

“Quantifying the Economic Value of Habitat Protection: Application of a Benefits Estimation Toolkit”



Workshop, April 3-4, 2008, Defenders of Wildlife headquarters,
1130 17th St. NW, Washington, DC



National Council for Science and the Environment
Improving the scientific basis for environmental decisionmaking

Wildlife Habitat Policy Research Program (WHPRP)



“Development of an Operational Benefits Estimation Tool for Habitat Conservation in the U.S.”

Investigators:

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John Loomis (CO State U.)

Frank Casey (Defenders of Wildlife)

Overall objectives of our project

- 1) Review and synthesize the literature on the economic benefits of conserving wildlife habitat
- 2) Provide wildlife planners with a tool that allows them to generate estimates of the economic value associated with conserving particular habitats/areas
- 3) Aid in prioritization of opportunity areas identified in state wildlife conservation strategies, based on the public and private benefits provided by the areas

Specific project objectives:

- Review and synthesize literature on property value premium impacts of habitat conservation; conduct meta-analysis to estimate open space property value premium model
- Review and synthesize literature on community economic competitiveness impacts of habitat conservation
- Review and synthesize literature on economic values of wildlife and habitat; estimate valuation models



Specific project objectives (contd.):

- Construct wildlife activity days model to estimate increase in recreation use and value resulting from increases in conservation acreage
- Assemble toolkit with easy-to-use models that allow users to estimate property premiums and wildlife-related recreation and passive use values associated with conserved lands

MO DC



Introduction to the Wildlife Habitat Benefits Toolkit

- Toolkit components and associated materials -

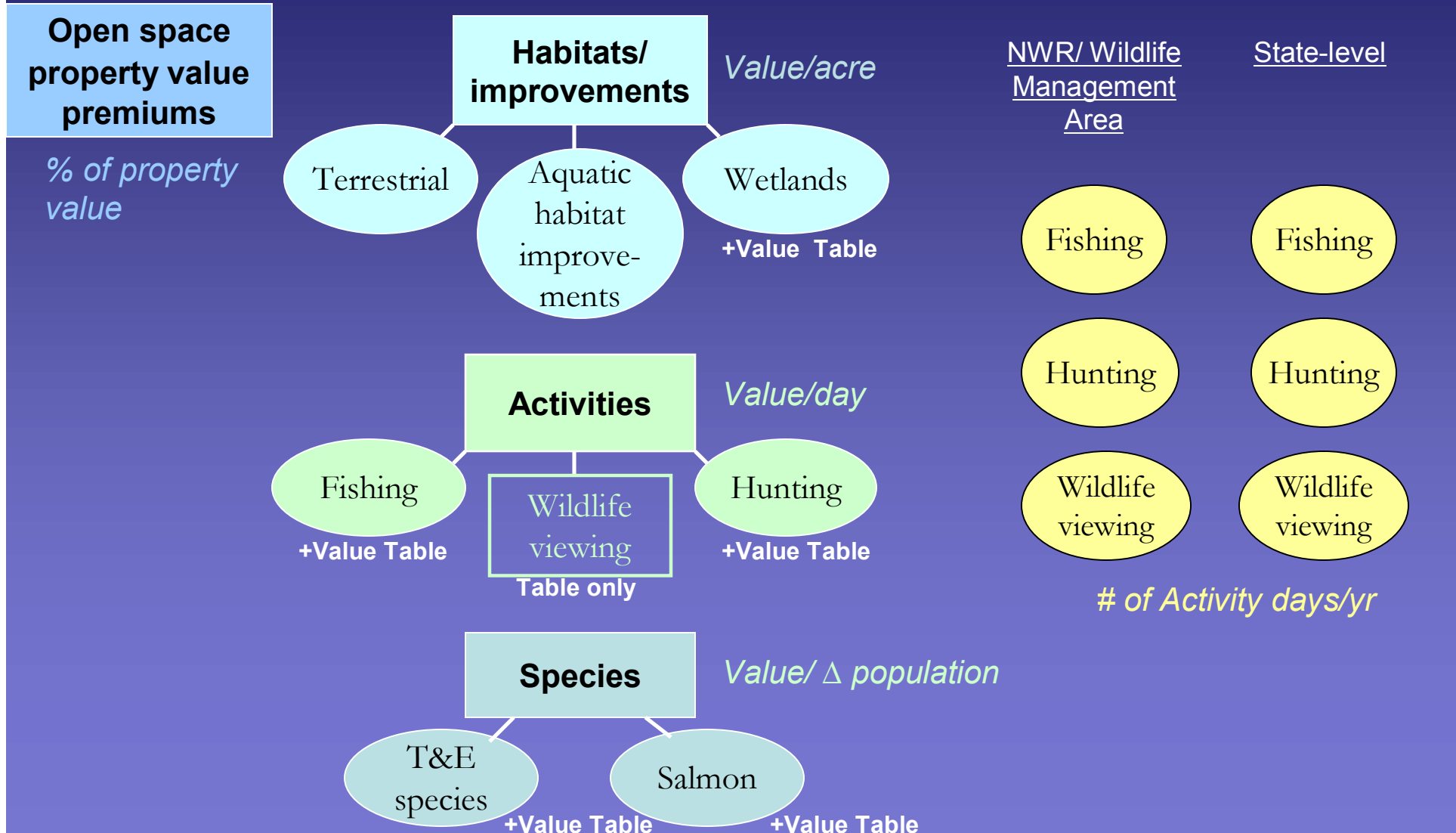
- Valuation models (spreadsheet-based)
- Value tables (by activity, region, species)
- Recreation use models (number of visitors)
- Technical reports detailing analysis and model estimation; literature reviews
- Manuals on how to apply individual models (incl. examples)

Introduction to the Wildlife Habitat Benefits Toolkit

- Overview of models -

Valuation models

Visitor use estimation models



Toolkit provides two approaches to valuation:

1. Value tables, with point and average values

Example: Average values of fishing day by fish type

Average Fishing Values (per angler day)

converted to 2006 base year

Species Category	N	NORTHEAST	N	SOUTHEAST	N	INTERMOUNTAIN	N	PACIFIC	N	ALASKA	N	NATIONAL
Cold Water	58		20		116		13		4		3	
Average		\$39.54		\$51.25		\$62.54		\$54.10		\$53.90		\$38.53
Median		\$27.04		\$51.19		\$47.22		\$45.31		\$58.37		\$31.47
Warm Water	119		63		38		3				7	
Average		\$42.87		\$54.37		\$45.55		\$28.59				\$55.59
Median		\$27.18		\$47.13		\$32.84		\$29.83				\$55.93
Coastal	11		34				24					9
Average		\$68.47		\$144.74				\$140.09				\$73.70
Median		\$7.34		\$73.32				\$102.10				\$59.66
Anadromous	33		1		16		27		18			3
Average		\$39.41		\$138.22		\$51.20		\$65.61		\$40.76		\$103.36
Median		\$4.69		\$138.22		\$49.21		\$57.92		\$38.90		\$78.30
Mixed	30		1		16				16			
Average		\$20.08		\$134.24		\$59.28				\$213.13		
Median		\$18.32		\$134.24		\$36.18				\$206.87		
Not Specified	112		16		48		14		2			1
Average		\$49.66		\$93.47		\$77.31		\$39.10		\$95.56		\$67.12
Median		\$36.01		\$34.20		\$62.70		\$43.12		\$95.56		\$67.12

Loomis, J. and L. Richardson, 2007. *Benefit Transfer and Visitor Use Estimating Models of Wildlife Recreation, Species and Habitats*. Department of Agricultural and Resource Economics, Colorado State University.

Additionally: Detailed point value database with over 900 observations

2. Regression analysis-based value functions customizable to a particular location

Example: Fishing value per angler day - **model** input page for trout fishing in rivers or streams

Value of Fishing per Angler Day

Instructions: Fill in the relevant cells marked "ENTER >" associated with the primary species and habitat you wish a value. Hit the enter key to get the value per day in output box. See accompanying user manual for detailed instructions and documentation.

STEP 1: Enter a 1 next to the primary species to be valued; 0 otherwise

ENTER >	<input type="text" value="0"/>	Salmon
ENTER >	<input type="text" value="1"/>	Trout
ENTER >	<input type="text" value="0"/>	Pike
ENTER >	<input type="text" value="0"/>	Bass
ENTER >	<input type="text" value="0"/>	Walleye
ENTER >	<input type="text" value="0"/>	Other freshwater species
ENTER >	<input type="text" value="0"/>	Other saltwater species
ENTER >	<input type="text" value="0"/>	Other aggregate groupings (bottomfish, etc.)

STEP 2: Enter a 1 next to the type of water body containing the species; 0 otherwise

ENTER >	<input type="text" value="0"/>	Lakes, ponds, and reservoirs
ENTER >	<input type="text" value="0"/>	Brackish, saltwater embayments (bays)
ENTER >	<input type="text" value="0"/>	Saltwater, offshore
ENTER >	<input type="text" value="1"/>	Rivers, streams, flowing-water systems
ENTER >	<input type="text" value="0"/>	Great Lakes

OUTPUT **\$/ Angler Day (2006 base year)**

- Habitat/species/recreation activity valuation models and visitor use models are the result of statistical analyses of literature findings.
- These predictive models were estimated on the basis of the findings of dozens to hundreds of studies.
- Models contain variables identified as significant in meta-analysis of studies
- The user can set key variables such that they reflect the reality of the area of interest, thus generating customized value estimates

Marc Del Sentro

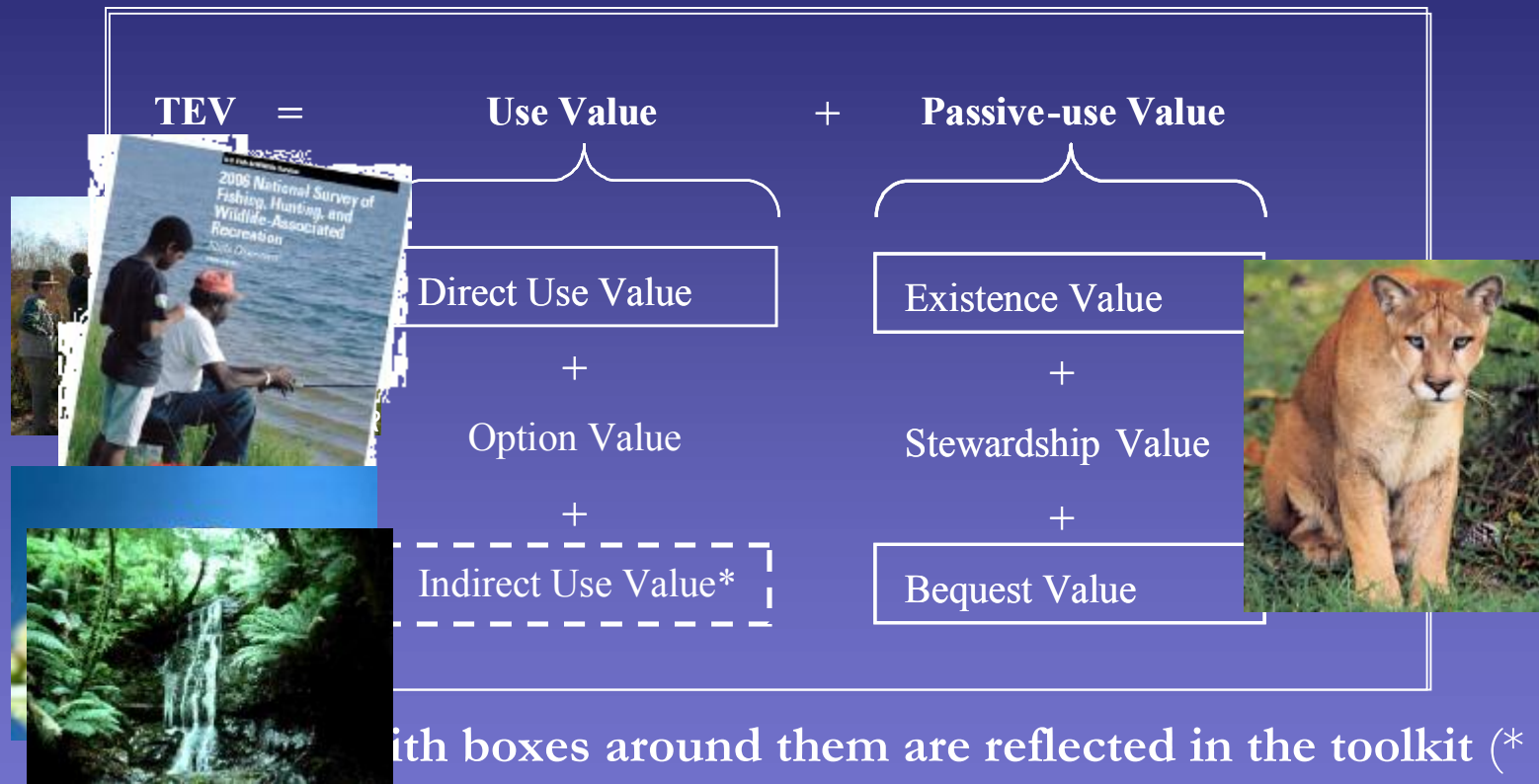


Next:

- What we mean by “economic value”
- How economic value is measured
- How it is measured in the toolkit
- How to estimate the value of a natural area using the toolkit

Economic valuation: Preliminaries

“Economic value” defined: Total Economic Value (TEV)



with boxes around them are reflected in the toolkit (* some ecosystem services are captured in the wetlands models).



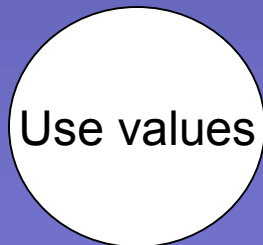
Since not all values associated with a particular resource are capable of being measured with the existing literature, toolkit-based estimates are conservative estimates of TEV.

Measuring economic value

Willingness to pay (WTP) – The maximum amount of money or other goods a person would give up in order to obtain a particular good or service.

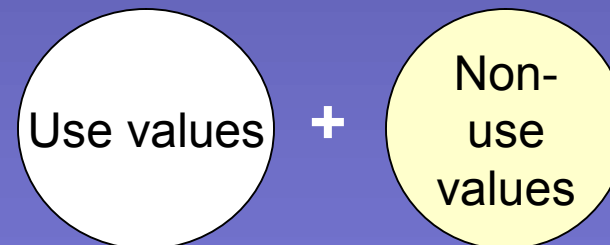
Revealed WTP

(Observed behavior –
market transactions)



Stated WTP

(Surveys)



- Resources not sold directly
- Resources with existence values


How “Value” is measured in the toolkit

Open space property premium model:

Value = market value of OS premium (% of property price), i.e., the benefit of proximity to open space captured by a property

All other models:

Value = total **net** benefit to consumer (consumer surplus, CS)
= benefits above and beyond any costs of (expenditures on) the activity in question

 Value estimates do not include trip or equipment expenditures or associated economic impacts (sales, earnings, jobs)

Estimating habitat values

All values are context-specific (location matters!), most vary from one site to the next

- ▶ Ideally: value of a site should be estimated by an original empirical study of the site using the same methods relied upon in the toolkit

Problem: Expensive, time-consuming

Alternative: Benefits transfer



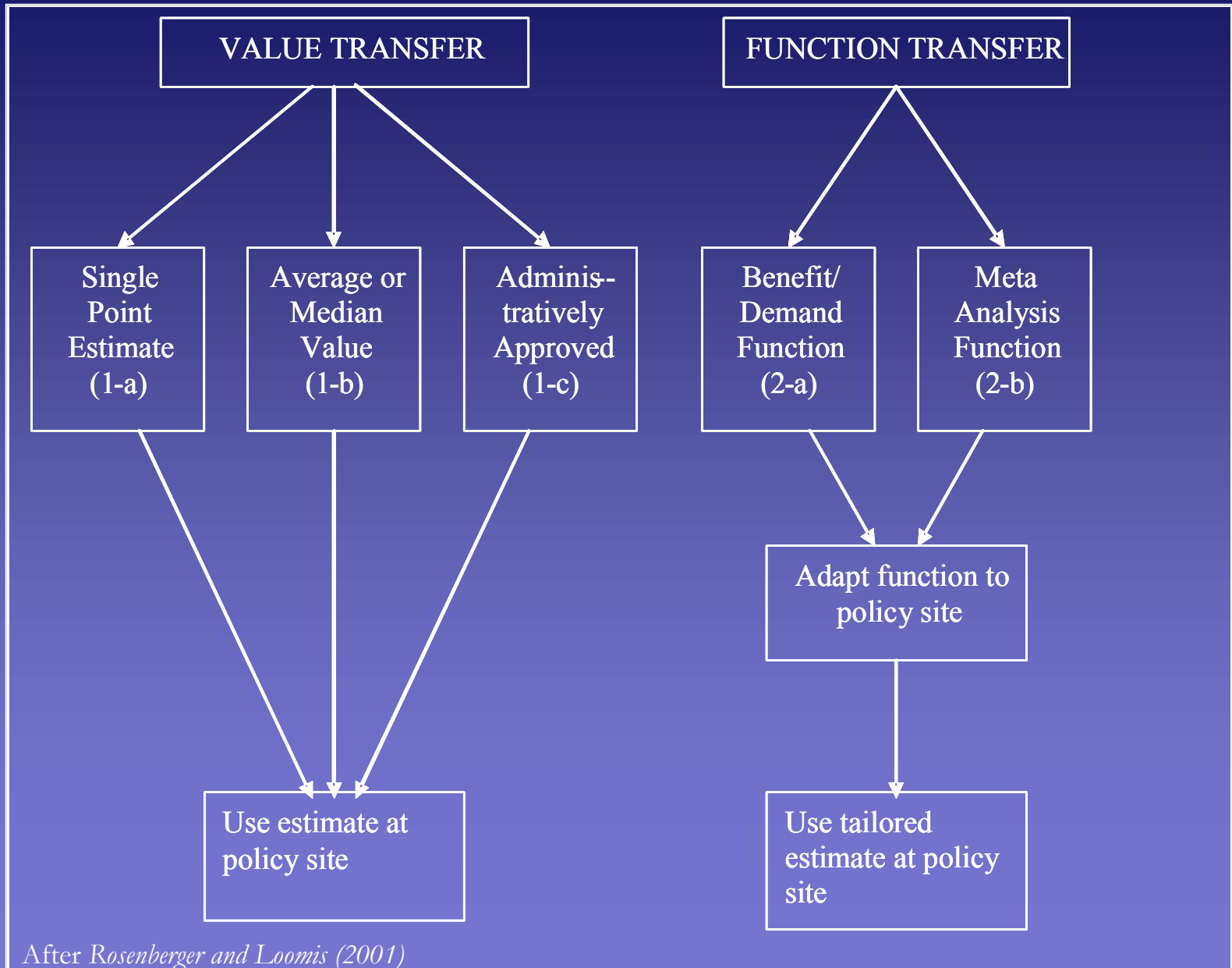
Benefits transfer

= Application of a value per unit estimate (per visitor day, per household, per acre) **from an existing study site to an unstudied policy site** for which such a benefit per unit value is needed.

