

Estimating Nonmarket Benefits of the Conservation Reserve Program

The basic goal of economic targeting of the CRP is to retire lands that result in the greatest net social benefits. To accomplish this, knowledge of the benefits of all activities that are influenced by the CRP is required. Aggregated measures of benefits for the whole Nation will not allow land to be targeted at a desirable, field-level parcel. Instead, these benefits need to be known at the local or “micro” level to effectively target lands to retire. This requires using models based on *individual* human preferences.

This report describes three models that account for selected environmental effects associated with broad changes in agricultural practices. We focus on how enrolling cropland into the CRP has affected freshwater recreation, pheasant hunting, and wildlife viewing. Due to differences in data availability, and in the nature of each activity, different approaches are used to analyze these three activities. However, in each case, the goal is to estimate the value of natural resource quality at a disaggregated level. Environmental targeting, which leads to differential impacts at the micro level, can then be investigated.

Before presenting the modeling results, we outline the basic theory underlying the measurement of “amenity” values of natural resources, as it pertains to rural land uses (Ribaud and Hellerstein, 1992). Next, we review previous CRP valuation studies, and then discuss how these studies could be improved with better data and estimation techniques. The three models featured in the study are then introduced, along with a discussion of the data sources used. We use the models to determine the recreational value (from freshwater-based recreation, pheasant hunting, and wildlife viewing) of the CRP as it presently exists, and to determine the consequences of adopting an alternative targeting mechanism.

Background: Measuring the Value of Natural Resources

The net economic benefit an individual receives from consuming a market good (or service) is defined as the excess, over and above the market price, that an individual would pay to consume the good (or service). This net benefit is often referred to as a “consumer surplus” (Deaton and Muelbauer, 1980).

Although not directly measurable, methods of determining consumer surplus are well known in the case of conventional goods (or services) traded in a market with observable prices (see Box 5). Once the consumer surplus associated with consuming the good (or service) is measured, valuation of quality changes can be accomplished by comparing consumer surplus before and after the change.

Valuing a change in natural resources, such as those that may be affected by environmental targeting of the CRP, is based on the same principle as for a good or service that is sold in the marketplace. The main difference is that natural resources often lack a fully developed market, hence they have no observable price (Freeman, 1979). The lack of observable prices complicates construction of measures such as consumer surplus that are based on an “excess over observable price” criterion. To address these complications, analysts often employ the concept of the “total economic value” an individual may derive from a natural resource (Randall and Stoll, 1983). Total economic value is essentially the same as net benefit, but recognizes that the value derived from the quality of the environment can be subdivided into two main categories:

- (1) *Use value*—the value an individual derives from directly using the resource.
- (2) *Nonuse value*—the value given to the existence of an environmental resource even though it is not currently used.

Use values are associated with activities such as swimming, hunting, and viewing nature where the individual comes into direct contact with the environment. These values also include commercial uses of natural resources, such as fishing, and consumptive uses, such as clean air and drinking water. Nonuse values are less tangible since they arise from environmental preferences rather than direct use. Three categories of nonuse values are (Smith, 1996):

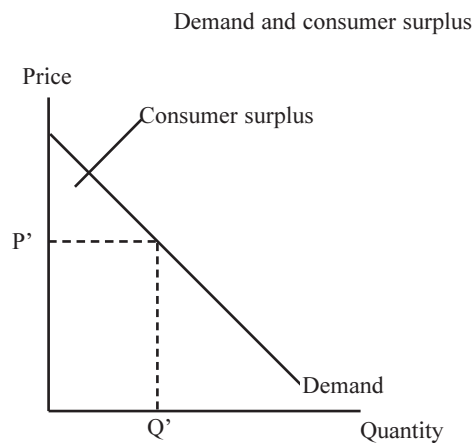
- (1) *Existence value*—the value derived from knowing that the resource is maintained.
- (2) *Bequest value*—the value the current generation gains from knowing that the resource is preserved for future generations.

Box 5—What is Consumer Surplus?

Measuring the contribution to human welfare due to the availability of a good, or service, is a common problem in applied economics. One approach is to compute consumer surplus. Loosely speaking, consumer surplus is the amount of money, above and beyond the market price, that a consumer would be willing to pay for a given good. If an individual buys a good for $\$X$, but would pay a maximum price of $\$X+\Y , then that individual's consumer surplus is $\$Y$. Most individuals experience consumer surplus in almost every good they purchase.

Policies that change prices, income, or the quality of goods can be evaluated in terms of how they affect individuals' consumer surplus. Simply put, desirable policies increase consumer surplus more than they increase other costs.

To compute the consumer surplus for a good, the demand function for that good must be specified. For example, the figure below (a linear demand function), shows that at market price P' , the quantity demanded will be Q' . The consumer surplus is the area below the demand function and above the price.



