An Agricultural Wetland Reserve:

Creating Wetlands from Drained Cropland

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Wetlands constitute some of our most productive natural habitats and valuable wildlands (Tiner). Of some 215 million acres of wetlands originally present when the United States was colonized, only 99 million acres remained in the mid-1970's; annual losses are estimated at between 300,000 and 450,000 acres (OTA). Conversion to agriculture accounted for 87 percent of 13.8 million acres of wetlands estimated lost between the mid-1950's and mid-1970's (Frayer, et al.).

A long-standing official policy of direct wetland conversion assistance ended with Executive Order 11990, issued in 1977. Indirect government assistance for wetland conversion, in the form of farm program benefits and income tax deductions, were largely eliminated by the so-called "swampbuster" provision of the 1985 Food Security Act and changes in the 1986 Tax Reform Act (Heimlich and Langner; USDI Vol. I). Moreover, undrained wetlands that are used for crop production (about 4 million acres) have recently been made eligible for the Conservation Reserve Program, offering landowners an alternative to wetland conversion and the consequences of the swampbuster provision (Fed. Reg.). The USDA Water Bank Program to conserve existing wetlands is being converted from a limited term lease program to a permanent easement program.

This evolving reappraisal of wetland values does not appear to be stopping at elimination of direct and indirect incentives for wetland conversion. President Bush, in his 1990 budget message, called for "no net loss" of wetlands as a national goal and an interagency task force is being assembled to recommend means for accomplishing this goal. The National Wetlands Policy Forum, convened by the Conservation Foundation at the request of the U.S. Environmental Protection Agency, recommended increased efforts at restoring altered wetlands to their natural state in pursuit of a long-term goal of increasing the quantity and quality of the nation's wetland resource base (Conservation Foundation). The Forum recommended implementing an Agricultural Wetlands Reserve Program to fund permanent easements and restoration of 2.5 million acres of wetlands converted to agriculture. A wetlands restoration program was included as part of Senate Bill 970 (the Fowler Bill) and in Senate Bill 1063 (the Lugar Bill). The National Wetland Priority Conservation Plan required by the Emergency Wetland Resources Act of 1986 and the North American Waterfowl Management Plan jointly prepared by the United States and Canada both call for increased acquisition and restoration of wetlands.

This paper analyzes a program of permanent easements on cropland converted from wetlands. It presents estimates of the extent, distribution, and characteristics of such cropland, estimates easement costs needed to compensate landowners for the opportunity cost of idling such lands, discusses the direct costs of restoring cropped converted wetlands, and discusses direct and indirect benefits of wetland restoration.

Concepts, Data, and Methods

Wetlands are defined in the Food Security Act as land with hydric soils that supports, or is normally capable of supporting, hydrophytic vegetation (Teels). Hydrophytic vegetation grows in water or in wet or saturated soils. Hydric soils are those which, in their undrained condition are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions (USDA Hydric soils). The cropland most logically suited for wetland restoration is that which occurs on hydric soils that have been drained for crop production.

A total of 55.6 million acres of cropland developed on hydric soils was identified from the NRI, comprising 13 percent of U.S. cropland. The geographic distribution of hydric cropland is different than that of remaining wetlands. Midwestern states such as Illinois, Iowa, Indiana, Ohio and Missouri have large amounts of cropland converted from former wetlands, but very little remaining wetland. On the other hand, states like Florida, Louisiana, Mississippi, Georgia, and South Carolina have large amounts of remaining wetlands, but relatively little cropland on hydric soils. Minnesota has substantial amounts of both hydric cropland and remaining wetlands.

Overall, hydric cropland is relatively productive. Land capability classes IIw and IIIw comprise 87 percent of hydric cropland. About 70 percent of hydric cropland meets the USDA prime farmland definition, compared with 55 percent of all cropland. About 65 percent of hydric cropland was used to grow corn and soybeans in 1982 and 85 percent was used to grow farm program crops.

A landowner holding such hydric cropland is assumed to be indifferent between continued cropping and a permanent easement if a one-time easement payment just equal to the discounted present value of returns to agricultural use were available. The minimum easement value can be calculated as:

$$V = \frac{1/n \sum_{i=1}^{n} (P_i * Y_i - C_i)}{r}$$

where:

V = the value of the one-time easement payment;

P_i = the price of the ith crop in the crop rotation;
Y_i = the yield of the ith crop;
C_i = the cost of producing the ith crop;
n = the number of crops in the rotation;
r = the discount rate.

