IMPACTS AND BENEFITS OF WATERFOWL PRODUCTION AREAS

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LIST OF ACRONYMS

Acronym	Meaning
CH	Charbonneau and Hay, 1978 paper
DMBM	Division of Migratory Bird Management, FWS
FHWR	National Survey of Fishing, Hunting, and Wildlife-associated Recreation
FWS	U.S. Fish and Wildlife Service
GDP	Gross Domestic Product
GHCN	Global Historical Climatology Network
HAPET	Habitat and Population Evaluation Team
HB	Hammack and Brown, 1974 book
IMPLAN	Impact Analysis for Planning software
I-O	Input-Output
NEV	Net Economic Value
PPR	Prairie Pothole Region
SUR	Seemingly Unrelated Regression
WMD	Wetland Management District
WPA	Waterfowl Production Area

NOTATION

Parameter	Meaning
q_w	Number of respondents at WMD w.
q_{aw}	Number of respondents at WMD w, pursuing activity a
Q_{aw}	Total number of visits by respondents at WMD w, pursuing activity a
N_{aw}	Number of annual visits to WMD w in activity a
N_w	Total number of annual visits to WMD w
Z_k	Vector of the minimum, maximum, or average number of visits in survey question
X_{ad}	Non-transportation expenditures by local or non-local visitors in activity a
L_{dw}	Average mileage from local or non-local visitors ZIP code to WMD w
C_{adw}	Total trip costs of local or non-local visitors participating in activity a at WMD w
NEV_a	Net economic value for activity a
NEV_{aw}	Total net economic value for activity a at WMD w
M	Individual income
S	Number of seasons hunted
E	Hunting expenditures
B	Seasonal bag
V_{Hi}	Individual's value of hunting in state H
h_H	Number of waterfowl hunters in state H
V_H	Value of hunting in state H
V_n	Value of hunting attributable to breeding state n
V_{On}	Value of hunting attributable to breeding state n in land ownership category O
V_w	Value of hunting attributable to WMD w
T	Proportion of duck lifetime spent on breeding grounds
P_{nH}	Probability that a duck in hunting state H was hatched in breeding state n
P_{On}	Probability that a duck in breeding state n was hatched on land in ownership category O
P_{Ow}	Probability that a duck was hatched on land in ownership category O at WMD w
P_{Own}	Probability that a duck in breeding state n was hatched on land in ownership category O at WMD w
R_{Own}	Recruitment rate for WMD w, in state n, and land ownership category O
A_{Own}	Area in square miles of WMD w, in state n, and land ownership category O
Indexes	
a	Recreational activities
w	Wetland management districts
d	Local/Non-local residence
i	Individual hunters
H	Hunting states (50 states)
n	Prairie Pothole Region breeding states (MN, ND, SD)
O	Ownership category (federally owned, F; federal easement, E; private, G)

EXECUTIVE SUMMARY

The U.S. Fish and Wildlife Service (FWS) manages lands set aside to preserve and develop nesting habitat for ducks and geese. These Waterfowl Production Areas (WPAs) provide recreational opportunities to their neighbors as well as increasing waterfowl populations. This study measures the impact of WPA visitors on the regional economies nearby and the benefits received by visitors to WPAs and those who hunt WPA produced waterfowl elsewhere in the country. The site-related estimates focus on Minnesota where a recent survey provided information about visitors. The off-site benefit estimates encompass the three Prairie Pothole Region (PPR) states of Minnesota, North Dakota, and South Dakota. These estimates will help planners by giving them a wider perspective on the role of WPAs in the regional and national economy.

Nearly 3,000 WPAs in 10 states preserve more than 735,000 acres of federally owned wetland habitat. An additional 2.2 million acres are managed under easement or leased to FWS. Most WPAs are in the Prairie Pothole Region of Minnesota and the Dakotas. Each year 98 percent of the revenues from the sale of federal Duck Stamps are used to expand the WPA and wildlife refuge system (DOI, 2005). WPAs are managed in multicounty units called Wetland Management Districts (WMDs) which coordinate wetland issues among federal, state, and private landowners.

If they are large enough, federally owned WPAs are open for public recreation, including hunting, fishing, and hiking. Most WPAs are not highly developed, but some have marked trails and parking areas. Section 1 of this document addresses the impacts and benefits that onsite recreation generates for society. It details the methods used to develop impact and benefit estimates and contains a discussion of the results.

FWS assesses each WPA periodically to determine what it needs to allow waterfowl to thrive. Nesting failure is the greatest constraint on waterfowl populations. In addition to preserving nesting habitat in WPAs, FWS may control predators and otherwise enhance the habitat to increase nesting success. As a result, WPAs produce more ducks per acre than neighboring private lands. The birds raised on WPAs migrate to other parts of the nation. As these birds migrate, they are hunted. The additional ducks provided by WPAs contribute to the benefits hunters enjoy from their sport. Using banding data, we estimate the benefits hunters receive down the flyway from WPA ducks. Section 2 of this document assesses these offsite benefits.

The rest of the Executive Summary provides an overview of the information presented in Sections 1 and 2. It also highlights key findings of the study in a brief conclusion.

ONSITE RECREATION

Neighborhood Impacts

Input-Output analysis (I-O) is a tool that economists use to model the interactions among industries. I-O uses matrix algebra to show how a dollar spent in one industry flows through the economy to other industries. I-O estimates the change in output of the economy, the number of new jobs created, and the additional labor income from a given stimulus. Caudill and Henderson (2003) combined FWS management information with regional I-O data to estimate the impacts of visitors to national wildlife refuges on nearby communities.

We conducted a similar analysis of the impacts of onsite recreation at WPAs using a survey of Minnesota WPA users (Vlaming et al., 2003). The survey included a question about the number of times during the course of a year that the respondent visited the WPA for different activities. Answers to this question were compiled and combined with estimates of the total number of visits to estimate the number of visitor-days in each activity in each WMD. The National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (FHWR) provided estimates of visitors' spending while on trips to WPAs. Combining this information yielded the total spending by visitors in each activity during the course of a year.

For modeling purposes, we defined the economic region as those counties in the WMD and any adjacent counties that contained major commercial centers. Impacts were estimated by applying the total expenditures related to each WMD to appropriate industry categories in a regional economic model. By far the largest cost category is gas and oil for driving to the WPA. This spending has only a small impact on the local economy because petroleum products are produced in only a few locations in the United States.

The regional impact results showed the five WMDs included in the Vlaming et al. survey generated $19.8 million (2004$) in spending by all visitors. Of this amount, $16.1 million came from visitors who had traveled more than 60 miles to the WPA. This non-local spending is a strong stimulus to rural communities. The regional economies cannot exploit this stimulus as well as more metropolitan areas. Nevertheless, the non-resident visitors to the five WMDs stimulated $ 18.7 million in additional output and 220 new jobs.

Table E-1. Summary of Non-Local Visitors Impact Results.

Wetland Management District	Non-Local Spending (thousand 2004$)	Total Impact (thousand 2004$)	Direct Jobs (Jobs)	Total Jobs (Jobs)
Detroit Lakes	$ 1,803.0	$ 2,053.9	17.6	22.2
Fergus Falls	3,500.1	4,095.7	36.0	46.2
Litchfield	1,606.7	1,997.5	17.9	23.5
Morris	7,059.5	8,765.1	75.4	107.0
Windom	1,536.9	1,781.4	16.9	20.8
Total	15,506.1	18,693.7	163.8	219.7

Neighborhood Benefits

Visitors to WPAs enjoy interactions with wildlife in a natural setting. FHWR asked each survey respondent about their net economic value (NEV) for a day of wildlife-associated recreation (U.S. Department of the Interior, 2003). The values stated by Minnesotans were $46 per day for wildlife viewing, and $48 per day for fishing. Since deer hunting was the only form of hunting considered in the Minnesota portion of the FHWR survey, we applied a value from the Charbonneau and Hay (1978) study to waterfowl hunters, $38 per day, and the deer hunting value to other forms of hunting on WPAs. We estimated the annual benefits to WPA visitors by applying these values to estimates of the number of visitor-days in each activity. Table E-2 shows that visitors garnered more than $9.9 million in increased well-being from their experiences at these five WMDs.

Table E-2. Annual NEV of On-Site Recreation Visitors
(thousand, 2004$)

WMD	Hunting	Fishing	Viewing	Total
Detroit Lakes	$ 621	$ 192	$ 333	$ 1,146
Fergus Falls	1,297	105	406	1,808
Litchfield	2,489	184	388	3,061
Morris	2,423	178	435	3,036
Windom	627	47	135	809
Total	$ 7,457	$ 706	$ 1,697	$ 9,860

WPAs provide many other services to society. Wetlands filter sediment and nutrients from water as it passes through. They also attenuate storm surges reducing flooding downstream. Isolated wetlands help to recharge groundwater supplies and provide habitat for many plants and animals. Thus, these estimates of direct use benefits for WPAs are only a small portion of the total benefits from the WPA program.

OFFSITE BENEFITS

Federal management of WPAs increases waterfowl production. The birds produced on WPAs migrate down the Mississippi Flyway to states as far away as Florida and Virginia. Hunters in the states they cross have the opportunity to hunt them and birders have the opportunity to observe them. Studies show that, generally, hunters enjoy their outings more if they see and bag more ducks. Birders are less interested in quantity, but enjoy knowing that there are plenty of birds in the wild. Thus, birds from WPAs contribute to recreational and hunting opportunities far from their place of origin and add to national well-being.

This portion of the study focuses on the contribution to national welfare from hunting WPA waterfowl. While birders' enjoyment is no less important, it presents much greater methodological issues. To calculate WPAs' contribution to national welfare, we first estimated the total benefits derived from duck hunting and then determined the proportion of that benefit that is attributable to WPA's. To accomplish this, we first determined the average NEV that one individual places on the hunting experience. The NEV of waterfowl hunting differs widely by state and region. Charbonneau and Hay

(1978) collected national data and estimated hunting benefits for all four flyways. We updated their values and estimated an individual NEV for each state. Updated to 2004 dollars and present incomes, individual NEV for the hunting season ranges from $279 in Michigan to $1,311 in Florida. The average is $569.

Next, we multiplied the average individual NEV estimate by each state's population of waterfowl hunters to calculate state-by-state benefits of additional waterfowl. There are 1.6 million waterfowl hunters in the United States so the national NEV of waterfowl hunting is estimated to be $770 million.

Finally, we determined the portion of the total benefits attributable to the PPR states and to individual WMDs. First, we established the connection between states where ducks are hunted and states where they originate. Then, we determined the incremental number of ducks from WPAs vis-a-vis private lands. WPAs produce 20 to 27 percent of North and South Dakota's duck output, while they produce 7 to 11 percent of Minnesota's duck production. WPAs in the Dakotas are larger and support a higher density of ducks. Ducks from federally managed lands are responsible for $8.4 million of hunters' NEV.

Table E-3 summarizes our preferred point estimate of the NEVs attributed to each state. There are many alternative formulations that are not shown. Alternative estimates of the total benefit to waterfowl hunting from federally managed WPAs range from $3.8 million to $9.9 million.

Table E-3. Net Economic Values Allocated to States and WPAs
(thousand 2004 dollars)

State	Value to State	Attributable to Breeding Grounds	Attributable to Federal Lands & Easements	Percent of Breeding Ground Value from Federal Lands & Easements
Minnesota	$ 2,150.9	$1,132.3	$ 83.7	7.4%
North Dakota	60,129.3	31,654.4	6,481.7	20.5%
South Dakota	16,671.1	8,776.3	1,789.9	20.4%
Total	$ 78,951.3	$ 41,563.1	$ 8,355.3	

CONCLUSIONS

This study estimated three important economic measures of WPAs.