Source: USDA, ERS.

- (3) *Option value*—the value of preserving the resource so that the option of using it at some future date is maintained.

Table 3 lists approaches for obtaining these values. Inferred approaches based on market behavior such as averting expenditures, changes in production costs, and revealed preference are commonly used to determine use values. The most commonly used method, revealed preference, assumes that a relationship between environmental quality and observable behavior exists. Presently, the only method that can be used to recover nonuse values is contingent valuation. Although contingent valuation has been criticized as unreliable (Diamond and Hausman, 1994), it has been upheld in the United States District Court of Appeals (U.S. Dept. of the Interior, 1989) and approved for use by Federal agencies performing benefit-cost analysis (Arrow and others, 1993; United States Water Resources Council, 1984).

Modeling CRP Impacts: A Stylized Framework

To apply the techniques of nonmarket analysis to environmental targeting of the CRP, we incorporate the relationship between land retirement and the flow of nonmarket benefits. This process involves several steps. For example, figure 1 outlines the relationship between the CRP and two potentially large “use value” impacts: impacts on water quality and impacts on wildlife.

• Water Quality—

In the case of water quality, retiring croplands reduces soil erosion and runoff, which results in lower levels of nutrients, sediments, and pesticides entering water bodies. This changes the biological conditions of the water and directly affects what users of the water body value. Anglers benefit from larger fish populations, and boaters, swimmers, and non-

Table 3—Methods of valuing nonmarket goods

Method	Value assessed	Description
Averting or defensive expenditures	Use value	Measuring expenditures made by individuals to reduce or negate pollution damages. Purchasing water filters or bottled water in response to polluted water are two examples (Bartik, 1988).
Changes in production costs	Use value	Inferring the cost of pollution by observing changes in firm profits, input costs, or output prices due to changes in environmental quality. Changes in output prices of marketable goods to consumers are one way to measure changes in environmental quality. It is also possible to measure this cost through changes in incomes of owners of factor inputs, or by changes in input expenditures (Freeman and Harrington, 1990).
Revealed preference	Use value	Observing individual behavior and inferring the demand for environmental quality (Mendelsohn and Brown, 1983). Typically, recreational trips are used to measure the demand for environmental quality and the travel cost serves as the price. Conventional demand equations are then estimated to determine the value of environmental quality. This is known as the travel cost approach.
Stated preference	Total value	Directly asking individuals their willingness to pay for a change in environmental quality (Mitchell and Carson, 1989; Randall and others, 1983). Individuals are either asked to state their willingness to pay for a change in quality (open-ended format contingent valuation), or asked to vote yes or no to a set amount (referendum format contingent valuation), or asked to order scenarios involving varying prices and levels of environmental quality (conjoint contingent valuation analysis).

Source: USDA, ERS.

contact recreationists benefit from clearer, more aesthetically appealing water.

• **Wildlife Habitat—**

The relationship is similar in the wildlife case. Establishing grassland or forest cover creates suitable habitat for birds, small game, and large game. This, along with improvements in water quality, increases wildlife populations. Hunters and wildlife viewers then benefit from these increased populations.

In both cases, there is a causal relationship between a possible distribution of the CRP (as mediated through a targeting mechanism) and nonmarket benefits. More specifically, the size, placement, and management of CRP lands affect physical variables. These decisions then change biological parameters, which impact habitat quality and fish and wildlife populations. These altered environmental conditions ultimately are reflected in the values the public places on the environment.

The analyses in this report focus on the values the public places on the enhanced recreational activities. *This does not imply that CRP affects only recreational values.* However, recreational activities serve as good examples, because they are often associated with environmental amenities. Recreational activities tend to be high-valued activities, so are very relevant when addressing the value of environmental impacts. And finally, recreational activities include market-based activities, such as the travel costs associated with obtaining access to the natural resource, where the strength of individuals' preferences is demonstrated in dollar-based terms.

As environmental targeting evolves, determining the changes in welfare caused by the ensuing changes in land retirement patterns may involve directly estimating each of these steps in the causal relationships. In the water-quality case, a physical model translating changes in soil erosion into changes in observable biological criteria such as water clarity and fish populations would be required. Similarly, the wildlife case involves estimating changes in populations of wildlife species resulting from habitat changes.

Figure 1

Links between CRP acreage and economic benefits

Step 1: CRP acreage creates physical effects



Water quality: Reductions in erosion decrease nutrient, pesticide, and sediment loadings.

Animal habitat: Creates beneficial grassland habitat for animals.

Step 2: Physical effects translate into biological results



Water quality: Decreases in loadings are beneficial for fish populations and improve the appearance of the water for recreational purposes.

Animal habitat: Populations of many wildlife species increase due to better habitat and water quality.

