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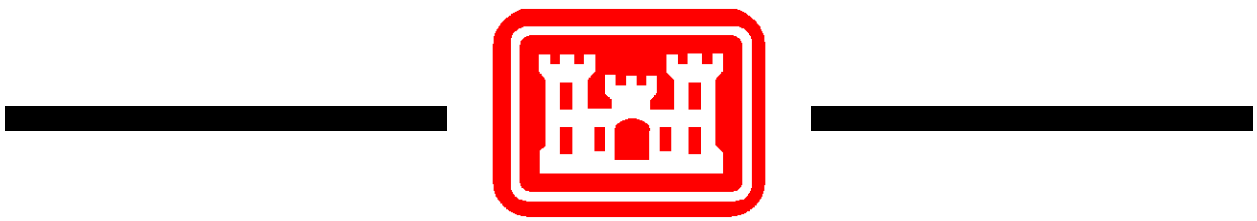
VALUATION ASSESSMENT OF ECOSYSTEMS



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VALUATION ASSESSMENT OF ECOSYSTEMS

1. Purpose.

a. This Public Works Technical Bulletin (PWTB) transmits a methodology for land managers to use when quantifying the economic value of Army lands. The PWTB provides a step-by-step approach to obtaining data needed to determine both monetary and environmental contributions that Army installations extend to their surrounding environment and communities. Besides the step-by-step approach, the PWTB includes an example application of the methodology for Fort McCoy, Wisconsin. For further assistance or clarification on how to use the methodology, contact the author, Mr. Don Pitts at Donald.Pitts@usace.army.mil.

b. All PWTBs are available electronically (in Adobe® Acrobat® portable document format [PDF]) through the World Wide Web (WWW) at the National Institute of Building Sciences' Whole Building Design Guide web page, which is accessible through URL:

http://www.wbdg.org/ccb/browse_cat.php?o=31&c=215

2. Applicability. This PWTB applies to all U.S. Army facilities engineering activities.

3. References.

a. Army Regulation (AR) 200-2, Environmental Effects of Army Actions, Headquarters, Department of the Army (HQDA), 23 December 1988.

b. Appendix D contains additional references to technical material.

4. Discussion.

a. The U.S. Army is responsible for managing millions of acres of land used to support a variety of training and testing activities. Land uses that result in deterioration can adversely affect the local environment and negatively affect regional ecosystems, but proper management of Army lands actually enhances (improves) regional ecosystems. In fact, the natural ecosystems maintained on Army installations often clean up regional pollution. The expansive natural areas and the environmental externalities of ecosystems on Army installations provide valuable economic services to their respective regions.

b. AR 200-2 establishes policy, procedures, and responsibilities for assessing the environmental effects of Army actions. In general, the National Environmental Policy Act (NEPA) and decision process outlined in AS 200-2 state that certain actions (e.g., facilities construction, unit training, flight operations, etc.) that "generate impacts on the environment") require a formal Environmental Assessment. Environmental Assessments generally focus on actions that may compromise the environment and negatively affect the regional ecosystem (e.g., release of toxic chemicals, use of pesticides or herbicides, etc.). Environmental Assessments should also consider the positive effects of the undeveloped ecosystems on Army lands, and the benefits that regional ecosystems derive from the Army's good stewardship of installation lands. This PWTB outlines methods to determine and quantify the environmental contributions that Army installations make to their regional ecosystems, and to calculate the monetary value of these contributions.

c. Appendix A to this PWTB contains a general description of the valuation assessment of ecosystems. This appendix provides simple calculation sheets and defines methods.

d. Appendix B presents a specific example of a demonstration of the valuation assessment at the Fort McCoy Army Reserve Training Facility.

e. Appendix C explains fee simple calculations.

f. Appendix D provides references for more detailed discussion of ideas presented in this document.

5. Points of Contact. HQUSACE is the proponent for this document. The POC at HQUSACE is Mr. Malcolm E. McLeod, CEMP-II, 202-761-0632, or e-mail: malcolm.e.mcleod@usace.army.mil

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Appendix A
Valuation Assessment of Ecosystems on Military Installations

Introduction

Army installations are often islands of pristine ecosystems in a sea of urban and agricultural development. An unexpected and often unrealized aspect of Army installations is that their mission of training soldiers requires large expanses of natural areas. The large numbers of Army personnel attracts urban development, which tends to grow near the installation, while the remaining surrounding rural land uses are usually agricultural. Both urban and agricultural land uses create their own varieties of pollution, which can enter the Army installation through air and water. Conversely, the mission of training soldiers can also result in environmental difficulties.

In general, Army installations are responsible land managers. The Army actively works to prevent pollution, and Army installation lands often passively clean up regional pollution through their natural ecosystems. The expansive natural areas and environmental externalities of the ecosystems on Army lands provide economically (and ecologically) valuable services to their respective regions. An accurate environmental assessment of installation lands should include the contributions of the included ecosystems to the region. To include these benefits in an environmental assessment, land managers must:

1. Identify the environmental benefits that the military installation provides to the region
2. Use an appropriate and accurate method to measure and quantify the economic ("dollar") value of those environmental benefits
3. Calculate the value of the environmental benefits that the military installation provides to the region
4. Estimate the total value of the ecological benefits that installation lands contribute to their region.

Step 1. Identify the environmental benefits of the military installation

First, qualitatively identify the environmental benefits the installation lands provide. Review the following list and answer "Yes or No" (Y/N) to the broad categories of benefits the installation provides. (Note: the methods outlined in this chapter may be applied to large or small tract investigations.)

Benefit	Y/N
1A. Do the installations lands provide habitat for threatened and endangered species (TES)?	
1B. Do the installation lands provide "Specialized Habitat"? "Specialized Habitat" is habitat suited to wildlife, and/or to commercial or recreational activities. Can you answer "yes" to any of the following:	
• Do the installation lands contribute to commercial fishing (for example, including temperature stabilization, sediment removal, nutrient addition and removal, and micro and macro invertebrate production)?	
• Do the installation lands contribute to recreational fishing?	
• Do the installation lands contribute to recreational hunting?	
• Do the installation lands contribute to non-consumptive recreation such as nature trails and bird watching?	
• Do the installation lands contribute to bequest values?	
• Do the installation lands contain habitat that contributes to other factors, such as supporting mollusks that filter water?	

