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Valuing urban wetland quality with hedonic price model

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ABSTRACT

Understanding urban resident's preference for different aspects of wetland quality is essential before taking initiatives on wetland protection, restoration and wise management. To examine how a single ecosystem type is valued, and how the different aspects of that ecosystems quality are preferred by households, this paper first used five metrics to measure various aspects of wetland quality and then applied hedonic price model to explore the relationship between wetland quality and property values in Franklin County, Ohio, using the semi-parametric estimation method.

Results suggest that urban residents' preference for wetland size and proximity to the nearest wetland exhibits an inverted U shape, which are robust with various specifications. The results regarding wetland quality indicate that the sign of estimated coefficients for quality of buffers, surrounding land usage, and quality of hydrological activity, and quality of special wetland remains consistent across different specifications. It also implies that urban residents prefer wider upland buffers, green space around the wetland, and historical or protected wetland. The semi-parametric results show that residents tend to favor appropriate human disturbance to wetland hydrology and substrate. This study contributes to the literature by using a series of novel index to measure various aspects of wetland ecosystem services in urban settings, including size of buffers and surrounding land use, quality of hydrological activity, quality of wetland substrate, presence of special wetland, and vegetation, interspersion and microtopography.

1. Introduction

While wetlands were once interpreted as harmful, disgusting places that were unfavored to nearby residents, in recent years, society has recognized the broader set of valuable ecosystem services (like water purification, flood control, and habitat for plenty of species) that they provide to the society (Boyer and Polasky, 2004). Given the changing public perception, it is perhaps not surprising that policies have been established to reduce the loss of wetlands nationally. In Ohio, for example, wetlands formerly totaled approximately 5,000.000 acres in the 1780's but were altered and drained until less than 483,000 acres were left in existence in the 1980's. Today most of the wetlands remaining in Ohio are remnants of much larger ecosystems and have been broken into small, isolated and privately owned tracts which do not benefit from the same protections that larger wetlands connected to navigable waterways enjoy.

Though the policies of "no net loss" (Clean Water Act, 2002) and the Ohio Revised Code sections 6111.02 through sections 6111.029 (Ohio Rev. Code, 1992) helped to slow down the loss of wetlands and in some cases actually encouraged growth in their numbers, they did little to ensure that existing ecosystem services that people value were preserved. Though it is difficult to quantify and monetize the economic value of wetlands due to lack of efficient market for these wetland services, an increasing number of studies have been carried out to value services of wetland ecosystems. The literature varies with valuation methods which include the net factor income method (e.g., Amacher et al., 1989; Schuijt, 2004), the replacement cost method (Gutrich and Hitzhusen, 2004), travel cost method (e.g., Cooper and Loomis, 1993), choice experiment (e.g., Carlsson et al., 2003; Birol et al., 2006). Studies about meta-analyses have also been conducted to assess what factors determine a wetland's value (e.g., Woodward and Wui, 2001; Brouwer et al., 2003; Brander et al., 2006). These studies mainly focus on valuing certain types of wetlands or single service or simple attributes provided by wetlands.

There is also large amount of literature that focuses on the correlation between wetlands and home sale prices (Lupi et al., 1991; Doss and Taff, 1996; Mahan et al., 2000; Earnhart, 2001; Bin and Polasky, 2003; Bin, 2005; Tapsuvan et al., 2009; Fan and Yang,

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2010). These studies in valuing the wetlands using hedonic price model vary with the geographic locations, measurement. However, in terms of the effect of wetland types on house price, there is no consistent agreement on how different ecosystem types may be preferred by home buyers. This research suggests that homeowners are sensitive to the type of wetland and that wetland values likely vary by location, however, the amenities used in most studies are very broad. As well, there is as yet no definitive work on how different aspects of wetland quality may be preferred by home owners. Additional characteristics are likely also to influence value. For instance, several of the studies have used broad classifications such as emergent, scrub-shrub, forested wetland, etc, to indicate something about the current condition of the wetland. These are undoubtedly important measures that may be visible to homeowners, but other characteristics like the quality of the habitat, soil type, etc. also will affect land value. For instance, an emergent wetland may provide habitat for birds, but the benefits homeowners receive will depend on the quality of the habitat. Alternatively, soil quality characteristics may affect the flow of water in the neighborhood of the wetlands, thus having important influences on home value.

To determine the land value impacts of specific aspects of wetland quality, this study employs a hedonic price model and semi-parametric estimation method to estimate the value of urban wetlands to homeowners and determine urban residents' preference for different wetland qualities. This study seeks to provide a more detailed examination of wetland quality using data collected specifically for the purposes of our hedonic estimation. Semi-parametric estimation method is used to explore the relationship between house price and different wetland attributes because it relaxed the traditional assumption of linear structure between dependent variable and independent. To conduct this analysis we couple home sale data in Franklin, Ohio with a newly collected data on the size and quality of urban wetlands to determine how residential homeowners value various aspects of wetlands in urban settings. Being aware of how urban residents value different wetland qualities is of significant importance as it's able to provide some evidence for urban planning policy-makers to lay more emphasis on certain quality protection and improvement of wetlands.