Step 3: Biological results affect consumer welfare



Water quality: Improved appearance and smell of water make it more desirable for contact recreation. Increased fish populations reduce angler effort. Surface-water bodies are more visibly appealing for noncontact users.

Animal habitat: Increased wildlife populations enhance hunting and wildlife-viewing activities through reduction in effort.

Source: USDA, ERS.

Ideally, these physical/biological models would be readily available. Unfortunately, the data required to estimate these relationships, and the knowledge of exactly how physical and biological interactions occur, are generally not available. Devising approaches to overcome these deficiencies is the major challenge facing the applied analyst. Often, an approach is adopted where a set of “environmental indicators” is used to represent the various physical and biological impacts of some policy. Although not ideal, this so-called “reduced form” approach allows the analyst to partially abstract from the ideal bio-physical models, while still incorporating available biophysical information.

Underlying the use of environmental indicators is the assumption that the link between physical effects and what recreationists value can be approximated by these indicators. In other words, since these indicators are proxies for the underlying environmental quality ultimately valued by recreationists, individuals are assumed to indirectly respond to them. For example, measures of the distribution of land types, such as “percent of land in cultivated crops” or “land in transitional wetlands,” may be used as indicators of

the overall abundance of wildlife-viewing opportunities.

Review of Prior Studies of the Recreational Value of the CRP

When considering where to target the CRP, analysts need to study how the CRP will affect recreational activities. Several studies have provided some limited economic analysis on this topic. Perhaps the best known are ERS studies that give national estimates of CRP’s effect on freshwater fishing and small-game hunting from the late 1980’s (Ribaudo and others, 1990). The National Biological Survey in the early 1990’s (Allen, 1994; John, 1993, 1994) further analyzed the CRP’s impact on the value of waterfowl hunting and bird watching.

Tables 4-6 describe the important features of these studies. These studies share a few common features:

- Most of these studies, except Ribaudo and others (1990), employ land use measures as environmental indicator variables. This land use information is generated from

Table 4—The 1990 ERS Freshwater Fishing Study

Environmental indicator	An “acceptable” water-quality (WQ) variable is defined for approximately 100 sub-State Wildlife Management Zones. This variable is based on sediment and chemical concentrations detected in surface waters at water-quality monitoring stations.
Econometric model	Using 1980 FHWAR* data, the authors estimated a two-stage probability-of-participation/quantity-given-participation model. Both stages use the WQ variable and personal characteristics as explanatory variables; the quantity stage also uses reported distance to most visited site as a price proxy.
Impact of CRP	A set of models are used to link erosion (and chemical runoff) rates from CRP land to levels of in-stream loadings of pollutants.
Effect of impact	By using multi-State data at the multi-State farm production region scale, in-stream loading changes are used to estimate a predicted WQ variable. With results from the econometric model, the analyst computes a new average quantity of trips (by multiplying the predicted probability of participation by the predicted number of trips).
Value of impact	The difference between the new quantity and the observed quantity is multiplied by an average value per trip; where the average value is obtained from a review of the valuation literature.

*1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.

Source: Ribaldo and others (1990).

Table 5—The 1990 ERS Small-Game Hunting Model

Environmental indicator	Several land-use proxies for habitat variables (such as percent forest land) are computed at the State level.
Econometric model	Using FHWAR* data, the authors estimated the probability of being a hunter, and the probability of being a small-game hunter; using the habitat variables and personal factors as explanatory variables.
Impact of CRP	Adjust the various habitat measures, based on the enrollment of land into the CRP.
Effect of impact	The probabilities of being a hunter, or of being a small-game hunter (given that one is a hunter) were predicted. Using average number of small-game hunting trips (assumed the same for all small-game hunters), a total number of small-game hunting trips is computed.
Value of impact	The difference between the new quantity and the observed quantity of small-game hunting trips is multiplied by an average value per trip; where the average value is obtained from a review of the valuation literature.

*1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.

Source: Ribaldo and others (1990).

Table 6—The 1992 NBS Waterfowl Hunting and Bird Watching Models

Environmental indicator	Several land-use proxies for habitat variables (such as percent forest land) are computed at the Wildlife Management Zone level. To account for congestion, these were divided by the population of the area.
Econometric model	Using FHWAR* data, the authors estimated a quality of experience/quantity of trip model. Both stages use the habitat measure, the distance to most preferred site, the distance to farthest site, and personal factors. In addition, the quantity model uses the predicted quality.
Impact of CRP	Adjust the various habitat measures, based on the enrollment of land into the CRP.
Effect of impact	For current participants, the quality measure is re-estimated, and then used to compute a predicted number of trips.
Value of impact	Using reported distance as a proxy for price, a “marginal value” of the habitat variables is computed. More important, the demand curve is integrated to compute a consumer surplus.