In addition to the opportunity cost of abandoning crop production, covered by the easement payment, the landowner may require payment for all or a portion of the direct costs of restoring the wetland. Easement costs would be reduced by earnings from fee hunting, fishing or other recreational use of the restored wetland, but these earnings cannot be estimated here. On the other hand, landowners may require additional compensation for the paperwork necessary to apply for the reserve or for disruptions to their normal farming patterns.

For this analysis, a computerized list of hydric soils identified by the National Technical Committee for Hydric Soils, a federal interagency task force, was obtained and merged to cropland records in the 1982 National Resources Inventory (NRI) (SCS 1985;SCS/ISSL). Irrigated and nonirrigated crop yields for each soil from the SCS Soil Interpretation Record (SOILS5) were then merged to each hydric cropland record, giving typical yields for that soil and drainage condition under high-level crop management (SCS 1983).

Two sets of crop prices were developed: projected 1990/91 national season-average market prices, adjusted to the geographic pattern of the average of prices received by farmers in each state between 1984 and 1988, representing the market price landowners in each location could expect to receive; and the expected 1990/91 target price for each program crop, representing the supported price of the crop (NASS; ERS, 1989a). Target prices were multiplied by one minus the Acreage Reduction Program set-aside percentage for each crop, reflecting the fact that target prices can only be obtained on a portion of the base acreage.

State-level crop budgets for 1986 based on ERS and NASS farm cost and return surveys were used to represent the cost of production for each crop in each state (Davenport). Where necessary, budgets from adjoining states were used where budgets for a particular state were not estimated. Total cash expenses, including variable cash expenses for seed, fertilizer, chemicals, machinery operations, and labor, and fixed expenses including general farm overhead, taxes and insurance, and interest, were used. No charges for capital replacement, returns to capital, net land rent, or unpaid labor were included since these costs are still incurred at the farm level if only a portion of the farm's acreage is enrolled in the wetland reserve. State budgets were adjusted to projected 1990/91 levels using the ratio of 1990/91 to 1986 national costs of production for each crop.

Net returns were calculated for crops in the 1979 through 1982 rotation reported in each of 75,532 NRI hydric cropland records. Crops included corn grain, sorghum grain, soybeans, cotton, peanuts, sunflowers, wheat, oats, rice, barley, and flaxseed. Arbitrary returns of $500 per acre for high-value crops (including fruit, nuts, vineyards, berries, horticultural crops, and vegetables) and State-level budgeted returns for hay were included in the calculations. Returns for all four years of the rotation were calculated for 42.3 million acres and for three years on 3.6 million acres, for a total of 83 percent of all hydric cropland on which yields were available. Permanent easement values were calculated by capitalizing the average net return for the rotation by a nominal interest rate of 10 percent, corresponding to current rates of return a landowner could obtain by investing the net proceeds of continued crop production in certificates of deposit or similar long-term investments.

Estimated Easement Costs for Wetland Restoration

Supply schedules for easement purchase on hydric cropland were estimated for program crop acreage at target prices and nonprogram crops at market prices (figure 1). The curves are constructed by accumulating the acreage at each estimated easement cost corresponding to the capitalized returns to the land in agricultural production. The curves reflect current economic rent from agricultural production but may not reflect landowners' actual willingness to grant easements at these prices because of expectations about future returns, reluctance to permanently forego crop production on this land, or rents from nonagricultural activities, such as urban development (Greene and Barnard).

Estimated returns were negative on 1.8 million acres, implying zero easement cost for these acres. In reality, some nominal easement price would probably be needed to induce owners of this land to participate in an easement program. One possibility is that these acres are kept in production to be set aside as part of required acreage reductions under commodity programs. In this situation, the land's value does not depend on its inherent productivity, but the opportunity cost of idling another, more productive acre on the farm. This opportunity cost was estimated by the average returns on the mix of program crops on acres with negative returns.

