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US EXPERIENCES WITH INCENTIVE MEASURES TO PROMOTE THE CONSERVATION OF WETLANDS

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FOREWORD

This paper is one of a series of 22 case studies that describe practical experiences in OECD Member countries with the use of incentive measures for the conservation of biodiversity and the sustainable use of its components. These case studies were submitted by OECD Member countries to the OECD Working Group on Economic Aspects of Biodiversity as a contribution to the OECD study of the design and implementation of appropriate incentive measures for biodiversity conservation and sustainable use. In order to ensure maximum comparability between the case studies, all were developed under the common methodology described in "Incentive Measures to Promote the Conservation and the Sustainable Use of Biodiversity: Framework for Case Studies" [OECD/GD(97)125].

The practical experiences described in the 22 case studies were used as the basis for the policy advice developed in the *Handbook of Incentive Measures for Biodiversity: Design and Implementation* (OECD, 1999). This *Handbook* combines the lessons learned through the various experiences described in the case studies – covering a wide range of ecosystems, economic pressures on biodiversity, and utilising various incentive measures – with sound economic theory to develop a practical, step-by-step guide for policy-makers on the design and implementation of successful incentive measures for the conservation and sustainable use of biodiversity.

This paper was written by Ralph E. Heimlich, Keith Wiebe, Roger Claassen, and Dwight Gadsby. It is released as an unclassified document under the responsibility of the Secretary-General of the OECD with the aim of bringing information on this subject to the attention of a wider audience.

This study, and the other 21 case studies submitted by Member countries, are available on the world wide web at http://www.oecd.org/env.

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US EXPERIENCES WITH INCENTIVE MEASURES TO PROMOTE THE CONSERVATION OF WETLANDS

by

Ralph E. Heimlich, Keith Wiebe, Roger Claassen, and Dwight Gadsby[1]

EXECUTIVE SUMMARY

This case study describes the incentive measures used in the US to conserve wetlands. For many years, various support measures were in place which contributed to the destruction of wetlands in the US, including direct subsidies for wetland drainage, market price support for agricultural products, tax incentives for purchasing wetland draining machinery, and other government assistance for draining wetlands or agricultural expansion and production. While most of these have been removed, they contributed to the conversion of nearly half the wetlands in the US to other uses since 1780. In addition to the removal of these adverse subsidies, positive incentive measures have also been developed for the conservation of wetlands. These include the purchase by government bodies of wetlands for protection purposes or agricultural lands for the restoration of wetlands, and the establishment of subsidies for conservation activities.

Ecosystem studied: inland freshwater ecosystems

Incentive measures used: government purchase, removal of adverse incentives, positive subsidies, information provision, scientific capacity building, institution building

Main lessons learned: Public sentiment evolves in relation to wetlands according to their scarcity and the relative needs for economic development, but can be influenced by education and dissemination of scientific knowledge; it is often necessary to use a variety of incentives to address the variety of pressures and their settings; each type of policy is costly in its own way –politically, legally, financially, etc; an important role is played by the reform of subsidies which encouraged the draining of wetlands.

1. GENERAL DESCRIPTION

In 1780, there were about 220 million acres of wetlands in what would eventually become the continental United States (Dahl, 1990; Heimlich, et al, 1997). The term “wetlands” masks a diversity of ecosystems in the US including the globally unique river of grass that is the Florida Everglades, extensive bottomland hardwood forests in the Southeast, shallow prairie pothole wetlands in the Northern Plains, and narrow ribbons of riparian wetlands in the arid West (Tiner, 1996; Cowardin, et al., 1979).

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Wetland losses often reduce biodiversity because many organisms depend on wetlands and riparian zones for feeding, breeding, and shelter (NRC, 1995). About one-third of North American bird species use wetlands, and 138 out of the identified 1 900 species are wetland dependent (Kroodsma, 1979; American Ornithologist's Union, 1983). Of the 240 or so invertebrates listed as threatened or endangered under the Endangered Species Act in 1995, 207 are wetland dependent. Waterfowl numbers, densities, and propagation are related to the number of wetlands per square mile (Bellrose, 1977; Stewart, 1996). Wetlands serve many hydrologic functions that influence wetland vegetation and biota, including flood storage and peakflow modification, groundwater recharge and discharge, local alteration of precipitation and evaporation, maintenance of water quality, estuarine water balance, and erosion reduction (Carter, 1996).

