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THE LONG-TERM TORT: IN SEARCH OF A NEW CAUSATION FRAMEWORK FOR NATURAL RESOURCE DAMAGES

Sanne H. Knudsen

ABSTRACT—Recent scientific evidence is proving that toxic releases have long-term, unintended, and harmful consequences for the marine environment. Though a new paradigm is emerging in the scientific literature—one demonstrating that long-term impacts from oil spills are more significant than previously thought—legal scholars, regulators, and courts have yet to consider the law's ability to remedy long-term ecological harms. While scholars have exhaustively debated causation questions related to latent injuries for toxic torts, they have overlooked the equally important and conceptually similar causation problems of long-term damages in the natural resource context. Likewise, only a few courts have considered the standards of proving causation for natural resource damages. They have not considered long-term injuries.

This Article provides a foundation for developing causation frameworks that respect the complexities of long-term ecological harms. Specifically, this Article uses scientific research to illustrate the causal difficulty of proving long-term ecological injuries. In doing so, it establishes the foreseeability of long-term injuries and the inadequacy of applying a traditional torts paradigm. Ultimately, this Article looks to toxic tort law and risk-of-injury cases for possible approaches to the causation challenges raised by long-term ecological injuries—these are challenges that, like latent toxic tort injuries, raise issues of time delay, aggregate exposure, synergistic effects, and multiple possible sources of harm.

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INTRODUCTION

With news cameras watching and oil still visible, it is easy to see the direct and devastating impacts of a spill in the days, weeks, and months following an oil spill disaster. In Prince William Sound—in the wake of the *Exxon Valdez* Oil Spill of 1989—the bird carcasses lined up on oily beaches bore a striking resemblance to bodies on a battlefield.[1] In San Francisco Bay—in the wake of the *Cosco Busan* Spill of 2007—tides carried a plume of heavy fuel beneath the Golden Gate Bridge as wildlife rescue workers combed beaches to save birds, fish, invertebrates, and marine mammals.[2] In the Gulf of Mexico—in the wake of the BP Gulf Oil

[1] Body counts were high in the wake of the Exxon spill. Searchers found carcasses of 1016 sea otters, 36,309 seabirds, and 144 eagles. JOE HUNT, MISSION WITHOUT A MAP: THE POLITICS AND POLICIES OF RESTORATION FOLLOWING THE EXXON VALDEZ OIL SPILL 5 (2009), *available at* http://www.nmfs.noaa.gov/ocs/mafac/meetings/2010_06/docs/mission_without_map_evos.pdf (providing a documented history, derived mostly from the public record and personal interviews, of the *Exxon Valdez* Oil Spill Trustee Council, a group of federal and state government trustees responsible for assessing and restoring natural resource injuries). These estimates represented only a fraction of the true death toll given that most carcasses sink. J.A. Wiens, *Recovery of Seabirds Following the* Exxon Valdez *Oil Spill*, *in* EXXON VALDEZ OIL SPILL: FATE AND EFFECTS IN ALASKAN WATERS 854, 870 (Peter G. Wells, James N. Butler & Jane S. Hughes eds., 1995) [hereinafter FATE AND EFFECTS].

[2] *See* Bryan Walsh, *Oily: How a San Francisco Oil Spill Took Its Toll on Fish*, TIME SCI. & SPACE (Dec. 28, 2011), http://science.time.com/2011/12/28/oily-how-a-san-francisco-oil-spill-took-its-toll-on-fish/; *see also* Terence Chea, *San Francisco Oil Spill Threatens Wildlife*, NAT'L GEOGRAPHIC NEWS (Nov. 9, 2007), http://news.nationalgeographic.com/news/2007/11/071109-AP-bay-spill.html. The *Cosco Busan* spill released "about 53,000 gallons of fuel oil into the San Francisco Bay" when the ship

Spill of 2010—oil-stained pelicans, dead and dying deep sea corals, and green sea turtle necropsies[3] gave glimpses of the ecological suffering that lurked in the shadows of burning oil fires.[4]

When the world's media outlets are flooded with graphic imagery of dead birds, oil-covered otters, and stranded whales, calls for greater vigilance in the form of tighter regulations are soon to follow.[5] Public outcry and political motivation similarly press government trustees to assess damages and hold responsible parties liable through civil and criminal settlements.

As striking as the images of oil and death are in the immediate wake of oil spills, the highly visible physical impacts of the spills fade relatively quickly. A more sinister set of concerns about long-term harms soon begins

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collided with the San Francisco–Oakland Bay Bridge in November 2007. NAT'L TRANSP. SAFETY BD., MARINE ACCIDENT REPORT: ALLISION OF HONG KONG-REGISTERED CONTAINERSHIP M/V *COSCO BUSAN* WITH THE DELTA TOWER OF THE SAN FRANCISCO–OAKLAND BAY BRIDGE, SAN FRANCISCO, CALIFORNIA, NOVEMBER 7, 2007 xi (2009).

> No injuries or fatalities resulted from the accident, but the fuel spill contaminated about 26 miles of shoreline, killed more than 2,500 birds of about 50 species, temporarily closed a fishery on the bay, and delayed the start of the crab-fishing season. Total monetary damages were estimated to be $2.1 million for the ship, $1.5 million for the bridge, and more than $70 million for environmental cleanup.

Id. The National Transportation Safety Board concluded that the pilot's use of "impairing prescription medications" was the most likely cause of the collision. *Id.*

[3] A necropsy is "an autopsy performed on an animal." *Necropsy Definition*, MERRIAM-WEBSTER, http://www.merriam-webster.com/dictionary/necropsy (last visited Mar. 12, 2014).

[4] The BP Gulf Oil Spill occurred on April 20, 2010, when the two-and-a-half-mile deep Macondo well exploded, leading to the sinking of BP's *Deepwater Horizon* drilling rig, the death of eleven crew members, and "the largest oil spill in U.S. history." NAT'L COMM'N ON THE BP DEEPWATER HORIZON OIL SPILL & OFFSHORE DRILLING, DEEP WATER: THE GULF OIL DISASTER AND THE FUTURE OF OFFSHORE DRILLING, REPORT TO THE PRESIDENT vi–vii (2011) [hereinafter DEEP WATER COMMISSION REPORT], *available at* http://www.gpo.gov/fdsys/pkg/GPO-OILCOMMISSION/pdf/GPO-OILCOMMISSION.pdf. The spill released more than 170 million gallons of oil into the Gulf of Mexico. Press Release, Nat'l Comm'n on the BP Deepwater Horizon Oil Spill and Offshore Drilling, Oil Spill Commission Landmark Report on Gulf Disaster Proposes Urgent Reform of Industry and Government Practices to Overhaul U.S. Offshore Drilling Safety 8 (Jan. 11, 2011) (on file with the *Northwestern University Law Review*). In the words of Commission Co-Chair William K. Reilly, the oil that spilled from the Macondo well "will harm the natural ecology of the Gulf in ways that will take decades to understand." *Id.* For an example of striking photographs in the wake of the BP Gulf Oil Spill, see *Gulf Oil Spill*, NAT'L GEOGRAPHIC, http://ngm.nationalgeographic.com/2010/10/gulf-oil-spill/gulf-spill-photography (last visited Mar. 12, 2014). *See also Louisiana Oil Spill 2010 Photos: Gulf of Mexico Disaster Unfolds*, HUFFINGTON POST, http://www.huffingtonpost.com/2010/04/30/louisiana-oil-spill-2010_n_558287.html#s159581 (last updated May 25, 2011).

[5] Though to many a distant memory, some consider the disturbing and dramatic images of the Santa Barbara oil spill of 1969 a significant catalyst in the birth of the modern-day environmental movement. *See* Sam Kalen, *Ecology Comes of Age: NEPA's Lost Mandate*, 21 DUKE ENVTL. L. & POL'Y F. 113, 138–39 (2010). Similarly, it is well accepted that outrage over the devastation in Prince William Sound, Alaska, directly spurred Congress to enact the Oil Spill Act of 1990 in an effort to shore up oil prevention and response regulations. *See, e.g.*, Janet E. Milne, *Earmarking for Environmental Damage: From Oil Spills to Climate Change*, 41 ENVTL. L. REP. NEWS & ANALYSIS 10,334, 10,335 (2011).

to set in. What are the long-term impacts of the *Exxon Valdez* Oil Spill on the Prince William Sound ecosystem? Why have the Pacific herring all but disappeared from Prince William Sound when the fishery was reporting record numbers just before the spill?[6] Is lingering oil still toxic to the harlequin ducks and sea otters that feed in intertidal areas?[7] Why are pink salmon eggs dying in streams exposed to weathered oil?[8] Does the decline of sea lions relate to the disappearance of herring, and is this ultimately connected to the spill?[9] How do the impacts of the *Exxon Valdez* Oil Spill compare to impacts of other environmental stressors like climate change?[10]

Similar questions have emerged following more recent oil spills. What is causing the abnormally high mortality of green sea turtles in the Gulf of Mexico?[11] Will the chemical dispersants used to clean up the BP spill have long-term toxic effects on marine life in the Gulf?[12] Is the National Academy of Sciences correct when, after the *Cosco Busan* Oil Spill, it

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[6] *See, e.g.*, S.D. RICE & M.G. CARLS, PRINCE WILLIAM SOUND HERRING: AN UPDATED SYNTHESIS OF POPULATION DECLINES AND LACK OF RECOVERY 2, 3 (2007), *available at* http://www.evostc.state.ak.us/Store/FinalReports/2005-050794-Final.pdf ("Although linkage of the 1993 collapse with the oil spill cannot be proved or disproved with certainty, reasons for poor recovery since the collapse remain perplexing."); *id.* at 3 (noting the "root causes" why the herring population has failed to recover for the past thirteen years are unknown).

[7] *See, e.g.*, Daniel Esler et al., *Cytochrome P4501A Biomarker Indication of Oil Exposure in Harlequin Ducks up to 20 Years After the* Exxon Valdez *Oil Spill*, 29 ENVTL. TOXICOLOGY & CHEMISTRY 1138 (2010) [hereinafter *Harlequin Duck Study*] (discussing numerous studies aimed at understanding whether species in the intertidal zone are exposed to lingering oil).

[8] *See, e.g.*, Stanley D. Rice et al., *Synthesis of Long-Term Impacts to Pink Salmon Following the* Exxon Valdez *Oil Spill: Persistence, Toxicity, Sensitivity, and Controversy*, 9 REVS. FISHERIES SCI. 165 (2001) (trustee-funded research suggesting long-term impacts from oil spill). *Cf.* E.L. Brannon et al., *Review of the* Exxon Valdez *Oil Spill Effects on Pink Salmon in Prince William Sound, Alaska*, 20 REVS. FISHERIES SCI. 20, 57 (2012) (Exxon-funded research critiquing trustee-funded studies and concluding that "pink salmon were not measurably damaged by the *Exxon Valdez* oil spill").

[9] *See* Richard E. Thorne & Gary L. Thomas, *Herring and the "Exxon Valdez" Oil Spill: An Investigation into Historical Data Conflicts*, 65 ICES J. MARINE SCI. 44, 48 (2008) (discussing the interrelationship between the decline of sea lions and the Pacific herring fishery collapse four years after the *Exxon Valdez* Oil Spill).

[10] *See, e.g.*, Mark A. Harwell et al., *A Conceptual Model of Natural and Anthropogenic Drivers and Their Influence on the Prince William Sound, Alaska, Ecosystem*, 16 HUM. & ECOLOGICAL RISK ASSESSMENT 672 (2010) [hereinafter *Conceptual Model*] (Exxon-funded research examining the natural processes, anthropogenic drivers, and resultant stressors that affect Prince William Sound, including the *Exxon Valdez* Oil Spill).

[11] *See* Shaila Dewan, *Sifting a Range of Suspects as Gulf Wildlife Dies*, N.Y. TIMES, July 15, 2010, at A1. For slideshow images, see *The Mystery of the Dead Sea Turtles*, N.Y. TIMES, http://www.nytimes.com/slideshow/2010/07/14/science/earth/20100715-NECROPSY-1.html (last visited Mar. 12, 2014).

[12] For a discussion of the controversial use of dispersants after the BP Gulf Oil Spill, see Robin Kundis Craig, *Legal Remedies for Deep Marine Oil Spills and Long-Term Ecological Resilience: A Match Made in Hell*, 2011 BYU L. Rev. 1863, 1865.

concludes "that even relatively small spills can have long-lasting biological effects"?[13]

While scientists are only just beginning to examine the potential for long-term impacts after recent oil spills, the science generated in the twenty-five year aftermath of the *Exxon Valdez* Oil Spill provides some guidance. Hundreds of millions of dollars have been spent studying the Prince William Sound in the hopes of understanding how the marine ecosystem responds to an oil spill disaster like the Exxon spill.[14] Industry and government scientists have generated countless studies and data trying to make sense of a complex ecosystem.[15]

Through these massive efforts, a new paradigm is emerging in the scientific literature. Scientists have learned that oil spills, once thought to cause intense damage only in the weeks or months after the spills, are tenacious. The oil lingers longer than expected and in more toxic forms than expected. Long after the media hype has calmed and nonlocal communities have moved on with their lives, the oil continues to disrupt ecosystems through sublethal, chronic injuries.

In a world where scientific evidence is mounting, it becomes increasingly necessary to ask whether the law adequately allows recovery for long-term natural resource injuries. Theoretically, the answer is yes. Federal statutes like the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Oil Pollution Act of 1990 (OPA) allow government trustees to recover natural resource damages in the wake of oil spills and other toxic releases.[16] This special category of damages is recovered on behalf of the public and must be used to restore the public resources that were injured by the release.[17] Natural

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[13] Walsh, *supra* note 2.

[14] In the time between the March 1989 oil spill and the October 1991 natural resource damage settlement, approximately $100 million was spent to answer two questions: what was injured by the spill, and how badly? *See* HUNT, *supra* note 1, at 193. After the settlement, over $178 million has been spent for research, monitoring, and general restoration efforts. *See EXXON VALDEZ* OIL SPILL TR. COUNCIL, LEGACY OF AN OIL SPILL: 20 YEARS AFTER *EXXON VALDEZ* 8 (2009), *available at* http://www.evostc.state.ak.us/Universal/Documents/Publications/AnnualStatus/2009AnnualReport.pdf. This figure does not include the $375 million spent in resource protection through habitat acquisition. *Id.*

[15] As of December 2008, Exxon Corporation's bibliography of research related to the *Exxon Valdez* Oil Spill contained citations to 403 scientific journal articles on research funded by Exxon. *See* CARRIE HOLBA, ALASKA RESOURCES LIBRARY & INFO. SERVS., *EXXON VALDEZ* OIL SPILL: FAQS, LINKS AND UNIQUE RESOURCES AT ARLIS 2 (2010), *available at* http://www.arlis.org/docs/vol2/a/EVOS_FAQs.pdf.

[16] *See* Oil Pollution Act, 33 U.S.C. § 2706 (2006); Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. § 9607(f)(1) (2006).

[17] 33 U.S.C. § 2706(f); 42 U.S.C. § 9607(f)(1).

resource damages cover a wide range of injuries, both short-term and long-term.[18]

Theory aside, can government trustees ever truly expect to recover damages for long-term ecological injuries? After all, long-term injuries take time to manifest. Practically, many settlements take place before the full suite of injuries manifests.[19] The long latency period also means that proving a causal link between the oil spill and the later manifested harm will be difficult. Indeed, the critical obstacle to recovering damages for long-term injury is causation. This is especially so when the interplay between exposure pathways, toxicity levels, migratory potential, intervening environmental stressors, and cascading effects is complicated.

Legal scholars, practitioners, and scientists alike have recognized the difficulty of meeting traditional causation standards for natural resource injuries. One government attorney remarked that "[d]iverse risk factors, poorly understood causative mechanisms, mixtures of multiple toxic substances, latency in the manifestation of injuries, and a host of other factors pose impossible proof burdens for plaintiffs under traditional tort standards of causation-in-fact."[20] Consistent with this observation, other scholars have described the burden of proving causation in natural resource damages claims as a "substantial technical barrier to recovery."[21] Likewise, scientists examining long-term impacts from oil spills readily describe

[18] *See* 43 C.F.R. § 11.14(v) (2012) (defining "injury" to include "a measurable adverse change, either long- or short-term, in the chemical or physical quality or the viability of a natural resource resulting either directly or indirectly from exposure to a discharge of oil or release of a hazardous substance or exposure to a product of reactions resulting from the discharge of oil or release of a hazardous substance"); Craig, *supra* note 12, at 1884 ("[N]atural resource damages embody a legal recognition that some forms of pollution, like major oil spills, cause both short-term and long-term damage to species and ecosystems, that this damage matters to human beings as well as to the environment, and that this damage involves substantial economic loss, including costs related to restoration and replacement. Nevertheless, natural resource damages are notoriously difficult to assess and quantify.").

[19] *See, e.g.*, HUNT, *supra* note 1, at 179 ("As time passed on, any connection to the spill has grown more and more faint and, certainly, more difficult to pinpoint and prove.").

[20] Anton P. Giedt, *Natural Resource Damages Under the Oil Pollution Act of 1990: Setting Standards for Causation-of-Injury by Agency Rule-Making*, 45 BAYLOR L. REV. 373, 375 (1993).

[21] James Peck, *Measuring Justice for Nature: Issues in Evaluating and Litigating Natural Resources Damages*, 14 J. LAND USE & ENVTL. L. 275, 296 (1999); *see also* DEEP WATER COMMISSION REPORT, *supra* note 4, at 183–84 ("Identifying and quantifying damages, particularly where complex ecosystems are involved, present enormous challenges. . . . Two sets of determinations—one concerning the baseline conditions against which damages to each species or habitat will be assessed and another concerning the quantification of those damages—are particularly difficult and consequential in terms of overall results."); Gerald F. George, *Litigation of Claims for Natural Resource Damages* (ALI-ABA Course of Study, June 22, 1998), WL SC84 ALI-ABA 951, 962 ("Establishing baseline resource conditions, injury, the extent of resulting change in those baseline conditions, and the causal link between injury and the release is often not easily accomplished. Those issues have occupied a major part of the debate between trustees and potentially responsible parties in the promulgation of natural resource damage assessment regulations. Likewise, those issues can complicate the trustee's litigation of a natural resource damage case.").

long-term effects as "more difficult to recognize and assess, primarily because different toxicity mechanisms are at work and they do not result in an immediate and obvious mortality."[22]

While many scholars have grappled with causation issues in the area of toxic torts, and while some commentators have acknowledged the difficulties of proving causation for natural resource damages, none have identified the emergence of a new scientific paradigm or given any significant attention to the causation challenges implicated by proving long-term ecological harm. Certainly none have undertaken the task of surveying tort law to offer a solution. This Article provides the academic foundation for providing a remedy for long-term ecological injuries.

This Article proceeds in four parts. Part I draws on the scientific literature to establish the need for a new causal paradigm for proving natural resource damages. Having established the foreseeability of long-term harms and the inadequacy of the traditional tort paradigm, Part II assesses the appropriateness of adopting a new causal paradigm in light of the statutory framework, jurisprudence, and central tenets of tort law. Part III identifies the core causation challenges that lie at the heart of proving long-term ecological injuries. Finally, Part IV offers some solutions by surveying tort law for approaches to situations where latent injuries take time to manifest and are often influenced by multiple intervening stressors.

The questions examined in this Article have implications for how government trustees choose to structure claims for natural resource damages. One example of how such claims have previously been structured is the *Exxon Valdez* Oil Spill. Government trustees settled the resulting claims in 1991, less than three years after the *Exxon Valdez* ran aground on Bligh Reef. At that time, no one thought significant amounts of oil would linger in toxic forms; no one expected that fifteen species would still be listed as unrecovered more than two decades after the spill.[23] Certainly no one anticipated that the Pacific herring fishery would collapse in 1993 and remain closed for eighteen of the twenty-four years following the spill, including every year since 1999.[24]

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[22] Robert E. Thomas et al., *Induction of DNA Strand Breaks in the Mussel (*Mytilus trossulus*) and Clam (*Protothaca staminea*) Following Chronic Field Exposure to Polycyclic Aromatic Hydrocarbons from the* Exxon Valdez *Spill*, 54 MARINE POLLUTION BULL. 726, 726 (2007); *see also Harlequin Duck Study*, *supra* note 7 (recognizing that "subtle effects . . . may be difficult to detect in nature").

[23] *EXXON VALDEZ* OIL SPILL TR. COUNCIL, *EXXON VALDEZ* OIL SPILL RESTORATION PLAN, 2010 UPDATE: INJURED RESOURCES AND SERVICES 7 (2010) [hereinafter 2010 UPDATE], *available at* http://www.evostc.state.ak.us/universal/documents/publications/2010IRSUpdate.pdf (listing fifteen species as "recovering," "not recovering," or "unknown").

[24] *See generally* Sanne Knudsen, *A Precautionary Tale: Assessing Ecological Damages After the* Exxon Valdez *Oil Spill*, 7 U. ST. THOMAS L.J. 95, 102–07 (2009) (describing collapse and circumstantial evidence linking Pacific Herring fishery collapse to the *Exxon Valdez* Oil Spill).

Knowing that they lacked complete information about long-term injuries, government trustees included a reopener provision in the settlement agreement for the *Exxon Valdez* case. The provision allowed trustees to make an additional one-time demand for then-unknown injuries sometime between 2002 and 2006. Such reopener provisions are fairly common in other natural resource damages settlements as well.[25] At first glance, reopener provisions might seem to solve the problem of timing. Not so. Even if settlements contain reopener provisions that theoretically allow for additional compensation for long-term injuries, those injuries have to be proven. In the case of Exxon, trustees have made an almost $100 million demand for additional damages under the terms of the reopener provision. These demands have been met mainly with silence and some suggestions that Exxon will challenge the alleged long-term injuries on causation grounds.[26]

In the case of the *Exxon Valdez* Oil Spill, the BP Gulf Oil Spill, and others, trustees will have to understand the limits of what science can prove in the face of the legal obstacles inherent in the current natural resource damages framework. Courts are just beginning to struggle with the causal issues and standards in natural resource damages cases. Only a few have considered the issue of proving causation for natural resource damages. Those that have examined the issue have taken a fairly cursory glance and have not considered long-term injuries or the oil spill context. This Article fully explores whether a relaxed causal standard would be appropriate and provides some guidance on how to approach the problem.

Ultimately, this Article recommends adopting a lenient version of the substantial factor test (termed by some courts as the contributing factor test), provided that courts clarify the parameters of the test. In particular, a meaningful and appropriate test would recognize that natural forces combine with man-made forces to create injuries. Notably, the substantial factor test should be satisfied by showing that the defendant's actions increased the risk of the injury, rather than by proving the precise biological pathway resulting in the injury.

I. THE NEED FOR A NEW CAUSAL PARADIGM

Long-term injuries following oil spills are of increasing concern. Scientists studying impacts from large-scale oil spills like the *Exxon Valdez* Oil Spill have begun to observe that "[i]n contrast to the short-term effects of crude oil spills, long-term biological impacts are more difficult to

[25] *See* HUNT, *supra* note 1, at 31 (noting that "reopeners had become a routine part of restoration settlements"); *see also id.* at 248–50 (discussing reopener). *See generally* William H. Rodgers, Jr. et al., *The* Exxon Valdez *Reopener: Natural Resource Damage Settlements and Roads Not Taken*, 22 ALASKA L. REV. 135 (2005) (providing a detailed history of the reopener).