The least easement cost for a restoration program containing 2.5 million acres of hydric cropland is estimated to be $194 million; $190 million of that cost would be for program crop acreage (table 1). Easement costs for 5 and 10 million acres, as well as the entire 45.9 million acres of hydric cropland for which easement costs could be calculated are also shown. Average costs per acre range from $77 to $1,038 for all hydric cropland. Marginal costs rise from $150 per acre to more than $3,500 per acre.

More than 90 percent of hydric cropland in the least-cost 2.5, 5, and 10 million acres is in program crops (including soybeans), although it is not possible to determine how much of this land is actually enrolled in commodity programs (table 2). Corn makes up about one-third and soybeans about one-quarter of least-cost hydric cropland available for restoration. Cotton acreage accounts for more than 20 percent of hydric cropland in the least-cost 2.5 million acres. The opportunity cost of this land as set-aside in commodity programs may increase easement costs for a wetland restoration program beyond the inherent rent attributable to this land in agricultural production.

Eleven states with large amounts of hydric cropland make up more than 80 percent of all easements in the least-cost 2.5, 5, and 10 million acres of hydric cropland and more than three-quarters of all hydric cropland (table 3). States with the greatest amounts of least-cost hydric cropland for restoration include Minnesota, Illinois, Iowa, Indiana and Missouri. Wetland states, like Mississippi and Louisiana, have substantial amounts of low-cost hydric cropland as well, but almost 80 percent of hydric cropland in Florida is in high-value crops implying high easement costs.

Comparing easement costs to land values or rents is difficult because such data are only available as averages over all soils and all quality levels. Farmland values for the 11 states in table 3 averaged $783 in 1989, about 20 percent less than the estimated easement cost on all hydric cropland in those states (ERS, 1989b). The low range in a survey of ASCS County Executive Directors reporting farmland values for 1988 averaged $413 per acre for the 11 states (USDA, 1988). Average easement costs for the least-cost hydric cropland are lower than average values for all farmland reported in these surveys, as expected.

Annual payments on 10-year leases of existing wetlands under the ASCS Water Bank Program averaged $15.35 per acre, or a capitalized easement value of $153 per acre (ASCS, 1988). Only one-third of the land under Water Bank agreements is wetland, while the remaining two-thirds is adjacent upland area for which agricultural use is restricted. Agreements carried out in 1989 averaged $24.08, or a capitalized value of $240 per acre. Permanent easements on wetlands and adjacent areas included in National Waterfowl Production Areas by the Migratory Bird Conservation Commission averaged $38.76 per acre, with leases in fiscal year 1988 costing $120.17 per acre (MBCC, 1988).

Wetland Restoration Costs

In addition to the cost of obtaining a permanent easement on cropped converted wetlands, the landowner and the government will share the cost of restoring hydric cropland to wetland condition. Wetland restoration efforts are underway that provide a basis for estimating wetland restoration costs (table 4). Average costs range from $100 per acre for some wetlands in the prairie pothole region of the Northern Plains to $3,500 per acre for some restorations in Florida. The more expensive restorations involve costs for water control structures needed to regulate flow over the wetland for wastewater assimilation (Battoe; Swindell). Most wetland restorations on cropland will probably be at the lower end of this range.

Benefits from Wetland Restoration

There are at least two general classes of benefits accruing to the proposed agricultural wetland reserve: direct benefits from restoration of the wetlands and indirect supply control benefits from taking existing cropland out of production. Direct benefits are extremely difficult to estimate, even in narrowly scoped local situations, because they reflect nonmarket goods, such as endangered species preservation or flood retention, or because they depend on complex causal linkages to observable market goods, such as commercial fisheries or waterfowl hunting. Indirect benefits are easier to estimate, but are problematical because they depend on anticipated crop surpluses.

Classes of direct values associated with functions performed by wetlands are generally well documented and include fish and wildlife habitat, hydrologic services such as flood retardation and groundwater recharge, and market and nonmarket values from such activities as commercial fishing and trapping, recreational fishing and hunting, and scientific and recreational nature study (Heimlich and Langner; Amacher et al.; Tiner; Conservation Foundation). A substantial literature of site-specific wetland valuation studies has accumulated. However, these studies lack consistent methods and generally fail to define a conceptual framework, or production function, which relates wetland characteristics to functions performed (Shabman and Batie; Amacher et al.). Most studies also fail to place these functions within the context of competing wetland and nonwetland suppliers of these functions and the socio-economic demand for such functions, limiting the extent to which such studies can be extrapolated to regional or national aggregate benefit estimates. At this time, there is no basis for developing such aggregate benefit estimates for wetland restoration.

