Economic Concepts and Methods

The following discussion of economic concepts and methods is designed to accompany the tutorial for the Water Research Foundation source water protection benefit-cost analysis tool. Sections are included in this methods document on defining the baseline, discounting and discount rates, sources of values for economic analyses including the benefits-transfer method, tables summarizing values from the published economics literature, and a listing of references.

Defining the Baseline

The baseline for analyzing a project is an important, but not always easy to grasp, concept. The baseline shows the expected view of the future if the source water protection project being considered was not undertaken. This is the alternate action that would be undertaken to accomplish the same goal as the source water protection project. For instance, the goal might be to reduce or eliminate a certain contaminant in a public water supply. If the if source water protection project is not undertaken and the system needs to expand conventional water treatment, then the expanded treatment is part of the baseline for the source water protection project.

The baseline is a key concept not only because it helps define the problem being addressed, but also because it can define expenditures that would have been needed in the future without the proposed project, and those avoided expenditures can be important benefits for the proposed source water protection project.

If no action is anticipated to accomplish the same goal as the proposed project, then it is appropriate for the baseline to be defined as the “status quo” or “do nothing” alternative to a source water protection project being considered. In this case, the impacts of the current situation projected in the future should be defined, and avoiding those impacts via the source water protection project can be counted as benefits.

Defining the baseline often is not an easy task. Often the utility has not already considered the project or action that it would undertake if not for the proposed project, much less defined that baseline clearly. Also, different stakeholders may have different views about the size or nature of the problem, and may even argue whether the problem exists. For all these reasons, the baseline should be defined with care, and in concert with public discourse.

Discounting and Discount Rates

Benefits and costs from water projects often occur as a stream of values over time. Capital costs are typically incurred during the earliest years of a project lifetime, and are recorded in the years they are expended, while operations and maintenance costs are typically recorded annually after construction has finished and project operation begins, until the end of the useful life of the project. Benefits may accrue after construction has been completed, and often continue over the useful life of the project.

Thus some type of benefit or cost value continues over the useful life of the project. Values that occur in different time periods need to be adjusted to their comparable "present values" to be able to sum values from different years, and compare values between projects. A present value is a sum of values into the future that have been discounted so that they are all counted in today's dollars.

There are two interrelated factors to consider when comparing values from different times – inflation and the "time value of money." When inflation is accounted for in recording or projecting values over time, the values are said to be in "nominal" terms. Many financial analyses are conducted in nominal dollars. However, for economic analyses, benefits and costs are normally *not* entered in dollars that include the general expected rate of inflation. The use of "real" or constant (i.e., not inflation-adjusted) dollars makes analyses easier and keeps inflation-related projections from clouding the analysis. In real dollars, a dollar today has the same purchasing power as a dollar 10 years from now. Real analysis only allows inflated dollars if the inflation for that benefit or cost is expected to be larger than the general rate of inflation. If a cost or benefit is expected to grow at the general rate of inflation, then the same amount is entered in each year (i.e. if 100 dollars is expected to grow annually at the rate of inflation, in real analysis 100 dollars is entered in every year into the future).

The second factor to consider is that most prefer to have a real (inflation adjusted) dollar today instead of a real dollar in the future because they prefer to use that dollar to consume today or they prefer to invest that dollar today to yield a return. This preference for near-term consumption over deferred consumption is referred to as the "time value of money." This rate of time preference is the real (i.e., inflation free), net of tax, and risk free rate of interest that would need to be paid to a person to entice them to consider delayed receipt of a real dollar.

The annual rate at which present values are preferred to deferred values is known as the discount rate. The greater the preference for immediate benefits (time preference), or the greater expected rate of return on other investments today (known as the opportunity cost of capital), the greater the discount rate. The discount rate can be expressed in nominal or real terms. A real discount rate is the nominal discount rate with the inflation rate subtracted out. The key is to use a real discount rate when analyzing dollars in real terms, and a nominal discount rate when analyzing values in nominal terms.

