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Habitat and Resource Equivalency Analysis: A Critical Assessment☆

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ABSTRACT

Restoration of ecological resource services from oil spills or chemical releases is a central component of natural resource damage assessments (NRDA) in the U.S. Equivalency analysis methods, particularly habitat equivalency analysis (HEA) and resource equivalency analysis (REA), are widely used methods for scaling compensatory restoration requirements. Although originally conceived for relatively modest habitat and/or short-duration injury, HEA is now widely used in service quantification and restoration scaling at large, complex NRDA sites. HEA can be viewed as a simplified alternative to a comprehensive ecosystem approach that requires more extensive primary data collection and differing assumptions.

The basic premise of equivalency analysis uses relatively simple computations. However, the theoretical underpinnings are complex and include many economic and ecological assumptions that are crucial in methodology application. This review provides needed scrutiny to HEA applications and practices. We also consider global trends in applying equivalency analysis, including its use in environmental liability legislation in the European Union and more novel applications, such as measuring damages from forest fires and calculating mitigation requirements in environmental impact assessments. Although the theoretical literature on the equivalency methods is relatively robust, more case studies of applications in actual applications are needed to help improve proper use of the methods and to encourage development of best practices by practitioners.

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1. Introduction

Natural resource damage assessment (NRDA) emerged in the United States (US) as a process under federal statutes (first Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] and the Clean Water Act [CWA] in the mid-1980s and then Oil Pollution Act [OPA] soon after its passage in 1990) through which trustees representing the public, including federal and state government agencies and Indian tribes, could recover damages from parties responsible for hazardous substance releases and oil spills that result in lost public benefits from injured natural resources. Over time, the NRDA process has changed from a primary emphasis on recovering monetary damages to one that emphasizes the use of restoration projects to offset natural resource service losses. Under this approach, restoration activities are conducted to create or enhance resource services by an amount equivalent to the interim loss of services between the time of a spill or release and return to baseline. Damages are based on the cost of the selected restoration alternative either as a direct payment or through the cost of performing the required restoration.[1]

To ensure that compensatory restoration neither under-compensates nor over-compensates for service losses, it was necessary to develop methods to scale restoration projects and the service flows deriving from those projects. Equivalency analysis methods including habitat equivalency analysis (HEA) and resource equivalency analysis (REA) were developed to facilitate restoration scaling. Early applications of equivalency analyses included relatively simple situations such as the quantification of sea grass losses, as well as quantification of losses to coral reefs.[2]

In the US, equivalency analysis, particularly HEA, has developed into an assessment method that has become favored among practitioners and is now widely used in NRDAs. More recently, in 2004, the European Union (EU) adopted Directive 2004/35/EC on environmental liability with regard to the prevention and remedying of environmental damage (the Environmental Liability Directive [ELD]). Based to some extent on the US experience with NRDA, the ELD explicitly incorporated the use of equivalency methods to scale compensatory remediation (Gard and Desvousges, 2013).

As familiarity with equivalency analyses increases, its applications have also broadened. Some of these applications were appropriate, but other applications were much less so. Since its inception, the HEA method has proven useful in negotiations to settle environmental damage liabilities.[3] However, HEA has not been subjected to the same level of academic and legal scrutiny as other valuation or scaling methods.[4] For example, in the United States, some proponents of the method have incorrectly used a variant of HEA to assess groundwater damages in NRDAs, which have not held up in court.[5] Several natural resource agencies in the US have tried to add more quantification to the environmental impact assessment process by using HEA to calculate mitigation requirements for large-scale projects. In addition, various wildfire damage cases have included the use of HEA as an integral part of the damages calculations. We discuss these latter two developments in more detail later in this paper.

Given the global scope of the use of equivalency analysis methods, the broadening of the applications well beyond the original intent, and the still relatively sparse published literature on HEA and REA, one concern that arises is that the principles of equivalency analysis may have been lost or ignored in the rush to find a simple method of analysis. Caution is required when HEA is applied to complex injuries or service losses, or new situations beyond which its use was originally intended. In this paper, we address the potential soundness of some of the recent expansions, and revisit the fundamental issues that have arisen in the more traditional application of equivalency analysis approaches. We also discuss the use of HEA in light of its more complex alternative, an ecosystem services approach.

This paper explores how and when equivalency analyses can be an effective tool for estimating losses and gains in ecological services. We provide examples from recent applications showing how equivalency analyses have been implemented, and discuss the kinds of situations and issues that either enable HEA to provide useful information on ecological services or preclude it from doing so. We also describe situations in which the approach may be inappropriate because the assumptions are too restrictive or better alternatives are available. The paper concludes with an assessment of the prospects for expanded use of equivalency analyses, including its use as a way of quantifying mitigation for environmental impact assessment.

2. Overview of Equivalency Analysis Techniques

The conceptual basis for using HEA in damage assessments was developed in papers by Mazzota et al. (1994), and Unsworth and Bishop (1994). HEA seeks to estimate the ecological value of lost resource services by determining the amount of resources (habitat) that would have to be provided to compensate for any loss (known as compensatory restoration or remediation) without assigning a monetary value to the services (Dunford et al., 2004). HEA is intended for use when the service losses are primarily ecological, not direct human use services, such as recreation.[6] In cases where affected habitat and other ecological services are easily identifiable and restoration through provision of equivalent services is possible, HEA is much more likely to be effective in determining the appropriate amount of compensation for ecological service losses. Conceptually, a REA is similar to a HEA, but service losses and

[1] However, it is important to note that the cost of restoration does not necessarily equal the value of the lost services. Restoration costs may be greater or less than the value of services lost (Unsworth and Bishop, 1994). Thus, this potential loss in equivalency between value and cost represents a potential drawback to the use of restoration projects.

[2] The National Oceanic and Atmospheric Association (NOAA) used HEA in a case (*United States v. Fisher*, et al. [Case No 92-10027-CIVIL-DAVIS]) and in a coral reef grounding case in the Western Sambo Reef in the Florida Keys National Marine Sanctuary (Julius et al., 1995).

[3] The NOAA website includes numerous Damage Assessment Restoration Plans that are based on the use of HEA, such as the St. Lawrence River site near Massena New York and Lavaca Bay in Texas. See https://www.darrp.noaa.gov/.

[4] For example, the travel cost method, and its most current variant, the random utility model, has been the subject of hundreds of research articles over a time period that covers 70 years since the original suggestion for the approach was made by Harold Hotelling (1947).

[5] *New Jersey Department of Environmental Protection, The Commissioner of the New Jersey Department of Environmental Protection, and the Administrator of the New Jersey Spill Compensation Fund v. Essex Chemical Corporation*; *New Jersey Department of Environmental Protection, The Commissioner of the New Jersey Department of Environmental Protection, and the Administrator of the New Jersey Spill Compensation Fund v. Union Carbide Corporation*.

[6] The value of human use services, such as fishing and wildlife viewing, directly translate into observable choices that people make. Therefore, it is more meaningful to observe the choices that people make than to estimate the value of those choices using HEA.