# On-Farm Pheasant Enhancement Potentials in Irrigated Agriculture

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The transformation of irrigated agriculture into a capital intensive industry has eroded much of the incidental biological complementarities between wildlife and irrigation development. Wildlife management agencies need to assess the economic impact of enhancement programs upon commercial agriculture. In this paper, opportunity costs of on-farm pheasant enhancement practices are estimated for typical Columbia Basin irrigated farms. These estimates are then compared with two measures of net benefits to establish the potential feasibility of on-farm pheasant enhancement programs.

Irrigation projects throughout much of the west have served to benefit more than agriculture and related industries. Extensive benefits accrue to wildlife from the creation of new habitats. Frequently, however, the extent of these benefits is short lived. Technological and structural changes accompanying project maturity typically promote more efficient cropping programs with little or no regard for wildlife [Goldstein; National Academy of Sciences; Peterka; Wagner, Besadny and Kabat]. Advances in irrigation technology and increased mechanization, for example, have led to the adoption of clean farming practices, drainage of wetlands, crop specialization, removal of fence rows, and a host of other factors that have contributed to habitat destruction or loss of habitat diversification. Wildlife managers are confronted with the difficult task of combatting these trend reversals.

Recognition of the problem as a resource allocation conflict between irrigated agriculture and wildlife offers insights into its resolution. Wildlife are unpriced goods that exhibit ownership externalities. Though publicly owned and protected by state laws, wildlife reside on private property where exclusion can be assured. But lack of a well developed market inhibits farmers from capturing the value of wildlife and forestalls deliberate allocation of resources for their intended production. Wildlife are reduced to the status of incidental by-products of agriculture; their abundance is a consequence of fragile biological complementarities with agricultural practices.

The Columbia Basin in Central Washington serves as a classic example of this problem. The U.S. Bureau of Reclamation developed a project to irrigate more than one million acres of desert. Project water was first delivered through the irrigation system in 1952 which sponsored dramatic increases in game bird populations and associated recreational benefits. The pre-project pheasant harvest, for example, totaled only 10,000 birds for the proposed irrigation area. By 1966, with more than 400,000 acres being irrigated, pheasant harvest had increased to 250,000 [Washington Department of Game].[1] A dramatic trend reversal accompanied subsequent project maturity. By

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[1]Game biologists attribute this growth rate to the nature of irrigated agricultural development during this period. Agriculture was characterized by a mosaic of relatively small, irregularly shaped farms for which capital accumulation was slow. Much of the technological advance was obtained through rotational and soil management practices. These less intensive management practices promoted an ideal environment for pheasant and other wildlife.

1977, the number of pheasant harvested in the project area declined 50 percent from its previous high. Recreational benefits decreased accordingly.[2]

Alarmed by declining pheasant populations, the Washington Department of Game began searching for means of stabilizing and enhancing pheasant populations. The Fish and Wildlife Coordination Act of 1956, and subsequent determination of its applicability to the Columbia Basin Project in 1967, provided wildlife managers with the impetus necessary to conserve and enhance pheasant in the project area.[3] Numerous pheasant enhancement practices have been proposed in the wildlife literature and by Game Department officials. Nearly all are based upon habitat improvement; many require alterations of current farming methods that are incompatible with pheasant production.

Farmers rebuffed these proposals as costly nuisances which restrict crop production and decrease profits. Throughout the development process, farmers strived to achieve cropping efficiencies that maximize net farm returns for given farm situations. These efficiency gains are now the source of controversy between farmers, wildlife managers and the general public. Farmers are unwilling to relinquish these gains and bear the cost of enhancement. They argue pheasant production must remain incidental to the cropping process. This position is supported by a recent Office of Water Research and Technology report which states "... irrigated land will be almost impossible to manage for the benefit of wildlife. Any beneficial relationships between irrigation and wildlife on cultivated land will be incidental" [Peterka, p. 42]. However, if pheasant production is left as an unintentional by-product of the cropping system, an abundant pheasant population might not perpetuate in irrigated agriculture. This could result in continued losses of public benefits and continued narrowing of the incidence of benefits from publicly funded irrigation projects.

