ECONOMIC ANALYSIS OF THE MIGRATORY BIRD HUNTING REGULATIONS FOR THE 2008-2009 SEASON

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Economic Background and Significance

The purpose of this economic analysis is to determine the economic effects of Federal regulatory alternatives for the 2008-2009 hunting season for migratory birds. This analysis centers on changing daily bag limits and season lengths, the two most important policy variables in the Federal framework. The analysis will show that differences in those key variables between alternatives result in measurable changes in the number of hunters, how often they hunt, and the amount of consumer surplus they enjoy as well as the amount of money they spend in pursuit of their sport. There are two components to this analysis: first, each of the regulatory alternatives will be evaluated for their effects on consumer surplus and second, each alternative will be evaluated for their effects on hunter expenditures. The results of this analysis will document the expected economic effects of the final framework for the 2008-2009 Fall migratory bird hunting season.

Migratory birds are a renewable, international, common property resource. Unlike resources with clear ownership, individuals have little or no incentive to conserve common property resources. A bird not taken today may be taken by another hunter tomorrow. Therefore, each consumer has an incentive to take as much of the resource as they can capture, so all consumers together can overexploit the resource. This type of market failure is termed an externality in that the actions of one party impose costs on others that cannot be captured by a market transaction. Over harvesting at the turn of the century resulted in depleted bird populations and inspired the Migratory Bird Treaties between the United States, Great Britain (Canada), Mexico, Japan, and the Soviet Union.

The Migratory Bird Treaty Act (Act) implementing the treaties authorizes the Secretary of the Interior to establish national frameworks within which States may establish migratory bird hunting regulations. The status of migratory bird populations are discussed in a series of annual reports available at http://www.fws.gov/migratorybirds/reports/reports.html. Annual environmental considerations are covered under a separate Environmental Assessment (EA), "Duck Hunting Regulations for 2007," and an annual Finding of No Significant Impact (FONSI) (U.S. Fish and Wildlife Service, 2007). Copies of the EA and FONSI are available upon request.

The Act is permissive. Without the national frameworks, the states cannot establish hunting seasons and hunting is prohibited. The national framework indirectly regulates migratory bird hunting in the United States by setting maximums for season length and bag limits under which the States can set hunting regulations. The States can be more restrictive than the Federal framework but not more lenient (e.g. the States can set shorter seasons and/or lower bag limits).

Government policies generate economic effects by changing the use of resources in the economy. Alternative resource allocations may increase the efficiency of the national economy and generate greater welfare for its citizens, or policies may redistribute resources from one region or industry to another. The former are national economic

effects. The latter are regional economic effects. By permitting hunting, the migratory bird hunting framework regulations generate both types of effects.

Approximately 1.5 million people reported buying duck stamps in 2006 according to the 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (2006 National Survey). In addition to State hunting licenses, duck stamps are necessary to hunt ducks or geese in the United States. This analysis looks at duck hunting and the economic effects of regulatory alternatives on that major component of all migratory bird hunting. Sufficient data exists for duck hunting to generate an analysis of hunter behavior in response to regulatory alternatives. The analysis for all migratory bird hunting is not possible because of data limitations but can be inferred from the results of the duck hunting analysis presented here. Duck hunting represented approximately 50 percent of all migratory bird hunting in 2006 (2006 National Survey).

Evidently, hunters by their choice to hunt, demonstrate that they derive more pleasure from duck hunting than from their next most preferred option for spending that time and money. The increment in their welfare versus the next most preferred activity and the increment in producer surplus versus the next most productive use of the resources are the national welfare benefits of duck hunting.
The magnitude of these welfare effects indicate that the migratory bird hunting frameworks constitute an economically significant rule, under the definition of Executive Order 12866.

Effects of Allowing Hunting of the Migratory Bird Population

The annual Environmental Assessment of the migratory bird hunting regulations provides detailed descriptions of three alternative frameworks for the annual duck hunting season:

Alternative 1. Issue restrictive regulations allowing fewer days than those issued during the 2007-2008 season.

Alternative 2. Issue moderate regulations allowing more days that those in alternative 1.

Alternative 3. Issue liberal regulations identical to the regulations in the 2007-2008 season.

The Service proposes to issue liberal migratory bird hunting regulations in 2008-2009 (Preferred Alternative 3). A final determination of which alternative to promulgate will be made when the analysis of the bird population status, due to be completed in the summer of 2008, is available.

Theoretical Model

Two approaches for looking at participant behavior are the Random Utility Model (RUM) and conjoint analysis. The RUM model is a discrete choice model that uses an

individual's utility function to explain an individual's choice among recreational sites. By incorporating recreational site attributes into the model, it is possible to measure the impact on welfare due to changes in site attributes.

The k^{th} hunter's utility function from a visit to site j for i days can be described as:

$$U_{ijk} = V_k(T_{jk}, A_j, S_k) + \epsilon_{ijk}$$

where T_{jk} = vector of travel costs for hunter k to site j
A_j = vector of attributes for site j
S_k = vector of socioeconomic attributes for hunter k
U_{ijk} = unobservable utility for hunter k at site j for i days.

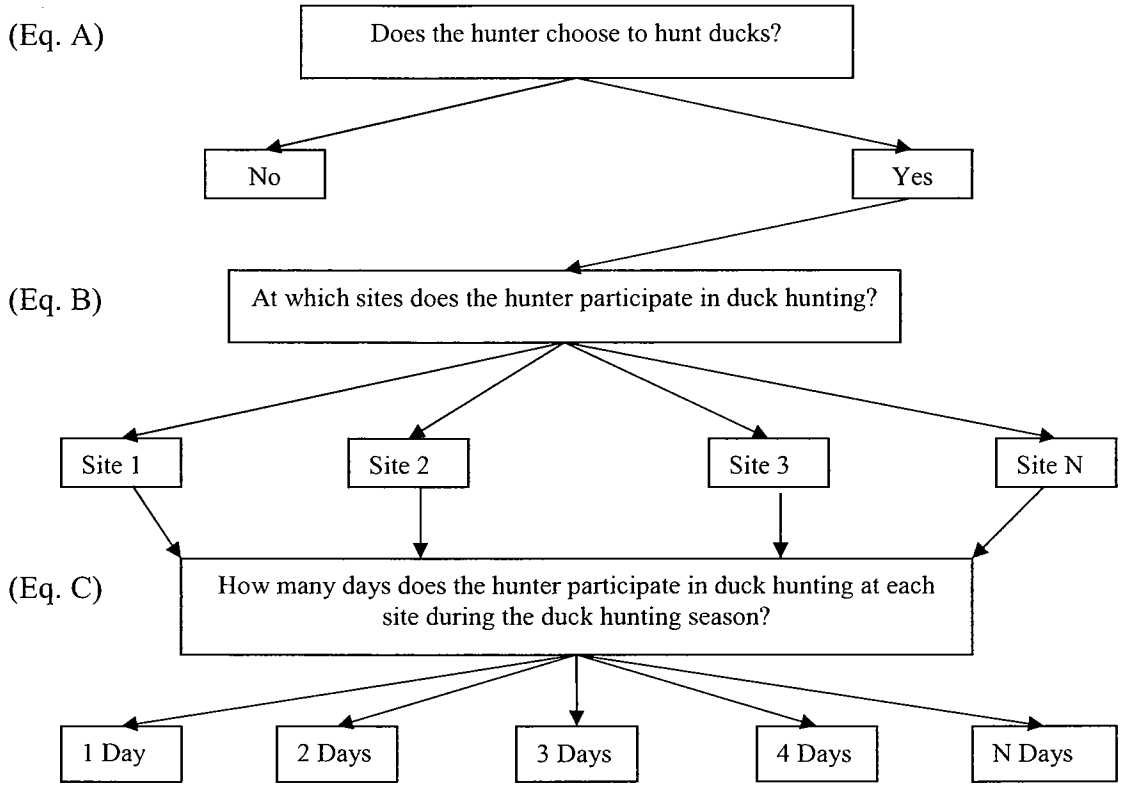
The hunter will choose to hunt ducks at a particular site for a number of days if his utility from hunting ducks at a particular site is greater than his utility of hunting for another animal at another site. The probability that a hunter will choose to participate in duck hunting at site j for i days is given as:

$$P(ijk) = P(i|j)P(j|k)P(k)$$

where $P(k)$ is the marginal probability of choosing to duck hunt, $P(j|k)$ is the conditional probability of choosing site j given that the hunter chooses to duck hunt, and $P(i|j)$ is the conditional probability of duck hunting for i days given that site j is chosen.