Benefit	Y/N
• Do the installation lands have aesthetic values, such as higher land prices due to proximity to habitat?	
• Do the installation lands contribute to the "edge effect"?	
• Do the installation lands contribute to "corridor provision"?	
1C. Do the installation lands have valuable hydrological characteristics? For example, installation lands may withhold flood waters that would otherwise cause damage downstream. The value of these characteristics may be determining by calculating the amount of water withheld and damage that amount would cause.	
1D. Do the installation lands provide sediment prevention and removal? Installations may provide a value in preventing sediment from entering the alluvial (soil) system from uplands, or remove sediment already in the alluvial system. This may be quantified by measuring the amount of sediment removed by a floodplain.	
1E. Are the installation lands forested? If so, they provide phytoremediation. Forested installation lands often provide "phytoremediation," in other words, they remediate metals or toxins, and remove agricultural nutrients (fertilizers) from the environment. This is commonly quantified by water tests and sampling.	

Benefit	Y/N
1F. Are the installation lands heavily vegetated or forested? If so, they provide "carbon sequestration." The measured amount of plant material (biomass) on installation lands is a measure of "carbon sequestration," or the amount of carbon (CO and CO2) removed from the environment. The amount of biomass is measured by taking field samples (count and measure); the amount of carbon (in tons) in the biomass is estimated by applying a mass formula appropriate to the type of wood fiber measured, and finally, a dollar value per ton of carbon yields the quantified value of the biomass. Carbon sequestration is valid in both cultivated and natural forests.	

Step 2. Quantify the dollar value of the environmental benefits identified in Step 1.

Quantitatively identify the environmental benefits installation lands provide in terms of a monetary value. Estimate monetary value for each item marked "Y" in Step 1. Review the following list for each environmental benefit, identify the valuation method you are most familiar with and estimate monetary value. If you are unfamiliar with the commonly used methods, a simple method is provided that will provide a rough estimate of monetary value. (Note: Multiple methods are frequently available for value estimation. Each has unique advantages and information requirements.)

Benefit	Calculated Value ($)
2A. Installation lands provide habitat for threatened and endangered species (TES)	**"Y"**
To measure the value of TES habitat, whether for listed or non-listed species, use one of the following methods (listed in order of preference): • Comparable Sales (estimate the value of installation land based on the value of other, comparable similar properties). • Inventory (estimate the cost to purchase the property and perform acceptable mitigation). • Travel Costs (calculate the amount consumers will pay to travel to the site [usually a recreational or historical destination]). • Price Hedonics (estimate the value based on the selling price of like properties and established market values). • Contingency Valuation (estimate the value the area based on its use, e.g., logging, grazing, or bird watching, to calculate the market value of the resource or activity.	

Benefit	Calculated Value ($)
If you are unfamiliar with the above methods, you can approximate monetary value with the following method. Contact local US Fish and Wildlife Service (USFWS) or Nature Conservancy (TNC) office to identify mitigation habitat purchases in the surrounding area. Convert the purchase prices to an acre basis. Obtain a capitalization rate for land from a local appraiser (the capitalization rate will be a decimal value). Multiply the capitalization rate by the sales price to estimate service price. NTC offices can be found at http://www.nature.org/wherewework/northamerica/states/ USFWS offices can be found at http://www.fws.gov/offices/	
2B. Installations lands provide "Specialized Habitat"? Measure the value of specialized habitat by one of the following methods:	**"Y"**
• Available use-based income.	
• In smaller watersheds, externalities with economic bases, such as less turbid water, which may enhance a commercial fishery, may provide market data.	
• The value gained by any commercial enterprise dependent on the resource.	
• Travel cost and contingency valuation.	
• Potential income based on all present uses.	

Benefit	Calculated Value ($)
If you are unfamiliar with the above methods, you can approximate monetary value with the following method. Use fees for hunting, fishing, recreation, plus travel and related costs from site- collected data or from a reference such as Aiken and LaRouche (2003). For example use number of hunting permits from installation records and cost per trip per person from Aiken and LaRouche to obtain total monetary value for that activity. Sum for all activities. Aiken, R., and G.P. La Rouche, 2003. Net Economic Values for Wildlife-Related Recreation in 2001. Report 2001-3, Division of Federal Aid, U.S. Fish and Wildlife Service, Washington, DC: http://library.fws.gov/nat_survey2001_economicvalues.pdf	
2C. Installations lands have valuable hydrological characteristics? Use the "Cost Avoidance" method to measure the value of hydrological characteristics.	**Y**
• Research county records (or local knowledge) to determine the frequency of floods, the amount of water withheld, and the damage that the floodwater would otherwise cause. (Avoided damages may include buildings and improvements with market value.)	
• Measure the value of commercial, habitat, or recreational uses of installation and surrounding lands that benefit from the backflow that enables these activities. The valuation is the same as the resource itself; backflow increases the value through extended use avoided cost of commercially replenishing the resource.	

Benefit	Calculated Value ($)
• If you are unfamiliar with the above methods, there are not simple methods to approximate monetary value. Estimating hydrologic benefits is difficult and you might not want to attempt valuation.	
2D. Installations lands provide sediment prevention and removal Use the "Cost Avoidance" method to measure the value of sediment prevention and removal. Measure the value for each of the relevant cost avoidance categories.	**Y**
Bank Stabilization: Using the Means Guides (R.S. Means Co., Kingston, MA), calculate the least expensive effective mechanical bank stabilization construction and maintenance cost. R.S. Means Co., Kingston, MA, http://www.rsmeans.com/	
• Sediment Prevention: Undisturbed natural areas will have little to no loss by erosion. If a proposed project will disturb a natural area, use the USLE (Wischmeier and Smith, 1978) to calculate projected annual soil loss through erosion. Multiply soil loss by local removal costs obtained from Means Guides (R.S. Means Co., Kingston, MA), to obtain monetary value.	
Wischmeier, W.H., and D.D. Smith. 1978. Predicting rainfall erosion losses - a guide to conservation planning. U.S. Department of Agriculture, Agriculture Handbook 537. Government Printing Office, Washington, DC: http://topsoil.nserl.purdue.edu/usle/AH_537.pdf	

