THE INADEQUACIES OF COST-BENEFIT ANALYSIS AS A TOOL FOR DECISION-MAKING: TO BREACH OR NOT TO BREACH

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I. INTRODUCTION

Construction of Ice Harbor Lock and Dam began in 1956;[1] by 1975 Lower Granite Dam, the last of the four Lower Snake dams, was completed.[2] In total, these dams create over 140 miles of slack water, allowing Lewiston to serve as the Pacific Ocean's most inland port—over 450 miles from the coast.[3] For the first time since their completion, shrinking salmon populations—among other concerns—have catalyzed sociopolitical support for dam removal.[4] This article is neither an opinion piece, meant to persuade the reader, nor an in-depth Cost-Benefit Analysis (CBA)

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1. U.S. Army Corps of Engineers, *Ice Harbor Lock and Dam*, USACE, https://www.nww.usace.army.mil/Locations/District-Locks-and-Dams/Ice-Harbor-Lock-and-Dam/ (last visited Mar. 7, 2022).

2. U.S. Army Corps of Engineers, *Lower Granite Lock and Dam*, USACE, https://www.nww.usace.army.mil/Locations/District-Locks-and-Dams/Lower-Granite-Lock-and-Dam/ (last visited Mar. 7, 2022).

3. U.S. Army Corps of Engineers, *Improving Salmon Passage: Final Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement*, USACE 1 (Feb. 2002). Report is available at: https://www.nww.usace.army.mil/Portals/28/docs/library/2002%20LSR%20study/Summary.pdf?ver=2019-05-03-131237–337.

4. *See generally* Rep. Mike Simpson, *The Columbia Basin Initiative*, SALMON, https://simpson.house.gov/salmon/ (last visited Mar. 7, 2022).

measuring the implicit and explicit costs and benefits of each decision. Rather, this article discusses and critiques CBA, in the case of large, polemic decisions, and highlights economic concepts and phenomena that should be considered in this ongoing debate.

First, let us define key concepts that are often misunderstood or misused in public discourse. Perhaps most important in our exposition, is the distinction between market and non-market value. Ultimately, economists are interested in the allocation of scarce resources that maximize social welfare and the distributional implications of such allocations.[5] Welfare in economics can be thought of as the total well-being of all actors in a society—a starkly different concept than its vernacular use.[6] Moreover, with this definition, it is immediately clear that strictly pecuniary or financial measures are entirely inadequate.[7] Recreators, who spend the day fly fishing, are rarely doing so for financial gain, but because they gain utility from the activity, yet no black ink appears on any balance sheet.

Thus, economists have devised methods to value "non-market" goods and activities, such that they can be appropriately valued in social and political decisions.[8] In CBA that involves public goods, the values assigned to these non-market costs and benefits are often crucial in driving the results.[9] For example, the EcoNorthwest consulting group recently concluded, "the benefits of [dam] removal exceed the costs, and thus society would likely be better off without the dams."[10] It is not my intent to refute their findings, which may be appropriate, but the conclusion is at least partially driven by the $8.65 billion non-market benefit estimate associated with maintaining healthy fish populations.[11] This benefit is separate from any additional economic activity created through improved fisheries and instead relies on the preferences and value system internal to the average household.[12] Using contingent valuation methods (among others), this value is estimated in dollar terms, to allow comparison.[13] These types of analyses are particularly important when mutually exclusive options have varying levels of privatization. To illustrate this point, imagine a large public lake with free entry. This

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5. W. DOUGLASS SHAW, WATER RESOURCE ECONOMICS AND POLICY: AN INTRODUCTION 23 (2d ed. 2021).

6. WALTER NICHOLSON & CHRISTOPHER M. SNYDER, MICROECONOMIC THEORY: BASIC PRINCIPLES AND EXTENSIONS 16 (12th ed. 2012).

7. ANTHONY E. BOARDMAN, ET AL., COST-BENEFIT ANALYSIS: CONCEPTS AND PRACTICE 8–13 (Cambridge Univ. Press eds., 5th ed. 2018).

8. A. Myrick Freeman, *Economic Valuation: What and Why*, *in* A PRIMER ON NONMARKET VALUATION 1, 1–2 (Patricia A. Champ et al. eds., 2003).

9. BOARDMAN ET AL., *supra* note 7, at 134–37.

10. ADAM DOMANSKI ET AL., LOWER SNAKE RIVER DAMS: ECONOMIC TRADEOFFS OF REMOVAL ECONORTHWEST iv (2019), https://static1.squarespace.com/static/597fb96acd39c34098e8d423/t/5d41bbf522405f0001c67068/1564589261882/LSRD_Economic_Tradeoffs_Report.pdf.

11. *See id.* at vi.

12. *See id.*

13. *See id.* at 107–08.

lake clearly improves the welfare of the community—not to mention the indirect economic benefits it may induce through increased tourism—but without non-market considerations, the privatization of the lake would be financially justified if it produced even a nominal amount of financial profit, since the lake in its public form does not produce revenue. In such cases, the value of non-market goods and services are simultaneously critical to the analysis and difficult to estimate accurately. Much of the ongoing debate around the Lower Snake dams is quintessentially an issue of how we quantify the costs, benefits, and values that do not appear in the market.

II. COST BENEFIT ANALYSIS

Let us now move onto cost-benefit analysis. Cost-benefit analysis was originally developed in the 1930's and used by the U.S. Army Corps of Engineers to evaluate natural resource decisions; not surprisingly, many of these analyses involved dams.[14] The United States Federal Government generally uses CBA at the direction of presidential executive orders, where such policies were first codified with President Ronald Reagan's signing of Executive order 12,291.[15] Under this and subsequent executive orders, the Office of Management and Budget (OMB) requires the use of BCA by government agencies under the executive branch of government. The Office of Information and Regulatory Analysis (OIRA), within OMB, is required to review any substantial change to policy or new projects.[16] Some version of this order was signed by every subsequent president, though the scope and scale of the required analysis varies by administration.[17]

In an ideal world, social cost-benefit analyses enable governments to make decisions that increase social value through improved allocation of scarce resources. These analyses should quantify, in monetary terms, all consequences of a decision to all relevant members of the society. Unfortunately, the same characteristics that make CBA an important part of government decision-making also limit its effectiveness as a tool in those decisions. When a business chooses to upgrade their distribution or production line, there are straightforward calculations of costs and revenues with minimal uncertainty. By comparison, large public projects, like the Lower Snake dams, rarely lend themselves to bright-line

14. BARRY C. FIELD, NATURAL RESOURCE ECONOMICS: AN INTRODUCTION 131 (2d ed. 2008).

15. *See* Exec. Order No. 12,291, 46 Fed. Reg. 13,193 (Feb. 17, 1981).

16. RICHARD O. ZERBE & TYLER SCOTT, A PRIMER FOR UNDERSTANDING BENEFIT-COST ANALYSIS 4 (2012).

17. *See, e.g.*, Exec. Order No. 12,866, 58 Fed. Reg. 51,735 (Sept. 30, 1993); Exec. Order No. 13,258, 67 Fed. Reg. 9385 (Feb. 28, 2002); Exec. Order No. 13,422, 72 Fed. Reg. 2763 (Jan. 18, 2007); Exec. Order No. 13,563, 76 Fed. Reg. 3821 (Jan. 21, 2011); Exec. Order No. 13,771, 82 Fed. Reg. 9339 (Feb. 3, 2017); Exec. Order 13,777, 82 Fed. Reg. 12,285 (Mar. 1, 2017); Exec. Order No. 13,992, 86 Fed. Reg. 7049 (Jan. 25, 2021).

calculations;[18] indeed, this peculiarity is precisely why they are government projects that would remain inefficiently provided in the free market. The reasons the government is responsible for the provision (or removal) of such projects—long time horizons, non-market benefits and costs, significant economic externalities, and substantial uncertainty—are the precise reasons CBA may be the wrong tool for the decision.

Implicit in the removal of the Lower Snake River dams is the CBA of each potential decision. At its core, social CBA attempts to maximize social welfare by evaluating whether the benefits to society outweigh the costs of a particular decision or project.[19] Whereas business CBA deals only with changes in revenues and costs as a function of inputs and outputs that move across markets, social CBA attempts to quantify both market and nonmarket goods and services. To frame this article and highlight the strength and weaknesses of the CBA approach, I will provide a non-technical description of the steps involved in government CBA with simple examples relevant to the ongoing debate.