It is now commonly accepted that wetlands provide valuable environmental benefits. However, in the United States many have been converted to other uses since the earliest colonial times, destroying and degrading wetland functions and values. Wetlands were considered a hindrance to settlement and land development; a nuisance that needed to be eliminated. As settlement spread across the land, wetlands were converted to other uses, primarily agriculture, with the pace of conversion increasing as available non-wetlands land decreased and drainage technology improved. By 1992, 45-50 per cent of the original wetlands in the 48 states had been converted to other uses, with losses approaching 90 per cent in Illinois, Indiana, Iowa, Missouri, and Ohio (Dahl, 1990)

This case study focuses on the evolution of US policies relating to wetlands from 1849 to the present. That evolution covered a range of policies:

- adverse incentives for wetland conversion;
- elimination of direct and indirect incentives for conversion;
- imposition of regulations, sanctions, and penalties for wetland conversion; and
- direct incentives for wetland conservation and restoration.

While all of these measures are examined in this study, the primary focus is on agricultural incentives.

2. IDENTIFICATION OF CAUSES AND SOURCES OF PRESSURES

2.1 Identification of sectoral activities and resulting pressures

The principal cause of wetland losses in the United States, as elsewhere, has been drainage and filling associated with land use change. Most wetland conversion in the 19th century was originally undertaken for agricultural purposes, although some converted land was subsequently used for urban development (figure 1). As settlement occurred in the 19th and early 20th century, the primary productivity that makes many wetlands and riparian areas so valuable in supporting biodiversity also attracted human interest for cultivation. In the earliest stages of settlement, wetlands were by-passed in favour of dry land with good water and trees. It was only toward the end of the 19th century, with the growing scarcity of easily accessible farmland, that farmers turned to the previously by-passed wetlands in earnest.

> *By a strange quirk of fate those who blazed the first trails and developed the first farms in Iowa found [...] that their timber-prairie farms near the rivers were often less valuable than the farms developed by those who came much later and took the*

> *land they had avoided. To be sure, the wet lands required considerable drainage expense, but even so these wet lands were eventually a better bargain.* (Peterson, 1967, pages 448-449).

Between first settlement[2] and 1954, 40-44 per cent of original wetlands were drained or filled. Data on land area drained (not all wetlands) shows that most of this activity probably occurred after 1885, with as much as 50 million acres drained by 1920 (Pavelis, 1987). With the explicit encouragement of federal government policies (see Section 2.3) and local cooperative efforts, wetlands were converted to agricultural and other uses at an average net rate of between 814-887 thousand acres per year between settlement and 1954.

2.2 Identification of underlying causes of biodiversity loss

Short of outright conversion to other land uses, additional sources of biodiversity loss associated with wetlands include degradation from sediment, nutrient, and pesticide pollution, and hydrological modification, including channelization, flood controls, and stream and aquifer withdrawals for irrigation and water supply (NRC, 1992; Tiner, 1984). While there is little quantitative information about these threats to US wetlands on a comprehensive basis, problems in specific areas are well documented (Heimlich, et al., 1997; Kusler, 1994; Schiedt, et al., 1989; Willard, et al., 1988).

The main factors underlying the historical agricultural conversion of wetlands in the United States were population growth and the development of trade in agricultural commodities. These created demands for agricultural land, some of which were met by clearing and draining wetlands. Under a system of private land ownership, most wetland functions and values benefit society at large, but the landowner cannot charge for these services. In the language of economists, they are public goods provided as a beneficial externality by landowners because they are undepletable, non-rival, and non-exclusionary and, hence, not traded in markets. Over the course of the 20th century, the public goods nature of wetland benefits, and the costs associated with their loss or degradation, have become increasingly appreciated. Society's claim on some of the "sticks" in the bundle of rights that constitute wetland ownership arises because the public benefits extend well beyond the bounds of wetlands properties themselves. Wetland conversion or degradation either deprives society of water quality, water quantity, fish and wildlife habitat, and recreation benefits, or increases the cost to society of replacing wetland services.