For the migratory bird harvest regulation, the random utility model would have a nested logit specification with three sequential decision-making levels. A nested model is necessary to ensure that the Independence of Irrelevant Alternatives (IIA) property is not violated. The IIA property assumes that the probability of choosing one alternative among two or more different types of recreational activities/sites is independent of the probability of choosing another alternative. By nesting together similar decisions, the IIA property holds true. The following figure diagrams the hunter's decision making process for duck hunting.

Figure 1. The duck hunter's sequential decision-making process.



The RUM is a good model to use to estimate the change in hunters' welfare as a result of a policy that changes duck hunting season length or bag limit. However, the migratory bird harvest regulation is a nationwide regulation covering 4 migratory bird flyways and 49 States with a vast number of site options for the duck hunter (equation B in Figure 1). To perform a valid RUM would require detailed information for each possible duck hunting site within the regulated 49 States. Thus, the data necessary to conduct a RUM would be prohibitively expensive to collect. The current National Survey of Fishing, Hunting, and Wildlife Associated Recreation collects data on hunters by state of residence and activity but the state level of specificity would make the application of a RUM model nearly impossible.

Conjoint analysis is a modeling technique more suited to household surveys. The model consists of a series of scenarios that are framed as possible choices for the respondent. For each scenario, key variables are given different values along with other variables that don't change and the respondent is asked to pick the preferred scenario. This approach holds promise to model hunting behavior as the scenarios could be specified to include alternative sites and activities. This approach has not been used for migratory bird

hunting nationwide, and as a result this approach cannot be implemented for the current analysis.

A model of duck hunting economics to compare the impact of each of the three alternatives was developed and is described in Appendix A. Current economic effects were determined by comparisons with Alternative 1. For purposes of analysis the base case was set as the restrictive Federal framework, i.e. the minimum migratory bird hunting permitted. This is referred to at alternative 1. Alternatives 2, and 3 result in increasing hunting days reflecting an increase in consumer surplus when compared to the baseline (alternative 1). The estimated economic benefits resulting from the preferred alternative (alternative 3) are the maximum achievable with the proposed framework.

Estimating Consumer Surplus

Estimates of individual's willingness to pay for duck hunting provides some insight into the size of the consumer surplus derived from this activity. Willingness to pay for migratory waterfowl hunting (which includes both ducks and geese) averaged $67 per day (2007$) (Walsh, Johnson, and McKean 1990). This is the average of 17 estimates the authors found in the research literature. In order to account for regional differences in consumer surplus estimates, data for estimating consumer surplus of waterfowl hunting by flyway are needed. The most recent flyway estimates in the existing literature has only one study where sufficient data were collected to derive consumer surplus estimates by flyway. Hay (1988) is the only study found that estimated values for each of the four flyways. Average consumer surplus estimates are required to evaluate the alternative duck hunting frameworks, which are specified by flyway. In this report, the average consumer surplus is presented as a range taken from the Hay (1988) study. To date, this is the most recent study that estimated consumer surplus by flyway. The daily consumer surplus estimates are used to determine the economic value of the baseline (restrictive migratory bird hunting regulations) and the estimated effects of changes brought about by different frameworks. The estimates from the Hay (1988) study provided the 95 percent confidence intervals for flyway consumer surplus per day used in this analysis. The estimates range from $36 to $58 (2007 $)per hunting day. The days of duck hunting reported in the 2006 Migratory Bird Hunting Activity and Harvest during the 2005 and 2006 hunting seasons – Preliminary Estimates (July 2007) were used to estimate the consumer surplus effects in the baseline. The results are shown in Table 1 below. This is the estimate for the consumer surplus if restrictive migratory bird hunting regulations were issued for the 2008-2009 season. The range of estimates used is more conservative than the Walsh, Johnson, and McKean findings from the literature.

Table 1. Consumer Surplus for the Baseline for Duck Hunting (Alternative 1)

Flyway	Duck Hunting Days	Consumer Surplus Per Day (2007 $)	Total Consumer Surplus
Atlantic	626,000	$36 - $52	$22 - $32 million
Mississippi	2,622,000	$42 - $54	$110 - $141 million

Central	809,000	$40 - $50	$32 - $40 million
Pacific	980,000	$42- $58	$41- $57 million
Total	5,037,000		$205 - $270 million

The national estimate of the consumer surplus with restrictive duck hunting regulations ranges from $205 million to $270 million (2007$) annually, with a mid-point estimate of $238 million. This surplus would be enjoyed by an estimated 741 thousand duck hunters.

Estimating Producer Surplus: Alternative 1/Baseline

The estimation of producer surplus is the missing value for a complete analysis of the economic benefits generated by the migratory bird framework. Producer surplus is more difficult to quantify in the case of a natural resource. There may be some producer surplus associated with land leases for access to waterfowl hunting as well as habitat leases to provide primary constituent elements needed to allow waterfowl to reproduce. Any producer surplus associated with the sale of equipment and services to hunters is not easily estimated since the data on profits margins for all these items are not known. Also, the large numbers of suppliers of services and equipment would tend to eliminate excess profits through competition. Since most, if not all the services and equipment have non-duck hunting applications, producers would tend to not be able to set a price that would include excess profits. Data to estimate producer surplus are not available and most likely producer surplus is minimal compared to consumer surplus.

Consumer Surplus Effects of Alternative Frameworks

An economic model of duck hunting was developed and estimated to evaluate the alternative duck hunting frameworks (Appendix A). This model is used to estimate changes in annual duck hunting days, changes in expenditures, and the changes in consumer surplus. An analysis of the alternative frameworks shows that the proposed framework for the 2008-2009 hunting season will maximize consumer surplus. Producer surplus, which is not estimated, should also be maximized, if it exists. All the alternative frameworks allow hunting regulations to be established, so there is a positive consumer surplus when compared to the base case (restrictive hunting regulations). The net effect of alternative frameworks results in relatively modest increases in consumer surplus primarily reflecting the fact that the frameworks are not severely binding on duck hunters decisions on how many days to hunt. The differences between season length, days afield, and bag limits and actual harvest are large enough that only marginal changes in hunter behavior are expected from alternative frameworks. The season length and bag limits set in the National framework, for example 90 days of hunting and 5 as a bag limit per day, are significantly higher than the typical hunters hunting for 8 days and having a bag per day slightly above 1 duck per day. Any changes in the National framework are expected to have only a small impact on hunter behavior. The result of using the model in Appendix A to evaluate the alternatives is given in Table 2 below. The mid-point of the consumer surplus per day values were used to develop the table 2 estimates.

Table 2. Estimated Consumer Surplus for Alternative Frameworks for the 2008-2009 Duck Hunting Season (Thousands of 2007 $).

Consumer Surplus Estimates by Framework

Flyway	Alternative 1 Restrictive	Alternative 2 Moderate	Alternative 3 Preferred
	(000$)	(000$)	(000$)
Atlantic	$27,400	$36,000	$45,800
Mississippi	$125,300	$142,100	$160,700
Central	$36,200	$44,600	$51,000
Pacific	$48,800	$54,700	$60,500
Total	$237,700	$277,400	$317,900
For the Average Hunter:			
Average Expenditure Per Day	$31	$37	$42
Average Consumer Surplus per Day	$47	$47	$47

The frameworks safeguard the efficient use of the resource over time by imposing limits on its exploitation. Overexploitation when access to the resource was unconstrained threatened its sustainability. Limiting resource consumption ensures future hunting opportunities and the resulting benefits to hunters.