Issue of concern: validity of estimate to the transfer site; requires

- Similarity of resource characteristics valued by people (quantity, quality)
- Similarity of user profiles
- Equality of values considered (TEV, use, passive use)
- Equality of value measures (total value, marginal value)

Approaches to benefits transfer



Toolkit valuation models

Based on meta-analyses

- Regression analyses of literature findings
- Pooling dozens to hundreds of observations
- Systematically account for differences in study methods and contexts to identify variables that explain the variation of results observed across primary studies

Meta analyses yield valuation functions (models)

- Can be used to estimate current values of habitat
- Can be used to predict changes in values associated with specific projects (habitat size increase, T&E species population increase, water quality improvement)

Value of Fishing per Angler Day

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ENTER >	<input type="text" value="0"/>	Great Lakes

OUTPUT \$/ Angler Day (2006 base year)



Toolkit valuation tables

- Based on literature reviews
- Provide mean, median, low and high values

Average Fishing Values (per angler day)

converted to 2006 base year

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Valuation study databases

- Valuation table spreadsheets include the associated databases from which tabular values were calculated
- Databases contain hundreds of studies analysts may use to identify values for point or average value transfer that most closely match their site/species of interest.

Open space property value premium model



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Reviewed 55 original quantitative OS studies

- National parks, forests and wildlife refuges
- State parks, state forests and forest preserves
- County/large urban parks
- Private forest lands and parks
- Study types: hedonic, CV, hybrid (conjoint analysis + CV), VECM, spatial equilibrium modeling



Pooled dataset contains 55 observations of OS premiums for “natural” open spaces



Location of included studies



Open space property premium value model

- 4 different model specifications tested
- 14 - 16 variables
- Final, reduced model retains only the 7 significant variables
- Explains 54% of observed variation in OS premiums in pooled dataset



Open space property premium value model

Model estimates open space property value premiums as a function of:

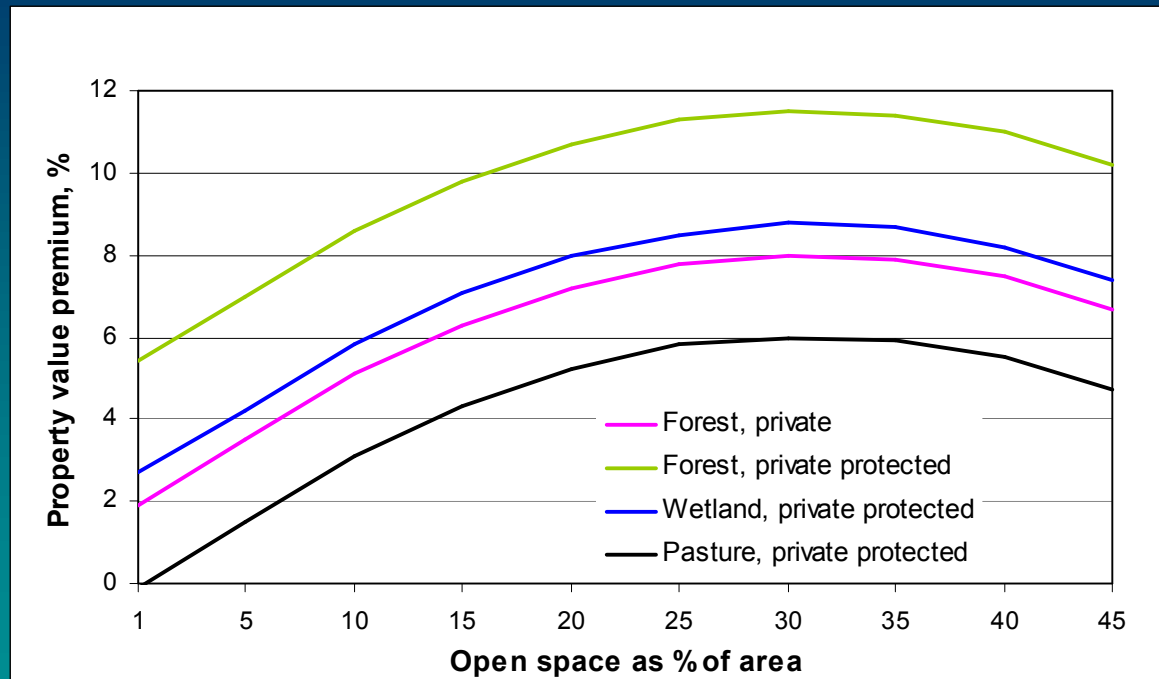
- **% of an area** that is covered by the specific open space of interest
- **land cover characteristics** (forest, park, pasture, wetland)
- **land ownership** (private, public, mixed)
- whether land is **protected** or not

Findings

- 10% increase in the percentage of open space in an area increases property values on average by 3.5%;
- marginal premiums decrease for successively larger open spaces
- premium is higher for forested, private, or protected open space or for parks
- premium is lower for agricultural open space