[26] Opposition of Defendants Exxon Corp. et al. to Motion of Richard Steiner for Leave to File *Amicus Curiae* Brief at 4, U.S. v. Exxon Corp., No. 3:91-cv-00082-HRH (D. Alaska Feb. 25, 2011).

recognize but can have serious population and ecosystem impacts."[27] Research after lesser known oil spills like the one in San Francisco Bay is reaching similar conclusions. To that end, a study published in the *Proceedings of the National Academy of Sciences* presented somewhat surprising findings that even smaller scale spills can have long-lasting biological effects.[28] One researcher remarked: "Based on our previous understanding of the effects of oil on embryonic fish, we didn't think there was enough oil from the *Cosco Busan* spill to cause this much damage."[29]

Concerns about the long-term impact of the BP Gulf Oil Spill have already drawn much attention from scientists and federal agencies.[30] The Marine Mammal Commission,[31] with input from related federal agencies, released a statement of research needs intended to guide the assessment of the BP spill's long-term effects on the Gulf of Mexico.[32] Drawing from emerging science and lessons learned as a result of the *Exxon Valdez* spill, the Commission anticipates that "long-term effects are a reasonable concern for Gulf marine mammals because of the amount of oil spilled, the quantity of dispersants applied both at the surface and at the wellhead, the low recovery rates of spilled oil, uncertainty regarding the eventual disposition of both oil and dispersants, and uncertainty regarding the effects

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[27] Thomas et al., *supra* note 22. *See generally* J. STEVEN PICOU & CECELIA G. MARTIN, LONG-TERM COMMUNITY IMPACTS OF THE *EXXON VALDEZ* OIL SPILL: PATTERNS OF SOCIAL DISRUPTION AND PSYCHOLOGICAL STRESS SEVENTEEN YEARS AFTER THE DISASTER (2007), *available at* http://www.arlis.org/docs/vol1/B/243478793.pdf (discussing disruptions to subsistence communities in decade after the spill).

[28] John P. Incardona et al., *Unexpectedly High Mortality in Pacific Herring Embryos Exposed to the 2007* Cosco Busan *Oil Spill in San Francisco Bay*, 109 PROC. NAT'L ACAD. SCI. E51 (2012).

[29] Walsh, *supra* note 2 (quoting Gary Cherr, coauthor of a National Academy of Sciences study about long-term biological effects of small oil spills).

[30] *See, e.g.*, Jane Lubchenco et al., *Science in Support of the* Deepwater Horizon *Response*, 109 PROC. NAT'L ACAD. SCI. 20,212, 20,217 (2012) ("Similar to the EVOS spill, some effects may be unknown or unappreciated for years, if ever."); Helen K. White et al., *Impact of the* Deepwater Horizon *Oil Spill on a Deep-Water Coral Community in the Gulf of Mexico*, 109 PROC. NAT'L ACAD. SCI. 20,303, 20,306 (2012) ("[I]t is too early to fully evaluate the footprint and long-term effects of acute and subacute exposure to potential waterborne contaminants resulting from the *Deepwater Horizon* oil spill."). For a short description of various scientific studies underway, see Jeff Smith, *Gulf Spill Pictures: Ten New Studies Show Impact on Coast*, NAT'L GEOGRAPHIC (Apr. 19, 2012), http://news.nationalgeographic.com/news/energy/2012/04/pictures/120420-gulf-oil-spill-impact-studies/#/deepwater-horizon-small-organism_51859_600x450.jpg.

[31] The Marine Mammal Commission is an independent agency of the U.S. federal government that was created under Title II of the Marine Mammal Protection Act of 1972. *See* 16 U.S.C. § 1401 (2006); *About the Marine Mammal Commission*, MARINE MAMMAL COMMISSION, http://www.mmc.gov/about/welcome.shtml (last visited Mar. 12, 2014).

[32] MARINE MAMMAL COMM'N, ASSESSING THE LONG-TERM EFFECTS OF THE BP DEEPWATER HORIZON OIL SPILL ON MARINE MAMMALS IN THE GULF OF MEXICO: A STATEMENT OF RESEARCH NEEDS 10–11 (2011), *available at* http://www.mmc.gov/reports/workshop/pdf/longterm_effects_bp_oilspil.pdf.

of the spill and response on features of the ecosystem important to marine mammals."[33]

Using the *Exxon Valdez* Oil Spill as a case study, this Part begins by surveying the scientific literature for mounting evidence of long-term injuries, illustrating why there is a notable shift in the foreseeability of these injuries. Because foreseeability is central to the proximate cause inquiry at the heart of tort liability,[34] the emerging understanding of long-term impacts ought to change the approach of government trustees in formulating natural resource damages demands and in the approach of courts reviewing the viability of those demands. In particular, the increased foreseeability of long-term harms lends greater support to the idea that responsible actors be held liable for long-term harms.[35]

Because liability in tort also turns on one's ability to prove some "reasonable connection" between the defendant's act and the plaintiff's injury[36] (causation-in-fact),[37] this Part goes on to illustrate why ascertaining a definitive causal pathway for suspected long-term injury is as complicated as Mother Nature herself. Finally, having established the complexity of proving long-term injury as a matter of science, this Part examines why a traditional causal standard is inappropriate for assessing long-term natural resource damages.

A. The Foreseeability and Significance of Long-Term Injuries

Extensive scientific studies of the Prince William Sound ecosystem in the wake of the *Exxon Valdez* Oil Spill have advanced our understanding of the breadth and depth of oil spill injuries. Those studies have revealed a

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[33] *Id.* at 10 (citation omitted).

[34] *See* W. Jonathan Cardi, *Reconstructing Foreseeability*, 46 B.C. L. REV. 921, 924 (2005) (arguing that foreseeability "might fit wholly and seamlessly within the elements of breach and proximate cause"); *see also* W. Jonathan Cardi, *Purging Foreseeability: The New Vision of Duty and Judicial Power in the Proposed Restatement (Third) of Torts*, 58 VAND. L. REV. 739, 794–804 (2005) (praising the *Restatement (Third) of Torts* for proposing to drop foreseeability from the duty element of tort).

[35] *See* Jed Handelsman Shugerman, *A Watershed Moment: Reversals of Tort Theory in the Nineteenth Century*, 2 J. TORT L. 2, 33–36 (2008) (discussing the relationship between foreseeability and moral accountability in the development of American tort law); *see also* RESTATEMENT (THIRD) OF TORTS: LIABILITY FOR PHYSICAL & EMOTIONAL HARM § 20 cmt. i (2005) (noting that foreseeability may be required before imposing strict liability on the theory that disposal of toxic substances is an abnormally dangerous activity); Guido Calabresi, *Concerning Cause and the Law of Torts: An Essay for Harry Kalven, Jr.*, 43 U. CHI. L. REV. 69, 95 (1975) [hereinafter *Concerning Cause*] ("[T]he general common law rule that, once proximate cause between defendant's fault and the injury exists, liability extends to more serious, but unexpected damages as well, seems to be a good starting point from a market deterrence point of view.").

[36] PROSSER AND KEETON ON THE LAW OF TORTS § 41, at 263 (W. Page Keeton et al. eds., 5th ed. 1984) [hereinafter PROSSER AND KEETON].

[37] *Id.* at 263–72.

pattern of chronic, sublethal effects that can plague ecosystems for many decades.[38]

Central to this growing body of scientific literature is a series of breakthrough studies demonstrating the continued presence of *Exxon Valdez* oil decades after the spill.[39] The first in this series was funded by the Trustee Council in 2001 and was intended to quantify the extent of oil residues remaining in Prince William Sound.[40] A team of researchers, headed by scientist Jeffrey Short, surveyed intertidal areas that were heavily or moderately oiled by the spill.[41] After digging more than 9000 pits at 91 sites, researchers found that over half of the sites were still contaminated with *Exxon Valdez* oil.[42] The degree of oiling ranged "from light sheening; to oil droplets; to [pits filled with] heavy oil."[43] In 2003, additional surveys found significant amounts of oil in the lower intertidal areas.[44] Based on the two studies, more than 21,000 gallons of oil were estimated to remain.[45]

Not only was the amount of oil significant,[46] but also most of the polycyclic aromatic hydrocarbons (PAH) were intact.[47] This meant that the

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[38] For examples of scientific studies that purport to be part of a "growing body of literature," see Daniel Esler et al., *Cytochrome P4501A Biomarker Indication of the Timeline of Chronic Exposure of Barrow's Goldeneyes to Residual* Exxon Valdez *Oil*, 62 MARINE POLLUTION BULL. 609, 610 (2011) [hereinafter Esler, *Goldeneyes*], and *Harlequin Duck Study*, *supra* note 7.

[39] For a summary of research on oil remaining in Prince William Sound following the *Exxon Valdez* Oil Spill, see NAT'L OCEANIC & ATMOSPHERIC ADMIN., REPORT ON RECENT LINGERING OIL STUDIES (2010) [hereinafter LINGERING OIL], *available at* http://www.evostc.state.ak.us/Universal/documents/LingeringOilReport.pdf.

[40] The findings were released as a series of three studies. *See* Jeffrey W. Short et al., *Estimate of Oil Persisting on the Beaches of Prince William Sound 12 Years After the* Exxon Valdez *Oil Spill*, 38 ENVTL. SCI. & TECH. 19 (2004) [hereinafter Short, *Estimate of Oil*]; *see also* Jeffrey W. Short et al., *Slightly Weathered* Exxon Valdez *Oil Persists in Gulf of Alaska Beach Sediments After 16 Years*, 41 ENVTL. SCI. & TECH. 1245 (2007) [hereinafter Short, *Slightly Weathered*]; Jeffrey W. Short et al., *Vertical Distribution and Probability of Encountering Intertidal Exxon Valdez Oil on Shorelines of Three Embayments Within Prince William Sound, Alaska*, 40 ENVTL. SCI. & TECH. 3723 (2006) [hereinafter Short, *Vertical Distribution and Probability*].

[41] Short, *Estimate of Oil*, *supra* note 40, at 19.

[42] *Oil Remains: The Persistence, Toxicity, and Impact of* Exxon Valdez *Oil*, *EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL, http://www.evostc.state.ak.us/index.cfm?FA=status.lingering (last visited Mar. 12, 2014) [hereinafter *Oil Remains*]. "All of the subsurface oil fingerprinted back to the source oil of the *Exxon Valdez*." *Id.* For an explanation of how oil is fingerprinted, see *infra* text accompanying note 107.

[43] *Oil Remains*, *supra* note 42.

[44] Short, *Vertical Distribution and Probability*, *supra* note 40, at 3726; *see also Oil Remains*, *supra* note 42.

[45] *Oil Remains*, *supra* note 42. "Additional surveys outside Prince William Sound have documented lingering oil also on the Kenai Peninsula and the Katmai coast, over 450 miles away." *Id.*

[46] "The amount of *Exxon Valdez* oil remaining substantially exceeds the sum total of all previous oil pollution on beaches in Prince William Sound, including oil spilled during a 1964 earthquake." *Id.* On the other hand, the original spill released an estimated 11 million gallons of oil into Prince William

remaining oil was nearly as toxic as the oil collected in the first weeks after the spill.[48] And the lingering oil was not thought to be disappearing anytime soon. Because the oil was only decreasing at a rate of 0%–4% per year, it would take decades to disappear entirely.[49]

Short's findings rocked the scientific community. The lower half of the intertidal zone is a "biologically-rich area where mussels, clams and other marine life are found in greatest abundance."[50] But the fact that oil remained in this area at toxic levels raised other important questions. After all, the presence of oil does not necessarily mean that animals were exposed to the oil. Indeed, one reason the oil lingers is the oil's location in remote areas that are not subject to much wave action or disturbance.[51]

News of persistent oil raised questions about whether the oil was bioavailable (likely to be absorbed by a living system)[52]: "[W]ere animals such as sea otters and harlequin ducks who feed in the intertidal [zone] . . . being chronically exposed to toxic PAH?"[53] To answer that question, researchers used biomarkers to study whether species like sea otters, harlequin ducks, and Barrow's goldeneye are still exposed to the lingering *Exxon Valdez* oil.[54] In particular, certain genes are expressed in vertebrates when individuals have been exposed to polycyclic hydrocarbons found in crude oil. Researchers can identify gene expression by measuring corresponding levels of enzyme production used to break down the oil.[55] Importantly, biomarkers do not indicate whether exposure to oil has compromised the survival or health of individuals.[56] Nonetheless, studies using biomarkers have confirmed that a number of vertebrates experienced persistent exposure to *Exxon Valdez* oil for more than a decade after the spill.[57] Some of those species include harlequin ducks, Barrow's goldeneye,

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Sound. *Questions and Answers*, *EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL, http://www.evostc.state.ak.us/index.cfm?FA=facts.QA (last visited Mar. 12, 2014).

[47] *See Oil Remains*, *supra* note 42.

[48] *Id.*

[49] *Id.*

[50] *Id.*

[51] LINGERING OIL, *supra* note 39, app. at 1 (noting that by 2001 it was known that oil lingered in Prince William Sound in areas protected by wave disturbance).

[52] *See Bioavailability Definition*, MERRIAM-WEBSTER, http://www.merriam-webster.com/dictionary/bioavailability (last visited Mar. 12, 2014).

[53] *Oil Remains*, *supra* note 42.

[54] *See* LINGERING OIL, *supra* note 39, app. at 11–17 (assembling and summarizing biomarker studies undertaken to assess the degree of residual oil impacting various species in Prince William Sound).

[55] Esler, *Goldeneyes*, *supra* note 38, at 609.

[56] *Id.*; *Harlequin Duck Study*, *supra* note 7.

[57] The biomarker used is P4501, which is an enzyme whose induction is an indicator of oil exposure. Esler, *Goldeneyes*, *supra* note 38, at 609.

adult pigeon guillemots, river otters, and two species of fish: masked greenlings and crescent gunnels.[58]

In the case of harlequin ducks, biomarker studies showed that the ducks in oiled areas had "unequivocally" higher levels of biomarker activity as late as 2009, two decades after the spill.[59] This finding is consistent with the harlequin ducks' life histories and feeding habits. "Harlequin ducks are marine birds that spend most of their annual cycle in intertidal and shallow subtidal zones . . . ."[60] They are common in Prince William Sound during nonbreeding season, have a small body size, and feed on a range of invertebrates found in the intertidal zone, including amphipods, snails, and polychaetes.[61] All of these factors place harlequin ducks at greater risk of exposure to *Exxon Valdez* oil than other sea birds because their behaviors and feeding depend on the very area where lingering oil is most likely to be found.[62]

Because biomarkers only measure exposure to oil, scientists have separately sought to determine whether the exposure to oil is negatively affecting individuals or populations. Detrimental impacts can be shown by depressed population numbers, higher incidence of reproductive failure in oiled areas, or greater incidence of disease in oiled areas.[63]

For harlequin ducks, exposure to oil translated to identifiable injury at least a decade after the spill. Consistent with evidence of exposure, they experienced demographic problems in oiled areas of Prince William Sound.[64] Scientists concluded that "continued exposure to lingering oil was likely a constraint on population recovery."[65] Indeed, some believe that more harlequin ducks have died because of chronic exposure to lingering oil than from acute injuries immediately following the spill.[66] Since the weeks and months following a spill are typically perceived as the period of highest damage,[67] the harlequin duck studies underscore the significance of long-term injuries on ecosystem recovery.

Like harlequin ducks, sea otters have also been unwilling participants in discovering the peril of long-term oil spill injuries. While most otter populations in Prince William Sound have rebounded from the shock of oiling and spill-related poisoning in the immediate aftermath of the spill,

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[58] *Harlequin Duck Study*, *supra* note 7, at 1142.

[59] *Id.*

[60] *Id.* at 1139.

[61] Esler, *Goldeneyes*, *supra* note 38, at 612; *Harlequin Duck Study*, *supra* note 7, at 1139.

[62] *Harlequin Duck Study*, *supra* note 7, at 1139.

[63] *Id.* at 1143.

[64] *Id.* at 1139. In particular, scientists documented "reductions in population trends, densities, and female survival relative to unoiled areas." *Id.* (citations omitted).

[65] *Id.*

[66] Esler, *Goldeneyes*, *supra* note 38.

[67] *Id.*

some populations continue to suffer.[68] The Knight Island population provides a good example.

The northern end of Knight Island is located just thirty-five miles from where the *Exxon Valdez* tanker ran aground and is located directly in the path of the oil.[69] Before the Exxon spill, sea otters thrived around northern Knight Island.[70] As of 2000, the otter population was still only about half of what it had been before the spill.[71] While the population appears to have made progress towards recovery, the 2009 population was still less than 30% of the pre-spill numbers.[72] The slow path to recovery is thought to be caused by continuing exposure to lingering oil: Short's studies have found lingering oil in the intertidal zones of Knight Island; biomarker studies show elevated liver enzymes in sea otters in oiled areas; sea otter behavior puts them at risk of exposure because they dig pits in the intertidal zone to search for food; and necropsies of sea otter carcasses found on northern Knight Island each spring show that mortality has been predominantly in prime-aged individuals (as opposed to the very young or very old, which is more typical).[73]

Related to the issue of how much oil remains in Prince William Sound and the bioavailability of that oil is the issue of how toxic the lingering oil is. Post-Exxon studies have analyzed Alaska North Slope crude oil to

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[68] *Oil Remains*, *supra* note 42.

[69] Janet Raloff, *Otters and Oil: Problems Remain*, SCI. NEWS (Mar. 25, 2009, 8:18 AM), https://www.sciencenews.org/blog/science-public/otters-and-oil-problems-remain.

[70] Scientists estimate that a population of about 165 sea otters inhabited northern Knight Island before the spill. J.L. BODKIN ET AL., U.S. DEP'T. OF THE INTERIOR & U.S. GEOLOGICAL SURVEY, TRENDS IN SEA OTTER POPULATION ABUNDANCE IN WESTERN PRINCE WILLIAM SOUND, ALASKA: PROGRESS TOWARD RECOVERY FOLLOWING THE 1989 *EXXON VALDEZ* OIL SPILL 12 (2011).

[71] *Id.* at 11 (estimating the population in 2000 to be seventy-nine otters).

[72] *Id.* at 13 (noting that the population in 2009 was about 116 otters as compared to 165 otters before the spill); *id.* (concluding that the upward trend since 2003 puts the otters on a path to recovery).

[73] *See* James L. Bodkin et al., *Long-Term Effects of the 'Exxon Valdez' Oil Spill: Sea Otter Foraging in the Intertidal as a Pathway of Exposure to Lingering Oil*, 447 MARINE ECOLOGY PROGRESS SERIES 273, 284 (2012) ("The overlap of lingering oil in the intertidal with intertidal foraging by sea otters provides a reasonable explanation for their slow population recovery."); *see also* J.L. Bodkin & B.E. Ballachey, *Sea Otter: Enhydra Lutris*, RESTORATION NOTEBOOK (*Exxon Valdez* Oil Spill Tr. Council, Anchorage, Alaska), Nov. 1997, at 5, *available at* http://www.evostc.state.ak.us/Universal/Documents/Publications/RestorationNotebook/RN_seaotter.pdf; J.L. Bodkin et al., *Sea Otter Population Status and the Process of Recovery from the 1989 'Exxon Valdez' Oil Spill*, 241 MARINE ECOLOGY PROGRESS SERIES 237 (2002), *available at* http://www.int-res.com/articles/meps2002/241/m241p237.pdf; JAMES L. BODKIN ET AL., PATTERNS AND PROCESSES OF POPULATION CHANGE IN SELECTED NEARSHORE VERTEBRATE PREDATORS: RESTORATION PROJECT 030423 FINAL REPORT 15 (2003); Raloff, *supra* note 69. For counterstudies and counterexplanations regarding the sea otter's plight, see Mark A. Harwell et al., *A Quantitative Ecological Risk Assessment of the Toxicological Risks from Exxon Valdez Subsurface Oil Residues to Sea Otters at Northern Knight Island, Prince William Sound, Alaska*, 16 HUM. & ECOLOGICAL RISK ASSESSMENT 727, 727 (2010) (concluding that "maximum-exposed sea otters would not receive a dose of PAHs sufficient to cause any health effects; consequently, no plausible toxicological risk exists to the sea otter subpopulation at [Northern Knight Island]").

assess its chemical makeup and toxicity as time elapses.[74] The results buck the conventional wisdom that weathered oil is less toxic and less bioavailable than freshly spilled oil. While weathered oil does not release toxins into the environment as readily as freshly spilled oil does, the chemical compounds that are released from weathered oil are more toxic.[75] In other words, lower doses of weathered oil are required to elicit a damaging response.[76] Still, how the toxins from weathered oil cause damage is also not as well understood. Scientists are beginning to discover that different PAH compounds released from oil operate through unique toxic pathways.[77] This means that as time elapses, toxic pathways and potential impacts from oil could fan out over the ecosystem, making it increasingly difficult to gauge the harms caused by an oil spill.[78]

Some long-term impacts from the Exxon spill are unrelated to lingering oil. For instance, two killer whale pods in Prince William Sound are examples of how acute injuries caused by oil spills can have permanent and devastating consequences.[79] In the case of the AB pod, a grouping of resident killer whales, thirteen members died as a result of the spill, including reproducing females.[80] Because many of the animals that were killed were juveniles and females, and because of whales' slow reproductive cycles, it could take decades for the AB pod to recover, in

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[74] RICE & CARLS, *supra* note 6, ch. 1; *see also* John P. Incardona et al., *Cardiac Arrhythmia Is the Primary Response of Embryonic Pacific Herring (*Clupea Pallasi*) Exposed to Crude Oil During Weathering*, 43 ENVTL. SCI. TECH. 201 (2009) (studying the impacts of weathered crude oil on herring embryos to explain long-term impacts of the Exxon spill on the herring fishery collapse).

[75] *See* RICE & CARLS, *supra* note 6, at 1.6.

[76] *See id.* at 1.6–1.8; *see also* Ernest L. Brannon et al., *Risk of Weathered Residual* Exxon Valdez *Oil to Pink Salmon Embryos in Prince William Sound*, 26 ENVTL. TOXICOLOGY & CHEMISTRY 780, 780–81 (2007) (presenting studies on pink salmon embryos suggesting a new chronic toxicity exposure paradigm).

[77] John P. Incardona et al., *Aryl Hydrocarbon Receptor-Independent Toxicity of Weathered Crude Oil During Fish Development*, 113 ENVTL. HEALTH PERSP. 1755, 1761 (2005), *available at* http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1315066/ (noting that "[b]ecause different PAHs act on fish embryos via independent toxic mechanisms, understanding the cumulative toxicity of PAH mixtures will be more challenging than previously appreciated").

[78] *Id.* A similar example can be found in the breakdown of pesticides in groundwater into daughter products. *See Breakdown Products of Widely Used Pesticides Are Acutely Lethal to Amphibians, Study Finds*, SCI. DAILY (June 25, 2007), http://www.sciencedaily.com/releases/2007/06/070623213748.htm.

[79] For a succinct description of the killer whale story and its implications, see Stanley D. Rice, *Persistence, Toxicity, and Long-Term Environmental Impact of the* Exxon Valdez *Oil Spill*, 7 U. ST. THOMAS L.J. 55, 58–59 (2009), noting that "[k]iller whale losses from the acute initial exposures are examples of the length of time for recovery of long-lived species with low reproductive rates." *See also Killer Whales*, *EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL, http://www.evostc.state.ak.us/index.cfm?FA=status.orca (last visited Mar. 12, 2014); Janet Raloff, *Exxon Valdez Killed Future for Some Killer Whales*, SCI. NEWS (Mar. 26, 2009, 7:46 AM), https://www.sciencenews.org/node/5170.

