Appendix III—Estimating Wetland Conversion for Agriculture in the Absence of Swampbuster and Section 404 of the Clean Water Act

Estimating the economic effects of wetland conversion is a two-step process. This appendix provides a detailed description of the methods and data used to make these estimates.

Step One: Estimating Potential Wetland Conversion

Wetlands are considered *potentially convertible* when the net present value (NPV) of expected return to crop production after conversion exceeds total costs of conversion (the NPV of return to land in its wetland condition plus drainage and clearing costs) by a proportion of total costs equal to the landowner's discount rate or a minimum return per acre:

$$\max_j(NPV_j) - NPV_i - CC_i > \max[r(NPV_i + CC_i) , m]$$

where NPV_j is the estimated net present value of returns to crop j after drainage (corn, sorghum, barley, oats, wheat, rice, cotton, or soybeans), NPV_i is the opportunity cost of land in its wetland condition use (forestry, pasture, or crop production), CC_i is the cost of draining and clearing land for crop production, r is the landowner's discount rate, and m is the minimum return per acre needed to justify the investment in drainage and clearing for crop production. Net present values are defined over a finite time horizon, which varies by wetland condition land use. For forested wetland, the time horizon is the length of a single forestry rotation. Other sites are assigned a 10-20 year time horizon, depending on the drainage technology used. The minimum return requirement excludes sites where conversion may not be undertaken due to low overall returns.

Potential wetland conversion at baseline prices is estimated for two scenarios. In the **low conversion** scenario we assume r=.06, m=$100 per acre, and exclude land which National Resources Inventory indicates has no probability of conversion to crop production in the foreseeable future. Natural Resources Conservation Service field technicians who collect National Resources Inventory data assess the probability that noncropland sites (including wetlands) will be converted to crop production based on potential agricultural returns, the cost of developing wetlands for crop production, and whether similar land had been converted to crop production in the past 3 years (USDA-SCS, 1991). Since National Resources Inventory estimates of conversion potential are based, in part, on economic considerations, we estimated a **high conversion** scenario, assuming that r=.06 and m=$500 for land where the National Resources Inventory indicates no conversion potential, and r=.06 and m=$100 otherwise. In both cases, wetland sites which are projected to be enrolled in the Conservation Reserve Program are excluded from consideration.[9]

Crop Returns

Eight commonly grown crops are considered: barley, corn, cotton, oats, rice, sorghum, soybeans, and wheat, including summer fallow rotations and double cropping, where appropriate. County-level crop prices are devised as follows: Prices from the posted county price data base for market year 1994 (Murray, 1996) are divided by U.S. average prices from *Agricultural Prices: Annual Summary, 1994* (USDA-NASS, 1994) to obtain a relative price for each county. Relative prices are multiplied by USDA baseline projections (USDA-WAOB, 1997) for national average prices to obtain prices used in the simulation. Site specific crop yields are devised by multiplying county average crop yields for 1991-95, obtained from *Crop Production* (USDA-NASS, various), by an index of relative productivity calculated from the productivity index (PI) developed by Pierce, and others, (1983) and calculated from the Soil Interpretive Record (SIR) database. The relative productivity index for a particular crop is the ratio of site specific PI to average PI for sites within the county where National Resources Inventory cropping history shows production of that crop.

Crop production cost data are at the State level (USDA-ERS 1991, 1993, 1997). The most recent State data, from 1989, are updated to 1995 by multiplying State costs by the ratio of 1995 to 1989 production costs at a regional level. We assume that the

[9]National Resources Inventory points that are most likely to be enrolled in a 36.4-million acre Conservation Reserve Program, given potential economic and environmental benefits, projected by Tim Osborn, Economic Research Service, USDA.

purchase cost of land is sunk and will not enter into the conversion decision and that unpaid operator labor costs will not increase due to wetland drainage.

Pasture Returns

State average pasture rental rates for 1994 are adjusted to site-specific conditions using the productivity index (PI) and to USDA baseline economic conditions using estimates of the percentage change in pasture rental rates from a 1-percent change in beef prices and costs. These estimates are obtained from regional regression models of pasture rents on beef prices and costs. Regional models are specified as:

$$R_{ps} = \prod_s \alpha_s^{d_s} \prod_i X_i^{\beta_i} \in$$

which can be written as:

$$\ln R_{ps} = \sum_s d_s \ln\alpha_s + \sum_i \beta_i \ln X_i + \ln \in$$

where R_{ps} is the State-average pasture rental rate for State s, d_s is a dummy variable for State s, the X's are a beef price and cow-calf cost index, the $\ln\alpha$'s and β's are parameters to be estimated, and $\ln\in$ is an error term. Regions are north-central States (Corn Belt and Lake States farm production regions), the South (the Southeast, Delta, and Appalachian farm production regions), Plains States (Northern and Southern Plains), and the West (Mountain and Pacific Coast States). Estimates are reported in appendix table 4. In the West, parameter estimates for the beef price index and cow-calf cost variables are not significantly different from zero, perhaps because of the large amounts of Federal land on which grazing fees are established by nonmarket procedures. For Western States, average pasture rental rates are assumed to be constant at 1994 levels. Estimated pasture rental rates average $13.06 per acre, but range up to $66 per acre.