The objective of this research is to assess the potential economic feasibility of on-farm pheasant enhancement in irrigated agriculture. Potential feasibility is established by first estimating opportunity costs of alternative pheasant enhancement practices and then comparing these estimates with available benefit valuation estimates.

## Analytical Framework

In the absence of apparent legal obligations which bind existing Columbia Basin irrigators to allocate resources toward pheasant production, provision of economic incentives is necessary to change the status of pheasant from an unintentional side effect of agricultural production to an intentional production alternative. The amount and type of resources producers will voluntarily divert from cropping activities depend upon the amount of economic incentives provided for wildlife production relative to other production possibilities. In the context of non-market goods such as pheasant, incentives received by farmers must equal or exceed the opportunity cost of their foregone production. Provision of incentives, however, is justified only if the resultant benefits are at least equal to the corresponding foregone farm income.

A variety of factors can impact the opportunity costs (feasibility) of enhancement in an agricultural setting as diverse as the Columbia Basin. Farm size, irrigation system, crop type, rotation, and machinery complement are potentially important contributors to differential costs of enhancement. Capability to analyze the economic impacts from each of these factors was a primary consideration in selecting an appropriate methodology for this analysis. Accordingly, an enterprise budget-

[2]Data do not permit accurate regional assessment of recreation days. But state-wide pheasant licenses declined almost 70 percent from the period of peak Columbia Basin pheasant harvest.

[3]The Fish and Wildlife Coordination Act requires recognition of fish and wildlife conservation and enhancement as legitimate project purposes in all federal water resources development programs with less than 60 percent of construction cost obligated.

ing technique was chosen despite its "partial" approach to the problem.

Typical farm practices were modeled into enterprise budgets for two farm sizes, three irrigation systems and five crops in six rotations using the Oklahoma State University Budget Generator [Kletke]. These base budgets were then modified to incorporate alternative pheasant enhancement practices. Establishment of undisturbed perennial cover, variations of first-cutting alfalfa harvest methods and provision of winter food were modeled. Deviations in net revenue between base and modified enterprise budgets were considered measures of the opportunity cost associated with implementing the various enhancement practices. Enhancement opportunity costs for each enterprise were then aggregated, by rotation, to provide an estimate of farm level opportunity costs. Relating farm level pheasant response estimates with foregone farm income provides a measure of opportunity costs per additional bird.

The five crops considered (alfalfa, grain corn, wheat, potatoes and sugar beets) account for 75 percent of the cropped acreage in the Basin. Besides the economic importance of these crops, each possess certain beneficial attributes for pheasant. The two farm sizes considered (160 and 320 acres) are commonly found in the Columbia Basin. Farms containing 320 acres or less, represent over 80 percent of operational farms and 56 percent of the irrigated acreage in the Columbia Basin Irrigation Project [U.S. Bureau of Reclamation]. Gravity flow and sprinkler irrigation systems were modeled even though the Columbia Basin project was designed for gravity flow irrigation. The advent of sprinkler technology combined with varied topography and soil characteristics throughout the Basin, promoted adoption of side-roll and center-pivot systems in addition to rill irrigation.

Each farm was assumed to have machinery and equipment necessary for the production of enterprises in the two farm sizes and in six rotations. Differences in machinery complements reflected typical size economies experienced in the Columbia Basin. Most fertilizer and chemical applications and all harvesting, with the exception of alfalfa on 320 acre farms, were assumed custom hired. All costs were computed for new machinery based on 1977 prices. Expected crop prices are five year averages (1973-77), input prices are Fall 1977, and yields are typical of the Columbia Basin.