[80] *See* C.O. Matkin et al., *Ongoing Population-Level Impacts on Killer Whales* Orcinus Orca *Following the 'Exxon Valdez' Oil Spill in Prince William Sound, Alaska*, 356 MARINE ECOLOGY PROGRESS SERIES 269, 273, 275 (2008).

contrast to the twelve years originally estimated.[81] Like the AB pod, the AT-1 Group of transient killer whales continues to suffer from the acute losses following the spill. To be sure, the group was already facing challenges before the spill, with a population of only twenty-two.[82] After the spill, however, there are only thirteen remaining individuals and the Group has lost any hope of recovery.[83] This long-term harm is most accurately described as an acceleration of a previously adverse trend.[84]

On the whole, these trends of persistent injury decades after the Exxon spill can be understood by reviewing the latest status report released by the *Exxon Valdez* Trustee Council.[85] That report summarizes the recovery status of the original list of thirty-two species and resources that were injured as a result of the spill. The list is not exhaustive of species that were injured but is representative of the greater ecosystem's road to recovery.[86] After more than two decades, only thirteen species have recovered (or are "very likely recovered").[87] Ten other species are listed as "recovering,"[88] a notoriously ambiguous category ranging from species that are almost recovered to those that barely pass the "not recovering" mark.[89] Ecosystem services including commercial fishing, passive use, tourism, and subsistence have not yet recovered but are categorized as "recovering."[90] Most notably, some keystone species like the Pacific herring are listed as not recovering at all.[91]

B. The Complicated Task of Proving Long-Term Injury

The post-Exxon research regarding long-term consequences of the spill illustrates that government trustees need to take steps to capture or preserve claims for long-term injuries. Long-term injuries do exist and they exist to a greater extent and magnitude than previously understood. The growing body of literature documenting long-term injuries strengthens the demands that trustees can make for natural resource damages. The mounting scientific evidence of long-term injuries means that these types

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[81] *Id.* at 278–79.

[82] *Id.* at 279.

[83] *Id.* (noting that the AT-1 Group "will likely go extinct within the next several decades").

[84] *Id.* (noting one lesson learned from the AT-1 Group is that "a major environmental perturbation can greatly hasten the decline toward extinction"); *see also* Raloff, *supra* note 79 (Craig Matkin is quoted as saying, "I don't want to make it sound like the oil spill is solely responsible for AT-1's decline . . . . It just exacerbated an already bad situation.").

[85] *See* 2010 UPDATE, *supra* note 23.

[86] *Id.* at 1.

[87] *Id.* at 7.

[88] *Id.*

[89] *See* HUNT, *supra* note 1, at 170–72.

[90] 2010 UPDATE, *supra* note 23.

[91] *Id.* at 7, 27.

of injuries are now foreseeable. Legally, this is significant given the role that foreseeability plays in the proximate cause inquiry.[92]

The Exxon studies also illustrate that determining the long-term consequences of a spill is a tremendous undertaking that requires many coordinated research studies to flesh out a potential causal pathway. Funding that kind of research effort is costly. Since the trustees settled their natural resource damages claims with Exxon in 1991, they have allocated $178 million of the settlement funds to general research and monitoring in the Prince William Sound area.[93] These expenses only slightly exceed the $176.5 million spent by state and federal trustees on injury assessment and litigation efforts in the two-and-a-half years leading up to the settlement.[94] Because long-term study of oil spills is costly, trustees may not always be able to fund the research necessary to uncover problems.

The study of the Exxon spill might be the best-case scenario in terms of trustees being in the position to make demands for long-term natural resource damages. This is so because the large natural resource damages settlement came relatively quickly after the spill and supplied the necessary funds to engage in extensive and ongoing study of Prince William Sound. Even so, recovering for long-term injuries is more complicated than simply funding studies and making demands. There are limits to even well-funded science. Chiefly, there is the simple fact that nature is complicated. Ecosystems are dynamic, complex, and varied in time and space.[95] Unraveling the mysteries of nature makes measuring the full extent and magnitude of oil-induced injuries more an exercise in rough justice than precision mathematics.

For example, the ecosystem in Prince William Sound is home to hundreds of species and many different habitat types, all interacting as part of a complex structure.[96] That structure, those species, and the habitats are all reacting to numerous biological, chemical, and physical processes aside from oil. Global climate conditions and weather patterns impact the cycles

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[92] *See supra* text accompanying notes 34 and 35; *see also* DAN B. DOBBS ET AL., THE LAW OF TORTS § 198, at 681–83 (2d ed. 2011) (explaining that proximate cause is the judicial tool used to cut off liability for policy reasons when the causal chain becomes too attenuated to justify imposition of liability).

[93] LEGACY OF AN OIL SPILL, *supra* note 14.

[94] *Id.*

[95] *See, e.g.*, Mark A. Harwell & John H. Gentile, *Ecological Significance of Residual Exposures and Effects from the* Exxon Valdez *Oil Spill*, 2 INTEGRATED ENVTL. ASSESSMENT & MGMT. 204, 204 (2006) [hereinafter *Ecological Significance*] ("Ecosystems are complex, diverse, dynamic, spatially and temporally variable, and continuously subject to a plethora of natural and anthropogenic stressors.").

[96] *Conceptual Model*, *supra* note 10, at 673 (citation omitted) ("[T]he [Gulf of Alaska] constitutes a highly productive ecosystem that sustains immense populations of seabirds, marine mammals, and fishes."); *see also Ecological Significance*, *supra* note 95, at 206 (cataloging confounding factors influencing ecological changes in Prince William Sound).

of nutrient upwelling in the nearshore areas of Prince William Sound.[97] Other chemical and physical factors like water currents and salinity also influence nutrient availability.[98] This in turn implicates the physical characteristics of the ocean bottoms and shorelines.[99]

When climate patterns alter nutrient availability, the impact cascades throughout the ecosystem. A change in nutrients, for example, influences the productivity of phytoplankton, which are the food base for forage fish like the Pacific herring and sand lance.[100] Those forage fish and other planktivores are the energy bridge to higher trophic levels. They utilize the energy from nutrients and provide fatty, high-energy foods for their predators, including larger fish, mammals, and sea birds.[101] It is because of this complex structure that populations of species undergo natural variations driven by any number of these dynamic influences.

The study of the Prince William Sound ecosystem beautifully illustrates that ecological complexity creates scientific challenges to recovering damages for long-term ecological injuries. It demonstrates the difficulty in proving causation due to lack of baseline data, natural variability, and problems of multiple stressors and multiple sources.

Consider, for instance, the problem of multiple sources. When scientific studies suggest that polycyclic aromatic hydrocarbons (PAHs) are bioavailable in the Prince William Sound ecosystem, one possible explanation is that the hydrocarbons are unrelated to the Exxon spill.[102] Hydrocarbons are not exactly novel in marine coastal environments. Natural, background sources of hydrocarbons in Prince William Sound come from eroding shale and natural oil seeps along the northern coast of the Gulf of Alaska.[103] Another significant release of hydrocarbons into Prince William Sound came from fuel oil and asphalt during the 1964 earthquake.[104] Human-derived sources of oil include incremental releases from cruise liners, fishing fleets, and oil tankers. Historical industrial sites are also thought to contribute to the hydrocarbons in Prince William Sound.[105] Then there are the more diffuse sources that can hardly be pinned on any particular location or single activity—hydrocarbons from

[97] *Conceptual Model*, *supra* note 10, at 710 ("Climate processes also have an important role in generating the stressors of physical disturbance, disease (*e.g.*, viral hemorrhagic septicemia, VHS), and introduced species (*e.g.*, species entering the system from warmer climates in response to global climate change).").

[98] *Id.*

[99] *Id.*

[100] *Id.* at 682.

[101] *Id.*

[102] *Ecological Significance*, *supra* note 95, at 209–10.

[103] *Id.* at 209.

[104] *Id.*

[105] *Id.* at 210.

atmospheric deposition of burning coal, forest fires, and global industrial sources.[106]

To deal with the problem of multiple possible sources, scientists have devised a system of hydrocarbon fingerprinting.[107] The *Exxon Valdez* oil, for example, is a mixture of crude oils from the North Slope of Alaska and contains an identifiable chemical makeup of PAHs.[108] This chemical makeup is the "fingerprint." Based on the types of PAHs that characterize the fingerprint, scientists can identify an appropriate biomarker that would indicate exposure of marine species to a particular source. For example, members of the cytochrome P450 1 gene family are strongly expressed when an individual has been exposed to the larger PAHs like those found in crude oil from the North Slope.[109] This biomarker has been used to study the exposure of marine species to *Exxon Valdez* oil in Prince William Sound.[110]

Assuming that the source of oil can be determined through PAH fingerprinting, however, there is still a problem of multiple stressors. Researchers must determine whether the ecosystem is experiencing difficulty with system-wide recovery because the PAHs associated with *Exxon Valdez* oil are wreaking chronic, sublethal havoc. Or, is it the combined stress from multiple sources of hydrocarbons that is sending the ecosystem over the edge? Nonhydrocarbon stressors add to the complication of identifying the principle reason for ailing populations.[111] Climate change, for instance, is warming oceans worldwide and altering sea-ice habitats in ways that have profound effects on marine species.[112] Some scientists have suggested that the changes caused in Prince William Sound due to hydrocarbon stressors pale in comparison to the natural variability of climate and other oceanographic processes that affect ocean resources.[113]

Mother Nature's alternative explanations keep coming. In 1993, the Pacific herring fishery collapsed, and it has yet to recover.[114] Before the spill, commercial herring fisheries experienced record numbers. After the spill, the fishery collapsed and has remained closed for fifteen of the last

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[106] *Id.* at 209.

[107] For an explanation of hydrocarbon fingerprinting, see A.E. Bence & W.A. Burns, *Fingerprinting Hydrocarbons in the Biological Resources of the* Exxon Valdez *Spill Area*, *in* FATE AND EFFECTS, *supra* note 1, at 84.

[108] *Id.* at 92.

[109] *Id.*; *see also Harlequin Duck Study*, *supra* note 7.

[110] *See Harlequin Duck Study*, *supra* note 7.

[111] *See Conceptual Model*, *supra* note 10, at 690–712 (modeling the relative influence of natural drivers and hydrocarbon sources on the marine resources in Prince William Sound).

[112] Scott C. Doney et al., *Climate Change Impacts on Marine Ecosystems*, 4 ANN. REV. MARINE SCI. 11, 14–16 (2012) (assembling the literature and cataloging impacts on climate change on oceans).

[113] *Conceptual Model*, *supra* note 10, at 712.

[114] *See* Knudsen, *supra* note 24; Rice, *supra* note 79, at 65.

twenty-one years. Some scientific studies suggest that the 1993 collapse of the Pacific herring fishery is related to the Exxon spill.[115] A common counterexplanation is natural variability[116]—herring populations worldwide are known to experience boom and bust cycles. The theory is that nature is simply doing what nature always does and the herring will return in time. Though attractive for its ease and optimism, this explanation does not necessarily explain why the herring populations in unoiled areas of Prince William Sound have rebounded since the spill while those in oiled areas continue to struggle.

Even if counterexplanations were fully explored and understood, yet another possibility is that several stressors acting together are responsible for the harms. The combination of stressors might be greater than the sum of its parts. In this way, multiple stressors might function synergistically to magnify harm to the ecosystem.[117]

This synergistic potential of toxic stressors means that lingering *Exxon Valdez* oil might not generate ecologically significant impacts if it were acting alone. If synergistic models were well understood, however, scientists might find that lingering oil could be responsible for (or at least contribute to) sending an already-stressed ecosystem into decline. For example, a population already experiencing increased susceptibility to disease as a result of warming oceans might succumb to that susceptibility if added toxins further weaken immune systems.[118] Or, a population already experiencing natural die-offs might be unable to rebound from the stress of a catastrophic event (e.g., killer whales in Prince William Sound).[119]

As if the complexity of multiple sources, natural variability, and synergistic complications were not enough, at least three other problems are wrapped up in the detection of long-term injuries. One problem has to do with knowing when a resource is injured and the others have to do with when it has recovered. First, as a practical matter, long-term injuries are generally detected in the course of monitoring the recovery of injured resources. After the Exxon spill, the Trustee Council identified twenty-

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[115] Knudsen, *supra* note 24.

[116] *Ecological Significance*, *supra* note 95, at 225–26 (attributing the sustained population loss of herring in Prince William Sound to "large natural interannual variability").

[117] *Conceptual Model*, *supra* note 10, at 703 ("[A] population or biological process might be marginally stressed by the influence of a single stressor. If, however, an additional stressor is added concurrently, the combined effects of both might have more significant consequences on the population. Thus, the effects of stressors might not be simply additive but combine nonlinearly.").

[118] *See id.* at 710 (climate change increases incidence of disease in oceans); Evelyn D. Brown & Mark G. Carls, *Pacific Herring (*Clupea Pallasi*)*, RESTORATION NOTEBOOK (Exxon Valdez Oil Spill Tr. Council, Anchorage, Alaska), Sept. 1998, at 4, *available at* http://www.evostc.state.ak.us/Universal/Documents/Publications/RestorationNotebook/RN_herring.pdf (suggesting that there is a higher incidence of disease among herring populations because immune systems were depressed by oil exposure).

[119] See discussion of killer whales *supra* notes 79–84 and accompanying text.

eight injured resources to monitor and study to determine long-term effects of the spill.[120] Certainly many more resources were injured,[121] but not all resources can be studied after a spill.[122] As a result, long-term injuries (or even shorter term injuries) can be missed. Some scientists studying the Exxon spill, for example, lament the failure to study the forage fish such as the sand lance.[123] As described above, the forage fish are the trophic link between plankton and larger fish and marine mammals. Understanding the impact of the spill on keystone species like the sand lance or the Pacific herring might have gone a long way towards understanding the cascading effects of the spill to higher trophic levels like sea otters or sea lions.[124]

Even when species are studied, determining when an injured species has recovered is also not straightforward. Under federal regulations governing the natural resource damage assessment process, trustees are supposed to use monetary damages to "restore" the injured resources.[125] This means returning the ecosystem to pre-spill conditions.[126] Given that ecosystems are constantly evolving and being acted upon by multiple natural and anthropogenic stressors, some commenters have suggested that returning to a defined state is not a realistic measure of recovery.[127] The reason is that the baseline for recovery of ecosystems shifts over time.[128] When ecosystem health is a moving target, the identification of injury by comparing present conditions to the past is not always useful.

Even if ecosystems could return to baseline, that standard for recovery presumes the existence of baseline information. Baseline data provides a basis for comparing pre- and post-spill population trends.[129] It gives clues as to natural fluctuations in the oiled and unoiled areas. It helps predict which species are doing well, which ones were stressed to start, and in general whether the ecosystem is balanced.[130] The process of narrowing down the root causes of ecological injuries would be easier if scientists had

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[120] *See* 2010 UPDATE, *supra* note 23.

[121] *Id.* at 1.

[122] HUNT, *supra* note 1, at 162 (noting that the restoration process is biased from the start because only the resources on the original list benefit from direct intervention, study, and restoration efforts).

[123] *Id.* at 55.

[124] *See id.*

[125] *See, e.g.*, CERCLA, 42 U.S.C. § 9607(f) (2006).

[126] OPA regulations define "recovery" as "the return of injured natural resources and services to baseline," which in turn means "the condition of the natural resources and services that would have existed had the incident not occurred." 15 C.F.R § 990.30 (2012).

[127] HUNT, *supra* note 1, at 164.

[128] *Id.*

[129] *See* 15 C.F.R. § 990.30 (allowing trustees to use "historical data, reference data, control data, or data on incremental changes" to establish the baseline).

[130] For an extensive discussion of case studies highlighting the benefits of baseline data, see Usha Varanasi, *Making Science Useful in Complex Political and Legal Arenas: A Case for Frontloading Science in Anticipation of Environmental Changes to Support Natural Resource Laws and Policies*, 3 WASH. J. ENVTL. L. & POL'Y 238, 242–54 (2013).

better and more baseline data.[131] Pre-spill population data, however, often does not exist.[132] Gathering data is costly and there is no systematic collection of baseline data by government or industry.[133]

In the case of Exxon, baseline data existed for some species associated with commercial fisheries (e.g., salmon or herring) or of particular interest to the public (e.g., bald eagles or sea lions). But for many species pre-spill data was limited (e.g., cormorants) or nonexistent (e.g., Pacific sand lance).[134] In the days following the spill, scientists were left scrambling to gather what baseline data they could before oil hit the shore.[135] This is no way to ascertain meaningful population trends. At least one commentator, drawing on reports from the Trustee Council, concluded that "[t]he lack of baseline data would become, over time, the single greatest obstacle to understanding the degree of injury suffered by individual species as well as measuring their ability to bounce back."[136]

To summarize the complexity of this situation, one might return to the point made earlier—that measuring the extent and magnitude of long-term injuries caused by environmental disasters like the *Exxon Valdez* Oil Spill is not an exercise in precision mathematics. Multiple sources of harm, synergistic effects, natural variability, lack of baseline understanding of the ecosystem to start, and overarching system pressures like climate change all provide ready-made counterexplanations to claims of long-term injuries.

C. Ruling Out a Traditional "But-For" Approach to Causation

On the one hand, science supports the notion that long-term injuries following oil spills are foreseeable and likely to be significant. On the other hand, injuries manifest in an environment with multiple stressors and intervening forces that combine to make causal pathways indirect and often uncertain. Together, these observations challenge us to consider whether existing legal frameworks can adequately remedy long-term harm caused

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[131] *See Ecological Significance*, *supra* note 95, at 222 (acknowledging that cormorants have not recovered after the Exxon spill but concluding that lack of baseline data makes it difficult to assess whether depressed populations are a result of the spill).

[132] Usha Varanasi, *Frontloading the Science in Anticipation of Environmental Disasters*, 37 FISHERIES 233, 233 (2012) (discussing frequent lack of "standardized and robust baseline information available about the state of the environment where the spill or storm may cause serious damage"); *see also* KRISTINA ALEXANDER, CONG. RESEARCH SERV., R41396, THE 2010 OIL SPILL: NATIONAL RESOURCE DAMAGE ASSESSMENT UNDER THE OIL POLLUTION ACT 8 (2010), *available at* www.fas.org/sgp/crs/misc/R41396.pdf ("It is not practical to expect to have up-to-date baseline data for every species everywhere there might be an oil spill.").

[133] *See id.*

[134] 2010 UPDATE, *supra* note 23, at 6 ("For many of the resources affected by the spill there was limited or no recent data on their status in 1989."); *Ecological Significance*, *supra* note 95, at 222 (discussing lack of baseline data for cormorants).

[135] HUNT, *supra* note 1, at 56–57.

[136] *Id.* at 57 & n.25.

by oil spills. Under a traditional causal standard, the answer is almost certainly no.

Notably, traditional causal standards are not the only approaches that tort law has to offer. Indeed, the complex causation problems raised by long-term natural resource damages are not new to tort law. Part II examines the myriad ways tort law has evolved and adapted to address complex causal problems, particularly in the toxic tort context. Before jumping to tort law's flexibility, however, it is worth considering why such flexibility is needed here. In other words, it is worth reviewing what traditional causal standards would require and why such standards would be an inappropriate default for the challenges of proving long-term natural resource damages. This is particularly the case given that many courts, even when moving away from traditional causal standards, retain some of the problematic language that might otherwise be inappropriate in the natural resource damages context.

At the most basic level, traditional causation requires plaintiffs to prove causation-in-fact and satisfy the limits of proximate cause.[137] Roughly speaking, causation-in-fact asks whether the alleged conduct actually caused any injury.[138] This component of the causal inquiry is focused on distilling facts. Did the *Exxon Valdez* oil play a role in the herring fishery collapse? Answering this question will be guided by scientific inquiry.[139] Ultimately, though, the question may not be answerable through direct evidence. Rather, circumstantial evidence (such as the timing of the collapse relative to the timing of the spill) might be the only evidence available.

Under traditional formulations, plaintiffs have the burden of proving that tortious conduct is a "but-for" cause of the alleged injury.[140] In many cases, the but-for test works smoothly and efficiently at identifying the tortious actor. In the case of oil spills like Exxon, many acute injuries are readily identifiable using the but-for test. For example, it was not hard to ascertain that but for the *Exxon Valdez* running aground Bligh Reef and spilling 11 million gallons of oil into Prince William Sound, there would not have been 871 oiled sea otter carcasses collected in the spill area in the days following the accident.[141] Likewise, but for the spill the commercial

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[137] DOBBS, *supra* note 92, § 198, at 681–82.

[138] *Id.* § 183, at 614.

[139] *Id.* at 615.

[140] David W. Robertson, *The Common Sense of Cause in Fact*, 75 TEX. L. REV. 1765, 1768 (1997) ("The most widely accepted test for making [the cause-in-fact] inquiry is the but-for test."); *see also* DOBBS, *supra* note 92, § 186, at 623 ("Under the but-for test, the defendant's conduct is a factual cause of the plaintiff's harm if, but-for the defendant's conduct, that harm would not have occurred.").

[141] *See Sea Otters*, *EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL, http://www.evostc.state.ak.us/index.cfm?FA=status.seaotter (last visited Mar. 12, 2014).

salmon fisheries would not have been closed for the 1989 and 1990 seasons.[142]

In a number of cases, however, including those most likely to arise in the context of long-term natural resource injuries, the but-for test fails to hold tortious actors liable.[143] In particular, where there are multiple causes capable of giving rise to a single injury, the but-for test may not be satisfied by any of the contributing causes.[144] For example, one of the pods of transient killer whales (the AT-1 Group) will never recover from the *Exxon Valdez* Oil Spill and will slowly go extinct.[145] One cause of that prognosis is the oil spill. But that is not the whole story. The pod had been suffering declines before the spill, possibly due to a diminished food base and exposure to other reproduction-inhibiting pollutants.[146] In this situation, the but-for test would not identify Exxon as an actual cause of extinction. Scientists cannot say that but for the Exxon spill, the AT-1 Group would not be facing certain extinction. Scientists can only say that the Exxon spill contributed to the acceleration and certainty of that extinction.[147] In that situation, no single cause necessarily satisfies the but-for test because there are alternative causes that might have given rise to the injury.

Another problem with the but-for test in the long-term natural resource damages context is that it can be applied only by comparing what happened with a hypothetical alternative[148]—it requires some sense of what would have happened absent the release of oil or toxics into the environment. While this counterfactual inquiry is speculative by nature (e.g., exactly what would have happened if the defendant had not run a red light is ultimately unknowable in a metaphysical sense), for many situations we have built up sufficient intuitions from life experience to make reasonable guesses and temper the speculation.[149] For that reason, it is sometimes said, "any layman is quite as competent" to answer ordinary cause-in-fact questions as "the most experienced court."[150] The same may not be true in

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[142] *See Commercial Fishing*, *EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL, http://www.evostc.state.ak.us/index.cfm?FA=status.human_fishing (last visited Mar. 12, 2014).

[143] *See* DOBBS, *supra* note 92, §§ 186, 187, 189, at 624–26, 631–36.

[144] For a description of alternative liability theory, which addresses the problem of multiple causes, see RESTATEMENT (SECOND) TORTS § 433B(3) (1965) ("Where the conduct of two or more actors is tortious, and it is proved that harm has been caused to plaintiff by only one of them, but there is uncertainty as to which one has caused it, the burden is upon each actor to prove that he has not caused the harm.").

[145] *See* discussion *supra* notes 79–84 and accompanying text.

[146] Kyle Hopkins, *Debate Persists About Long-Term Effects of Exxon Valdez Oil Spill*, ANCHORAGE DAILY NEWS (Feb. 6, 2009), http://www.adn.com/2009/02/06/682335/debate-persists-about-long-term.html.

[147] *See* Matkin, *supra* note 80, at 279.

