Implicit Prices of Wetland Easements

Steven D. Shultz, North Dakota State University
(sshultz@ndsuext.nodak.edu)
&
Steven J. Taff, University of Minnesota
(sjtaff@umn.edu)

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Abstract

Farmland prices were regressed against sale size, gross production values, surrounding land uses and wetlands, and perpetual wetland easements administered by United States Fish and Wildlife Service. Each additional wet wetland acre reduced average cropland values by $209 or 51% of average local crop land values while each additional wetland easement acre reduces average land values by $234 which corresponds to 57% of local cropland values.

Introduction

The implicit prices of wetlands and wetland easements in North Dakota and other areas of production agriculture that contain with high concentrations of wetlands have been difficult to quantify in spite of the fact that hedonic valuation method (HVM) based multiple regression models have been successfully been used to quantify wetland values in other areas of the country. Particular obstacles have included: limited sample sizes of land sales and the lack of wetland specific data detailing cropping patterns, soil productivity, wetlands, and wetland easements.

This present study attempts to overcome these obstacles by analyzing 236 agricultural land sales between 1995 and 2002 across three contiguous North Dakota counties in conjunction with site-specific land use and soil productivity data (based on satellite imagery and digital soil surveys), detailed wetland information (based on the National Wetland inventory and satellite imagery), and wetland easement locations from the small wetlands acquisition program of U.S. Fish and Wildlife Service (FWS).

It is widely assumed that both wetlands and wetland easements negatively influence agricultural land values due to the forgone agricultural production associated with non-cropped or grazed land as well as the nuisance of having to farm around wetlands. Nevertheless, knowledge of the magnitude of these negative implicit values is considered relevant in order to ensure that governmental agencies charged with the task of preserving wetland habitat in order to benefit society at large, are paying fair-market prices for such wetlands. In fact, currently used FWS wetland easement appraisal procedures and values are based on previous studies that quantified the impact of wetland easements on farmland values in the seventies and eighties (Brown, 1976 and 1984).

Background

Wetlands in North Dakota and the FWS Easement Program

Since the early 1960's landowners in North Dakota and other parts of the Prairie Pothole Region that extends from the upper Midwestern United States into Canada, have been actively participating in numerous wetland easement programs administered by both public and private conservation organizations. This region has been targeted for such programs as it contains some of the highest concentrations of wetlands and waterfowl breeding habitat in the continental United States in conjunction with relatively low land values (Sidle and Harmon, 1987).

One of the largest of these programs is the small wetland acquisition program of the United States Fish and Wildlife Service (FWS), which began in 1958 and is financed through the sale of Migratory Bird Hunting and Conservation Stamps. By 1998 this program had purchased 1.2 million wetland easement acres in Montana, Nebraska, North Dakota, and South Dakota at a cost of $46.7 million (Heimlich et. al., 1998).

A FWS wetland easement is a formal conveyance of certain property rights from the landowner to the federal government. In exchange for a one-time payment, the landowner agrees not to drain, fill, or level pre-defined wetlands. However, certain farming practices that do not damage the integrity of a wetland, such as grazing, hay cutting, and cropping when the wetlands dry naturally, is usually permitted.

The wetland easement enrollment process begins with FWS Realty staff soliciting, or entertaining inquiries from landowners in particular areas where they wish to establish easements. When the FWS and the landowner agree on the desirability of particular wetlands to be placed under easement, an easement payment offer is calculated using a set of pre-established procedures that are based on federal appraisal standards (USFWS, 1993). The first step in the easement valuation process involves quantifying the location, size, type, and tract boundary of easement wetlands. The easement tract boundary must incorporate all of the wetlands to be placed under easement and in most cases is selected to coincide with the public land survey system. The land surrounding easement wetlands is defined as the easement tract. Non-wetlands within an easement tract are not encumbered by the easement and the primary purpose of an easement tract is for the calculation of easement payments and to serve as an administrative and management unit.

A per acre easement tract value is the weighted average of crop, pasture, hay, and marshland values in a tract with values being obtained from analyses of nearby (comparable) land sales. Tract land values are then adjusted (reduced) by procedures specific to the type of wetlands being placed under easement and in particular, the likelihood of a particular wetland being drained and farmed in the future.