The steps of public CBA are generally to:

1) Identify specified objectives,
2) Identify all alternative projects to achieve those objectives,
3) Determine who has standing (whose costs and benefits should be included),
4) Identify and quantify impacts,
5) Select specific metrics by which to measure impacts
6) Predict—to the best of our ability—these metrics and impacts across the life of each alternative project,
7) Monetize impacts,
8) Discount costs and benefits to present value,
9) Conduct a sensitivity analysis. [20]

Although these steps are numbered for tractability, the process is rarely ordinal.[21] Most notably, steps one through three should be performed iteratively such that stakeholders and objectives are jointly determined.[22] The goal of this section is to provide readers with a brief explanation of each step and to discuss ways in which CBA may be an inadequate tool for evaluating public projects and decisions at the scale of the Lower Snake dams. I will now briefly outline each step, highlighting its importance and limitation in the CBA process.

A. Identify Specified Objectives

To appropriately identify the objects of potential projects or policies, decision makers must start by answering the following question: What is the rationale or

18. *See* BOARDMAN ET AL., *supra* note 7.
19. FIELD, *supra* note 14, at 131.
20. BOARDMAN ET AL., *supra* note 718, at 5.
21. *Id.* at 6–8.
22. *See id.*

justification for considering a new (or change in) project or policy? In the case of the Lower Snake, the answer is explicit:

The Northwest seems to be caught in a status quo of fighting over salmon and the four LSR dams through lawsuits, biops, EIS's, appeals, spills, press releases etc. that have outcomes that generally pick winners and losers. It is a cycle that appears never-ending with neither side gaining leverage over the other anytime soon. Either the salmon will go extinct or the courts or some other body will step in and take drastic unilateral action.[23]

While restoring fish populations is the explicit goal of reevaluating the status quo,[24] there are numerous implicit objectives just behind the curtain: maintaining cheap and green electricity production,[25] preserving agricultural production in the region,[26] preserving Native American culture,[27] and improving the welfare of Idaho (and other state) citizens.[28]

To warrant these objectives, cost-benefit analyses must determine to what extent the setting includes functioning markets and *market failures*. Broadly speaking, market failures are any situation in which allocative efficiency will not be reached when economic agents (individuals, firms, *inter alia*) act in their own self-

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23. Mike Simpson, *The Northwest in Transition: Salmon, Dams, and Energy* 3, U.S. CONGRESSMAN MIKE SIMPSON, https://simpson.house.gov/uploadedfiles/websiteslides2.4.pdf (last visited Mar. 7, 2022) [hereinafter *Northwest in Transition*]. As an aside, I realize that the audience of the Idaho Law Review may not be receptive to the concept of reducing lawsuits, but economically speaking, these suits are something akin to large *transaction costs* that prevent economically efficient solutions.

24. *Why Remove the 4 Lower Snake River Dams?*, SAVE OUR WILD SALMON, https://www.wildsalmon.org/facts-and-information/why-remove-the-4-lower-snake-river-dams.html (last visited Mar. 7, 2022) (discussing global warming effects on the Columbia-Snake River); *see also Northwest in Transition*, *supra* note 23, at 7.

25. Mike Simpson, *What if? Simpson on Salmon Recovery*, at 1:56, YOUTUBE (Feb. 6, 2021), https://www.youtube.com/watch?v=z5_fm7UGsw4. These are (implicit) objectives based on Mike Simpson's proposal or common sense, since as a society we still need power and water.

26. *Id.* at 2:03.

27. This objective is referenced across numerous news sources and statements. *See* Andrew Kennard, *Pacific Northwest Tribes Call for Removal of Lower Snake River Dams at Salmon and Orca Summit*, NATIVE NEWS ONLINE (July 13, 2021), https://nativenewsonline.net/currents/pacific-northwest-tribes-call-for-removal-of-lower-snake-river-dams-at-salmon-and-orca-summit; Lynda V. Mapes, *Salmon People: A tribe's decades-long fight to take down the Lower Snake River dams and restore a way of life*, SEATTLE TIMES (Nov. 29, 2020, 6:00 AM), https://www.seattletimes.com/seattle-news/environment/salmon-people-a-tribes-decades-long-fight-to-take-down-the-lower-snake-river-dams-and-restore-a-way-of-life/.

28. While there is debate over the effectiveness and objectives of our democracy, the goal of promoting general welfare is laid out in Preamble of the US Constitution. *See* U.S. CONST. pmbl.

interest.[29] In the context of the Snake River dams, these failures are largely attributed to the nature of the goods in the market (*public good* or *common pool*) and *externalities*.[30] An economic externality occurs when a decision imposes costs or benefits on a third party that is not directly related to that decision.[31] Producer-based pollution is the most common example of this phenomenon: individuals may be affected by a pollution by-product regardless of whether they were involved in the production or consumption of the primary product.[32] In the case of dams, and water management more generally, market failures abound.[33]

The declining and possible extinction of fish populations is an obvious externality, which may not have been properly considered—either because of scientific uncertainty or political will—when the dams were constructed.[34] Citizens across the Northwest (and internationally) are affected by dwindling salmon populations, many of whom have little ability to affect policy (we discuss the undemocratic scenarios of diffuse costs and concentrated benefits below).[35] Subsistence fishing is no longer an option, yet those who lost their livelihoods have gone largely uncompensated.[36]

However, the dams also exist in the context of numerous functioning markets. Let us think of these dams as providing goods and services to the greater Pacific Northwest. In this case, the provision of water and energy are largely *intermediate goods*, or products used in the production process to make other goods, which are eventually sold to consumers.[37] In addition to the dam's ability to provide power and extend the irrigation season, they also allow for the low-cost transportation of agricultural products—primarily wheat—down river, and other products—primarily wood and pulp—upriver.[38] The economic consequences of breaching these dams can largely be characterized as a shock to energy and transportation sectors, which have direct implications for the *comparative advantage* of

29. *See generally* BERNARD SALANIÉ, MICROECONOMICS OF MARKET FAILURES (MIT Press 2000).

30. *Id.* at 89.

31. *Id.*

32. *See generally* LYNNE LEWIS & TOM TIETENBERG, ENVIRONMENTAL ECONOMICS AND POLICY (7th ed. 2019).

33. *See generally* SHAW, *supra* note 5.

34. *See generally* KEITH PETERSEN, RIVER OF LIFE, CHANNEL OF DEATH: FISH AND DAMS OF THE LOWER SNAKE (Confluence Press 1995).

35. The interdependence of salmon population and healthy communities has been documented in numerous academic articles, news stories, and books. *See, e.g.*, NATIONAL RESEARCH COUNCIL, UPSTREAM: SALMON AND SOCIETY IN THE PACIFIC NORTHWEST (Nat'l Acads. Press 1996).

36. Nathaniel Gillespie et al., *Socioeconomic Benefits of Recreational, Commercial, and Subsistence Fishing Associated with National Forests*, 43 FISHERIES 379, 432–39 (2018).

37. Bureau of Economic Analysis, *What are intermediate inputs?*, BEA (Mar. 10, 2006), https://www.bea.gov/help/faq/185.

38. *See generally Grain Exports*, PORT OF LEWISTON, https://portoflewiston.com/our-rivers/grain-exports/ (last visited Mar. 7, 2022).

agricultural and industrial operations across the region.[39] Thus, the objective to restore salmon populations while maximizing social welfare very quickly becomes cumbersome, requiring the estimation of substantial market and non-market impacts.

B. Identify all alternative projects to achieve these objectives

This step requires that all feasible alternatives to achieve—in part or in whole—the objectives be identified. In reality, the number of potential alternatives is often very large and can vary across not just attributes but also attribute levels, for example, the size of the dam or the efficiency of a fish ladder.[40] In this context the alternatives are simple. The Northwest has spent roughly $17 billion on fish recovery efforts ("alternatives"),[41] but five of the fourteen salmon species are still experiencing declines in population and five more are classified as in crisis; only four species have shown any improvement.[42] Over the past decades, numerous alternatives were suggested by federal agencies and were either ineffective or declared illegal.[43] U.S. District Court Judge Michael Simon was scathing in his 2016 ruling. He found, among other things, that the 2014 BiOp was "legally insufficient," relying on "uncertain benefits" and "ignor[ing] the dangerously low abundance levels" of many threatened or endangered species.[44] Thus, there are only two alternatives left based on the rationale provided by Senator Simpson and others: To breach or not to breach, that is the question.