- The **NEV of offsite hunting of waterfowl** produced on Prairie Pothole Region WPAs is **$ 8.4 million** with a range of $ 3.8 million to $ 9.9 million.

- The **NEV of recreational visitors' use** of WPAs in Minnesota is **$ 9.9 million**.

- The **impact of Minnesota WPAs** non-local visitor spending on the local economy is **$18.7 million in additional output and 220 new jobs**.

Clearly, there are many ways to arrive at these estimates and the values we calculated reflect the choices made in this study. Alternative approaches and different choices will yield different estimates, but these are likely to fall within our range of results.

Many factors go into the regeneration of waterfowl and assigning value to each one is a fool's errand. An attribute that was vitally important one year might be less important the next because of changes in rainfall, weather, or policy. A change in bag limits or hunting seasons, for example, could have more significance for waterfowl hunting benefits than the number of ducks available.

WPAs provide many other services to society that were not addressed in this study. They have become important reserves for endangered species and wetland habitat. In addition, they provide hydrological services, such as groundwater recharge. Society needs and values these services in addition to those discussed in this study.

SECTION 1
LOCAL IMPACTS OF VISITORS TO WATERFOWL PRODUCTION AREAS

The U.S. Fish and Wildlife Service (FWS) manages lands set aside to preserve and develop nesting habitat for ducks and geese. These Waterfowl Production Areas (WPAs) provide recreational opportunities to their neighbors as well as increasing waterfowl populations. The primary purpose of this report is to estimate the value of the additional recreation attributable to federal management of WPAs. This study measures the benefits received by visitors to WPAs and those who hunt WPA produced waterfowl elsewhere in the country as well as the impact of WPA visitors on nearby regional economies. The site-related estimates focus on Minnesota where a recent survey provided information about visitors. The off-site benefit estimates encompass the three primary Prairie Pothole Region (PPR) states of Minnesota, North Dakota, and South Dakota. These estimates will help planners and decisionmakers by giving them a wider perspective on the role of WPAs in the regional and national economy.

The Duck Stamp Act of 1934 authorized federal intervention to preserve wetland habitat for migratory birds. The Service developed these acquisitions and easements into a system of nearly 3,000 WPAs. In the Prairie Pothole Region of Minnesota and the Dakotas, FWS has acquired approximately 600,000 acres in WPAs and holds long term easements on another 2.2 million acres. Table 1-1 shows the acreage acquired or leased in fiscal years 2000 through 2004 for WPAs in the PPR and nearby states. WPAs claimed 59 percent of Federal Duck Stamp revenues during these years and almost 300,000 acres were protected. Much of the acquisition emphasis has been on South Dakota during these years though other states also continue to increase WPA holdings. While the primary purpose of WPAs is waterfowl nesting habitat, federally owned WPAs are open for recreation.

Visitors spend money wherever they go, and that spending generates economic activity. Imagine Las Vegas or Cancun without the economic activity generated by tourists. Visitor spending also generates job opportunities, not only in the tourist service industries but in the whole economy. The ripple effect as visitor spending flows through the economy can generate new economic activity in a region. This section quantifies the impact of spending by visitors to Minnesota WPAs.

Input-Output analysis (I-O) is a tool that economists use to model the interactions among industries. I-O uses matrix algebra to show how a dollar spent in one industry flows through the economy to other industries. The I-O analysis estimates the change in output of the economy, the number of new jobs created, and the additional labor income from a given stimulus.

What Economists Mean By "Benefits" and "Impacts"

Benefits

Consumer surplus is the difference between what a consumer is willing to pay for a good and what she actually had to pay to consume it. The terms "Benefit" and "Net Economic Value" are synonymous with "consumer surplus."

To make the concept more concrete, consider buying an apple. If you pay $1.00 for the apple, the pleasure of enjoying the apple must be worth at least $1.00 to you. You were willing to pay $1.00 enjoy it. If the apple costs $5.00, you might reconsider and decide not to buy it. An economist would say that $5.00 "exceeds your willingness to pay." The total economic value you derive from the apple, therefore, is somewhere between $1.00 and $5.00.

Say the maximum you are willing to pay is $1.75, then the total economic value you receive from an apple is $1.75 and the net economic value is 75 cents ($1.75 minus the $1.00 you had to pay for it). Thus 75 cents is your benefit from consuming the apple.

Impacts

Impacts are the flows of resources associated with final demand. They represent the full economic consequences of a consumer purchase.

Returning to the apple analogy, the $1.00 you paid at the grocery store to consume the apple stimulates a long train of resource transactions. In addition to paying the wholesaler for the apple, the grocery store uses your $1.00 to pay its staff to stock the shelves and run the cash registers. The grocery store counts the $1.00 as revenue and the wholesaler also counts the portion of the $1.00 that he receives as revenue. The employee at the cash register receives part of the $1.00 as income and might buy something at the store further adding to the store's revenue. Your $1.00, therefore, has an impact on the local economy that is greater than $1.00 considering all of the cycles of spending associated with your purchase. Economists refer to these total reverberations of spending as impacts.

Table 1-1. Fish and Wildlife Service WPA Acquisitions, by State, Acres and Dollars, 2000-2004.

State	Acres				
	2000	**2001**	**2002**	**2003**	**2004**
Minnesota	4,230	2,659	3,659	3,632	2,074
North Dakota	7,355	7,589	6,462	5,920	4,643
South Dakota	56,167	56,762	36,918	29,641	29,617
Iowa	1,520	582	1,555	358	881
Wisconsin	743	374	410	311	253
Montana	8,830	13,109	5,597	1,364	1,937
Total Acres	78,845	81,074	54,601	41,227	39,405
	Nominal Dollars				
	2000	**2001**	**2002**	**2003**	**2004**
Minnesota	$ 3,410,976	$ 2,689,130	$ 3,239,060	$ 3,329,137	$ 2,236,055
North Dakota	1,061,570	947,125	1,093,900	689,500	669,950
South Dakota	6,209,763	7,476,411	6,602,647	6,072,260	7,803,395
Iowa	1,784,660	1,246,037	3,291,350	768,759	1,957,640
Wisconsin	2,047,650	656,728	1,245,037	931,681	464,750
Montana	1,056,000	2,316,955	1,613,600	256,250	725,840
Total Spending	$ 15,570,620	$ 15,332,386	$ 17,085,593	$ 12,047,587	$ 13,857,630

Source: FWS Division of Realty, 2005

Caudill and Henderson (2003) combined FWS management information with regional I-O data to estimate the impacts of visitors to national wildlife refuges on nearby communities. Like Caudill and Henderson, we used the Impact Analysis for Planning (IMPLAN) I-O software to estimate regional effects. IMPLAN is an off-the-shelf software package for conducting I-O analysis. It was developed by the University of Minnesota for the U.S. Forest Service and has been applied in many regional impact studies.

The steps in an I-O analysis are as follows:

1. Estimate the annual number of visitor-days by activity and residence at each Wetland Management District (WMD).
   a. Estimate total visitation to the WMD.
   b. Divide the total visitation into the different activities visitors pursue in the WPA.
   c. Further divide the number of visitors in each activity by those that are local and those that are non-local.
2. Estimate the average and total spending by local and non-local visitors to the WMD.
3. Build an I-O model of the local economy and apply visitors' spending to it.
4. Interpret the results.

The following sections discuss the data and methods used to accomplish each step.

ESTIMATING ACTIVITY LEVELS

The starting point for calculating visitor spending by activity and object of spending at each WMD is the "Corrected Estimated Total Number of Groups (sic: should be "Visitors") Fall Weekend Days," column in Table 3 of the June 2003 study, *Estimating Visitor Use Levels at Waterfowl Production*

Areas in Minnesota (Vlaming et al., 2003). These estimates are the result of a survey of Minnesota WPA visitors in the fall of 2000 and 2002. Comparable data is not available for WPAs in other states. So this section discusses only Minnesota impacts.

Total Annual Visitation

Vlaming et al. developed estimates of fall visitation to each WMD, but also included some sampling during the course of the year to estimate non-fall use. They found that 90 percent of all activity occurs in the fall. Thus, fall visits can be adjusted to an annual total using a factor of 1/0.90, or:

(1) $$N_w = N_{Fw}(1/0.90)$$

where: N_w = Total annual number of visits to WMD, w, and
N_{Fw} = Fall visitation to WMD, w.

Activity Distribution

The Vlaming et al. study included a question on the number of times each year the respondent participated in any of several activities at WPAs. The respondent circled a number indicating whether they participated 1 to 5 times, 6 to 10 times, 11 to 30 times, 31 or more times, or did not participate in that activity at all. Thus, each respondent could be categorized by number of visits in each activity. Since the number of visits categories are exhaustive, the proportions in each category represent a probability distribution of the number of visits. Table 1-2 shows the probability distribution of respondents by number of visits per year and activity for Morris WMD, in Minnesota, as an example. Each row in Table 1-2 sums to 100 percent.

Table 1-2. Proportions of Morris WMD Respondents in Each Activity Category.

	Visits per year				
Activity	**1 - 5**	**6 - 10**	**11 - 30**	**31 - 50**	**0**
Hunting					
Upland bird	43.0%	22.7%	14.1%	0.8%	19.5%
Waterfowl	38.3%	25.0%	18.0%	7.8%	10.9%
Deer	34.4%	6.3%	3.9%	2.3%	53.1%
Small game	17.2%	3.1%	0.8%	0.8%	78.1%
Trapping	3.1%	0.0%	0.8%	0.0%	96.1%
Fishing					
Fishing	7.8%	5.5%	5.5%	5.5%	75.8%
Observation and Photography					
Observing from car	31.3%	14.8%	12.5%	10.9%	30.5%
Viewing wildlife/birds	29.7%	12.5%	6.3%	3.9%	47.7%
Photographing nature	14.1%	3.9%	0.0%	0.8%	81.3%
Other					
Working with dog	14.8%	13.3%	13.3%	5.5%	53.1%
Hiking/walking	24.2%	10.9%	0.8%	3.1%	60.9%
Picnicking	8.6%	1.6%	0.8%	0.0%	89.1%
Mushroom hunting	4.7%	0.0%	0.0%	0.0%	95.3%

Source: Vlaming et al., 2003, survey.

The expected number of annual visits by survey respondents for each activity is calculated by multiplying the proportion of respondents in each visit category by the mid-point of the range of visits in the category. Using the median value of each range (3, 8, 20.5, 40.5) gives a central estimate. Morris WMD upland bird hunters, for example average 6.3 visits per year. Multiplying this average by the number of respondents who said they participated in the activity yields the number of visits by respondents for each activity. Thus,

$$(2) \qquad E(Q_{aw}) = \sum_k \frac{q^k_{aw}}{q_w} Z_k$$

where: Q_{aw} = Number of visits by respondents in activity a, at WMD w.
q_w = Total number of respondents at WMD w.
q^k_{aw} = Number of respondents in number of visits category k, in activity a, at WMD w.
Z_k = The median number of visits stated in the survey question in number of visits category k.

The percentage of respondents' visits in each activity is used as a pattern to allocate the total number of visits estimated earlier, N_w , to activities on each WMD.

$$(3) \qquad N_{aw} = N_w \left(\frac{Q_{aw}}{\sum_a Q_{aw}} \right)$$

where: N_{aw} = Number of annual visits in activity a, at WMD w.

N_w = Total annual number of visits to WMD, w, and
Q_{aw} = Number of visits by respondents in activity a, at WMD w.

Table 1-3 illustrates the allocation of 69,232 estimated annual visits to Morris WMD based on the number of visits by activity of the respondents in the survey. The survey showed that 46.2 percent of respondent visits were related to waterfowl hunting, which implies that 31,991 (= 0.462 × 69,232) of all visits included waterfowl hunting. Waterfowl hunting is the primary activity of most visitors to WPAs. However, upland bird hunting is also significant.