*1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.

Source: Allen, 1994; John, 1993, 1994.

USDA's Natural Resources Conservation Service's National Resources Inventory (NRI), and is commonly incorporated as sub-State averages such as the percentage of farmland in a Wildlife Management Zone. Because Ribaud (1989) was estimating water-quality benefits, his model employed measures of water quality.

- All of the studies rely on the U.S. Fish and Wildlife Service's National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (FHWAR) as a primary source of data on individuals' recreational activity (i.e., behavioral data). This survey is one of the few nationwide sources of data devoted to outdoor recreation. Unfortunately, due to confidentiality and other factors, the geographical specificity of the data is limited to sub-State regions.
- In each study, the fishing and small game models use per-trip values, obtained from the travel cost literature, to impute changes in value due to the CRP. The waterfowl-hunting and wildlife-viewing models directly compute a consumer surplus from their estimated demand curves.
- These studies used econometric methods that were based on highly simplified statistical models and aggregated data.

Features of the Nonmarket Benefit Models

These prior analyses of the nonmarket impacts of the CRP relied on highly aggregated data and relatively unsophisticated estimation methods. Measures of resource availability were based on regional averages instead of smaller more localized areas. Some of the studies extrapolated benefit measures from related studies rather than determining the benefits from behavioral data. The imputation of trip prices was often based on the most recent destination visited rather than a consideration of the entire set of choices made by the respondent. The econometric models employed had limited scope and handled quality changes at substitute sites in a simplified fashion.

In the context of environmental targeting, the final point is crucial. That is, environmental targeting is driven by the notion that careful placement and man-

agement of the CRP (or other similar programs) will increase per acre (or per program dollar) benefits. An "all or nothing" analysis of the entire CRP, which typifies the above models, is ill suited to examine the more subtle and place-specific changes likely to arise by variations in a targeting mechanism.

The models constructed for this study are designed to circumvent some of the shortcomings of prior models and are formulated to allow a focus on the effects of environmental targeting.³ The foremost change is an improvement in the resolution of the geographical and behavioral data; the models are better suited to deal with substitute sites. Additionally, the range of activities analyzed is extended from earlier studies in the case of freshwater-based recreation (as opposed to freshwater fishing), and all wildlife viewing (as opposed to bird-watching). The single activity model (pheasant hunting) is also presented as an example of an environmental amenity (the size of the pheasant population) that is thought to be heavily affected by the CRP. Each of the three separate models incorporates some of the improvements listed in Box 6.

Data Used in the Nonmarket Benefit Models

Examining the nonmarket impacts of environmental targeting requires information about recreational behavior and the natural resource base (see Box 7). In this study, three primary databases are used: the 1995 National Survey of Recreation and the Environment (NSRE), the 1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (FHWAR), and the 1992 National Resources Inventory (NRI).

In the water-quality component of this study, behavioral information is derived from an ERS-funded component of the 1995 NSRE. The component of the NSRE used in this analysis was undertaken specifically to collect data on water-based recreation. Four sub-State regions located in Washington, Nebraska, Indiana, and Pennsylvania were sampled. Respondents were asked to recall the number of trips

³Presently, much of the environmental valuation literature is poorly suited for this type of problem. Most travel cost models focus on a single site or incorporate a relatively small number of substitute sites that include no measures of site quality. These models are good at examining demands in localized areas, but less effective at considering changes at the national level. Contingent valuation models often examine global changes with minimal focus on geographic variability.

Box 6—Improvements in Nonmarket Benefit Models in This Study

Better measures of recreational choice.

The 1991 FHWAR survey contains more accurate demographic data. This version of the survey contains more detailed information on residential location (i.e., ZIP Codes) than was previously available. This aids in a more exact description of the resources available to each individual. Additionally, because the survey was conducted after the CRP was in place, it reflects changes in behavior that occurred due to this program. The ERS component of the 1995 National Survey of Recreation and the Environment was used to measure freshwater recreation. This survey, although drawn from a limited geographical area, was designed to highlight the relationship between land use and recreational behavior.

More accurate measures of landscape diversity.

Using sub-county location information in the NRI, in combination with geographical information system techniques, estimates of relevant landscape features were derived throughout the United States at higher resolution than otherwise possible. In addition to providing a more accurate description of an individual's environment, this higher resolution permits local variations in the landscape to be accounted for.

Better estimation techniques.

Recent advances in estimation methods allow quality variations to directly influence consumer behavior. In addition, these models are better able to simultaneously account for both the decision to engage in a recreation activity and the intensity of participation.

Individual based benefits measures.

