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Analysis

# Benefit transfer with limited data: An application to recreational fishing losses from surface mining

Marisa Mazzotta [a,*], Lisa Wainger [b], Samantha Sifleet [c,1], J.Todd Petty [d], Brenda Rashleigh [a]

[a] U.S. EPA Office of Research and Development, Atlantic Ecology Division, 27 Tarzwell Drive, Narragansett, RI 02882, United States
[b] University of Maryland Center for Environmental Science, Chesapeake Biological Lab, P.O. Box 38, Solomons, MD 20688, United States
[c] RTI International, 3040 Cornwallis Road, Research Triangle Park, NC 27709, United States
[d] Division of Forestry and Natural Resources, West Virginia University, Morgantown, WV 26506, United States

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ABSTRACT

The challenges of applying benefit transfer models to policy sites are often underestimated. Analysts commonly need to estimate site-specific effects for areas that lack data on the number of people who use the resource, intensity of use, and other relevant variables. Here, we address issues of applying transfer functions to sites that have sparse or missing data. We present options for estimating data to apply meta-regression models (MRMs) in ways that are scale-appropriate and sensitive to local conditions. Using a case study of the potential lost welfare to freshwater anglers as a result of mountain top coal mining within West Virginia, we integrate: 1) an empirical ecological model of fish community changes; 2) an MRM that relates changes in catch rates to changes in anglers' utility; and 3) a spatial participation analysis that maps trip distribution using multiple survey datasets. We evaluate two scenarios: partial (20%) and full use of existing mine permits. Our conservative estimates of annual welfare loss are $120,500 for the partial scenario and $627,800 for the full scenario, due to changes in recreational fishing catches. These results are sensitive to catch rate assumptions and socio-demographic characteristics that varied widely depending on the spatial scale of measurement.


## 1. Introduction

Benefit transfer (BT) is often considered to be a straightforward valuation method that is relatively easy and inexpensive to apply, as compared to conducting primary studies (Iovanna and Griffiths, 2006; Ready and Navrud, 2005; Richardson et al., 2015; Wilson and Hoehn, 2006). The current state of the art in benefit transfer is the use of meta-analysis approaches to develop a transfer function, and meta-regression models (MRMs) are increasingly being estimated with the intention of providing the best possible transfer functions (Bergstrom and Taylor, 2006; Johnston and Rosenberger, 2010; Richardson et al., 2015; Shrestha et al., 2007; U.S. EPA, 2010). While issues remain with MRM techniques, generally accepted standards for conducting and testing MRMs have been developed to promote the rigor and consistency of applications (Bergstrom and Taylor, 2006; Boyle et al., 2010; Boyle et al., 2013; Nelson and Kennedy, 2009; Rosenberger and Loomis, 2001; Stanley et al., 2013).

Given a well-conducted and robust MRM with policy-relevant parameters, additional complications arise from the sparse to nonexistent data available to fit the model to a novel location. In order to apply an MRM to a policy scenario, various types of site-specific information are needed, and it is typically assumed that such information is readily available. In the ideal world, all the necessary policy-relevant data would be available to allow practitioners to follow the most rigorous standards when conducting a benefit transfer. However, managers commonly need to estimate site-specific effects for areas that lack data on the number of people who use the resource, total participation, and other relevant variables needed to transfer benefits.

In the literature, most studies that address issues related to applying meta-analysis focus on out of sample transferability and other methodological and model robustness issues. Here, we focus on issues related to data needs and approaches to dealing with sparse or missing data for policy sites; these issues have been less widely discussed in the literature, though there are various examples of policy evaluations using MRM for benefit transfer (Iovanna and Griffiths, 2006; Johnston et al., 2005; Mazzotta et al., 2014; Van Houtven et al., 2007). In this paper, we describe the integration of ecological and economic models and present approaches to addressing data limitations. In particular, we present an approach to modeling recreation participation by location through spatial modeling of existing national databases. We illustrate model estimation challenges and approaches to dealing with those challenges by presenting a specific policy application — evaluating potential lost fisheries ecosystem service (ES) values caused by surface coal mining in the Appalachian region of the U.S., focusing on recreational fishing

* Corresponding author.
*E-mail address:* mazzotta.marisa@epa.gov (M. Mazzotta).
[1] Formerly ORISE fellow at U.S. EPA Office of Research and Development.

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values. Section 2 describes the policy context and case study; Section 3 describes our methods; Section 4 presents results of the models and the policy application; and Section 5 contains a discussion and conclusions.

## 2. Policy Context and Case Study Description

Mountaintop coal mining is a surface mining practice involving the removal of mountaintops to expose coal seams, and disposing the associated mining overburden in adjacent valleys, termed "valley fills." Valley fills occur in steep terrain where disposal alternatives are limited. Mountaintop coal mining operations are concentrated in eastern Kentucky, southern West Virginia, southwestern Virginia, southeastern Ohio, and scattered areas in Tennessee (U.S. EPA, 2011) (Fig. 1). Bernhardt and Palmer (2011) note that, to date, about 1.1 million hectares of forest in this region have been converted to surface mines and more than 2000 km of stream channel have been buried beneath mining overburden as a result of these activities.