Table 1-3. Allocation of Total Annual Visits to Activities Based on Sample, Morris WMD.

Activity	Visits by Respondents	Percent	Annual Number of Visits
Fishing	125	5.1%	3,502
Deer Hunting	196	7.9%	5,503
Small Game Hunting	35	1.4%	985
Upland Bird Hunting	651	26.4%	18,272
Waterfowl Hunting	1,140	46.2%	31,991
Trapping	1	0.1%	36
Viewing Wildlife/Birds	319	12.9%	8,944
Total	2,468	100.0%	69,232

Source: ERG Calculation

Local/Non-Local Use Distribution

The Vlaming et al. survey included the respondents' ZIP code. Figure 1 shows the distribution of visitors' ZIP codes across Minnesota for each WMD. Although there is a natural concentration of local ZIP codes around each WMD, ZIPs much further afield are also present.[1] Clearly, people from the Twin Cities use the distant WPAs of Detroit Lakes (light blue), Fergus Falls (rose), and Morris (green) WMDs. ArcMap geographic information system software calculated the distance from the centroid of each respondent's ZIP code to the centroid of the WMD headquarter's ZIP code. All WPAs are within 60 miles, 2-hour drive, of a city with a population of 10,000 or more. A city of this size serves as a local hub and a source for visitors to the WPAs. Local visits were defined as those coming from within 60 miles of the WMD, while non-local visitors traveled from more than 60 miles away. (We did not pursue algorithms for determining over-the-road distances or distances from the respondent's ZIP code to the location where they were actually intercepted. These calculations require considerably more complex software.)

[1]Visitors in a given ZIP may have used more than one WMD but only one color is shown in Figure 1 for each ZIP code.

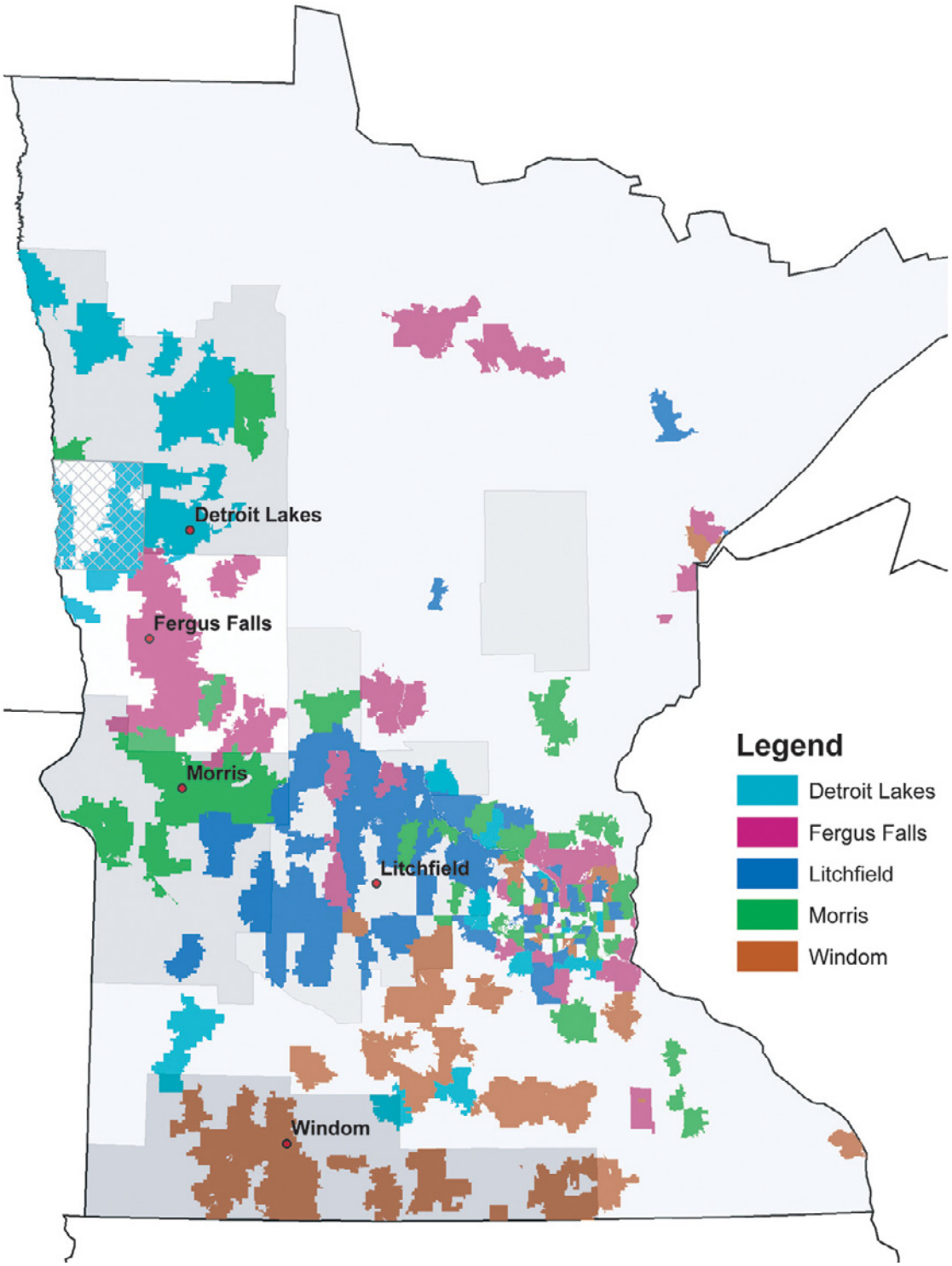

Figure 1. Distribution of Visitors' Home ZIP Codes and WMD Regional Economic Areas.

The proportions of local and non-local visitors to each WMD was then used to allocate each estimate of visitation by activity as:

(4) $$N_{adw} = N_{aw}\left(\frac{q_{dw}}{q_{w}}\right)$$

where: N_{adw} = Number of annual visits in activity a, by local/non-local visitors, at WMD w.
q_{dw} = Number of local/non-local respondents at WMD w.
N_{aw} = Number of annual visits in activity a, at WMD w
q_{w} = Total number of respondents at WMD w.

CHARACTERIZING SPENDING

The amount of money spent for each visit was derived from the 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (U.S. Department of the Interior, 2002) (FHWR). The FHWR values were updated to 2004 dollars using the GDP Chain-type price index (CEA, 2005). Average spending for food, lodging, transportation, and other goods by activity is shown in Table 1-4. The top 1 percent of responses were deleted from this data in order to remove some outliers. Minnesota and West North Central regional data were considered representative for this purpose. Travel costs were calculated as the average distance traveled by local and non-local visitors to each WMD times $0.375 per mile which is the 2004 federal reimbursement rate for private automobile use. Travel costs were added to total non-transportation spending to derive spending per trip by activity. The number of trips times these costs yields total spending for each activity, and local/non-local spending for each WMD:

(5) $$C_{adw} = N_{adw}\left(\left(0.375\,L_{dw}\right) + X_{ad}\right)$$

where: C_{adw} = Total trip costs of local/non-local respondents participating in activity a, at WMD w.
L_{dw} = Average distance in miles from local/non-local respondent's zip code to WMD w.
N_{adw} = Number of annual visits in activity a, by local/non-local visitors, at WMD w.
X_{ad} = Non-transportation trip costs from FHWR Survey for local/non-local participants in activity a.

Table 1-4. Expenditures per Visitor-Day by FHWR Survey Categories and Type of Activity. (2004 dollars per visitor-day)

Activity	Food	Lodging	Transport	Other	Total
Residents					
Fishing	10.15	3.71	8.37	7.95	30.19
Deer Hunting	11.35	1.50	8.82	1.12	22.79
Small Game Hunting	8.39	0.74	9.52	1.50	20.14
Upland Bird Hunting	10.17	0.32	9.11	1.06	20.66
Waterfowl Hunting	10.17	0.32	9.11	1.06	20.66
Trapping	8.39	0.74	9.52	1.50	20.14
Viewing Wildlife/Birds	10.10	10.01	5.95	2.24	28.31
Non-Residents					
Fishing	20.07	18.02	20.10	9.24	67.43
Deer Hunting	26.32	3.09	27.24	7.62	64.27
Small Game Hunting	29.50	15.13	28.28	12.83	85.73
Upland Bird Hunting	28.50	10.80	23.42	1.61	64.32
Waterfowl Hunting	28.50	10.80	23.42	1.61	64.32
Trapping	29.50	15.13	28.28	12.83	85.73
Viewing Wildlife/Birds	34.96	17.62	36.77	2.48	91.83

Source: U.S. Department of the Interior, 2002, Special Runs from National Survey of Fishing, Hunting, and Wildlife-Associated Recreation CD-ROM.

Table 1-5, and Figures 2 and 3, provide total visits and spending by WMD and activity. The total estimated annual spending by all WMD visitors is $ 19.8 million. Morris WMD has only 2.6 percent more visits than the next most visited WMD, Litchfield, but almost twice as much spending as the next highest spending WMD, Fergus Falls. The difference is explained by the number of non-local visitors. Non-local visitors traveled at least 60 miles to the WMD so their travel costs are substantially greater than local visitors. Travel costs are calculated based on the average trip length at each WMD by local and non-local visitors, so WMDs whose non-local visitors travel farther will have higher travel costs. Because of its proximity to the Twin Cities population center, only 22 percent of Litchfield's visitors are big spending, non-local residents, while 76 percent of Morris and 51 percent of Fergus Falls visitors are non-local.

Table 1-5. Total Visits and Visitor Spending by Activity and WMD.

Activity	Detroit Lakes	Fergus Falls	Litchfield	Morris	Windom	Total
Visits (Visitor days per year)						
Upland Bird Hunting	3,540	7,030	28,250	18,270	9,400	66,480
Waterfowl Hunting	6,130	18,790	21,500	31,990	3,310	81,730
Deer Hunting	3,930	4,290	4,160	5,500	590	18,470
Small Game Hunting	520	470	1,880	980	280	4,140
Trapping	-	190	90	40	40	350
Fishing	3,780	2,070	3,630	3,500	920	13,900
Viewing Wildlife	6,850	8,350	7,970	8,940	2,770	34,890
Total	24,760	41,190	67,480	69,230	17,310	219,970
Spending (2004 dollars per year)						
Upland Bird Hunting	$ 331,100	$ 678,100	$ 1,465,400	$ 2,106,700	$ 910,600	$ 5,491,800
Waterfowl Hunting	573,500	1,813,900	1,115,400	3,688,400	321,200	7,512,400
Deer Hunting	364,100	408,300	216,200	619,800	56,300	1,664,700
Small Game Hunting	51,900	49,300	102,600	125,600	29,600	359,000
Trapping	-	20,100	4,700	4,600	4,000	33,400
Fishing	379,300	213,200	212,700	426,600	95,500	1,327,300
Viewing Wildlife	683,600	870,400	445,200	1,129,900	295,100	3,424,100
Total	$2,383,500	$ 4,053,300	$ 3,562,200	$ 8,101,600	$ 1,712,200	$19,812,800

Source: Vlaming et al., 2003, and ERG calculations, rounded.

REGIONAL INPUT-OUTPUT MODEL

Regional economies are defined by where people work and shop. In rural areas too distant from urban centers for commuting, the primary concern in defining a region is the availability of shopping and services. The smallest geographic unit covered by IMPLAN data is the county; therefore, a region is defined as a set of counties. For this project, regional economies were defined as the constituent counties of the WMD, plus any contiguous counties that contain cities likely to serve as regional hubs for economic activity. The region for the Morris WMD, for example, includes Kandiyohi County, in order to encompass the city of Wilmar, which is considerably larger than any other city in the area.