Benefit	Calculated Value ($)
R.S. Means Co., Kingston, MA: http://www.rsmeans.com/	
• Upland Sediment Retention: Sediment from upland areas that enter natural buffers may be up to 100% retained. Use the USLE (Wischmeier and Smith, 1978) to determine the amount of sediment entering the buffer area. Multiply soil capture by local removal costs obtained from Means Guides (R.S. Means Co., Kingston, MA), to obtain monetary value.	
Wischmeier, W.H., and D.D. Smith. 1978. Predicting rainfall erosion losses - a guide to conservation planning. U.S. Department of Agriculture, Agriculture Handbook 537. Government Printing Office, Washington, DC: http://topsoil.nserl.purdue.edu/usle/AH_537.pdf	
R.S. Means Co., Kingston, MA, http://www.rsmeans.com/	
• Floodwater sediment retention: Floodwaters entering floodplains, lakes, channels and fields slow and leave sediment as they recede. This sediment may be measured by sediment traps. Determine the amount of sediment removed or retained on tons per acre basis. Multiply soil retained by local removal costs obtained from Means Guides (R.S. Means Co., Kingston, MA), to obtain monetary value. R.S. Means Co., Kingston, MA: http://www.rsmeans.com/	

Benefit	Calculated Value ($)
2E. Installations lands provide phytoremediation. Measure the value of phytoremediation using one of the following methods.	**"Y"**
• Since removal of agricultural nutrients is the most important role of riparian forests, water tests for nitrogen and phosphorus can be used to test an area for nutrients entering and leaving an area. Multiply sediment removed by cost to mechanically remove to estimate monetary value.	
• If you are unfamiliar with the above method, you can approximate monetary value with the following method. Assume a conservative nutrient load of 11.17 lb of N/acre/year derived from corroborating studies (Shabman and Zepp (2000). Costs to mechanically remove N are approximately $2.50/lb. Multiply nutrient load by mechanical removal cost to estimate monetary value. Shabman, L.A. and L. Zepp, 2000. An approach for evaluating nonstructural actions with application to the Yazoo river (Mississippi) backwater area. EPA report under Grant X 984355-98. Environmental Protection Agency, Washington, DC: http://www.americanrivers.org/site/DocServer/Independent_Economic_Analysis.pdf?docID=6963	
2F. Installations lands are heavily vegetated and provide carbon sequestration. Measure the value of carbon sequestration using one of the following methods.	**"Y"**

Benefit	Calculated Value ($)
• Measure the amount of biomass using commonly available methods. A cubic meter of wood fiber has 0.5 tons of carbon, use total stem biomass in the study area multiplied by 1.25 and then by 0.5 to derive carbon mass. Then apply the growth indices to derive an estimate of annual sequestration. Assume a value of $18.42 per ton of carbon. This value is conservative and defensible until carbon markets are more fully utilized in this country.	
• Estimate biomass using existing forestry inventory data or similar data. A cubic meter of wood fiber has 0.5 tons of carbon, used total stem biomass in the study area multiplied by 1.25 and then by 0.5 to derive carbon mass. Then apply the growth indices to derive an estimate of annual sequestration. Assume a value of $18.42 per ton of carbon. This value is conservative and defensible until carbon markets are more fully utilized in this country.	
• If you are unfamiliar with the above method, you can approximate monetary value with the following method.	

Benefit	Calculated Value ($)
Estimate biomass assuming common values found in the literature. Frank (2004) noted above-ground biomass from 782 to 2173 kg/hectare, root biomass from 11.8 to 17.4 tons/acre. Lal (2004) noted organic carbon sequestration for dryland grasslands, sequestering from 40 to 400 kg/hectare/yr in soils and 2000 to 4000 kg/hectare/yr in biomass. A cubic meter of wood fiber has 0.5 tons of carbon. Use total stem biomass in the study area multiplied by 1.25 and then by 0.5 to derive carbon mass, then apply the growth indices to derive an estimate of annual sequestration. Assume a value of $18.42 per ton of carbon. This value is conservative and defensible until carbon markets are more fully utilized in this country.	

Step 3. Total the dollar value of all environmental benefits identified in Step 1 and quantified in Step 2.

Total environmental benefits estimated in Step 2. Copy values from Step 2. If no values were estimated in Step 2, enter $0.

Benefit	Value ($)
3A. Do the installations lands provide habitat for threatened and endangered species (TES)?	
3B. Do the installation lands provide "Specialized Habitat"?	
3C. Do the installation lands have valuable hydrological characteristics?	
3D. Do the installation lands provide sediment prevention and removal?	
3E. Are the installation lands forested?	
3F. Installations lands are heavily vegetated and provide carbon sequestration.	
Sum values 3A through 3F to obtain cumulative value of environmental services on an acre basis. Multiply by the number of acres to obtain total value of environmental services for the parcel of land under consideration.	

Appendix B
Demonstration of Ecosystem Valuation Using Fort McCoy, Wisconsin

Location

Fort McCoy is a 60,000-acre Army Reserve Training Facility located in west-central Wisconsin, approximately 30 miles east of the Mississippi River. The approximate coordinates are 29.3N and 81.95W at the center.

History

This region of Wisconsin was home to the Ho-Chunk (aka Winnebago) people for the 2000 years prior to settlement by persons of European origin, which began in the early 1800s. The Ho-Chunk maintained their savanna habitat through controlled burning, keeping the uplands suitable for elk and bison, resulting in the oak savanna conditions seen today.

The settlement by white people was accompanied by destructive farming practices that lead to severe erosion and degradation of the alluvial systems. As the farm productivity degraded, the farmers began to abandon grain crops and turned to dairy farming. During the first 80 years of agriculture in the region, the streams were transformed from cold water to warm water, and sediment degraded streams to the point that the trout were extirpated and carp became the dominant species. Soil conservation efforts on the private lands began slowly in 1934.

Fort McCoy escaped much of this agricultural impact. The predominantly sandy soils were not as productive for grain crops, and the lush herbaceous vegetation was ideal for cattle. Small parts of the region contained by Fort McCoy were farmed, but the area in which Fort McCoy was initially formed was in a cattle ranch.

The Army began buying property for training in 1909. Parcels of land that had been abused were removed from production. Rehabilitation on the land now occupied by Fort McCoy 25 years began earlier than the first private land soil conservation efforts in other parts of the region.