Payments for 'conventional' easements on potentially drainable (i.e., temporary or seasonal) wetlands are estimated by multiplying average easement tract land values by a pre-established chart value and the wetland acreage to be placed under easement. Chart values used to reduce tract land values were derived from previous FWS studies of the impact of wetland easements on property values (Brown, 1976), and range from 0.3 to 0.75 depending on specific locations and land values (proportions increase with land values). Payments for 'discounted' easements on difficult to drain (i.e. large and/or deep semi-permanent, permanent, or lacustrine) wetlands are estimated by multiplying wetland easement acreage by the average value of marshland and the same chart values used for non-discounted wetlands. Marshland values are obtained from analyses of comparable sales and are almost always significantly lower than cropland and pastureland values.

Wetland easement payments for individual wetlands within a tract are then summed and offered to a landowner as a lump-sum, non-negotiable easement payment. Easement wetlands cannot be drained leveled or burned and are therefore not available for cropping in most years. However, they can be used for pasture and/or hay production when and if they dry of natural causes (either throughout particular growing seasons or during more extended dry-cycle periods. All other ownership interests and in particular the right to control access to the wetland remains in tact.

Previous Studies of the Implicit Values of Wetland and Easements

While the literature on valuing the components of farmland prices is extensive (Boisvert, Schmitt, and Regmi, 1997 and Barnard, *et al.,* 1997), and while there are numerous articles on the implicit values of wetlands or wetland proximity in urban areas (Doss and Taff, 1996; Mahan, Polasky, and Adams, 2000), there exists limited empirical research that has actually quantified the implicit value wetlands in purely agricultural areas, or the implicit value of wetland easements.

Landowner decision-making with regard to converting wetlands to farmland has been modeled by Claassen et al., (1998) who concluded that estimates of potential wetland conversion were quite sensitive to the profit maximizing behavior of landowners and specifically changes in expected commodity prices. They also noted that the potential agricultural productivity of unconverted wetlands varied significantly which negates the use of average productivity estimates. Similarly, it was proposed that large numbers of landowners would potentially enroll in the Wetland Reserve Program (WRP) if offered one time easement payments that equaled the capitalized net returns from agricultural production in perpetuity plus additional compensation to account for administrative (transaction) costs and/or for disruptions to normal farming operations (Heimlich, 1994).

Parks, et al., (1995) estimate the proportion of eligible land enrolled in the WRP within counties based on a function of opportunity costs, restoration program payments, and both land and landowner characteristics. Landowners were expected to participate when easement payments exceeded the larger of discounted wetland profits and net discounted agricultural profits. From this it was determined that required lump sum payments required for farmers to enroll in the WRP were 80 percent greater than actual amounts paid to program participants.

A framework for modeling land prices as a function of spatial characteristics, asset pricing, and risk was pioneered by Copozza and Sink (1994), and applied to the theoretical valuation of wetland conservation easements by Tegene et al., (1999) who imply that both future returns from agriculture and the potential (uncertain) revenue associated with agricultural to urban land conversions (represented by option values), are critical to the easement valuation process.

The only studies that have attempted to measure the impact of wetland easements on agricultural land prices are those by Brown (1976 and 1984). In the first study the price of 134 unimproved agricultural land sales between 1973 and 1974 in three distinct geographical regions of North and South Dakota were regressed against crop, pasture, wetland, and FWS wetland easement acres. It was discovered that type 4 and 5 wetlands (assumed to be under water for the entire growing season in most years) did not have a statistically significant impact on sale prices in any of the three regions. However, each additional wetland easement acre decreased sale prices in northeastern North Dakota by $167 (60 percent of average land values), had no statistically significant influence in central North Dakota, and decreased sale prices in Northeast South Dakota by $36 (27 percent of average land values) albeit only at the 90% confidence level. Limitations with this study include relatively small sample sizes associated with each study region, the absence of a variable measuring soil productivity, and the fact that wetland acreage was also represented as wetland easement acreage (in cases of wetland easements), which could possibly explain the illogical result of wetland acreage having an insignificant impact on sale prices even when wetland easement acreage had a negative impact on prices.