[148] DOBBS, *supra* note 92, § 187, at 626–28.

[149] *See* Robertson, *supra* note 140, at 1769 ("All of these but-for inquires call upon common sense.").

[150] *Id.* at 1765 (quoting WILLIAM L. PROSSER, THE LAW OF TORTS, § 41 at 237 (4th ed. 1971)).

the context of long-term natural resource damages. For long-term injuries, neither laymen nor scientists might be able to offer a plausible guess as to what the state of the environment would have looked like absent the Exxon spill. They might not be able to say what the marine ecosystem would have done in a vacuum. Scientists have a hard enough time discerning the science of what is actually happening, let alone what might happen many years in the future.

Legal scholars, practitioners, and scientists have recognized that traditional causation standards might not be a good fit for natural resource injuries.[151] The fit may be even worse for long-term injuries. To that end, scientists examining long-term impacts from oil spills readily described long-term effects as "more difficult to recognize and assess, primarily because different toxicity mechanisms are at work and they do not result in an immediate and obvious mortality."[152]

The challenge, it would seem, is finding an appropriate causal paradigm—one that provides more than a theoretical opportunity for holding responsible parties liable for long-term impacts and yet is sufficiently discerning so as to uphold notions of fairness underlying tort law. This challenge has been considered in the toxic torts literature with respect to latent injuries,[153] but remains surprisingly unexamined for long-term natural resource damages. Taking up that challenge is the subject of the remainder of this Article.

II. ASSESSING THE SPACE FOR A NEW CAUSAL PARADIGM

Before seeking out an alternate causal paradigm befitting the complexity of proving long-term injuries, one might first ask what room exists in the legal framework for adopting a nontraditional path. To that end, this Part begins by considering tort law's ability to address complex causal questions like those raised by long-term natural resource damages. This Part goes on to examine the statutory framework and its requirements for proving causation. Next, this Part surveys the limited jurisprudence in which courts have attempted to articulate a standard for causation in the natural resource damages context. Finally, this Part comes full circle to tort and considers whether a relaxed causation paradigm fits the central tenets of tort law.

In the end, this Part concludes that room does exist for considering an alternate causal paradigm—in fact there is substantial need for clarity in

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[151] *See supra* notes 20–22 and accompanying text; *see also* Robert L. Rabin, *Environmental Liability and the Tort System*, 24 HOUS. L. REV. 27, 29–32 (1987) (noting that "[t]raditional tests of causal responsibility—the but-for principle, substantial factor causation, *pro rata* joint-and-several liability—are operating in foreign territory when they are employed in [environmental tort] cases").

[152] Thomas et al., *supra* note 22; *see also Harlequin Duck Study*, *supra* note 7 (recognizing that "subtle effects . . . may be difficult to detect in nature").

[153] *See infra* Parts II.A, IV.B.

this unsettled area. Only a small handful of courts have grappled with the causal standard for proving ordinary natural resource injuries, and none have expressly considered long-term injuries.[154] The courts that have considered the issue diverge in the degree to which traditional tort paradigms should govern the causation inquiry in natural resource damages law. This issue could greatly benefit from some clarification and additional analysis.

A. Room Within Tort Law

The complicated questions of causation raised by long-term ecological harm are not new to tort law. Time and time again, tort law has proven itself perfectly comfortable with evolving to handle nontraditional problems in a variety of contexts. The most notable evidence of tort law's flexibility is the well-accepted deviation away from the rigid but-for test and the now widespread preference for the more intuitive substantial factor test.[155] A classic statement of the substantial factor test might provide:

> [W]here two or more causes have concurred to bring about an event, and any one of them, operating alone, would have been sufficient to cause the identical result, "the defendant's conduct is a cause of the event if it was a material element and a substantial factor in bringing it about."[156]

Early cases restricted the application of the substantial factor test to multiple tortious actors, where the negligence of more than one person combined to cause harm.[157] Courts later expanded the substantial factor test to cases where forces of unknown origin combined with tortious conduct to cause harm.[158] In particular, in the classic tort case of *Anderson v. Minneapolis, St. P. & S. S. M. Ry. Co.*,[159] the defendant negligently started a bog fire that swept over a large area and eventually merged with another fire of independent and uncertain origin. The combined fires burned the plaintiff's property and the defendant was held liable.[160] Important for the purposes of natural resource injuries, the "twin fires" case established that

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[154] *See infra* Part II.C.

[155] DOBBS, *supra* note 92, § 189, at 631–36; *see also* PROSSER AND KEETON, *supra* note 36, § 41, at 268 (recognizing test as more intuitive than the rigid but-for test).

[156] ITT Indus., Inc. v. Borgwarner, Inc., 700 F. Supp. 2d 848, 876 (W.D. Mich. 2010) (quoting Artesian Water Co. v. Gov't of New Castle Cnty., 659 F. Supp. 1269, 1283 (D. Del. 1987) (providing an example of this classic statement and application of the test)); *see also In re* Methyl Tertiary Butyl Ether ("MTBE") Prods. Liab. Litig., 643 F. Supp. 2d 461, 464 (S.D.N.Y. 2009) (describing the need to show that "each individual defendant's contribution, *taken alone*, would have caused an injury" as the defining feature of the substantial factor test (quoting *In re* Methyl Tertiary Butyl Ether ("MTBE") Prods. Liab. Litig., 644 F. Supp. 2d. 310, 319 (S.D.N.Y. 2009))).

[157] Robertson, *supra* note 140, at 1779 & n.57.

[158] *See id.*

[159] 179 N.W. 45 (Minn. 1920).

[160] *Id.* at 46.

the substantial factor test applies regardless of whether the multiple causes are natural or man-made.[161]

These classic versions of the substantial factor test are uniformly considered a legitimate departure from the traditional but-for test and often used to handle more complex questions of causation.[162] Indeed, courts that have grappled with setting the proper causal standard for natural resource damages claims have considered adopting the substantial factor test. Some have adopted the test while others have rejected it for an even more flexible version called the contributing factor test.[163]

In addition to the emergence of the substantial factor test to address combined causes, similarly innovative doctrines have been created to handle problems of concurrent causes. In the classic case of *Summers v. Tice*,[164] the court adopted a burden-shifting framework to deal with concurrent causes. In that case, the plaintiff was injured when two hunters negligently shot in his direction. Under the circumstances, it could not be determined which of the two negligent defendants had actually caused the injury.[165] Recognizing that the plaintiff might be without any remedy under traditional causal paradigm, the Supreme Court of California held both defendants jointly and severally liable. The burden of proof shifted to the defendants to absolve themselves of liability if they could.[166]

Tort law's agility in handling complex problems of causation continues in the modern context. For instance, in cases involving medical malpractice claims, courts have assigned liability where the defendant caused an increased risk of harm to the plaintiff or, more often, reduced the plaintiff's chance of survival.[167] In those cases, courts recognize the uncertain and speculative nature of predicting what the likely outcome would have been but for the medical malpractice.[168] Nevertheless, courts impose liability to avoid systematic avoidance of liability by physicians in these cases.[169] A similar risk-of-injury approach might be fitting to long-term ecological harms, where the counterfactual inquiry is equally uncertain and yet the tortious actor's role in increasing the likelihood of harm is fairly clear.

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[161] *See* Robertson, *supra* note 140, at 1777–78 (describing combined forces test and noting that one force operates independent of any wrongdoing by the defendant).

[162] *See id.* at 1776–78.

[163] *See infra* Part II.C.

[164] 199 P.2d 1 (Cal. 1948) (en banc).

[165] *Id.* at 2–3.

[166] *Id.* at 3–5.

[167] See *infra* notes 337–45, and accompanying text for a discussion of the risk-of-injury analysis in the medical malpractice cases.

[168] *See, e.g.*, Herskovits v. Grp. Health Coop. of Puget Sound, 664 P.2d 474, 477–78 (Wash. 1983) (en banc) (discussing the difficulty of applying a counterfactual inquiry to a medical malpractice case).

[169] *Id.* at 477.

In addition to the risk-of-injury cases, several innovations have been adopted in the area of toxic torts to deal with problems of proving causation for latent, long-term health injuries. Such issues were at the heart of cases like asbestos litigation, tobacco litigation, Agent Orange litigation, and others.[170] Indeed, there is a rich body of toxic tort literature discussing problems of proof and seeking out alternate causal frameworks for difficult-to-prove latent injuries.[171]

The degree to which specific doctrines in toxic tort can adequately address similarly complex causal problems in the natural resource damages context requires closer examination and is an issue that will be taken up more fully in Part IV. For now, it is simply worth recognizing that difficult-to-prove causal problems emerge regularly in tort law. The toxic tort cases and others provide ample examples of how tort law has adapted and demonstrated its virtue as a flexible tool.

B. Room Within the Statutory Framework

If tort law possesses the inherent flexibility needed to tackle emerging causal issues in the natural resource damages context, can the existing statutory framework accommodate such innovative potential? Consider that three major federal congressional statutes—CERCLA, OPA, and the Clean Water Act—make natural resource damages available for injuries from oil and toxic releases.[172] Under these statutes, federal, state, and tribal trustees have authority to seek natural resource damages on behalf of the public.

Importantly, long-term natural resource injuries are among the category of injuries that Congress intended to remedy. In particular, natural resource damages are available for a broad suite of injuries including "a measurable adverse change, either long- or short-term, in the chemical or physical quality or the viability of a natural resource."[173] In addition, in a

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[170] *See, e.g.*, *In re* Methyl Tertiary Butyl Ether ("MTBE") Prods. Liab. Litig., 644 F. Supp. 2d 310 (S.D.N.Y. 2009) (applying commingled product theory liability in a case involving groundwater contamination from gasoline additive); Hall v. E.I. Du Pont de Nemours & Co., 345 F. Supp. 353 (E.D.N.Y. 1972) (applying enterprise liability in a case involving an unidentifiable asbestos manufacturer); Sindell v. Abbott Labs., 607 P.2d 924 (Cal. 1980) (applying market share liability in a landmark products liability decision involving the DES drug).

[171] *See*, *e.g.*, David E. Bernstein, *Getting to Causation in Toxic Tort Cases*, 74 BROOK. L. REV. 51 (2008); Daniel A. Farber, *Toxic Causation*, 71 MINN. L. REV. 1219 (1987); Donald G. Gifford, *The Peculiar Challenges Posed by Latent Diseases Resulting from Mass Products*, 64 MD. L. REV. 613 (2005); Steve Gold, *Causation in Toxic Torts: Burdens of Proof, Standards of Persuasion, and Statistical Evidence*, 96 YALE L.J. 376 (1986); Gary E. Marchant, *Genetic Data in Toxic Tort Litigation*, 14 J.L. & POL'Y 7 (2006).

[172] Some states also provide additional statutory schemes allowing recovery for natural resource damages. The causation requirements associated with state statutes is beyond the scope of this Article. Instead, this Article focuses on the major federal statutes that will be the most instrumental in determining natural resource liabilities for oil spills.

[173] 43 C.F.R. § 11.14(v) (2013). Of particular note is the fact that damages are available for loss of ecosystem function. 33 U.S.C. § 2702(b)(2)(A) (2006). *Cf.* J.B. Ruhl, *Making Nuisance Ecological*,

move that facilitates recovery for long-term injuries, Congress provided a three-year statute of limitations that runs not from the date of incident but from the date that the injuries are discovered.[174]

Notably, these statutes do not require any particular level of ecological disruption to characterize a resource as injured. Injury is defined broadly enough to include "an observable or measurable adverse change in a natural resource."[175] The broad definition of injury means that assigning liability for long-term natural resource injuries is at least theoretically possible.

But what measure of causal proof does Congress deem sufficient to support a claim for long-term injuries? The answer to that question is less clear. At a minimum, some causal connection is required. CERCLA, for instance, makes responsible parties liable for "damages for injury to, destruction of, or loss of natural resources, including the reasonable costs of assessing such injury, destruction, or loss *resulting from such a release*."[176] OPA similarly provides for natural resource damages that result from a discharge of oil.[177] Courts agree that this statutory language requires trustees to show a causal link between injuries and the release.[178]

In *Ohio v. Department of Interior*, the D.C. Circuit considered whether a natural resource damages claim required a showing of causation. That case involved several challenges to the Department of Interior's regulations on natural resource damage assessment under CERCLA.[179] One of the challenges alleged that the level of proof required for establishing injury to biological resources was too rigorous and inconsistent with Congress's intent to relax common law burdens of proof for causation. The court recognized that Congress had liberalized causal standards of proof for cost recovery and cleanup actions under CERCLA. Nonetheless, the court refused to require federal agencies to adopt a similar scheme for natural resource damage actions. In particular, the court concluded, "There is little evidence, however, that Congress specifically intended to ease the standard of proof for showing that a particular spill caused a particular biological injury."[180] The court held that CERCLA is ambiguous as to whether causal

58 CASE W. RES. L. REV. 753 (2008) (making the case that lost ecosystem services can be redressed by nuisance law but only in so far as the injury generates a traditional economic injury).

[174] *See* CERCLA § 113(g)(1), 42 U.S.C. § 9613(g)(1) (2006).

[175] 15 C.F.R. § 990.30 (2013).

[176] CERCLA § 107, 42 U.S.C. § 9607(a)(4)(C) (emphasis added).

[177] *See* Oil Pollution Act § 1002(a), 33 U.S.C. § 2702(a).

[178] *See, e.g.*, Ohio v. U.S. Dep't of Interior, 880 F.2d 432 (D.C. Cir. 1989) (concluding that CERCLA requires a causal link between the release and injury for purposes of establishing natural resource damage claims); Idaho v. Bunker Hill Co., 635 F. Supp. 665, 674 (D. Idaho 1986) ("(T]he use in Section 107(f) of the word 'resulted' ties the damages to the releases. The proof must include a causal link between releases and post-enactment damages which flowed therefrom.").

[179] 880 F.2d at 438.

[180] *Id.* at 470.

burdens for natural resource damages claims ought to be relaxed in keeping with the broader policy goals of CERCLA.[181] In applying *Chevron* deference to CERCLA's ambiguities on the matter, the court upheld the Department of Interior's incorporation of traditional causation analysis in its regulations.[182]

While *Ohio v. Department of Interior* clarifies the requirement that trustees show a causal link between the release and the injury, it does not resolve the question of the degree of proof required. Congress was silent on the issue and so was the court. In fact, the court's acknowledgment of CERCLA's ambiguity in *Ohio v. Department of Interior* leaves open the possibility that a more relaxed causal standard would also have been reasonable. In a later D.C. Circuit decision, *Kennecott Utah Copper Corp. v. Department of Interior*,[183] the court again acknowledged that there must be a causal link between the alleged injury and the release, but noted, "Congress has not specified precisely what that causal relationship should be."[184] Congress appears to have left to the courts' discretion the task of choosing a causal test that is befitting to the challenges of proving long-term injuries.

Where might the causal test for long-term injuries come from? One natural and obvious option is tort law. In fact, though natural resource damages are provided by statute, several courts have appropriately recognized that a natural resource damages action brought under CERCLA[185] "sounds basically in tort."[186] Tort law, in turn, supports a wide range of causal standards, including the traditional but-for test and the more relaxed contributing factor test.[187]

In determining whether a more lenient causation standard is appropriate for natural resource damages, one might consider the larger statutory frameworks that house natural resource damages. CERCLA in particular is known for its radical departure from traditional liability

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[181] *Id.*

[182] *Id.*

[183] 88 F.3d 1191 (D.C. Cir. 1996).

[184] *Id.* at 1224.

[185] The similarity in the natural resource damage provisions provided in CERCLA, OPA, and the Clean Water Act support a uniform approach to natural resource damages under any of these major statutes. *See* Oil Pollution Act, 33 U.S.C. § 2706(a) (2006); CERCLA, 42 U.S.C. § 9607(f)(1) (2006); Clean Water Act, 33 U.S.C. § 1321(b)(7) (2006).

[186] United States v. Montrose Chem. Corp. of Cal., 788 F. Supp. 1485, 1491 n.2 (C.D. Cal. 1992) (quoting *In re* Acushnet River & New Bedford Harbor: Proceedings re Alleged PCB Pollution, 712 F. Supp. 994, 1000 (D. Mass. 1989)). *But see* Memphis Zane May Assocs. v. IBC Mfg. Co., 952 F. Supp. 541, 546 (W.D. Tenn. 1996) ("Traditional tort notions of causation do not apply in CERCLA, which utilizes a 'status-based' liability standard." (quoting Peter M. Manus, *Natural Resource Damages from Rachel Carson's Perspective: A Rite of Spring in American Environmentalism*, 37 WM. & MARY L. REV. 381, 417 (1996))).

[187] PROSSER AND KEETON, *supra* note 36, §§ 41–44, at 263–319.

schemes and for its imposition of strict joint and several liability for cleanup costs based simply on categorical association with certain sites.[188] For cost recovery actions,[189] showing causation is not required at all.[190] As Professor John Copeland Nagle has explained, ordinarily "[c]ausation is a necessary prerequisite for assigning responsibility in tort law, even in strict liability regimes. Nonetheless, courts have excused the victims of hazardous waste injuries from proving causation under CERCLA because of the well-noted difficulties in determining the cause of injuries from hazardous substances."[191]

Very little separates the natural resource damages from other types of liability created by CERCLA and OPA. In fact, some commentators have noted that the only feature separating natural resource damages from cost recovery actions is that trustees have to show an actual release to recover natural resource damages, whereas recovery for cleanup costs requires only a threatened release of oil or other toxins.[192] These nearly identical legal frameworks have led at least one commentator to argue for the same causal standard to apply to natural resource damages as recovery actions—namely, to jettison a causal requirement for natural resource damages entirely.[193] Though current statutory frameworks foreclose that option absent legislative reform, the similarity between cost recovery and natural resource damages claims might, at a minimum, suggest that the existing

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[188] 4 WILLIAM H. RODGERS, JR., ENVIRONMENTAL LAW: HAZARDOUS WASTES AND SUBSTANCES ch. 8 (1992 & Supp. Winter 2012).

[189] For a basic discussion of cost recovery actions, see Jason E. Panzer, Note, *Apportioning CERCLA Liability: Cost Recovery or Contribution, Where Does a PRP Stand?*, 7 FORDHAM ENVTL. L.J. 437, 443 (1996):

> CERCLA authorizes two types of legal actions which allow parties to recover cleanup expenses: cost recovery actions under § 107(a), which impose joint and several liability, and contribution actions under § 113(f), which impose only several liability. The section under which a plaintiff proceeds significantly affects parties' rights concerning the scope of the defendant's liability, the plaintiff's burden of proof, the applicable statute of limitations, and the availability of defenses. Under the § 107 cost recovery action, a plaintiff may shift virtually all of its CERCLA liability to the defendant with a relatively light burden of proof. In contrast, the § 113(f) contribution action only permits plaintiffs to recover the defendant's equitable share of the response costs, and imposes a more stringent burden of proof.

Id. (footnotes omitted).

[190] *See* RODGERS, *supra* note 188.

[191] John Copeland Nagle, *CERCLA, Causation, and Responsibility*, 78 MINN. L. REV. 1493, 1496 (1994) (footnotes omitted); *see also* O'Neil v. Picillo, 883 F.2d 176, 179 (1st Cir. 1989) (citation omitted) ("It has not gone unnoticed that holding defendants jointly and severally liable . . . may often result in defendants paying for more than their share of the harm. Nevertheless, courts have continued to impose joint and several liability . . . reasoning that where all of the contributing causes cannot fairly be traced, Congress intended for those proven at least partially culpable to bear the cost of the uncertainty.").

[192] *See, e.g.*, Nagle, *supra* note 191, at 1514–16.

[193] *See* James R. MacAyeal, *The Comprehensive Environmental Response, Compensation, and Liability Act: The Correct Paradigm of Strict Liability and the Problem of Individual Causation*, 18 UCLA J. ENVTL. L. & POL'Y 217 (2000).

statutes leave room for a more relaxed causation requirement for natural resource damages.

C. Room Within the Existing Jurisprudence

In an area replete with complicated causal pathways and multiple forces combining to create harm, courts have struggled in the face of very little congressional guidance to develop a single standard for proving causation for natural resource damages. Not many courts have considered the issue.[194] Those that have differ in their conclusions and are relatively narrow in their approaches. All suffer from the confusion that inevitably arises when the substantial factor test from traditional tort law is adopted or rejected without clarification of its meaning. Indeed, further examination reveals that their approaches are not as different as they might otherwise appear. Moreover, their approaches might differ because some are more careful than others to distinguish between cost recovery and natural resource damages actions under CERCLA.[195]

One court has declined to formally adopt a new, special causation standard for natural resource damages claims under CERCLA. In *United States v. Montrose Chemical Corp. of California*, the U.S. District Court for the Central District of California announced in an unpublished order that a "sole or substantially contributing" factor test applies to determining causation for natural resource damages claims.[196] The issue arose in the context of a motion to dismiss and the court's conclusion was not supported by citations or any analysis. Nonetheless, the court dismissed the trustee's complaint as insufficiently pled because the trustee had not alleged, for each defendant, that specific releases were the "sole or substantially contributing" cause of specific natural resource injuries.[197]

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[194] Only three courts have decided the issue, with varying levels of analysis. *See* Coeur D'Alene Tribe v. Asarco Inc., No. CV91-0342NEJL, CV96-0122NEJL, 2001 WL 34139603, at *4 (D. Idaho Mar. 30, 2001) (rejecting the substantial factor test as too restrictive and adopting the more relaxed contributing factor test); United States v. Montrose Chem. Corp. of Cal., No. CV 90-3122 AAH (JRX), 1991 WL 183147, at *1 (C.D. Cal. Mar. 29, 1991) (adopting substantial factor test with no analysis); *In re* Acushnet River & New Bedford Harbor: Proceedings re Alleged PCB Pollution, 722 F. Supp. 893, 897 (D. Mass. 1989) (rejecting substantial factor test as too restrictive and adopting more relaxed contributing factor test).

[195] There are three major causes of action under CERCLA: cost recovery claims (imposes joint and several liability for cleanup expenses); contribution claims (imposes several liability and allows parties that have been sued to seek indemnity from other potentially responsible parties); and natural resource damages claims (allows specially designated government trustees to seek damages that will be used for restoration). *See* CERCLA §§ 107(a), 113(f), 42 U.S.C. §§ 9607(a), 9613(f). "The section under which a plaintiff proceeds significantly affects parties' rights concerning the scope of the defendant's liability, the plaintiff's burden of proof, the applicable statute of limitations, and the availability of defenses." Panzer, *supra* note 189. Because of these various causes of action, courts and litigants have to be cautious about treating cases from one context as controlling for another.

[196] *Montrose*, 1991 WL 183147, at *1.

[197] *Id.*

The *Montrose* court did not expressly discuss the bounds of its test. It did not specify what a plaintiff must show in order to satisfy this standard. Must the release be a substantial contributing cause when standing alone, as the classic version of the substantial factor test would require? How significant must the contribution be to rise to the level of "substantial"? Since the *Montrose* case comes out of the Central District of California, and since the California Supreme Court has permitted even very minor forces to be considered "substantial factor[s],"[198] perhaps the *Montrose* court intended to create a lenient version of the substantial factor test. In that case, we might consider whether the *Montrose* decision is really all that different from the other two courts that have considered the issue.