Geology

Being in the unglaciated region of Wisconsin, Fort McCoy has ancient topography and is far different from the rest of the state and the Midwest. The geologic origins are layers of sandstone and limestone affected by geologic uplift that formed the region known as the Western Upland of Wisconsin. This is a fully dissected cuesta with a major slope to the south/southwest.

This dissection is the result of millions of years of slow erosion creating long valleys, known locally as "coulees." Topographical relief is substantial with changes of several hundred feet from the rivers to the ridge tops. The primary upper geological strata is limestone, which has eroded in the uplands, exposing the softer sandstone and shale deposits, the alluvium of which is the parent material for most of the soils in the area. Other soil material found in the region is loess. The soil and water pH throughout the region is moderate, usually ranging from 6.0 – 7.0.

Soils

The dominant soils in the wetlands and floodplains are sands of the Dawson peat and Newson sandy loam series. They are deep, almost level, poorly drained soils subject to flooding and ponding. They have a seasonal high water table, ranging from above the surface of the soil to within 30 cm of the surface. This seasonal fluctuation of the water table may be rather dynamic, creating seasonal periods when the soils are dry, and excessively dry during periods of drought. The total acreage of these soils on the facility is 5558 acres.

Of the upland soils, 80 percent, or 49,837 acres, are classified as sand. These are deep, excessively drained soils with very little organic matter, with slopes ranging from nearly level to 45 degrees. The remaining upland soils are sandy loams (776 acres) and silty loams (914 acres). None of the upland soils are rich in organic matter, and all are subject to severe water and wind erosion.

Watersheds

The La Crosse River begins in a wetland in the northeast sector of Fort McCoy. Much of the installation is in watershed, and it is the largest landholder in the upper La

Crosse watershed. This river is a minor tributary of the Mississippi River system and in its entirety is classified by Wisconsin Department of Natural Resources (DNR) as a Class II trout stream, meaning conditions are overall good, there is some natural reproduction, but some stocking might be required to meet the demands of the fishery. Koperski (2002) noted the importance of the upper La Crosse watershed in that it forms the basin and water quality aspects for two very important recreational areas of the state.

Bordering Fort McCoy to the west is the La Crosse River Fishery Area owned by the Wisconsin DNR. This 463-acre fishery is open to hunting and fishing by the public. Further down river is the La Crosse River Marsh, 4000 acres of wetland floodplain that is one of the more important ecosystems in the nation. Situated on the Mississippi flyway, the marsh is heavily used by waterfowl for breeding and migratory stop-overs. It also provides habitat for numerous declining wetland birds, reptiles, and amphibians. The portion of the river flowing through this wetland contains 64 species of fish, which is 40 percent of the species occurring in Wisconsin. Five species of state-listed fish occur in these waters, and northern pike use the marsh extensively for propagation.

In the northern part of the installation is Robinson Creek, a major tributary of the Black River, a major tributary of the Mississippi River system. Numerous creeks, wet coulees, floodplains, and wetlands are tributaries of the river systems.

Climate

According to the Soil Conservation Service (SCS, 1984), the climate is continental, with frequent pressure systems moving from west to east. Weather is variable in all seasons. Spring is often late in coming, occurring as periodic warm and cold periods. Precipitation peaks in June. Summers are warm, with several hot and humid spells, and cool periods may be expected during all summer months. The growing season is considered May 11 to September 27, so ground that is inundated or saturated for 7 consecutive days during the growing season could be delineated as wetland. Fall arrives in mid-September and often lingers into late November, and the transition to winter can be abrupt.

Winters are long, cold, and snowy, with periodic thaws common, usually in February. Total mean precipitation is 28 in., and annual seasonal snowfall is 39.3 in. with extremes of 83 and 14 in. recorded. The average winter daily temperature is 19.9 °F, and average daily summer temperatures are 68.4 °F. The recorded extremes are –48 °F and 109 °F. The prevailing westerly winds have an average range from 12 mph in April to 7 mph in August.

Vegetation

Albert (1995) mapped the ecosystems of the Upper Great Lakes region and placed most of Fort McCoy in the Driftless area of the Eau Claire subsection. The drier soils and greater frequency of fires result in oak dominance in forests and savannas. Fort McCoy also lies in the intersections of two ecotones, in the east-west transition from eastern forest to western prairie, which contributes to the savanna ecosystems that dominate much of the uplands on the installation.

Fort McCoy is also in the north-south transition from northern coniferous forest to central deciduous forest. There is a gradiation on the installation between these two forest types, and examples of both may be found. Many plants reach their northern and southern limits within this zone. More than 800 plant species have been recorded on Fort McCoy.

The upland savannas depend on fire to maintain an open structure. With fire suppression, the vegetation of the savannas quickly succeed into a more closed canopy forest condition. Oak grubs remained persistent in spite of the fires, and in fire suppression events grow profusely. The oak seed bank lasts for several years, and fire or logging will quickly activate it. Because of the terrain and early history, Fort McCoy is one of the few locations in the Driftless area that had little cultivation, and original vegetative communities remain relatively intact.

Approximately 40,000 acres (16,000 hectares) are considered forested, with 5500 acres (2200 hectares) considered grassland. The oak savannas may be dynamic, depending on the fire regime, and succession to oak forest may occur rapidly in the absence of fire. Oak wilt is also present, reducing oak stands to oak savanna or grassland.

The records of the installation forester greatly facilitated this review of environmental externalities. There are 3950 identified vegetation stands, and spatial areas and densities (recorded as cords) provided by the forester were used extensively in this work.

Aspen (Populus sp.) is prevalent as canopy and sometimes understory. When appearing as a canopy species, understory may be grasses, central hardwoods, red maple (Acer rubrum), scrub oak, upland brush, white birch (Betula papyrifera), and white pine (Pinus strobes). Central hardwoods may be found with understory recruitment, grasses, and upland brush. Grassland areas, approximately 5500 acres, may dominate upland brush and grass recruitment. Jack pine (Pinus banksiana) may be found as the overstory of aspen, jack pine recruitment, red pine (Pinus resinosa), oak scrub, upland brush, and white pine. Lowland brush may be found as the canopy of white pine and lowland brush recruitment. Northern hardwoods associations may dominate their own recruitment or upland brush.

