Comments on "Economic Analysis for the Proposed Definition of 'Waters of the United States' – Recodification of Pre-existing Rules"

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September 27, 2017

Introduction

Two years ago, the U.S. Environmental Protection Agency and U.S. Department of the Army (EPA-Army 2015) estimated that the total quantified benefits of the Clean Water Rule (CWR) range from a low of $339 million to $350 million (2014 dollars). The largest component of these benefits was due to wetland mitigation, which was estimated at $306 million (using the "original number of ORM2 other waters records" scenario). EPA-Army (2015) concluded that the benefits of the CWR exceed the costs.

The EPA and Army (2017) now state that the "largest and most uncertain estimates from the[ir] 2015 CWR … [economic analysis] are associated with the benefits of the CWA 404 program." The agencies argue that the wetland mitigation benefits are uncertain for several reasons. In response to this uncertainty the agencies choose to dismiss the monetized benefits presented in their 2015 analysis, instead presenting them as qualitative benefits in EPA-Army (2017). They justify this decision by stating that they "believe the cumulative uncertainty in this context is too large to include quantitative estimates in the main analysis for this proposed rule" (page 9). In the low (high) end scenario (Tables 1 and 2 on page 10 in EPA-Army (2017)) the $314 million (2016 dollars) in wetland mitigation benefits from EPA-Army (2015) are replaced by "$B".

Any conclusion that the benefits of the CWR are less than the costs is not supported by the current analysis. The EPA's conclusion that the benefits are less than the cost is baseless.

There is no need for the agencies to resort to qualitative analysis of the wetland mitigation benefits. A review of the pre-2000 studies now dismissed by the agencies indicates that many of the concerns being raised by EPA-Army (2017) are not justified. Many of the studies used in EPA-Army (2015) conducted a scope test and other validity tests. Lessons from the temporal reliability literature suggest that environmental values produced in those types of studies are fairly stable over long periods of time. Further, meta-analyses of the broader wetland valuation literature suggest that there are systematic (i.e., explainable) differences in values over studies and over time. That is, studies conducted in the past can be adjusted to account for methodological advances using insights from meta-analyses of the valuation literature, resulting in updated valid results.

In addition, there have been more recent wetland valuation studies that have appeared in the literature. We have identified several additional valuation studies published since 2000. These studies suggest that the wetland mitigation benefits estimated by the agencies in their original economic analysis (EPA-Army 2015) were accurately measured.

Finally, the agencies have taken two contrasting positions with regard to the uncertainty of wetland mitigation benefits. In EPA-Army (2015), the agencies used only the point estimate

without sensitivity analysis around this estimate, ignoring the uncertainty. In EPA-Army (2017), the agencies again choose to avoid sensitivity analysis but this time they move to an extreme and avoid quantitative measurement of the benefits. Using sensitivity analysis as an appropriate strategy for addressing uncertainty is discussed below.

Considering these issues, the agencies' decision to consider only qualitative wetland mitigation benefits appears to be an illogical overreaction to a normal level of uncertainty in the conduct of standard benefit-cost analysis of environmental policy. Even if the agencies now feel justified in only presenting qualitative wetland mitigation benefits, there is no evidence that these benefits would be so small as to reverse the sign on the net benefits calculation (i.e., positive net cost savings on page 20 in EPA-Army (2017)). The only way to justify a negative net benefit calculation would be to conduct the appropriate sensitivity analysis, as discussed below, and show that negative net benefits are more likely than positive net benefits, which was not done.

Review of the pre-2000 Studies that were dismissed by the EPA

In its original analysis, EPA-Army (2015) relied on studies that are referred to as contingent valuation (CVM) or "willingness to pay" studies. Economists conduct such studies by asking randomly selected individuals within a geographic area to place a value on preserving part of the environment, in this case wetlands, under different conditions. Since it would not have been feasible to conduct a nationwide CVM study concerning the valuation of wetlands, the agencies used a statistical approach called "benefit transfer" to estimate wetland mitigation benefits based on existing studies.

Benefit transfer is a valuation method used for environmental estimation when it is not feasible to conduct a new study because time or money constraints are prohibitive (Johnston et al. 2015). Benefit transfer involves a literature review of available studies that summarizes economic values for a similar policy scenario and this summary is transferred to the study area. In this case EPA-Army (2015) relied on existing wetlands benefit studies to determine what the benefits of wetland mitigation would be nationwide. They identified 10 studies that provided 22 wetland benefit estimates. The agencies divided the estimates into forested wetlands (4 studies, 13 value estimates) and emergent wetlands (6 studies, 9 value estimates) and found the geometric means of the 13 and 9 value estimates. The agencies used these point estimates (single dollar value/acre) from the existing studies to develop an overall point estimate for wetland mitigation benefits nationwide in their benefit analysis.