For benefit-cost analyses (BCAs) of source water protection projects, which are generally investments made for broad public benefit, the investment is often being made by the utility, and the utility's cost of capital is often the appropriate discount rate to use. This might be reflected by the real cost of capital that municipal agencies must pay on capital raised through selling bonds. In this case, the private cost of capital observed in markets is the appropriate basis for use in making public project decisions, thus reflecting the social rate of time preference. If inflation is expected to be 3% in the future, and the cost of capital observed in the market is 5.5%, then the real discount rate would roughly be 2.5% (roughly the 5.5% nominal cost of capital minus 3% general inflation rate[1]). If the utility is not able to obtain bonds to fund all of its desired projects, then the appropriate interest rate is higher.

There are philosophical and practical aspects to the choice of discount rate, and there is not always general agreement among economists or policymakers about the correct discount rate to apply to reflect the social rate of time preference – a social rate of discount to adjust for distortions in private rates of discount. An argument for a discount rate lower than the cost of capital is that discounting distorts project benefits that may occur far into the future and thus affect future generations, or that include irreversible outcomes (e.g., species extinctions). This potential distortion is especially likely for project lifetimes greater than 40 years. For project lifetimes less than 40 years, private rates of discount (such as the utility's cost of capital) can more comfortably be used to evaluate public projects (Griffin, 2006).

Various governmental agencies provide guidance on choice of a discount rate, and in some instances a particular discount rate has been specified for use with a type of project. The federal Office of Management and Budget (OMB) regularly updates discount rates in Appendix C to its Circular Number A-94 on *Guidelines and Discount Rates for Cost Benefit Analyses of Federal Programs* (OMB, 1992). OMB recommends using real interest rates on Treasury notes and bonds matched to the project time period for the real discount rate. The real interest rate on a 20-

[1] A more precise calculation of the real discount rate can be made using the formula $d = (r-i)/(1+i)$, where d = real discount rate, i = expected inflation rate, and r = nominal discount rate. Setting the nominal discount rate equal to the cost of capital of 5.5%, and expecting an inflation rate of 3% results in $(0.055-0.03)/(1+0.03) = 0.024272$, or roughly 2.5%.

year and 30-year notes as of January 2008 was 2.8%. OMB also mandates that federal agencies apply a 7% real rate of discount when evaluating the costs and benefits of federal regulatory actions (U.S. EPA, 2000), although other rates often are used in sensitivity analyses (and a 3% real rate is typically used by U.S. EPA to reflect the social rate of time preference). Finally, federal water resource agencies also are directed to use specific rates to evaluate water project alternatives by the Federal Code of Regulations, Plan Formulation and Procedures (for federal fiscal year 2010, the general planning rate is 4.375%).

No matter what discount rate is chosen for analyzing a project, a sensitivity analysis should be performed to explore the effect of discount rates higher and lower than the rate chosen. This involves systematically changing the discount rate to see the effect on the net present value of the project from different discount rate assumptions. For instance, if the initial real discount rate used for analysis is 3%, a sensitivity analysis could be performed shows the net benefits of the project at discount rates ranging from 0% up to 6% or beyond, and record those values in a simple table. Use the Control Panel for a project option, Step 9 in the tool which is the benefit-cost summary for a project option, to change the discount rate and see the effect on net monetized benefits.

To compare streams of value over time from different projects, the stream of values for each project is discounted to “present value” using the discount rate. If both benefits and costs are involved, the present value of the costs is subtracted from the present value of the benefits to get the net present value (NPV) of the project. If the NPV of a project is greater than zero, then the present value of the benefits is greater than the present value of the costs. The NPV of different projects can be compared if they are adjusted to be in the same year’s dollars. Comparison of NPV of projects allows apples-to-apples comparisons of project values regardless of possible differences in the timing of benefits and costs for each project.