Oaks are found as the canopy for aspen and central hardwoods, grass (as in savannas), and oak recruitment. Red maple is found dominating alder (Alnus regosa), central hardwoods, and oaks. Red pines are the canopy species over aspen, grasses, jack pines, and scrub oak. Scrub oak is found as the canopy species over aspen, central hardwoods, grasses, jack pine, red maple, red pine, scrub oak, and upland brush. White pine is the canopy over alder, aspen, herbaceous vegetation, jack pine, red maple, red pine, scrub oak, and white pine recruitment.

Upland wildlife includes white tail deer (Odocoileus virginianus), northern harrier (Circus cyaneus), red fox (Vulpes fulva), gray fox (Urocyon cinereorgenteus), raccoon (Polycyon lotor), badger (Taxidea taxus), thirteen-lined ground squirrel (Citellus tridecemlineatus), meadow vole (Microtus pennsylvanicus), and numerous upland birds and reptiles. The upland bird populations on Fort McCoy are among the better examples of remaining upland bird populations in the country.

Logging

Fort McCoy is south of the historic Wisconsin dense pine forests, but there has been logging activity on the installation. Though there are no records, a small sawmill was

located on the now Army property, most likely to provide lumber for local needs. From 1942 to 1946, a wartime sawmill cut oak and pine for railroad ties and blocking for vehicle shipping. No records were kept, but anecdotal evidence suggests 100,000 board feet a year were harvested during this time. In 1948, the Army entered into a timber management plan with the Wisconsin Conservation Department, initially for fire control, and this expanded to commercial harvests and associated management in 1954. In 1966, the installation hired its first professional forester, and today jack pine, red pine, oak, and aspen are harvested annually.

Aquatic Resources

There are no glacial lakes (and therefore no natural lakes) in the region. There are eight impoundments ranging from 2 to 93 acres, all built between 1920 and 1962. Two impoundments have been recently removed, two dredged and upgraded with bottom-draw dams, and the remaining four are in a deteriorating condition. Impoundments in cold-water ecosystems often have water quality issues, as do these. Except for the two maintained impoundments, the remaining are filling in rapidly, and one is already managed as a wetland rather than a lake.

Two non-alluvial lakes are formed by borrow pits, the material used in road construction. These are warm water lakes and the fisheries are managed as such.

The installation contains 71.2 miles of streams and tributaries, most of which are associated with the La Crosse and Black River watersheds. The Wisconsin DNR recognizes 47 miles of these as trout streams, with 30 miles of Class I trout streams, meaning they are of excellent quality, and recruitment is adequate to support angling pressure. There are 11.2 miles of Class II streams, and 5.9 miles of Class III streams, meaning trout can survive, but recruitment is restricted or non-existent.

Two streams originate on the facility and are unique and pristine to the degree of being designated state natural areas. Streams that have headwaters beginning off the installation enter the boundaries with lower water quality readings. The Fort McCoy (1999) Integrated Natural Resource Management Plan cited a 1997 study by Drake, which

noted aquatic insects on the installation were indicative of excellent water quality.

Water quality is well protected. Military vehicles are required to use hardened stream crossing areas, and logging is restricted in the buffer zones. Required buffer width varies according to features such as slope, vegetation, and other factors. Vehicular maneuvers are not allowed within 50 m of riparian areas.

There are approximately 4000 acres of wetlands on Fort McCoy, and 3000 acres of floodplain forests. Those associated with alluvial systems are old, but newer wetlands have been formed by anthropogenic activity such as building roads and railroads. Associated wetland vegetation includes: white pine (Pinus strobes), red maple (Acer rubra), quaking aspen (Populus tremuloides), white oak (Q. alba), box elder (Acer negundo), red maple (Acer rubrum), silver maple (Acer saccharinum), paper birch (Betula papyrifera), Swamp birch (Betula pumila), musclewood (Carpinus caroliniana), bitternut hickory (Carya cordiformis), shagbark hickory (Carya ovata), pagoda dogwood (Cornus alternifolia), roundleaf dogwood (Cornus rugosa), red ozier dogwood (Cornus stolonifera), tamarack (Larix laricina), eastern hophornbean (Ostrya virginiana), cottonwood (Populus deltoids), big-tooth aspen (Populus grandidentata), Lombardy poplar (Populus nigrapoison), swamp oak (Quercus bicolor), bur oak (Quercus macrocarpa), willows (Salix amygdaloides, S. bebbiana, S. pedicellaris, S. rigida, S. sericea), sumac (Toxicodendron vernix), speckled alder (Alnus incana), star flower (Trientalis borealis), winter berry(Ilex verticillata), dewberry (Rubus trivialis), cinnamon fern (Osmunda cinnamomea), skunk cabbage (Symplocarpus foetidus), bunchberry (Cornus Canadensis), bluejoint grass (Calamagrostris canadensis), sedges (Cyperaceae), sphagnum moss, meadowsweet (Spirea latifolia), cattails (Typha sp.), and small dogwoods (Cornaceae).

Many of these species are unusual wetland vegetation, indicative of the sandy soils. The hydrology is present for the wetland delineation, and wetland obligate plants are in the vegetative mix. White pine is not a wetland tree, but it survives not only in dry, well-drained soils, but also very wet, especially sandy wetlands and floodplains. Its limiting factor is pollution more than moisture. While the red maple is known to frequent wetlands, trembling aspen is not known as a wetland plant. White oaks are normally found on the edge of delineated wetlands, tolerant of some

wet and then dry conditions. Yeager (1949) reported high mortality of white oaks in Illinois when subjected to inundated or saturated conditions for more than a few days. Tamarak is an interesting addition of species in the floodplain forest. This northern species, like white pine, can be tolerant of wet or dry conditions and is suited to sandy alluvial soils.

Faunal species noted within the wetlands were white-tailed deer (Odocoileus virginianus), mink (Mustela vison), otter (Lutra canadensis), white-footed deer mouse (Peromyscus leucopis), muskrat (Ondatra zibethica), beaver (Castor canadensis), sandhill crane (Grus canadensis), osprey (Pandion haliaetus), great blue heron (Ardea herodias), least bittern (Ixobrychus exilis), several species of ducks, northern harrier (Circus cyaneus), sora rail (Porzana carolinensis), marsh wren (Cistothorus palustris), swamp sparrow (Melospiza Georgiana), red-winged blackbird (Agelaius phoeniceus), wood turtle (Clemmys insculpta), Blanding's turtle (Emydoidea blandingii), green frog (Rana clamitans), northern water snake (Nerodia sipedon), and spring peeper (Pseudacris crucifer).

