expect that a thorough exploration of the uses of moratoria in these cases will be informative and useful in considering the potential role and contribution of moratoria in additional socio-technical disruptions that may follow these, either via further development of specific aspects of these three areas or through further advances in research or technology that present new concerns.