To enter monetary values into the tool, the user needs to be aware of the year the cost or benefit estimate was created. If the estimate was made from 1990 onward, it can be entered into the tool along with that corresponding “Dollar Year” (for example the estimate was made in 2006, so the Dollar Year to be entered is 2006), and the tool will automatically use the consumer price index to update values to 2008 dollars.

Sources of Value

Market Prices

Prices that can be observed for goods or services are the preferred and most direct source of information to use in a cost-benefit analysis. For instance, market prices typically are used for the direct costs of the project, such as the capital or operating costs for a project. However, for an economic assessment of benefits and costs of a project, many of the important outcomes pertain to “nonmarket” goods and services. This means that there are no market prices to observe for many key outcomes (e.g., for a day enjoying an outing in a wetland, or fishing on flow-enhanced streams). Thus, nonmarket valuation approaches are required for many benefits and costs.

Similarly, avoided costs are an important source of benefit values. These benefits accrue from reducing or eliminating expenditures that would have been required if not for the source water protection project. A common avoided cost from source water protection projects is the cost of expanded or upgraded treatment that can be avoided due to source water protection efforts.

However, there are potential issues to be alert to when using avoided costs as a proxy for benefits values. Avoided costs can be used as measures of benefits when they would actually be incurred in the absence of the source water protection project. If it cannot be reasonably stated that those costs would actually have been incurred under the baseline project that would have been undertaken if not for the source water protection project, then those avoided costs should not be used.

Non-Market Valuation

When valuing benefits when there is not a market, monetary values need to be derived using various well established methods developed by economists for “nonmarket valuation.” These nonmarket valuation approaches can help develop dollar estimates for some important types of source water project benefits.

There are primary and secondary non-market valuation methods. Primary methods usually involve conducting a study with original research. There are two main types of non-market valuation methods, known as stated preference methods, and revealed preference methods.

Stated preference methods involve surveying those who may enjoy the benefit to be valued, and include contingent valuation and conjoint analysis. Two common stated preference methods are the contingent valuation method and the conjoint/stated choice method. The contingent valuation asks the respondent to give their willingness-to-pay for the resource in questions. This method can value not only direct use values, but also nonuse (e.g., existence and bequest) values for natural and environmental resources. The conjoint/stated choice method asks for a ranking of choices instead of an answer to one willingness-to-pay question, and can also be applied to derive estimates of either use or nonuse values.

Revealed preference methods are based on observing individuals’ behavior and associated voluntary choices to spend money for a benefit in order to infer the value of a nonmarket good or service. While there may not be active markets to buy and sell days of outdoor recreation, there are often costs that individuals incur to undertake direct use activities. For these types of uses, often we can use the record of costs incurred to develop proxy “prices” for the activity, and use that information in developing the demand curve, and thus value, of water-related services. This approach uses observations on people's behavior, or their associated expenditures, as indications of "revealed preferences" for the good. Methods have been developed, and are discussed below, that use these revealed preferences to develop estimates of the value of non-marketed goods and services including many water uses.

Revealed preference methods include travel cost and hedonic modeling. The travel cost method asks resource users to estimate travel expenditures they made to in order to trace out a demand curve for recreational use of natural and environmental resource site. Willingness to pay for use of the site can then be estimated from the demand curve. The hedonic pricing method uses a statistical approach estimate the relative contribution of different attributes of the resource to its value. It can be used to value a wide variety of factors that influence observed prices, and is often used to infer the value of environmental goods.

Benefits Transfer

Some of the drawbacks of the various primary research methods are given in Table 1. The biggest drawback is that the often high cost and time required in performing original research means that primary research is usually not an option for assessing source water protection projects.