In contrast to the *Montrose* court, two other district courts have rejected the substantial factor test as too restrictive for natural resource damages claims. Instead, they have adopted a more relaxed contributing factor test. The first district court to adopt a relaxed causal test was the U.S. District Court for the District of Massachusetts. In *Acushnet River*, a CERCLA case involving the PCB contamination of the Acushnet River and New Bedford Harbor, the court considered whether the defendants would be held liable for natural resource damages arising from a mixture of PCB releases—some of which were federally permitted and some of which were not.[199] The court rejected the substantial factor test and concluded that the trustees need only show that the nonfederally permitted releases were a "contributing factor to an injury."[200]

Even though the court in *Acushnet River* ultimately adopted a contributing factor test, it did so somewhat reluctantly. The court in *Acushnet River* acknowledged that the first draft of its opinion would have required proof that the nonfederally permitted releases were a "substantial" factor in bringing about the injury. In a footnote, the court explained that it adopted the more relaxed test because of an intervening decision from the First Circuit, *O'Neil v. Picillo*.[201] The court did not explain, however, why it believed the First Circuit's opinion was controlling. The First Circuit opinion did reject substantiality as a basis for determining joint and several liability under CERCLA, but the case dealt with a recovery action and was not necessarily controlling on the issue of causal standards for natural resource damages.[202] Nonetheless, whether out of confusion or a deliberate attempt to reconcile the various remedies available under CERCLA, the district court in *Acushnet River* backed away from its initial impulse to impose the more traditional substantial factor test. Like the *Montrose* court, the court in *Acushnet River* did not discuss what evidence a plaintiff would

198 *See, e.g.*, Bockrath v. Aldrich Chem. Co., 980 P.2d 398, 404 (Cal. 1999).

199 *In re* Acushnet River, 722 F. Supp. at 895–97.

200 *Id.* at 897 (footnote omitted).

201 *Id.* at 897 n.8 (citing O'Neil v. Picillo, 883 F.2d 176 (1st Cir. 1989)).

202 *See O'Neil*, 883 F.2d at 178, 179 n.4.

have to show to meet the test adopted by the court. This makes it more difficult to know what the court believed was the difference between "substantial factor" and "contributing factor."

By the same token, the court in *Acushnet River* also did not offer an explanation as to what showing is necessary to satisfy the contributing factor test. In a footnote, the court offered only the slightest justification by acknowledging that defendants responsible only for *de minimis* contributions to harm should not be held liable.[203] The court only cited two sources that discuss the *de minimis* exception in the context of the substantial factor test,[204] and none that discuss it within the contributing factor test. The court offered no standard for what *de minimis* means in the more relaxed contributing factor test.

The most thorough examination of the proper causal test for natural resource damages came from the U.S. District Court for the District of Idaho in *Coeur D'Alene Tribe v. Asarco*.[205] In that case, federal and tribal trustees filed a natural resource damages claim for injuries caused by mine tailings[206] in northern Idaho.[207] In response to the defendant's motion for summary judgment, the court was asked to consider whether the trustees had established the requisite level of causation to prove natural resource damages.[208] The court began its analysis with CERCLA's statutory language and in particular the phrase "resulting from."[209] Interestingly, the court found the statutory language ambiguous even on the issue of whether Congress meant to create a stricter causation standard for natural resource damages claims than for response cost actions.[210]

On balance, and in keeping with other courts that have considered the threshold issue, the court concluded that CERCLA imposes a causation requirement for natural resource damages claims.[211] The court's reading of the statute as ambiguous, however, likely played a role in the court's decision to adopt a lenient standard of causation. In particular, the court

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[203] *Acushnet River*, 722 F. Supp. at 897 n.11.

[204] *Id.* (citing Dep't of Envtl. Prot. v. Ventron Corp., 440 A.2d 455, 463 (N.J. Super. Ct. App. Div. 1981), *aff'd as modified*, 468 A.2d 150 (N.J. 1983); RESTATEMENT (SECOND) OF TORTS § 431 (1965)).

[205] No. CV91-0342NEJL, CV96-0122NEJL, 2001 WL 34139603 (D. Idaho Mar. 30, 2001).

[206] Mine tailings are waste byproducts generated when metals are extracted from large quantities of rock during mining operations. *See* U.S. ENVTL. PROT. AGENCY, TECHNICAL REPORT: DESIGN AND EVALUATION OF TAILINGS DAMS 1 (1994), *available at* http://www.epa.gov/osw/nonhaz/industrial/special/mining/techdocs/tailings.pdf.

[207] 2001 WL 34139603, at *1.

[208] *Id.* at *2.

[209] *Id.* at *3.

[210] *Id.* at *4. Recall that the D.C. Circuit in *Ohio v. Department of Interior* had previously held that some proof of causation was required by CERCLA in the natural resource damage context, even though the statute was ambiguous as to what the particular standard should be. *See supra* notes 179–82 and accompanying text.

[211] *Coeur D'Alene Tribe*, 2001 WL 34139603, at *5.

explained that traditional notions of causation do not apply in response cost actions. When there are problems of multiple polluters and commingled waste, imposing quantitative thresholds or requiring the trustee to trace releases to each responsible party is "too restrictive."[212]

Applying the rationale associated with response cost cases, the court found that the "causation standard for [natural resource damage] actions is also less restrictive than traditional federal common law."[213] The court concluded that where releases have been commingled, trustees have only the burden of proving that a release of commingled hazardous substances is a contributing factor to the harm.[214] To be a contributing factor, the release must have been more than a *de minimis* amount, and "at least some of the injury would have occurred if only the Defendant's amount of release had occurred."[215]

Throughout its opinion, the court was careful to distinguish between recovery actions and actions for natural resource damages. The court's adoption of the recovery action rationale in the natural resource damages context is not a function of confusion; it is a deliberate recognition that similar causation standards ought to be applied to factual situations that pose similar problems of proof.

The court's justification for a less stringent causation standard comes from the problems associated with commingled waste. After articulating the relaxed standard for commingled releases, the court went on to say, "In cases where releases have *not* been commingled, the burden would be to show that such release was the sole or proximate cause to the injury to the natural resources."[216] The court, therefore, distinguished commingled releases from noncommingled releases. This distinction does not emerge from any deeper examination of whether the causal problems in natural resource damages claims actually turn on the characterization of releases as commingled. If taken literally, the court's distinction between commingled and noncommingled waste creates some problems for the recovery of long-term injuries after oil spills or other such singular releases.[217]

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[212] *Id.*

[213] *Id.*

[214] *Id.*

[215] *Id.*

[216] *Id.*

[217] Oil spills are typically singular releases, not commingled. Nonetheless, oil spills pose causal dilemmas similar to the kind of commingled hazardous substance release at issue in Asarco and therefore warrant similar treatment. In both cases, there are many contributing forces that complicate the causal question. For long-term injuries from singular releases like oil spills, there can be multiple sources of toxins negatively impacting the ecosystem in combination, though the relative contribution of each might be unknown. *See Conceptual Model*, *supra* note 10, at 672, 690–712 (describing the multiple natural and anthropogenic stressors that affect ecosystem function of Prince William Sound after the *Exxon Valdez* Oil Spill). Similarly, for commingled waste releases, there are multiple contributors to harm, though the relative weight of each is unknown. *See* Nagle, *supra* note 191, at 1500

To summarize the paucity of jurisprudence, three district courts have considered what causal standard should be applied to natural resource damages actions under CERCLA—one used substantial factor, one would have applied substantial factor but for its belief that a First Circuit decision in a recovery action case was controlling (likely a point of confusion), and one would apply a relaxed contributing factor test, but only where there is commingled waste. No courts have expressly considered the issue under OPA. No courts have considered the unique burdens of proving long-term natural resource injuries.

D. Room Within Broader Tort Goals of Corrective Justice and Deterrence

It is one thing to say that statutes and court decisions leave room for an alternate causal paradigm for proving long-term natural resource injuries. It is another thing to adopt a relaxed causal standard when doing so leaves responsible parties exposed to greater liability for injuries that are admittedly further removed in time from the original spill, and thus more difficult to prove with great certainty. Before offering up alternate paradigms that would facilitate the recovery of long-term damages, it is worth pausing to consider whether doing so would be consistent with underlying principles of tort law.

One small caveat is in order. Though there is a rich torts literature and passionate scholarly debate over which goal—corrective justice or deterrence—lies at the heart of tort, stepping into that debate is not the aim of this Article.[218] The aim here is much more modest; it simply asks whether a relaxed form of causation for long-term natural resource injuries is justified under either a corrective justice or deterrence theory of tort. The character of ecological injuries and the inherent risks associated with oil transport and drilling suggest that a relaxed causal paradigm for natural

(describing causation difficulties under CERCLA); *infra* note 248 (assembling cases discussing the complex nature of Superfund releases). In each case, there are commingled *stressors*—whether arising from commingled waste or the uncertain combination of multiple forces working together through unknown mechanisms to wreak environmental havoc. In either case, the difficulty of quantifying relative contributions of harm necessitates a causal standard that alleviates the need to weigh the relative contribution of harm from multiple actors or multiple forces. *See* Nagle, *supra* note 191. The distinction between multiple polluters and multiple forces, each of which combine to cause harm, may be a distinction without a difference when it comes to the adoption of the contributing factor test. All of this is to say that when the *Asarco* court suggested that a relaxed causation standard was not appropriate in the case of noncommingled releases, the court most likely did not have the case of oil spills or long-term injuries in mind.

[218] For a thorough examination of the scholarly literature and debate, see Gary T. Schwartz, *Mixed Theories of Tort Law: Affirming Both Deterrence and Corrective Justice*, 75 TEX. L. REV. 1801, 1802–11 (1997).

resource damages would concurrently serve the corrective justice and deterrence rationales.[219]

Under the theory of corrective justice, tort liability is rationalized by the moral responsibility that the tortious actor has to the injured party.[220] Corrective justice is an extension of early rationalizations of tort liability in terms of "fairness" or "moral sense of community."[221]

Viewing the issue from a corrective justice standpoint, relaxing the causal paradigm for long-term natural resource injuries makes good sense for two reasons. The first is the inability of a traditional paradigm to provide full compensation.[222] Retaining a causal paradigm that demonstrably absolves tortious actors from liability for long-term injuries contradicts the corrective justice goal of tort law. Similar observations have been made in the toxic torts context. For example, to avoid systematically undercompensating victims of difficult-to-prove latent injuries, Professor Margaret Berger suggests the causal element be eliminated entirely for certain toxic tort cases.[223] Doing so, she argues, is necessary to serve the needs of corrective justice. Otherwise, "[c]ausation knocks out the link between culpability and liability."[224] While the statutory language of CERCLA and OPA does not permit elimination of the causal element for natural resource damages,[225] Professor Berger's underlying observations apply equally well to the factually similar context of long-term natural resource damages.

The public nature of injuries arguably places greater moral responsibility on the tortious actor to fully restore the health of collectively owned resources. To that end, a unique and defining feature of natural resource damages claims are their roots in the public trust doctrine and their purpose of ensuring that the public is adequately compensated for losses to collectively owned natural resources.[226] Also, unlike in toxic torts

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[219] *Id.* at 1821 (arguing that the American rule of strict liability for abnormally dangerous activities is justified on both corrective justice and deterrence grounds).

[220] *See, e.g.*, George P. Fletcher, *Fairness and Utility in Tort Theory*, 85 HARV. L. REV. 537 (1972) (examining corrective justice rationale).

[221] *See* Schwartz, *supra* note 218, at 1802 & n.3 (citing James Barr Ames, *Law and Morals*, 22 HARV. L. REV. 97, 101, 109 (1908), as an example of how early justifications of tort law appealed to a sense of fairness).

[222] *See* discussion *supra* Part I.C.

[223] *See* Margaret A. Berger, *Eliminating General Causation: Notes Towards a New Theory of Justice and Toxic Torts*, 97 COLUM. L. REV. 2117, 2131–34 (1997).

[224] *Id.* at 2134.

[225] *See* discussion *infra* Part II.B.

[226] *See* Manus, *supra* note 186, at 433–38. For an argument of why greater responsibilities attach to public trust resources, see James M. Olson, *Shifting the Burden of Proof: How the Common Law Can Safeguard Nature and Promote an Earth Ethic*, 20 ENVTL. L. 891, 906–07 (1990) ("With the recognition that certain global commons—the . . . seas, sea beds . . . —are critical to the sustainability of earth and are impressed with a public trust, those who seek to alter, reallocate, or dispose of such commons directly—or indirectly through pollution—have the burden of proving that their proposed

cases where plaintiffs seek compensation for private injuries, natural resource damages must be used to restore the injured ecosystems. Because recovered damages are earmarked for the public benefit, a more aggressive tort liability scheme (with more relaxed causal requirements) does not carry the risk of providing a windfall to a single individual. Rather, to the extent that a relaxed causal paradigm carries a risk of overcompensation, any resulting windfall returns to the public sphere. Such windfalls might even be characterized as a Pigovian tax[227] on engaging in activities that can result in catastrophic harm.

Tort law has long found liability for activities with a high risk of public harm. For example, the abnormally dangerous activities doctrine imposes strict liability on actors that introduce unusual dangers into the community.[228] Before imposing strict liability under this doctrine, courts consider, among other factors, the likelihood that any resulting harm will be great, the existence of a high degree of risk to the land of others, and the inability to eliminate the risk through exercise of reasonable care.[229] These factors could be applied to oil transport or drilling. Consider that the New Jersey Supreme Court has applied this doctrine to hold a "landowner . . . strictly liable to others for harm caused by toxic wastes . . . stored on his property and flow[ing] onto the property of others."[230]

Of course, the idea here is not to argue for a strict liability regime for oil spills, but rather to illustrate that tort law has seen fit to relax liability schemes for activities that by their very nature pose great risk to the public. Under similar logic, it would seem that tort law could amply support a relaxed causal standard as consistent with its underlying goals of fairness and deterrence. In fact, a tort system focused on corrective justice would

conduct would not impair the functional or sustainable level of these natural systems or their values. The public trust, by shifting the burden of proof, thus brings an ethical dimension within the reach of the legal system.").

[227] A Pigovian tax (also spelled Pigouvian) is a "tax levied on an agent causing an environmental externality (environmental damage) as an incentive to avert or mitigate such damage." *Pigouvian Tax Definition*, GLOSSARY OF STAT. TERMS, http://stats.oecd.org/glossary/detail.asp?ID=2065 (last updated Nov. 20, 2001). Several scholars have discussed how the Pigovian tax could guide environmental and energy policy. *See* Shi-Ling Hsu, *Fairness Versus Efficiency in Environmental Law*, 31 ECOLOGY L.Q. 303, 396 (2004) (suggesting greater use of Pigouvian taxes "to make environmental law take greater account of efficiency-oriented approaches"); Thomas Merrill & David M. Schizer, *Energy Policy for an Economic Downturn: A Proposed Petroleum Fuel Price Stabilization Plan*, 27 YALE J. ON REG. 1 (2010) (comparing the advantages and disadvantages of a petroleum fuel price stabilization plan to a Pigouvian tax); *see also* Robert H. Frank, *Heads, You Win. Tails, You Win, Too*, N.Y. TIMES, Jan. 6, 2013, at BU6 (explaining the economic, social, and individual benefits of Pigovian taxes).

[228] RESTATEMENT (SECOND) OF TORTS § 520, at 36 (1977).

[229] *Id.*

[230] Dep't of Envtl. Prot. v. Ventron Corp., 468 A.2d 150, 157 (N.J. 1983).

reject the prospect of a private tortfeasor reaping profit from an activity that leaves the public to absorb the cost of long-term harm.[231]

There is at least one countervailing consideration. Though oil transport and drilling might well be high-risk activities, these activities are not without public benefit. Some might argue that the public and industrial society demand the existence of oil companies and their engagement in oil transport and drilling, despite the known risks. Given the public service provided by oil transport and drilling, some might argue that imposing harsher standards of liability simply shifts the responsibility of an oil-dependent nation from society writ large onto the few companies that have taken on the task of providing a desired service.

Courts would likely reject the idea that the public demand for oil might justify less rigorous forms of liability. Such a social utility analysis, if litigants were inclined to suggest one, might be derived from the unavoidably unsafe products doctrine. That doctrine has been invoked most prominently in cases where products liability actions are made against manufacturers of vaccines.[232] In those cases, the societal goal of maintaining an adequate supply of vaccines outweighs the risks inherent in the products, and courts have limited tort liability.[233] In other areas where defendants have made similar social utility arguments, however, courts have rejected them. For example, the Wisconsin Supreme Court rejected an electric utility's argument that the benefits of providing electricity for the community outweighed the harm suffered by a plaintiff: "We know of no acceptable rule of jurisprudence that permits those who are engaged in important and desirable enterprises to injure with impunity those who are engaged in enterprises of lesser economic significance."[234]

It is not simply tort's corrective justice goal that would be served by a causal paradigm more befitting the difficulties of proving long-term natural

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[231] *See* Sindell v. Abbott Labs., 607 P.2d 924, 936 (Cal. 1980) ("[A]s between an innocent plaintiff and negligent defendants, the latter should bear the cost of the injury."); *see also* Escola v. Coca Cola Bottling Co., 150 P.2d 436, 441 (Cal. 1944) (en banc) ("The cost of an injury and the loss of time or health may be an overwhelming misfortune to the person injured, and a needless one, for the risk of injury can be insured by the manufacturer and distributed among the public as a cost of doing business.").

[232] *See* RESTATEMENT (SECOND) OF TORTS § 402A cmt. k (1965) (discussing the unavoidably unsafe products doctrine and its application to vaccines); *see also* Graham v. Wyeth Labs., 666 F. Supp. 1483, 1496 (D. Kan. 1987) (discussing the limits of the unavoidably unsafe products doctrine but explaining that "[c]omment k recognizes that some products, such as certain drugs, are so beneficial and necessary that the manufacturer of these products should not, in all instances, be held strictly liable for unforeseeable harm").

[233] *See, e.g.*, Shackil v. Lederle Labs., 561 A.2d 511, 524 (N.J. 1989).

[234] Jost v. Dairyland Power Coop., 172 N.W.2d 647, 653 (Wis. 1969) (discussed in ROBIN KUNDIS CRAIG ET AL., TOXIC AND ENVIRONMENTAL TORTS: CASES AND MATERIALS 80–81 (2011) [hereinafter TOXIC TORTS]). In *Jost*, sulfur dioxide gas emitted from the plant settled onto farm fields and caused damage and loss of market value to the crops. *Id.* at 649. Jost and the other farmers brought suit in nuisance against Dairyland for the damage caused. *Id.*

resource damages. A relaxed causal standard for natural resource damages also serves the deterrence goal of tort law. That goal is worth pursuing for two reasons. First, the injuries resulting from an oil spill are catastrophic and hard, if not impossible, to undo.[235] There is no doubt that every oil spill leaves a permanent stain on the environment, so there is an even greater need to deter oil spills from occurring in the first place.

Second, many oil spills are avoidable. Consider the type of corporate behavior that resulted in the BP Gulf Oil Spill and the *Exxon Valdez* Oil Spill. The Exxon spill was the result of a corporate culture that had become complacent with alcoholism and desensitized to the risk of oil transport.[236] Similarly, the BP spill was the result of a pattern of reckless decisions regarding the maintenance and safety of oil rigs.[237] The avoidability of the Exxon and BP oil spills suggest that deterrence still has a role to play.

One way to encourage corporations to attend to safety is through legislation, in the way that Congress passed OPA in 1990 after the Exxon spill. Another way is to demand more complete liability and adopt a causal paradigm that holds tortfeasors liable for the full suite of ecological injuries. The risk of more substantial damages would motivate corporations engaged in oil transport and drilling to adhere more strictly and consistently to safety protocols. In some ways, this is simply an argument for assigning liability to the cheapest cost avoider, which is the party in the best position to identify risks and adopt modifications in behavior.[238]

The idea that tort law would support assigning liability to the cheapest cost avoider is not new.[239] Judge Guido Calabresi has long since and aptly remarked that the deterrence goals in tort law are to be achieved "by creating incentives so that people will avoid those future injuries worth avoiding and thus achieve an optimal trade-off between safety and injury in a world where safety is not a free good, and hence injury is not a total

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[235] For a discussion of ecological injuries following the *Exxon Valdez* Oil Spill, see *supra* Part I.A.

[236] *See* Brief of Experts on Alcohol in the Workplace as Amici Curiae Supporting Respondents, Exxon Shipping Co. v. Baker, 554 U.S. 471 (2008) (No. 07-219), 2008 WL 275485.

[237] DEEP WATER COMMISSION REPORT, *supra* note 4, at vii ("The explosive loss of the Macondo well could have been prevented.").

[238] Guido Calabresi, *Optimal Deterrence and Accidents*, 84 YALE L.J. 656, 666 (1975) [hereinafter Calabresi, *Optimal Deterrence*]; *see also* Guido Calabresi, *Concerning Cause*, *supra* note 35, at 84 (identifying the attributes of the cheapest cost avoider).

[239] *See supra* note 238; *see also* Guido Calabresi & Jon T. Hirschoff, *Toward a Test for Strict Liability in Torts*, 81 YALE L.J. 1055, 1060 (1972) ("It requires of such an institution only a decision as to which of the parties to the accident *is in the best position to make the cost-benefit analysis between accident costs and accident avoidance costs and to act on that decision once it is made.*"); Stephen G. Gilles, *Negligence, Strict Liability, and the Cheapest Cost-Avoider*, 78 VA. L. REV. 1291, 1301–03 (1992) ("[I]n modern American tort law[,] . . . many negligence cases may in practice be litigated by reference to the cheapest cost-avoider test . . . . [T]he cheapest cost-avoider criterion played a central part in determining the meaning of strict liability *and* the meaning of negligence throughout the long evolution of English tort law . . . .").

bad."[240] Calabresi suggests that choosing an appropriate causation paradigm can help achieve that optimal allocation.[241] In particular, the key is allowing flexibility in the causation inquiry.[242] Causal concepts, Calabresi explains, are simply tools for assigning fault in accord with social goals.[243] The rigid application of causal concepts, therefore, "would no longer adequately serve the goals we can analyze nor would they permit the introduction of goals we cannot affirm too openly or have not been able to analyze at all."[244]

III. IDENTIFYING THE CORE CAUSAL CHALLENGES

Having identified the need for a new causal paradigm to remedy long-term ecological injuries, and having concluded that space for an alternate paradigm exists, the logical next question is what such a paradigm might look like. Indeed, given that tort law has a history of grappling with difficult questions of causation, the real question is whether tools already exist that could adequately address the causal problems raised by long-term ecological injuries. Where is the flexibility of tort law needed? In other words, what are the core causal challenges that lie at the heart of long-term ecological injuries?

One way of uncovering the core challenges might be to consider what they are not. For instance, in the area of toxic torts, an area raising similar problems of latent, long-term injuries, courts have fashioned numerous innovative approaches to causation. Many of these innovations address problems of the indeterminate defendant.[245] While those cases involve injuries traceable to a particular type of product (e.g., asbestos), difficult questions of causation arise because the plaintiff cannot identify which of the many defendant product manufacturers caused the harm.[246] To deal with

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[240] Calabresi, *Concerning Cause*, *supra* note 35, at 77.

[241] *Id.* at 81 ("The requirement of proximity in causal relationships, unlike that of *but for* relationships, may help to select from the universe of causally linked actions those actions worth deterring collectively."); *id.* at 85 (suggesting that "[o]ne could do away with the *but for* test" if one employed other methods for identifying the cheapest cost avoider); *id.* at 88 ("Past foreseeability is not, however, a prerequisite to liability if the object is market deterrence.").

[242] *Id.* at 107.

[243] *Id.* at 106.

[244] *Id.* at 107.

[245] *See* DOBBS ET AL., *supra* note 92, § 189, at 633 & n.10 (listing examples of many different tort doctrines that might be relevant in a multiple polluter situation).