In a follow-up study, sale prices of agricultural land on a per acre basis were regressed against the percentage of alternative land capability classes and wetland easement acres within 268 sale parcels in eight distinct regions across North and South Dakota and Minnesota (Brown, 1984). Wetland easements which were present within 45% of all the sales were found to have a statistically significant (and negative) impact on land values in only 3 of the 8 regions. In three north central North Dakota counties with 34 sales, each wetland easement acre reduced land values by $950 a value which somewhat illogically exceeds the average value of an acre of cropland in this region. In four Central North Dakota counties with 33 sales, each wetland easement acre reduced land values by $176 (68% of the average value of land in the region). Finally in a single county in east central South Dakota with 44 sales, each wetland easement acre decreased sale values by $239 (70% of the average value of land in the region).

The author noted that multiple regression results were limited due to the small the limited sample sizes and the high degree of multicolinearity among the explanatory variables used to measure proportion of alternative land capability classes associated with the sale. Another limitation that we suspect may have impacted the validity of estimated wetland easement coefficients is the fact that wetland acreage itself is not accounted for in the model meaning that the wetland easement variables is capturing both the impact of wetlands and wetland easements.

Despite the limitations associated with the 1976 and 1984 studies, their results were considered the best available at the time and were subsequently used by the FWS to establish wetland easement valuation procedures (proportional chart values) that are still in effect. Specifically, based on the observed negative impacts of wetland easements on land values, the FWS calculates wetland easement payments to landowners that range between 30 and 90 percent of local farmland values, depending on the location (State) and surrounding land values (with the percentage increasing with land values). In North Dakota the proportions start at 30% for land valued less than $150 and acre and increase proportionally up to 90% for land valued at $800 or more an acre and greater. In contrast, in South Dakota and Minnesota the proportions are 30% for land valued less than $200 and acre.

It is our contention that an empirical evaluation of the impact of both wetlands and wetland easements on land values is warranted due to the various limitations associated with past studies, and to evaluate how these implicit prices of wetlands and easements may have changed in the last 10 years. Our present analyses will therefore incorporate relatively larger sample sizes, sale specific gross agricultural revenues derived from cropping patterns and soil productivity, wetland conditions and land uses surrounding both wetlands and easements. Increased specificity with regards to cropping patterns, soil productivity, wetlands, and wetland easements is made possible through the use of recently available geographic information system (GIS) technology and data.

A Conceptual Model of the Implicit Value of Wetlands and Easements:

A hedonic valuation approach is used to estimate the implicit value of wetlands and wetland easements where the purchase price of agriculture land is specified to be a function of the expected gross returns from agricultural production over time (Palmquist, 1989 and Boisevert et al, 1997). This approach is particularly appropriate for the study area of southeastern North Dakota where land is used almost exclusively for production agriculture and there exist ubiquitous quantities of wetlands. In other words, wetlands within the study area have little intrinsic (non-production) value to purchasers of agricultural land.

In our hedonic model of agricultural land values, it is assumed that gross returns from agriculture based on site specific cropping patterns and crop-specific yields along with local product prices are a sufficient proxy for the variation in net returns across sales in our sample. That is, it is assumed that all agricultural producers within the study area have similar operating expenses and that the primary factor influencing variations in the profitability of agricultural land is variations in soil productivity.

In order to identify the implicit value of wetlands and wetlands easements, in our hedonic model, estimates of gross agricultural returns for land parcels do not include wetland or wetland easement acreage. By representing wetlands and wetland easement acreage as separate explanatory variables in the model it is easier to identify their specific impact on agricultural land values. This also avoids the need for estimating the agricultural productivity of wetlands that may be used for agricultural production in particularly dry years. Such estimates are in fact quite problematic as they depend on temporal levels of precipitation and site-specific hydrologic-soil conditions in conjunction with detailed cropping patterns of producers.

Gross returns from agricultural are expected to have a positive impact on sale prices due to the profit maximizing behavior of agricultural producers purchasing land while wetlands are expected to negatively influence sale prices because they cannot usually be farmed except in unusually dry years and/or without incurring drainage costs. However, wetlands are expected to have at least some value to purchasers of agricultural land as may potentially be used for livestock watering and/or and late-season haying operations. Similarly, temporary wetlands with little or no water throughout the growing season may also be used for cropland production depending on seasonal weather patterns.