C. Determine who has standing

Legal and economic standing are similar enough in concept that I will not dedicate much time to its exposition, except to say standing in CBA may be more political in nature. Generally, standing is determined on provincial criteria, though some push back strongly against this limited scope.[45] Indeed, many negative externalities (e.g., greenhouse gases) are prolific precisely because their costs are

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39. Donn A. Reimund, *The Northwest, in* ANOTHER REVOLUTION IN US FARMING? 404–45 (U.S. Dep't of Agric. 1979), https://ageconsearch.umn.edu/record/294032/?ln=en.

40. BOARDMAN ET AL., *supra* note 7, at 6-9.

41. Mike Simpson, *The Columbia Basin Initiative*, U. S. CONGRESSMAN MIKE SIMPSON, https://simpson.house.gov/salmon/ (last visited Mar. 7, 2022).

42. *2020 State of Salmon in Watersheds*, WASH, STATE RECREATION AND CONSERVATION OFF., GOVERNOR'S SALMON RECOVERY OFFICE (2020), https://stateofsalmon.wa.gov/wp-content/uploads/2020/12/StateofSalmonExecSummary2020.pdf. at 5-6

43. Nat'l Wildlife Fed'n v. Nat'l Marine Fisheries Serv., 184 F. Supp. 3d 861, 880 (D. Or. 2016).

44. *Id.* at 876.

45. *See* Dale Whittington & Duncan MacRae, Jr., *The Issue of Standing in Cost-Benefit Analysis*, 5 J. POL'Y ANALYSIS & MGMT. 665, 666–67 (1986).

not considered beyond socio-political boundaries.[46] I will take a moment to briefly address some nuances in the concept of standing that may be underdeveloped in the current context.

Large infrastructure or policy decisions in one market are likely to induce new price equilibria in related markets.[47] These shifts have implications for not only the markets they directly affect but any secondary markets and markets for *related goods*.[48] Related goods are products whose price and quantity affect each other.[49] A simple example would be goods that can be easily substituted: If the price of Coca-Cola increases, consumers substitute for other brands of cola. In the case of the Lower Snake dams, hydroelectric energy production has numerous substitutes (natural gas, wind, coal).[50] According to a Bonneville Power Administration analysis, approximately 1000 megawatts of power are created by the Lower Snake Dams—approximately the average annual consumption of the City of Seattle.[51] There are numerous implications for energy markets and those who will benefit from a shift in production technology, but readily available substitutes generally reduce concerns that shocks to one product (hydroelectric energy) will substantially injure end-use consumers because they can switch to the available substitute.[52] Although there are implications for grid reliability and other nuances which should also be considered.

Let us look at what, in my opinion, is the most difficult constraint to overcome—barge transportation. First, barge transportation does not have readily available substitutes and innovation is limited by physical, social, and political constraints.[53] Moreover, *terminal charges*, the expenses associated with loading

46. Daniel A. Farber, *Uncertainty as a Basis for Standing*, 33 HOFSTRA L. REV. 1123 (2005).

47. BOARDMAN ET AL., *supra* note 7, at 163–65 (discussing CBA impacts on secondary markets); *see also* Wiktor Adamowicz et al., *Assessing Ecological Infrastructure Investments*, 116 PROC. NAT'L ACAD. SCI. 5254 (2019).

48. G. Lacombe et al., *Are Hydropower and Irrigation Development Complements or Substitutes? The Example of the Nam Ngum River in the Mekong Basin*, 39 WATER INT'L 649, 650 (2014); Biswo N. Poudel et al., *Water Supply and Dams in Agriculture*, *in* THE ROUTLEDGE HANDBOOK OF AGRICULTURE ECONOMICS 285 (Gail L. Cramer et al. eds., 2019).

49. WALTER NICHOLSON & CHRISTOPHER SNYDER, MICROECONOMIC THEORY: BASIC PRINCIPLES AND EXTENSIONS 183–85 (Cengage Learning12th ed. 2017) (1972).

50. BONNEVILLE POWER ADMIN., BPA FACTS: FISCAL YEAR https://www.bpa.gov/-/media/Aep/finance/investor-relations/gi-bpa-facts.pdf (August 2020).

51. *Lower Snake River Dams Provided Crucial Energy and Reserves in Winter 2021*, BONNEVILLE POWER ADMIN. (June 16, 2021), https://www.bpa.gov/about/newsroom/news-articles/20210616-lower-snake-river-dams-provided-crucial-energy-and-reserves-in-winter-20.

52. *See* NICHOLSON & SNYDER, *supra* note 49, 92–98, 617–20 .

53. Samuel P. Huntington, *The Marasmus of the ICC: The Commission, the Railroads, and the Public Interest*, 61 YALE L.J. 467, 503–05 (1952); Anthony Perl & James A. Dunn, Jr., *Fast Trains: Why the U.S. Lags*, 277 SCI. AM. 106, 107 (1997).

and unloading shipped materials, can be substantial, which limits the economic feasibility of a hybrid truck-rail-barge system.[54]

While wheat is still ranks third in terms of acres planted in the United States, the share of global wheat exports from the United States has declined from twenty-five percent in 2005 to around fifteen percent in 2021.[55] This shift is attributed to the relatively low wheat prices of recent years and the increase in production by the European Union and Russia.[56] Wheat remains the primary crop on the Palouse because it is compatible with the topography and climate of the region.[57] In economic terms, the region has a *comparative advantage*; producers in the area can grow wheat at a lower opportunity cost than farmers outside the region.[58] Increases in shipping costs are unlikely to fundamentally change this advantage and thus will not result in a substantial change in the agricultural landscape as we know it. However, given the low margins, additional costs are likely to affect farmer profitability. Senator Simpson's proposal explicitly acknowledges this potential loss and allocated billions of dollars for direct payments to farmers.[59] Though, it is worth noting that climate change may in itself reduce the competitiveness of wheat farming in the Pacific Northwest.[60] Final estimates are not yet available for the year, but wheat yields in the Palouse may be down by as much as thirty percent due to

54. WILLIAM F. SAMUELSON & STEPHEN G. MARKS, MANAGERIAL ECONOMICS 101 (Jennifer Manias et al. eds., 7th ed. 2021). Example rates can be found at *Comparing the Costs of Rail Shipping vs Truck*, RSI LOGISTICS (Apr. 20, 2020), https://www.rsilogistics.com/blog/comparing-the-costs-of-rail-shipping-vs-truck/#:~:text=The%20cost%20to%20combine%20rail%20and%20truck%20using,can%20cut%20transportation%20costs%20by%20more%20than%20half.

55. *Wheat Overview*, U.S. DEP'T AGRIC. ECON. RSCH. SERV., https://www.ers.usda.gov/topics/crops/wheat/ (Feb. 23, 2022).

56. *Id.*

57. ANDREW P. DUFFIN, PLOWED UNDER: AGRICULTURE AND ENVIRONMENT IN THE PALOUSE 40 (2007).

58. *See* David J. Cann et al., *Agroecological Advantages of Early-Sown Winter Wheat in Semi-Arid Environments: A Comparative Case Study from Southern Australia and Pacific Northwest United States*, 11 FRONTIERS PLANT SCI. 1, 4 (2020); Roland C. Bevan, *Discussion: Economics of Crop Rotations and Fertilizer Use in the Palouse Wheat-Pea Area*, 33 W. AGRIC. ECON. ASS'N PROC. ANN. MEETING 373, 376–77 (1960).

59. *See, e.g.*, U. S. CONGRESSMAN MIKE SIMPSON, THE NORTHWEST IN TRANSITION: SALMON, DAMS AND ENERGY 25, https://simpson.house.gov/uploadedfiles/websiteslides2.4.pdf (last visited Mar. 24, 2022).

60. Claudio O. Stöckle et al., *Assessment of Climate Change Impact on Eastern Washington Agriculture*, 102 CLIMATIC CHANGE, 77, 95–97 (2010); Tai M. Maaz et al., *Impact of Climate Change Adaptation Strategies on Winter Wheat and Cropping System Performance Across Precipitation Gradients in the Inland Pacific Northwest, USA*, 5 FRONTIERS ENV'L SCI. 1, 23(2017).

the extreme drought of 2021.[61] If such weather patterns become the new normal, wheat production in the area will be drastically reduced, which would alleviate at least some of the transportation constraints associated with dam removal.