The frameworks have little direct effect on other agencies' actions nor any material budgetary impact. As the framework procedure has been in place for over 20 years, no novel legal or policy issues are raised by these regulations.

Economic Effects of Alternative Frameworks

Table 2 shows the estimated increases in consumer surplus from duck hunting of the alternative frameworks when compared to the base case for each flyway. The total increases in consumer surplus ranges from $237.7 million for the restrictive framework to $317.9 million for the preferred framework.

Alternative 1 This alternative includes restrictive regulations allowing fewer days than those issued in 2007-2008. Bag limits are 3 ducks below the 2007 levels and seasons are 30 to 47 days shorter. The reduced bag limit reduces the probability of hunting about 1 percent resulting in 238,000 fewer hunters. Total hunting days would be approximately 1.7 million fewer days. Taken

together the restrictive framework results in an estimated $237.7 million (2007$) in duck hunter consumer surplus.

Alternative 2 Bag limits under this alternative are the same as under the preferred alternative (Alternative 3) but season lengths are 14 to 21 days shorter. Duck hunters would spend fewer days afield. The reduced season length decreases the probability of hunting resulting in 112,000 fewer hunters. Estimated consumer surplus would be $277.4 million (2007$).

Alternative 3 The preferred regulations similar to the 2007-2008 regulations have the most positive economic effect when compared to the base case used in this analysis. The estimated consumer surplus ranges from $274 to $362 million with a mid-point estimate of $318 million. The bag limits and season lengths results in an estimated 979 thousand duck hunters. This alternative is the preferred alternative and maximizes the total hunters' welfare benefits which are related to bag and days afield.

The differences between alternatives are relatively small. This reflects the fact that there is only a small influence of the national frameworks to changing the actual days afield and hunter bag limits.

Duck hunting accounted for approximately 62 percent of all migratory bird hunting days in 2006. This estimate of duck hunting benefits, if extrapolated to all migratory bird hunting, would be higher than the current estimate. There is no data to support this extrapolation so it is not performed.

State Costs of the Rule

The framework regulations for migratory bird hunting impose some costs of administration and enforcement on the States. If there were no migratory bird hunting, the States could apply their resources to different ends. As the States also derive revenue from licenses and sales taxes on hunting supplies, the net effect on State resources is uncertain.

If States were free to set hunting seasons and bag limits (abrogating the Migratory Bird Treaty Act), some might opt for longer seasons and higher bag limits without regard to the health of the waterfowl populations. To the extent the frameworks constrain the regulatory regime these States may impose, the framework imposes an opportunity cost on the States. The opportunity cost is the lost revenue and hunter expenditures the State cannot recover because it is constrained by the framework in its hunting regulations. There is no way to quantify this cost. In particular, the long run impact of over harvesting the population would be difficult to estimate and value.

SMALL ENTITY ANALYSIS

Regional Benefits of the Rule

This rule will have national economic benefits in the form of increased consumer surplus in excess of $100 million. This rule will set in place the proposed national framework for the establishment of migratory bird hunting for the 2008-2009 season. While the national framework is aimed at regulating hunter behavior, it has indirect effects in the form of hunter expenditures that affect small businesses nationwide. Although expenditures on hunting are an important effect to understand they do not constitute benefits of the rule since they are offset by reduced expenditures on other activities not related to hunting. Because of the magnitude of direct expenditures (a total of $1.4 billion in 2007 dollars), which includes special equipment with some portion going to small entities, the Fish and Wildlife Service (Service) estimates that this regulation is a major rule under the Small Business Regulatory Enforcement Fairness Act. Consequently, the Service believes the rule will have a significant beneficial economic effect on a substantial number of small entities. This impact will be focused on regions with high migratory bird hunting activity. As a result, this updated economic analysis is being made available for public review.

Major categories of Hunter Expenditures

Waterfowl and other migratory bird hunting represent an important part of the total economic activity generated by fishing and hunting in the United States. The National Survey of Fishing, Hunting and Wildlife Associated Recreation (2006 Survey) indicates that migratory bird hunter expenditures, exclusive of licenses, stamps, tags, permits, and special equipment totaled over $1.2 billion in 2006(2007$).

This analysis looks at duck hunting and the economic effects of regulatory alternatives on that major component of migratory bird hunting. Expenditure data specific to duck hunters are not directly available from the Survey. An estimate of duck hunter expenditures was obtained by using the numbers of active duck hunters and hunter days reported in the 2006 Waterfowl Harvest and Hunter Activity Administrative Report and the per capita and per day expenditure data reported in the 2006 Survey updated to 2007 dollars. Resulting expenditures for travel and equipment in the four flyways totaled $1.2 billion (2007$). Equipment and daily spending were estimated for each flyway. Equipment expenditures are calculated as per hunter equipment spending in the 2006 Survey times the number of duck hunters reported in the Administrative Report. Daily expenditures are calculated as variable expenditures (food, travel, and lodging) per year divided by total days from the 2006 Survey multiplied by duck hunter days from the Administrative Report. (All dollar figures in this section are constant 2007 dollars.)

Assuming that duck hunters distributed their spending among the Survey's travel expenditure categories in the same way as did other migratory bird hunters in 2006, duck hunters spending would have been as follows:

CATEGORY	PERCENT	EXPENDITURES
Equipment	41.27%	$502.2 million
Food	17.3	211.2
Transportation	36.6	445.9
Lodging	4.9	59.4
Other	0	0
Total	**100.0%**	**$1,218.7 million**

Migratory bird hunters spent $1.2 billion for guns, ammunition, travel, and recreational services in 2006 (2007 $). These resources would have been spent on other activities if migratory bird hunting had not been possible so they do not represent a change in national economic efficiency or welfare. Nevertheless, this spending is important for the industries and regions where the money is spent. If items like hunting camps, off-road vehicles, and land are included, 2006 spending for migratory bird hunting increases substantially.

Beneficiaries of the Rule

There were an estimated 979 thousand active duck hunters in the U.S. in 2006 (U.S. Department of the Interior 2007). The number of duck hunting stamps sold in the U.S. has increased in the last ten years going from approximately 1 million in 1991 to 1.5 million in 2006. Because of differences in survey methodologies the number of stamps sold and hunter estimates cannot be reconciled at this time. In addition to hunters, a wide range of businesses and individuals benefit economically from the establishment of the annual migratory bird hunting regulations. A partial list of migratory bird hunter expenditure categories and the types of businesses that benefit from those expenditures are shown below.

Migratory bird hunting regulations generate significant economic activity for small businesses. Nationwide, migratory bird hunters spent $1.2 billion at small businesses in 2006 (Table 3). Over 960 thousand small businesses will share in these sales. All but four of the States with reported sales derive, as a minimum, an excess of $2 million in small business sales from migratory bird hunting.

Expenditure Item	**Examples**	**Beneficiaries**
Equipment and Supplies	Guns, ammunition, boats	Sporting goods stores, department stores, boat dealers
Transportation	Gasoline, oil, repairs, air travel, vehicles	Service stations, vehicle dealers and rental agencies

Lodging		Motels, campgrounds
Food and Beverages		Restaurants, grocery stores
Lands and Leases	Club memberships, daily and seasonal hunting fees	Hunting clubs, private land owners
Clothing	Specialized clothing, waders, boots	Retail clothing stores, mail order firms

Limited information is available on the number of businesses and individuals in the various categories who benefit from duck hunter expenditures. This is not surprising considering that those who provide equipment, supplies and services to duck hunters often provide identical or similar items to non-hunters. For example:

1. A motel in a duck hunting area may obtain a portion of its income from duck hunters. Registrants are not requested to indicate the nature of their travel. The same situation prevails for food service establishments, gasoline stations, etc.