## Pheasant Enhancement Practices

Pheasant enhancement practices identified by the Washington Department of Game and published wildlife literature emphasize elements critical to pheasant productivity, including permanent cover, adequate nesting cover, and winter food supply. An advisory committee comprised of Game Department officials, farmers and irrigation district officers selected nine enhancement practices for analysis. Each practice evaluated here was recommended by the Game Department as having limited impact upon the farmer. The nine practices may be grouped into one of three broad categories: planting perennial cover crops, altering alfalfa harvest methods, and supplying winter food.

### *Cover Crops*

Clean farming practices in the Columbia basin have destroyed much of the permanent cover. To compensate, two six-foot wide strips planted the full length of opposite farm edges were evaluated along with planting the corners of center pivot irrigation systems. Asparagus and an alfalfa-grass mixture (alfalfa/big bluegrass/fescue) were chosen as cover crops because of their value to pheasant, their ability to outcompete most weeds and their acceptability to farmers. Cover crops were presumed left undisturbed.

Strips directly affect farm income by removing currently cropped land from production. The corresponding opportunity cost equals foregone farm income plus cover crop establishment costs. An additional opportunity cost is incurred when planting cover crops in corners of center pivot irrigated fields. Establishment and maintenance of corner cover crops necessitates their irrigation, which in turn creates an opportunity cost equal to the income foregone from not planting harvestable crops. We assume cover crops could be irrigated for the same per acre cost as the interior portion of the field.

Amortized cover crop establishment costs were added to enterprise operating inputs. No changes were made in annual irrigation costs associated with strips which were assumed irrigated identically to the base enterprise.

### *Alteration of Alfalfa Harvest Methods*

Alfalfa is a preferred pheasant nesting cover [Frank and Woehler; Joselyn and Warnock]. But peak pheasant hatch follows the first hay harvest and many nests and hens are destroyed during harvest operations. First cutting alfalfa harvest variations are attempts to increase pheasant nesting success. Modeled variations include delaying the first alfalfa cutting one and three weeks, and raising the mowbar an additional ten inches. Any delay beyond the optimum alfalfa harvest date results in direct income losses to the farm operator because of declining hay quality, and in some instances, yield losses. Similarly, raising the mowbar decreases the quantity of hay harvested in the first mowing and the quality of hay harvested in the second. Specific modifications to the alfalfa enterprise budgets, including changes in price per ton, yield and total revenue per acre are presented in Table 1 by cutting.

### *Supplying Winter Food*

Adequate winter food supply increases winter carry-over and enhances nesting success by improving the condition of pheasants entering the nesting season. Two methods of providing additional winter food were examined; leaving an unharvested ten-foot wide perimeter corn strip, and leaving corn stubble through winter. Both enhancement practices necessitate the planting of spring wheat which was assumed to suffer a 20 bushel per acre lower yield than winter wheat. Gross receipts also decrease when a perimeter corn strip is left unharvested.

## Pheasant Response Estimates

Estimates of high, mean and low pheasant responses for each of the nine enhancement practices were provided by the Washington Department of Game [Foster]. These response estimates were measured as increments to fall populations and include both hen and cock pheasants.[4] See Bagwell, Matulich and Pietsch for a detailed listing of the pheasant response estimates.

## Whole Farm Aggregation and Feasibility Criteria

Bird response and opportunity cost aggregated over the entire farm provide a comprehensive view of the cost per pheasant for a given farm situation. Farm level opportunity cost is equal to the per acre enhancement opportunity cost for each enterprise times the corresponding acreage, and summed over all enterprises within the selected farm rotation. The product of per acre bird response (low, mean or high estimates) for each enhancement practice and cropped farm acreage equals the estimated farmwide bird response. Foregone farm income divided by estimated farmwide bird response yields the opportunity cost per pheasant.

The feasibility of selected enhancement practices was established using a two-fold criterion. The cost of producing pen-raised birds provided a cost estimate of an alternative production process. Current Game Department costs of raising and releasing pheasant total $6.14 per bird. Additionally, a direct measure of net benefits received from the consumptive value of pheasant was employed. Wolfley developed marginal value

[4]Game Department data did not permit assessing the differential impact of cover-crop type on pheasant response, e.g., a cover strip established along an alfalfa field was presumed to yield the same bird response as a cover strip established along a potato field.