Since, both permanent and temporary wetlands have the potential to be drained and hence converted to agricultural land. Therefore quantifying the characteristics of wetlands (whether they are permanent/wet or temporary/dry) as well as the land uses surrounding them (cropland versus haying and pastureland) is critical in determining their implicit value. If wetlands cannot be drained either for technical or legal reasons, their implicit price should be equal to forgone agricultural production. However, if wetlands can be drained, and the resulting land has a productive capacity equal to surrounding land, then their implicit price should be equal to drainage costs.

The implicit price of wetland easements should represent the difference in agricultural production on potentially drained agricultural land (minus drainage costs) and the actual agricultural production allowed within the easement contract (generally only haying under naturally dry conditions or livestock watering). Therefore, the implicit value of permanent wetland easements is likely to be highest when they are associated with shallow and easily drained wetlands surrounded highly productive cropland whereas deep and difficult to drain wetlands surrounded by low valued cropland and/or pastureland. In contrast, easements on temporary (dry) wetland are not expected to have a large negative impact of agricultural sale values. Alternatively the present value of compensatory easement value payment could also be considered as the implicit price of a wetland easement as this income would not be available to subsequent landowners. This however assumes that a buyer values the wetland(s) in question similarly to original owner who entered into the easement agreement.

The general hedonic specification used to quantify the factors influencing the sale price of agricultural land is therefore:

$$P_L = f\,(Z_s, Z_n, Z_e, Z_f)$$

where PL = Sale price of agricultural land on a per acre basis

Z_s = Sale characteristics

Z_p = Productivity measures

Z_w = Wetland characteristics

Z_e = Wetland easement characteristics

Procedures and Data Variables:

Sale prices of land parcels (P_L) are represented on a per acre basis due to the fact that many of the sold parcels were of varied size. Sale characteristics (Z_s) are represented by the reciprocal of the size of the sold parcel (*Size*) and a time trend variable (*Trend*) accounting for the year of the sale (Table 1). Sale size was expected to have a positive impact on sale prices on a per acre basis due to economies of scale. That is, buyers are expected to be able to negotiate more favorable prices when the purchases are particularly large. The time trend variable was also expected to be positively related to sale prices as overall sale prices rose by an average of 3.4% annually during the 7 year study period.

Information regarding sales was collected from county sale (deed) between 1995 and 2001 in three adjacent southeastern North Dakota Counties (Dickey, Ransom and Sargent). These three counties were selected for the study because they contain a mix of alternative agricultural land uses and substantial amounts of wetland and wetland easements. Basic information concerning the location, size, and price of the sales along with the names of buyers and sellers was contained within these records was complimented by information obtained via telephone and/or both and mail surveys of both buyers and sellers. From this, sales were excluded from the study if the transaction: was between family members; included farmstead, irrigation, equipment, buildings or other improvements; or sold for non-agricultural purposes (a few parcels were sold for home sites and/or hunting purposes).

[Table 1 Here]

Productivity (Z_p) is represented by the gross revenue per acre of crop and pastureland within the sale parcel (*Rev/Ac*). This variable was expected to positively influence sale prices as a result of the profit maximizing behavior of agricultural producers. This variable was calculated by multiplying crop and pastures acreage of individual sales by exogenously estimated crop and pasture revenues per acre in the section where the sale occurred. Exogenous section level crop and pasture gross revenues were calculated by multiplying specific crop and rangeland acreage (over 13 different crops) quantified from landsat satellite imagery classifications made by the North Dakota agricultural statistics service (NDASS) with section level crop yield values estimates (from the SSURGO digital soil survey of the Natural Resource Conservation Service) and county and/or statewide crop and livestock prices. The resulting gross revenue estimates are considered to be a strong indicator of the relative productivity of different parcels of land sold.

Wetland characteristics (Z_w) include the percent of wetlands within a sale parcel that that were permanent (wet) versus temporary (dry), and surrounded by crop land versus pastureland. Wetland acreage was estimated by overlaying a digital (GIS) version of national wetland inventory (NWI) with satellite imagery based classifications of standing water throughout the growing season of when the sale took place (NDASS, 1997 to 2001). Permanent wetlands were classified as NWI wetlands wet throughout the growing season while temporary wetlands were NWI wetlands dry for at least part of the growing season. These wetland estimates were also compared to landowner (seller/buyer) estimates of permanent (marshland) acreage within sold parcels. The determination of whether wetlands were surrounded by cropland versus pastureland was made at the same time by quantifying areas of crop and pastureland surrounding the wetlands using GIS based buffering commands.