Table 1: Primary economic valuation methods for nonmarket goods and services, comparative advantages and disadvantages

Travel cost	
+	Uses observed behavior
-	Measures use values only, often expensive and time-intensive to collect adequate data
Hedonic pricing	
+	Uses observed housing, property, or labor market behavior to infer values for the non-market value in question
-	Measures use values only, requires extensive market data, assumes market prices capture the non-market good's value
Contingent valuation	
+	Only method that can estimate nonuse values, also can estimate use values
-	Time-intensive and expensive to implement, challenges in framing survey questions to elicit valid responses, potential response biases
Conjoint/stated choice	
+	Similar to contingent valuation, except respondents are surveyed about a set of choices instead of a single willingness-to-pay question
-	Time-intensive and expensive to implement, challenges in framing survey questions to elicit valid responses, potential response biases

A second-best, but practical way of valuing benefits it to use a method known as benefits-transfer (BT). The BT approach involves taking the results of existing valuation studies and transferring them to another context, such as a different geographic area or policy context. Under suitable circumstances (as described below), estimates for use or nonuse values may be derived by using BT to apply an annual willingness-to-pay estimate from the literature to the site being evaluated for the source water protection project. This is often done by taking a value per unit from the literature, and applying that value to the units at the site being transferred to. For instance, a willingness-to-pay value per household can be transferred to a new site by applying that value per household from the literature to the number of households at the new site.

The advantages of using BT include time and financial savings, as conducting original research can be time consuming and expensive. However, the disadvantages of using BT include decreased accuracy as compared to primary research specifically tailored to the issue and site at hand, and the potential difficulty in obtaining relevant, high-quality existing studies.

One such challenge in the BT approach is defining the appropriate "market" for the impacted site (e.g., what are the boundaries for defining how many households are assigned a BT-based value, such as dollars per year to preserve wetland habitat?). Another challenge arises due to the frequent need to attribute a BT estimate for a large outcome (e.g., avoiding a species extinction in a state) to the fractional contribution to the whole from the proposed project being valued (e.g., the marginal additional protection for the endangered species provided by a source water protection project in a single location).

Well-developed literature is available to guide those applying BT in the choice and use of appropriate studies (e.g., Desvousges et al., 1992), and the key steps are described below. When implemented correctly, the BT approach is accepted as a suitable nonmarket estimation method for estimating the use and nonuse benefits of changes in the level or quality of environmental resources, especially when used cautiously and transparently, and with a recognition that the estimates are not intended to be precise. And, including a well-prepared benefit transfer is much better than not including non-market economic values in the economic analysis, partially because including them helps make sure those values are not overlooked (Loomis, 2009). However, primary research is broadly considered a far better alternative, when time and resources allow.

When conducting BT, one should make certain that each of the following steps is carefully done (as stated in U.S. EPA, 2000):

- Describe and carefully consider the issue (including characteristics and consequences) and the population impacted (e.g., will impacts be felt by the general population or by specific subsets of individuals such as users of a particular recreation site?).

- Identify existing, relevant studies through a literature search.

- Review available studies for quality and applicability. The quality of the study estimates will determine the quality of the BT. Assessing studies for applicability involves determining whether available studies are comparable to the issue at hand. Below are several guidelines for evaluating usefulness of a particular study for BT for a particular situation (based on guidance provided in U.S. EPA, 2000):

  - The technical quality of the study should be assessed. The original studies must be based on adequate data, sound economic and scientific methods, and correct empirical techniques.

  - The expected changes in site conditions should be similar in magnitude and type in the project being appraised and on those projects from which the data are obtained.

  - If possible, studies that analyze locations and populations similar to those of the project being evaluated should be used.

  - The cultural differences between project location and the source of data should be carefully considered.

- Transfer the benefits estimates. This step involves the actual transfer of benefits over the affected population to compute an overall benefits estimate. The transfer may simply involve applying a user day value as derived from the primary study, or a more complex transfer of the benefits function derived empirically by the original researchers or from a meta analysis of multiple studies.