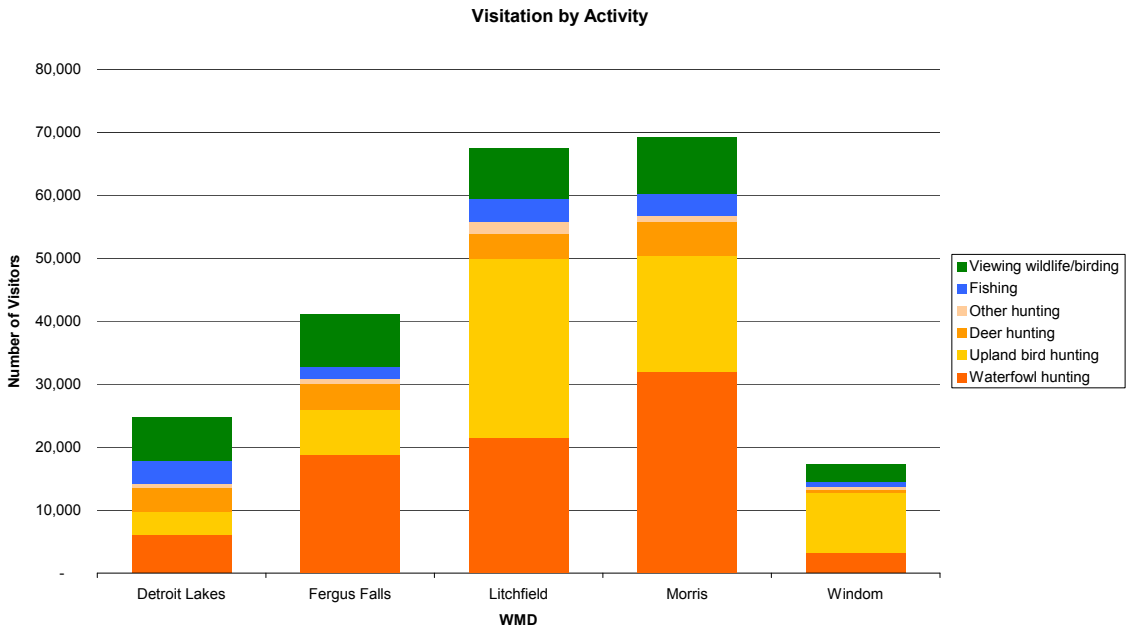

Figure 2. Number of Visitors by Activity.
Source: Vlaming et al., 2002

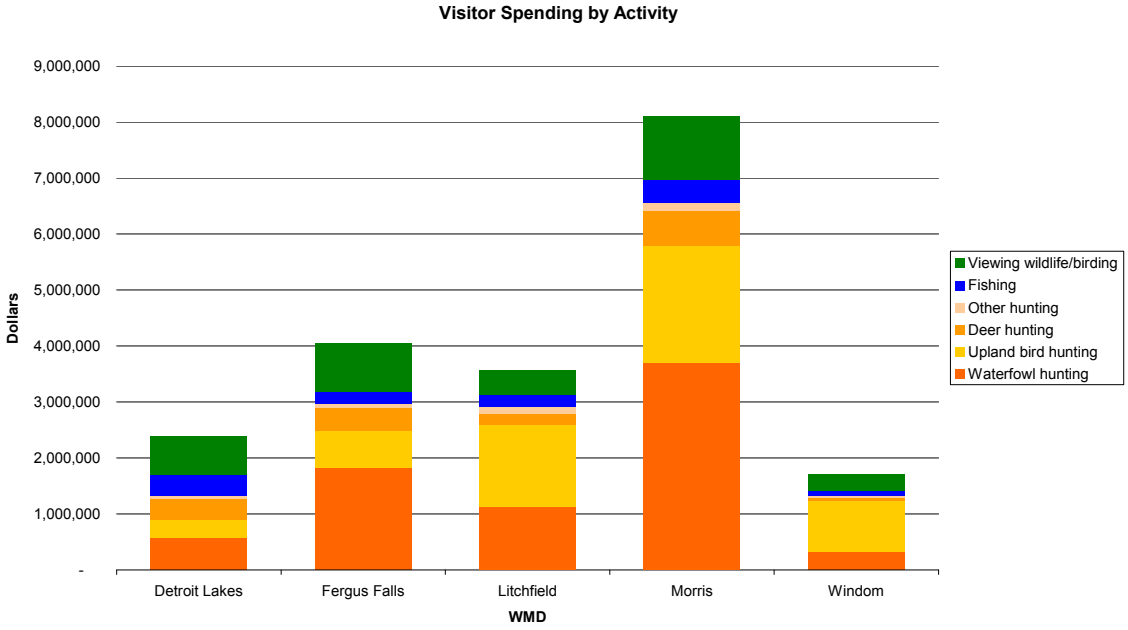

Figure 3. Visitor Spending by Activity.
Source: Vlaming, et al., 2002; FHWR, 2002; ERG Calculation

Impacts are estimated by applying the expenditures calculated above to appropriate industry categories in the IMPLAN model. Table 1-6 shows how spending in the four categories of the FHWR survey were allocated to IMPLAN sectors. This allocation is the same as that used by Caudill and Henderson (2003). Although other allocations are sometimes used in the literature, the effect of alternative allocations on the outcome is limited by the industries within the local economy. By far, the largest cost category is gas and oil. Since petroleum products are produced in only a few locations in the United States, almost all of this spending leaves the region immediately, generating very little local economic impact.

Table 1-6. Allocation of FHWR Survey Expenditures to IMPLAN Industries

FHWR Category	IMPLAN Industry Number and Name	Allocation from FHWR Category to IMPLAN Industry	
		Non-Resident	Resident
Lodging			
	463 Hotels	100%	0%
Food			
	1111 Food for off-Site consumption	65%	35%
	1120 Purchased meals	35%	65%
Transportation			
	8140 Gas & oil	85%	90%
	8130 Car repairs	10%	10%
	8330 Airlines	5%	0%
Other			
	421 Sporting goods	40%	40%
	1500 Tobacco products	1%	1%
	1112 Alcoholic beverages	1%	1%
	2100 Shoes	8%	8%
	2311 Clothing: women's	8%	8%
	2321 Clothing: men's	8%	8%
	2800 Personal items	8%	8%
	3100 Toilet articles	8%	8%
	5900 Telephone	6%	6%
	5917 Postage	6%	6%
	991H Film developing	6%	6%

Source: Caudill and Henderson, 2003.

IMPACT RESULTS

Most Minnesota WPAs are in rural areas so most of the visitor spending is quickly exported. Table 1-7 shows that of $7.0 million in direct spending by non-local visitors to Morris WMD, $4.0 million has no direct effect in the region because it pays for imported goods. The remaining $3.0 million recirculates within the region generating an additional $532,500 in indirect activity and inducing $1,173,100 in additional household activity. The total change in output from non-local visitors to Morris WMD is $4.7 million. Table 1-8 shows the direct and total effects of non-local visitor spending for the other four WMDs in the survey and the total for all five WMDs. Taken together, the five WMDs generate $18.7 million in additional output annually.

A similar pattern is seen in Table 1-9 which shows the number of jobs created as a result of non-local spending at the five WMDs. The direct effect is quite substantial while the multiplier is relatively small. Spending by non-local WPA visitors generates directly 164 jobs throughout Minnesota. When all of the multiplier effects are considered non-local WPA visitors' spending generates 220 jobs. These figures do not include FWS employees, nor contractors working at the WPAs.

Table 1-7. Impact on Output of Spending by Non-Local Visitors to Morris WMD, Minnesota.
(Thousand 2004 $)

Industry	Direct	Indirect	Induced	Total
Agriculture	25.0	43.7	20.7	89.5
Mining	0.0	0.0	0.0	0.0
Construction	0.0	32.7	119.2	152.0
Food Processing	91.1	31.7	30.0	152.7
Apparel	3.1	0.4	7.3	10.9
Manufacturing	58.1	54.9	23.6	136.7
Sporting Goods	0.0	0.0	0.1	0.1
Transportation	79.5	74.1	43.6	197.2
Other Services	12.1	125.0	251.6	388.7
Wholesale Trade	513.5	58.4	56.4	628.3
Retail Trade	969.8	3.2	112.1	1,085.0
Eating & Drinking Places	332.8	8.9	46.4	388.2
Financial Services	4.9	61.4	147.5	213.8
Lodging Places	529.4	4.6	6.6	540.6
Automobile Services	380.1	6.9	13.9	400.8
Other Amusements	0.8	6.4	6.1	13.3
Recreation Services	2.0	0.0	6.6	8.6
Government	24.0	20.2	281.4	325.6
Total in Region	3,026.3	532.5	1,173.1	4,731.9
Exported from Region	4,033.2	0.0	0.0	4,033.2
Total	7,059.5	532.5	1,173.1	8,765.1

Source: ERG Calculation with IMPLAN.

Table 1-8. Changes in Output from Non-Local Visitors Spending at Minnesota WMDs.
(Thousands 2004 $)

Industry	Windom WMD		Litchfield WMD		Fergus Falls WMD		Detroit Lakes WMD		All	
	Direct	Total	Direct	Total	Direct	Total	Direct	Total	Direct	Total
Agriculture	4.9	19.4	8.0	42.3	8.9	34.3	4.4	7.5	51.2	193.0
Mining	-	-	-	-	1.1	1.3	-	-	1.1	1.3
Construction	-	8.4	-	14.0	-	25.2	-	10.9	-	210.5
Food Processing	41.1	58.4	73.3	102.1	76.5	109.9	5.9	8.0	287.9	431.1
Apparel	-	-	0.3	0.9	-	-	0.1	0.4	3.5	12.2
Manufacturing	0.8	13.5	0.8	25.8	-	19.3	0.1	10.6	59.8	205.9
Auto Parts & Accessories	-	5.3	-	2.0	-	1.4	-	0.5	-	9.2
Sporting Goods	-	-	1.4	1.5	0.3	0.4	-	0.2	1.7	2.2
Transportation	23.0	46.4	18.8	48.5	69.4	129.4	21.2	48.9	211.9	470.4
Other Services	1.8	58.2	3.9	99.7	5.7	164.5	3.5	72.0	27.0	783.1
Wholesale Trade	92.0	110.5	100.2	127.8	206.5	244.8	118.2	136.6	1,030.4	1,248.0
Retail Trade	205.2	225.4	222.4	253.9	494.4	550.9	248.0	272.2	2,139.8	2,387.4
Eating & Drinking Places	81.2	91.2	103.4	116.1	177.1	205.2	80.0	93.3	774.5	894.0
Financial Services	0.4	40.3	1.6	68.4	4.1	107.9	2.6	49.7	13.6	480.1
Lodging Places	136.7	138.7	172.2	175.0	246.9	255.3	123.1	126.2	1,208.3	1,235.8
Automobile Services	77.9	81.5	76.5	81.9	205.0	215.0	106.1	110.5	845.6	889.7
Other Amusements	0.2	1.6	0.4	3.2	0.5	5.5	0.3	5.0	2.2	28.6
Recreation Services	0.2	0.7	0.3	1.2	0.7	2.9	0.5	2.3	3.7	15.7
Government	5.6	16.0	4.3	14.3	11.1	30.6	7.3	17.4	52.3	403.9
Total in Region	671.0	915.5	787.8	1,178.6	1,508.2	2,103.8	721.3	972.2	6,714.5	9,902.1
Exported from Region	865.9	865.9	818.9	818.9	1,991.9	1,991.9	1,081.7	1,081.7	8,791.6	8,791.4
Total Impacts	1,536.9	1,781.4	1,606.7	1,997.5	3,500.1	4,095.7	1,803.0	2,053.9	15,506.1	18,693.7

Note: “All” column includes Morris WMD in Table 1-7.
Source: ERG calculation with IMPLAN.