Supply control benefits from taking existing cropland out of production of farm program crops only accrue under existing programs if substantial deficiency payments, land diversion payments, or commodity purchase, storage, and disposal costs would be made in the absence of an agricultural wetland reserve. Given trends toward reducing deficiency payments in current agricultural policy thinking, it is not clear to what extent reductions in annual supply control costs can be counted on to offset easement costs of an agricultural wetland reserve.

Over the period 1977-1987, $44 billion in farm program costs was spent to idle 284 million acres, or $155 per acre per year. Direct government payments (including payment-in-kind certificates) averaged $217 per year per acre idled between 1985 and 1987 (ERS 1988a and 1988b). However, there were no payments made directly for idling acreage in 1980 and 1981 and only $40 and $97 per acre idled in 1983 (PIK) and 1984, respectively. By contrast, permanent easement of 5 million acres in a wetland reserve is estimated to cost $810 million, or $162 per acre.

Based on simulation of supply and demand under existing commodity programs, a 5 million acre wetland reserve would raise prices of major commodity crops between 3 and 7 percent by 1995. Reductions in deficiency payments and farmer owned reserve storage payments would reduce government expenditures $4.3 billion over 5 years, not counting supply control effects for the remainder of the permanent easement.

Conclusion

This analysis identifies 55.6 million acres of cropland converted from wetlands on hydric soils that is the likely universe for an agricultural wetland reserve. A supply response schedule was developed for 45.9 million acres of hydric cropland on which easement costs based on capitalized net returns to crop production could be estimated. Average easement costs for reserves of 2.5 to 10 million acres range from $77 to $300 per acre, while marginal costs range from $150 to $500 per acre. Available data indicates that an additional $100 to $500 per acre may be needed for restoration costs. Direct benefits from wetland restoration, the primary rationale for such a reserve, are difficult to estimate, but indirect benefits from supply control of program crops could be substantial.

Estimates presented in this paper provide a first step in economic analysis of wetland restoration program proposals. Implementation of a wetland reserve and restoration program would be improved by better estimates of the relative benefits of restoring different types of wetlands in different locations. Selecting more productive, and thus more expensive, cropland for restoration could yield higher direct and indirect benefits and thus could be socially optimal.

Further research is needed to test the sensitivity of these estimates to variation in crop prices and production costs. Additional research is needed on restoration costs and to devise alternative reserve selection criteria and evaluate benefits and costs for each alternative.

Figure 1 Supply curves for easement purchase on hydric cropland.