- Address uncertainty. Because BT involves judgments and assumptions, the researcher should clearly describe all judgments and assumptions and their potential impact on final estimates, as well as any other sources of uncertainty inherent in the analysis.

A review of some of the more accessible literature on non-market values is provided through this tool, and are listed in the following section.

Some suggested methods for utilizing these tables are listed here, including picking a value from the table because the transfer site is very similar to the policy site, using an “average value transfer” of relevant studies, or utilizing a range of values from the literature. These approaches are outlined below.

Average-Value Transfer

The following method is adapted from Rosenberger and Loomis (2001) as cited in Loomis (2009). The concept is to use the average value from the relevant set of studies as the transfer measure from the literature to the policy site. The primary steps to performing an average-value transfer include identifying and quantifying the management- or policy-induced changes in the variable being analyzed (i.e. user-days of recreation, or acres of wetlands), and locating and transferring a dollar per unit value average consumer surplus measure for that variable. Specific steps to take in performing this transfer are [adapted from Rosenberger and Loomis (2001)]:

1. Identify the resources affected by a proposed action.
2. Translate resource impacts to changes in variable being studied.
3. Estimate changes in this variable.
4. Search the tables provided for relevant study sites.
5. Assess relevance and applicability of study site data.
6. Calculate an average of a subset of applicable study values.
7. Multiply benefit value by total change in the variable being studied.

A variation on the average value transfer is enter the a range of per-unit values for the resource in question. This benefit-cost tool is designed to allow the user to enter either one value or a range of values. If entering a range of values, the user can pick a low-end and high end value and enter these on the monetization page.

Tables Summarizing Values from Published Economics Literature

Drinking water quality

Summary of willingness to pay (WTP) estimates for drinking water quality improvements

WTP/averting expenditure (updated to 2008 dollars[a])	Description	Source	Study type
$5.65 per person, per month	This is the amount Georgia residents spent to avoid risks associated with poor water quality. Annual estimates were $57 per person, per year for bottled water and $10 per person, per year for filtration.	Abrahams et al. (2000)	Revealed preference
$2.78 increase in monthly averting expenditures per household	This is the average monthly increase (over a 21-month contamination period) in averting expenditures per household in Perkasie, Pennsylvania, that undertook averting actions to avoid effects of TCE contamination. Total WTP was estimated at $106,460 to $228,040.	Abdalla et al. (1992)	Revealed preference
$16.11–$19.46 per household, per month	This study estimated the amount Georgia households would be willing to pay to reduce the risk of increasing nitrates in drinking water supplied by public systems.	Jordan and Elnagheeb (1993)	Stated preference
$65.38–$87.17 per household, per month	This is the amount residents in four regions of western and mid-western United States would pay for a hypothetical water filter system that would reduce nitrates in drinking water. Aggregate WTP was estimated at $508 million.	Crutchfield et al. (1997)	Stated preference
$12.44–$12.73 per household, per month	This study found that Nebraska residents would be willing to pay this amount to reduce nitrates and all other contaminants, respectively.	Sukharomana and Supalla (1998)	Stated preference
$3.57–$6.72 per household, per month	This is the amount residents in a nine-county region of southwestern Minnesota would be willing to pay to reduce copper contamination in their drinking water ($42.96–$80.61 per household, per year). Total aggregate WTP was estimated at $2.3–$3.4 million per year.	Kim and Cho (2002)	Stated preference
$4.93–$10.18 per household, per month	This is the amount residents in Ontario, Canada, were willing to pay for improved water quality in the Grand River watershed for protection of drinking water.	Brox et al. (2003)	Stated preference

a. Estimates reported in each study were updated to average 2008 values based on the year the survey was administered unless the study-indicated values were reported for a specific year.