[246] Classic burden-shifting cases like *Summers v. Tice*, 199 P.2d 1 (Cal. 1948) (en banc), are likewise founded on the notion that all relevant defendants are before the court. In *Summers*, for instance, there were only two possible defendants, both of those defendants were before the court, both defendants acted negligently, and one of those defendants actually caused the injury. *See* 199 P.2d at 1–2. However, in situations where the cause of an injury is not fully known and where there are multiple potential defendants, not all of whom are parties to the case, courts are more reluctant to impose joint and several liability under *Summers*. *See, e.g.*, Sindell v. Abbott Labs., 607 P.2d 924, 931 (Cal. 1980) (rejecting the application of *Summers* to the toxic tort context where there were over 200 potential

this problem, some courts have applied a theory of "enterprise liability," whereby all manufacturers of a given product are held jointly liable if they adhered to industry-wide safety standards that created an unreasonable risk of harm.[247]

Similar to the indeterminate defendant problem, many CERCLA cases grapple with the difficulties of apportioning harm among multiple polluters. Typically, those cases involve the release of a hazardous substance that is a mixture of substances from many generators leaking from hundreds of barrels or more.[248] Given the length of time over which releases occurred and the number of parties that have contributed over time to the pool of toxic waste, separating whose waste caused what harm is nearly impossible.[249] In fact, the causal difficulties that arise in that situation are well-known drivers in Congress's decision to jettison a traditional causation requirement in CERCLA cost recovery actions.[250] In those actions, the government only needs to show that there was a release from the site, but it need not show which potentially responsible party's substance caused the actual harm.[251]

One key feature of multiple polluter cases is that a group of potentially responsible parties is typically identified by their relation to the site where the release took place. While delineating the particular harm attributable to

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defendants, not all of whom were joined in the litigation); *see also* Rutherford v. Owens-Ill., Inc., 941 P.2d 1203, 1216 (Cal. 1997) (noting that "the majority of courts have refused to extend the doctrine of alternative liability and its burden-shifting" to cases where the court is uncertain whether the culpable party is before the court).

[247] *See, e.g.*, Hall v. E.I. Du Pont de Nemours & Co., 345 F. Supp. 353 (E.D.N.Y. 1972). Generally, this theory is reserved for industries comprised of a relatively small number of manufacturers complicit in unacceptable testing, warning, and efficacy standards for their common product. *Id.*

[248] *See, e.g.*, *In re* Bell Petroleum Servs., Inc., 3 F.3d 889, 903 (5th Cir. 1993) (noting that "most CERCLA cost-recovery actions involve numerous, commingled hazardous substances with synergistic effects and unknown toxicity"). The leading case on imposing joint and several liability under CERCLA, *U.S. v. Chem-Dyne Corp.*, described the nature of its fairly complex factual determination like this:

> The Chem-Dyne facility contains a variety of hazardous waste from 289 generators or transporters, consisting of about 608,000 pounds of material. Some of the wastes have commingled but the identities of the sources of these wastes remain unascertained. The fact of the mixing of the wastes raises an issue as to the divisibility of the harm. Further, a dispute exists over which of the wastes have contaminated the ground water, the degree of their migration and concomitant health hazard.

572 F. Supp. 802, 811 (S.D. Ohio 1983).

[249] *Bell Petroleum*, 3 F.3d at 897–99 (surveying CERCLA jurisprudence on joint and several liability and describing multiple cases in which courts found it difficult to apportion liability from multiple, commingled sources); *see also* O'Neil v. Picillo, 883 F.2d 176, 179 (1st Cir. 1989) ("[W]here wastes of varying (and unknown) degrees of toxicity and migratory potential commingle, it simply is impossible to determine the amount of environmental harm caused by each party.").

[250] Nagle, *supra* note 191 (footnote omitted) ("[C]ourts have excused the victims of hazardous waste injuries from proving causation under CERCLA because of the well-noted difficulties in determining the cause of injuries from hazardous substances.").

[251] *Id.* at 1511.

each might be a difficult proposition, confidence is relatively high that the harm is caused by the collective actions of the group.[252] Often, therefore, the potentially responsible parties are held jointly and severally liable.[253]

By contrast to the indeterminate defendant cases in toxic tort or CERCLA's multiple polluter cases, oil spills are generally one-time releases from a single tortfeasor or vessel. Incidents like the *Exxon Valdez* Oil Spill or the BP Gulf Oil Spill are readily identifiable in terms of the substance released, the parties responsible for that release, and the timing of the release. In the oil spill context, therefore, the causation dilemma goes beyond apportioning liability among members of an identifiable group.

Unlike problems of apportioning harm among multiple defendants, the most nettlesome problem characterizing long-term harms from oil spills is the differentiation of harm from background stressors and the oil exposure itself. Oceans are particularly challenging in this regard. Several scholars and international organizations have noted that the background degraded state of the oceans is a substantial issue.[254] For example, the United Nations Environment Program has assembled a laundry list of background stressors that threaten ocean ecosystems, including pollution from "land-based sources, oil spills, untreated sewage, heavy siltation, eutrophication (nutrient enrichment), invasive species, persistent organic pollutants (POPs), . . . acidification, radioactive substances, marine litter, overfishing and destruction of coastal and marine habitats."[255]

Climate change is adding to and compounding these existing background stressors.[256] A 2011 workshop led by the International Programme on the State of the Ocean and the International Union for Conservation of Nature concluded that "[r]esilience of the ocean to climate change impacts is severely compromised by the other stressors from human activities" and that "[e]cosystem collapse is occurring as a result of both current and emerging stressors."[257]

As Professor Robin Kundis Craig has explained, these background stressors are even more problematic when synergistic interactions are

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[252] *See Chem-Dyne Corp.*, 572 F. Supp. at 810.

[253] *See id.*; Nagle, *supra* note 191, at 1519–20.

[254] *See, e.g.*, Robin Kundis Craig, *Avoiding Jellyfish Seas, or, What Do We Mean by "Sustainable Oceans," Anyway?*, 31 UTAH ENVTL. L. REV. 17 (2011) [hereinafter *Avoiding Jellyfish Seas*].

[255] *See* UNITED NATIONS ENV'T PROGRAMME & GRID-ARENDAL, OUR PRECIOUS COASTS: MARINE POLLUTION, CLIMATE CHANGE AND THE RESILIENCE OF COASTAL ECOSYSTEMS 15 (Christian Nellemann & Emily Corcoran eds., 2006), *available at* http://www.grida.no/files/publications/our-precious-coasts_lr.pdf.

[256] *See Avoiding Jellyfish Seas*, *supra* note 254, at 30; Robin Kundis Craig, *Ocean Governance for the 21st Century: Making Marine Zoning Climate Change Adaptable*, 36 HARV. ENVTL. L. REV. 305, 315–23 (2012) [hereinafter *Ocean Governance for the 21st Century*].

[257] A.D. ROGERS & D.D'A. LAFFOLEY, INTERNATIONAL EARTH SYSTEM EXPERT WORKSHOP ON OCEAN STRESSES AND IMPACTS: SUMMARY REPORT 6 (2011), *available at* http://www.stateoftheocean.org/pdfs/1906_IPSO-LONG.pdf.

considered.[258] In particular, Professor Craig warns that "[o]verfishing is generally considered the primary threat to marine biodiversity, especially when fishing methods also destroy habitat . . . . Overfishing can also interact synergistically with other stresses, such as marine pollution, to destroy the productivity of a particular marine area."[259] In more general terms, Professor Robert Rabin has described the problems of collective and synergistic harms for environmental torts:

> [E]nvironmental torts evoke an entirely different perspective on liability, one which is virtually unknown at common law. Frequently, environmental harm is a consequence of the aggregate risk created by a considerable number of independently acting enterprises. . . . Or, it may be that the risk inherent in the product is substantial, but it soon merges into a common pool. Whatever the case, environmental harm is very often *collective* harm.[260]

Few tort doctrines grapple expressly with situations where man-made and natural or background forces combine to create a single, indivisible injury. A notable exception is the twin fires case that was an early adopter of the substantial factor analysis.[261] In that case, two fires combined to burn down the plaintiff's property; one fire was from an unknown origin and could not therefore be traced to a tortious actor. Nonetheless, the court applied the substantial factor test and concluded that the defendant could be held liable even where another force—whether natural or unnatural—might also have independently caused the harm. There is one caveat, however. Each cause has to be sufficient *on its own* to cause the harm.[262] This caveat poses no problem to the twin fires scenario but the same might not be true in some natural resource damages settings where there are multiple contributing causes, whose collective stress gives rise to harm even though no one individual stressor would be sufficient. In that way the twin fires formulation of the substantial factor test fails to recognize harm from synergistic causes.

This is not to say that tort law, or the substantial factor test, is incapable of addressing synergistic harms. California courts, for instance, have adopted a broad version of the substantial factor test that would hold defendants liable so long as "the contribution of the individual cause [is] more than negligible or theoretical."[263] In addition, the idea of synergistic harms has been identified in the *Restatement (Third) of Torts*. In particular, comment f observes that the substantial factor test would be appropriate in

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[258] *See Avoiding Jellyfish Seas*, *supra* note 254, at 26.

[259] *Id.*

[260] Rabin, *supra* note 151, at 32.

[261] *See supra* notes 159–61 and accompanying text.

[262] DOBBS ET AL., *supra* note 92, § 189, at 632.

[263] Rutherford v. Owens-Ill., Inc., 941 P.2d 1203, 1220 (Cal. 1997); *see also* Bockrath v. Aldrich Chem. Co., 980 P.2d 398, 404 (Cal. 1999) (emphasizing the broad nature of the substantial factor test by clarifying that "a very minor force that does cause harm is a substantial factor").

situations where the tortious conduct combines with other forces to create harm (even if it does not create harm on its own):

> In some cases, tortious conduct by one actor is insufficient, even with other background causes, to cause the plaintiff's harm. Nevertheless, when combined with conduct by other persons, the conduct overdetermines the harm, i.e., is more than sufficient to cause the harm. . . . The fact that an actor's conduct requires other conduct to be sufficient to cause another's harm does not obviate the applicability of this Section.[264]

In this way, the *Restatement Third* seems to support the use of the substantial factor test (or some version thereof) in cases where exposure to oil combined with other environmental stressors (including background stressors) to create harm. Similarly, the *Restatement* would seem to recognize the imposition of liability where synergistic effects of an oil spill give rise to harm.

Conceptually, comment f comes closest to appropriately capturing the multiple interacting forces that potentially combine to create harm when toxic stressors are added to sensitive marine ecosystems. To the extent that this approach most accurately describes the problems faced by trustees in the natural resource damages context, it provides a useful starting point for thinking about how to apply doctrines like the contributing factor test to injuries manifesting in the long-term wake of oil spills.

This might be a good place to pause for a moment and consider why tortfeasors should be prepared to shoulder the costs of long-term harms, especially if they arise only in combination with other forces of nature. Why should Exxon or BP be held liable for long-term injuries when those injuries will necessarily be a partial function of environmental factors beyond their control? The Gulf of Mexico, for instance, was not exactly a poster child for pristine ecosystems before the BP Gulf Oil Spill.[265] And the *Exxon Valdez* Oil Spill is certainly not solely responsible for the inevitable extinction of the AT-1 pod of killer whales in Prince William Sound.[266] In each of these examples, the tortfeasor might contribute only relatively small stressors, but in the already fragile state of an overstressed ecosystem, these could lead to more catastrophic long-term impacts than would otherwise have been predicted. In the case of the killer whale pods, the harm may be the acceleration of an adverse but probable event.

One reason tortfeasors should shoulder the burden of synergistic harms might come from a basic principle of tort: nature is like a classic eggshell plaintiff.[267] Parties such as Exxon or BP, who are engaged in risky

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[264] RESTATEMENT (THIRD) OF TORTS: LIABILITY FOR PHYSICAL AND EMOTIONAL HARM § 27 cmt. f, at 380 (2010).

[265] Craig, *A Match Made in Hell*, *supra* note 12, at 1890.

[266] *See supra* note 84.

[267] DOBBS ET AL., *supra* note 92, § 206, at 711–13 (explaining the eggshell plaintiff rule and its role in the proximate cause inquiry).

behavior with potentially catastrophic environmental consequences, take the plaintiff as they find it. Nature comes in complicated forms with varying levels of susceptibility to injury, depending on the other stressors acting upon the particular ecosystem at issue. Complications like climate change and natural variability are simply part of the backdrop. Indeed, enough evidence that climate change is happening has emerged that it can fairly be considered the new vulnerable and uncertain state in which nature exists. When viewed as simply part of the eggshell plaintiff that is nature herself, climate change, like a preexisting condition, cannot fairly serve as a counterexplanation for long-term harm. Given that enough scientific literature has now been assembled to make long-term injuries more foreseeable, the eggshell plaintiff rule is even more apt—that long-term injuries will be sustained is foreseeable even if the amount or particular type of the harm is still unknown.[268]

An alternative approach would be apportionment—that is, apportioning harm between background stressors and the oil spill defendant. Apportionment, a concept that has been both suggested[269] and criticized[270] in the toxic tort context, would hold defendants liable for only the portion of the harm that was attributable to the oil spill. The appeal of such an approach is fairness to the defendant, and for that reason, it is worth considering.[271] The practical infeasibility of apportionment, however, demands a different solution.

In the CERCLA cost recovery context, where there are multiple polluters who have contributed or potentially contributed hazardous substances to a site of release, courts have rejected apportionment as too

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[268] *Id.* (describing the rule as one that imposes liability for foreseeable harms even when the amount of harm is not foreseeable).

[269] *See, e.g.*, Dafler v. Raymark Indus., Inc., 611 A.2d 136, 146 (N.J. Super. Ct. App. Div. 1992), *aff'd*, 622 A.2d 1305 (N.J. 1993) (affirming apportionment between smoking and asbestos); Gerald W. Boston, *Toxic Apportionment: A Causation and Risk Contribution Model*, 25 ENVTL. L. 549, 549 (1995) (suggesting for "toxic tort cases involving multiple sources of toxic-related risks . . . a risk contribution model that compares the toxic-related risks each entity created that contributed to the resultant harm").

[270] *See* Martin v. Owens-Corning Fiberglas Corp., 528 A.2d 947, 948 (Pa. 1987) (reversing instruction allowing apportionment between smoking and asbestos); Richard W. Wright, *Allocating Liability Among Multiple Responsible Causes: A Principled Defense of Joint and Several Liability for Actual Harm and Risk Exposure*, 21 U.C. DAVIS L. REV. 1141 (1988) (criticizing the abandonment of joint and several liability); *see also* Robert M. Guo, *Reasonable Bases for Apportioning Harm Under CERCLA*, 37 ECOLOGY L.Q. 317, 319–20 (2010) ("Making apportionment easier to justify, and thereby making recovery of cleanup costs harder to obtain, contravenes CERCLA's objective of placing the cost of cleanup on persons whose activities contributed to the contamination.").

[271] *See* Jules L. Coleman, *Tort Law and the Demands of Corrective Justice*, 67 IND. L.J. 349 (1992); Christopher H. Schroeder, *Corrective Justice and Liability for Increasing Risks*, 37 UCLA L. REV. 439 (1990).

complicated and burdensome on the plaintiff.[272] Rather, Congress has accepted a polluter-pays approach that assigns liability and then leaves potentially responsible parties to sort out apportionment among themselves.[273]

Similar complications would arise if courts attempted to apportion harm for long-term ecological harms. In fact, it would conceivably be even more difficult to apportion harm between a defendant and an unquantifiable mixture of diffuse environmental stressors that together depress the healthy functioning of an ecosystem.[274] Imagine, for a moment, how one would divide liability among the impacts of overfishing, climate change, and runoff pollution on a marine ecosystem. First, one would have to quantify the degree to which each of the stressors impacted the marine ecosystem and by which biological pathways.[275] After all, the relevance of each stressor's contribution to the harm will depend on the type of harm at issue. Second, one would have to know how each of the stressors interacted with the others so that synergistic potential could be accounted for.[276] These

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[272] *See, e.g.*, O'Neil v. Picillo, 883 F.2d 176, 179 (1st Cir. 1989) (noting that "where wastes of varying (and unknown) degrees of toxicity and migratory potential commingle, it simply is impossible to determine the amount of environmental harm caused by each party").

[273] Nagle, *supra* note 191, at 1493, 1509 (explaining that CERCLA is a "polluters pay" liability scheme that has been interpreted to impose joint and several liability on defendants in part because of "the difficulty a plaintiff encounters in trying to prove that the actions of a particular defendant were the cause in fact of the hazardous substances, especially at sites where many companies and individuals contributed substances"); *see also* Marsh v. Rosenbloom, 499 F.3d 165, 178 (2d Cir. 2007) ("CERCLA manifests Congress's intent that hazardous waste sites should be cleaned up and that those responsible for the contamination should bear the costs."); United States v. Aceto Agric. Chems. Corp., 872 F.2d 1373, 1380 (8th Cir. 1989) ("[T]he two essential purposes of CERCLA [are] . . . 'that the federal government be immediately given the tools necessary for a prompt and effective response to the problems of national magnitude resulting from hazardous waste disposal . . . [and] that those responsible for problems caused by the disposal of chemical poisons bear the costs and responsibility for remedying the harmful conditions they created.'" (quoting Dedham Water Co. v. Cumberland Farms Dairy, Inc., 805 F.2d 1074, 1081 (1st Cir. 1986))).

[274] A number of courts have rejected apportionment for commingled waste. *See* William C. Tucker, *All Is Number: Mathematics, Divisibility and Apportionment Under* Burlington Northern, 22 FORDHAM ENVTL. L. REV. 311, 322 n.47 (2011) (assembling cases where apportionment was rejected).

[275] *See id.* at 316 ("[I]n proving that the harm at a Superfund site is divisible, a defendant must take into account a number of factors relating not just to the contribution of a particular defendant *to* the harm, but also to the *effect* of that defendant's waste on the environment, including the 'relative toxicity, migratory potential, degree of migration or "synergistic capacities" of the hazardous substances at issue.'" (quoting United States v. Agway, Inc., 193 F. Supp. 2d 545, 548 (N.D.N.Y. 2002))).

[276] For an example of a court rejecting apportionment because of unknown synergistic potential, see *United States v. Vertac Chemical Corp*., 966 F. Supp. 1491, 1504 (E.D. Ark. 1997), which rejected volumetric apportionment based on the number of barrels, because where "hazardous substances are commingled, a defendant cannot rely on merely volumetric evidence."

types of inquiries have proven unworkable in other tort contexts and have been squarely criticized as a result.[277]

The complication of apportionment, as it turns out, may be a reason to adopt a more simplified view of background stressors, one where background stressors are simply accepted as part of the inherent character of the injured ecosystem. Of course, as in the CERCLA context, if a defendant insists on apportionment to reduce its liability, the court could shift the burden of proof on the defendant to demonstrate that harm could be apportioned.[278] The issue of burden shifting even outside the context of apportionment is taken up later.

IV. IN SEARCH OF CLARITY AND A NEW CAUSAL PARADIGM

By unpacking the core causation challenges, some of the existing tort innovations can be ruled out as possible solutions. More importantly, existing tools can be better assessed. In particular, this Part examines the viability of three approaches that courts have used to resolve difficult-to-prove cases of causation. First, it is possible that courts should simply continue to apply a contributing factor test. This Part considers that possibility and explains how courts might avoid unduly restricting the usefulness of the contributing factor test for resolving long-term harms. Next, this Part examines whether the general–specific causation framework adopted in toxic tort would be beneficial for long-term ecological harms. In doing so, this Part explores whether a risk-of-injury analysis, like that adopted by some courts in the medical malpractice or smoker–asbestos cases, might ultimately strike the right balance between holding responsible actors accountable and protecting defendants from undue liability. Finally, this Part discusses when courts might reasonably resort to a burden-shifting framework.

A. Assessing the Contributing Factor Test

Can the contributing factor test properly assign liability and respond to problems of background stressors and synergistic effects? The roots of the substantial factor test suggest that its more lenient counterpart—the contributing factor test—could be applied to find liability among multiple

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[277] *See* Kenneth S. Abraham, *Individual Action and Collective Responsibility: The Dilemma of Mass Tort Reform*, 73 VA. L. REV. 845, 865 (1987) (rejecting proposals for proportionate causation, remarking that "[l]ogical though this approach might be, it is unfortunately very impractical, because nothing even remotely as precise a proxy for the probability of responsibility as market share is available in most nonsignature disease cases").

[278] *See, e.g.*, United States v. Chem-Dyne Corp., 572 F. Supp. 802, 810 (S.D. Ohio 1983) ("[W]here the conduct of two or more persons liable under § 9607 [of CERCLA] has combined to violate the statute, and one or more of the defendants seeks to limit his liability on the ground that the entire harm is capable of apportionment, the burden of proof as to apportionment is upon each defendant.").

forces, whether natural or man-made. To be sure, the doctrine appears suited to handle problems of synergistic harms, and nothing in the tort doctrines themselves would prohibit extension of the contributing factor test to the oil spill context where there is a single release. More importantly, the intuitive nature of the test would provide much-needed flexibility in an area where injuries and causal pathways will be diverse and will require a nimble hand in determining when causation has been established.

To be sure, doctrines of great flexibility can also bring great confusion. In that sense, the courts would be wise to clarify the contours of the contributing factor test before adopting it wholesale. Indeed, the few courts that have adopted the contributing factor test in the classic CERCLA context have perhaps left more questions than they have answered. Before simply endorsing the contributing factor test, therefore, courts would be wise to (1) clarify what the contributing factor test requires and (2) avoid unnecessary restrictions that undermine the test's usefulness for addressing background stressors and synergistic harms.

1. Clarifying the Test.—Courts that have grappled with setting the proper causal standard for natural resource damages claims have considered whether to adopt the substantial factor test or its more relaxed cousin, the contributing factor test. Some have adopted the substantial factor test and some have rejected it. All have assumed that the test has a single formulation, as if calling it by name carries with it a well-settled and clear body of jurisprudence. In truth, the substantial factor test has taken on several forms.[279] The range of formulations helps to explain why courts in the natural resource damages context have been thus far unable to speak with much uniformity or clarity regarding the appropriate causal standard.

The early form of the substantial factor test would hold a defendant liable, even where there are several tortious acts, if the defendant's conduct was "a material element and a substantial factor" in bringing about the harm.[280] The twin fires case opened the test up to cases where natural forces combined with tortious conduct to cause harm.[281] Notably, both of these more classic versions require each cause to be capable of the entire harm standing alone.[282] As discussed above, that requirement could prove

[279] Robertson, *supra* note 140, at 1776 (describing confusion associated with courts having used the term "substantial factor" test in three different senses).

[280] PROSSER AND KEETON, *supra* note 36, § 41, at 267.

[281] Robertson, *supra* note 140, at 1779 n. 57.

[282] *See* ITT Indus., Inc. v. Borgwarner, Inc., 700 F. Supp. 2d 848, 876 (W.D. Mich. 2010) ("[W]here two or more causes have concurred to bring about an event, and any one of them, operating alone, would have been sufficient to cause the identical result, 'the defendant's conduct is a cause of the event if it was a material element and a substantial factor in bringing it about.'" (quoting Artesian Water Co. v. Gov't of New Castle Cnty., 659 F. Supp. 1269, 1283 (D. Del. 1987))); *In re* Methyl Tertiary Butyl Ether ("MTBE") Prods. Liab. Litig., 643 F. Supp. 2d 461, 464 (S.D.N.Y. 2009) (describing the need to show that "defendant's contribution, *taken alone*, would have caused an injury" as the defining

problematic for long-term harms that result from synergistic impacts of the oil spill in combination with background stressors.