Table 1-9. Changes in Employment from Non-Local Visitors Spending at Minnesota WMDs.
(Jobs)

Industry	Morris WMD		Windom WMD		Litchfield WMD		Fergus Falls WMD		Detroit Lakes WMD		All	
	Direct	Total	Direct	Total	Direct	Total	Direct	Total	Direct	Total	Direct	Total
Agriculture	0.1	0.7	-	0.1	-	0.3	0.1	0.3	-	0.1	0.2	1.5
Mining	-	-	-	-	-	-		-	-	-	-	-
Construction	-	1.7	-	0.1	-	0.2	-	0.4	-	0.2	-	2.6
Food Processing	0.4	0.6	0.2	0.2	0.3	0.4	0.4	0.5	-	-	1.3	1.7
Apparel	-	0.1	-	-	-	-	-	-	-	-	-	0.1
Manufacturing	0.1	0.9	-	0.1	-	0.2	-	0.2	-	0.1	0.1	1.5
Sporting Goods	-	-	-	-	-	-		-	-	-	-	-
Transportation	0.8	2.1	0.2	0.5	0.2	0.5	0.6	1.1	0.2	0.5	2.0	4.7
Other Services	0.2	8.3	-	1.3	0.1	2.0	0.1	3.6	0.1	1.7	0.5	16.9
Wholesale Trade	5.8	7.1	1.1	1.3	1.0	1.3	2.5	3.0	1.4	1.6	11.8	14.3
Retail Trade	29.7	34.0	6.0	6.8	5.8	6.6	14.4	16.4	7.0	7.9	62.9	71.7
Eating & Drinking Places	13.0	15.1	3.1	3.5	3.7	4.2	6.4	7.4	2.9	3.4	29.1	33.6
Financial Services	0.1	1.7	-	0.3	-	0.5	0.1	0.9	-	0.4	0.2	3.8
Lodging Places	19.0	19.4	4.9	5.0	5.6	5.7	8.1	8.4	4.3	4.5	41.9	43.0
Automobile Services	5.6	6.0	1.2	1.3	1.1	1.2	3.1	3.3	1.6	1.6	12.6	13.4
Other Amusements	-	0.3	-	-	-	0.1	-	0.1	-	0.1	-	0.6
Recreation Services	0.1	0.4	-	-	-	0.1	-	0.2	-	0.1	0.1	0.8
Government	0.2	8.5	0.1	0.2	-	0.2	0.1	0.4	0.1	0.2	0.5	9.5
Total in Region	75.4	107.0	16.9	20.8	17.9	23.5	36.0	46.2	17.6	22.2	163.8	219.7

Source: ERG calculation with IMPLAN.

BENEFITS FROM ONSITE RECREATION

The previous sections showed how spending by visitors to WPAs affects the local economy. As discussed in the box on page 8, visitors get more pleasure from their trip than the amount they pay. The difference between the maximum they would be willing to pay to enjoy the site and the amount they must pay to enjoy it is the social benefit or net economic value (NEV) of their trip. FHWR measured these values for deer hunters, walleye anglers, and wildlife watchers in Minnesota. Hunters and wildlife watchers both indicated NEV of $48.64 per day while anglers indicated slightly more, $50.76 per day (U.S. Department of the Interior, 2002; updated to 2004 dollars using GDP Chain-type price index). The FHWR did not measure the NEV for other types of hunting, i.e. small game, waterfowl, or upland birds. From the duck hunting benefit equations developed for the off-site recreation analysis, we estimate that the average Minnesota duck hunter has a NEV of $38 per day. Lacking direct data on Minnesota upland bird or small game hunters, we use the deer hunting value to estimate their NEV.

Total NEV is simply the number of visitor-days in each category multiplied by the NEV.

(6) $$NEV_{aw} = N_{aw} \times NEV_{a}$$

Where: NEV_a = NEV for activity a,
NEV_{aw} = Total NEV for activity a at WMD w, and
N_{aw} = Number of annual visits in activity a, at WMD w.

Table 1-10 and Figure 4 summarize the results. Those WMDs with the most visitation generate greater NEV. Upland bird hunting at Litchfield and waterfowl hunting at Morris dominate other WMDs and activities. Indeed bird hunting accounts for two-thirds of the NEV from all activities at WPAs. The Minnesota WPAs NEV estimate of $9.9 million compares favorably with Caudill and Henderson's estimate of $124.5 million for all Region 3 national wildlife refuges and national estimate of $792.1 million for all refuges nationwide. Hunting has among the highest NEV per visitor day so fewer visits can add up to a greater total NEV.

Table 1-10. Annual NEV of On-Site Recreation Visitors.
(thousand, 2004$)

	Detroit Lakes	Fergus Falls	Litchfield	Morris	Windom	Total
Hunting						
Upland birds	$ 172	$342	$1,374	$ 889	$ 457	$3,234
Waterfowl	233	714	817	1,216	126	3,106
Deer	191	209	202	268	29	899
Small Game	25	23	92	48	13	201
Trapping	-	9	4	2	2	17
All Hunting	$621	$1,297	$2,489	$2,423	$ 627	$ 7,457
Fishing	192	105	184	178	47	706
Viewing	333	406	388	435	135	1,697
Total	$ 1,146	$ 1,808	$3,061	$3,036	$ 809	$9,860

Source: U.S. Department of the Interior, 2003; ERG Calculation

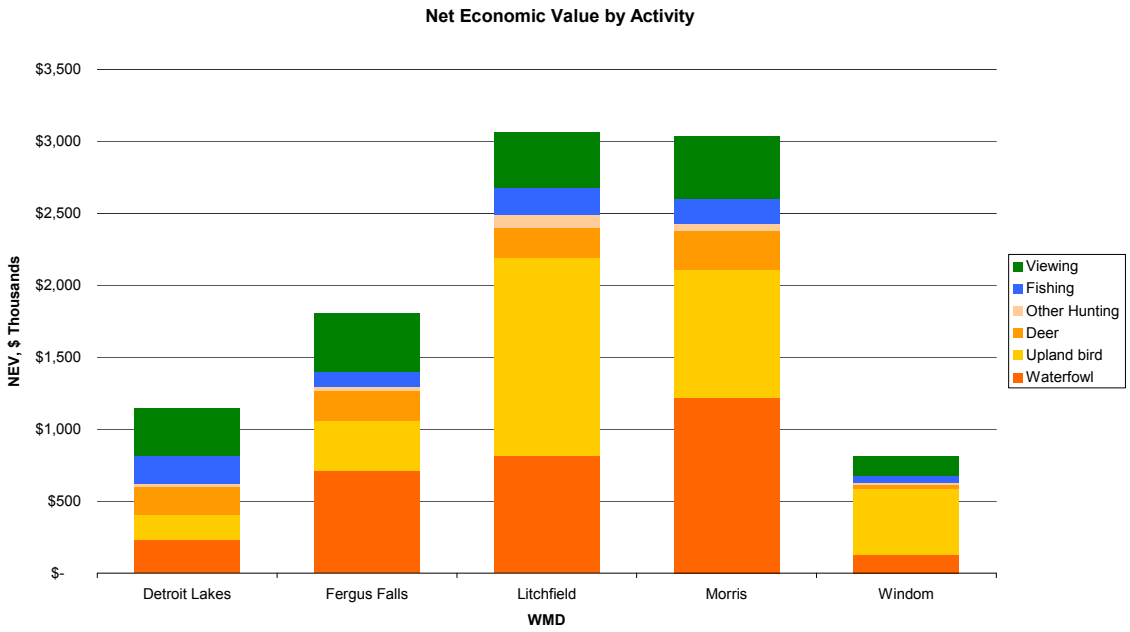

Figure 4. Net Economic Value by Activity.
Source: Vlaming, et al., 2002; FHWR, 2002; Charbonneau and Hay, 1978; ERG Calculation

SECTION 2
OFFSITE BENEFITS OF WATERFOWL PRODUCTION AREAS

BACKGROUND

WPAs increase production of waterfowl through management. Nesting success is improved by adapting the landscape of WPAs to waterfowl needs. An important role of WPAs is simply conserving small wetlands from drainage and development. Predators are a major cause of nestling and female mortality during the breeding season (Reynolds, 2002). Some WPAs are fenced or provide specially designed nest boxes to discourage predators. Mowing is timed to avoid disturbing nests while improving feeding opportunities. A combination of strategies leads WPAs to generate greater duck production than surrounding private lands.

The birds produced on WPAs contribute to recreational and hunting opportunities far away from their place of origin and thereby add to national well-being. Migratory bird hunters spent $1.4 billion during 2001 (U.S. Department of the Interior, 2002). Studies have shown that hunters, in general, enjoy their outings more if they see and bag more ducks. By providing more ducks, WPAs increase the pleasure of the duck hunting experience.

This study seeks to quantify that contribution to national welfare by estimating the total benefit derived from duck hunting and then estimating the proportion of that benefit attributable to WPAs. The study adopts a benefit transfer strategy with three phases.

1) Determine individual net economic value (NEV) for waterfowl hunting.
2) Expand the individual NEV estimate to the population of waterfowl hunters to estimate the national benefit of waterfowl hunting.
3) Determine the contribution of WPAs to the stock of waterfowl subject to hunting and pro rate national benefits to the WPAs.

The following sections detail the model, methods, and data to show the development of the benefit estimates.

MODEL

This section presents the mathematical model we used to attribute the NEV that hunters derive from hunting waterfowl to the WPAs in Prairie Pothole Region (PPR) states.

Individual utility (U_i) is modeled by the inverse utility function (V_i), which is a function of income (M), number of seasons hunting (S), hunting expenditures (E), and seasonal bag (B).

(7) $$U_i = V_i(M, S, E, B)$$

The sum of all bird hunter's individual NEVs in a state is the value for the hunting state. It is estimated by multiplying the valuation function, estimated at the mean values for the state (subscript H), by the number of waterfowl hunters in the state (h_H).

(8) $$V_H = h_H V_i(M_H, S_H, E_H, B_H)$$

The hunting state NEV is allocated to nesting states by the probability that birds hunted there came from the nesting state (P_{nH}).

(9) $$V_n = \sum_H P_{nH} V_H$$

The nesting state NEV (V_n) is allocated to WMDs as the product of the probability that birds come from each ownership category (P_{On}), the proportion of the state duck population found in that WMD (P_{Own}), and the proportion of the bird's lifetime spent on the breeding grounds summed over federally owned land (T) and land with a federal easement in the WMD counties

(10) $$V_w = \sum_{O=F,E} V_n P_{On} P_{Own} T$$

There are many different ways to estimate the parameters of the model such as V_H, P_{nH}, and P_{On}. We describe our preferred approach and then discuss alternative methods in the final section.

INDIVIDUAL NET ECONOMIC VALUE

Charbonneau and Hay (1978) (CH) used data from a 1974 Patuxent Wildlife Research Center national survey of waterfowl hunters. The survey sample was randomly drawn from a list of federal duck stamp purchasers. They received 3,641 usable responses from all four flyways. The survey asked the respondent to say how much a "good day hunting" was worth by comparing it to a movie ticket. Although the study does not meet current criteria for reliable contingent valuation surveys, no later studies have estimated nationally consistent NEVs in the waterfowl hunting context. CH remains the primary source of waterfowl hunting values in natural resource damage assessment contexts (U.S. Department of the Interior, 1999).

CH estimates a function, $V_i(M,S,E,B)$, for the Marshallian NEV attributable to duck hunting. CH assume that income (M), seasons hunted (S), expenditures for hunting (E), and seasonal bag (B) are

the relevant demand shifters. They estimate the equation as a double log model. The estimation result for the United States can be represented as:

$$V_i = e^{2.322} M^{0.029} S^{0.055} E^{0.363} B_A^{0.245} B_B^{0.124} B_C^{0.171} \quad (11)$$

where B_A, B_B, and B_C, represent the seasonal bag for puddle ducks, diving ducks, and geese, respectively (CH, Table 3). The formulation imposes a Cobb-Douglas form on the demand function so it satisfies the typical constraints of utility theory (decreasing marginal benefit, downward sloping demand, etc.). CH estimated a separate equation for each flyway.