**TABLE 1. Price per Ton, Yield and Total Revenue per Acre for Base and Modified Alfalfa Enterprise Budgets**

| Enterprise Budgets | Price[a] | | | Yield | | | Total Revenue | | |
|---|---|---|---|---|---|---|---|---|---|
| | Low | Mean | High | First Cutting | Second Cutting | Third Cutting | Low | Mean | High |
| | ---------dollars--------- | | | --------------tons-------------- | | | ------------dollars------------ | | |
| Alfalfa Base Budget | 50.00 | 58.60 | 65.00 | 3 | 2 | 1 | 300.00 | 351.60 | 390.00 |
| Alfalfa Harvest Variations | | | | | | | | | |
| Delay Mowing 1 week[b] | | | | 3 | 2 | 1 | 270.00 | 321.60 | 360.00 |
| Delay Moving 3 weeks[c] | | | | 3.5 | 2.5 | -- | 210.00 | 261.60 | 300.00 |
| Raise Mowbar[d] | | | | 1.5 | 3 | 1 | 230.00 | 277.30 | 312.50 |

[a]Price per ton is assumed unchanged for the three cuttings in the base budget. Low and high price estimates are also provided. Per ton price deviations associated with alfalfa harvest variations are provided by cutting.

[b]Delay mowing one week is assumed to decrease first cutting alfalfa price $10 per ton.

[c]Delay mowing three weeks is assumed to decrease first and second cutting alfalfa price $15 per ton and eliminate the third cutting.

[d]Raising the mowbar ten additional inches is assumed to decrease second cutting alfalfa price $15 per ton.

estimates for Columbia Basin pheasant based upon the direct survey method of measuring willingness to pay, as adapted by Hammack and Brown. The estimated mean marginal value over the entire sample population was $5.83 per bird, but ranged from $.57 to more than $39.00. This mean marginal value, in concert with the Game Department cost of producing pen raised birds, establish the two feasibility criteria.

Enhancement practices exhibiting small opportunity cost deviations above these value estimates may be potentially feasible. Habitat improvement provides additional unmeasured benefits corresponding to superior survival abilities and greater hunting value of wild pheasant, in addition to extensive unmeasured benefits accruing to other consumptive and nonconsumptive wildlife.

## Empirical Results

Foregone farm income, pheasant responses, and opportunity cost per bird are presented in Table 2 according to enhancement practices, farm size and rotation. Variations among irrigation systems were slight and are therefore, aggregated in this table. Similarly, operations dominated by the alfalfa enterprise are combined together, including alfalfa-wheat, alfalfa-corn-wheat and alfalfa-wheat-wheat rotations.

Opportunity costs range from $6.88 to $800.00 per bird. This wide range reflects the relative pheasant response rates as well as the value of crops in generating farm income.[5] Cover crops in the form of strips were found to offer potentially feasible enhancement methods. Strips in association with low value crops yield costs of $6.88 to $8.74 per pheasant for the 160 acre farm. In light of additional unmeasured benefits to other wildlife attending habitat development, these costs compare favorably with that of Washington Game Department pen-raised pheasant costs and the estimated mean marginal value of pheasant. Costs of $10 to $21 per bird were estimated for 320 acre farms. Strips in high value crop rotations, like potatoes and sugar beets, yield costs per bird ranging from $10 to $21 irrespective of farm size. The alternative use value for land planted to high value crops (potatoes and sugar beets) is always greater than for land planted to lower valued crops (alfalfa, corn

[5]Relative response rate refers to the estimated number of birds generated by a particular enhancement practice.