In their new analysis (2017), the agencies justify their choice to not present monetized benefits because of the age of the CVM studies, which were all conducted before 2000, prior to advances in the CVM. For example, EPA-Army (2017) criticizes the early studies for not conducting validity tests, in particular a scope test. However, several of these studies did conduct a scope test. In addition, several conducted other important validity tests. Another concern now expressed by the agencies is the stability of these values over time (i.e., temporal reliability), but the contingent valuation literature has found that, in general, environmental values are stable over time. In addition, the effects of changes in environmental attitudes or other factors can be evaluated and quantified. We address each of these issues below. We then consider the wetlands

CVM literature more broadly and find that there are models that estimate systematic differences in wetland values across study period and study methods. These more recent studies reveal that systematic differences can be used to develop more accurate wetland mitigation benefits for the CWR.

Scope Test

One criticism made by the agencies (2017) when assessing the pre-2000 studies is that they did not conduct the scope test. The scope test is a validity test where the researcher varies the quantity or quality of the environmental attribute at issue. Economic theory suggests that the benefit should increase (or at least not decrease) as quantity or quality increases. The scope test is important for two reasons. First, the test can generate insights about the accuracy of estimated benefits. Accuracy is a function of validity and reliability, and the scope test is one of several "internal" validity tests that often, though not always, are conducted. An internal validity test considers whether estimated values vary logically with other variables that should cause it to vary. For example, if an environmental policy increases the quantity or quality of an environmental endpoint (e.g., protected wetlands acres) then the benefit of that protection should increase. Similarly, if the individual cost of that protection increases to a survey respondent then a survey respondent should be less likely to be in favor of that protection.

The agencies' claim that none of the 10 studies cited in their original analysis conducted a scope test is verifiably false. Six of the studies conduct a scope test and five of the studies pass the test. Blomquist and Whitehead (1998) find that wetland benefits increase with the quality of the wetland as measured by the wetland type attributes described in the survey. Dillman et al. (1993) also find differences in economic value across wetland type. Lant and Tobin (1989) conduct a scope test but the samples are too small to draw any conclusions. Loomis et al. (1991) find that wetland benefits are greater for a program that maintains current wetlands and protects additional wetlands relative to a program that only maintains current wetlands. More explicit tests with these same data can be found in Hanemann et al. (1991) and Hoehn and Loomis (1993). Mullarky and Bishop (1999) and Whitehead and Blomquist (1991) conduct scope tests by informing one group of respondents that wetlands reclamation will lead to lower damages relative to a no reclamation scenario. Both of these studies pass the scope test.

Other Validity Tests

The scope test is one of several internal validity tests that are routinely conducted in the CVM literature (see Whitehead and Haab (2013) for a description of internal and other validity tests). Another validity test is one that assesses whether respondents are responsive to the cost of the program. Six of the 10 studies used in the agencies' original analysis find that survey responses are sensitive to the cost of the wetlands protection program (e.g., Azevedo et al. 2000, Blomquist and Whitehead, 1998, Dillman et al., 1993, Loomis et al. 1991, Mullarky and Bishop 1999, Whitehead and Blomquist 1991).

In addition, Azevedo et al. (2000) conduct a divergent validity test. A divergent validity test considers whether different wetland protection programs would yield different values. Azevedo et al. (2000) finds that this is the case.

Temporal Reliability

The agencies justify their new choice to not present monetized benefits for wetlands because of the age of the CVM studies, all conducted before 2000. According to the agencies, "public attitudes toward nature protection could have changed" since the studies were conducted. To address that concern, the agencies should have conducted additional analyses rather than deleting the wetland mitigation benefits, particularly because any change in public attitudes would be unlikely to result in net benefits of the CWR becoming a net cost.

There is an economic valuation literature considering this issue, known as "temporal reliability." A temporal reliability test involves conducting more than one CVM survey, with time between surveys. The time periods considered have been one month, one year, five years and more. If the magnitude of willingness to pay is consistent across time, then willingness to pay is considered temporally reliable. However, a temporal difference in willingness to pay does not necessarily indicate unreliable results. If willingness to pay changes predictably over time in response to changing factors that affect willingness to pay then the researcher may conclude that the CVM is reliable.