Market failure is a principal underlying cause of wetland conversion in the United States because the interplay of market forces cannot sustain the socially optimal balance between conversion and conservation. The costs of losing wetlands are shifted to society, rather than internalised by the producer. The cost of conversion is artificially lowered because the public functions and values generated by wetlands are not marketable, and so are not considered in the private landowner's calculation of benefits and costs (OECD, 1996, p. 51).

Wetland conversion or degradation, as an input to crop production, generates unintended adverse effects on individuals other than the wetland owner (i.e., detrimental externalities). The problem faced by policy makers, courts, and society is to decide who holds the right to convert wetlands, and thus who is entitled to compensation when that right is exercised or taken away. Approximately 75 per cent of remaining wetlands in the contiguous 48 states are privately owned. Private ownership of wetlands historically implied the right to convert wetlands to other uses to increase their productive value. It is

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2 Defined here as the date each state joined the Union.

only since 1972 that some regulations and programmes have been put in place to assert public claims on the public benefits produced by wetland resources.

Another underlying cause of conversion in excess of socially desirable levels is that information about wetlands is incomplete. More and better scientific information required, including knowledge of how wetlands and other components of ecosystems function together. Practical application of wetland science to the problem of distinguishing between wetlands to be protected and other lands is also a problem. Most important, the economic linkages between wetlands functions and services that have values to humans are not well understood (see Section 5.3).

In the past, US institutions failed to protect wetland resources for future generations because wetland resources were in the charge of agencies whose mission in the late 19th and early 20th centuries was primarily to develop resources for human habitation and economic uses (USDI 1988 and 1994). It was only when wetland conservation became an explicit policy objective that institutions and agencies were set apart or established that included conservation as part of their mission, such as the Environmental Protection Agency, the US Army Corps of Engineers, and the Natural Resources Conservation Service. Although these agencies have significant authority for wetland conservation under various legislation, they are constrained by resource limitations of budget and personnel, resulting in some degree of enforcement failure at the current time.

2.3 Identification of adverse incentives with negative impacts on biological diversity

For most of US history, public incentives in various forms were provided to encourage wetland conversion.

Direct and Indirect Subsidies

Although public society is now trying to assert claims on wetland resources, the US Congress gave 64.9 million acres of wetlands to 15 States in the Swampland Acts of 1849, 1850, and 1860. The purpose of the grants was to enable States to reclaim their wetlands through construction of levees and drains to reduce flooding and eliminate mosquito breeding areas. Nearly all of the lands granted to States were transferred to private ownership and large acreages were converted to other uses (Shaw and Fredine, 1971). Since then, a long list of Federal programmes have provided incentives for wetland loss, including construction of reservoirs for flood control, irrigation, and hydroelectric power, highway projects, flood disaster relief and flood insurance, subsidies and tax incentives to forestry, and grazing policies on federal land (USDI, 1994).

USDA was involved in helping farmers drain wetlands from an early date. Drainage inventories in 1906 and 1922 identified 75-79 million acres of wetlands with potential for drainage to accommodate agricultural production (Gray, et. al, 1924; Wright, 1907). Beginning in 1936, USDA provided cost-sharing for wetland drainage, a practice which continued into the late 1970s (Pavelis, 1987; National Audubon Society, 1996). The Civilian Conservation Corps (CCC) and other federal relief agencies conducted drainage activities in the 1930s. The linkage between flood control and agricultural drainage was only made explicitly in 1953, and the US Army Corps of Engineers (USACE) and USDA joined a formal partnership in the passage of the Federal Watershed Protection and Flood Prevention Act (P.L. 83-566). This Act included construction of drainage outlet channels in co-operation with State and local governments.

Concerted cooperative efforts between farmers and federal and state entities expanded the supply of arable land. Mattson concluded that in the Mississippi Delta "land clearing was common and appeared to be linked to better control of water regimes and flooding. In these circumstances it would seem inevitable that improved drainage linked to the installation of an arterial channel system by the Corps of Engineers and other projects, would hasten the conversion of remaining hardwood forests to highly productive, generally large, crop fields" (Mattson, 1975, p. 31).