**TABLE 2. Foregone Farm Income, Expected Mean Pheasant Responses, and Opportunity Cost per Pheasant for Alternative Enhancement Practices: By Farm Size and Rotation (1973-1977 prices)**

| Enhancement Practices | Rotation[a] | 160 Acres | | | 320 Acres | | |
|---|---|---|---|---|---|---|---|
| | | Foregone Farm Income | Pheasant Response | Opportunity Cost per Pheasant | Foregone Farm Income | Pheasant Response | Opportunity Cost Per Pheasant |
| | | (dollars) | | (dollars) | (dollars) | | (dollars) |
| Cover Crops[b] | | | | | | | |
| Strips[c] | A | 110-172 | 16-20 | 6.88-8.74 | 313-442 | 32-39 | 9.80-11.41 |
| | W-P | 320-414 | 16-20 | 17.07-21.02 | 668-838 | 32-39 | 17.44-21.42 |
| | W-P-W-SB | 258-332 | 16-20 | 14.60-16.87 | 526-673 | 32-39 | 16.45-1709 |
| | W-W-W-SB | 156-215 | 16-20 | 9.76-10.91 | 323-444 | 32-39 | 10.10-11.28 |
| Corners[d] | A | 6,237-6,550 | 83 | 72-81 | 15,396-16,801 | 166 | 93-101 |
| | W-P | 16,327 | 83 | 196 | 33,134 | 166 | 199 |
| | W-P-W-SB | 13,094 | 83 | 157 | 26,729 | 166 | 161 |
| | W-W-W-SB | 7,909 | 83 | 95 | 15,712 | 166 | 94 |
| First Cutting Alfalfa | | | | | | | |
| Harvest Variation | | | | | | | |
| Delay Mowing 1 Week | A | 2,925-4,110 | 19-27 | 152 | 5,850-8,220 | 39-54 | 152 |
| Delay Mowing 3 Weeks | A | 7,924-11,135 | 85-120 | 93 | 15,943-22,761 | 171-240 | 93-95 |
| Raise Mowbar 10 Inches | A | 7,244-10,179 | 85-120 | 85 | 14,489-20,358 | 171-240 | 85 |
| Winter Food Supply | | | | | | | |
| Corn Stubble | A | 850-1,046 | 1.3-1.6 | 654 | 1,698-2,090 | 2.6-3.2 | 653 |
| Unharvested Perimeter Corn Strip (10′) | A | 1,092-1,364 | 1.4-1.7 | 800 | 2,047-2,596 | 2.8-3.4 | 755 |

[a]Rotations are defined by the following notation: W = winter wheat; P = potatoes, SB = sugar beets; A = predominantly alfalfa rotations including A-W, A-W-W, and A-C-W (where C refers to grain corn). All crops are annual except alfalfa which is assumed to have a 6-year perennial life.

[b]Both aspargus and alfalfa/big blue grass/fescue mixture are included as cover crops for strips and corners.

[c]Two six-foot wide strips were planted the length of opposite farm edges.

[d]Four 7.5 acre corners were planted to perennial cover crops for each 130-acre center pivot irrigation system.

and wheat). Since modification of farm operations for the enhancement of wildlife is the same for all crop types considered, the higher valued crops are associated with higher opportunity costs. Both corner cover crops and alfalfa harvest variations were associated with much higher opportunity costs, averaging $120 per bird. Provision of winter food supplies were found to yield extremely high costs of more than $600 per bird.

These results bring to focus an important wildlife management principle; the greatest marginal contribution to a wildlife population need not be equated with the least cost enhancement practice. For example, planting corners to a cover crop generates higher costs per bird than strips in spite of the four-fold greater bird response associated with corners. Loss of harvestable cropland relative to farm level bird response is smaller for strips.[6] Alfalfa harvest variations also proved uneconomical despite large bird responses. Raising the mowbar an additional ten inches was least expensive followed by delaying the first cutting three weeks and one week ($85, $94 and $150 per bird, respectively).

Supplying winter food would appear to have little impact on farm income, but in fact has a large unforeseen opportunity cost. Stubbling, for example, seems to have no economic impact other than altering seasonal workloads. However, there is a hidden cost from not being able to follow with the most desired rotation crop. Both winter food supply practices require following corn with spring wheat as opposed to winter wheat — reducing wheat yields 20 bushels per acre.