A number of studies have investigated, using identical surveys and samples of respondents, whether an environmental benefit estimate changes over long time periods. The current conclusion from this literature is that environmental benefit estimates are temporally reliable, in that values are stable across time or vary in expected ways—i.e. that with a known change in public attitudes, values can be adjusted (Carson et al. 1997, Whitehead and Hoban 1999, Loureiro and Loomis 2017). In light of that conclusion, an unsupported claim of changed public attitudes is not a sufficient justification to warrant replacing monetized benefits with qualitative benefits ($B). Instead, if there is potential that changing attitudes about wetlands or income changes would lead to different values from 2000, which the agencies have not demonstrated, then this change should be dealt with explicitly in the benefit transfer exercise using methods established in the literature.

Accounting for Advances Since 2000

The agencies (2017) are correct in their statement that there has been much progress made in valuation methods since 2000. The wetlands valuation literature has moved in two important directions. First, the contingent valuation method has moved in the direction of increasing the degree of accuracy of estimated values by addressing the incentives that survey respondents face. For example, the current state of the art is to ask a closed-ended referendum question with a coercive payment vehicle (e.g., a tax) (Carson and Groves 2007, 2011).

Second, surveys that respondents think have a realistic chance of affecting policy are considered "consequential" (Carson and Groves 2007). Consequential surveys are thought to more accurately measure true benefits because respondents have an incentive to answer truthfully if their responses might affect policy. There is a small literature assessing how consequentiality affects benefit estimates (Vossler and Watson 2013, Groothuis et al. 2017). The early evidence suggests that consequentiality increases benefit estimates. This suggests that if similar studies were conducted today the benefit estimates would be larger than obtained in pre-2000 studies

(e.g., Blomquist and Whitehead 1998, which uses a voluntary contribution payment vehicle). This suggests that there is uncertainty in the wetland mitigation benefit estimates, but that the estimates used by the agencies undervalue wetlands. More consequential benefit studies would strengthen the conclusion that the net benefits of the CWR are positive.

Another advance since the early contingent valuation literature is a recognition that hypothetical bias affects estimates. Hypothetical bias results when values revealed in actual transactions are lower than values revealed in hypothetical settings. Murphy et al. (2015) find that hypothetical valuations may be 1.35 times larger than real valuations. Several hypothetical bias mitigation approaches have emerged (Loomis 2011). A number of studies find that hypothetical values adjusted downward for hypothetical bias yield values similar to those revealed in real settings (Blumenschein et al. 2008).

However, the studies where hypothetical bias has been detected are focused on goods traded in laboratory or simulated markets that do not exhibit consequentiality (Carson and Groves 2007). Vossler and Watson (2013) find that hypothetical and actual referendum votes with a coercive payment vehicle (property tax) yield similar values for respondents who believe the hypothetical votes are consequential. Carson, Groves and List (2011) find similar results for a laboratory experiment with real and consequential hypothetical transactions.

Although there have been many advances in the non-market valuation literature, these advances do not invalidate the older literature. Results from the newer literature allow for an understanding of how the older wetlands valuation literature could be adjusted to more accurately reflect values in the current time period, as is explained below.

More Recent Wetland Valuation Studies

The agencies (2017) state that the "agencies attempted to find more recent studies" and that "more recent wetland studies were not available" (page 8). My review of the literature does not reveal any recent contingent valuation wetland studies that fit the geographic criterion described by EPA-Army (2015) for the CWR. While there have not been many recent contingent valuation studies this is not because of a lack of attention paid to this issue by economists. The paucity of studies is more a function of the direction that the "stated preference" literature has taken in the past 15 years. Contingent valuation is one approach to eliciting preferences from survey respondents. Stated preference questions have more recently taken the form of "discrete choice experiments" (Carson and Louviere 2011). Adamowicz (2004) predicted the movement towards choice experiments and empirical analysis of the factors affecting this movement can be found in Crastes et al. (2014) and Mahieu et al. (2014). Although the form has changed, the substance of the two approaches is similar.

Discrete choice experiments involve asking respondents for hypothetical votes or other choices with varying attributes over the alternatives. For example, respondents could be presented with wetland protection programs that vary the quantity and quality of wetland protected, along with the cost. Respondents would then choose from among several of these "packages" or the status quo. Discrete choice experiments may differ from contingent valuation in the number of attributes among the alternatives, the number of alternatives or the layout of the choice questions

in mail or online surveys. However, the most basic format of the choice experiment question is equivalent to contingent valuation (Carson and Czajkowski 2014). Given that wetlands provide multiple ecological functions, discrete choice experiments are a better option than basic contingent valuation (Carlsson et al. 2003).