Economic theory dictates that marginal measures should be used to compute the impacts of changes in an individual's choice set. In practice, this suggests using individual specific demand curves whenever possible, rather than average trip values derived from studies of similar populations. Using estimators that can exploit higher resolution data, the ability to obtain and use individual specific demand curves is enhanced.

Source: USDA, ERS.

taken to wetlands, lakes, and rivers less than 100 miles from their residences within the last 12 months in cases where water was an important reason for the trip. The sample contains information on 1,510 persons evenly divided among the four areas. About 50 percent of the respondents participated in at least one freshwater-based activity, with participants averaging 10 trips per year.

The pheasant-hunting model and the wildlife-viewing model use the 1991 FHWAR, which measures participation in wildlife-based outdoor recreational activities. A two-stage sampling design is used, with a quarter of a million people asked screening questions regarding their overall participation in hunting, fishing, and wildlife viewing. A followup survey, using those judged most likely to be active participants, was

then conducted. Approximately 50,000 individuals reported wildlife-associated recreation, with about half reporting nonconsumptive activities (i.e., wildlife viewing) and half reporting fishing and hunting activities. For purposes of the analysis, 5,851 individuals sampled were identified as potential pheasant hunters and more than 18,000 individuals sampled were identified as potential “wildlife-viewers.”

Unlike earlier studies that used FHWAR data, the version of the survey used here contains the ZIP Code location of each respondent's home. This information helps construct a more accurate description of the recreational amenities available to each respondent. The result is a better identification of resource qualities affecting recreational behavior. One drawback is the lack of precise information about the location of

Box 7—Data Requirements for Recreation Demand Models

Recreation demand models require information about recreational behavior and the natural resource base. In this study, three principal sources of data are used:

(1) Data on the natural resource base from the **National Resources Inventory**

- More than 800,000 locations sampled nationwide.
- Extensive land use information.
- Soil and land cover information.

(2) Water-quality model behavioral data from the **National Survey of Recreation and the Environment**

- Sampled 1,500 respondents in four dispersed regions of the United States.
- Focused on water-based recreation.
- Information on up to nine locations visited over the past year.

(3) Pheasant-hunting and wildlife-viewing model data from the **National Survey of Fishing, Hunting, and Wildlife-Associated Recreation**

- Extensive sample of more than 50,000 individuals nationwide.
- Sophisticated sampling and data collection techniques.
- Information on a wide variety of activities.

Source: USDA, ERS

the destination visited by each respondent. The only information pertaining to destinations is the State visited and the distance traveled.⁴

We used the 1992 National Resources Inventory (1992 NRI) to describe the natural resource base in all three studies. The 1992 NRI is the most recent of a series of inventories conducted every 5 years by the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS). The NRI contains information on the status, condition, and trends of land, soil, water and related resources on non-Federal land in the United States. The survey is scientifically designed and based on recognized statistical sampling methods.

To obtain a national sample of land use characteristics, NRCS samples more than 800,000 locations. Each datum, or point, represents a homogenous area of land. Because the location of these points is not available due to confidentiality restrictions, the point data are aggregated into larger areas which this analysis uses. These areas, termed "NRI polygons" are constructed by aggregating points found in 14,414

⁴An earlier version of the FHWAR contains slightly better information on destination location. Instead of identifying destination by State, a sub-State "wildlife management zone" was identified.

nonoverlapping subcounty regions formed by the intersection of county boundaries, NRCS Major Land Resource Areas, and USGS hydrological units in the continental United States.⁵

Freshwater-Based Recreation Results

The NRI, which describes the physical conditions where recreation occurs, contains information on erosion levels but not on pollutant loadings. In terms of the links between CRP acreage and economic benefits highlighted in figure 1 (pg. 11), only the information describing the physical effects of CRP acreage measured by soil erosion is available (Step 1). In the absence of detailed data describing how those physical effects impact the health of the ecosystem (Step 2) and ultimately affect consumer welfare (Step 3), it is assumed that erosion influences recreational behavior via unspecified biological and physical processes.

Models of lake- and river-based recreation were estimated from the regional NSRE data described in the preceding section. NRI polygons served as possible sites that recreationists might visit, and are described by average soil erosion and other physical data found

⁵The average size of an NRI polygon is 132,365 acres; with sizes ranging from 100 acres to over 3 million acres.

in the NRI (see Appendix A for details). The regional models were then transferred to the entire United States using benefit-transfer techniques. These techniques involve transferring the actual demand equation rather than a single point estimate as was done in earlier studies. Table 7 shows the total annual consumer surplus estimates. The combined benefits of all water-based recreation in lakes and rivers throughout the United States are slightly over \$37 billion per year. Recreation occurring at lakes accounts for the majority of these benefits. This estimate of the value of water-based recreation is similar in magnitude to estimates by Carson and Mitchell (1993). They calculated that the annual benefits of achieving a “swimmable” water-quality goal at all water bodies in the United States range from \$24 billion to \$40 billion.