Training by soldiers on foot is not restricted in the wetlands, but vehicular traffic is allowed only when they are frozen and damage is minimal. Logging is done only when wetlands and floodplains are frozen. Wetland hardwoods and aspen are harvested as part of the ruffled grouse management paradigm. White pine is valued in the timber harvest program and thinned appropriately for larger stem size. Standard forestry provisions such as higher residual basal areas and leaving dominant trees are practiced.

In some situations succession is set back as a wildlife management practice. Beaver populations are mediated to prevent degradation of trout habitat, and invasive plants such as purple loosestrife and glossy buckthorn are actively controlled.

Water Quality

The installation conducted intensive water testing from 1993-1996, and continued monitoring through 2001. Now the program supports quarterly testing and testing during rain and drought events. Pollutants such as fecal coliform (common in livestock agriculture regions) and suspended solids are higher in water entering the installation than

leaving it (Noble, 1997). Two creeks enter the installation from the south that travel extensively through off-installation agricultural areas, and these creeks are higher than others on the installation in fecal coliform, turbidity, and suspended solids (Noble, 1998).

Uplands

The uplands constitute a vast majority of the ecosystem and are predominantly oak forest, savanna, grasslands, and brush lands. The excessively drained sands provide a xeric landscape, and frequent fires caused by military training and controlled burns maintain the oak forest and prevent succession to white pine. In areas where fire has been suppressed, there is a conspicuous amount of red maple, black cherry, and white pine in the understory. Fires and the lack of agricultural disturbance have maintained areas of the quality oak savanna that once dominated this entire region, but are rare now.

It is estimated that at the time of European settlement there were 2.1 million acres of oak savanna in Wisconsin, and now only 2000 acres remain, 300 of those on Fort McCoy. Restoration of savannas appears likely, as military commanders consider them excellent training areas. With over 20,000 acres of low quality oak forest on the installation, there is great potential for these restoration efforts. Jack pines are also present and managed as a logging asset.

The installation has approximately 3800 acres containing wild lupine (Lupus perennis), the singular plant responsible for the survival of the Federally endangered Karner blue butterfly (Lycaeides melissa samuelis Nab). This plant is found only in sandy, open, upland areas such as the oak savannas and goat prairies. Karner blues are found in 95 percent of the wild lupine populations on Fort McCoy.

The upland sandy soils have a thin A horizon of organic matter overlaying thick sand, and when this is lost, the sand is highly susceptible to wind erosion. There have been long-term efforts at restoring these blowouts, but it was recently recognized that they are necessary for several rare insects and some are now allowed to remain.

Open grassy areas on steep slopes and ridge tops, locally known as goat prairies, contain several rare grasses and

prairie species and are protected from damage. Their greatest imperilment is encroachment from trees.

On the north and northeast facing slopes, red oaks are the dominant tree species, but regeneration is poor, with basswood and white pine gaining successional favor. Prescribed burning is being implemented to encourage successful oak regeneration.

Demonstration

Fort McCoy was selected to demonstrate use of the techniques devised in this work. The following table identifies each environmental benefit considered in the demonstration. The following sections describe how each benefit was quantified. In this example, a number of other types of benefits are shown to illustrate how the approach can include other environmental benefits that local installation personnel can identify.

Step 1. Identify the environmental benefits of the military installation

Benefit	Y/N
1A. Do the installations lands provide habitat for threatened and endangered species (TES)?	**N**
1B. Do the installation lands provide "Specialized Habitat"? "Specialized Habitat" is habitat suited to wildlife, and/or to commercial or recreational activities. Can you answer "yes" to any of the following:	**Y**
• Do the installation lands contribute to commercial fishing (for example, including temperature stabilization, sediment removal, nutrient addition and removal, and micro and macro invertebrate production)?	**N**
• Do the installation lands contribute to recreational fishing?	**Y**
• Do the installation lands contribute to recreational hunting?	**Y**

• Do the installation lands contribute to non-consumptive recreation such as nature trails and bird watching?	**Y**
• Do the installation lands contribute to bequest values?	**Y**
• Do the installation lands contain habitat that contributes to other factors, such as supporting mollusks that filter water?	**Y**
• Do the installation lands have aesthetic values, such as higher land prices due to proximity to habitat?	**Y**
• Do the installation lands contribute to the "edge effect"?	**N**
• Do the installation lands contribute to "corridor provision"?	**N**
1C. Do the installation lands have valuable hydrological characteristics? For example, installation lands may withhold flood waters that would otherwise cause damage downstream. The value of these characteristics may be determining by calculating the amount of water withheld and damage that amount would cause.	**N**
1D. Do the installation lands provide sediment prevention and removal? Installations may provide a value in preventing sediment from entering the alluvial (soil) system from uplands, or remove sediment already in the alluvial system. This may be quantified by measuring the amount of sediment removed by a floodplain.	**N**
1E. Are the installation lands forested? If so, they provide phytoremediation. Forested installation lands often provide "phytoremediation," in other words, they remediate metals or toxins, and remove agricultural nutrients (fertilizers) from the environment. This is com-	**Y**

monly quantified by water tests and sampling.	
1F. Are the installation lands heavily vegetated or forested? If so, they provide "carbon sequestration." The measured amount of plant material (biomass) on installation lands is a measure of "carbon sequestration," or the amount of carbon (CO and CO2) removed from the environment. The amount of biomass is measured by taking field samples (count and measure); the amount of carbon (in tons) in the biomass is estimated by applying a mass formula appropriate to the type of wood fiber measured, and finally, a dollar value per ton of carbon yields the quantified value of the biomass. Carbon sequestration is valid in both cultivated and natural forests.	**Y**

1A Threatened and Endangered Species

Threatened and endangered species were not identified as an environmental benefit. As such no monetary value estimated. The following shows how threatened and endangered species benefits could have been estimated.

In October 2002, Wisconsin TNC purchased 900 acres of agriculture land, prairie remnant, CRP fields, and rolling ridgetop, located in Iowa County 40 miles west of Madison (development pressure), just south of Hwy 151 (four-lane highway), for $1,900/acre. This was the top market value as determined by an appraisal. The land was highly developable, but was discounted because of size. Smaller tracts, 40 and 80 acres, are selling for $5000—$7,000/acre. The Wisconsin purchases illustrate that habitat purchases are subject to all the pressures of any real estate transaction, and in many situations this results in habitat land being more valuable than developed land.