Farm size was found to impact on the opportunity cost per bird in nearly every enhancement practice. In particular, the 160 acre farm size exhibited lower opportunity costs than the 320 acre farm. This conclusion is a consequence of economies of size. Two exceptions are noted. Planting corner cover crops in the three year wheat-one year sugar beet rotation faced slightly higher opportunity cost per bird on the 160 acre farm. The additional economies gained from farming corners on 320 acres are less than those on 160 acres. Supplying winter food by leaving an unharvested perimeter corn strip also incurred lower opportunity costs on the 320 acre farm. A greater percentage of the smaller corn field is left unharvested than with the larger field. This difference in unharvested acreage offsets any economies achieved with the larger farm.

Crop price sensitivity analysis (based on 1973-1977 price ranges) revealed the results to be sensitive to price variability. Foregone farm income and opportunity cost per pheasant are summarized in Table 3 according to enhancement practice and rotation for 160 acre farms. However, foregone farm income is presented as minimum and maximum ranges based on low and high crop prices. The likely opportunity cost range per pheasant (mean response rate) and the maximum opportunity cost range per pheasant are also presented. These values provide a narrow range in which costs per bird are expected to fall. The maximum range represents the extreme bounds of per bird opportunity costs, reflecting low foregone farm income/high bird response estimates and high foregone farm income/low bird response estimates. Variations among irrigation systems were small and are therefore aggregated in this table. Similarly, operations dominated by the alfalfa enterprise are combined together.

The maximum range in opportunity costs varies from $3.19 to $1500 per pheasant. The expected range of opportunity costs per bird for strips of cover established along farm edges is $4.51 to $26.75, depending upon modeled farm situation. If enhancement practices are selectively applied to small, less intensively cropped farms (160 acre alfalfa farms) yielding high bird responses, costs per bird would range from $3.19 to $7.36 for low and high crop prices, respectively.

[6]Corners consume 30 acres of the 160 acres and yield 83 birds farmwide. By comparison, strips account for only 0.7 acres, yet enhance 20 birds. Stated equivalently, corners accommodate less than 3 birds per acre of cover crop as opposed to more than 27 birds per acre of cover in strips.

**TABLE 3. Foregone Farm Income, Opportunity Cost Range per Pheasant (Mean Response Range) and Maximum Opportunity Cost Range per Pheasant for Alternative Enhancement Practices: By Rotation, 160-Acre Farm**

| Enhancement Practices | Rotations[a] | Foregone Farm Income[b] | | Likely Opportunity Cost Range Per Pheasant[c] (mean pheasant response) | | | Maximum Opportunity Cost Range per Pheasant[d] | |
|---|---|---|---|---|---|---|---|---|
| | | ---dollars--- | | ---dollars--- | | | ---dollars--- | |
| | | min. | max. | min. | mean[h] | max. | min. | max. |
| Cover Crops[e] | | | | | | | | |
| Strips[f] | A | 72 | 198 | 4.51 | 6.88-8.74 | 10.41 | 3.19 | 16.00 |
| | W-P | 215 | 526 | 11.30 | 17.07-21.02 | 26.75 | 7.99 | 41.13 |
| | W-P-W-SB | 161 | 425 | 8.62 | 14.60-16.87 | 21.59 | 6.09 | 33.19 |
| | W-W-W-SB | 87 | 271 | 5.45 | 9.76-10.91 | 13.78 | 3.85 | 21.19 |
| Corners[g] | A | 4,422 | 8,063 | 53 | 72-81 | 97 | 35 | 155 |
| | W-P | 11,783 | 21,375 | 142 | 196 | 257 | 94 | 411 |
| | W-P-W-SB | 8,129 | 17,031 | 98 | 157 | 205 | 65 | 328 |
| | W-W-W-SB | 4,303 | 10,312 | 52 | 95 | 124 | 34 | 198 |
| First Cutting Alfalfa | | | | | | | | |
| Harvest Variation | | | | | | | | |
| Delay Mowing 1 Week | A | 2,925 | 4,110 | 152 | 152 | 152 | 124 | 196 |
| Delay Mowing 3 Weeks | A | 7,924 | 10,809 | 93 | 93 | 93 | 87 | 106 |
| Raise Mowbar 10 Inches | A | 6,825 | 10,618 | 80 | 85 | 88 | 79 | 101 |
| Winter Food Supply | | | | | | | | |
| Corn Stubble | A | 623 | 1234 | 479 | 654 | 791 | 311 | 1,500 |
| Unharvested Perimeter Corn Strip (10′) | A | 795 | 1604 | 576 | 800 | 967 | 306 | 1,348 |