A number of choice experiments have estimated the value of coastal wetland protection in the United States. For example, Milon and Scrogin (2006) estimate the value of restoration of the Florida Everglades. Petrolia et al. (2014) estimate the value of protection of Louisiana coastal wetlands. Both of these studies are able to provide estimates for various wetland functions (e.g., provision of water quality and species abundance).

Newell and Swallow (2013) conduct a choice experiment with real payments for farmland, woodland and residential wetlands in northern Rhode Island. As part of the study, participants were asked to make actual payments to an organization carrying out wetland mitigation. Economists consider valuation studies with real payments (or real votes) to be more accurate than hypothetical payments as in stated preference studies. They find that wetland mitigation benefit is $0.75 per acre for 10 year protection. Newell and Swallow compare their estimates to the contingent valuation studies summarized by Brouwer et al. (1999) for each type of wetland they consider. They conclude that their values may be lower than those summarized in Brouwer et al. (1999). Their comparison provides a means of adjusting the EPA wetland mitigation benefits for state of the art valuation methods.

Rather than dismiss the EPA-Army (2015) wetlands benefit valuation, EPA-Army (2017) should have broadened their concept of contingent valuation to consider discrete choice experiments that include wetlands as one attribute or that value wetland attributes in order to include more recent studies in their quantification of the CWR benefits.

Inadequate Treatment of Uncertainty

Uncertainty is inherent in any economic analysis. Statistical uncertainty is captured in confidence intervals that result from the statistical properties of the central tendency of a benefit estimate (i.e., variance around the mean). Other types of uncertainty result in a range of values that bound the central tendency of benefits from above and below. The agencies, by only presenting a point estimate of the central tendency of wetland mitigation benefits in EPA-Army (2015), did not handle their estimation of benefits correctly. But that is not a rationale for abandoning the EPA-Army (2015) quantitative benefit estimation of wetland mitigation benefits, as EPA-Army (2017) has done.

Instead, the agencies should address the uncertainty using standard, textbook methods and available meta-analyses. Two relatively straightforward standard approaches to implement are best/worst case analysis and breakeven analysis. In order to conduct both types of uncertainty analysis the agencies should develop a range of benefit estimates.

Meta-Analyses

Researchers have conducted meta-analyses of wetland benefit studies (Brouwer et al. 1999, Woodward and Wiu 2001, Brander et al. 2006, Brander et al. 2013). A meta-analysis is a

statistical summary of an empirical literature. Instead of computing the geometric mean of a few wetland benefit studies as in EPA-Army (2015), a conditional mean function is estimated statistically. In the conditional mean function the mean wetland value depends on wetland characteristics, location, and methods used in the various studies.

The meta-analyses described below analyzed a greater number of wetlands valuation studies than were examined by EPA-Army (2015), which allows greater statistical reliability. For example, each of the wetland benefit meta-analyses studies described below find that the average wetland benefit per acre increases at a decreasing rate with the total wetland acreage (although with the particular functional form used, the effect diminishes with the size of the wetland valued). This indicates that the body of literature represented by these studies passes the scope test, lending validity.

Some of these analyses focused on CVM, others used different approaches. All of the meta-analyses demonstrated that wetlands valuations could be determined. The agencies could have, and should have, evaluated these meta-analyses before dismissing wetland mitigation benefits as too uncertain.

Brouwer et al. (1990) assess the contingent valuation method literature by reviewing contingent valuation studies. In a regression model with 92 observations of wetland values from 30 studies, the authors find that an income tax payment vehicle produces estimates 158% larger than other payment vehicles. Open-ended questions produce value estimates that are 38% lower than other types of value elicitation questions. Studies conducted in North America produce value estimates that are 162% higher than elsewhere. Studies where flood control and water quality are affected by wetlands protection yield higher values.

Woodward and Wui (2001) review 39 studies that generate wetland value estimates. Instead of focusing on contingent valuation like Brouwer et al. (1990), Woodward and Wui consider contingent valuation and several other valuation methods. Woodward and Wui also assess the quality of the valuation study and whether it was published in a peer-reviewed journal. They find that these factors do not affect the average values, only the variance. Comparing coastal to freshwater wetlands, the authors find no difference. Comparing across valuation method, the authors conclude that contingent valuation produces conservative value estimates.

Brander et al. (2006) include tropical wetland valuation studies in their meta-analysis. Similar to Woodward and Wui (2001) they include contingent valuation and other valuation methods. Brander et al. use 215 wetland valuation estimates from 80 studies in their statistical analysis. They find that wetland value increases with GDP per capita and the relevant population, lending validity to the valuation literature. They find that freshwater marsh wetland types produce lower values and woodland wetlands produce higher wetland values, relative to other wetland types.