Water Supply Reliability – Stated Preference

Summary table of willingness-to-pay (WTP) results from stated preference studies (2008 USD$)

Annual WTP/household	Shortfall amount	Frequency	Probability	Source
$158	10% to 15 %	1 in 5 years	20%	Carson and Mitchell (1987)
$290	10% to 15 %	2 in 5 years	10%	Carson and Mitchell (1987)
$168	20%	1 in 30 years	3.3%	CUWA (1994)
$218	30% to 35%	1 in 5 years	20%	Carson and Mitchell (1987)
$493	30% to 35%	2 in 5 years	10%	Carson and Mitchell (1987)
$296	50%	1 in 10 years	5%	CUWA (1994)
$128	na	na	na	Griffin and Mjelde (2000)
$147	na	na	na	Griffin and Mjelde (2000)
$94[c]	0.16% to 9.2%[b]	na	na	Howe and Smith (1994)[a]
$108[e]	0.23% to 12.2%[d]	na	na	Howe and Smith (1994)
$232[f]	na	na	na	Hensher et. al. (2006)
$54[g]	na	na	na	Tapsuwan et. al. (2007)

na = not applicable; WTP = willingness-to-pay; WTA = willingness to accept.
Shortfall amount = the percent of water available compared to the amount fully demanded
Frequency = frequency with which a shortfall condition may occur (e.g., 1 in 10 years)
Probability = probability of a shortfall event
a. Howe and Smith (1994) also estimated WTA values for decreases in reliability. Annual WTA results per household for approximately a 0.7% to 11% decrease in reliability, depending on the city, ranged from $80 to $195. Annual WTA results for approximately a 1.7% to 40% decrease in reliability, depending on the city, ranged from $95 to $281.
b. This percentage range does not represent the magnitude of the shortfall, as is the case in the other studies. This range represents increased probability over the base probabilities of the standard annual shortage event (SASE). The actual percentage increase is dependent on the city. The associated dollar values are the annual WTP per respondent for an increase over their current reliability. If “no” respondents for this increased probability range are included into the data set (respondents’ WTP = $0), the WTP range is from $19/year to $33/year per respondent.
c. Value represents the average of the WTP range given in the study ($82 to $106 per year).
d. See table note c above. If “no” respondents for this increased probability range are included into the data set, the WTP range is from $15/year to $29/year per respondent.
e. Value represents the average of the WTP range given in the study ($75 to $140 per year).
f. This is the average amount that householders are willing to pay to move from a situation with continuous restrictions at stage 3 or above all year every year, to a situation with virtually no chance of restrictions.
g. This is the annual amount householders are willing to pay for the option of moving from 1 day to 3 days of sprinkler use

Water Supply Reliability – Revealed Preference

Water supply reliability values inferred from revealed preference studies (2008 USD$)

Value ($/acre-foot)	Basis	Source
$60 to $270	Loss in value per AF due to a price induced reduction in water consumption of 25%	Fisher et al. (1995)
$210 to $299	The value (AF/year) of drought proofing based on drought penalties and rate increases for customer	2002 Recycled Water Task Force (2002)
$387	The difference in cost of local groundwater supplies versus the Metropolitan Water District of Southern California non-interruptible rate	NRC (1997)
$70	The rate per AF that MWD credits local water retailers to store imported water in local reservoir to increase reliability of imported supplies	Varga (1991)
$130	The rate per AF that MWD credits local water retailers to seasonally store imported water to increase capacity and yield of imported water system	Varga (1991)
$413	The benefit per AF of conjunctive use storage to ensure greater reliability	Thomas and Rodrigo (1996)
$3,901 to $27,330	Total PV losses associated with a 17% (cumulative through 2010) and 47% (cumulative through 2050) reduction in supply in Metropolitan Atlanta.	Wade and Roach (2003)

AF = acre-foot, which is 325,851 gallons; MWD = Metropolitan Water District of Southern California
PV = present value