2. The number of sporting goods stores in the United States is obtainable. However, such stores may cater to fishermen, bowlers, skiers, joggers, etc., in addition to hunters. Without knowledge of their specialty, knowing the number of sporting goods stores is not sufficient.

3. Considerable leasing of lands for hunting and other purposes is accomplished informally without record keeping, and the payment is often in cash or otherwise undocumented.

Methods

This analysis combines information from the 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Surveys), the U.S. Department of Commerce County Business Patterns 2006 database, and the fisher library web site at the University of Virginia to develop estimates of migratory bird hunters' expenditures at small businesses. The Survey provides excellent information about hunters and anglers expenditures for sporting trips and equipment. Trip expenditures are categorized as food, lodging, transportation, and other travel items (e.g., guide fees, access fees, and rentals). Equipment expenditures include guns, ammunition, and decoys. Expenditures for magazines, memberships, vehicles, cabins, land, and dogs are excluded from this analysis. As very few respondents purchased these items, the data are considered unreliable.

The Surveys do not collect information about vendors. Therefore, another method is necessary to find the proportion of total expenditures that can be attributed to small businesses. The U.S. Department of Commerce publishes the County Business Patterns

database that includes the number of enterprises by county and North American Industrial Classification (NAIC). For this analysis, a small business is defined as any business having less than 50 employees. The County Business Patterns information permits calculation of small business' share of establishments but not their share of sales. An alternative methods was used to allocate sales to small businesses from establishment information for each State. If all businesses sell about the same amount, the share of expenditures spent at small businesses will be the proportion small business *establishments* are to the total number of establishments. This proportion probably overstates small business' share. A large discount department store probably sells more guns and ammunition than a small neighborhood gun shop. Using this method generates estimates of expenditures by migratory bird hunters at small businesses. To illustrate the State level of benefits, the following tables have been developed based on the 2006 National Survey. The estimates are reported in Table 3 and are shown by State and expenditure category. All expenditures in this section are reported in thousands of 2007 dollars.

Table 4, Estimated Migratory Bird Hunters' Expenditures on Food, illustrates the calculations for each of the expenditure categories shown on Tables 4 through 7. The first column contains State totals of the amounts respondents to the Survey reported they spent for food while on trips whose primary purpose was to hunt migratory birds. Food may be bought at a restaurant (NAIC 5812) or grocery store (NAIC 5410) so both types of establishments were combined. The second column shows the number of establishments in NAIC 5812 or 5410 in each State. The third column shows the number of establishments categorized a small businesses in each State. The proportion small business establishments are of the total is the method used to allocate expenditures to small businesses. This allocation is shown in the fifth column.

Although more than 25,000 hunters and anglers were interviewed for the Survey, these expenditure estimates are based on only those who actually hunted during 2006 and stated that the primary purpose of their trip or equipment purchase was hunting migratory birds. Only a small subset of hunters in each State meets both criteria so the expenditures are quite sensitive to individual responses. Zero totals are based on small sample sizes. Small samples may also inflate expenditure estimates. A zero estimate for a state indicates a small sample size and no estimate was attempted.

County business pattern information may also introduce errors. To avoid disclosure of private information, the Census Bureau withholds employment information when there are few establishments in a geographic area. Exclusion of a single large employer can greatly affect the proportion attributed to small business. In addition, entry of enough firms into an area results in all of the establishments appearing in the statistics. This exacerbates the instability of the published series. No effort was made to compensate for unreported firms in this analysis.

Surveys of a wide range of businesses would be required to obtain the necessary detailed data. The Small Entity Analysis included in this section spreads expenditures across all beneficiary businesses in proportion to the number of establishments.

The direct expenditures described above cycle through the economy generating additional income and sales. Analysis of this multiplier effect is beyond the scope of this report but clearly $1.2 billion is the minimum benefit from the migratory bird regulations.

Results

Migratory bird hunting generates considerable revenue for small businesses. In Arkansas and Texas, migratory bird hunting would be considered a significant industry generating over $100 million in expenditures in each state. The multiplier effect in each of these regions generates significantly more economic activity. Nationwide, migratory bird hunters will spend approximately $1.2 billion at thousands of small businesses in 2006. Some of this economic activity would occur without the annual promulgation of hunting regulations. Since much of the equipment and services used in migratory bird hunting can be used for other purposes, some of the annual sales would continue even if migratory bird hunting were prohibited. Much, if not all of this business activity would be redirected to alternative pursuits.

Evaluation of Alternatives

Each alternative outlined above results in a different level of economic stimulus generated from duck hunter spending. State expenditures for enforcement of duck hunting regulations are not affected by any of the proposed alternatives. In each case, the States would be required to field about the same enforcement effort. Only if the frameworks greatly relaxed bag limits and seasons would the States be able to reduce enforcement effort significantly. Alternatives 1 and 2 will reduce State license sales and sales taxes on hunting goods compared to the preferred Alternative 3. These revenue losses would be in addition to the lost benefits of expenditures in local economies.

Although reduced hunting now may result in more ducks to hunt next year, higher populations also increase the risk of disease outbreaks and unhealthy competition, in the absence of adequate natural predation. The opportunity cost of duck hunting, ignoring long run effects, is minimized by the preferred framework, Alternative 3.

Table 3. Estimated Expenditures by Migratory Bird Hunters at Small Businesses – Summary
(Millions of 2007 dollars)

State	*Food*	*Lodging*	*Transportation*	*Equipment*	*Total*
Alabama	$4.8	$1.4	$4.8	$4.7	$15.7
Alaska	$0	$0	$0	$2.1	$2.1
Arizona	$1.4	$.4	$2.9	$6.6	$11.2
Arkansas	$17.4	$5.0	$31.2	$57.8	$111.5
California	$17.7	$4.8	$48.9	$117.2	$88.6
Colorado	$3.1	$.9	$5.4	$12.2	$21.7
Connecticut	$0	$0	$0	$0	$0
Delaware	$.4	$.1	$.6	$2.0	$3.1
DC	$0	$0	$0	$0	$0
Florida	$0	$0	$0	$0	$0
Georgia	$7.8	$2.3	$6.2	$58.3	$74.6
Hawaii	$0	$0	$0	$0	$0
Idaho	$1.6	$.5	$1.3	$5.5	$8.9
Illinois	$3.6	$1.0	$32.3	$19.1	$56.0
Indiana	$2.6	$.8	$5.7	$13.6	$22.8
Iowa	$.4	$.1	$1.7	$17.1	$19.3
Kansas	$3.8	$1.0	$6.9	$8.2	$19.9
Kentucky	$0	$0	$0	$12.6	$12.6
Louisiana	$11.7	$3.2	$22.6	$19.0	$56.5
Maine	$0	$0	$0	$0	$0
Maryland	$3.6	$1.0	$8.3	$37.1	$50.0
Massachusetts	$.6	$.2	$.6	$0	$1.4
Michigan	$0	$0	$0	$0	$0
Minnesota	$3.0	$.9	$4.5	$16.5	$24.9
Mississippi	$6.3	$1.9	$2.7	$18.1	$29.0
Missouri	$8.7	$2.5	$9.3	$39.2	$59.8
Montana	$.7	$.2	$1.0	$0	$1.8
Nebraska	$3.3	$.9	$5.4	$6.9	$16.6
Nevada	$0	$0	$0	$0	$0
New Hampshire	$0	$0	$0	$7.1	$7.1
New Jersey	$0	$0	$0	$0	$0
New Mexico	$0	$0	$.7	$1.0	$1.7
New York	$0	$0	$0	$0	$0
North Carolina	$2.0	$.6	$2.5	$8.8	$13.9
North Dakota	$2.5	$.7	$5.0	$1.9	$10.1
Ohio	$0	$0	$0	$0	$0
Oklahoma	$3.0	$.9	$7.0	$7.5	$18.5