That said, the California Supreme Court's version of the substantial factor test would assign liability to even "very minor force[s]" so long as they contributed to the harm in some way.[283] This version appears to impose liability even for synergistic causes and might even equate to what other courts are terming the contributing factor test.

Related to these relatively simple statements of the substantial factor test, some courts have concluded that multiple forces contributing to the harm will be deemed causes-in-fact so long as their conduct viewed as a whole gave rise to the harm and so long as any one force is not so insignificant when compared to the others.[284] One such version of this is really a but-for inquiry, where there are many individual but-for causes that combine to create injury even though none of them standing alone would have generated the harm. Indeed, in this version courts appear to say they are applying the substantial factor test and then confusingly go on to examine causation under the traditional but-for test.[285] Other courts apply the substantial factor test to resolve issues of proximate cause.[286] In an apparent attempt to assemble these various perturbations, the *Restatement (Second) of Torts* introduces yet another set of several factors for courts to consider.[287]

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feature of the substantial factor test (quoting *In re* Methyl Tertiary Butyl Ether ("MTBE") Prods. Liab. Litig., 644 F. Supp. 2d 310, 319 (S.D.N.Y. 2009))).

[283] Bockrath v. Aldrich Chem. Co., 980 P.2d 398, 404 (Cal. 1999).

[284] *See* Robertson, *supra* note 140, at 1776–77*; see also* PROSSER AND KEETON, *supra* note 36, § 41, at 267–68 (describing a similar test).

[285] *See* Robertson, *supra* note 140, at 1779 & n.60 (describing this phenomenon and citing cases such as *Hasha v. Calcasieu Parish Policy Jury*, 651 So. 2d 865, 874–75 (La. Ct. App. 1995)).

[286] *See id.* at 1780. In a 1912 article in the *Harvard Law Review*, Jeremiah Smith proposed using the substantial factor test to guide the proximate cause inquiry. *See* Jeremiah Smith, *Legal Cause in Actions of Tort*, 25 HARV. L. REV. 303, 308–10 (1912). Some courts have taken up the suggestion. *See, e.g.*, Mitchell v. Gonzales, 819 P.2d 872, 878 (Cal. 1991) (en banc) (holding that jury instructions should use the term "substantial factor" rather than "proximate cause" because the latter term was more likely to mislead jurors and confuse). *But see* Viner v. Sweet, 70 P.3d 1046, 1050–51 (Cal. 2003) (clarifying that *Mitchell* did not repudiate the "but for" test for causation).

[287] *See* RESTATEMENT (SECOND) OF TORTS § 433, at 432 (1965). These factors, on the whole, appear to be more in line with the version of the test that would hold contributing forces liable for the harm:

> 1. The extent to which the defendant's actions contributed to the harm, compared to the extent to which other forces contributed to the harm;
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> 2. Whether the defendant's actions created a force or series of forces that operated up to the time of the harm, or by contrast, whether the defendant's actions were harmless until acted upon by forces outside the defendant; and
>
> 3. The amount of time that elapsed between the defendant's actions and the harm.

See id. Of note, this last consideration would systematically undermine the recovery of long-term damages, as by definition that is a category of harms for which substantial time has elapsed between the conduct and the injury. Courts should approach the application of the *Restatement* cautiously in the

The lesson, at bottom, is that the substantial factor test is not a rigid or mechanical one. It is intuitive in nature and has given rise to many formulations. This means that courts purporting to apply the substantial factor test to resolve causation issues need to be deliberate in their description and application of the test. Simply uttering "substantial factor test" does not in and of itself clarify the causal standard being applied.[288] Rather, it invites confusion unless additional parameters are set forth.

Confusion is precisely what appears to be emerging in the natural resource damages context. In particular, the district courts in *Asarco* and *Acushnet River* rejected the substantial factor test in favor of the less restrictive contributing factor test. But less restrictive as compared to what? Neither court adequately defined the dimensions of the test that it was rejecting, making it more difficult to understand the alternative that it had in mind. Since there are many versions of the substantial factor test, more information is needed to discern what causal test the courts meant to reject or adopt. In addition, the *Montrose* court out of California adopted the substantial factor test, which may effectively amount to the contributing factor test anyway depending on the version that the court had in mind.[289]

The *Asarco* case offers the most thorough analysis. It relies on a Ninth Circuit opinion involving a CERCLA cost recovery action.[290] In that opinion, *Boeing v. Cascade Corp.*, the Ninth Circuit described the twin fires version of the substantial factor test and concluded that such a test is appropriate in the special case of causal overdetermination:

> [W]here either polluter's conduct would have caused the same response cost to be incurred in the same amount, and the conduct was of substantially equal blameworthiness, the proper construction of the causation requirement in the statute is that both polluters should be treated as having caused the response cost.[291]

Having referenced this traditional test for causation, the *Asarco* court went on to note that "for the response cost claim, traditional notion[s] of proximate cause do[] not apply."[292] Though the court recognized that—unlike in response cost claims—there is a causation requirement for injury to natural resources, the court concluded that the "causation standard for [natural resource damages] actions is also less restrictive than traditional

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context of long-term injuries for that reason, or risk systematically undermining Congress's intent to allow recovery for injuries that are long-term in nature.

[288] *See, e.g.*, Rutherford v. Owens-Ill., Inc., 941 P.2d 1203, 1214 (Cal. 1997) ("The term 'substantial factor' has not been judicially defined with specificity . . . .").

[289] *See supra* notes 196–98 and accompanying text.

[290] Coeur D'Alene Tribe v. Asarco Inc., No. CV91-0342NEJL, CV96-0122NEJL, 2001 WL 34139603, at *4–5 (D. Idaho Mar. 30, 2001) (citing Boeing v. Cascade Corp., 207 F.3d 1177, 1185 (9th Cir. 2000)).

[291] *Boeing*, 207 F.3d at 1185.

[292] *Coeur D'Alene Tribe*, 2001 WL 34139603 at *5.

federal common law."[293] The court rejected the "sole or substantially contributing cause" test as too restrictive in the natural resource damages context.[294]

It would appear that the court was at a minimum rejecting the classic form of the substantial factor test—the trustee need not show that the contributing cause would be sufficient to cause the injury if standing alone. However, the court's reference to proximate cause suggests that the court might also have meant to relax the proximate cause inquiry and expand the scope of liability to natural resource injuries that are more indirect and further removed from the release itself. Unfortunately, the court's analysis of the substantial factor test is not specific enough in terms of torts nomenclature to know for sure what the court had in mind, other than that the new test ought to be less restrictive.

Of course, in a perfect world the causal test that the courts intended to adopt would be obvious because the preferred test would be adequately described. That too turns out to be problematic. In other words, not only is it unclear what the *Acushnet River* and *Asarco* courts meant to reject in terms of a substantial factor test, but it is also unclear what kind of causal showing they intended the contributing factor test to require. Each court refers to the contributing factor test as though that test is well established in torts literature. This in fact is not the case. While the *Restatement* and the literature discuss the substantial factor test, the contributing factor test does not appear in the torts nomenclature.[295]

The best explanation of what the contributing factor test means comes from the *Asarco* court. After rejecting the substantial factor test, the court explained that "[i]n cases where releases have been commingled, the Court finds the [t]rustees have the burden of proving a release that results in commingled hazardous substances is a 'contributing factor.'"[296] The court defined a contributing factor as "more than a de minimis amount—to an extent that at least some of the injury would have occurred if only the Defendant's amount of release had occurred."[297] Setting aside the qualification for commingled waste, the *Asarco* court appears to be describing the California version of the substantial factor test, where even very minor forces can be causes-in-fact sufficient to create liability. The only limit appears to be that the contributing force is something more than *de minimis*. What that threshold is, however, the court did not say. In future cases, courts (or the legislature if it cares to take up the issue) can provide

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[293] *Id.*

[294] *Id.*

[295] See PROSSER, *supra* note 150, § 41, at 236–44, and DOBBS ET AL., *supra* note 92, §§ 186–187, 189, at 623–36, for absence of any reference to a relaxed form of the substantial factor test or the contributing factor test.

[296] *Coeur D'Alene Tribe*, 2001 WL 34139603 at *5.

[297] *Id.*

clarity regarding the contours of the contributing factor test by being more explicit about what they are rejecting and what they mean to adopt.

To assist courts in their clarification, there may be some reference points that can help ground the contributing factor test in existing principles and thereby explain its dimensions. First, as mentioned above, the contributing factor test could be a shorthand way of referring to the least rigorous form of the substantial factor test, what this Article refers to as the California version. Second, and similarly, the test might refer to a comment made in the *Restatement (Second) of Torts* that explains, "[I]f the defendant's conduct had any effect, the effect was substantial."[298] Third, some prominent commentators have suggested that the conduct of multiple actors can be aggregated and considered as a whole using the but-for inquiry:

> When the conduct of two or more actors is so related to an event that their combined conduct, viewed as a whole, is a but-for cause of the event, and application of the but-for rule to them individually would absolve all of them, the conduct of each is a cause in fact of the event.[299]

Professor Richard Wright similarly suggested conceptualizing causation in a way that aggregates conduct or events into a set.[300] Rather than impose an aggregate but-for test, Wright would find causation has been established "if the entire set of events is sufficient to cause the harm and the defendant's act is a necessary element of the set."[301] Under this formulation, oil spills that set off a chain of events and contribute to an altered natural environment might be lumped into a set of events that together caused the injury and therefore give rise to liability. Wright's aggregate formulation appears consistent with the relaxed contributing factor test.

A similar theory—called the commingled product theory—has been applied in product liability cases. In a multidistrict litigation products liability case involving groundwater contamination by a gasoline additive, the Southern District of New York allowed the plaintiff to pursue punitive damages under a commingled product theory.[302] The court explained the

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[298] RESTATEMENT (SECOND) OF TORTS § 431 cmt. b (1965). The key difference is that the *Restatement* would also impose a proximate cause inquiry whereby the significance of the contribution is used as a threshold for holding a defendant liable. *Id.* § 431 cmt. a. By contrast, the contributing factor test would appear to jettison proximate cause inquiry and hold any contributing cause liable so long as it meets the *de minimis* bar.

[299] PROSSER AND KEETON, *supra* note 36, § 41, at 268.

[300] DOBBS, *supra* note 92, § 189, at 635.

[301] *Id.* (citing Richard W. Wright, *Causation in Tort Law*, 73 CALIF. L. REV. 1735, 1788–94 (1985)).

[302] *In re* Methyl Tertiary Butyl Ether ("MTBE") Prods. Liab. Litig., 644 F. Supp. 2d 310, 319 (S.D.N.Y. 2009); *see also In re* Methyl Tertiary Butyl Ether ("MTBE") Prods. Liab. Litig., 643 F. Supp. 2d 461, 464–68 (S.D.N.Y. 2009) (discussing apportionment and describing earlier ruling on commingled product theory).

commingled product theory by contrasting it with the substantial factor test:

> What sets the commingled theory apart from the traditional theory of causation . . . is that the [plaintiff] need not show that each individual defendant's contribution, *taken alone*, would have caused an injury. . . . [T]he [plaintiff] need only show that the . . . defendant's MTBE *contributed* to the commingled product that caused the injury.[303]

Aside from the products liability context and its application to resolve an indeterminate defendant problem,[304] this description comes closest to the contributing factor test that the *Asarco* court described. Importantly, the spirit of the commingled product theory appears consistent with the contributing factor test; both are attempts to modify traditional causal standards for more complex tort situations that otherwise impose difficult causal burdens on the plaintiff. In this way, the theory supports the application of the contributing factor test to the difficult-to-prove cases of long-term harm.

In sum, a survey of the torts literature suggests that the contributing factor test, despite the paucity of citations provided by adopting courts like *Asarco*, does have roots in tort doctrine and is a legitimate starting point for determining causation in natural resource damages cases. The challenge for the courts is to more plainly describe the dimensions of the test they mean to adopt or reject. Without that, confusion and inconsistency among courts will most certainly arise. Notably, this call for clarity applies regardless of whether courts are choosing to adopt the substantial factor or the contributing factor test. Depending on the contours of the test, in fact, they could well be one and the same.

2. Avoiding Undue Limitations.—While the contributing factor test has some appeal for resolving the causation challenges described in this Article, no court has considered its application in the oil spill context. The two courts that have adopted it were addressing fairly classic CERCLA cases involving multiple polluters and a mixture of toxins in the release. In doing so, these courts have not only failed to clarify the test, but they have also introduced conditions that would make the test problematic in the oil spill context or for long-term ecological harms more generally. In the

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[303] *In re MTBE*, 643 F. Supp. 2d at 464 (some alterations in original) (quoting *In re MTBE*, 644 F. Supp. 2d at 319) (internal quotation marks omitted).

[304] Whereas CERCLA traditionally imposes joint and several liability, the commingled product theory imposes only several liability determined by "the defendant's share of the market at the time of the injury." *In re MTBE*, 644 F. Supp. 2d. at 320 (quoting *In re* Methyl Tertiary Butyl Ether ("MTBE") Prods. Liab. Litig., 591 F. Supp. 2d 259, 274 n.72 (S.D.N.Y. 2008)). In addition, the commingled product theory presumes multiple defendants who have produced the same product. *See In re MTBE*, 591 F. Supp. 2d at 274–75. In the natural resource damage context, as noted above, there may or may not be multiple defendants and there may be multiple kinds of toxins at issue.

future, courts would be wise to avoid these limitations, unless deliberate restrictions on liability were intended.

The first undue restriction was introduced by the *Asarco* court when it adopted the contributing factor test only for commingled releases.[305] On its face, then, the court would appear to reject the application of the contributing factor test to a single substance release like an oil spill. The court, of course, did not consider harms from oil spills, much less long-term harms. If it had, the court might not have drawn a difference between commingled and noncommingled waste.[306] The injury lag times associated with long-term harm increase the likelihood that the harm is due, at least in part, to the synergistic impacts of multiple compounding ecosystem stressors. In that sense, long-term harms are just as much a product of "commingled" stressors as the harm resulting from the classic commingled waste.

The second undue restriction introduced by the *Asarco* court is the suggestion that plaintiffs prove that "at least some of the injury would have occurred if only the Defendant's amount of release had occurred."[307] To the extent the court would require trustees to show that the amount of oil released would be capable of causing the alleged injury on its own, this aspect of the test could be problematic in its failure to account for synergistic impacts.

In most situations, requiring the defendant's release to be capable of injury on its own poses little problem and even has some intuitive appeal. For long-term injuries, however, considering the release in a vacuum may not fully appreciate the synergistic nature of the release in combination with other stressors. By even asking if a defendant's release would have created harm on its own, the test seems to invite the possibility that stressors causing harm can be separated out from one another.

In that sense, the test as described by the *Asarco* court might incorrectly encourage courts to consider the release in isolation and not the greater context of the release. To be sure, any given toxic stressor might not cause ecologically significant injury if the ecosystem were otherwise robust and able to absorb some shock.[308] That same amount of toxic input to an already stressed ecosystem might, however, be enough to cause significant population declines.[309] In other words, background stressor and synergistic impacts matter. For this reason, the test as articulated by the *Asarco* court

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[305] Coeur D'Alene Tribe v. Asarco Inc., No. CV91-0342NEJL, CV96-0122NEJL, 2001 WL 34139603, at *5 (D. Idaho Mar. 30, 2001).

[306] *See supra* text accompanying note 217.

[307] 2001 WL 34139603, at *5.

[308] *See* Craig, *A Match Made in Hell*, *supra* note 12, at 1886–87 (describing resilience theory and "an ecosystem's ability to absorb change and persist in function and relationships").

[309] *Id.*

does not appear to be responsive to the core causal challenges of long-term harms.

In addition, recall that the purpose of CERCLA's aggressive joint and several liability scheme was avoiding the divisibility problems when there are multiple tortfeasors whose hazardous substances have commingled in some unknown way and have been released into the environment. To require trustees seeking natural resource damages to prove that the long-term harm would have been caused by the oil acting in isolation simply reverses the logic of the modified liability scheme.

What this means is that courts adopting the contributing factor test should avoid articulating the test as requiring proof of harm by the defendant's release alone. The relevant inquiry may simply be whether the evidence shows that the release, alone or in combination with other stressors, contributed to the harm. That is the essence of the contributing factor test and the problematic language might simply be an unnecessary remnant of more traditional formulations of the substantial factor test.

B. Borrowing from Toxic Torts

Even if courts were to adopt the contributing factor test without some of the undue and problematic limitations discussed here, courts will still need to put a finer point on exactly what a trustee plaintiff will be required to prove. To assist in that endeavor, courts may be wise to borrow from the area of toxic torts.

Many of the distinguishing characteristics of long-term natural resource damages claims are also true of toxic tort cases.[310] In particular, natural resource damages claims raise issues of sublethal injuries, long latency periods, multiple causal agents, and aggregate risk. Likewise, toxic tort plaintiffs tend to suffer from disease, fertility problems, or some other chronic injury.[311] In addition, toxic tort injuries often involve long latency periods.[312] In some cases, the time from exposure to the manifestation of

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[310] *Compare* TOXIC TORTS, *supra* note 234, at 230 (describing the distinguishing characteristics of harm caused by asbestos), *with* Rabin, *supra* note 151, at 27–32 (discussing the distinguishing characteristics of toxic tort and environmental harm cases).

[311] Rabin, *supra* note 151, at 27–32; Jean Macchiaroli Eggen, *Toxic Reproductive and Genetic Hazards in the Workplace: Challenging the Myths of the Tort and Workers' Compensation Systems*, 60 FORDHAM L. REV. 843, 864 (1992) (discussing the difficulty of proving causation for infertility issues allegedly resulting from toxic exposure in the workplace).

[312] TOXIC TORTS, *supra* note 234, at 228–30. While in many nontoxic tort cases the effect almost immediately follows the cause, long latency periods are the primary reason that proving causation is so difficult in toxic tort cases. *See, e.g.*, RESTATEMENT (THIRD) OF TORTS: LIABILITY FOR PHYSICAL AND EMOTIONAL HARM § 28 cmt. c, at 402 (2010) ("[T]he causes of some diseases, especially those with significant latency periods, are generally much less well understood. Even known causes for certain diseases may explain only a fraction of the incidence of such diseases, with the remainder due to unknown causes.").

the disease can range from twenty to fifty years.[313] And, like the problems of synergistic causes giving rise to long-term ecological harms, toxic tort cases may also involve multiple agents, capable of causing harm when acting alone or in concert with other stressors.[314] Finally, and relatedly, some toxic tort cases raise the problem of aggregate risk, where a disease might be the result of multiple exposures to the same or different toxic products over time.[315]

Not surprisingly, toxic tort cases are notorious for raising causation challenges. Indeed, the difficulty of proving causation is often the defining characteristic setting toxic torts apart from regular torts.[316] Notably, within the toxic torts literature and jurisprudence, courts and scholars recognize that deviation from traditional causal paradigms is both necessary and appropriate.[317] It is necessary to prevent injustice to injured plaintiffs who would otherwise be left without a remedy. It is appropriate given the flexibility of tort law to serve the demands of justice.

In light of the similarities between long-term ecological injuries and toxic torts, the remainder of this Article will consider whether alternative tort principles used in toxic tort law are appropriate paradigms for proving causation in the natural resource damages context. In particular, this Part considers how the differentiation of general and specific causation within the toxic torts framework might clarify the plaintiff's evidentiary burden for natural resource damages claims. In doing so, this Part examines the risk-of-injury approach to satisfying the substantial factor test and considers the applicability of burden-shifting paradigms that seek to ease the plaintiff's causal burden. Ultimately, this Part concludes that some combination of these tools might be a good fit for proving long-term ecological injuries.

1. Proving General and Specific Causation.—In toxic tort cases, the causation-in-fact inquiry is typically framed as two issues: general causation and specific causation.[318] General causation addresses whether

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[313] TOXIC TORTS, *supra* note 234, at 230.

[314] *Id.* at 159.

[315] *See* Susan R. Poulter, *Science and Toxic Torts: Is There a Rational Solution to the Problem of Causation?*, 7 HIGH TECH. L.J. 189, 234 (1992) (discussing synergistic effects of toxic exposure and raising the example of smoking and asbestos); *see also* F.D.K. Liddell, *The Interaction of Asbestos and Smoking in Lung Cancer*, 45 ANNALS OCCUPATIONAL HYGIENE 341, 342 (2001) (examining the history and evidence to present "the most reliable assessment of the interaction between asbestos exposure and cigarette smoking in the causation of lung cancer").

[316] TOXIC TORTS, *supra* note 234, at 159 ("With the rise of toxic torts . . . proof of causation has become one of the most complex and controversial aspects of tort liability.").

[317] For a sampling of the literature providing suggestions for relaxing the causal paradigm in the area of toxic torts, see Berger, *supra* note 223; Gold, *supra* note 171; and Allen Rostron, *Beyond Market Share Liability: A Theory of Proportional Liability for Nonfungible Products*, 52 UCLA L. REV. 151 (2004).

[318] TOXIC TORTS, *supra* note 234, at 192.

the substance at issue is capable of causing the type of harm alleged in the case.[319] Does smoking cause lung cancer? Scientific evidence tending to prove general causation might include some combination of epidemiological studies, clinical trials, animal studies, time trend data, biological mechanism research, or in vitro studies.[320]

Assuming a plaintiff can successfully establish that the offending agent is a possible cause of injury, the plaintiff must then prove specific causation. Specific causation asks the more pointed question: whether exposure to the substance at issue caused the plaintiff's injury.[321] Specific causation requires linking a particular injury to the defendant's release. Did the plaintiff develop lung cancer from smoking? Because multiple agents might be theoretically capable of causing an alleged injury, the process of proving specific causation often involves a differential diagnosis whereby the plaintiff "rules out" alternative causes.[322] The heart of proving specific causation is showing the plaintiff's exposure to the toxic agent.[323] The plaintiff must also show that the dose (the amount of exposure) was capable of causing the alleged harm.[324]

In the oil spill context, proving general causation would require showing that exposure to oil is capable of causing the alleged injury—e.g., disrupting the reproductive capacity of sea otters. Proving specific causation would require showing that sea otters were exposed to oil in doses capable of causing injury and that the oil came from the defendant's release.

By itself, the general and specific causation framework does not ease the causal burden so much as clarify it. Indeed, the epidemiologic evidence required to satisfactorily prove specific causation is simply a form of the

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[319] *See id.* at 193.

[320] *See id.* at 188 (citing JOSEPH SANDERS, BENDICTIN ON TRIAL 45–61 (1998) (describing the types of evidence used to prove causation in toxic tort cases involving Bendictin, a morning sickness pill given to pregnant women and later alleged to cause birth defects)); *see also* DeLuca v. Merrell Dow Pharm., Inc., 911 F.2d 941, 954 (3d Cir. 1990) (discussing the persuasiveness of epidemiological studies in showing general causation for Bendictin litigation).

[321] TOXIC TORTS, *supra* note 234, at 193.

[322] *See id.* at 192–93; *see also* Cavallo v. Star Enter., 892 F. Supp. 756, 771 (E.D. Va. 1995), *aff'd in part, rev'd in part*, 100 F.3d 1150 (4th Cir. 1996) ("The process of differential diagnosis is undoubtedly important to the question of 'specific causation.' If other possible causes of an injury cannot be ruled out, or at least the probability of their contribution to causation minimized, then the 'more likely than not' threshold for proving causation may not be met.").

[323] *See* RESTATEMENT (THIRD) OF TORTS: LIABILITY FOR PHYSICAL AND EMOTIONAL HARM § 28 cmt c., at 405 (2010) (noting that in some cases the general and specific causation inquiries might be merged, but "[i]n any case, plaintiff's exposure to the toxic agent must be established").