Brander et al. (2013) conduct a meta-analysis with international wetland valuation studies through 2005. Brander et al. (2013) use their meta-analysis to estimate the benefit of “wetland regulating services in agricultural landscapes” in the United States. They employ 38 studies and 66 wetland valuation estimates. Their statistical model finds that the water supply function yields lower values, relative to other wetland functions. Overall, surrounding wetland abundance lowers

wetland values suggesting that wetland valuation studies are able to capture the effect of substitutes.

Results from these studies show that the variation in wetland benefits across primary study are systematic and vary in a way consistent with economic theory. The wetlands valuation literature is large and robust enough for use in benefit-cost analysis with the appropriate sensitivity analyses to address the uncertainty inherent in the exercise. Rather than dismissing the wetland mitigation benefits as uncertain, the agencies should have used one or more of these meta-analyses to develop alternative estimates for use in sensitivity analysis.

Meta-analysis has been used to develop benefit estimates for other environmental policies (Johnston et al. 2015). For example, in a study funded by the EPA, Van Houtven, Powers, and Pattanayak (2007) developed a meta-analysis model to estimate benefits of the Clean Water Act (Griffiths et al. 2012).

The agencies' original analysis (2015) used a point estimate of a summary of benefit estimates from several studies to provide benefit estimates for the CWR. In effect, the agencies (2015) conducted a benefit estimate ("unit") transfer. More rigorous benefit transfer can involve the transfer of benefit functions from a case study to a policy site. Benefit function transfer allows benefit estimates to be adjusted for differences in socioeconomic characteristics and other factors from the case study to the policy site. Since there are a large number of policy sites in the CWR, benefit function transfer is not feasible. Moeltner and Woodward (2009) provide an application of meta-analysis for benefit estimation using, coincidentally, 6 of the 10 wetland valuation studies included in EPA-Army (2015).

As suggested above, it is possible to obtain estimates of the direction and magnitude of the factors that have led to improvements in contingent valuation and stated preference methods over time with meta-analysis. For example, the earlier wetland valuation studies were less likely to use an income tax payment vehicle and more likely to use an open-ended valuation elicitation question. Both of these factors would increase wetland mitigation values if the same studies were implemented today. With an estimate of the direction and magnitude of the effect of methodological progress it is possible to produce (a) a more refined point estimate and (b) upper and lower ends of the likely range of the benefit estimates for the CWR. The agencies could approximate the effect of changes in methodology by incorporating the results from available meta-analyses.

Using the meta-analyses would give a likely range of wetland mitigation values, making it possible to use two approaches to evaluate uncertainty. Given a likely range of wetland mitigation values the best/worst case analysis would compare the high end of the cost estimates with the low end of the benefits range and the low end of the costs with the high end of the benefits. If the wetland mitigation sensitivity analysis is incorporated in the benefit-cost analysis and if the net benefits of the CWR are still positive then there is more confidence that the implementation of the CWR would improve social welfare. If the net benefits of the CWR are negative, then there is less confidence. Alternatively, a breakeven analysis would incrementally adopt assumptions and adjustments that make the benefit estimates lower until the net benefits

are zero (i.e., benefits = costs). At this point the decision maker would make a judgement about the likelihood of these cumulative adjustments in terms of social welfare.

Conclusion

In their new analysis, the agencies have justified rejection of monetized wetland mitigation benefit estimates due to the "cumulative uncertainty" generated by the age of the reviewed studies. Based on an analysis of the literature I conclude that this justification is not supported by the wetlands valuation literature. There are a number of reasons to believe that the wetland mitigation valuation estimates produced by the agencies' original study (2015) are accurate within a reasonable range. My review of the literature has identified factors that could increase and decrease the wetland mitigation estimates used by EPA-Army (2015). But regardless of whether the valuation figures are in fact higher or lower than the EPA-Army (2015) benefit figures, my evaluation leads me to conclude that there are significant benefits associated with wetlands.

The agencies decision to use qualitative benefits in their new analysis is a rejection of the standard practice of benefit-cost analysis when confronted with uncertainty. The agencies' analysis should consider wetlands valuation literature and best/worst case and breakeven sensitivity analysis. The benefit analysis should only default to consideration of qualitative wetland mitigation benefits as in EPA-Army (2017) only if this sensitivity analysis results in a very wide range of likely estimates of the wetland mitigation benefits provided by the CWR.

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