However, agriculturalists are not the only "buyers" of train transportation. The increased demand for rail and truck transportation will drive the equilibrium price up for all individuals and businesses that use the service.[62] The magnitude and persistence of this increase depends largely on *elasticity* and is empirically unknown, but *ceteris paribus*, removing barge traffic will result in higher prices for rail and truck transportation in the area.[63] These secondary effects create losers, those needing to pay more to transport their product to market, without providing adequate compensation, since that is limited largely to those in the agricultural sector.[64] Without going into the high-level economic theory, these effects on secondary markets are usually issues of distributional impacts not economic efficiency.[65] Even more problematic than the quantification of costs and benefits in secondary markets is the determination of who gets standing *in praxis*.[66]

This brings us to the most substantial critique of the CBA process, which I will call *civic participation disparities*. There are many socio-political phenomena that explain these disparities (e.g., historically disenfranchised groups, voting restrictions, etc.),[67] but economists are generally concerned with the concentration of costs and benefits.[68] In particular, projects and policies with concentrated benefits and diffuse costs can subvert democracy because the majority interests are trumped by minority interest groups, due largely in part to the *free-rider* and other *collective action* problems.[69] The concept is straightforward; a policy or project has a small negative effect on many such that the individual inconvenience or cost of civic participation is sufficiently high that they do not participate (and to some degree hope others will).[70] Simultaneously, the benefits for a small group are

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61. Press Release, USDA, Wheat Production Totals for Idaho, Oregon, and Washington Down from 2020, at 1 e (July 12, 2021) https://www.nass.usda.gov/Statistics_by_State/Washington/Publications/Current_News_Release/2021/CP07_01.pdf.

62. Johannes Bröcker, *Computable General Equilibrium Analysis in Transportation Economics*, 5 HANDBOOK TRANSP. GEOGRAPHY & SPATIAL SYS. 269 (2004).

63. Marc A. Johnson, *Impacts on Agriculture of Deregulating the Transportation System*, 63 AM. J. AGRIC. ECON. 913 (1981).

64. Mike Simpson, *Columbia Basin Initiative*, U. S. CONGRESSMAN MIKE SIMPSON, https://simpson.house.gov/salmon/ (last visited Jan. 16, 2022).

65. BOARDMAN ET AL., *supra* note 7, at 163–65 (discussing CBA impacts on secondary markets).

66. *Id.*

67. Mark S. Reed et al., *Who's in and Why? A Typology of Stakeholder Analysis Methods for Natural Resource Management*, 90 J. ENV'T MGMT. 1933, 1933–36 (2009).

68. *Id.*

69. *See generally* MANCUR OLSON, JR., THE LOGIC OF COLLECTIVE ACTION: PUBLIC GOODS AND THE THEORY OF GROUPS (1975) (Seminal work first explaining the many issues with collective action.).

70. *Id.*

substantially high to induce strong participation.[71] In such cases, the "squeaky wheel" or concentrated interests get the grease to the detriment of the majority.

A recent example of this phenomenon was Washington Initiative 1634, the Prohibit Local Taxes on Groceries Measure.[72] In reality, this was an effort to preempt local governments from being able to level "sugar tax[es]," though it was framed quite differently in lobbying and advertisement efforts.[73] According to Ballotpedia, the "Yes! To Affordable Groceries" committee spent nearly $22 million largely from donors with significant revenue to lose, such as The Coca-Cola Company, PepsiCo, Inc., Keurig-Dr. Pepper, Red Bull North America, and the Washington Food Industry Association.[74] The two committees formed in opposition of this legislation, the "Healthy Kids Coalition" and "Healthy Inmates for Healthy Minds," spent less than $126 thousand, or 0.6% of large food industries that have a strong, vested interest in preventing sugar (and other grocery) taxes.[75]

While an ideal cost-benefit analysis would accurately quantify the welfare effects to all peoples, it is ethically and practically difficult to determine the bounds of who has standing in such analyses.[76] For example, there is an ongoing legal debate around the standing—or lack thereof—for future generations, who clearly have interest in environmental and multi-generational infrastructure decisions.[77] Determination of standing is further complicated by the historic context in which major water projects were implemented. One of many examples is the 1946 construction on the Pick-Sloan Flood Control dams that ultimately submerged seven hundred miles of tribal lands in the Missouri Valley.[78] Even when standing is determined reasonably, the impacts and associated monetized gains and losses can present additional problems.

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71. *Id.*

72. *Washington Initiative 1634, Prohibit Local Taxes on Groceries Measure (2018)*, BALLOTPEDIA, https://ballotpedia.org/Washington_Initiative_1634,_Prohibit_Local_Taxes_on_Groceries_Measure_(2018) (last visited 1/21/2022).

73. *Id.*

74. *Id.*

75. *Id.*

76. A thorough discussion of determining standing in CBA can be found in Dale Whittington & Duncan MacRae, Jr., *The Issue of Standing in Cost-Benefit Analysis*, 5 J. OF POL'Y ANALYSIS & MGMT. 664 (1986); and Trumbull, William N., *Who has standing in cost-benefit analysis?*, 9 J. POL'Y ANALYSIS AND MGMT. 201 (1990).

77. Bradford C. Mank, *Standing and Future Generations: Does* Massachusetts v. EPA *Open Standing for Generations to Come?*, 34 COLUM. J. ENV'T L. 1, 3–7 (2009).

78. Peter Capossela, *Impacts of the Army Corps of Engineers' Pick-Sloan Program on the Indian Tribes of the Missouri River Basin*, 30 J. ENV'T L. & LITIG. 143, 144–47 (2015).

D. Identify and quantify impacts

After the analyst determines whose costs and benefits matter, the specific impacts of a project must be catalogued.[79] An impact inventory is broadly defined as any input, output, or reallocation of resources.[80]

Different groups will benefit from the existence or breaching of the Lower Snake dams. Some impacts are already in monetary terms, though many may be expressed in other units (time, difficulty, *inter alia*).[81] The most obvious impact of dam breaching is a (hopefully) healthier fish population.[82] While healthy fish populations may have innate value, CBA is inherently anthropocentric, such that the benefits of this ecological boon need to accrue *to* groups or individuals.[83] How do we account for the impact of healthy fish populations?

Consider anglers, they are likely to benefit from the increase in fishing quality (a metric for which may be decreased time per fish caught) and a change in fishing access (likely an increase for fly fisherman and a decrease for boat-based fishing). Guiding companies and tourism industries may see an increase in demand and revenue.[84] All these would be considered *use values*, and most policy focuses on these more concrete and measurable costs and benefits.[85]

However, it is important to acknowledge that environmental economists also allow for non-use values in many of their analyses.[86] Generally, these benefits include: (1) *option value*s – the benefit (to society or an individual) placed on maintaining an asset or resource for the future, even if there is no plan to use it;[87] (2) *bequest values* – the value of maintaining or preserving an asset for future generations;[88] and the most controversial, (3) *existence value* – the benefit people feel by knowing a particular environmental or ecological resource exists.[89] The converse of existence value is often easier to interpret; one may experience disutility because the Tasmanian Tiger and the Bubal Hartebeest no longer exist—both went extinct in the mid 1900's—regardless of their intention to interact with

79. BOARDMAN ET AL., *supra* note 7, at 6–8.

80. *Id*.

81. *Id*.

82. Mike Simpson, *The Columbia Basin Initiative*, U.S. CONGRESSMAN MIKE SIMPSON, https://simpson.house.gov/salmon/ (last visited Mar. 7, 2022).

83. The debate over river personhood and other non-human standing is interesting, but beyond the scope of this article.

84. Heidi M. Pitts et al., *A Hedonic Price Analysis of the Outfitter Market for Trout Fishing in the Rocky Mountain West*, 17 HUM. DIMENSIONS WILDLIFE 446, 458 (2012).

85. *See generally* John Loomis, *Quantifying Recreation Use Values from Removing Dams and Restoring Free-Flowing Rivers: A Contingent Behavior Travel Cost Demand Model for the Lower Snake River*, 38 WATER RES. RSCH. 2-1 (2002).

86. Tom Crowards, *Nonuse Values and the Environment: Economic and Ethical Motivations*, 6 ENV'T VALUES 143, 143 (1997).

87. *Id.* at 146.

88. *Id.*

89. *Id.* at 144.

these species in any tangible way.[90] While non-use values are a method to account for the more transcendental, including them in CBA is likely to face numerous legal and political challenges.[91] Of course, improved fish populations are only one impact of breaching the dams.