Permanent wetlands are expected to have a statistically negative impact on sale prices because they are usually to wet to produce a crop. In contrast temporary wetlands are not expected to have a statistically significant impact on sale prices they can usually be cropped or hayed in most growing seasons. In fact, it is suspected that many landowners and most purchasers of land are unaware that these temporary wetlands (identified to us using the NWI) even exist within land parcels. It may also be the case that higher crop productivity is associated with temporary wetlands due to their higher levels of moisture content.

The expected impact of the wetland variables surrounded by pastureland on sale prices were somewhat uncertain: While permanent wetlands surrounding pastureland can often be used to water livestock, if these wetlands are substantial (as many of them were during the wet cycle when these sales took place), they can also reduce available livestock forage. Similarly, in most years temporary wetlands surrounding pastureland can be used for pasture and/or hayland in the middle to late stages of the growing season when they dry naturally. Therefore in most cases these wetlands should be indistinguishable from adjacent pasture acreage.

The percentage of wetland easements within sale parcels (Z_e) were also classified by both wetland condition (permanent versus temporary), and by surrounding land uses (cropland versus pastureland).   This required a GIS-based spatial overlay of USFWS easement tracts, sale parcels, the NWI, and NDASS satellite imagery based water classifications from 1997 to 2001. However, not enough temporary wetland easements surrounded by pastureland existed for this variable to be included in the model.

All three wetland easement variables (*PermEaseCrop* , *TempEaseCrop and EasePast*) were expected to negatively impact sale prices due to both the forgone agricultural production associated them and due to the fact that new buyers would not be able to receive compensation for enrolling these wetlands in easement programs. Permanent wetland easements surrounded by cropland were expected to have a larger impact on sale prices than both temporary wetlands surrounded by cropland which can often be farmed. Since there were so few temporary easements surrounded by pastureland, a single variable was used to represent all easements surrounded by pastureland (EasePast). Since these wetlands can often be used as important water sources for livestock and/or gazed and hayed when they dry of natural causes it was expected that the magnitude of this coefficient would be smaller than those of the cropland easement variables.

Finally, it should be noted that wetlands and wetland easements were not double counted. That is, wetland acreage that was also under easement was not considered as both wetland acreage and easement acreage but rather only as wetland easement acreage. For example a parcel with 10 acres of wetlands of which 4 acres were under easement, was considered to have 6 wetland acres and 4 acres of wetland easements.

The marginal effects of the explanatory variables representing wetlands and wetland easements as represented by the estimated coefficients of the wetland and easement variables will be compared to those from previous studies and to land values within the study area

Results:

Summary Statistics:

Summary statistics associated with the 236 usable agricultural land sales from 1995 to 2001 in Ransom and Sargent County are summarized in Table 2. Land sales were most frequent in Sargent county (94), followed by Ransom (77) and Dickey (65). The average sale price was $407/acre with non-easement sale values selling for approximately 4% less than parcels with wetland easements ($411/acre versus $395/acre) in spite of the fact that wetland percentages are similar across easement/non-easement land, and that crop and pasture land within easement sale parcels generated higher gross revenues per acre ($106/acre/year) than surrounding crop/pastureland in non-easement parcels ($103/acre/year). This limited bivariate analysis provides a preliminary indication that wetland easements negatively influence sale values. **[Table 2 Here]**

Average sale prices increased from $386 per acre in 1995 to $464 per acre in 2001 (a cumulative increase 20% or 3% annually). Estimates of cropland values NASS landowner surveys with landowners indicate that prices between 1995 and 2001 increased 21% in these counties, or alternatively 3.4% annually indicating that the sales within our study sample are consistent with other in the region.

The average size of sold parcels was 197 acres and does not differ much among parcels with and without easements. The proportion of sold land devoted to cropland (71%) and pastureland (16%) remains consistent across easement and non-easement sales. However, it was not uncommon for some sold parcels to be comprised entirely of pastureland, particularly in Dickey County. Non-easement land had on average fewer permanent wetlands than easement land (10% versus 13% respectively) and more land enrolled in the CRP program (3% versus 1% respectively).