This paper contributes to the literature in two aspects. Firstly, on-site verification and visual inspections were performed to increase the accuracy of the results by eliminating discrepancies in the regression outcomes as there are bound to be errors between actual ecosystems present and those being reported. Most of the previous researches directly used the wetland data from National Wetland Inventory. The problems associated with it might be that what is being identified in the data as a wetland may not be, and that what is being identified as a given type of wetland in the data may actually be a different inundated habitat type. If this is not examined it may lead to mistakes in interpreting residents' preference for wetlands. Secondly, to the best of our knowledge, this is the first study to estimate how different aspects of wetland quality affect land values. A series of novel indices to measure various aspects of wetland ecosystem services has been used, including size of buffers and surrounding land use, quality of hydrological activity, quality of wetland substrate, presence of special wetland, and vegetation, interspersion and microtopography.

2. Measuring wetland quality

2.1. Metrics of wetland quality

To determine the ecological quality and the level of function of a particular wetland, a tool called the Ohio Rapid Assessment Methodology (ORAM) was used to give a proposed jurisdictional wetland a quality rating (Babb, 2012). It's noteworthy that the numeric score obtained from the ORAM is not an absolute number with intrinsic meaning, but allows for relative comparisons between wetlands to be made.[1] For this part, we used five indexes to measure the physical characteristics of a given ecosystem and then assign them a quantifiable score.

The first metric[2] (metric1) concerns the area surrounding the study site and has two categories dealing with upland buffers and land usages. This section can be responsible for up to fourteen percent of the final total. The scoring for buffers ranges from wide to very narrow with wide being the highest scoring level. The category for surrounding land use ranges from very low to high with very low being the highest scoring level. This metric may also correspond with adjacent green space. If a buffer is categorized as very wide or of a high quality this would indicate that there is green space other than the wetlands present at the site and may account for some of the positive preference associated with this metric.

The second metric (metric2) to be considered concerns the hydrology of the site in question. Like the first metric, this category is broken down into smaller sections. Each of these sections – water source, depth, connectivity, hydrological modifications and the duration of the saturation of the site – all receive their own score which in turn is totaled for the score of the metric. This metric can account for up to thirty percent of the entire ORAM score. The most important of these sub-sections concerns the extent to which the hydrology of the site has been changed by human influenced disturbances. The disturbances that affect the quality of the site's hydrology come in the form of manmade channels, ditches and dams that redirect or prevent the natural flow of water into or through a given area. As the number of these disturbances increases then the score of this metric decreases. The ORAM form contains a listing of the possible disturbances that could lower the quality of the site so that the researcher may accurately assess the amount to which the area has been altered.

The third metric (metric3) deals with human caused disturbances and the amount to which the wetland substrate has been altered. This metric contains three sections including development disturbance and alteration and is responsible for up to twenty percent of the total ORAM score. Like the previous section it includes a list of the possible man-made disturbances that could be present at the site including mowing, construction, dredging and farming.

The fourth metric (metric4) concerns the presence of special ecosystems. If a wetland falls into one of the types: bog, fen, old growth forest, mature forested wetland, coastal wetlands and unrestricted hydrology, coastal wetlands and restricted hydrology, lake plains and prairies, relict wet prairies, known occurrence of threatened/endangered species, significant migratory songbird/waterfowl habitat, it will be regarded as a "special" wetland, and its points will be assigned or deducted based on guidance for rating which is shown in Appendix. This section can be responsible for up to ten percent of the total ORAM score. If a wetland scores positive in this category then it is a good indication that it is a rare or unique in the state – and possibly nationwide – and will likely be a higher category score than if the uniqueness of the study area were not considered.

The fifth metric (metric5) of the ORAM deals with plant communities, interspersion and microtopography of a site. It is separated into four questions, each dealing with one of the above characteristics of the research site. This section can comprise up to twenty percent of the total score of the completed ORAM. The first question in this section looks at what plant communities are present at the site being studied. For each habitat present within the delineated boundaries of the wetland there can be assigned a score of zero to three depending on the

[1] Ohio Environmental Protection Agency. Ohio Rapid Assessment Method for Wetlands v. 5.0. 2001. http://www.epa.state.oh.us/portals/35/401/oram50um_s.pdf.

[2] The number of the metrics here is not exactly the same as the number in the rating form shown in Appendix. metric1 here is metric 2 in the Appendix. Metric2 here is metric 3 in the Appendix and etc.