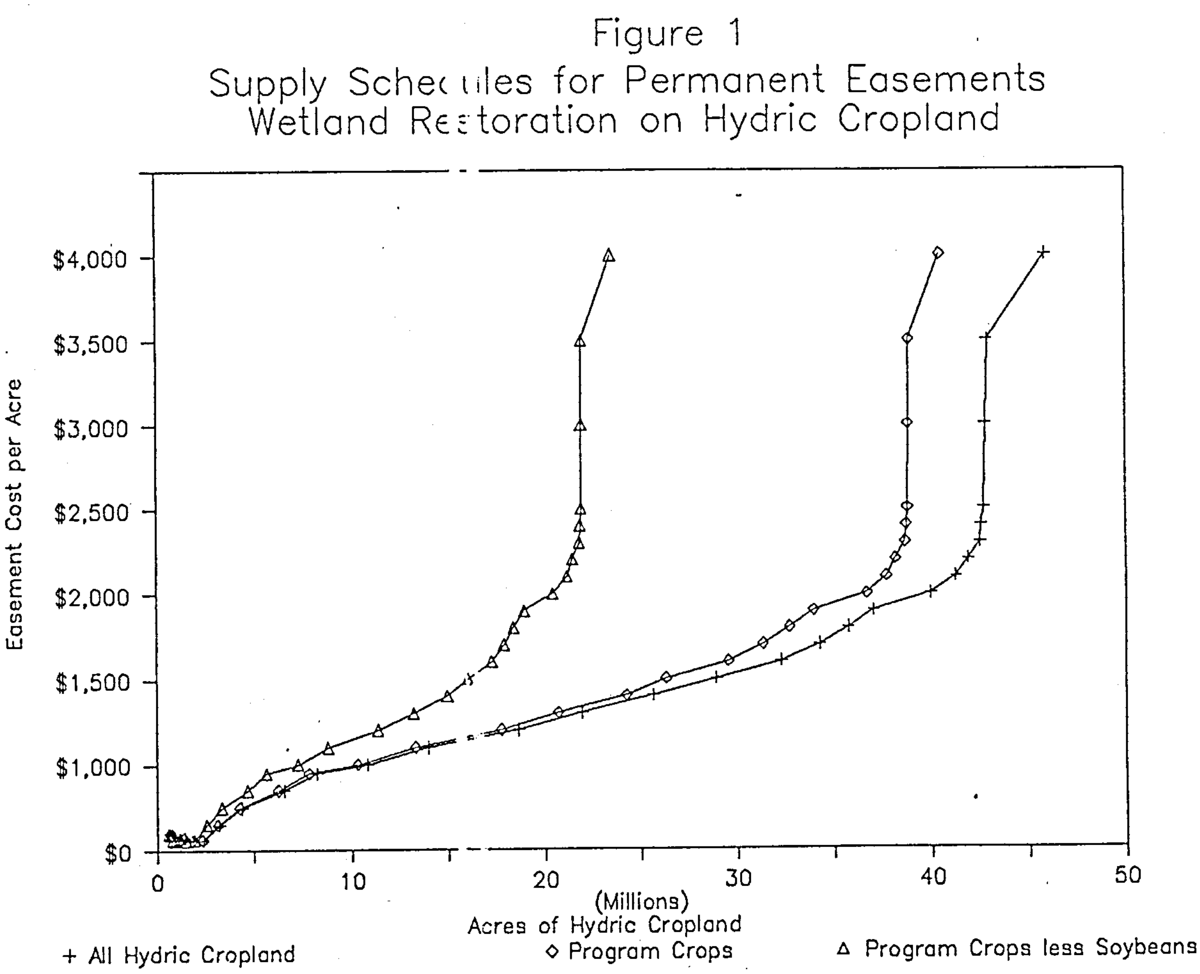

Table 1--Easement costs of least-cost hydric cropland at selected agricultural wetland reserve sizes

	Reserve Size			
	2.5 million acres	5 million acres	10 million acres	All hydric cropland
	Million dollars			
Total cost				
Program crops1/	$189.8	$773.4	$2,818.2	$38,532.9
All crops	$193.5	$809.6	$2,995.1	$47,646.7
	Dollars per acre			
Cost per acre				
Average	$77	$162	$300	$1,038
Marginal	$150	$350	$500	>$3,500

1/ Includes corn, sorghum, wheat, rice, oats, barley, cotton, and soybeans.

Table 2--Crops produced on least-cost hydric cropland at selected agricultural wetland reserve sizes

	Reserve Size			
	2.5 million acres	5 million acres	10 million acres	All hydric cropland
	Thousand acres			
Soybeans	435	1,119	2,785	16,970
Corn	926	1,816	3,446	15,676
Wheat	308	780	1,742	4,914
Cotton	566	601	659	707
Rice	0	0	0	617
Oats	71	210	360	596
Sorghum	104	164	248	534
Barley	42	140	263	483
Program crops1/	2,452	4,830	9,502	40,496
Other crops	48	170	498	5,408
Total	2,500	5,000	10,000	45,904
	Percent			
Soybeans	17.4	22.4	27.9	37.0
Corn	37.0	36.3	34.5	34.2
Wheat	12.3	15.6	17.4	10.7
Cotton	22.6	12.0	6.6	1.5
Rice	0.0	0.0	0.0	1.3
Oats	2.8	4.2	3.6	1.3
Sorghum	4.2	3.3	2.5	1.2
Barley	1.7	2.8	2.6	1.1
Program crops	98.1	96.6	95.0	88.2
Other crops	1.9	3.4	5.0	11.8
Total	100.0	100.0	100.0	100.0

1/ Includes corn, sorghum, wheat, rice, oats, barley, cotton, and soybeans.