[324] *See, e.g.*, Bernard D. Goldstein, *Toxic Torts: The Devil Is in the Dose*, 16 J.L. & POL'Y 551 (2008); *see also* Mancuso v. Consol. Edison Co. of N.Y. Inc., 56 F. Supp. 2d 391, 403 (S.D.N.Y. 1999) ("A fundamental tenet of toxicology is that the 'dose makes the poison' and that all chemical agents, including water, are harmful if consumed in large quantities, while even the most toxic substances are harmless in minute quantities.").

classic preponderance of the evidence standard.[325] It is not clear, therefore, that the framework alters the underlying and traditional causation paradigm.[326] Rather, it simply provides a formula for applying that traditional paradigm to a toxic tort context.[327]

If this general and specific causation framework were applied to the natural resource damages context, the largest hurdle to proving causation would be providing evidence of specific causation. It is conceivable, in other words, that government trustees could obtain evidence that exposure to oil, or even weathered oil with an altered toxic profile, was capable of causing harm. Proving specific causation, however, would ostensibly require some understanding of exposure pathways, biological mechanisms connecting exposure to injury, and cause–effect relationships between various resource elements within the affected ecosystem.

In this sense, the complication of proving specific causation is amplified in the natural resource damages context. There are two reasons for this. First, our research and understanding of how the human body works is more advanced than our understanding of the feedback mechanisms and cause–effect relationship within the marine ecosystem in which oil spills take place. Second, the exposure pathways and biological mechanisms underlying species disease and demographic collapse are magnitudes more complex in the natural resource damages context than in harm to a single human plaintiff.

The Pacific herring fishery collapse in Prince William Sound just three years after the *Exxon Valdez* Oil Spill is a good example. That collapse was a catastrophic injury for which there is still little definitive evidence linking it to the Exxon spill. There is strong circumstantial evidence and there is some evidence demonstrating an exposure pathway, but the time lag and the complex biological mechanisms involved make it a difficult puzzle to solve with certainty.

Proving injury to natural resources involves not just proof that a particular toxin caused a particular disease in a single individual. Rather, in the context of oil spills, showing harm to natural resources involves understanding causal relationships between an oil spill and long-term species demographics when the exposure pathways are both direct and indirect and when the interdependencies of species might disperse the

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[325] *See* Poulter, *supra* note 315, at 229 & n.189; David Rosenberg, *The Causal Connection in Mass Exposure Cases: A "Public Law" Vision of the Tort System*, 97 HARV. L. REV. 849 (1984).

[326] *See, e.g.*, Sindell v. Abbott Labs., 607 P.2d 924, 928 (Cal. 1980) (citations omitted) ("We begin with the proposition that, as a general rule, the imposition of liability depends upon a showing by the plaintiff that his or her injuries were caused by the act of the defendant or by an instrumentality under the defendant's control. The rule applies whether the injury resulted from an accidental event or from the use of a defective product.").

[327] *See* Alani Golanski, *General Causation at a Crossroads in Toxic Tort Cases*, 108 PENN. ST. L. REV. 479, 486 (2003) (describing general and specific causation as a process of plying apart the traditional causal inquiry into two levels).

direct impacts of a spill well into the food web.[328] That means there is not likely to be definitive evidence that oil exposure to herring roe in year one is capable of causing the Pacific herring fishery to collapse in year three,[329] or that the exposure to chemical dispersants used in the wake of the BP Gulf Oil Spill could cause some yet-unknown long-term injury.[330]

A causation paradigm that requires definitive proof of specific causation is not likely to serve the broader goals of tort law any more than traditional paradigms. In that sense, we might be cautious about applying wholesale the general framework for proving toxic tort claims to oil spills—namely, the requirement that plaintiffs show some combination of evidence proving general and specific causation. And yet, the general and specific causation framework is quite useful in focusing the discussion of what evidentiary proof a government trustee would have to offer in order to recover damages for long-term ecological injuries.

2. Applying a Risk-of-Injury Approach.—If we return to the ruminations of Judge Calabresi and accept the premise that market deterrence goals are served by assigning liability to the cheapest cost avoider, some causal link between the accident and the injury is necessary.[331] That causal link, however, does not have to take the form of a traditional *but-for* relationship.[332] Rather, Calabresi explains that the more relevant inquiry is whether the defendant's actions increased the chances that the injury would occur: "There is a causal link between an act or activity and an injury when we conclude on the basis of the available evidence that the recurrence of that act or activity will increase the chances that the injury will also occur."[333] In other words, a risk-of-injury analysis is the key.[334]

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[328] *See supra* Part I.B. for discussion of complicated and interdependent relationships that drive ecosystem function.

[329] *See* discussion *supra* Part I.B and notes 114–16.

[330] *See* Seth Borenstein, *Gulf Oil Spill Dispersants 'Sticking Around,' Long-Term Effects Remain Unclear*, HUFFINGTON POST (Jan. 26, 2011, 5:32 PM), http://www.huffingtonpost.com/2011/01/27/gulf-oil-spill-chemical-d_n_814749.html; *see also* Alice C. Ortmann et al., *Dispersed Oil Disrupts Microbial Pathways in Pelagic Food Webs*, PLOS ONE, July 2012, *available at* http://www.plosone.org/article/fetchObject.action?uri=info%3Adoi%2F10.1371%2Fjournal.pone.0042548&representation=PDF.

[331] *See* Calabresi, *Concerning Cause*, *supra* note 35, at 84 (to identify the cheapest cost avoider, "[g]enerally a causal link between an activity and an injury would be required").

[332] *Id.* at 85 (noting that the "role of *but for* causation in a system of market deterrence is less obvious than that of causal linkage" and even suggesting that "[o]ne could do away with the *but for* test and employ other methods to achieve the same end").

[333] *Id.* at 71. *See also id.* at 84–85 (discussing causal link as the relevant inquiry for serving market deterrence goals).

[334] Several scholars have examined the viability of a risk-of-injury test in the toxic torts context. *See, e.g.*, Jamie A. Grodsky, *Genomics and Toxic Torts: Dismantling the Risk–Injury Divide*, 59 STAN. L. REV. 1671 (2007) (arguing that with advances in the emerging field of genomics, toxic tort law can

Calabresi's framing of the critical issue as one of risk of injury is consistent with how some courts have approached the definition of substantial factor in some of the leading smoker–asbestos cases. In those cases, the plaintiff is typically a long-time smoker who brings an action against his employer for asbestos-related injuries or wrongful death.[335] Like claims related to long-term ecological injuries, the smoker–asbestos cases raise issues involving synergistic causes, scientific uncertainty, and long latency periods.[336]

In one such case, *Rutherford v. Owens-Illinois, Inc.*, the Supreme Court of California considered what type of evidentiary showing the plaintiff had to make under the substantial factor test in order to recover for asbestos-related injuries. The court began by noting that the plaintiff had the burden of establishing causation and that in the California courts this meant showing that the defective products supplied by the defendant were a substantial factor in bringing about the injury.[337] The court continued with a detailed examination of the evidentiary proof that a plaintiff would have to submit in order to meet its burden. In particular, the plaintiff would need to show exposure to the defendant's product.[338] The plaintiff did not have to show, however, that fibers from the defendant's product were the actual cause of the lung cancer.[339] To that, the court remarked that "[p]laintiffs cannot be expected to prove the scientifically unknown details of carcinogenesis, or trace the unknowable path of a given asbestos fiber."[340] Rather, to prove causation, the plaintiff only needed to show that exposure to a particular product was a substantial factor contributing to the plaintiff's *risk* of developing cancer.[341] The court concluded by reminding the parties that "[t]he substantial factor standard is a relatively broad one, requiring only that the contribution of the individual cause be more than negligible or theoretical."[342] Given the similarity between the California substantial factor test and the contributing factor test, the *Rutherford* court's treatment of the causation standard in the smoking–asbestos context is particularly relevant to the problem of proving long-term ecological harms.

The risk-of-injury analysis has also been adopted by several courts in the medical malpractice area.[343] The leading case from the Washington

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move away from traditional showings of physical injury to support recovery); *id.* at 1679 n.17 (assembling the toxic tort literature on risk-of-injury theory).

[335] *See, e.g.*, Rutherford v. Owens-Ill., Inc., 941 P.2d 1203 (Cal. 1997).

[336] *See, e.g.*, *id.* at 1206, 1209, 1218.

[337] *Id.* at 1214.

[338] *Id.* at 1223.

[339] *Id.* at 1219–20.

[340] *Id.* at 1219.

[341] *Id.* at 1220.

[342] *Id.*

[343] *See, e.g.*, Dillon v. Evanston Hosp., 771 N.E. 2d 357, 368 (Ill. 2002) (recognizing and joining trend toward "allowing compensation for increased risk of future injury as long as it can be shown to a

Supreme Court, *Herskovits v. Group Health Cooperative of Puget Sound*, considered whether a physician could be held liable for professional negligence when he failed to timely diagnose lung cancer and thereby statistically decreased the plaintiff's chance of survival.[344] The court adopted a risk-of-injury analysis. Otherwise, the court noted, a defendant might be "completely insulated because of uncertainties as to the consequences of his negligent conduct."[345]

If courts were to adopt a risk-of-injury analysis for long-term ecological injuries, government trustees seeking natural resource damages would be required to show that the injured resource was exposed to the defendant's oil and that oil exposure increased the risk of the injury alleged. This later showing would likely require some evidence of general causation, namely that the oil is capable of causing the harm alleged.

To tie the risk-of-injury analysis back to the general and specific causation framework, we might consider whether courts that adopt a risk-of-injury threshold are effectively requiring plaintiffs to satisfy the two-part inquiry. It would appear so. As for general causation, plaintiffs must show that the defendant's product is capable of causing the type of harm alleged. Without that showing, plaintiffs could not meet the risk-of-injury test. In other words, if the defendant's product is not capable as a general matter of causing the type of harm alleged it cannot be said to increase the risk of that harm. Similarly, the risk-of-injury threshold requires plaintiffs to satisfy the specific causation inquiry, albeit by less traditional means. To that end, plaintiffs prove a causal link between the injury and the defendant's product by showing exposure to defendant's product. Importantly, the risk-of-injury analysis does not require plaintiffs to show specific causation by demonstrating exactly how exposure to defendant's product caused the particular harm. Plaintiffs simply have to show that the defendant's product increased the risk of injury. That alternative formulation of specific causation is necessary, as the courts note, because the scientific complexity and uncertainty of demonstrating precise causal pathways would otherwise insulate defendants from liability for harms caused after long latency periods and synergistic causes. In the risk-of-injury cases, in other words, courts are necessarily taking a broader view of specific causation. At the same time, the courts are ensuring that plaintiffs are proving a causal link by satisfying both parts of the general and specific causation framework.

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reasonable degree of certainty that the defendant's wrongdoing created the increased risk"); Herskovits v. Grp. Health Coop. of Puget Sound, 664 P.2d 474 (Wash. 1983) (en banc) (adopting a risk-of-injury analysis); *see also* VICTOR E. SCHWARTZ ET AL., PROSSER, WADE AND SCHWARTZ'S TORTS CASES AND MATERIALS 281–84 (12th ed. 2010) (assembling the risk-of-injury cases in the medical malpractice context).

[344] 664 P.2d at 474.

[345] *Id.* at 477 (quoting Hamil v. Bashline, 392 A.2d 1280, 1287 (Pa. 1978)).

Notably, the risk-of-injury analysis allows a court to tailor the requirements of specific causation to long-term natural resource damages. In that sense, the general and specific causation framework could be a workable approach for long-term ecological injuries if approached in combination with a risk-of-injury threshold. There is, of course, nothing magical about the general and specific causation framework, and it is not an indispensable part of the causation inquiry. In fact, courts that apply the risk-of-injury threshold are not necessarily discussing it in the context of the general and specific causation framework. In *Rutherford*, for example, the California Supreme Court adopted a risk-of-injury analysis as part of the substantial factor test.[346] It is useful, however, to test how these various approaches fit together and note that they are consistent. In that way, courts that are otherwise inclined to apply the general and specific causation framework to toxic tort-like cases can continue to do so and still approach the specific causation inquiry through a risk-of-injury threshold.

3. Shifting the Burden of Proof.—As noted, problems would arise if courts were to adopt wholesale the general and specific causation framework without matching the needs of the specific causation inquiry to the challenges of the long-term tort. In that way, the general–specific causation framework does not by itself resolve the causal difficulties faced by trustees because the issue of proving specific causation looms large. While one way to alleviate this difficulty is to adopt a risk-of-injury approach, another way is through burden shifting. In particular, if courts were willing to shift the burden of proof in cases where trustees are claiming long-term natural resource injuries, a general and specific causation paradigm might prove viable in its current form. In fact, one could imagine a framework by which trustees were required to rule in oil as a possible causal agent under a general causation inquiry and then defendants were given the opportunity to demonstrate that another specific cause was more likely the actual cause.

Notably, the *Rutherford* case is actually a burden-shifting case at its core. In that smoker–asbestos case, the California Supreme Court was asked to decide whether the trial court erred in giving a burden-shifting instruction on the issue of causation.[347] Recall that plaintiffs ordinarily carry the burden of proof on causation. In that case, the trial court shifted the burden to the defendant on the theory that the case presented potentially

[346] *See* Rutherford v. Owens-Ill., Inc., 941 P.2d 1203 (Cal. 1997); *see also* Shelly Brinker, Comment, *Opening the Door to the Indeterminate Plaintiff: An Analysis of the Causation Barriers Facing Environmental Toxic Tort Plaintiffs*, 46 UCLA L. REV. 1289 (1999) (arguing that courts should return to a substantial factor approach to establishing causation in the toxic tort context); *id.* at 1321 (discussing *Allen v. United States*, 588 F. Supp. 247 (D. Utah 1984), *rev'd on other grounds*, 816 F.2d 1417 (10th Cir. 1987), where the court applied the substantial factor approach to resolve plaintiffs' allegations of injury from exposure to radiation).

[347] *Rutherford*, 941 P.2d at 1206.

insurmountable barriers to proving causation in light of the long latency periods and exposure to multiple forms and brands of asbestos products with varying degrees of toxicity.[348] Ultimately, the California Supreme Court concluded that a burden-shifting instruction was unnecessary given that the plaintiff could satisfy the substantial factor test by simply showing that the defendant's product contributed in some way to the increased risk of injury.[349] The causation test was lenient and did *not* require the plaintiff to prove "with medical exactitude that fibers from a particular defendant's asbestos-containing products were those, or among those, that actually began the cellular process of malignancy."[350] In other words, the application of the risk-of-injury threshold to satisfy an otherwise lenient substantial factor test was enough to afford the plaintiff a reasonable chance of recovery even when synergistic causes and long latency periods were involved.[351]

If the substantial factor test (or contributing factor test, as the case may be) proves a burdensome standard, and otherwise threatens to leave trustees "remediless"[352] for long-term ecological injuries, a burden-shifting framework might be justified. In other difficult-to-prove cases, courts and Congress have seen fit to shift the burden of proving causation to the defendant.[353] Similarly, in some countries like China the courts

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[348] *Id.* at 1227.

[349] *Id.* at 1219–20; *see also* Lineaweaver v. Plant Insulation Co., 37 Cal. Rptr. 2d 902 (Ct. App. 1995) (finding that burden shifting is inappropriate and unnecessary in asbestos cases).

[350] *Rutherford*, 941 P.2d at 1206.

[351] *But see* Menne v. Celotex Corp., 861 F.2d 1453, 1468–69 (10th Cir. 1988) (applying Nebraska law and holding that in concurrent cause cases "where the plaintiff can show that a defendant's asbestos dust caused some harm and possibly substantial harm but cannot show the relative contribution of that defendant to the overall harm" the burden shifts to the defendant to prove that exposure to the defendant's product was not sufficient to be a substantial factor in causing the harm).

[352] In the classic burden-shifting case of *Summers v. Tice*, 199 P.2d 1 (Cal. 1948) (en banc), the fundamental justification for shifting the burden was that all defendants might escape liability and the plaintiff left "remediless." *Id.* at 4.

[353] Congress has provided burden-shifting frameworks in a number of different situations, including workers' compensation cases—*see, e.g.*, Rainey v. Dir., Office of Workers' Comp., 517 F.3d 632, 634–35 (2d Cir. 2008) (clarifying that, pursuant to the Longshore and Harbor Workers' Compensation Act, 33 U.S.C. § 901 et seq., once claimants have made out a prima facie case by establishing that the claimant "suffered harm, and that workplace conditions . . . could have caused, aggravated, or accelerated the harm," even when there are preexisting conditions or prior conditions, the burden of production shifts to employers to rebut a presumption of causation (quoting Am. Stevedoring Ltd. v. Marinelli, 248 F.3d 54, 64–65 (2nd Cir. 2001)))—and discrimination cases—*see, e.g.*, Univ. of Tex. Sw. Med. Ctr. v. Nassar, 133 S. Ct. 2517 (2013) (clarifying that the Civil Rights Act of 1991 codified the burden-shifting and lower causation framework for Title VII discrimination claims based on race, color, religion, sex, or national origin); McDonnell Douglas Corp. v. Green, 411 U.S. 792, 802 (1973) (explaining that in Title VII cases, once a claimant has made out a prima facie case of racial discrimination, the burden shifts "to the employer to articulate some legitimate, nondiscriminatory reason for the employee's rejection"). In addition, courts have creatively allowed burden shifting to promote fairness where innocent plaintiffs would otherwise be unable to prove causation because of uncertainties as to particular causal pathways. *See, e.g.*, Sindell v. Abbott Labs., 607 P.2d 924, 928 (Cal.

categorically shift the burden of disproving causation to the polluter in environmental cases.[354]

4. Tying the Pieces of the Old Together to Form the New.—In the end, some combination of a lenient substantial factor test, a risk-of-injury analysis that is tied more to general causation than specific causation, and burden-shifting frameworks when appropriate would assist courts in resolving the causal challenges of long-term ecological injuries. Specifically, if we follow the logic of Judge Calabresi and accept that establishing a causal link is key to serving market deterrence, and if we follow the analysis of the smoker–asbestos cases like *Rutherford v. Owens-Illinois Inc.*, we might arrive at a causation inquiry for long-term ecological injuries that looks something like this:

First, the touchstone for proving causation is a relaxed form of the substantial factor test, which some courts in the natural resource damages area have labeled as the contributing factor test. Because this test is flexible at its core, the test requires only that the oil spill was one factor (not necessarily *the* factor) that contributed to the alleged long-term injury.

Second, to prove that the oil spill was a contributing factor, the government trustees must prove that the injured resource was exposed to the oil and that oil exposure would increase the risk of the injury alleged. The trustees need not show the particular biological pathway or mechanism by which the oil actually caused the alleged harm. This test assigns liability even if there are other contributing causes or background stressors that have combined to create the alleged harm.

Finally, if in a given case this framework would systematically preclude recovery for long-term harms, the court may see fit to invoke a burden-shifting framework. Such a move, however, would more likely be reserved for a decision made by the legislature or after empirical evidence regarding systematic undercompensation of long-term harms is available.

1980) (holding that once a plaintiff joins the manufacturers of a substantial share of DES that the plaintiff's mother may have taken, the burden shifts to the manufacturers to prove that they could not have produced the injury-causing product); *Summers*, 199 P.2d at 3–4 (holding that the lower court properly shifted the burden to the defendants to absolve themselves where both defendants negligently shot at the plaintiff and one pellet entered the plaintiff's eye). Scholars have also proposed burden shifting when there are extraordinary challenges preventing plaintiffs from proving causation. *See* Alexandra B. Klass, *Pesticides, Children's Health Policy, and Common Law Tort Claims*, 7 MINN. J.L. SCI. & TECH. 89, 92, 136 (2005) (suggesting that in cases where the plaintiff can prove the pesticide manufacturer "failed to conduct reasonably available testing to gather currently unavailable scientific evidence on the issue of causation" the burden should shift to the defendant to rebut the presumption that "the defendant's failure to conduct the testing was negligent, and that the testing would have resulted in data not already available that would cause a reasonable manufacturer to take the pesticide off the market or use a less harmful design").

354 *See* Adam Moser & Tseming Yang, *Environmental Tort Litigation in China*, 41 ENVTL. L. REP. NEWS & ANALYSIS 10,895, 10,897 (2011) (discussing Articles 65 and 66 of the new China Tort Law, which "unambiguously state that the burden of proof in environmental tort actions is on the polluter").

CONCLUSION

As scientific studies in the wake of the *Exxon Valdez* Oil Spill demonstrate, long-term ecological injuries are increasingly foreseeable. For oil spills and toxic substance releases, Congress expressly provided a mechanism for recovering for long-term injuries: natural resource damages. There are several factors, however, that undermine trustees' ability to recover long-term injuries. Some are complications of Mother Nature herself. Some are complications of our legal system.

This Article is the first to combine the scientific and legal literature to provide an in-depth study of the causation challenges of proving long-term ecological harms. Using the long-term studies done in the wake of the *Exxon Valdez* Oil Spill, this Article establishes the causation difficulties of proving long-term injuries and demonstrates why a new causal paradigm is necessary. In particular, this Article shows why, in the face of a new scientific paradigm, traditional causation standards—e.g., the but-for test or the classic form of the substantial factor test—will exclude otherwise legitimate claims for long-term injuries.

This Article provides the academic foundation for a suitable causation paradigm. First, it demonstrates that an alternative paradigm is permissible under the statutory framework, is needed within the jurisprudence, and is desired to meet the central tenets of tort law. Second, it surveys tort principles and the toxic torts literature to offer a solution. Strangely, the seemingly obvious overlap between two worlds—one contemplating latent injuries to human bodies and one examining long-term injuries to ecosystems—has not been the focus of scholarly attention before. While some scholars have examined similar causation problems in toxic tort and mass product liability cases, none have examined the challenges implicated in the context of natural resource damages.

Ultimately, while this Article set out in search of a new paradigm for a new problem, in the end the flexibility of tort law and the problems of latent injuries in other cases leave us with an emerging problem that, when approached with care and consideration, can be resolved through a careful combination of existing tools that are meant to alleviate some of the inherent difficulties of proving causation when synergistic causes and long latency periods are involved. To that end, this Article argues that the intuitive nature of the contributing factor test makes it appealing in light of the many varying fact scenarios that are typical in natural resource damages cases.

But, if a contributing factor test is more widely applied in the natural resource damages context, courts should clarify the parameters of the test. A meaningful and appropriate test would recognize that natural forces combine with man-made forces to create injuries. Background stressors and synergistic causes are at the heart of the causal challenges posed by long-term ecological injuries. In addition, the contributing factor test should be

applied in combination with a risk-of-injury analysis. Absent a lenient application of the substantial factor test, preferably with a risk-of-injury threshold, a burden-shifting approach might be appropriate. Whatever the precise formulation, it is important to see that tort law is capable of adapting to emerging issues posed by long-term ecological injuries without resorting to legislative reform.

That said, legislatures might still consider whether the time and expense of figuring out how to assign liability for long-term harms could or should be avoided entirely. In particular, though this Article meets the challenge of proving causation on its own terms and explains how tort law is suited to meet those challenges, legislative reform could simply jettison the causal inquiry. Or, legislatures might simply invoke a multiplier to calculate liability for long-term harms as some fraction of the still-complicated but more measurable short-term impacts. Indeed, trustees might look to the amount and type of oil spill as well as other defining factors related to the sensitivity of the marine ecosystem impacted to create a liability matrix.

The point here is that the causal inquiry is only central to the question of redress so long as proof of causation is part of the statutory framework. This Article seeks a tort-based solution for overcoming causal barriers to the recovery of long-term ecological injuries. Other work might fairly consider innovations in the statutory or regulatory framework to address causation or other barriers.