1B Specialized Habitat

Recreational Fishing

In 2003, the fishing program sold $9064 in permits to accommodate 1567 fishers. These fishers, like the hunters paid for Wisconsin fishing permits and incurred travel and sometimes lodging costs. Travel costs for hunting are from

the USFWS (1998) and converted to 2004 dollars at 4 percent/yr. Most fishers are considered local, with a travel cost of $10/trip, minimum two trips/fisher, for a travel cost total of $31,340. Added to the receipts for fishing permits, this gives the on-site fishing a cash service value of $40,404.

Recreational Hunting

In 2003, Fort McCoy sold $74,458 in hunting permits to accommodate 5517 hunters and 7 trappers. These fees represent direct income to the Fort McCoy wildlife program. The hunters paid other expenses, such as Wisconsin hunting license fees, and their travel and lodging.

Travel costs for hunting are from the USFWS (1998) and converted to 2004 dollars at 4 percent/yr. Fort McCoy records indicate that approximately 80 percent of the hunters using the installation are Wisconsin residents. Using the most conservative amount offered for big game hunters (which is the lowest of game types), the average in-state hunter spends $199 for the hunting season. This total is used because it is the most conservative, the majority or hunters on Fort McCoy are there for primarily big game, and big game hunters exhibit high site fidelity. In-state travel costs are therefore $878,306 ($1,202,022 in 2004 dollars). The 20 percent out of state hunters travel from as far as California and Florida, but the average travel cost is $291/hunter, for a travel value of $11,034 ($15100 in 2004 dollars). Travel costs plus permits provide a hunting value on Fort McCoy of $1,292,580.

Nonconsumptive Use - Camping

Total camping and use receipts in recent years have been steady at approximately $102,000/yr. Data is presently being collected that may eventually enable computation of travel costs as well. Early results of this attempt indicate that 57 percent of recreational visitors are from within Wisconsin, or within a 2-hour travel distance, indicating one-purpose trips. Using the Aiken and LaRouche (2003) average of $17.50/trip/person for non-hunting and fishing outdoor recreation, the approximately 20,000 annual visitors are spending $350,000 annually in travel costs. The total social value for camping and other use recreation is $452,000 or $9.42/acre.

Other Habitat Use - Logging

Logging is exercised with caution on Fort McCoy, and not as the first priority. Training requirements, aquatic resources and ecological considerations have precedence over logging profits. Logging is done in wet areas only in winter, and riparian buffers are carefully maintained. Forest associations for logging purposes are 20,000 acres of low quality scrub oaks, 9000 acres of Jack pine, 4000 acres of quality oak, and 3000 acres of red pine. Lesser amounts of aspen, red maple, paper birch, and white pine collectively cover approximately 4000 acres. Rotations are planned for jack pine at 45 years on 170 acres, red pine at 120 years on 170 acres, red oak at 90 years on 45 acres, and aspen at 40 years on 52 acres. The logging program is mature to the point that annual harvests are rather static, and the year 2003 receipts of $143,000 were typical. An additional $700 was received for firewood gathering permits, a program that helps remove slash and trees killed by oak wilt. With 48,000 acres in the forest inventory, the acre/yr income is a low $3. Since the logging is performed for ecological, training and safety purposes, the true benefit of the logging program is that these purposes are served at a net profit.

Other Habitat Use - Off-Site Recreation

Fort McCoy enhances recreation off the installation in several ways. Being among the most pristine habitats in the region, the installation is a net exporter of game. Having large, undisturbed procreation areas for waterfowl, deer, turkey, upland birds, and other game animals, the installation most likely provides game for neighboring properties.

More important are the riparian systems moving through the installation, especially the La Crosse River. Directly adjacent to the installation is the La Crosse River Fishery area operated by the Wisconsin Department of Natural Resources. This 563 acre property is open at no fee and may be used for most outdoor pursuits such as boating, canoeing, cross-country skiing, hunting, and fishing.

Anecdotal evidence indicates this to be a valuable resource to the people of Wisconsin, but usage data is not available since there is no fee and no use monitoring. The existence and apparent popularity of this state recreation area sends

an important message on the management of Fort McCoy. That this recreation area is directly downstream from the installation and is rated as a Class I cold-water fishery (Thompson, 2004) is a testimony to the excellent stewardship of the natural resources program at Fort McCoy. As the river passes through impoundments downstream of the state fishery, it eventually becomes one of the best warm water fisheries in the state.

Further downstream is an even more important habitat, the La Crosse River Marsh, which is a 4000-acre wetland at the confluence of the La Crosse and Mississippi Rivers. Much of this marsh is within the city limits of La Crosse, WI, and is considered an important entity in defining the city. Moyer (1989) performed a contingency valuation survey and reported a high value by the residents of the city, and that the marsh is also visited by people from other cities and states. She documented numerous uses: school classes ranging from kindergarten to graduate level in the University of Wisconsin, La Crosse, to training by the college ROTC, and recreational pursuits ranging from canoeing to biking to cross-country skiing. Her study noted high values for the march ranging from spiritual to economic.

This marsh holds high importance nationally as a resting area for migrating birds and waterfowl, spawning area for fish, and harbors several Federally listed aquatic fauna (Wisconsin DNR, 1997).

Though somewhat distant from Fort McCoy, this marsh still owes much of its health to the natural resources program at Fort McCoy. The river gets a clean start on the installation, far more so than if its headwaters were in urban or agricultural areas.

Other Habitat Use - Agricultural Outlease

Small portions of property in the edges of Fort McCoy are leased for agriculture and other purposes. Ninety acres are leased for water storage, 22 acres for grazing, and 42 acres for cranberry production. Total income from these leases is $1300/yr, or $8.44/acre. This lease price is usable in that it establishes willingness to sell and willingness to pay, on marginally natural areas, the type used in Army training.

Other Habitat Use – Military Training

Fort McCoy serves to train soldiers for combat, and this is a legitimate value of service of the natural areas, since natural areas are required for training. This is a service provided in conjunction with all others, therefore is an added value of the natural resources. Lease value in the region is established by agricultural leasing; this value is applied for training, as this is the cost avoided by avoiding a land lease requirement.