The CRP’s contribution to these benefits is determined by calculating the difference in consumer surplus with and without the program. To predict consumer surplus without the program, subsequent erosion levels were predicted using the universal soil loss equation found in the NRI. These new erosion estimates were then used in the recreation demand model to predict consumer surplus without the CRP. The difference between consumer surplus levels with existing and no-CRP erosion rates appears in table 7. Again, the majority of the benefits are to lake-based recreation. The total annual contribution of CRP to all freshwater-based recreation is approximately \$35.4 million. This estimate is of the same magnitude as Ribaudo’s (1989) estimate of \$21.4 million, but larger

because Ribaudo considered only fishing whereas this model considers all freshwater recreation. Compared with the total consumer surplus estimates, the (1991) CRP’s contribution to benefits of water-based recreation is small. Total benefits are highest in the South Eastern, Pacific/Mountain, and North Eastern regions. Both total CRP benefits and benefits per acre are highest in the South Eastern and North Eastern regions. This is not surprising since these regions contain a large portion of the U.S. population and a large number of surface-water recreation sites.

Pheasant-Hunting Recreation Results

Biological evidence indicates that the CRP mostly affects avian species (Allen, 1994). Ring-necked pheasants, in particular, have been shown to be influenced by use of agricultural lands and the presence of CRP lands (Basore and others, 1987; Hill, 1976; Jahn, 1988; Messick, and others, 1974, Minn. Dept of Natural Resources, 1985; Warner, 1979 and 1984; Warner and others, 1984). Furthermore, data from the 1991 FHWAR indicate that the pheasant is the most popular upland game bird throughout the Midwest. For these reasons, pheasant hunting, a component of small-game hunting, is presented as a species-specific special case.

Like the freshwater-based recreation model, an ideal pheasant-hunting demand model would contain a component linking biological activity with human behavior. Establishing a model linking CRP to pheasant popula-

Table 7—Freshwater-based recreation: Consumer surplus by region

Region ¹	Total consumer surplus ²		Consumer surplus due to CRP ³		Consumer surplus ⁴
	Lake	River	Lake	River	
----- Million dollars per year -----					
Pacific/Mountain	7,423.93	1,004.65	1.27	0.42	0.21
Northern Plains	685.66	95.71	2.13	0.34	0.28
Southern Plains	2,628.66	353.49	1.34	0.13	0.29
South Eastern	6,743.19	1,364.27	8.90	1.87	2.93
North Eastern	14,524.97	2,570.00	17.33	2.61	2.45
Total	32,006.41	5,388.12	30.98	5.37	1.07

¹The Pacific/Mountain region contains WA, OR, CA, MT, ID, WY, NV, UT, CO, AZ, NM; the Northern Plains region contains ND, SD, NB, KS; the Southern Plains region contains OK, TX; the South Eastern region contains AR, LA, MS, AL, GA, SC, FL, TN, NC, VA, KY, WV; the North Eastern region contains MN, WI, MI, IA, MO, IL, IN, OH, PA, NY, VT, MD, DE, NJ, RI, CT, MA, NH, ME.

²Annual consumer surplus evaluated at estimated erosion levels resulting from acres in the CRP in 1992 (signups 1-11). Lake and river refer to recreation occurring at lakes and rivers (respectively).

³This is the difference between total annual consumer surplus with CRP and the total without CRP. Erosion levels observed in 1982 were used in place of observed erosion in the latter case.

⁴Consumer surplus attributable to the CRP on a per acre basis. Source: USDA, ERS.

tions, which actual and potential hunters value, would be desirable in this case. Unfortunately, the data required to accomplish this are not available. However, given the numerous studies documenting the improvements in pheasant habitat from CRP land, a reduced-form model such as was used in the water-based recreation demand case is defensible. In this study, it is assumed that hunters value pheasant populations, which are directly affected by availability of CRP land.

The model was estimated from the recreational data in the FHWAR and the environmental data from the NRI (see Appendix B for details). Because pheasant hunting is not significant across the Southern Plains and South Eastern regions of the United States, this study assumes that pheasant-hunting benefits in these areas are insignificant. Therefore, this study calculates no pheasant-hunting benefits in these regions.

Based on the population-weighting information (provided in the FHWAR survey), total consumer surplus associated with pheasant hunting is estimated to be \$184 million annually (table 8). Dividing this total by the number of trips observed in the survey shows that the average value of a day spent pheasant hunting is approximately \$23. This result is consistent with Walsh, Johnson, and McKean who found that, across the Nation, the value of hunting upland game birds averaged \$27 per day.