[a]Rotations are defined by the following notation: W = winter wheat; P = potatoes; SB = sugar beets; A = predominantly alfalfa rotations including A-W, A-W-W, A-C-W (where C refers to grain corn). All crops are annual except alfalfa which is assumed to have a 6-year perennial life.

[b]Minimum and maximum foregone farm income values are based on low and high crop prices.

[c]Low, mean and high estimates of foregone farm income divided by mean pheasant response estimates.

[d]Minimum opportunity costs per bird are derived as low foregone farm income divided by high bird response estimates. Maximum opportunity costs per bird are derived as high foregone farm income divided by low bird response estimates.

[e]Both aspargus and alfalfa/big bluegrass/fescue mixture are included as cover crops for strips and corners.

[f]Two six-foot wide strips planted the length of opposite farm edges.

[g]Four 7.5 acre corners corresponding to each 130-acre center pivot irrigation system.

[h]Ranges in mean opportunity cost per pheasant are a result of aggregating alfalfa rotations, irrigation systems and cover crop varieties. Ranges and partial dollar figures are provided only for values less than $50.

## Conclusions and Implications

Irrigation development has failed to guarantee or, in many cases, even consider the allocation of resources between crops and wildlife. Almost without exception, only the single use concerns of commercial agriculture have been addressed. Benefits (losses) to wildlife have been incidental. The traditional doctrine that wildlife management can be analyzed separate from agricultural production fails to expose the underlying causes and solutions to the problem. It elicits the erroneous belief that widlife management is a biological problem — a belief that is almost certain to perpetuate the incidental by-product or externality characteristics of wildlife. In general, most wildlife in an irrigated agricultural setting are not separate from the agricultural environment, but to a considerable extent, a consequence of it.

The rise and subsequent decline in Columbia Basin pheasant population is a consequence of market failure, but need not be an essential characteristic of irrigated agricultural development. Contrary to results found by Peterka, wildlife enhancement may be potentially feasible in irrigated agriculture. Costs of $6.88 to $8.74 per additional bird (based on mean price and response levels) were found by providing strips of permanent cover on small farms growing less intensively farmed, low value crops. It is here that alternative resource usage exhibits the most favorable economic tradeoffs. By comparison with the $6.14 pen raised bird cost, the estimated mean marginal value of $5.83, and in consideration of additional value corresponding to survival rate, hunting value of wild birds and extensive unmeasured benefits to other wildlife, pheasant enhancement appears feasible. Feasibility may be promoted further if least cost enhancement strategies are directed towards farms yielding high bird responses.

Farmers must be compensated for lost income attending on-farm enhancement, and the method of compensation is fundamental to program success. Two methods appear potentially relevant: establishment of a private market and implementation of a public enhancement program. Selling of hunting privileges in the form of trespass rights is common in many states. But in the case of pheasant, such arrangements are rarely coincident with on-farm habitat improvement necessary to enhance the species. Not only are most farmers unaware of relevant biological and economic marginal tradeoffs, but trespass rights usually are sold on farms that offer abundant pheasant populations from natural biological complementarities. Establishment of extensive private markets that provide full compensation to Columbia Basin farmers for enhancing pheasant is unlikely in the near future.