The Natural Resource Conservation Service in Wisconsin has a unique method for establishing CRP payments in the state, by paying according to prevailing land rents. In the area around Fort McCoy, this amount ranges from $64 to $68. Using the low $64/acre, the cost avoided for providing Army training is $64/acre, or $3,072,000/yr for 48,000 acres of natural areas.

Other Habitat Use - State Natural Areas

There are three designated State Natural Areas on Fort McCoy. Two are wetland areas associated with floodplains along stream headwaters, and the other is a unique oak barrens with some of the most rare plants in the state. Valuation of these areas is elusive, though an extensive contingency valuation survey would likely give a better indication than most methods. The limited contingency valuation attempted within the scope of this work yielded extremely high estimates of value; these may be considered, but are not used in the final service valuation.

1C Hydrological Characteristics

This characteristic is not identified as an environmental benefit. Sediment removal and prevention is inconclusive. The fact that the vast majority of these alluvial systems originate on Fort McCoy and leave the installation very clean (with little turbidity) adds an indeterminable value to the floodplains. An attempt to capture value for these services can be made in the fishery section. Alluvial systems entering the installation are generally more turbid and polluted than those leaving, but due to the short duration those systems are on installation property, this service is impossible to quantify, and flood events and other natural and anthropocentric phenomena skew the data.

1D Sediment Prevention and Removal

This characteristic is not identified as an environmental benefit for the same reasons described above in " Hydrological Characteristics."

1E Phytoremediation

Nitrogen (nitrate and nitrite), phosphorus, and carbon are significantly reduced in the alluvial systems, though at no time do they exceed minimally acceptable levels. The carbon reduced is organic carbon, which is innocuous to anthropocentric interests and useful by flora and fauna. Using the Shabman and Zepp (2002) model, with pasture being the alternative to the present ecosystems, the difference between forests and pasture is 5.9 lb of N and P exported/acre/yr. Using their value of $2.50/lb for mechanical removal, this adds a value of $14.75/acre, or $708,000 in pollutant service for the 48,000 acres of natural areas. The more marketable product of this cleanliness is in the aquatic fauna.

1F Carbon Sequestration

Smith and Heath (2004) noted that, in this region, forest biomass on public timberlands contain an average of 52.6 tons of carbon/hectare, while non-living plant matter contains 27.9 tons/hectare, and soil organic carbon is 116.6 tons/hectare. There may also be considerable mineral carbon stores in soils in the form of calcium carbonate. Studies have shown no significant soil carbon loss from forested soils following removal of 30 percent of the above ground biomass, so the management practices of Fort McCoy prevent net losses of soil carbon.

Fort McCoy forestry records indicate 48,962,160 cu ft of stem fiber. Assuming a cubic meter of wood fiber has 0.5 tons of carbon, this represents 954,763 tons of carbon presently sequestered as tree biomass. Using a value of $18.42 per ton, sequestration provides a monetary value of $17,586,716.

Using the multiples listed in Table A-1 below, the annual wood fiber carbon sequestration is 47,738 tons of carbon/yr, with an estimated annual service value of $879,336, or $18.31/acre.

Table A-1. Growth Multiples for Floodplain Forest Trees To Be Used in Small Projects.

Type	Early Growth	Mid-Growth	Mature +
Conifers/pioneers	1.05 – 1.10	1.03 - 1.06	1.0 – 1.03
Hardwoods	1.01 – 1.03	1.02 – 1.05	1.0 – 1.02

Using the Lal (2004) organic carbon sequestration rates in dryland grasslands, sequestering from 40 to 400 kg/hectare/yr in soils and 2000 to 4000 kg/hectare/yr in biomass, is the best approach. Taking conservative sums of 3100 kg/hectare on 20,000 hectares, this is 62,000 metric tons of soil and grass carbon sequestration per year, with a value of $1,142,040. Adding a factor of 0.20 to conservatively allow for brush sequestration, the annual total is $1,199,142.

Step 3. Total the dollar value of all environmental benefits identified in Step 1 and quantified in Step 2.

Benefit	Value ($)
3A. Do the installations lands provide habitat for threatened and endangered species (TES)?	**$0**
3B. Do the installation lands provide "Specialized Habitat"? (hunting + fishing + logging + agricultural lease + training)	**$5,001,284 ($122.45/ac)**
3C. Do the installation lands have valuable hydrological characteristics?	**$0**
3D. Do the installation lands provide sediment prevention and removal?	**$0**
3E. Are the installation lands forested?	**$708,000 ($14.75/ac)**
3F. Installations lands are heavily vegetated and provide carbon sequestration.	**$879,339 ($18.81/ac)**
Sum values 3A through 3F to obtain cumulative value of environmental services on an acre basis. Multiply by the number of acres to obtain total value of environmental services for the parcel of land under consideration.	**$6,588,623 ($135.38/ac)**

Appendix C
Deriving Fee Simple Values for Comparison

It is sometimes useful to consider two values of natural property: (1) value to the landowner, and (2) value to society. Social value often will exceed landowner value. Federal programs such as the Conservation Reserve Program and Wildlife Habitat Preservation Program mitigate this difference by providing the landowner an income closer to true social value than would be supplied by commercial income. When government disposes of land as in a sale, BRAC action or other disposal action, society is best served by the social values being considered to determine the highest and best use of the property and making the effort to allow that most beneficial use.

The value to the landowner as income property with no consideration of social value or off-site benefits can be calculated using fee simple value. Fee simple value can be estimated using comparable sales. Sales for habitat or mitigation in the region establish a market value likely to be used in mitigation, levy of fines, and litigation. The use of sales of farmland and forests generally does not reflect the additional social value of the property.

The societal value of land includes services like removal of sediment and carbon sequestration can be applied a value per spatial area. Each service is a free-standing value providing it does not damage another service. Sustainable logging that does not reduce the values of habitat, sediment removal, carbon sequestration, and other services as an added value. For example, the full value of services of a floodplain forest could be: Logging income + carbon sink value + sediment capture + pollutant capture + habitat value + endangered species habitat value + flood costs avoided + recreation value + other values (or any combination). To estimate societal value, the methods outlined in this PWTB can be used. When the annual service value has been determined, the local capitalization rate can be used to convert the annual service value to fee simple value for comparison with landowner value.

Appendix D
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