Let us consider wheat farmers; breaching the dams will result in fewer transportation options (at least in the short-term).[92] They will experience an increase in cost to move their product to processors (a metric that is already monetized), but the change in transportation method will also impact commuters and drivers, since increased trucking will lead to additional traffic congestion and driving dangers—numerous studies have found significant increases in traffic accidents and fatalities when heavy trucking increases regionally.[93]

The additional water supplies provided by these dams is also a consideration. While the irrigation is only a secondary purpose of the dams, they provide additional (primarily) intra-season storage and may keep groundwater levels artificially high, reducing pumping costs and increasing groundwater availability.[94] Dryland agriculture is already dominant across the landscape, so it is clearly possible for agricultural operations to succeed with reduced irrigation, though irrigation is often considered a crucial climate adaptation strategy.[95]

There is an additional caveat in determining impacts which is perhaps the most fundamental concept in economics: opportunity cost. Understanding what impacts should be counted requires careful consideration to avoid double counting, sunk cost fallacies, and identifying the appropriate status quo or counterfactual.[96] Economists generally equate the true cost of a resource with its opportunity cost, defined as the cost of what society must give up in putting those resources to a new

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90. Espen D. Stabell, *Existence Value, Preference Satisfaction, and the Ethics of Species Extinction*, 41 ENV'T ETHICS 165, (2019).

91. Note, *Existence-Value Standing*, 129 HARV. L. REV. 775 (2016) (discussing the legal argument around existence value).

92. PETER HELMLINGER ET AL., EXECUTIVE SUMMARY: COLUMBIA RIVER SYSTEM OPERATIONS ENVIRONMENTAL IMPACT STATEMENT, COLUMBIA RIVER SYSTEMS OPERATIONS 15 (2020), https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll7/id/14957.

93. Jove Graham et. al., *Increased Traffic Accident Rates Associated with Shale Gas Drilling in Pennsylvania*, 74 ACCIDENT ANALYSIS & PREVENTION 203, 207 (2015); Lucija Muehlenbachs et al., *The Accident Externality from Trucking: Evidence from Shale Gas Development*, 88 REG'L SCI. AND URB. ECON. 1, 1 (2021).

94. HELMLINGER ET AL., *supra* note 92, at 23–24.

95. George Frisvold & Ting Bai, *Irrigation Technology Choice as Adaptation to Climate Change in the Western United States*, 158 J. OF CONTEMP. WATER RSCH. & EDUC. 62 *passim* (2016).

96. ANTHONY E. BOARDMAN ET AL., COST-BENEFIT ANALYSIS: CONCEPTS AND PRACTICE 3, 7, 112 (Cambridge Univ. Press 5th ed. 2018).

use.[97] I am not elaborating on these points in favor of brevity, but Brookshire et al. (1983, 761) provide a concise example of nuances of such choices:

If a laborer employed in digging an irrigation canal could alternatively be used to build a highway, then the opportunity cost of that labor would be what society gives up in highways to build irrigation canals instead. . . . [I]f the labor used to build an irrigation canal could be employed in no other way, its opportunity cost is zero. This concept is often used to justify assigning little or no cost to labor used to construct a project in an area of high unemployment.[98]

Indeed, in a seminal case involving Wyoming's Big Horn Water Adjudication, expert economic witnesses argued that unemployment rates were sufficiently high to justify the opportunity cost of labor at zero value.[99] The argument being, there was no cost of reallocating labor to the new use because it had no opportunity value in existing labor markets.[100] In practice, this decision inflates that value of the new project and would not be justified if those laborers would otherwise be employed.[101]

It should be clear at this point that the impacts to be catalogued depend heavily on the groups granted standing in the analysis. It is critical to include a comprehensive list of impacts associated with each project alternative, but *in praxis*, analyses must be practicable.

E. Select specific metrics by which to measure impacts

While impacts are the construct in which CBA is interested, specific metrics or indicators must be identified to evaluate these impacts. I will largely gloss over this step, but metrics can be measured as time, dollars, measurable ecological impacts, *inter alia*. The choice of specific metrics and indicators depends heavily on data availability.

One caveat worth mentioning in the selection of metrics is the phenomenon commonly referred to as Goodhart's Law, so named after British economist, Charles Goodhart.[102] Goodhart's law states that when a feature of the economy is picked as an indicator of the economy, then it inexorably ceases to function as that indicator because people start to game it.[103] More simply, metrics can be gamed by economic actors such that identification of a metric to measure a particular objective inherently reduces the ability of that metric to do so.[104]

CBA requires that we measure something in order to inform our understanding of how each alternative contributes to the state objectives. In

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97. *Id.*at 9.

98. David S. Brookshire et al., *Economics and the Determination of Indian Reserved Water Rights*, 23 NAT. RES. J. 749, 761 (1983).

99. *Id.*

100. *Id.* at 761–63.

101. *Id.* at 762–63.

102. Adrian C. Newton, *Implications of Goodhart's Law for Monitoring Global Biodiversity Loss*, 4 CONSERVATION LETTERS 264, 265 (2011).

103. *Id.* at 264–66.

104. *Id.* at 265.

practice, analysts might choose metrics that are easier to measure instead of those that accurately reflect the performance of the alternative.[105] Newton provides an explanation of why such metrics are problematic when discussing biodiversity and ecosystem health[106]—two major aspects of the Lower Snake dam debate.[107]

F. Predict—to the best of our ability—these metrics and impacts across the life of each alternative project

As is true with all large infrastructure and policy decisions, the impacts of dam breaching accrue across time. Thus, the sixth step in the process requires predicting the flows of these costs and benefits for each period within a *planning horizon*. Although the planning horizon is often project specific, large public infrastructure investments such as the Lower Snake dams generally include a 50-to-100-year planning horizon in CBA.[108] The consideration of the timeline largely depends on the projects and policies in question and is generally much longer in public than private sectors.[109]

Of course, the prediction of complex (and particularly non-stationary) systems involves significant uncertainty, and the idea that estimates of such systems will be accurate across that time scale are laughable. In the 1930s, the preeminent economist John Maynard Keynes predicted that his grandchildren would only need to work 15 hours per week, yet fulltime working-age adults still clock in 40.5 hours each week.[110] Any analysis which included labor time based on Keynes's prediction would be severely inaccurate, yet multigenerational time scales are the planning horizon for which dam construction (and decommission) decisions are made.

In the case of fish populations, clear action is necessary to prevent species extinction; though it is worth noting that Representative Simpson—and others—acknowledge that even with dam removal, fish recovery is uncertain.[111] Water

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105. BOARDMAN ET AL., *supra* note 9696, at 2–3.

106. Newton, *supra* note 102102, *passim.*

107. LOWER SNAKE RIVER DAMS STAKEHOLDER ENGAGEMENT DRAFT REPORT (2019), https://www.governor.wa.gov/sites/default/files/images/Lower%20Snake%20River%20Dams%20Report%20Draft%20for%20Public%20Review_122019.pdf?utm_medium=email&utm_source=govdelivery (discussing the ecological motivation for dam removal).

108. BUREAU OF RECLAMATION, STRATEGIC ASSET MANAGEMENT PLAN 1 (2020), https://www.usbr.gov/infrastructure/docs/Reclamation_Strategic_Asset_Management_Plan.pdf ("[M]ost of the [Bureau of] Reclamation's facilities are more than 50 years old and some dams are more than 100 years old.").

109. BOARDMAN ET AL., *supra* note 95, at 221–25.

110. Richard B. Freeman, *Why do we work more than Keynes expected?, in* REVISITING KEYNES: ECONOMIC POSSIBILITIES FOR OUR GRANDCHILDREN 135, 135 (Lorenzo Pecchi & Gustavo Piga eds., 2008).

111. *The Columbia Basin Initiative*, U.S. CONGRESSMAN MIKE SIMPSON, https://simpson.house.gov/salmon/ (last visited Mar. 7, 2022).

temperatures are crucial for anadromous salmonids, and the Pacific Northwest is in the midst of a record drought and heat wave.[112] Globally, the five hottest years on record have all occurred since 2016.[113] Thus, any CBA based on predictions built on an inherently unstable and highly uncertain ecosystem are folly.