Table 3--Location of least-cost hydric cropland at selected agricultural wetland reserve sizes

	Reserve Size			
	2.5 million acres	5 million acres	10 million acres	All hydric cropland
	Thousand acres			
Minnesota	606	1,638	3,009	7,973
Illinois	220	379	831	7,306
Iowa	263	575	1,570	6,152
Indiana	82	103	142	3,953
Missouri	119	448	1,129	3,164
Arkansas	67	99	189	1,897
Mississippi	365	384	439	1,715
Michigan	73	225	528	1,385
Louisiana	106	129	255	1,330
Kentucky	62	83	109	391
Texas	66	85	105	368
Subtotal	2,029	4,147	8,305	35,635
Other states	471	853	1,695	10,269
Total	2,500	5,000	10,000	45,904
	Percent			
Minnesota	24.2	32.8	30.1	17.4
Illinois	8.8	7.6	8.3	15.9
Iowa	10.5	11.5	15.7	13.4
Indiana	3.3	2.1	1.4	8.6
Missouri	4.8	9.0	11.3	6.9
Arkansas	2.7	2.0	1.9	4.1
Mississippi	14.6	7.7	4.4	3.7
Michigan	2.9	4.5	5.3	3.0
Louisiana	4.2	2.6	2.5	2.9
Kentucky	2.5	1.7	1.1	0.9
Texas	2.6	1.7	1.1	0.8
Subtotal	81.2	82.9	83.1	77.6
Other states	18.8	17.1	16.9	22.4
Total	100.0	100.0	100.0	100.0

Table 4--Some Wetland Restoration Costs

Project	Projects	Acres	Costs per acre: Average	Costs per acre: Range
South Dakota (lake) 1/	1	20,000	$100	$50-$350
Minnesota (pothole) 2/	40	355	na	up to $100
Minnesota (pothole) 3/	144	385	$135	$43-$166
Tile cutting	18	na	$43	na
Tile riser	6	na	$59	na
Ditch plug	120	na	$74	na
Ditch plug w/culvert	na	na	$166	na
Michigan, Indiana 4/	125	375	$250	$50-$2,000
Tile cutting	na	na	$175	$50-$500
Ditch plug	na	na	$600	$250-$1,500
Florida (lake) 5/	1	900	na	$1,100-$2,200
Florida 6/	1	1,200	$3,500	na

1/ Lake Thompson, National Wildlife Federation, Prairie Wetlands Resource Center (NWF, Nomsen).
2/ Reinvest in Minnesota (Wenzel). Figure cited is the maximum that RIM will pay, not the total restoration cost.
3/ Mid-Continent Waterfowl Management Project, Joint venture among U.S. Fish and Wildlife Service, Minnesota Department of Natural Resources, and private groups on Conservation Reserve Program land (Dornfeld, Piehl, and Rondeau). Excludes FWS staff time averaging $126 per acre of wetland.
4/ Fish and Wildlife Service, Bloomington, IN. Includes labor of FWS refuge crew (Ruwaldt).
5/ Lake Apopka, St. John's Water Management District. This project involves extensive diking and water control structures for water quality treatment in the restored wetland that would not be required in most cropland restorations (Battoe).
6/ Orlando Easterly Artificial Wetlands. Includes costs for water control structure necessary for use as wastewater assimulation (Swindell).

References

Amacher, G.S., R.J. Brazee, J.W. Bulkley, and R.W. Moll. 1988. An Interdisciplinary Approach to Valuation of Michigan Coastal Wetlands. University of Michigan, School of Natural Resources. Ann Arbor, MI.

Agricultural Conservation and Stabilization Service, USDA. 1988. Water Bank Program From Inception of Program through September 30, 1988. U.S. Department of Agriculture. Washington, DC.

Battoe, L. St. John's Water Management District. personal communication.

Conservation Foundation. 1988. Protecting America's Wetlands: An Action Agenda. The Final Report of the National Wetlands Policy Forum. Washington, DC.

Davenport, G. 1988. State-Level Costs of Production, 1986. Staff Report No. AGES880122. Economic Research Service, U.S. Department of Agriculture. Washington, DC.

Dornfeld, R., J. Piehl, and T. Rondeau. 1988. "Wetland Restoration Potential on CRP Land." in Stuber, P.J. (ed.) Proceedings of the National Symposium on Protection of Wetlands from Agricultural Impacts. Biol. Rep. 88(16). U.S. Fish and Wildlife Service, Ft. Collins, CO. pp.68-72.