Appendix table 4—Estimated percentage change in pasture rental rates (t-ratio in parentheses)

Item	North	South	Plains	West
Beef price index	0.92	0.50	1.11	-0.31
	(8.51)	(6.09)	(6.64)	(-0.44)
Cow-calf costs	-1.42	-1.16	-2.09	.82
	(-22.72)	(-22.34)	(-13.12)	(0.72)

Source: ERS analysis.

Beef price data are from various issues of *Agricultural Prices: Annual Summary* (USDA-NASS, 1994). Cow-calf production costs were obtained electronically from the Economic Research Service, U.S. Department of Agriculture (USDA-ERS, 1996).

Forest Returns

Returns to bottomland hardwood rotations are calculated for 13 Southern States. In the North, where rotation lengths are considerably longer than in the South, forestry is assumed to be a residual land use (that is, wetland that cannot be profitably drained for other uses is retained in forested wetland), although some management may eventually be undertaken to encourage desirable species (Luppold, 1996). In Western States, data limitations preclude estimation of forest opportunity costs.

Bottomland hardwood yields (oak-cypress-gum stands) are from McClure and Knight (1984). Yields for high, medium, and low productivity sites are matched to National Resources Inventory sites using the site index (SI) from the SIR data base. Soils with an SI of less than 60 are classified as low, SI 60-78 as medium, and SI above 78 as high. Hardwood saw timber and pulpwood prices are from Timber Mart South (Norris, 1986). Regeneration costs are from *The South's Fourth Forest* (USDA-FS, 1988). Base prices are a 3-year average and are adjusted up by 1.5 percent per year to match USDA Forest Service projections (Haynes, 1990).

Returns are calculated for a single rotation of 30-40 years, depending on expected prices and site productivity. Rotation length is chosen on the basis of maximum NPV. Timber is assumed to be harvested in a clear-cut operation yielding both saw timber and pulpwood. Returns are estimated for a 6-percent discount rate. The average NPV of expected returns to bottomland hardwood forestry is $137 per acre but ranges up to $442 per acre, depending on site productivity and stumpage prices.

Drainage and Clearing Costs

The cost of drainage, annual drainage maintenance, and land clearing was also estimated by local technical experts (USDA-SCS, 1989) by major land resource area and State. These costs were adjusted to 1995 levels using the index of purchases of nonresidential farm structures (Pavelis, 1996).

Step Two: Estimating Longrun Economic Effects

Commodity price, crop acreage, and farm income effects of the proposed wetland delination change are derived as comparative static impacts of augmenting land supply in the U.S. Regional Agricultural Sector Model (USMP). USMP is an agriculture sector spatial equilibrium model, as described in McCarl and Spreen (1980), that incorporates agricultural commodity supply, use, and policy measures (House, 1987). USMP has been applied to project the effects on U.S. national and regional agriculture of changes in export levels and variability (Miller, and others, 1985), trade agreements (Burfisher, and others,1992), imports (Spinelli, and others, 1996), input taxes (Peters, and others, 1997), irrigation policy (Horner, and others, 1990), ethanol production (House, and others, 1993), wetlands policy (Heimlich, and others, 1997), sustainable agriculture policy (Faeth, 1995), and various other policy and program scenarios.

USMP models production of 10 crops: corn, sorghum, oats, barley, wheat, rice, cotton, soybeans, hay and silage. Sixteen primary livestock production enterprises are included, the principal being dairy, swine, beef cattle, and poultry. Coefficients in crop and livestock enterprise budgets were developed from USDA's National Resources Inventory, Cropping Practices Survey (CPS), and Farm Costs and Returns Survey (FCRS) data. USDA's Economic Research Service and National Agricultural Statistical Service collect CPS and FCRS data. Several dozen processed and retail products are included in the model structure, including dairy products, pork, fed and nonfed beef, poultry, soy meal and oil, livestock feeds, and corn milling products. Acreage, commodity supply/use, Conservation Reserve Program acreage, prices, production practices, and so forth are validated exactly to USDA baseline projections for 2001 (USDA-WAOB, 1997) and corresponding geographic information. For example, USMP's base U.S. corn acreage planted in 2001 equals the USDA baseline projection (80.5 million acres) and corn acreage in each model region/practice stratum is determined by share information from National Resources Inventory and CPS regional data. On the demand side, domestic use, exports, ending stocks, and price levels for crop and livestock commodities and most processed or retail products are endogenously determined within the model structure with domestic consumption, commercial stock, export and other demand functions specified with elasticities from the FAPSIM econometric simulation model (Green and Price, 1987).

We use the regional acreage of potentially convertible wetlands to shift land supply curves in USMP's 45 regions. Regions are specified as the intersection of the 10 USDA Farm Production Regions and the 26 USDA Land Resource Regions (USDA-SCS, 1981). We assume that converted wetlands may then be cropped at the regional marginal cost of production that existed prior to the wetlands conversion. Comparative static adjustments to the wetland delineation acreage shifts explain how the sector changes between the base period and several years later when the change has worked itself out and the sector returns to equilibrium. Changes are recorded in both aggregate indicators, such as U.S. farm income, and detailed indicators, such as acreage in corn-bean rotation in the central Corn Belt. USMP acreage planted and commodity supply response use a positive mathematical programming formulation (Howitt, 1995) with U.S. aggregate commodity supply response calibrated to supply response elasticities from the FAPSIM model. Responses in individual region, tillage practice, rotation and other strata follow nested adjustment functions which are part of the PMP calibration, and sum up to aggregate response. No exogenous bounds or flexibility constraints are used.