Of course, natural systems are not the only area where uncertainty can prevent reasonable predictions. Perhaps the biggest source of unpredictability comes from innovation. This brings us to the concept of *induced innovation*, which has a long history in the energy sector.[114] Induced innovation is the phenomenon in which a substantial price increase or government regulation causes society to innovate by developing technologies and practices to minimize the use of that input or otherwise meet a constraint.[115] In recent years, the Energy Independence and Security Act of 2007 led to the phase out of traditional incandescent bulbs.[116] The chicken-littles at the time complained about the poor light quality and dangers of CFL's.[117] The sky did not fall; LED light bulbs of every shape, size, and color quickly filled the void, accounting for 13% of total sales and 35% of outdoor use, saving over 450 trillion btu's compared to incandescent bulbs each year.[118] Spot markets, tiered pricing, and rebates have developed to reduce peak demand and induce efficient appliance adoption.[119]

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112. *Historical Palmer Drought Indices*, NOAA: NAT'L CTRS. FOR ENV'T INFO., https://www.ncdc.noaa.gov/temp-and-precip/drought/historical-palmers/maps/psi/202101-202112 (last visited Mar. 7, 2022) (showing drought conditions in Columbia River Basin during 2021).

113. *Global Temperature*, NASA: GLOB. CLIMATE CHANGE, https://climate.nasa.gov/vital-signs/global-temperature/ (last visited Mar. 7, 2022) (showing graph of historical temperature anomalies).

114. *See generally* David Popp, *Induced Innovation and Energy Prices*, 92 AM. ECON. REV. 160 (2002).

115. Paul A. Samuelson, *A Theory of Induced Innovation Along Kennedy-Weisäcker Lines*, 47 REV. ECON. & STAT. 343 (1965) (presenting the economic theory behind this concept).

116. *How the Energy Independence and Security Act of 2007 Affects Light Bulbs*, U.S. EPA, https://www.epa.gov /mercury/how-energy-independence-and-security-act-2007-affects-light-bulbs (last visited Mar. 7, 2022).

117. Richard Simon, *Texas Aglow With Effort to Save the Incandescent Bulb*, LOS ANGELES TIMES (Jul. 9, 2011, 12:00 AM), https://www.latimes.com/world/la-xpm-2011-jul-09-la-na-adv-texas-light-bulbs-20110710-story.html; Nicolas Loris, *Banning the Incandescent Light Bulb*, THE HERITAGE FOUNDATION (Aug. 23, 2010), https://www.heritage.org /environment/commentary/banning-the-incandescent-light-bulb.

118. NAVIGANT CONSULTING INC., U.S. DEP'T OF ENERGY, ADOPTION OF LIGHT-EMITTING DIODES IN COMMON LIGHTING APPLICATIONS (Jul. 2017), https://www.energy.gov/sites/prod/files/2017/08/f35/led-adoption-jul2017_0.pdf.

119. Steven E. Henson, *Electricity Demand Estimates under Increasing-Block Rates*, 51 S. ECON. J. 147 (1984); Xavier Labandeira et al., *A Meta-Analysis on the Price Elasticity of Energy Demand*, 102 ENERGY POL'Y 549 (2017); Peter Cramton & Steven Stoft, *Forward Reliability Markets: Less Risk, Less Market Power, More Efficiency*, 16 UTILS. POL'Y 194 (2008).

These transition periods often have distributional impacts, creating winners and losers. For example, richer homes with the ability to buy energy star appliances may be less hurt by the introduction of tiered pricing than those who do not have the financial capital to upgrade or install solar panels.[120] In energy, this is a particular concern since energy demand is often *inelastic*, which suggests household consumers have limited ability to cut back in the short term, increasing household bills.[121] Of course, new technologies can also help. For example, smart thermostats can be programmed to minimize peak load prices, attenuating the use curve throughout the day.[122] This *induced innovation* can ultimately decrease the total capacity needs of the grid, much like lower per capita water use allows water utilities to require lower firm-yield water portfolios.

There is a lively debate around how the removal of these dams will affect grid reliability, greenhouse gas emissions, and energy costs for businesses and residents across the Northwest.[123] Currently, these dams provide around 1,000 megawatts on average.[124] By comparison, a combined-cycle natural gas power plant brought online since 2017 averages around 820 megawatts.[125] In recent years, nearly every source of energy production (nuclear, natural gas, solar) has made significant advancements in energy production such that the total production decrease associated with removing the dams is negligible.[126] A recent study estimated the total cost of replacing the current energy production between $400 million and $1.2 billion, depending on the energy mix and level of demand-side management strategies, increasing the average utility bill by less than $2 a month.[127] Indeed, in

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120. Cristina Cattaneo, *Internal and External Barriers to Energy Efficiency: Which Role for Policy Interventions?*, 12 ENERGY EFFICIENCY 1293, 1302, 1306 (2019).

121. *Id.* at 1296.

122. Krystian X. Perez et al., *Integrated HVAC Management and Optimal Scheduling of Smart Appliances for Community Peak Load Reduction*, 123 ENERGY & BLDGS. 34, 38–39 (2016); Rajendra Adhikari et al., *An Algorithm for Optimal Management of Aggregated HVAC Power Demand Using Smart Thermostats*, 217 APPLIED ENERGY 166, 174 (2018).

123. U.S. ARMY CORPS OF ENG'RS ET AL., EXECUTIVE SUMMARY: COLUMBIA RIVER SYSTEM OPERATIONS ENVIRONMENTAL IMPACT STATEMENT 2 (2020), https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll7/id/14957.

124. BONNEVILLE POWER ADMIN., A NORTHWEST ENERGY SOLUTION: REGIONAL POWER BENEFITS OF THE LOWER SNAKE RIVER DAMS 2 (Mar. 2016), https://legacy.bpa.gov/news/pubs/FactSheets/fs-201603-A-Northwest-energy-solution-Regional-power-benefits-of-the-lower-Snake-River-dams.pdf.

125. Glenn McGrath, *Power block in natural gas-fired combined-cycle plants are getting bigger*, U.S. ENERGY INFO. ADMIN. (Feb. 12, 2019), https://www.eia.gov/todayinenergy/detail.php?id=38312.

126. ECONORTHWEST, LOWER SNAKE RIVER DAMS: ECONOMIC TRADEOFFS OF REMOVAL 33 (July 29, 2019), https://static1.squarespace.com/static/597fb96acd39c34098e8d423/t/5d41bbf522405f0001c67068/1564589261882/LSRD_Economic_Tradeoffs_Report.pdf.

127. *Id.* at 32.

recent years the price advantage of Bonneville Power Authority provided hydropower electricity has almost entirely dissipated.[128] However, the dams currently provide significant capacity and have the ability to ramp up production to meet peak loads effectively.[129] Thus, as is often the case with energy, the binding constraint is power storage, which can be made available when demand outpaces supply.

While these estimates may have some merit, one major development in battery storage would drastically change any prediction substantially, and such developments are very difficult to anticipate—even Moore's Law has failed in recent years.[130] Thus, the necessity for CBA to justify large public projects and policies is paradoxical, since it is in such arenas where the costs and benefits have the potential to affect the most people and precisely those arenas where our predictions are least accurate. Even if impacts could be determined with reasonable certainty, there are significant barriers to making this information actionable.

G. Monetize Impacts

First, I would like to address a common misconception of non-economists. The primary motivation for the monetization of impacts is not to assign values for the sake of commodification.[131] Rather, monetization is simply a unit conversion tool that allows economists to compare dissimilar impacts and choose between them when they are mutually exclusive.[132] Said another way, it is our way of converting pelicans to grizzly bears. How many of one would a society give up in order to gain the other? So long as we live in a resource scarce world, we need a way to standardize impacts of any project or policy.

Of course, there are many areas where such conversion is vexatious. For example, the Nez Perce Tribe has been vocal about the dam's effect on salmon populations, which are a staple in the tribe's diet and traditions.[133] How many megawatts does it take to balance against cultural genocide? While the question is hyperbole, we in the dismal science regularly monetize human lives, the statistical value of which is around $10 million.[134] This concept of monetizing lives is abhorrent to some, but a practical necessity when setting policies and designing projects. This quandary is referred to as *incommensurability*, or the inability of measuring impacts in the same unit on a cardinal scale. Comparability is a requirement for the

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128. *Id.* at iv.

129. *Id.* at 33.

130. Fred Schlachter, *No Moore's Law for Batteries*, 110 PROC. NAT'L ACAD. SCI. [PNAS] 5273 (Apr. 2, 2013); Carleton Coffrin, *Invited Seminar at the Advanced Network Science Initiative Technical Report: Beyond Moore's Law: Exploring the Future of Computation*, LOS ALAMOS NAT'L LAB'Y (Feb. 18, 2019), https://permalink.lanl.gov/object/tr?what=info:lanl-repo/lareport/LA-UR-19-21268.