To determine (the 1991) CRP's contribution to the benefits of pheasant hunting, the consumer surplus associated with pheasant hunting without the CRP

must be predicted. The first step in doing this was to determine the agricultural land use patterns that would likely exist with no CRP. Following Osborn (1993), it was assumed that any areas with CRP land would have the land use observed when the 1982 NRI was conducted (which was before the CRP was implemented). The difference between the predicted consumer surplus without CRP and the previous estimate generates a consumer surplus of \$80.3 million. Dividing the regional estimates by CRP acreage gives per acre benefits of \$0.33 in the Pacific/Mountain region, \$3.00 in the Northern Plains region, and \$6.24 in the North Eastern region.

Comparing table 7 with table 8 indicates that, first, the total consumer surplus estimate for freshwater-based recreation is much larger than the total consumer surplus estimate for pheasant hunting. The popularity of freshwater-based recreation compared with pheasant hunting explains this. Freshwater-based recreation includes a wide range of activities involving a substantial proportion of the population across the United States. Pheasant hunting, on the other hand, is a single activity confined to a limited area. The results also indicate that the gain in consumer surplus associated with the CRP is larger for pheasant hunting than for freshwater-based recreation. This reflects the large impact the CRP has had on pheasant populations compared with the CRP's impact on freshwater quality. The CRP has had a tremendous positive impact on pheasant populations (Allen, 1994), which play a critical role in the hunting experience. The effect on water quality is less dramatic. This may explain why the

Table 8—Pheasant hunting: Consumer surplus levels by region

Region ¹	Total consumer surplus ²	Consumer surplus due to CRP ³	Consumer surplus ⁴
	----- Million dollars per year -----		\$/Acre/year
Pacific/Mountain	6.50	2.70	0.33
Northern Plains	58.36	26.69	3.00
Southern Plains	N/A ⁵	N/A ⁵	N/A ⁵
South Eastern	N/A ⁵	N/A ⁵	N/A ⁵
North Eastern	118.85	50.86	6.24
Total	183.77	80.28	2.36

¹The Pacific/Mountain region contains WA, OR, CA, MT, ID, WY, NV, UT, CO, AZ, NM; the Northern Plains region contains ND, SD, NB, KS; the Southern Plains region contains OK, TX; the South Eastern region contains AR, LA, MS, AL, GA, SC, FL, TN, NC, VA, KY, WV; the North Eastern region contains MN, WI, MI, IA, MO, IL, IN, OH, PA, NY, VT, MD, DE, NJ, RI, CT, MA, NH, ME.

²Annual consumer surplus evaluated at 1992 CRP levels.

³This is the difference between total annual consumer surplus with the CRP and total without the CRP.

⁴Consumer surplus attributable to the CRP on a per acre basis.

⁵Negligible pheasant hunting occurs in these regions.

Source: USDA, ERS.

CRP-induced benefits of pheasant hunting are so much larger than in the freshwater-based recreation case.

Wildlife-Viewing Results

Like the two preceding models, the impact of the CRP on nonconsumptive, wildlife-oriented recreation (wildlife viewing) would be best modeled in a multi-step process, with changes in wildlife populations, induced by the CRP, influencing public participation. Again, the requisite biophysical models and behavioral data are not readily available. Hence, this study assumes that some relationship exists between land use and recreational trip taking.

In particular, a “representative trip” model is used. This model estimates the total number of trips taken to all locations as a function of indicators of landscape characteristics. These indicators, derived from NRI data, proxy for the size and health of wildlife populations (and other ecological attributes) at recreational sites that may be available to an individual. Specifically, measures of the level of CRP, cropland, forest land, grassland (range and pasture), urbanization, and landscape diversity are used.

As with the water-quality and pheasant models, a reduced-form model is used to control for variations in environmental characteristics. For each individual, five distance zones are constructed (see appendix figure 1 in Appendix B). For each of these distance zones, a weighted average of each of the several landscape characteristics is generated.⁶ In addition to the zonal landscape characteristics variables, several personal characteristics were also included, such as sex, race, education level, and household income. Lastly, distance to most-visited site was used to construct a proxy for trip price.

The three models presented in this study illustrate different means of accounting for variations in the price and quality of recreational sites. The water-quality model uses explicit information on the location of visited sites while the pheasant-hunting model uses ancillary information on bird populations to impute the location of visited sites. The wildlife-viewing model uses data that contain neither explicit site information nor secondary information that can be used to impute

⁶As described in Appendix C, to increase the flexibility of the model, the parameter used to compute the weighted average is an estimable parameter.

a site choice. Therefore, a more complex econometric model using the observed data to proxy for site choice is needed.

To estimate welfare impacts, a benefits-transfer approach is used.⁷ The predicted number of trips is multiplied by a per trip value obtained from a contingent valuation question included in the FHWAR survey. Further description of the model and a detailed discussion of results are included in Appendix C.