Open space property premium value model

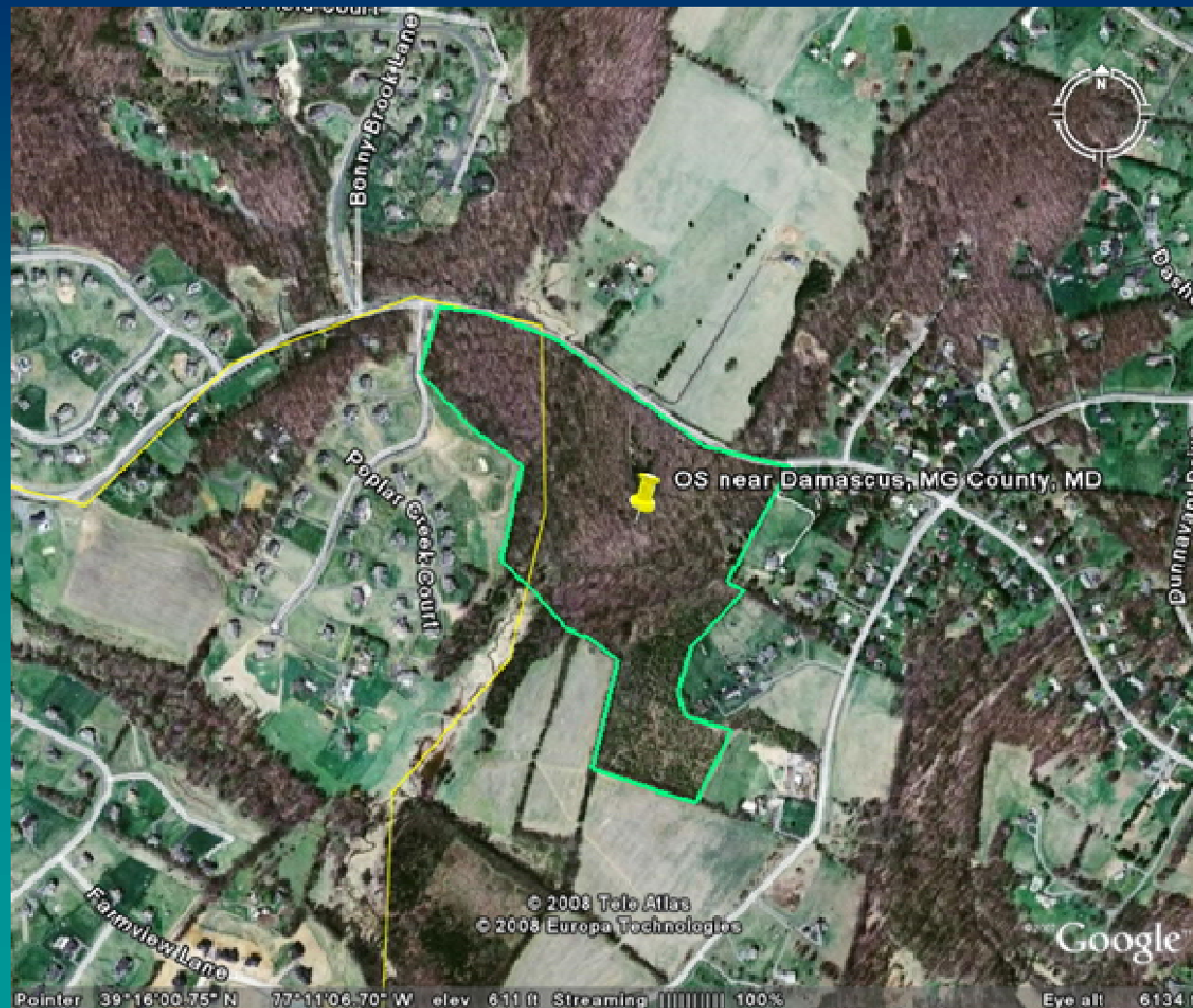
Estimated OS premium as a function of relative size of an open space (for selected open space types)



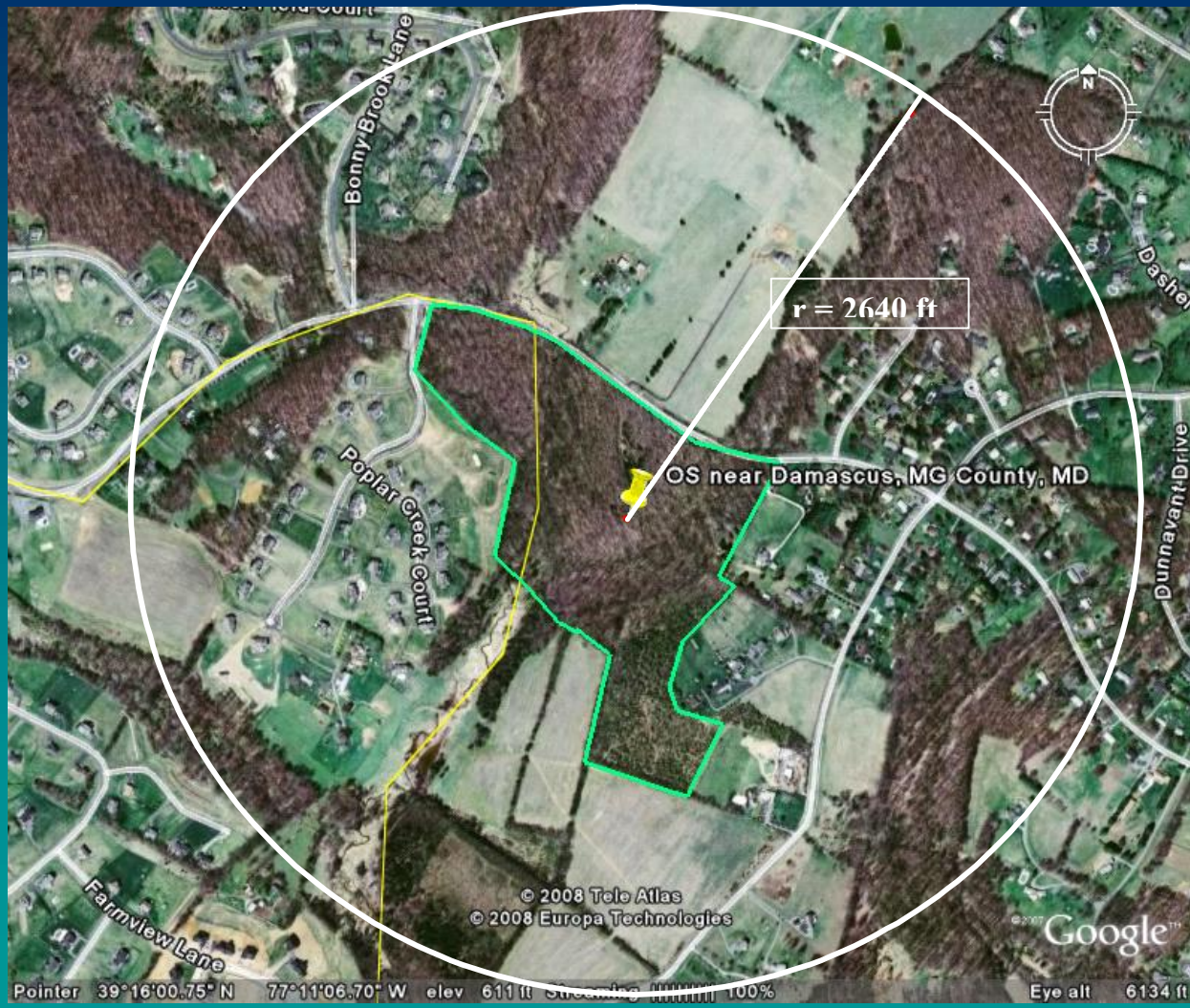
NOTE: The model likely underestimates the size of actual open space premiums (because of transformation of data to generate pooled dataset)