Permanent wetlands with water in them throughout most of the growing season were more common than temporary (dry) wetlands, especially among easement sales. From the perspective of acreage across the entire sample of sales, cropland was more common than pastureland. Alternatively, 167 sales (71% of the total) had were dominated by cropland (i.e. were comprised of 90% or more cropland) whereas only 25 sales (11%) were dominated by pastureland. The remaining 44 sales (19%) were a mixture of crop and pastureland. Cropland sale prices averaged $453/acre while pasture sales averaged $234/acre and mixed sales averaged $326/acre

Easement acreage occurred within 62 sale parcels (26% of all sales) and made up 15% of total acreage. Easements are more common on permanent versus temporary wetlands and cropland is the dominant land use surrounding permanent wetland easements and practically the only land use surrounding temporary wetland easements.

Multivariate Regression Results:

The results of the multivariate regression model to quantify the factors influencing the sale price of 236 parcels across three counties in southeastern North Dakota are summarized in Table 3. The model has an R^2 value of 0.60 and a computed F-statistic of 33.3 indicating that all of the explanatory variables considered jointly have a statistically significant influence on sale prices at the 99% confidence level. No serious cases of multicolinearity among the explanatory variables were detected. **[Table 3 Here]**

Somewhat unexpectedly, the size of sales (*Size*) did not have a statistically significant impact on per acre sale prices using either linear or non-linear functional forms. The insignificance of the size variable is likely due to the fact that there were few very large or very small sales (greater than 640 acres or smaller than 40 acres) in the study sample. As expected, the year of sale (*TimeTrend*) had a statistically significant and positive impact on sale prices at the 99% confidence level. Each additional year from 1995 to 2002 increases average sale values by $9.6 an acre. Also as expected, annual gross revenues per acre of crop and pastureland (*RevAc*) had a statistically significant positive impact on sale prices: Each additional $1 increase in gross revenues per acre increases average sale prices by $3.2.

As hypothesized, the variable representing permanent wetlands surrounded by cropland (*PmtWetCrop*) had as statistically significant negative impact on sale prices at the 99% confidence level. Each 1% increase in permanent wetland acreage surrounded by cropland increases sale prices by $2.09. Alternatively, each additional acre of this wetland type decreases average sale prices by $209/acre. Since average sale prices for cropland in the study area are $456/acre, this corresponds to a 46% price reduction. If average (crop and pasture) land values within the study area are considered ($406/acre), this corresponds to a 51% price reduction.

The variable for temporary wetlands surrounded by cropland (*TempWetCrop*) had a relatively small but statistically significant impact on sale prices at the 95% confidence level ($82/acre for every additional wetland acre). It was expected that these wetlands would not have a statistically significant impact on sale prices because they can be cropped or hayed in most growing seasons. It is suspected that the positive relationship between these temporary wetlands and sale prices is due to the fact that most land purchasers do not know these temporary wetlands exist and possibly that crop productivity associated with these wetlands is higher than productivity of nearby land due to their potentially higher levels of moisture content.

Neither of the variables representing permanent/temporary wetland surrounded by pastureland (*PmtWetPast and TempWetPast*) had a statistically insignificant impact on sale prices. With permanent wetlands this was somewhat expected due to two offsetting factors: the benefits of using wetlands for livestock watering sources versus the opportunity costs of loss of forage acreage. The statistical insignificance of temporary wetlands was also expected as temporary wetlands surrounding pastureland are for the most part indistinguishable from adjacent pasture land.

As hypothesized, the variable representing easements on permanent wetlands surrounded by cropland (*PmtEaseCrop*) had as statistically significant negative impact on sale prices at the 95% confidence level. Each additional acre of this wetland type will decrease average sale prices by $234/acre which is 58% lower than average sale prices on a per acre basis. This means that purchasers of agricultural land place an additional 6% discount on permanent wetlands surrounded by cropland when they are under easement. Alternatively 52% of the price depreciation can be attributed to the wetlands themselves resulting from foregone agricultural production, while 6% can be attributed to the easements as a result of forgone easement payments.