Table 9 shows the regional and national estimates of consumer surplus values. As with the pheasant-hunting model, the population-weighting information provided in the FHWAR survey is used to derive a change in consumer surplus due to the adoption of the CRP. The value of this change, \$348 million for the entire Nation, is fairly close to the \$380-million value realized by the NBS estimates of bird-watching.

The largest total benefit and benefit per acre is in the North Eastern region, followed by the Southern Plains, Northern Plains, and South Eastern regions. The model uses an anomalous negative benefit for wildlife viewing in the Pacific/Mountain region associated with the distribution of CRP acres. One possible explanation is that the Pacific region contains little CRP land in highly populated States (such as California) where intensive recreation occurs, and large amounts of CRP land in relatively unpopulated States (such as Montana and Wyoming). This results in the appearance that CRP is negatively correlated with recreational activity.

Discussion

The results of these three models indicate that CRP acres enrolled as of 1992 have had a beneficial effect on recreational activities. The largest effects are associated with increased wildlife-viewing recreation (\$348 million), followed by pheasant hunting (\$80 million), and freshwater recreation (\$36 million). The effects on a per acre basis are similar in magnitude. The largest average per acre benefit is associated with wildlife viewing (\$10.02), followed by pheasant hunting (\$2.36) and freshwater-based recreation (\$1.07).

⁷The coefficient on the proxy price could have been used to directly estimate consumer surplus measures of the value of these trips. However, the price coefficient was not stable, resulting in coefficients with the incorrect sign in a few regions.

Table 9—Wildlife viewing: Consumer surplus levels by region

Region ¹	Total consumer surplus ²	Consumer surplus due to CRP ³	Consumer surplus ⁴
	----- Million dollars per year -----		\$/Acre/year
Pacific/Mountain	1,385.31	-34.98	-4.27
Northern Plains	122.68	26.75	3.01
Southern Plains	315.25	62.35	12.14
South Eastern	1,260.52	4.89	1.33
North Eastern	3,616.74	288.70	35.44
Total	6,700.48	347.71	10.02

¹The Pacific/Mountain region contains WA, OR, CA, MT, ID, WY, NV, UT, CO, AZ, NM; the Northern Plains region contains ND, SD, NB, KS; the Southern Plains region contains OK, TX; the South Eastern region contains AR, LA, MS, AL, GA, SC, FL, TN, NC, VA, KY, WV; the North Eastern region contains MN, WI, MI, IA, MO, IL, IN, OH, PA, NY, VT, MD, DE, NJ, RI, CT, MA, NH, ME.

²Annual consumer surplus evaluated at 1992 CRP levels.

³This is the difference between total annual consumer surplus with the CRP and total without the CRP.

⁴Consumer surplus attributable to the CRP on a per acre basis.

Source: USDA, ERS.

Although these models offer a number of improvements over prior research, they are subject to several criticisms. In particular:

- Instead of specifying the complete physical, biological, and behavioral relationships between land retirement, environmental quality, and recreational nonmarket benefits, these models use a less desirable dependence upon environmental indicators. This reduced-form approach is adopted due to both a lack of knowledge about how these interactions occur and a lack of data required to represent them. This problem is not uncommon in the valuation literature and is likely to continue until comprehensive physical and biological models are available.
- The lack of exact destination location information in the FHWAR hindered further refinement of the wildlife-viewing and pheasant-hunting models. In nonmarket valuation models, recreational trips are assumed to be associated with the environmental quality of the destination. Imprecise knowledge of the location and environmental characteristics of destinations will thereby lessen the precision of the estimates.
- Although not unique to the problem of valuing the CRP, it can be difficult to sepa-

rate the demand for CRP-influenced recreation from the demand for other goods. For example, it is assumed that freshwater trips were solely for recreation, hence the cost of a trip can be attributed to the recreation experience. The models do not separate other enjoyable activities aside from recreation that may occur on a trip. This is a common drawback found in most nonmarket valuation models.

Despite these problems, the models basically succeed in identifying plausible relationships between land use and recreational values based on observed behavior. Additionally, the flexibility of the models offers the advantage of improved accuracy. Being based on behavioral and biophysical micro-data, one can apply the models' results to new scenarios relatively easily. Thus, the impacts of changes in targeting mechanisms can be potentially quantified by carefully applying the models' results.

We note that the per acre magnitude of these benefits (~\$13 per acre) is smaller than the average CRP rental rate (~\$50 per acre). Of course, these benefits are only a subset of the positive impacts of the CRP; hence they should not be used as a justification (or critique) of program funding. In fact, the major use of these findings is to provide a baseline for an analysis of a simulated targeting mechanism conducted in the next chapter.