Oregon	$2.6	$.7	$4.9	$34.5	$42.7
Pennsylvania	$4.4	$1.1	$6.3	$0	$11.9
Rhode Island	$0	$0	$0	$0	$0
South Carolina	$5.9	$1.7	$3.4	$0	$11.0
South Dakota	$1.8	$.5	$1.6	$1.1	$5.0
Tennessee	$5.2	$1.6	$4.0	$17.5	$28.3
Texas	$32.9	$9.6	$82.0	$114.2	$238.7
Utah	$1.3	$.4	$4.6	$25.6	$31.9
Vermont	$0	$0	$0	$1.0	$1.0
Virginia	$1.6	$.4	$1.3	$11.4	$14.8
Washington	$.6	$.2	$1.6	$0	$2.3
West Virginia	$0	$0	$0	$0	$0
Wisconsin	$2.7	$.8	$6.0	$48.7	$58.2
Wyoming	$0	$0	$0	$0	$0
TOTAL	**$169.2**	**$48.3**	**$333.6**	**$654.4**	**$1,205.5**

Table 4. Estimated Migratory Bird Hunters' Expenditures on Food
(Expenditures in thousands of 2007 dollars)

State	*Total MB Hunter Expenditures on Food*	**Establishments**			
		Total Number of Establishments	*Number of Small Businessess*	*Percent Small Businesses*	*Estimated MB Hunters' Expenditures at Small Businesses*
Alabama	$5,369	7,652	6,796	88.8%	$4,768
Alaska	$0	1,450	1,364	94.1%	$0
Arizona	$1,636	9,738	8,480	87.1%	$1,424
Arkansas	$19124	4,729	4,304	91.0%	$17,405
California	$19,416	72,587	66,107	91.1%	$17,683
Colorado	$3,498	9,955	8,941	89.8%	$3,141
Connecticut	$0	7,513	6,994	93.1%	$0
Delaware	$431	1,710	1,517	88.7%	$382
DC	$0	1,847	1,695	91.8%	$0
Florida	$0	33,247	28,932	87.0%	$0
Georgia	$8,757	17,203	15,348	89.2%	$7,812
Hawaii	$0	3,348	2,992	89.4%	$0
Idaho	$1,776	2,725	2,516	92.3%	$1,640
Illinois	$4,404	23,999	21,730	90.5%	$3,625
Indiana	$3,032	11,263	9,877	87.7%	$2,659
Iowa	$452	5,641	5,085	90.1%	$408
Kansas	$4,206	5,144	4,612	89.7%	$3,771
Kentucky	$0	7,036	6,201	88.1%	$0
Louisiana	$13,061	8,075	7,207	89.3%	$11,657
Maine	$0	3,478	3,261	93.8%	$0
Maryland	$4,091	10,553	9,420	89.3%	$3,651
Massachusetts	$701	15,284	14,068	92.0%	$645
Michigan	$0	19,423	17,583	90.5%	$0
Minnesota	$3,381	9,212	8,156	88.5%	$2,993
Mississippi	$7,022	4,619	4,172	90.3%	$6,342
Missouri	$9,831	10,721	9,524	88.8%	$8,733
Montana	$711	2,367	2,230	94.2%	$669
Nebraska	$3,597	3,479	3,158	90.8%	$3,265
Nevada	$0	4,301	3,796	88.3%	$0
New Hampshire	$0	3,280	2,994	91.3%	$0
New Jersey	$0	19,908	18,696	93.9%	$0

New Mexico	$0	3,285	2,889	87.9%	$0
New York	$0	46,646	44,225	94.8%	$0
North Carolina	$2,280	16,698	14,993	89.8%	$2,047
North Dakota	$2,781	1,350	1,224	90.7%	$2,521
Ohio	$0	22,192	19,674	88.7%	$0
Oklahoma	$3,296	6,651	6,091	91.6%	$3,018
Oregon	$2,768	8,966	8,385	93.5%	$2,589
Pennsylvania	$4,856	24,078	21,723	90.2%	$4,381
Rhode Island	$0	2,682	2,487	92.7%	$0
South Carolina	$6,618	8,466	7,509	88.7%	$5,870
South Dakota	$1,913	1,713	1,585	92.5%	$1,770
Tennessee	$5,928	10,586	9,383	88.6%	$5,254
Texas	$37,002	39,154	34,787	88.8%	$32,875
Utah	$1,455	3,971	3,518	88.6%	$1,289
Vermont	$0	1,666	1,560	93.6%	$0
Virginia	$1,789	15,071	13,586	90.1%	$1,613
Washington	$614	14,372	13,333	92.8%	$570
West Virginia	$0	3,262	2,966	90.9%	$0
Wisconsin	$3,005	10,501	9,418	89.7%	$2,695
Wyoming	$0	1,177	1,096	93.1%	$0
TOTAL	**$188,400**	**583,974**	**528,188**		**$169,170**

Table 5. Estimated Migratory Bird Hunters' Expenditures on Lodging
(Expenditures in thousands of 2007 dollars)

State	*Total MB Hunter Expenditures on Lodging*	**Establishments**			
		Total Number of Establishments	*Number of Small Businessess*	*Percent Small Businesses*	*Estimated MB Hunters' Expenditures at Small Businesses*
Alabama	$1,510	746	704	94.4%	$1,425
Alaska	$0	318	294	92.5%	$0
Arizona	$460	1,132	985	87.0%	$400
Arkansas	$5,378	646	607	94.0%	$5,053
California	$5,460	5,567	4,865	87.4%	$4,771
Colorado	$984	1,270	1,140	89.8%	$883
Connecticut	$0	388	325	83.8%	$0
Delaware	$121	163	153	93.9%	$114
DC	$0	106	40	37.7%	$0
Florida	$0	3,511	3,000	85.4%	$0
Georgia	$2,462	1,693	1,558	92.0%	$2,266
Hawaii	$0	263	152	57.8%	$0
Idaho	$499	397	371	93.5%	$467
Illinois	$1,126	1,491	1,301	87.3%	$982
Indiana	$853	915	851	93.0%	$793
Iowa	$127	619	566	91.4%	$116
Kansas	$1,183	549	510	92.9%	$1,099
Kentucky	$0	725	680	93.8%	$0
Louisiana	$3,673	747	653	87.4%	$3,211
Maine	$0	659	632	95.9%	$0
Maryland	$1,150	629	528	83.9%	$966
Massachusetts	$197	792	652	82.3%	$162
Michigan	$0	1,444	1,346	93.2%	$0
Minnesota	$951	1,082	977	90.3%	$858
Mississippi	$1,975	614	586	95.4%	$1,884
Missouri	$2,764	1,146	1,048	91.4%	$2,528
Montana	$200	556	538	96.8%	$193
Nebraska	$1,012	386	361	93.5%	$946
Nevada	$0	459	421	91.7%	$0
New Hampshire	$0	389	353	90.7%	$0

New Jersey	$0	1,211	1,087	89.8%	$0
New Mexico	$0	670	621	92.7%	$0
New York	$0	2,054	1,760	85.7%	$0
North Carolina	$641	1,647	1,547	93.9%	$602
North Dakota	$782	236	218	92.4%	$722
Ohio	$0	1,463	1,334	91.2%	$0
Oklahoma	$927	614	580	94.5%	$875
Oregon	$778	1,051	976	92.9%	$723
Pennsylvania	$1,366	1,463	1,249	85.4%	$1,166
Rhode Island	$0	130	111	85.4%	$0
South Carolina	$1,861	1,100	992	90.2%	$1,678
South Dakota	$538	476	451	94.7%	$510
Tennessee	$1,667	1,307	1,227	93.9%	$1,565
Texas	$10,405	3,725	3,433	92.2%	$9,589
Utah	$409	558	500	89.6%	$367
Vermont	$0	305	276	90.5%	$0
Virginia	$503	1,456	1,282	88.0%	$443
Washington	$173	1,299	1,179	90.8%	$157
West Virginia	$0	306	283	92.5%	$0
Wisconsin	$845	1,226	1,120	91.4%	$772
Wyoming	$0	408	372	91.2%	$0
TOTAL	**$52,978**	**52,107**	**46,795**		**$48,287**