131. BOARDMAN ET AL., *supra* note 7, at 190.

132. BOARDMAN ET AL., *supra* note 7, at 44, 190.

133. Benedict J. Colombi, *Salmon and the Adaptive Capacity of Nimiipuu (Nez Perce) Culture to Cope with Change*, 36 AM. INDIAN Q. 75, 75–97 (2012).

134. *Mortality Risk Valuation*, ENV'T. PROT. AGENCY (Jan. 16, 2022, 10:19 AM), https://www.epa.gov/environmental-economics/mortality-risk-valuation.

monetization of any impact, yet numerous scholars and researchers suggest that such comparisons are rarely possible.[135] Moreover, the process can introduce inherent inequity since the goal of CBA is generally economic efficiency. For example, transportation infrastructure investments often value benefits by savings in travel time, but these values differ based on method of travel. For example, the 2016 dollar-per-person-hour savings used by the US Department of Transportation was calculated at $25.40 for surface travel (buses etc.) but $63.20 for air and high-speed rail travel.[136] This determination increases the relative value of air travel—generally utilized by those in higher socioeconomic classes—compared to bus travel. Indeed, the conflicting objectives of equity and efficiency are well-recognized by economists.[137]

While the monetization process allows us to compare dissimilar impacts and outcomes, it brings us back to the distinction between market and non-market values. EcoNorthwest's conclusion that, "the benefits of removal exceed the costs, and thus society would likely be better off without the dams," almost entirely depend on the value applied to non-market amenities.[138] While it is important to quantify these real-world benefits, the hypothetical nature of many contingent valuation methods leads to considerable consternation.[139] The exposition of *revealed* and *stated preference* methods is beyond the scope of this article, though it is worth pointing out that quantifying damages as related to natural resources is a contentious point in litigation, particularly with regards to non-market

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135. Matthew Adler, *Incommensurability and Cost-Benefit Analysis*, 146 U. PA. L. REV. 1371, 1371–418 (1998); Jonathan Aldred, *Incommensurability and Monetary Valuation*, 82(2) LAND ECON. 141, 141–61, (2006); Billy Christmas, *Incommensurability and Property Rights in the Natural Environment*, 26 ENV'T POL. 502, 502–20 (2017).

136. Memorandum to Secretarial Officers and Modal Administrators (Sep. 27, 2016) (accessed at: https://www.transportation.gov/sites/dot.gov/files/docs/2016%20Revised%20Value%20of%20Travel%20Time%20Guidance.pdf).

137. Ida Kristoffersson, Leonid Engelson & Maria Börjesson, *Efficiency vs equity: Conflicting objectives of congestion charges*, 60 TRANSP. POL'Y 99, 99–107 (2017).

Tol, R. S. Equitable cost-benefit analysis of climate change policies. 36 *Ecological Economics* 1, 71-85. (2001).

138. ADAM DOMANSKI ET AL., LOWER SNAKE RIVER DAMS: ECONOMIC TRADEOFFS OF REMOVAL iv (ECONorthwest, 2019), https://static1.squarespace.com/static/597fb96acd39c34098e8d423/t/5d41bbf522405f0001c67068;

139. BOARDMAN ET AL., *supra* note 7, at 346; RICK BAKER & BRAD RUTING, ENVIRONMENTAL POLICY ANALYSIS: A GUIDE TO NON-MARKET VALUATION 15 (2014); Tyron Venn & David E. Calkin, *Accommodating non-market values in evaluation of wildfire management in the United States: challenges and opportunities*, 20(3) INT'L J. OF WILDLAND FIRE, 327–328 (2011).

environmental harms.[140] While contingent valuation has been used for this purpose, numerous areas of the law which value intangible harms (most notably pain and suffering damages) do not require a valuation of any type; and instead rely on jury discretion.[141] In any case, large public projects require a method to value the non-market components of their effects, and the results from such investigation have significant influence on CBA results.[142]

H. Discount the costs and benefits to present values

After the impacts are monetized across time, these values are converted to present day value using a predetermined *discount rate*, which can drastically change CBA results. The discount rate is used to adjust for the time value of money.[143] Generally speaking, society—and the actors comprising it—prefer near-term benefits to those that accrue far into the future.[144] A discount rate converts all future costs and benefits to present values that allow comparison.[145] Of course, this practice introduces the chance for vested parties to significantly alter results if the analysis is not conducted in good faith.[146] As a hyperbolic example, imagine we have two mutually exclusive options. A mine would completely destroy an otherwise healthy fishery that provides $200,000 in net benefits each year. The mine provides $1,000,000 in net benefits each year for 10 years, after which it is exhausted. Let us further assume (for simplicity) that we plan on a 100-year timeline. If no discount rate were applied, the mine would produce $10,000,000 in net benefits, while a healthy fishery would provide $20,000,000—clearly the better option. However, as analysts and decision-makers become more myopic (increase the discount rate), the future benefit of a healthy fishery becomes less valuable. Even at the low discount rate of 2%, the mine becomes the preferred option with an expected net present value of $9,162,236 compared to the healthy fishery of $8,792,063. This example highlights the inability of traditional CBA to capture costs and benefits that accrue far into the future. Moreover, it suggests that even reasonable decisions by the analyst can alter the ranking of mutually exclusive projects or decisions.

Thus, long time horizons ensure that even at very low discount rates, the costs and benefits that accrue far in the future are near meaningless in today's value. While there is some rationale for these discounted future flows, the two most

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140. Robert J. Johnston et al., *Contemporary Guidance for Stated Preference Studies*, 4(2) *J. OF THE ASS'N OF ENV'T AND RES. ECONOMISTS*, 319–323 (2017); DANIEL MCFADDEN & KENNETH TRAIN, *CONTINGENT VALUATION OF ENVIRONMENTAL GOODS* (2017); Brian D. Israel et al., *Legal obstacles for contingent valuation methods in environmental litigation*, *CONTINGENT VALUATION OF ENV'T GOODS*, at 292–94 (2017).

141. Sameer H. Doshi, *Making the Sale on Contingent Valuation*, 21 TUL. ENV'T L.J. 295, 295–340.

142. ANTHONY E. BOARDMAN, ET AL., COST-BENEFIT ANALYSIS: CONCEPTS AND PRACTICE 8–13 (Cambridge Univ. Press eds., 5th ed. 2018).

143. *Id.*

144. *Id.*

145. *Id.*

146. Edward R. Morrison, *Judicial Review of Discount Rates Used in Regulatory Cost-Benefit Analysis*, 65(4) UNIV. CHI. L.R. 1333 (1998).

salient justifications are becoming less tenable in the public sphere.[147] The first reason to discount is the implicit assumption that societies grow wealthier over time and experience increased standards of living, such that a dollar today is worth more since our real incomes in the future will be higher.[148] Of course, climate change, degrading infrastructure, and a fraying social fabric cause us to question the validity of this assumption. The second rationale is time preference.[149] People are myopic, so costs and benefits that accrue closer to the present are more important from a psychological perspective.[150] While this phenomenon may be true in terms of the human psyche, it does not reflect the normative or ethical considerations of compromising the future for the present.[151] Indeed, this is the mentality that has led to the "OK Boomer" response from millennial and y generations, who feel their futures were discounted at too high a rate throughout the last half of the twentieth century.[152]

Moreover, making current decisions that knowingly affect future generations (which is clearly the case in dams with 50-100 planning horizons) has numerous implications for intergenerational justice.[153] Though they are largely beyond the scope of this paper, intergenerational morality and trade differs from concurrent markets and decisions in several ways.[154] The most relevant distinction between concurrent decision makers and intergenerational ones is the *lack of direct reciprocity* between generations.[155] No mutual cooperation can exist, and there can be no exchanges in-kind.[156] There also exists a permanent *asymmetry in power relations* between living people and those who will live in the future.[157] Present generations exercise complete power over the state of the world for (remote) future generations.[158] As a related concept, those presently alive can affect the very

147. Ben Groom et al., *Declining Discount Rates: The Long and the Short of it*, 32 ENV'T & RES. ECON. 445, 445–47 (2005).

148. *Id.* at 452.

149. *Id.* at 447.

150. *Id.* at 469.

151. Mark A. Moore, et al., "*Just Give Me a Number!" Practical Values for the Social Discount Rate*, 23 J. POL'Y ANALYSIS & MGMT. 789 (2004).

152. Rebecca Elliot, *The 'Boomer Remover': Intergenerational Discounting, the Coronavirus, and Climate Change*, 70 THE SOCIO. REV. 74, 82 (2022).

153. Simon Caney, *Climate Change, Intergenerational Equity and the Social Discount Rate*, 13 POL. PHIL. & ECON. 320 *passim* (2014).