Benefit Transfer

Benefit transfer is a recognized technique for applying NEV values measured in one situation and location—the study site—to a different situation and location—the policy site. Boyle and Bergstrom (1992) cite three basic criteria that must be met for a meaningful benefits transfer.

1) The policy site must be similar to the study site.
2) The population at the policy site must be similar to the population at the study site.
3) The environmental changes from the policy action being valued must be similar to those valued at the study site.

The physical sites and populations to be valued in this study are identical to the CH sample frame—specifically, duck hunters in the Mississippi Flyway, where most of the PPR waterfowl migrate. CH surveyed duck hunters nationally and derived NEV estimates by flyway. Naturally, population characteristics have changed in the intervening 25 years. In this study, we assume that preferences have remained stable, and we adjust income, expenditures, bag, and seasons hunting to current values derived from recent sources to update the CH values. The 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (U.S. Department of the Interior, 2002), for example, provides current expenditure information.

The question formats in CH did not describe a clear environmental change to be valued. The study also included an alternative formulation, which included the number of days hunting during the season. Clearly, the authors considered the welfare gains to be a function of bag and days hunting. Empirical estimation showed these attributes to be significant determinants of total NEV. The derivatives of these functions with respect to days or birds provide estimates of NEV for the marginal day or marginal bird. Thus, the environmental change valued is the change in characteristics of the hunting season which is adequate for this benefit transfer.

Update to Current Data

In order to estimate NEV, all of the variables of the valuation equation must be updated. Individual information for each duck hunter was not easily available so we evaluated equation 11 at the 2001 median income (BLS, 2003) and the FHWR mean expenditures on waterfowl hunting (U.S. Department of the Interior, 2002) for each state. This captures the heterogeneity among duck hunters across states. The number of ducks bagged in 2001 was reported in Martin and Padding (2002). Average hunter bags for diving ducks and geese were not reported in the 2001 data so the average values in CH for each flyway were used in this study. These values in 2001 dollars were updated to 2004 dollars using the GDP Chain-type Price Index (CEA, 2005).

Equation 11 was updated to determine V_i, the NEV for the whole hunting season. This is appropriate for this study because it measures the NEV from the whole hunting experience. It includes the higher NEV of the first duck bagged on the first day as well as the last. The marginal value relates only to the last unit consumed. With the typical assumption of declining marginal returns, we know the last unit consumed has the lowest value. Applying the marginal value of the last unit to the whole season would understate the NEV for the season.

The NEV values estimated with this update process are in the same range as the estimates from the original sources, after inflation and differences among states. Table 2-1 shows the hunter NEV for the entire season.

Table 2-1. Net Economic Value (NEV) of Duck Hunting Season by State, 2001.

State	Hunter Income, $ 2001	Hunter Spending, $ 2001	Season Bag per Hunter, Birds	CH NEV per Hunter, $2004
ALABAMA	$ 49,241	$ 1,112	10	449
ARIZONA	59,807	1,013	5	363
ARKANSAS	46,691	851	13	445
CALIFORNIA	66,190	816	13	420
COLORADO	69,180	965	7	397
CONNECTICUT	74,712	683	4	819
DELAWARE	69,467	650	5	880
FLORIDA	51,007	1,237	11	1,311
GEORGIA	59,627	856	7	1,059
IDAHO	53,556	831	7	363
ILLINOIS	64,662	1,031	7	406
INDIANA	56,551	648	5	314
IOWA	57,387	488	8	321
KANSAS	58,001	574	8	336
KENTUCKY	53,831	819	7	378
LOUISIANA	46,667	950	20	522
MAINE	51,275	702	7	965
MARYLAND	74,968	623	6	913
MASSACHUSETTS	73,180	629	4	829
MICHIGAN	63,088	461	5	279
MINNESOTA	73,779	573	7	326
MISSISSIPPI	42,240	716	9	380
MISSOURI	57,895	616	12	387
MONTANA	44,992	736	6	344
NEBRASKA	61,077	812	6	356
NEVADA	63,587	2,023	3	426
NEW HAMPSHIRE	71,889	649	4	831
NEW JERSEY	72,505	792	6	970
NEW MEXICO	46,390	836	5	355
NEW YORK	58,980	816	4	898
NORTH CAROLINA	53,446	1,053	8	1,128
NORTH DAKOTA	50,128	527	7	313
OHIO	58,520	921	4	338
OKLAHOMA	49,870	772	10	386
OREGON	57,803	1,043	8	410
PENNSYLVANIA	60,920	667	3	742
RHODE ISLAND	64,035	399	5	734
SOUTH CAROLINA	52,849	817	12	1,169
SOUTH DAKOTA	55,559	757	6	353
TENNESSEE	50,114	1,163	13	495
TEXAS	57,224	894	10	408
UTAH	66,302	1,046	7	400
VERMONT	57,132	373	6	756
VIRGINIA	70,362	641	5	858
WASHINGTON	59,507	1,092	9	435
WEST VIRGINIA	41,557	556	3	692
WISCONSIN	63,507	860	4	327
WYOMING	55,626	657	6	330
Average				$ 569

Source: U.S. Department of Commerce, Census Bureau, 2002; Martin and Padding, 2002; Charbonneau and Hay, 1978; Hammack and Brown, 1974; ERG Calculation.

EXPANSION TO ESTIMATES OF HUNTING STATE NET ECONOMIC VALUE

Another element of benefit transfer is scaling the benefits to the new situation. In this case, we estimate the total benefits of all waterfowl hunting and then attribute a portion of the benefits derived back to the WPA.

Harvest surveys provide the FWS Division of Migratory Bird Management (DMBM) with substantial information about hunters and the harvest of waterfowl (Martin and Padding, 2002). A first approximation of the number of waterfowl hunters is the number of migratory waterfowl stamps sold in each state. However, this number is inflated by the number of stamps sold to philatelists and birders supporting the program who have no intention to hunt. Survey data allows DMBM to estimate the number of "adult hunters," h_H, in each state and their total number of days hunting. Multiplying h_H by the value of V_i, updated to 2004 dollars, we derive the hunting state's total NEV, V_H shown in Table 2-2. The totals imply that 1.6 million active waterfowl hunters garner $770 million in NEV from their pastime. This comports with the *Regulatory Impact Analysis of the Migratory Bird Hunting Regulations for the 2004-2005 Season* which estimated national duck hunting NEV to be in the range of $734 million to $1,064 million (Charbonneau, 2005).

Table 2-2. Waterfowl Hunting Total Net Economic Value by State Where Hunting Took Place

State	2001 Adult Hunters	CH Value for Adult Hunters, thousand 2004 $
ALABAMA	16,922	$ 7,605
ARIZONA	5,853	2,124
ARKANSAS	64,314	28,593
CALIFORNIA	74,335	31,257
COLORADO	45,013	17,885
CONNECTICUT	5,824	4,772
DELAWARE	7,061	6,211
FLORIDA	16,420	21,520
GEORGIA	22,645	23,982
IDAHO	23,025	8,358
ILLINOIS	53,849	21,870
INDIANA	27,542	8,648
IOWA	31,073	9,959
KANSAS	26,067	8,765
KENTUCKY	19,405	7,341
LOUISIANA	96,890	50,549
MAINE	10,482	10,116
MARYLAND	28,701	26,210
MASSACHUSETTS	8,709	7,220
MICHIGAN	65,056	18,143
MINNESOTA	136,368	44,513
MISSISSIPPI	24,755	9,415
MISSOURI	40,924	15,848
MONTANA	21,215	7,298
NEBRASKA	32,974	11,755
NEVADA	7,037	2,997
NEW HAMPSHIRE	4,769	3,961
NEW JERSEY	11,433	11,090
NEW MEXICO	4,700	1,670
NEW YORK	39,582	35,533
NORTH CAROLINA	29,539	33,334
NORTH DAKOTA	33,905	10,610
OHIO	32,596	11,004
OKLAHOMA	20,377	7,874
OREGON	31,791	13,049
PENNSYLVANIA	49,748	36,931
RHODE ISLAND	1,586	1,163
SOUTH CAROLINA	22,788	26,645
SOUTH DAKOTA	32,658	11,522
TENNESSEE	36,301	17,952
TEXAS	144,495	58,886
UTAH	28,267	11,320
VERMONT	4,276	3,232
VIRGINIA	21,408	18,367
WASHINGTON	33,668	14,635
WEST VIRGINIA	1,967	1,361
WISCONSIN	71,219	23,303
WYOMING	9,994	3,294
Total	1,589,519	**$ 769,694**

Source: Martin and Padding, 2002; ERG Calculation.

ALLOCATION TO PRAIRIE POTHOLE REGION STATES

Mallard banding data provides a basis for allocating hunting benefits to PPR states, P_{NH}. Munro and Kimball (1982) analyzed data from birds banded as fledglings to estimate the derivation of harvest by region. For a given hunting site, they provide a percentage distribution of the regions of origin of the available mallards.

Table 2-3 indicates the percentages and values allocated from each hunting state to the Missouri River Basin area of origin which most closely coincides with the PPR in the Munro and Kimball study (i.e., P_{NH} and V_N). Figure 5 maps the same information. Darker colors indicate a higher percentage of the state's harvest came from ducks banded in the Missouri River Basin area of origin. For example, 15.9 percent of mallards harvested in Alabama were banded in the Missouri River Basin. These methods suggest 10 to 11 percent of the national benefits are derived from waterfowl hatched in PPR states. The basin total was allocated to each PPR state based on each state's share of duck recruitment.

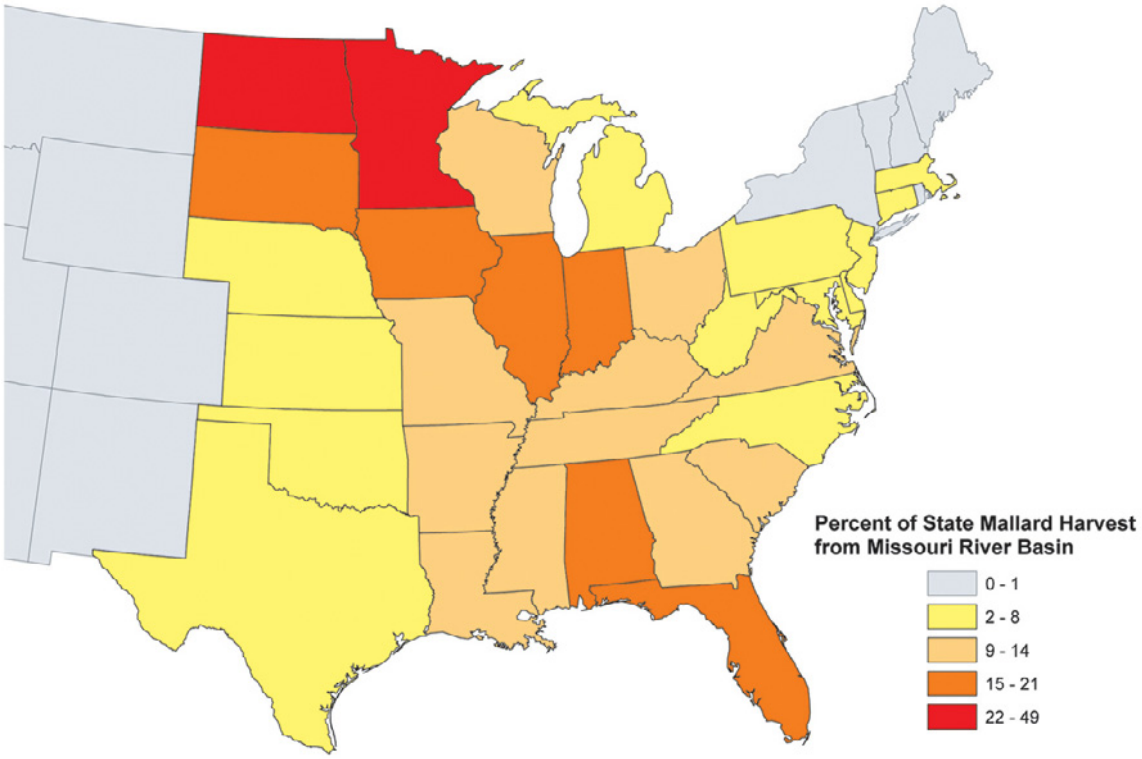

Figure 5. Proportion of State Duck Harvest from Missouri River Basin Region.
Source: Munro and Kimball, 1982.