Table 6. Estimated Migratory Bird Hunters' Expenditures on Transportation
(Expenditures in thousands of 2007 dollars)

State	*Total MB Hunter Expenditures on Transportation*	**Establishments** *Total Number of Establishments*	*Number of Small Businessess*	*Percent Small Businesses*	*Estimated MB Hunters' Expenditures at Small Businesses*
Alabama	$4,957	5,789	5,641	97.4%	$4,831
Alaska	$0	604	583	96.5%	$0
Arizona	$3,089	4,082	3,831	93.9%	$2,899
Arkansas	$31,980	3,367	3,289	97.7%	$31,239
California	$52,480	20,546	19,157	93.2%	$48,932
Colorado	$5,629	3,834	3,647	95.1%	$5,355
Connecticut	$0	2,685	2,554	95.1%	$0
Delaware	$644	734	690	94.0%	$605
DC	$0	133	130	97.7%	$0
Florida	$0	15,492	14,732	95.1%	$0
Georgia	$6,476	9,315	8,971	96.3%	$6,237
Hawaii	$0	777	713	91.8%	$0
Idaho	$1,313	1,583	1,524	96.3%	$1,264
Illinois	$34,150	8,758	8,289	94.6%	$32,321
Indiana	$5,962	5,909	5,663	95.8%	$5,714
Iowa	$1,736	3,920	3,828	97.7%	$1,695
Kansas	$7,058	2,974	2,892	97.2%	$6,864
Kentucky	$0	4,469	4,338	97.1%	$0
Louisiana	$23,473	4,325	4,159	96.2%	$22,572
Maine	$0	1,837	1,795	97.7%	$0
Maryland	$8,990	3,522	3,270	92.8%	$8,347
Massachusetts	$588	4,823	4,589	95.1%	$559
Michigan	$0	8,504	8,244	96.9%	$0
Minnesota	$4,681	5,030	4,833	96.1%	$4,498
Mississippi	$2,802	3,754	3,669	97.7%	$2,738
Missouri	$9,687	6,306	6,054	96.0%	$9,300
Montana	$987	1,342	1,305	97.2%	$960
Nebraska	$5,599	2,213	2,152	97.2%	$5,445
Nevada	$0	1,607	1,491	92.8%	$0

New Hampshire	$0	1,498	1,445	96.5%	$0
New Jersey	$0	5,688	5,379	94.6%	$0
New Mexico	$769	1,939	1,858	95.8%	$737
New York	$0	11,064	10,602	95.8%	$0
North Carolina	$2,585	9,522	9,230	96.9%	$2,505
North Dakota	$5,172	950	916	96.4%	$4,987
Ohio	$0	9,351	8,902	95.2%	$0
Oklahoma	$7,291	3,840	3,722	96.9%	$7,067
Oregon	$5,203	3,002	2,835	94.4%	$4,914
Pennsylvania	$6,658	9,867	9,384	95.1%	$6,332
Rhode Island	$0	876	837	95.5%	$0
South Carolina	$3,547	4,855	4,712	97.1%	$3,442
South Dakota	$1,610	1,228	1,200	97.7%	$1,573
Tennessee	$4,165	6,449	6,220	96.4%	$4,018
Texas	$85,391	20,396	19,584	96.0%	$81,992
Utah	$4,874	2,036	1,941	95.3%	$4,647
Vermont	$0	926	904	97.6%	$0
Virginia	$1,411	7,046	6,735	95.6%	$1,348
Washington	$1,647	4,861	4,613	94.9%	$1,563
West Virginia	$0	2,190	2,138	97.6%	$0
Wisconsin	$6,321	5,459	5,245	96.1%	$6,074
Wyoming	$0	815	788	96.7%	$0
TOTAL	**$348,927**	**252,092**	**241,223**		**$333,574**

Table 7. Estimated Migratory Bird Hunters' Expenditures on Equipment
(Expenditures in thousands of 2007 dollars)

State	*Total MB Hunter Expenditures on Equipment*	**Establishments** *Total Number of Establishments*	*Number of Small Businessess*	*Percent Small Businesses*	*Estimated MB Hunters' Expenditures at Small Businesses*
Alabama	$5,107	3,039	2,771	91.2%	$4,657
Alaska	$2,345	343	304	88.6%	$2,078
Arizona	$7,376	2,723	2,420	88.9%	$6,555
Arkansas	$63,341	1,707	1,557	91.2%	$57,775
California	$19,377	16,516	14,684	88.9%	$17,228
Colorado	$13,569	2,974	2,695	90.6%	$12,296
Connecticut	$0	1,966	1,749	89.0%	$0
Delaware	$2,209	572	510	89.2%	$1,969
DC	$0	288	271	94.1%	$0
Florida	$0	11,076	10,071	90.9%	$0
Georgia	$64,348	5,259	4,765	90.6%	$58,303
Hawaii	$0	969	893	92.2%	$0
Idaho	$6,186	811	719	88.7%	$5,485
Illinois	$21,823	6,443	5,628	87.4%	$19,062
Indiana	$15,609	3,164	2,762	87.3%	$13,626
Iowa	$19,394	1,737	1,532	88.2%	$17,105
Kansas	$9,389	1,417	1,241	87.6%	$8,223
Kentucky	$14,078	2,276	2,045	89.9%	$12,650
Louisiana	$20,915	2,783	2,539	91.2%	$19,081
Maine	$0	838	758	90.5%	$0
Maryland	$42,072	2,820	2,488	88.2%	$37,119
Massachusetts	$0	3,576	3,153	88.2%	$0
Michigan	$0	5,371	4,721	87.9%	$0
Minnesota	$19,154	2,711	2,343	86.4%	$16,554
Mississippi	$19,466	2,080	1,931	92.8%	$18,071
Missouri	$44,233	3,193	2,832	88.7%	$39,232
Montana	$0	664	602	90.7%	$0
Nebraska	$7,767	1,025	913	89.1%	$6,919
Nevada	$0	1,228	1,093	89.0%	$0
New Hampshire	$8,255	892	768	86.1%	$7,108

New Jersey	$0	5,205	4,693	90.2%	$0
New Mexico	$1,126	1,037	945	91.1%	$1,026
New York	$0	11,771	10,806	91.8%	$0
North Carolina	$9,650	5,309	4,830	91.0%	$8,780
North Dakota	$2,248	366	318	86.9%	$1,953
Ohio	$0	5,677	4,954	87.3%	$0
Oklahoma	$8,410	1,883	1,684	89.4%	$7,521
Oregon	$39,223	1,867	1,643	88.0%	$34,517
Pennsylvania	$0	6,580	5,820	88.4%	$0
Rhode Island	$0	557	505	90.7%	$0
South Carolina	$0	3,003	2,757	91.8%	$0
South Dakota	$1,321	448	398	88.8%	$1,174
Tennessee	$19,388	3,547	3,194	90.0%	$17,458
Texas	$127,405	11,654	10,446	89.6%	$114,199
Utah	$29,155	1,256	1,102	87.7%	$25,581
Vermont	$1,057	516	492	95.3%	$1,008
Virginia	$12,769	4,326	3,865	89.3%	$11,409
Washington	$0	2,698	2,343	86.8%	$0
West Virginia	$0	968	868	89.7%	$0
Wisconsin	$56,913	2,716	2,324	85.6%	$48,698
Wyoming	$0	387	358	92.5%	$0
TOTAL	**$734,680**	**162,232**	**145,103**		**$654,420**

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Appendix A

Introduction

To analyze the 2008-2009 migratory bird hunting framework, an economic model was necessary that described hunter behavior under different regulatory frameworks. Available data to apply any model efforts consisted of the 2006 National Survey of Fishing, Hunting and Wildlife-Associated Recreation and the Administrative Reports for the 2005-2006 waterfowl hunting season. The 2006 National Survey is the most current database that is comprehensive enough to allow this type of analysis. The 2006 Survey data is still in its final stage of review before being released for detail analysis. The primary research interest of this analysis is the tradeoff between season length and bag limit assuming a desired total harvest of ducks. This is not the question these alternative frameworks pose. Each framework varies both bag limit and season length in order to not over harvest the species. The present analysis seeks to quantify these relationships and apply them to changes in both season length and bag limit.