In contrast, the variable representing easements on temporary wetlands surrounded by cropland (*TempEaseCrop*) did not have a statistically significant impact on sale prices. It was originally hypothesized that such easements would have a statistically significant and negative impact on sale values because these temporary and usually shallow wetlands are relatively easily drained and/or farmed in most years and hence easements on them should result a relatively high opportunity costs associated with forgone agricultural production. This unexpected result may be a result of the fact the purchasers of land are unaware that easements on these temporary wetlands exist. It may also be the case that these easement wetlands are being farmed by landowners as they have dried naturally over time. Further investigations into this phenomena (how these temporary wetland easements surrounded by cropland are actually being utilized) through the use using satellite imagery and/or field visits is probably warranted. In future surveys with land buyers, it may also be useful to question them regarding their knowledge of the existence of easements on both permanent and temporary wetlands.

Finally, the variable representing easements on wetlands surrounded by pastureland (*EasePast*) had a statistically significant and negative impact on sale prices at the 99% confidence level. Again this variable combines both permanent and temporary wetlands although almost all of these wetlands are permanent. Each additional acre of wetland easements surrounding pastureland reduces average sale prices by $384. It was hypothesized that this variable would have a negative impact on sale values but the magnitude of the impact is somewhat surprising: It is 94% of the value of average sale prices on a per acre basis. This large implicit price is troubling because non-easements surrounding pastureland had an insignificant impact on sale prices. As well, the implicit prices for easements surrounding pastureland are 63% greater than the implicit price for easements on permanent wetlands surrounding cropland even though cropland easements are clearly associated with forgone agricultural income while the easements surrounding pastureland have the potential to allow the watering livestock or haying/grazing when these wetlands dry naturally. This illogical result (an exaggerated implicit price for easements surrounding pastureland) may be result of the fact that there were not a lot of wetland easements surrounding pastureland in the study sample (only around 1% of all sold acreage was associated with these easement types). Further investigation into the specific conditions associated with the particular sales associated and wetland-pasture easements is probably warranted as is the replication of this study across other North Dakota counties.

In summary, the implicit values of wetland and easements are quantifiable using a hedonic modeling approach and these values vary with the type of wetland/easement being evaluated. In some cases the implicit wetland and easement values appear to be closely related to the levels of forgone agricultural production associated with wetlands and easements. Exceptions were however noted in two cases: temporary easements surrounding cropland not having an impact on sale prices, and easements surrounding pastureland having large implicit prices that even exceeded the implicit prices of easements surrounding cropland.

Conclusions:

This study has demonstrated that the marginal implicit prices associated with wetland and wetland easements are quantifiable using a hedonic based multiple regression approach and that in most cases that these implicit prices are consistent with economic theory. That is, it has been empirically shown that the implicit values of wetlands and wetland easements generally increase with expected levels of forgone agricultural production associated with wetlands and easements. However, two exceptions were noted with regards to temporary easements surrounded cropland and permanent and temporary easements (combined) surrounded by pastureland. It is recommended that further research be conducted to investigate these two anomalies: a determination as to whether buyers of agricultural land are aware of the existence of temporary wetland easements surrounding cropland, and an assessment of how easements surrounding pastureland are actually used by producers.

This study also demonstrated that the quality and reliability of implicit value estimates of wetlands and easements depend on the classification of wetland conditions and the specification of surrounding land uses. It is therefore recommended future hedonic modeling of wetlands and easements, as well easement appraisal procedures of the FWS (and other agencies) fully account for variations in wetland conditions and surrounding land uses. Fortunately the quantification of wetland conditions and surrounding land uses, is now greatly facilitated (even across large areas) with the advancement of GIS technologies and spatially related data sources such as the NWI, digital soil surveys, annual satellite imagery based land use data, and easement locations.

A caveat to this research is that the regression model did not account for the potential for wetlands to be drained which has an obvious impact on the opportunity cost and income generating potential of wetlands. In general, temporary wetlands are more easily drained than permanent wetlands, yet within permanent wetlands there is likely to be range of wetland characteristics and drainage potential. In fact, FWS easement appraisal valuation formulas account for the potential drainage of wetlands. That is, easier to drain wetlands are given higher easement values than difficult to drain wetlands.