Table 2-3. Munro and Kimball Allocation of Ducks from Hunting States to Missouri River Basin

State where hunting took place	Percentage of Ducks from Missouri River Basin	Total NEV for Active Hunters, thousand 2004 $	Value Attributable to Missouri River Basin Ducks, thousand 2004 $
ALABAMA	15.9 %	$ 7,605	$ 1,209
ARIZONA	-	2,124	-
ARKANSAS	13.6	28,593	3,889
CALIFORNIA	0.1	31,257	31
COLORADO	0.5	17,885	80
CONNECTICUT	8.3	4,772	396
DELAWARE	4.2	6,211	261
FLORIDA	19.4	21,520	4,175
GEORGIA	8.7	23,982	2,086
IDAHO	0.2	8,358	17
ILLINOIS	16.4	21,870	3,587
INDIANA	15.8	8,648	1,366
IOWA	20.6	9,959	2,052
KANSAS	5.4	8,765	473
KENTUCKY	12.3	7,341	903
LOUISIANA	10.9	50,549	5,510
MAINE	-	10,116	-
MARYLAND	5.6	26,210	1,468
MASSACHUSETTS	3.4	7,220	245
MICHIGAN	6.3	18,143	1,143
MINNESOTA	48.8	44,513	21,722
MISSISSIPPI	12.3	9,415	1,158
MISSOURI	11.8	15,848	1,870
MONTANA	0.9	7,298	66
NEBRASKA	5.9	11,755	688
NEVADA	0.2	2,997	6
NEW HAMPSHIRE	-	3,961	-
NEW JERSEY	4.0	11,090	444
NEW MEXICO	0.3	1,670	4
NEW YORK	1.3	35,533	462
NORTH CAROLINA	7.0	33,334	2,333
NORTH DAKOTA	33.8	10,610	3,581
OHIO	8.6	11,004	946
OKLAHOMA	5.4	7,874	425
OREGON	0.1	13,049	13
PENNSYLVANIA	3.8	36,931	1,403
RHODE ISLAND	-	1,163	-
SOUTH CAROLINA	12.7	26,645	3,384
SOUTH DAKOTA	16.4	11,522	1,884
TENNESSEE	12.0	17,952	2,154
TEXAS	5.3	58,886	3,092
UTAH	0.1	11,320	11
VERMONT	-	3,232	-
VIRGINIA	8.7	18,367	1,598
WASHINGTON	0.1	14,635	15
WEST VIRGINIA	7.9	1,361	108
WISCONSIN	11.5	23,303	2,680
WYOMING	0.4	3,294	13
Total		**$ 769,694**	**$ 78,951**
Proportion of value to Missouri Valley			10.26 %

Source: Munro and Kimball, 1982; ERG Calculation.

ALLOCATION TO FEDERAL MANAGEMENT IN PPR STATES

The DMBM establishes framework guidelines for waterfowl hunting, which regulate how many birds may be taken each year. DMBM uses an adaptive harvest management system based on nesting success in the PPR. Annual aerial Habitat and Population Evaluation Team (HAPET) surveys of breeding populations and wetland conditions provide information to establish the framework regulations. HAPET surveys include information about recruitment by land ownership category, i.e. whether the land being observed is owned by the federal government, under easement to the federal government, or privately owned. These observations form the basis for estimating the proportion of ducks from each PPR state and the proportion that is attributable to federal land management, P_{ON}. If we assume that relative recruitment rates and death rates are stable for each ownership category and WMD, then the proportions in the population will reflect annual total recruitment. We can look at one year's recruitment to draw conclusions about the probability of a duck being from a particular state, WMD, and land ownership category. For example, P_{ON} can be calculated within each state by summing across WMDs as:

$$P_{On} = \frac{\sum_{w} A_{Own} R_{Own}}{\sum_{O} \sum_{w} A_{Own} R_{Own}} \quad (12)$$

where: A_{OWN} = area in square miles of each land ownership type within the WMD, and
R_{OWN} = recruitment rate per square mile.

Similarly, P_{OW} can be calculated for each WMD as its proportion of the state recruitment in that land ownership class:

$$P_{Ow} = \frac{A_{Own} R_{Own}}{\sum_{w} A_{Own} R_{Own}} \quad (13)$$

We used a duck production function that statistically relates precipitation and ownership status to recruitment in each WMD.

Duck Production Function

One approach to estimating recruitment is a production equation that shows the contribution of ownership category and weather to duck production at each WMD. We estimated the production models by regressing recruitment rate per square mile on winter precipitation, ownership dummies, and a time trend variable. The "per square mile" formulation avoids issues of heteroskedasticity among WMDs. The three explanatory variables were:

- **Winter Precipitation**: The Mallard Model (U.S. Department of the Interior, 2001a) and similar efforts indicate that a major predictor of duck production is the number of ponds formed by snow melt and precipitation before the breeding season. The number of ponds can be predicted by the amount of precipitation in the area from December through March. The Global Historical Climatology Network (GHCN) provides monthly historical temperature and precipitation series

for more than 20,000 weather stations worldwide (U.S. Department of Commerce, 2002). We selected up to three stations from among the stations in the vicinity of each WMD as proxies for the weather at the WPAs. We then summed the precipitation recorded at each station from December to March each year to estimate a winter total precipitation. Then, we averaged the measures from the three stations to estimate precipitation at the WPAs. These data gave correlations between precipitation and wetland area reported in the HAPET data of 0.12 to 0.73, most are between 0.24 and 0.57.

- **Time Trend/Break**: Plots of recruitment rates over time also indicate an upward trend or an abrupt change in counts at one point in time (a break). This trend could be due to improvement in counting techniques, changes in observers, or large scale changes in the environment. A trend variable or break dummy was included in the model to account for this source of variation.

- **Ownership Status**: We modeled ownership status as a parallel shift in the production function by a set of dummy variables. We included dichotomous, 0/1, variables to indicate whether the observation was from land owned by the federal government in fee title or land with a conservation easement to the federal government as indicated in the HAPET data. Private land was the excluded category. Thus, the coefficients on the federal fee ownership and easement dummies indicate the incremental recruitment per square mile attributable to the ownership status.

HAPET and GHCN provided data for 19 PPR WMDs from 1987 to 2001. All 19 WMD production functions were estimated simultaneously using ordinary least squares and the Seemingly Unrelated Regressions (SUR) technique. SUR uses covariance among the WMDs to improve the precision of the parameter estimates. All of the estimated functions had significant F-tests at the 5 percent level or better. Adjusted R-squared statistics for the equations ranged from 0.41 to 0.83. These tests of fit indicate that the model captures a substantial portion of the variation in recruitment rates at WPAs. Table 2-4 shows the estimated coefficients for each model and their t-values.

As expected the winter precipitation and ownership coefficients had positive signs with a few exceptions. Federal fee ownership resulted in a greater increase in recruitment rate than easement rights. The regression equations yield estimates of 2001 recruitment by ownership type by inserting average rainfall and setting the time trend/break variable to 2001. With the ownership dummies set to zero, the regression equation yields the average production per acre for private lands in the WMD. Recruitment on federal lands is estimated by adding the coefficients for easement or fee lands to the private recruitment rate. Multiplying recruitment rate for each WMD by the number of square miles in that form of ownership in each WMD yields estimates of total recruitment.

Recruitment Results

The results suggest approximately 20.1 percent of PPR ducks come from federal property, even though federal management reaches only 13 percent of the land area. Table 2-5 shows that in North Dakota, 20.5 percent of ducks are from federally managed lands. The primary sources of these ducks are large easement holdings at Crosby, Devils Lake, and J. Clark Salyer WMDs where recruitment rates are considerably higher than on nearby private lands. Minnesota recruitment from federally managed lands is considerably lower, 7.4 percent, because only a small proportion of land is under federal management.

Table 2-4. SUR Predicted Recruitment per Square Mile and Total Recruitment by WMD and Ownership Class.

	WMD Area in Square Miles			SUR Calculated Recruitment per Sq Mi, 1996-2001			Total Annual Duck Recruitment, thousands			
WMD Unit	**Federal**	**Easement**	**Private**	**Federal**	**Easement**	**Private**	**Federal**	**Easement**	**Private**	**Total**
Minnesota										
DETROIT LAKES WMD	53	59	4,747	62	27	24	3.3	1.6	114.5	119.3
FERGUS FALLS WMD	50	86	2,167	59	31	18	3.0	2.6	38.8	44.4
LITCHFIELD WMD	20	23	3,799	62	36	11	1.2	0.8	40.5	42.6
MORRIS WMD	97	81	4,520	61	38	17	5.9	3.1	75.5	84.4
Ratio to Private/Total				*3.51*	*1.90*	*1.00*	13.3	8.1	269.3	290.8
Percent Share							4.6%	2.8%	92.6%	100.0%
North Dakota										
ARROWWOOD WMD	86	656	4,137	167	164	129	14.3	107.3	533.4	655.0
AUDUBON WMD	42	681	4,376	226	183	174	9.6	124.4	763.4	897.4
CROSBY WMD	114	1,056	5,643	215	191	158	24.4	201.8	890.1	1,116.3
DEVILS LAKE WMD	76	1,471	8,599	231	174	136	17.6	255.5	1,169.8	1,442.9
J. CLARK SALYER WMD	148	1,232	5,172	361	286	266	53.5	352.1	1,375.4	1,781.0
KULM WMD	66	865	3,358	534	230	200	35.4	198.6	672.7	906.7
LONG LAKE WMD	52	948	3,675	176	208	127	9.2	197.4	467.0	673.6
TEWAUKON WMD	33	266	2,886	265	123	128	8.7	32.9	369.4	411.0
VALLEY CITY WMD	27	389	5,160	78	51	43	2.1	19.7	222.8	244.7
Ratio to Private/Total				*1.65*	*1.18*	*1.00*	174.7	1,489.8	6,464.1	8,128.6
Percent Share							2.1%	18.3%	79.5%	100.0%
South Dakota										
MADISON WMD	45	384	5,466	66	41	27	3.0	15.8	149.5	168.2
SAND LAKE WMD	59	1,570	8,408	241	227	162	14.2	357.0	1,364.9	1,736.0
WAUBAY WMD	50	714	4,686	119	89	60	6.0	63.7	279.7	349.4
Ratio to Private/Total				*1.71*	*1.43*	*1.00*	23.2	436.5	1,794.0	2,253.7
Percent Share							1.0%	19.4%	79.6%	100.0%
Total All PPR States							211.2	1,934.4	8,527.5	10,673.0

Source: U.S. Department of the Interior, 2002; ERG Calculation

These total recruitment figures are on the high end of the expected range. Total fall flight of mallards in the Mississippi Flyway is on the order of 11 million ducks (U.S. Department of the Interior, 2001b). Fall flight estimates include mallards from prairie Canada, Wisconsin, and Michigan. Mallards are about one-quarter of the total population of ducks breeding in the area. The surveys on which our estimates are based do not distinguish mallards from other ducks, so expecting 10.7 million first- year ducks from WMDs may not be overstating their contribution to down-flyway recreation.