Groundwater

Examples values of willingness-to-pay (WTP) for improved groundwater quality

Value (2008 USD)	Description	Source
$1.00-$3.09 per 1,000 gallons	Scarcity present values of groundwater in Hawaii, which may reflect values of recharging groundwater sources.[a]	Moncur and Pollock, 1988
$52-$1,041 per household, per year	Values for ensuring uncontaminated groundwater supplies for the future.	Low: Powell et al., 1994 High: Henglen et al., 1992
$83-$1,710 annually per household	This meta-analysis (of eight studies) examined household WTP for restoration of contaminated groundwater.	Boyle et al., 1994
$3.10-$3.92 annually per household	Passive use values for restoration of contaminated groundwater in Montana (adjusted from total use values of $4.17-$6.92).	Schulze et al., 1993
$75 annually per household	Value reflecting what Ohio residents were willing to pay for increased protection of groundwater.	De Zoysa, 1995

a. For most natural resources, the existence of scarcity and the extent of the scarcity rent can be determined. That portion of the resource price in excess of extraction costs signals scarcity and defines the value of the resource in situ (Moncur and Pollock, 1988).

Wetlands

Examples of values of wetlands

Value (2008 USD)	Description	Source
$14,183 per wetland acre	Using a discount rate of 3%, this study estimated that present values per wetland acre are: commercial fishery = $846; trapping = $401; recreation = $181; storm protection = $7,549; total of these values = $8,977/acre ($1983).	Costanza et al., 1989
$75 annually per household	This study examined what Ohio residents were willing to pay for increased protection of wetlands of the Maumee River and Western Lake Erie basins in Ohio.	De Zoysa, 1995
$10 to $39 per household per year	This study estimated WTP for wetland preservation benefits in western Kentucky.	Dalecki et al., 1993
$1,405 per acre per year for 30 years ($385,092 per acre over 15 years)	This study estimated economic benefits of wetlands for wastewater treatment use, in terms of savings over conventional wastewater treatment methods.	Breaux et al., 1995
$8 and $27 annually per household	This study estimated WTP for preserving the Clear Creek wetland in western Kentucky.	Whitehead and Bloomquist, 1991
$170-$2,714 per acre lump sum	Values reflect the range of restoring wetlands from croplands, by estimating easement costs, restoration costs, and the present discounted value of perpetual crop production.	Heimlich, 1994
$107 to $166 annually per respondent	Values reflect what respondents are willing to pay for protection of wetlands in New England.	Stevens et al. (1995)
$57 annually per household	This study is a meta-analysis of 30 studies. The largest mean WTP by wetland function was in terms of flood control ($85), with the smallest for water generation ($20).	Brouwer et al., 1997
$664 to $11,994 per acre for residents of the drainage basin, and from $9,554 to $81,158 across residents of the state of Michigan.	The study estimated wetland benefits for Saginaw Bay, Michigan.	Cangelosi et al., 2001
$5-$1,895 per acre annually	The predicted values per acre of single-service wetlands range from $5 for presence of amenities to $1,895 for presence of birdwatching opportunities, with most services having predicted values in the $312-$624 range.	Woodward and Wui, 2001

Per Acre Wetland Values

Per acre annual values of wetland services

Service	Mean value per acre[a] (2008 USD)
Flood mitigation	615
Quality	653
Quantity	199
Recreational fishing	558
Commercial fishing	1,217
Bird hunting	109
Bird watching	1,895
Amenity	5
Habitat	615
Stormwater treatment	653

a The predicted values are obtained at the means of year and acre variables. It must be emphasized that the values do not represent marginal values and cannot be summed to obtain the value of multiple function wetlands.

Source: Woodward and Wui, 2001.