Open space property premium value model

Example: 50-acre forested open space, privately owned, under conservation easement



Open space property premium value model



Property value premium estimator model

Instructions: Fill in all cells marked "ENTER >". (See accompanying user manual for detailed instructions and documentation.)

[OS property premium model](#)

STEP 1: Select shape of area of analysis in which property value premiums are analyzed

ENTER > Enter "C" for circular and "R" for rectangular shape of area

STEP 2: Enter the radius (circular area) or length and width (rectangular area) of the area of analysis

ENTER > Radius of area in feet

OUTPUT: **503** Size of study area (acres)

STEP 3: Enter the size of the open space

ENTER > Size in acres of the open space whose property value impact is to be estimated

OUTPUT: **9.9** %OSChange. Percentage of the study area occupied by the open space of interest.
Example: A 20 percent increase in open space in the area of interest is indicated as "20".

STEP 4: Enter the appropriate values for the indicator variables

ENTER > FOR. Enter "1" if the open space is a forest. Otherwise, enter "0".

ENTER > PARK. Enter "1" if the open space is a park. Otherwise, enter "0".

ENTER > AG. Enter "1" if the open space is agricultural land. Otherwise, enter "0".

ENTER > PROT. Enter "1" if the open space is protected. Otherwise, enter "0". Protection is defined as the absence of the possibility of development (i.e., easement, public ownership).

ENTER > PRIV. Enter "1" if the open space is privately owned. Otherwise, enter "0".

$P_{OS} =$ % increase in average residential property value from open space of interest

STEP 5: Enter the number of residential properties located in the area

ENTER Number of properties located in study area. NO

ENTER > Average value of properties (\$)

OUTPUT: **\$5,415,004** Estimated total property premium in study area attributable to open space of interest

Use public assessor/private appraiser or Census data to get this info

Open space property premium value model

- The model was estimated on the basis of observations that link *increases in OS* in an area to increases in residential property values.



The model quantifies the particular value premiums associated with a specific open space, existing or proposed, or of improvements to an existing open space, independent of (i.e., in addition to the effect of) any other open spaces in the area.

The impact of other open spaces on the size of the premiums associated with the particular open space in question are already implicitly accounted for in the estimates, because the observations in the source studies on the basis of which the model was estimated express the marginal or incremental impact of an *additional* unit of open space on property values, *given the total quantities of open space in the study area.*

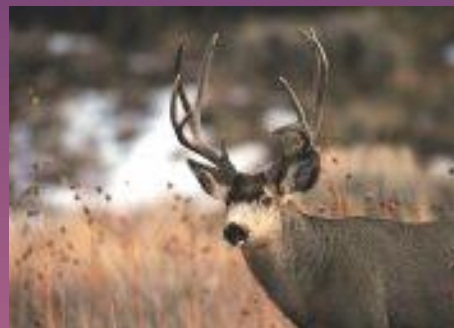
Habitat and Species Valuation models and Visitor Use Estimation models



KY DFW



Adele Hodde, IL DNR



NM DGF



GA DNR

Overview: Habitat and Species Valuation Models

- 1) Habitat Valuation Tables and Models
 - Wetlands value per acre table & models (2)
 - Aquatic resource improvements model
 - Terrestrial habitat model

- 2) Species Valuation Models
 - Salmon value table & model
 - T/E and rare species values & model

All models are based on meta-analyses of literature

Example:

Wetland Value per acre Meta Function 2a

Wetland Valuation Model 2

Total Economic Value of Wetlands per Acre

Instructions: Fill in all cells marked "ENTER >".
See accompanying user manual for detailed instructions and documentation.

STEP 1:	Enter average household income for the particular state the wetland is in; can be found in 'State HH Income' Tab- column B	
	ENTER >	\$0
STEP 2:	Enter the total acres of the wetland to be valued	
	ENTER >	0.00
STEP 3:	Enter share of wetland acres for the particular state the wetland is in, can be found on 'Share' Tab, Column D	
	ENTER >	0.00
STEP 4:	Place a 1 next to the type of wetland to be valued; 0 otherwise.	
	ENTER >	0
	ENTER >	0
	ENTER >	0
		Freshwater Marsh
		Saltwater Marsh
		Prarie Pothole
STEP 5:	Place a 1 next to the region the wetland is in; 0 otherwise	
	Explanation of regions can be found in the 'ERS Farm Regions' Tab	
	ENTER >	0
	ENTER >	0
	ENTER >	0
	ENTER >	0
		Heartland
		Northern Crescent
		Mississippi Portal
		All Other Regions
STEP 6:	Place a 1 next to the ecosystem service to be valued; 0 otherwise	
	ENTER >	0
	ENTER >	0
	ENTER >	0
	ENTER >	0
	ENTER >	0
	ENTER >	0
	ENTER >	0
	ENTER >	0
	ENTER >	0
		Flood Prevention
		Water Quality
		Water Supply
		Recreational Fishing
		Commercial Fishing
		Birdhunting
		Birdwatching
		Amenity
		Habitat
OUTPUT		
	\$0	Flood prevention
	\$0	Water Quality
	\$0	Water Supply
	\$0	Recreational Fishing
	\$0	Commercial Fishing
	\$0	Birdhunting
	\$0	Birdwatching
	\$0	Amenity
	\$0	Habitat
Total for all Ecosystem Services---->	\$0	\$/ Acre (2006 base year)
	\$0	Total \$ Value of Wetland