Federal assistance to drain wetlands for the production of subsidised crops expanded agricultural production, but sometimes led to abandonment or under-utilization of land as supply control measures (such as acreage set asides and long-term retirements) focused on marginally productive land, either incomplete conversions of wetland or lands displaced by converting more productive wetlands. For example, the North Carolina Conservation Needs Committee in 1962 estimated a gain of over 45 per cent (144 800 acres) of cropland for the nine major crops in the 10 county Albemarle area (Hoover, 1969). Large scale conversion in the area in the 1970s affected thousands more acres (Carter, 1975). By the mid-1980s, however, much of this land proved unprofitable for agriculture and was given to the US Fish and Wildlife Service (FWS) to expand the Alligator River National Wildlife Refuge. A similar situation occurred with soybean production in part of the delta states of Arkansas, Mississippi, and Louisiana (Kramer and Shabman, 1993; USDI, 1988)

Market Price Support

Prior to 1985, US farm price and income support programmes were another important factor encouraging wetland conversion (USDI, 1988; Heimlich and Langner, 1986). Before market prices for crops rose in the mid-1970s, and after they fell in the mid-1980s, subsidy rates in the farm programmes set effective prices for commodities higher than prevailing market prices. Basic eligibility for price and income support programmes was determined by the base crop acreage and voluntary compliance with land set aside provisions designed to control supplies of programme crops produced. Producers' payments were based on the crop acreage base, less the set aside requirement, times the programme yield, times a deficiency payment based on the difference between targeted support prices and market prices. Converting wetlands and other kinds of land for crop production in high-price periods insured a higher gross subsidy in low-price years when the programmes operated. Further, to the extent that converted wetlands were not completely drained, these may have been the least productive croplands that could be idled to meet required acreage set asides. Thus, US price and income support programmes created an incentive to convert wetlands, as well as other lands.

Tax Incentives

Prior to 1986, wetland conversion investments were favored in the Internal Revenue Code governing US income taxes in a number of ways (Heimlich and Langner, 1986; Heimlich, 1986; Ward, et al., 1989). First, expenses for land clearing, drainage, and land shaping could be deducted from farm income. Deducting these expenses instead of capitalising them decreased the taxable basis of the improved land, resulting in larger capital gains when the land was sold. Deductions were also available for depreciation of machinery used in wetland conversion under the accelerated cost recovery system and for interest payments on debt financing conversion investments. An investment tax credit equal to 10 per cent of the depreciable investments associated with conversion was also available. Finally, up to 60 per cent of long-term capital gains realised from the sale of improved farmland could be excluded from ordinary income and taxed at preferential capital gains rates. In addition to farm income, all of these tax reducing provisions were available to shelter non-farm income and could easily be applied to incomes of

passive investors. The effect of these provisions was to reduce the cost of wetland conversion, providing an incentive for further conversion activity.

Infrastructure Provision

The US Army Corps of Engineers has been rechannelling rivers since the 1870s when work began on the Mississippi River (Beauchamp, 1987). Flooding along the Mississippi in the 1940s engendered the Flood Control Act of 1944, further authorising the Corps of Engineers to construct major drainage districts and flood control channels. Many existing drainage districts in the Mississippi Valley were re-activated in order to reap the benefits of an enhanced flood control infrastructure. Floods in both the Mississippi and the Missouri Valleys in the early 1950s provided additional impetus for flood control work that provided for drainage outlets. Between 1929 and 1974, USACE flood control projects affecting 5.5 million acres were authorised in the Lower Mississippi alluvial plain and construction was completed affecting 4.5 million acres (USDI, 1988).

Establishment of the Bureau of Reclamation in 1902 provided new federal involvement in agricultural drainage programmes (USDI, 1988). Construction of outlet channels into which landowners could drain their wetlands was also a major impact of small watershed programmes (USDI, 1988, page 19). The majority of channelising work under P.L. 566 occurred in four Southeastern states: Georgia, Louisiana, Mississippi, and North Carolina. A 1972 study by Arthur D. Little concluded that, "on balance, the weight of evidence is marginally in favor of channeling both untouched natural streams and man-altered channels in terms of... economic effects". Conflicts with environmentalists concerned about preservation of wetlands began when the Soil Conservation Service (SCS) began straightening stream channels (Gillette, 1972).