154. *Id*.

155. Kimberly A. Wade-Benzoni*, A Golden Rule Over Time: Reciprocity in Intergenerational Allocation Decisions*, 45 ACAD. MGMT. J. 1011, 1015 (2002).

156. *Id*. at 1014–15.

157. *Id*. at 1012.

158. *Id*.

existence of future people, not simply their circumstances. How do we appropriately value the costs and benefits of future individuals when decisions made today affect the probability that such individuals ever exist?

Returning to the more concrete, discount rates are often used for political reasons, where the net present value of a project can vary widely based on the rate and stream of costs and benefits across time. One mathematical solution to this problem—though it certainly doesn't fully address the aforementioned critiques of discounting—is the use of declining discount rate schedules, which have been adopted in numerous OECD countries, but have yet to be adopted by the United States.[159]

I. Conduct a sensitivity analysis

Because CBA is often conducted *ex ante*, to justify one choice over another, net present values are predictions based on conditional assumptions and significant uncertainty.[160] The last step in CBA is to rerun the analysis with altered assumptions and states of the world. We will not dedicate time to the many methods used for sensitivity analysis; it is only included as a step for completeness.

III. DISCUSSION

The Lower Snake River dams have become a lightning rod across the Pacific Northwest, with implications for the future of farming, fishing, river recreation, and energy across the region. Both supporters and detractors of the dams use economic rationale to support their stance.[161] Politicians, lawyers, and interest groups

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159. *See* Kenneth Arrow et al., *Determining Benefits and Costs for Future Generations*, 341 SCI. 349, 350 (2013) (providing a thorough presentation and justification for declining discount rates).

160. ANTHONY E. BOARDMAN ET AL., COST-BENEFIT ANALYSIS: CONCEPTS AND PRACTICE 3 (Cambridge Univ. Press 5th ed. 2018).

161. SAVE OUR WILD SALMON, https://www.wildsalmon.org/projects/restoring-the-lower-snake-river/recent-economic-analyses-of-the-lower-snake-river-dams.html (last visited March 24, 2022); *See Study: US Would Lose over $2.3 Billion by Breaching Lower Snake River Dams*, WASHINGTON ASSOCIATION OF WHEAT GROWERS, https://www.wawg.org/study-us-would-lose-over-2-3-billion-by-breaching-lower-snake-river-dams/ (last visited March 24, 2022); *see also* U.S. ARMY CORPS OF ENG'RS ET AL., EXECUTIVE SUMMARY: COLUMBIA RIVER SYSTEM OPERATIONS ENVIRONMENTAL IMPACT STATEMENT 2 (2020), https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll7/id/14957. River advocacy groups like Save Our Wild Salmon present numerous studies citing the economic rationale for breaching the dams, while dam advocates like the Washington Association of Wheat Growers do the same for their continued use. *See* SAVE OUR WILD SALMON, https://www.wildsalmon.org/projects/restoring-the-lower-snake-river/recent-economic-analyses-of-the-lower-snake-river-dams.html (last visited March 24, 2022; *see Study: US Would Lose over $2.3 Billion by Breaching Lower Snake River Dams*, WASHINGTON ASSOCIATION OF WHEAT GROWERS, https://www.wawg.org/study-us-would-lose-over-2-3-billion-by-breaching-lower-snake-river-dams/ (last visited March 24, 2022). The Executive Summary of the Columbia River System Operations Environmental Impact Statement, prominently lists a series of economic measures (jobs, etc.) likely to be affected by breaching the lower dams on page 29. U.S. ARMY

promote CBA as a means to help answer this difficult question.[162] As Duncan Kennedy said:

"What makes the efficiency or cost-benefit analysis attractive and interesting is that it appears to involve only one rather uncontroversial (or at least apolitical) value judgment: If a change in the legal regime helps those who gain by it more than it hurts those who lose, it is a good idea to put it into effect."[163]

Indeed, CBA has become prevalent in the field of environmental economics and policy making because it is an algorithm with concise steps that produces a numeric solution. While there are many instances where formal CBA is a useful tool to guide decisions, I would like to suggest that the decision to breach the Lower Snake dams is not one of them.

Generally, the criticisms of CBA involve ethical claims around incommensurability; proponents of this idea suggest alternative decision tools.[164] For example, as a thought experiment, instead of conducting a CBA, we can envision a process in which impacts are incommensurate, such that all external negative impacts—ignoring for the moment the difficulty of estimating impacts—must be negated to justify one choice over another. Every salmon that dies as a result of the dams must be replaced with another salmon. If a choice allows for the negation of all negative impacts and still provides benefit, it is an acceptable option. Of course, this is a thought experiment because operationalizing such a system is wildly impractical; but no more so than the *Coase Theorem*, which is taught in nearly every economic 101 course across the country.[165]

CORPS OF ENG'RS ET AL., EXECUTIVE SUMMARY: COLUMBIA RIVER SYSTEM OPERATIONS ENVIRONMENTAL IMPACT STATEMENT 2 (2020), https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll7/id/14957.

162. SAVE OUR WILD SALMON, https://www.wildsalmon.org/projects/restoring-the-lower-snake-river/recent-economic-analyses-of-the-lower-snake-river-dams.html (last visited March 24, 2022); *See Study: US Would Lose over $2.3 Billion by Breaching Lower Snake River Dams*, WASHINGTON ASSOCIATION OF WHEAT GROWERS, https://www.wawg.org/study-us-would-lose-over-2-3-billion-by-breaching-lower-snake-river-dams/ (last visited March 24, 2022); *see also* U.S. ARMY CORPS OF ENG'RS ET AL., EXECUTIVE SUMMARY: COLUMBIA RIVER SYSTEM OPERATIONS ENVIRONMENTAL IMPACT STATEMENT 2 (2020), https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll7/id/14957; *See* Bonneville Power Admin., *supra note* 124 at 1.

163. Duncan Kennedy, *Cost-benefit Analysis of Entitlement Problems: A Critique*, 33 STAN. L. REV. 387, 388 (1981).

164. Jonathan Aldred, *Incommensurability and Monetary Valuation*, 82 LAND ECON. 141, 141–42 (2006); Jonathan Aldred, *Cost-benefit Analysis, Incommensurability and Rough Equality*, 11 ENV'T VALUES 27, 27–29 (2002); Cass Sunstein, *Incommensurability and Valuation in Law*, 92 MICH. L. REV. 779, 780–82 (1993).

165. Michael R. Butler & Robert F. Garnett, *Teaching the Coase Theorem: Are We Getting it Right?*, 31 ATL. ECON. J. 133, 140 (2003).

The argument against CBA as a tool in the removal of the Lower Snake dams does not need to rely on moral or ethical grounds but can instead be rooted in practical and empirical considerations. The coupled human-natural system and the ecological, hydrological, and economic uncertainty in predicting potential impacts over 50-years creates error bars so large that any attempt to quantify a point estimate (as a Net Present Value) is dubious.

Transportation via rail and trucks is perhaps the most straightforward aspect of the analysis, and in such sectors, *ex ante* CBA estimates are known to be problematic. Burt Van Wee writes

"At first sight carrying out a CBA for rail projects seems straightforward, since cost estimates are almost always available, and the most dominant benefits are generally known, being the travel time saved and the increase in consumer surplus due to induced demand. However, the practice is much more complex: the quality of current estimates for costs and benefits is often poor and several benefits-related aspects are ignored."[166]

For the more complicated facets of dam removal (for example, future innovation in the energy sector or the monetization of tribal culture) our predictions are laughably inadequate.

I am, and will continue to be, an avid supporter of quantitative analyses to achieve efficient solutions and ardently disagree with scholars like Ackerman who claim the fatal flaw in CBA is its complete reliance on the "impossible attempt to price the priceless values of life, health, nature, and the future."[167] However, when economists are faced with wicked problems, which by definition have extreme uncertainty and no boundary conditions, it would be hubris to evaluate alternative solutions with a single number. In these cases, I acquiesce and suggest that better public policy decisions will be made through democratic principles and traditional regulation.

166. Bert Van Wee, *Rail Infrastructure: Challenges for Cost–benefit Analysis and Other Ex Ante Evaluations*, 30 TRANSP. PLAN. AND TECH. 30, 31–48 (2007).

167. Frank Ackerman & Lisa Heinzerling, *Pricing the Priceless: Cost-benefit Analysis of Environmental Protection*, 150 U. PA. L. REV. 1553, 1584 (2002).