Example: Statistical model underlying valuation spreadsheet

Wetland Valuation Model 2

1	<u>Variable</u>	<u>Mean</u>	<u>Coefficient</u>	<u>Product</u>
2				
3	Constant	1.00	-2.297	-2.297
4	INCOME (/1000)	43.95	0.095	4.175155
5	YEAR	16.32	0.197	3.21504
6	ACRES	356640.19	-3.85E-07	-0.137306473
7	SHARE	0.13	-5.415	-0.70395
8	FRESHWATER MARSH	0.54	-1.088	-0.58752
9	SALTWATER MARSH	0.28	-2.087	-0.58436
10	PRARIE POTHOLE	0.10	-1.961	-0.1961
11	HEARTLAND	0.07	1.316	0.09212
12	NORTHERN CRESCENT	0.28	2.681	0.75068
13	MISSISSIPPI PORTAL	0.17	-0.158	-0.02686
14	ALL OTHER REGIONS	0.31	-0.585	-0.18135
15	FLOOD	0.25	-0.477	-0.11925
16	WATER QUALITY	0.28	1.235	0.3458
17	WATER SUPPLY	0.21	0.929	0.19509
18	RECFISH	0.32	-0.015	-0.0048
19	COMFISH	0.28	1.073	0.30044
20	BIRDHUNT	0.32	0.015	0.0048
21	BIRDWATCH	0.24	1.57	0.3768
22	AMENITY	0.19	-1.518	-0.28842
23	HABITAT	0.32	0.023	0.00736
24	CVM	0.39	-1.437	-0.56043
25	HP	0.04	-0.154	-0.00616
26	TCM	0.06	-0.658	-0.03948
27	NFI	0.19	0.628	0.11932
28	PFMP	0.07	-1.827	-0.12789
29	EA	0.03	5.296	0.15888
30	PUBLISH	0.69	2.489	1.71741
31				
32	Ln \$/acre of wetland			\$ 5.60
33				
34	\$/acre (2003 base year)			\$ 269.89

Overview: Habitat and species valuation models (contd.)

3) Activity Values and Models

- Hunting: Average values, database & model
- Fishing: Average values, database & model
- Wildlife viewing: Average values & database

All models are based on meta-analyses of the literature

Bruce Schuette, MO DNR



Example: Hunting Value/day table (+underlying database) ...

[Hunting Value Table](#)

Hunting Value Table (per day)

converted to 2006 base year

Species Category	N	NORTHEAST	N	SOUTHEAST	N	INTERMOUNTAIN	N	PACIFIC	N	ALASKA	N	NATION
Big Game	142		66		141		30		13			6
Min		\$4.25		\$6.16		\$6.39		\$10.18		\$15.30		\$21.31
Max		\$298.29		\$138.19		\$294.37		\$172.35		\$133.78		\$287.54
Average		\$58.45		\$54.94		\$71.37		\$59.16		\$62.82		\$186.12
Median		\$52.15		\$50.34		\$58.43		\$54.31		\$50.07		\$192.02
Small Game	11		1		27		4					7
Min		\$3.81		\$165.04		\$4.35		\$36.70				\$21.15
Max		\$69.92		\$165.04		\$275.28		\$305.65				\$89.49
Average		\$32.40		\$165.04		\$65.51		\$155.62				\$69.07
Median		\$33.88		\$165.04		\$46.67		\$140.07				\$74.57
Waterfowl	39		24		31		12					2
Min		\$3.27		\$21.91		\$3.58		\$24.34				\$123.04
Max		\$126.42		\$126.42		\$250.38		\$133.26				\$145.42
Average		\$35.99		\$45.85		\$51.77		\$64.82				\$134.23
Median		\$29.21		\$35.42		\$35.42		\$47.98				\$134.23

Loomis, J. and L. Richardson, 2007. Benefit Transfer and Visitor Use Estimating Models of Wildlife Recreation, Species and Habitats. Department of Agricultural and Resource Economics, Colorado State University.

... and Model

[Hunting Value Per Day META Function](#)

Value of Hunting per Hunter Day

Instructions: Fill in relevant cells marked "ENTER >" associated with the region the hunting value is for, the land ownership type, and if the type of species being valued is
Hit the enter key to get the value per day in output box.
See accompanying user manual for detailed instructions and documentation.

STEP 1: Enter a 1 next to the site location; 0 otherwise

ENTER >	<input type="text" value="1"/>	Intermountain region (AZ, CO, ID, KS, MT, ND, NE, NM, NV, SD, UT, WY)
ENTER >	<input type="text" value="0"/>	Northeast region (CT, DE, IA, IL, IN, MA, MD, ME, MI, MN, MO, NH, NJ, NY, OH, PA, RI, VT, WI, WV)
ENTER >	<input type="text" value="0"/>	Pacific region (CA, HI, OR, WA)
ENTER >	<input type="text" value="0"/>	Southeast region (AL, AR, FL, GA, KY, LA, MS, NC, OK, SC, TN, TX, VA)

STEP 2: Enter a 1 if land ownership is public; 0 if private or mixed public private)

ENTER >

STEP 3: Enter a 1 if the species being hunted is waterfowl; 0 if big or small game

ENTER >

OUTPUT \$/ Hunter Day (2006 base year)

User Benefit Transfer Options

1. Use average value for activity, habitat or species by region from Value Tables; OR:
2. Use database to find most similar study and apply that value; OR:
3. Use meta analysis based value functions
 - Spreadsheet templates
 - User sets relevant variables to customize estimate to site



Overview: Visitor Use Estimation models

- 1) National Wildlife Refuge and State Wildlife Management Area Visitation Models for lower 48 states
- 2) State level Visitation Models for lower 48 states

Each set of models contains the following models:

- Wildlife viewing
- Hunting: Total Hunting, Big Game, Small Game, Migratory Birds
- Fishing: Freshwater and Saltwater

1) Refuge/State Wildlife Area visitation models

- Based on regression analysis of FWS NWR visitation data, refuge characteristics and population and income in surrounding area

Example:

[Refuge](#)
[Nonconsumptive](#)
[Visitor Use](#)
[Estimating Model](#)

Non-consumptive User Days per Year (new Refuge/wildlife area)

Instructions: Fill in relevant cells marked "ENTER >" associated with Refuge or wildlife management area acres, coastal vs. non-coastal, income and population of surrounding counties. Hit the enter key to get nonconsumptive visits per year in output box. See accompanying user manual for detailed instructions and documentation.