Contributions of Other Environments

This study has assumed so far that all of the NEVfrom waterfowl hunting is attributable to the birds and that the only contribution to the existence of the birds is their place of origin. Hunters do not parse the value of a hunting trip into the various elements of the trip, so we cannot assign parts of the NEV to each of the trip's attributes (e.g., so much for the harvest, so much for enjoying the outdoors, so much for seeing other wildlife). We can say that without the ducks, there would be little point to the sport, and this recreational activity would not be viable. So it is rational to attribute the value of a hunting season to the population of birds that make it possible.

Nesting success is the weak link that must be addressed to increase the duck population (i.e. it is the limiting factor in waterfowl production) (Reynolds, 2002). Ducks require many other resources to survive and thrive, however. They must have safe stopover sites on their migration and good feeding grounds at their wintering location. While creating a complete duck production function, including wintering environment, migration patterns, and complete climatological information would be ideal from a management decisionmaking viewpoint, this undertaking is not possible given the current level of information available.

Two approaches remain to attribute value to duck production requirements. First, as changes in population are largely driven by nesting success, it appears that the other requirements for production are already provided in excess amounts. Good nesting habitat is the resource governing marginal production. Therefore, all of the value of the marginal duck should be ascribed to the limiting resource. If we think of our analysis as valuing the incremental change in ducks available for hunting attributable to WPAs, then it is appropriate to place all of the value on the nesting grounds.

Alternatively, if we consider our exercise as an allocation of the total value of duck hunting to all of the resources that produce ducks, then we should apportion some share of the value to the nesting grounds and some to other necessary resources. We allocated the value of the duck season on the basis of the amount of time ducks spend on the breeding grounds versus elsewhere, T.

To estimate the proportion of a duck's lifetime that is spent on the breeding grounds, we constructed a life table of mallards based on Anderson (1975). Anderson estimated season to season survival rates for male and female ducks by age. Applying these rates to a life table yields the proportion of its life that a male or female duck has spent on the breeding grounds, given its age. Clearly, when a fledgling is first banded, it has survived several months and all of that time has been near the location where it hatched. As it joins the fall flight and is subject to the risks of hunting and weather, the proportion of its lifetime spent elsewhere grows and its probability of survival falls. The life table is a month by month calculation of survival and time on breeding ground. The final result is that the average adult duck has spent about 53 percent of its life using the resources of a breeding ground. For simplicity, we assume that all ducks return to the breeding ground of their origin. Although this is not strictly true, other ducks from other sites substitute for those that do not return to their native place.

Allocation to Wetland Management Districts

The Munro and Kimball derivation of ducks data may be used to attribute hunter NEV to the region of origin. The Munro and Kimball Missouri River Basin region most closely matches the PPR. Table 2-3 showed the allocation of total NEVs for each hunting state to the Missouri River Basin region. By this method, the CH value attributes $79.0 million to PPR states. A further step is necessary to allocate this to each state. Duck recruitment, based on the five-year average annual value, is used to split the regional total to states. The process is shown on Table 2-5. The relatively low recruitment rates in Minnesota mean that very little of the Missouri basin value is attributed to that state resulting in very low values attributed to federal management there. Federally managed lands are credited with $8.4 million when the state totals are distributed by ownership class.

Table 2-5. Disaggregation of Value to Ownership Categories by SUR Recruitment Rates based on Munro and Kimball Distribution.
(Thousand 2004 $)

State	Value to State	Value to Breeding Grounds	Total Value Attributed to State			Total Federal & Easement
			Federal	Easement	Private	
Minnesota	$ 2,150.9	$ 1,132.3	$51.9	$ 31.7	$ 1,048.7	$ 83.7
North Dakota	60,129.3	31,654.4	680.3	5,801.4	25,172.7	6,481.7
South Dakota	16,671.1	8,776.3	90.2	1,699.7	6,986.4	1,789.9
Total	$ 78,951.3	$ 41,563.1	$ 822.4	$7,532.9	$ 33,207.8	$ 8,355.3

Source: ERG Calculation

As a final step, the state shares of hunting NEV were allocated to WMDs in proportion to the shares the WMDs provide of total annual recruitment from federal and easement lands within the state. Table 2-6 shows the share each WMD contributes to recruitment which reflects both the recruitment rate and size of the WMD's holdings relative to other WMDs in the state. These proportions were then applied to the state totals to allocate NEV to individual WMDs. J. Clark Salyer WMD in North Dakota has the largest value attributed to it, $1.6 million.

Table 2-6. Hunting NEV Attributable to Each WMD Based on Average Recruitment (Thousand 2004 $)

		State Shares of Avg Recruitment		Values Attributable to WMD		
Unit	**State**	**Fee**	**Easement**	**Fee**	**Easement**	**Total**
DETROIT LAKES WMD	MN	24.6%	13.4%	13	6	19
FERGUS FALLS WMD	MN	21.8%	33.2%	12	10	22
LITCHFIELD WMD	MN	10.3%	8.0%	5	3	8
MORRIS WMD	MN	43.3%	45.4%	23	12	35
Minnesota Total		100.0%	100.0%	52	32	84
ARROWWOOD WMD	ND	6.6%	8.0%	56	418	473
AUDUBON WMD	ND	4.6%	7.8%	37	484	522
CROSBY WMD	ND	13.2%	15.7%	95	786	881
DEVILS LAKE WMD	ND	10.4%	16.4%	68	995	1,064
J. CLARK SALYER WMD	ND	30.0%	19.3%	208	1,371	1,580
KULM WMD	ND	24.3%	13.8%	138	774	911
LONG LAKE WMD	ND	4.5%	16.0%	36	769	804
TEWAUKON WMD	ND	5.3%	1.7%	34	128	162
VALLEY CITY WMD	ND	1.1%	1.2%	8	77	85
North Dakota Total		100.0%	100.0%	680	5,801	6,482
MADISON WMD	SD	9.0%	2.2%	12	61	73
SAND LAKE WMD	SD	42.9%	53.0%	55	1,390	1,445
WAUBAY WMD	SD	17.6%	9.6%	23	248	271
South Dakota Total		100.0%	100.0%	90	1,700	1,790

Source: ERG Calculation

ALTERNATIVE ESTIMATIONS

There are many different sources and methods that might have been used to develop these estimates. Hammack and Brown (1974) conducted a contingent valuation survey for the Pacific flyway similar to CH national analysis. Nichols and Hines (1987) provide an alternative distribution to Munro and Kimball (1987) by analyzing the distribution of ducks banded in winter rather than as fledglings. Rather than using a regression to estimate the impact of federal management on recruitment, we could have used a simpler method that does not control for other factors but merely compares the average production per acre. Presenting all of the tables showing all of the different combinations would be confusing and unproductive. Table 2-7 summarizes the basic waterfowl hunting results for all eight combinations of input parameters and methods.

Table 2-7. Hunting NEV by PPR State Using Alternative Parameter Values.
(Thousand, 2004$)

Valuation Source	Derivation Source	Distribution Method	ND	SD	MN	Total
Charbonneau and Hay	MK	SUR	6,481.7	1,789.9	83.7	8,355.3
	MK	Average	3,149.3	1,612.6	2,527.4	7,289.3
	NH	SUR	2,371.9	1,723.4	1,745.6	5,840.9
	NH	Average	6,978.7	2,847.8	104.0	9,930.5
Hammack and Brown	MK	SUR	4,055.0	1,119.8	52.3	5,227.1
	MK	Average	1,971.3	1,060.9	1,685.2	4,717.5
	NH	SUR	1,484.7	1,133.8	1,163.9	3,782.4
	NH	Average	4,365.9	1,781.6	65.0	6,212.6

Note: MK = Munro and Kimball analysis of fledgling banded mallards.
NH = Nichols and Hines analysis of winter banded mallards
SUR = Seemingly Unrelated Regression distribution method
Average = Average recruitment distribution method.

Hammack and Brown (1974) found considerably lower values than CH when both results are placed in 2004 dollars. As a result, all of the Hammack and Brown versions indicate considerably lower benefit levels. As Hammack and Brown studied only the Pacific flyway, they may well have missed the large number of avid waterfowl hunters on the Mississippi Valley.

Nichols and Hines (1987) analyzed data from ducks banded on their wintering ground in order to track where they returned to and where they were ultimately harvested. Like the Munro and Kimball data, this provides a basis for deriving the source of birds in hunting states.

In the main analysis, we conducted a regression analysis in order to distinguish the effects of ownership from other environmental effects. Another approach is to take the average recruitment rate per square mile for each WMD and land ownership category (R_{Ow}) over a period of years. Basically,

(14) $$R_{OW} = \frac{\sum_t R_{OWt}}{Years}$$

where t indexes years of observations. As would be expected, federally owned land has higher recruitment rates than leased land, which has higher recruitment rates than private land. When combined with the number of square miles in each ownership category for each WMD, these rates indicate the proportion of ducks from federally managed lands. The results also indicate the number of ducks that would have been produced if all of the land were in private ownership (i.e. without any management for waterfowl production).

Using these alternatives, the results range from $3.8 million to $9.9 million of NEV attributable to federal management of WPAs. The distribution among the PPR states changes considerably depending on how recruitment is calculated. This shows that we can have more confidence in the total value than in the values distributed to states and WMDs.

BENEFITS FROM NON-USE RECREATION

Migratory waterfowl are a significant target of 30 million birders throughout the United States. Large aggregations of wintering waterfowl draw crowds to the Texas and New Jersey coasts. Migratory resting sites along the Platte and Mississippi are legendary in the birding community. The sight of thousands of ducks and geese taking flight is truly breathtaking. Survey data also indicate that birders capture significant value from the experience. Estimates of individual NEV range from $10 per day in Delaware to $114 per day in Alaska (U.S. Department of the Interior, 2003). Considerable total NEV can be attributed to recreational birding.

But how does this translate into value for WPAs? In the hunting section, we showed that it is possible to allocate the NEV from places where recreation takes place back to the place of origin of the object of the recreation. Non-use values, however, are quite different. Since the bird is not consumed when a birder enjoys it, the same bird may be experienced by countless people in the course of its lifetime. Nor do more birds necessarily make for a better birding trip. Once some limit is reached, more birds in an area may not improve the experience. Small reductions in the number of birds in a large flock would go unnoticed by the majority of bird watchers. Thus, the marginal benefit of additional observations of common birds is near zero.

One could conduct an allocation similar to our attribution of hunting benefits to WPAs; however, the connections from birder to nesting site are tenuous. Allocation of multiple uses of the individual bird is a particularly daunting methodological challenge.

This is not to say that WPAs do not provide a service of value to birders. As discussed in the visitation section, birders make significant use of WPAs as places to visit. WPAs also help to preserve bird populations by protecting habitat. In this role, they can be considered as ensuring the future presence of substantial numbers of waterfowl. Birders are willing to pay to ensure that future birders have the opportunity to see waterfowl. This option value shows how much it is worth to the birder to maintain the option of being able to bird later. It is analogous to a stock option, where you pay for the right to purchase a stock, whether or not you actually do purchase it. Also like stock options, option values for natural resources are very difficult to estimate.

CONCLUSION

Many factors contribute to the regeneration of waterfowl. This study has attempted to sort out some of those factors and attribute the social welfare from one use of waterfowl to the FWS WPA program. Clearly, there are many ways to view the benefits from one activity, and one method may have no greater validity than another. The choices made in this study yield an estimate of $8.4 million and a range of $3.8 million to $9.9 million annually for the NEV of hunters for PPR WPAs. WPAs provide many other services to society. Some of these are valued in other portions of this study but many cannot be quantified with current methods.

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