Several environmental issues are associated with mountaintop mining and valley fills, including forest fragmentation, altered hydrology, degraded water quality, and possible negative impacts on macroinvertebrates, fish, and drinking water (Freund and Petty, 2007; Merriam et al., 2013; Palmer et al., 2010; Petty et al., 2010; U.S. EPA, 2011). As a result, regional policy-makers and environmental managers are interested in quantifying the effects of mining on ecosystem services to support environmental decision making associated with managing mountaintop removal-valley fill (MTR-VF) mining (e.g., permit decisions or remediation requirements) and long-term strategic planning by communities. Because mountaintop mining impacts vary spatially, depending on affected systems and populations, managers can benefit from spatially-explicit analysis of potential economic impacts from scenarios of mining intensity to inform their decisions.

Our study area includes a portion of West Virginia that encompasses most of the area in the state where MTR-VF mining occurs (Fig. 1). The study area includes the watersheds of the Elk, Gauley, Upper Kanawha, Coal, Upper Guyandotte, and Lower Guyandotte Rivers, Tug Fork, and Twelvepole Creek, which drain a total of 20,795 km$^2$. The area is about 80% forested, and the primary developed land uses are coal mining and residential. MTR-VF mining currently accounts for around 3% and residential development accounts for around 6% of the total land area in the study area. We limited our analysis to effects on wadeable streams and large rivers (8.0 km$^2$ to 4354 km$^2$ drainage area) within the mining region, and did not include headwater streams or great rivers.

Recreational fishing is highly relevant to policy discussions, because it is potentially adversely affected by MTR-VF mining and it is a popular activity for Appalachian residents and visitors. In addition, fishing provides a supplemental food source for some food insecure populations in the region (Gorimani and Holben, 1999). However, creel survey data are not collected locally, so little site-specific data exist on the number of anglers, days spent fishing, catch rates, and other angler characteristics (e.g., income, age, avidity) that are relevant to assessing value of recreational fishing changes. The best available data on participation and angler characteristics are from the U.S. Fish and Wildlife Service's (USFWS) National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (FHWAR) (U.S. Fish and Wildlife Service (USFWS), 2011a), which, given sampling density, cannot be robustly disaggregated to spatial scales finer than the state (U.S. Fish and Wildlife Service (USFWS), 2011b).

To examine the influence of surface coal mining on the economic values associated with recreational fishing, we developed integrated ecological and economic models and applied them to the case study area. We first developed and refined ecological models to relate mining

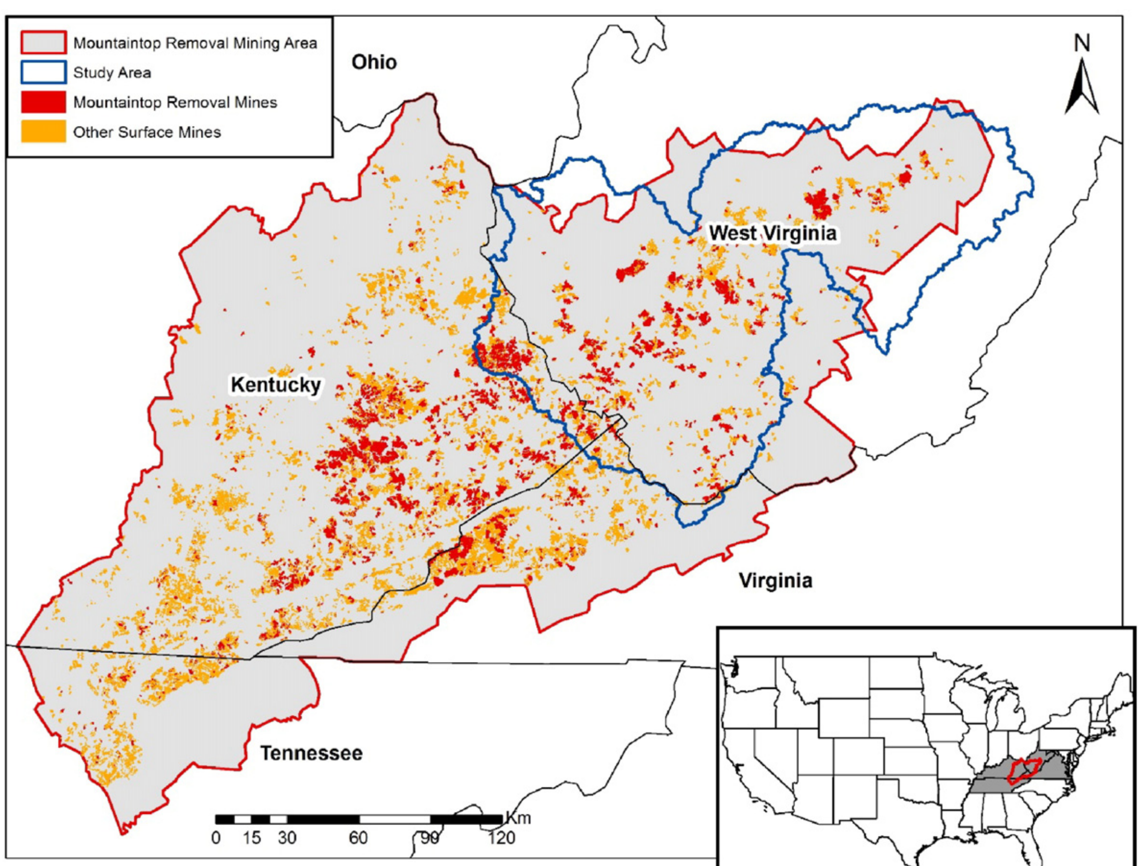


**Fig. 1.** Study area and the encompassing Appalachian mountaintop removal and surface coal mining region (mines were mapped by Skytruth (2009)).