In the absence of private markets, a publicly administered program appears necessary if pheasant enhancement is socially desired. Any form of compensation will require contracts pledging participation. Contract life is a critical consideration in maintaining a stable pheasant population and avoiding transient enhancement benefits. It is also an important factor in selecting the appropriate cover crop. For example, a 20 year contract would be required to fully realize the amortized establishment costs of asparagus. Price variability and risk, however, pose serious impediments to long term contractual arrangements. Given an unwillingness to commit resources well into the future, it is unlikely that farmers would realize the fully amortized asparagus establishment cost. A shorter asparagus life will increase amortized establishment costs and decrease estimated bird response.[7] The alfalfa-grass mixture may then be a favored cover crop. A further contractual consideration involves transference of public monies to private property owners. Equity considerations dictate assurance of public access to enhanced areas.

While the method of financing such a program has not been studied, equity considerations suggest the cost of enhancement should be borne by those who would benefit.

[7]The resultant bird response reduction is a consequence of realizing only a small response during the relatively long asparagus establishment period.

The most obvious beneficiaries are pheasant hunters. Pheasant hunters, however, are not the only beneficiaries from wildlife enhancement. A more detailed analysis of the beneficiaries of wildlife enhancement may help in designing compensatory schemes for farmers.

The findings of this study are premised upon the assumption that farmers maximize net returns for a given farm situation. Yet not all farm operators behave as profit maximizers. Substantial utility gains may be realized from production of wildlife. If so, contractual agreements with these farm operators may be negotiated more readily — possibly even at lower costs. Similarly, farm operators may also be more willing to enter into contractual agreements if their farms are not fully developed. The unfarmed land would yield a source of guaranteed income. Cost savings may also accrue from decreased weed control.[8]

Pheasant enhancement feasibility in irrigated agriculture requires substantive change in the present game laws. Hunting regulations must be liberalized in the enhancement area to allow bagging of some hen pheasants. Opportunity costs per bird are predicated upon total increased bird responses, but current hunting regulations stipulate bagging of roosters only. Failure to harvest hens in the enhanced areas would approximately double the cost of enhancement, and threaten feasibility. Although hen hunts are a sensitive political issue, wildlife biologists suggest limited hen hunts are biologically sound [Weigand; Gardner; Mitcham].

The specific findings of this study are conditional upon certain limitations. First, no attempt was made to determine the optimum cover crop strip width — the least cost enhancement practice. An alternative strip width or configuration may achieve lower opportunity costs per pheasant. Second, only two potential cover crop varieties were analyzed. Other grasses, various woody covers and commercially grown crops may alter enhancement costs. Third, pheasant response estimates provided by the Washington Department of Game are preliminary. Refinement of these estimates, in addition to including variations among irrigation systems and cover crop varieties, could impact per bird opportunity costs and possibly alter the conclusions drawn here. Fourth, no attempt was made to model variations in crop quality or yield when grown under alternative irrigation systems. Data refinement may implicate irrigation systems as important policy considerations. Fifth, only costs in the form of direct income losses to crop production were analyzed. The increased cost, real or perceived, attending increased hunting pressure, possible crop depredation, vandalism and general nuisance has not been addressed. It is likely that these unmeasured costs must be reconciled to obtain contractual agreements. Costs of program implementation and enforcement have also been omitted from this analysis. Estimation of these costs would be necessary to assure feasibility. However, if enhancement is selectively applied to farms yielding high response rates, such costs are less likely to challenge feasibility.

While enhancement of wildlife within irrigated agriculture appears potentially feasible, it can be costly. Arbitrary or capricious policies can force undue hardships upon participating irrigators. If on-farm wildlife enhancement policies are developed, policy makers must be sensitive to the opportunity costs of enhancement faced by farm operators.

[8]Wildlife enhancement may be appropriate even in unfarmed areas. Present weedy cover may not benefit pheasant as much as cover crops. Moreover, elimination of existing natural vegetation may be required as a weed control measure.

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