Economic Research Service. 1989a. Agricultural Outlook. Table 22, Farm Programs, Price Supports, Participation and Payment Rates. U.S. Department of Agriculture, Washington, DC. Jan/Feb, page 56.

Economic Research Service. 1989b. Agricultural Resources, Outlook and Situation Summary, Land Values. U.S. Department of Agriculture. Washington, DC.

Economic Research Service. 1988a. Agricultural Resources, Cropland, Water, and Conservation Situation and Outlook Report. AR-12. U.S. Department of Agriculture. Washington, DC.

Economic Research Service. 1988b. National Financial Summary, 1987. ECIFS 7-1. U.S. Department of Agriculture. Washington, DC.

Federal Register. January 10, 1989. 54(6):801-803.

Frayer, W.E., T.J. Monahan, D.C. Bowden, and F.A. Graybill. 1983. Status and Trends of Wetlands and Deepwater Habitats in the Coterminous United States, 1950's to 1970's. Colorado State University, Department of Forest and Wood Sciences. Fort Collins, CO.

Greene, C.R. and C.H. Barnard. 1988. "Agricultural Land Markets in U.S. Urban-Fringe Counties." Landscape and Urban Planning. 16(1988):293-301.

Heimlich, R.E. and L.L Langner. 1986. Swampbusting: Wetland Conversion and Farm Programs. AER-551. Economic Research Service, U.S. Department of Agriculture. Washington, DC.

Migratory Bird Conservation Commission. 1988. 1988 Annual Report. Washington, DC.

National Wildlife Federation. 1989. "South Dakota Wetlands Restoration Underway." National Wildlife. p. 31.

Nomsen, D. Prairie Wetland Resource Center. personal communication.

National Agricultural Statistics Service. 1989. Crop Values, 1988 Summary. CrPr 2-1. U.S. Department of Agriculture, Washington, DC.

Office of Technology Assessment. 1984. Wetlands: Their Use and Regulation. OTA-O-206. U.S. Congress. Washington, DC.

Tiner, R.W., Jr. 1984. Wetlands of the United States: Current Status and Recent Trends. National Wetlands Inventory, U.S. Fish and Wildlife Service. Washington, DC.

Ruwaldt, J. and M. Pansy. U.S. Fish and Wildlife Service, Bloomington, IN. Personal communication.

Shabman, L.A. and S.S. Batie. 1985. Socioeconomic Functions and Values of Wetlands: A State-of-the-Art Review. Tech. Report Y-85. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

Soil Conservation Service. 1985. Hydric Soils of the United States, 1985. U.S. Department of Agriculture, Washington, DC.

Soil Conservation Service and Iowa State Statistical Laboratory. 1984. National Resources Inventory: A Guide for Users of 1982 NRI Data Files. (draft). U.S. Department of Agriculture, Washington, DC.

Soil Conservation Service. 1983. Application of Soil Information: Soil Interpretations. Part 603, National Soils Handbook. U.S. Department of Agriculture, Washington, DC.

Swindell, C. Post, Buckley, Schuh and Jernigan Engineering. Personal communication.

Teels, B.M. 1988. "Status of SCS Wetland Determinations Under the 1985 Food Security Act." in P.J. Stuber (coord.) Proceedings of the National Symposium on Protection of Wetlands from Agricultural Impacts. Biological Report 88(16), U.S. Fish and Wildlife Service, U.S. Dept. of Interior. Fort Collins, CO.

U.S. Department of Agriculture. 1988. U.S. Farmland Values 1987-88, Summary for ASCS County Executive Directors. July 18.

U.S. Department of the Interior. 1988. The Impact of Federal Programs on Wetlands. Vol.I: The Lower Mississippi Alluvial Plain and the Prairie Pothole Region. A report to Congress by the Secretary of Interior. Washington, DC.

Wenzel, T.A. 1988. "Reinvestment in Minnesota (RIM) Wetlands Restoration Program." in Stuber, P.J. (ed.) Proceedings of the National Symposium on Protection of Wetlands from Agricultural Impacts. Biol. Rep. 88(16). U.S. Fish and Wildlife Service, Ft. Collins, CO. pp.131-135.