STEP 1: Enter the total acres within the Refuge/wildlife area

ENTER >

0

STEP 2: Enter a 1 if open coastal water is present on the Refuge/wildlife area; 0 otherwise

ENTER >

0

STEP 3: Enter the per capita income of surrounding counties. Can be found at: <http://www.bea.gov/regional/reis/>
Click on state at bottom of page to get per capita income by county

ENTER >

\$0

STEP 4: Enter the population of counties within a 60 mile radius of the Refuge/wildlife area

ENTER >

0

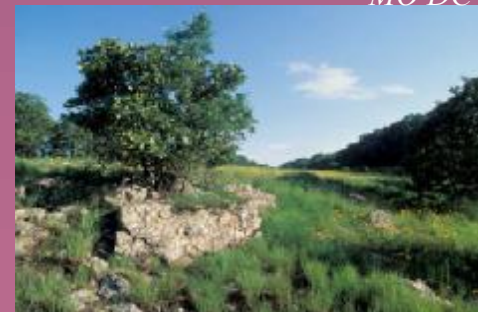
OUTPUT

0

Nonconsumptive User Days / year

2) State-level visitation models

- Based on regression analysis of state-level wildlife related recreation activity days (hunting, fishing, and wildlife viewing from USFWS National Survey), acres of habitat and land access for a state, and human population and median income for that state



State-level visitation models

Example:

[State Level Wildlife Viewing Visitor Use Estimating Model](#)

State Wildlife Viewing Days

Instructions: Fill in relevant cells marked "ENTER >" associated with acres and state income and population.
Hit the enter key to get the change in wildlife viewing days per year in output box.
See accompanying user manual for detailed instructions and documentation.

CURRENT STATE VALUES (use the 'State Variable Input' Tab)

STEP 1: Enter the current acres of each type of land within the state of interest (use the 'State Variable Input Values' Tab)

ENTER > State Forest Land
ENTER > Private Forest Land

STEP 2: Enter household median income for the state of interest (use the 'State Variable Input Values' Tab)

ENTER >

STEP 3: Enter the state population (use the 'State Variable Input Values' Tab)

ENTER >

16,477 State Wildlife Viewing Days / year

STATE VALUES WITH MANAGEMENT/POLICY ACTION

STEP 1a: Enter the total number of acres of each type of land within the site of interest

ENTER > State Forest Land
ENTER > Private Forest Land

16,477 Wildlife Viewing Days / year for the site of interest

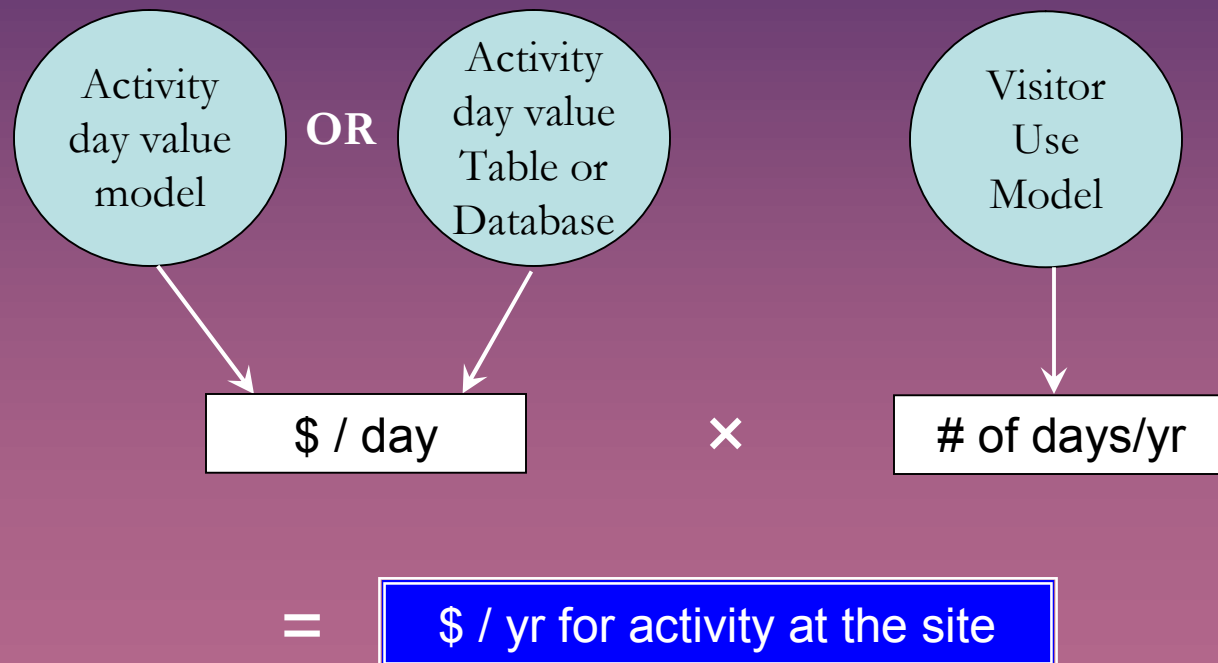
CHANGE IN VISITATION DUE TO MANAGEMENT/POLICY ACTION

0 Change in Wildlife Viewing Days / year

Linking Activity Day Values and Visitor Use models

Estimating the value of a site for wildlife-associated recreation:

- Fishing
- Hunting
- Wildlife viewing



Combining Model Outputs

Activity valuation models (wildlife-associated recreation)

+ Habitat Valuation models (wetlands, terrestrial and aquatic habitats)

+ Species Valuation models (T&E, Salmon)

+ Open Space Property Value Premium model

Value estimates can be combined to generate an estimate of the “total” value of a site/habitat

Requirement: some models have variables for a value estimated in other models; these variables must be set to zero to avoid double counting when combining model results.

Example: Terrestrial Habitat model has open space variable. If adding results of OS Property Premium model and Terrestrial Habitat model to estimate the value of a site, set the OS variable in the Terrestrial Habitat model to “0”.

Now its your turn to try the models!

- Exercises to apply each type of model
- Feedback
 - Please note anything that is not clear in the spreadsheet input & results screens
 - Please note anything confusing in the instructions, examples
 - Please let us know how to improve the spreadsheets to make them more useful to you in your job