Because of the less stringent data requirements, the empirical approach employed for this analysis is a reduced form of the random utility model by bypassing the site decision equation. The hunter's decision is limited to two questions. First, does the hunter choose to hunt ducks? Second, how many total days does the hunter choose to hunt ducks during one hunting season? The methodology used to analyze the impacts of varying the season length and/or bag limit is explained in the following text.

In any season, the total harvest of ducks (K) is the product of average bag per day per hunter (B), average days afield per hunter per season (DAF), the probability that a hunter will hunt ducks (PROB), and total hunters of all game (H):

$$(1) \qquad K = (B)\,(DAF)\,(PROB)\,H$$

The variables in the model and in the subsequent empirical analysis are defined in Table 8. The analysis was conducted under the assumption that total harvest, K, is set according to annual biological considerations. To develop the parameters of the model it was assumed that once K is determined, it remains constant under all alternative combinations of daily bag and season length. Therefore in the model, any change in K, denoted as (dK), is equated to zero.

This can be seen in the total differential of equation (1):

$$(2) \qquad dK = dB\frac{\delta K}{\delta B} + dDAF \quad \frac{\delta K}{\delta DAF} + d(PROB) \quad \frac{\delta K}{\delta PROB} = 0$$

The differential shows that the various components of dK can be allowed to vary as long as the effects of their changes on K net out to zero. The components are the changes in duck harvest that can be attributed to changes in bag per day (dB), days afield (dDAF), and probability (dPROB). It is assumed that total number of hunters (H) remains

constant. Measuring the compensating changes in these components is what ultimately permits the determination of the tradeoffs between bag limit and season length. The magnitude of the change in harvest caused by each of the components is the product of the initial change in the component and the partial derivative of K with respect to the component. For example, the effect on K of a change in daily bag (dB) is the product of dB and the partial derivative of harvest with respect to daily bag ($\delta K/\delta B$). Thus, equation (2) summarizes the nature of the tradeoffs between daily bag limits and season length in setting the regulatory framework. It shows that any increase in daily bag ($dB > 0$) must be offset by decreases in DAF and PROB such that total harvest remains the same ($dK = 0$).

Table 8. Definition of Variables

Variable	*Definition*	*Unit of Measurement*
PROB	Probability of duck hunting, given that a person hunts	1 = if hunts ducks 0 = otherwise
DAF	Days afield per hunter per season	Days
SL	Season length	Days
BL	Bag limit per hunter per day	Ducks
B	Actual daily harvest per hunter	Ducks
K	Duck harvest per season	Ducks
H	Number of hunters of all species	Participants
DH	Number of duck hunters	Participants
HD	Duck hunting days (DAF x DH)	Days
AGE	Age of individual	Years
INC	Individual's household income	Thousands of dollars
Gender	Sex of individual	1 = if male 0 = female
METRO	Urban residence	1 = if residence is in urban area 0 = otherwise
BD05	2005 average daily harvest of ducks per hunter in individual's state of residence	Ducks
WH05	Square miles of waterfowl habitat in individual's state of residence in 2005	Square miles of wetlands per square mile of total state area
AES	Average 2006 equipment expenditures of duck hunters	2007 Dollars
AVS	Average 2006 variable expenditures per day for duck hunting	2007 Dollars
E	Elasticity of season length with respect to days afield	Unitless Number

To measure those tradeoffs it is first necessary to express the components of (2) in other terms. From equation (1), the partial derivatives of total harvest with respect to daily bag (B), days afield (DAF), and probability (PROB) are:

$$(2.1) \quad \frac{\delta K}{\delta B} = DAF(PROB)H$$

$$(2.2) \quad \frac{\delta K}{\delta DAF} = B(PROB)H$$

$$(2.3) \quad \frac{\delta K}{\delta PROB} = B(DAF)H$$

Two equations were specified to incorporate hunter behavior into the model. It is assumed that a hunter makes two decisions.

First, a hunter decides whether to hunt ducks. The decision to participate is binary; the individual either hunts ducks (PROB=1) or he does not (PROB=0). The mean of PROB is the proportion of hunters that hunts ducks, the participation rate.

As discussed in detail below, the decision to participate is influenced by a number of factors. The probability that a given hunter will hunt ducks is a function of age, sex, residence in a rural versus urban area, income, season length, and the amount of waterfowl habitat and the bag per day per hunter in the individual's home state. To simplify the discussion, all factors influencing the decision to hunt ducks except bag per day can be combined in the intercept (a), making the probability that an individual hunts ducks a function of bag per day.

$$(3) \quad PROB = a + bB$$

Second, after deciding to hunt ducks the hunter must decide how many days to hunt during the season (DAF). The days afield decision is influenced by a number of the same variables: income, availability of duck habitat, and bag per day. Once again, all factors influencing DAF except bag per day can be summarized in the intercept ©.

$$(4) \quad DAF = c + eB$$

Solving equation (4) for B and substituting into equation (3) yields:

$$(5) \quad PROB = a + \frac{b(DAF - c)}{e}$$

The derivative of (5) with respect to DAF is:

$$(6) \qquad \frac{dPROB}{dDAF} = \frac{b}{e}$$

Substituting (6) and the partial derivatives (2.1, 2.2, and 2.3) into equation (2) and solving for the change in DAF results in:

$$(7) \qquad dDAF = \frac{-dB(DAF)(PROB)H}{B(PROB)H + \frac{b}{e}B(DAF)H}$$

Equation (7) may be simplified by combining all factors on the right hand side except dB into a constant, J. This makes the tradeoffs between changes in DAF and B apparent, in equation (8).

$$(7.1) \quad J = \frac{(DAF)(PROB)H}{B(PROB)H + \frac{b}{e}B(DAF)H}$$

$$(8) \qquad dDAF = -dB(J)$$

Note that B in the model is actual bag whereas the policy variable set in the regulations is bag limit (BL), a maximum number of ducks per day attained by relatively few hunters. The estimated relationship between changes in B and BL for each flyway is shown in Table 10. When dBL is known, the corresponding dB is determined from those estimates. The change in days afield (dDAF) for a given dB is derived from (8). With H and K constant, the new probability (PROB) is then calculated by substituting the new levels of DAF and B into equation (1). This keeps the duck hunters in the flyway on the isoquant representing a constant total harvest (K) while allowing BL and SL to vary.

The change in SL consistent with the change in BL is determined programmatically. The elasticity of SL with respect to DAF (the ratio of the percent change in SL to the percent change in DAF):

$$(9) \qquad E = \frac{dSL}{SL} \Big/ \frac{dDAF}{DAF} = \left(\frac{dSL}{dDAF}\right)\left(\frac{DAF}{SL}\right)$$

Equation (9) shows how much DAF must change in response to the change in SL to produce the required new level of BL. If BL is increased, SL must decrease if total harvest is to be held constant.

After the new probability of duck hunting is determined, the difference (dPROB) between it and the base probability is multiplied by the total number of hunters (H) to obtain the change in the number of duck hunters (dDH). Assuming that the new hunters will spend the same amount on equipment as the average of previous duck hunters (AES), the product of dDH and AES is the first part of the economic impact (IMP_1)

caused by changing BL. The second part of the impact (IMP_2) is the change in variable expenditures. It is the product of dHD, the change in hunter days due to the change in BL, and average variable spending (AVS) per day.