Aquatic Threatened or Endangered Species

Examples of willingness-to-pay (WTP) values for aquatic threatened or endangered species

Value (2008 USD)	Description	Source
$8.23 per household	This study found an average state-wide bid of $6.88 (2002 USD) per household to preserve the striped shiner, a state-listed endangered minnow with no direct use value in Wisconsin (the striped shiner is state listed as an endangered species, but not listed federally).	Boyle and Bishop (1987)
$12.25 annually per taxpayer[a]	This study found that taxpayers would be willing to pay an average of $10.24 (2002 USD) annually to preserve the federally-listed endangered Colorado squawfish in New Mexico.	Cummings et al. (1994)
$45-$127 (average of $80) annually per household	This meta-analysis examined WTP values for protection of Pacific salmon/steelhead.	Loomis and White (1986)
$10-$11 (average of $10) annually per household	This meta-analysis examined WTP values for protection of Atlantic salmon.	Loomis and White (1986)
$11.09 annually per household	This study estimated WTP for protecting instream flows specifically for the silvery minnow on the middle Rio Grande and to protect minimum instream flows on all major New Mexico rivers to protect 11 total listed fish species.	Barrens et al. (1996)

a. More than one taxpayer may reside per household.

Recreation

Consumer values per person per day for selected recreational activities, U.S. and U.S. regions (2008 dollars)

Recreation activity	All U.S. studies	N	Inter-mountain, Mean	N	North-east, Mean	N	Pacific Coast, Mean	N	South-east, Mean	N	Alaska, Mean	N	Multiple Region, Mean	N
Backpacking	59.38	6	-	-	-	-	59.38	6	-	-	-	-	-	-
Birdwatching	33.74	8	-	-	39.73	3	-	-	30.16	5	-	-	-	-
Camping	42.39	48	39.57	21	37.74	10	118.94	4	29.39	11	-	-	13.47	2
Cross-country skiing	35.77	12	34.06	7	39.44	3	55.14	1	-	-	-	-	17.32	1
Fishing	53.75	177	56.50	48	37.16	69	50.56	15	90.28	27	70.65	4	54.17	14
Floatboating/rafting/canoeing	115.01	81	77.16	22	100.66	6	31.73	4	145.28	47	20.70	1	38.76	1
General recreation	40.01	39	55.23	12	19.23	5	36.87	9	48.75	9	16.91	1	4.56	3
Hiking	35.15	68	43.92	7	85.69	3	26.49	49	68.82	7	17.69	1	28.54	1
Hunting	53.48	277	55.34	109	54.08	87	51.85	18	40.30	44	74.86	7	70.31	12
Motorboating	52.74	32	61.18	7	33.83	3	30.71	8	67.16	13	-	-	39.16	1
Mountain biking	84.09	32	210.27	6	46.65	1	56.62	16	56.56	8	-	-	24.08	1
Off-road vehicle driving	26.12	10	26.00	7	-	-	46.01	1	5.97	1	-	-	27.27	1
Picnicking	47.25	13	32.22	5	21.46	1	73.20	3	41.74	2	-	-	21.46	1
Swimming	48.65	26	33.67	1	25.31	7	31.10	4	69.43	13	-	-	26.85	1
Waterskiing	55.87	4	64.92	2	17.24	1	-	-	-	-	-	-	76.36	1
Wildlife viewing	48.28	240	42.45	61	35.67	65	82.61	23	45.70	54	56.22	8	64.24	29

Source: Loomis, John. 2005. Updated outdoor recreation use values on national forests and other public lands. Gen. Tech. Rep. PNW-GTR-658. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station 26 p.

N = Number of studies

<u>Regions</u>

Intermountain: AZ, CO, ID, KS, MT, ND, NE, NM, SD, UT, WY

Pacific Coast: CA, OR, WA, HI

Southeast: AL, AR, FL, GA, KY, LA, MS, NC, OK, SC, TN, TX, VA

Northeast: CT, DC, DE, IA, IL, IN, MA, MD, ME, MI, MO, MN, NJ, NH, NY, OH, PA, RI, VT, WI, WV

It is important to note that all “unit” benefit measures provided in this table are consumer surplus per activity-day per person. Therefore, when translating resource impacts into recreation use changes, these impacts should be expressed in activity days.

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