The satellite imagery approach utilized in this study only noted whether or not surface water existed within a wetland throughout the growing season. No attempt was made to estimate the depth and hence the drainage potential of wetlands. The FWS has recorded wetland drainage potential associated with recent easement contracts (in the last 10 years) but unfortunately such information is missing from older easement contracts. Future research should attempt to estimate drainage potential of wetlands and wetland easements either through field surveys or through the use of more advanced remote sensing procedures. In the meantime it is recommended that hedonic regression modeling intended to estimate the implicit prices of wetlands and wetland easements take advantage of currently available GIS based data and quantify the condition of wetlands/easements as well as their surrounding land uses.

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Table 1: A Summary of Explanatory Variables

Variable	Description	Hypothesized Impact
Size	Size of Sale (Acres)	+
TimeTrend	Year of Sale: 1995-2001	+
RevAc	Gross Revenue ($/Ac)	+
PmtWetCrop	Permanent wetlands surrounded by crops (%)	-
PmtWetPast	Permanent wetlands surrounded by pasture (%)	?
TempWetCrop	Temporary wetlands surrounded by crops (%)	-
TempWetPast	Temporary wetlands surrounded by pasture (%)	?
PmtEaseCrop	Permanent easements surrounded by crops (%)	-
EasePast	Easements surrounded by pasture (%) (primarily permanent wetlands)	-

Table 2: Summary Statistics of Land Sales in the Tri-County County Study Area

	All Sales (n=236)		Non-Easement Sales (n = 174)		Easement Sales (n = 62)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Price ($/Ac)	406.78	127.64	411.11	126.53	394.60	130.97
Size (Ac's)	196.68	120.87	197.03	122.22	195.69	117.98
Gross Revenue ($/Ac)	104.19	29.17	103.44	28.61	106.29	30.85
Cropland (%)	0.71	0.34	0.71	0.34	0.70	0.33
Pastureland (%)	0.16	0.30	0.16	0.30	0.15	0.29
CRP (%)	0.03	0.16	0.04	0.17	0.01	0.11
All Wetlands (%)	0.15	0.16	0.14	0.18	0.16	0.08
Permanent Wetlands (%)	0.10	0.11	0.08	0.11	0.13	0.09
Temporary Wetlands (%)	0.05	0.13	0.06	0.15	0.03	0.03
Pmt. Wetlands in Crop (%)	0.08	0.10	0.07	0.11	0.10	0.08
Pmt. Wetlands in Pasture (%)	0.02	0.06	0.02	0.05	0.04	0.08
Temp. Wetlands in Crop (%)	0.04	0.13	0.04	0.15	0.03	0.03
Temp. Wetlands in Pasture (%)	0.01	0.05	0.02	0.05	0.00	0.01
Easements (%)	0.04	0.07			0.15	0.08
Wet (Pmt.) Easements (%)	0.03	0.07			0.12	0.08
Temporary Easements (%)	0.01	0.02			0.03	0.03
Easements in Crops (%)	0.03	0.06			0.11	0.08
Easements in Pasture (%)	0.01	0.04			0.04	0.08
Perm. Easements in Crops (%)	0.02	0.05			0.08	0.08
Perm. Easements in Pasture (%)	0.01	0.04			0.03	0.08
Temp. Easements in Crop (%)	0.01	0.02			0.02	0.03
Temp. Easements in Pasture	0.00	0.01			0.00	0.01

Table 3: Regression Results: The Benchmark Model

	Coefficient	Std. Error	T-statistic	P
Benchmark Model (R^2 = 0.60)				
Size	0.006875	0.045741	0.15	0.881
TimeTrend	9.461601	2.676252	3.535	0
RevAc	3.223444	0.221078	14.581	0
PmtWetCrop	-208.76	59.53319	-3.507	0.001
TempWetCrop	82.21695	42.56373	1.932	0.055
PmtWetPast	-33.8915	153.6451	-0.221	0.826
TempWetPast	-86.7635	136.4842	-0.636	0.526
PmtEaseCrop	-234.156	112.3497	-2.084	0.038
TempEaseCrop	-130.975	338.2704	-0.387	0.699
EasePast	-383.631	131.8942	-2.909	0.004
Constant	50.51954	30.54746	1.654	0.1

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