(10) Impact = $IMP_1 + IMP_2$

(10.1) IMP_1 = dDH(AES), where:
dDH = (dPROB)(H)

(10.2) IMP_2 = (dHD)(AVS), where:
dHD = dDH(DAF + dDAF) + dDAF(DH)

Thus, the economic impacts are measured as changes from the base case in terms of hunter equipment spending and spending for food, travel and lodging as the number of duck hunters and days afield change in response to the regulatory alternatives.

Estimation of the Model Parameters

As discussed above, the individual hunter is assumed to first decide whether to hunt ducks and then decide the amount of time to spend in the field. The individual's decision whether or not to hunt ducks is specified as a function of age, sex, residence in rural versus urban areas, income, season length, and average bag per day and amount of waterfowl habitat in the hunter's home state. The last two variables are included as measures of the relative quality and availability of waterfowl among states. The days afield (DAF) equation is a function of household income, average daily harvest, season length, and residence in rural versus urban areas. The variables in the equations are defined in Table 8. Data used for this analysis are from the 2006 National Survey of Fishing, Hunting and Wildlife Associated Recreation, and the Waterfowl Harvest and Hunter Activity Administrative Reports for the 1979 through 2006 seasons. These data sources provide the required variability in harvest, season length and bag limits to allow the estimation of the economic model.

The two equations were estimated on a national basis because there was insufficient variation for some variables to estimate individually for each flyway. The probability equation was estimated with logit equation, and the days afield equation was estimated with ordinary least squares. Below each parameter estimate is the t-value in parentheses. The probability equation is estimated for all hunters. The days afield equation is estimated for those hunters who hunted ducks. The results are shown in Table 9 below.

Table 9. Results

Parameter	Probability (Eq. 11)		Days Afield (Eq. 12)
	Coefficient	Marginal Effect	
Intercept	-4.441	--	15.2
	(0.007)		(2.82)
AGE	-0.014	-0.00103	
	(0.00007)	(0.00029)	
SEX	0.709	0.04486	
	(0.005)	(0.0151)	
METRO	0.078	0.00538	-0.648
	(0.002)	(0.0094)	(1.252)
INCOME	0.011	0.000958	-0.014
	(0.00003)	(0.000129)	(0.016)
BD05	0.512	0.04363	2.286
	(0.002)	(0.00906)	(1.14)
WH05	0.002	0.0002765	
	(0.00002)	(0.000081)	
SL	0.002	0.00014	-0.103
	(0.00009)	(0.000398)	(0.039)
	n = 4,263 LR = 357,191.4 Pr > ChiSq = 0.0001		n = 470 R^2 = 0.02 F = 2.17 Pr > F = 0.0715

In equation (11), all coefficients are significant and show that the probability that a hunter will hunt ducks is higher for male hunters and residents of urban areas, other things being equal. The probability decreases among older hunters but increases with household income and with the quality of duck hunting and length of the season in the home state. BD05, representing average daily bag in the previous year, was used instead of B as a measure of the quality of hunting in the individual's home state. The quality of the previous year's duck hunting was considered a more relevant factor for hunter decisions in 2007.

In equation (12), only coefficients for season length and bag per day are significant. The coefficients of BD05 is positive and SL is negative which indicates that hunters in states with a higher bag per day hunt ducks more days per year than do hunters in other states, and the negative coefficient on season length is probably due to the fact that season length for some flyways is so long that it has no influence on days afield, other things being equal. Also, the number of days spent duck hunting is inversely related to income and residents of urban areas, other things being equal.

Estimates of equations (3) and (4) were developed for each flyway from the coefficients in (11) and (12) by using flyway mean values for all independent variables except BD05 and collapsing them into the intercept (Table 10). The same coefficients of BD05 from

equations (11) and (12) were used in all flyways. For example, the intercept (a) in the probability equation is 10.509 for the Mississippi Flyway. The slope (b) in the probability equation is 0.002 for all flyways. The key parameters used in the analysis are sown in Table 10 below.

Table 10. Key Flyway Parameters Used in 2007 Update

	Flyway			
	Atlantic	*Mississippi*	*Central*	*Pacific*
Eqn 3. PROB = a +bB				
b =	0.04363	0.04363	0.04363	0.04363
Eqn 4. DAF = c + eB				
C=	7.4046	7.56576	5.849746	3.000644
E=	2.286	2.286	2.286	2.286
Eqn 7.1. J =	9.6906	9.85176	7.135746	5.286644
Response of B to BL				
Increase in BL	3.0%	3.5%	5.0%	3.9%
Decrease in BL	-9.88%	-8.12%	-12.97%	-18.46%
Elasticity of SL to DAF	4.427	5.509	3.875	2.884

The elasticity of SL with respect to DAF (percent change in SL due to a one percent change in DAF) was estimated from a set of time series/cross section data for the years 1979 to 2006. The equation is as follows:

DAF = 4.27 + .034SL + ..503lagged bag/day + .836 split seasons + .163 zones +
(.008) (.412) (.283) (.229)
.0096 bag limit + .05 pacific flyway + .033 central flyway + .126 Miss.
(.052) (.016) (.013) (.011)
flyway + .028 Atlantic flyway + -.328 Dummy for new method
(.011) (.358)

R squared = .81
N = 108

The partial of DAF with respect to SL = .034 computed for the nation was converted to a flyway specific elasticity of SL with respect to DAF – the percent change of SL for a one percent change in DAF. This was done by taking the reciprocal and multiplying it by the ration of DAF to SL for each flyway. The Mississippi Flyway elasticity is 5.509.

The remaining estimates for the preferred alternative representing the 2006 hunting season were obtained from other sources. Starting with the first row of Table 10, the total seasonal duck harvest (K) used in equation (1) was obtained from the Administrative

Report. The numbers of hunters differs somewhat in the 2006 Survey, the 2007 Administrative Report, and state license data. Estimates of duck hunters from Administrative Reports were used to be compatible with harvest and days afield information. Total hunters of all game and participation rates are from the 2006 Survey.

The base case probability (PROB) was estimated as follows. Daily harvest (B) and days afield (DAF) are from the 2007 Administrative Report, and PROB was solved for by substituting H and K into equation (1). The responsiveness (dB/B) of daily harvest (in percent) to a one unit change in bag limit (dBL) based on independent research results is in Table 10. It is flyway specific and is shown separately for increases and decreases. For example, an increase in the Mississippi Flyway BL from 4 to 5 ducks per day causes a 3.5 percent increase in B and a decrease in the BL from 4 to 3 per day causes a 7.9 percent decrease in B. To extend the results to more than a unit change in bag limit the same rate of change is applied to additional units in either direction, i.e., a change from 4 to 6 ducks per day yields twice the change in B as a change from 4 to 5.

Estimation of economic effects of alternative frameworks.

Equations 1 through 9 above were rewritten as follows to allow the derivation of the economic effects by flyway of alternative bag limits and season lengths.

- The change in the probability of duck hunting is equal to change in days afield times b/e.

- The change in daily harvest is equal to the change in days afield divided by J.

- The change in season harvest is equal to the change in hunter days times the change in daily harvest.

- The change in days afield is equal to the change in season length times the days afield divided by the elasticity times the season length.

- The change in duck hunters is equal to the change in probability of hunting ducks times the total number of hunters.

- The change in hunters days is equal to the days afield plus the change in days afield times the change in the number of duck hunters.

- The change in equipment expenditure is equal to the change in duck hunters times the equipment expenditures per hunter.

- The change in average variable expenditures is equal to the change in duck hunter days times average variable expenditures.

- The change is total expenditures is the sum of the change in equipment expenditures plus the change in variable expenditures.