3. IMPACTS ON ECOSYSTEMS

Nearly half of wetlands in the contiguous US have been converted to other uses since 1780, seriously affecting the natural ecosystems of which they form an important component. Net rates of wetland conversion dropped from more than 800 thousand acres per year between settlement and 1954 to less than 80 thousand acres per year in 1982-92 (Table 1). Agriculture's share of gross conversion dropped from more than 80 per cent in 1954-74 to 20 per cent in 1982-92, while urban development's share rose from 8 per cent to 57 per cent. This long-term reduction in wetland conversion for agriculture is partly due to changing economics, but is mainly the result of Federal and state wetland regulatory programmes.

By 1992, 45-50 per cent of the original wetlands in the 48 states had been converted to other uses, with losses approaching 90 per cent in Illinois, Indiana, Iowa, Missouri, and Ohio. The rate of wetland conversion dropped steadily from the mid-1950s on, to 10 per cent of historic rates, and shifted away from demands for agricultural uses to urban uses. These data show that, while the US is still losing wetlands every year, it is moving toward the goal of "no net loss" of wetland acreage, as has been Federal policy for the last eight years (see Section 6).

Table 1. **Average annual wetland conversion, contiguous states, settlement to 1992**
(1 000 acres p.a.)

	Up to 1954		**1954-74**		**1974-82**		**1982-92**	
Wetlands Converted to:		%		%		%		%
Agriculture	na	na	593	81	235	53	31	20
Urban development	na	na	54	8	14	3	89	57
Other	na	na	35	5	168	38	16	10
Deepwater	na	na	48	6	29	6	20	13
Total	na	na	730	100	446	100	156	100
Converted to wetlands from:								
Agriculture	na	na	248[1]	91	82	53	8	10
Urban development	na	na			0	0	2	2
Other	na	na			53	34	18	24
Deepwater	na	na	25	9	20	13	49	64
Total	na	na	272	100	156	100	77	100
Net change in wetlands[2]								
Agriculture	na	na	435[1]	95	153	53	23	29
Urban development	na	na			14	5	87	110
Other	na	na			115	40	-2	-2
Deepwater	na	na	23	5	9	2	-29	-37
Total	814-887	100	458	100	290	100	79	100

Source: ERS compilation of sources, including Dahl (1990); US Fish and Wildlife Service, National Wetland Status and Trends Analysis, mid- 1950's to mid-1970's and mid-1970's to mid-1980's, excluding Alaska and Hawaii and deepwater habitats; Soil Conservation Service, USDA, National Resources Inventories, 1982 and 1992, excluding Alaska, Hawaii and Caribbean and estimated acreage of deepwater habitats. See Appendix II for methods.

Notes:

1 Conversion from agriculture, urban development and other uses and net conversion not available

2 Conversion of wetland to non-wetland uses, plus increases in wetlands due to restoration, abandonment, and flooding.

Of the 224 million acres of wetlands and former wetlands in the 48 states, land uses for 195 million acres can be determined for 1992 (Table 2). More than 83 million acres of land on hydric soils (soils formed under wet conditions), and which are no longer classified as wetlands, were probably converted from wetlands since settlement. Two-thirds of this land was under crop production in 1992, and another 15 per cent was in pasture and range uses. Urban, transportation, and water uses that may be on converted wetlands can not be determined because no soils information is available. In addition, land in all uses that was converted from wetlands not on hydric soils also can not be identified.

Table 2. **Wetlands and former wetlands by land use, 1992**
(in thousand acres)

	Wetlands				**Former wetlands**	**Total**
	Hydric	Not hydric	Not known	Subtotal	Hydric	
Cropland	9 080	1 471	0	10 551	55 424	65 975
Pastureland	6 629	1 357	0	7 986	6 452	14 438
Rangeland	6 159	1 605	0	7 764	5 995	13 759
Forest land	55 817	5 297	0	61 114	9 461	70 575
Miscellaneous	16 923	1 841	0	18 764	3 040	21 804
Urban	0	0	952	952	0	952
Rural transportation	0	0	559	559	0	559
Water	0	0	3 826	3 826	0	3 826
Federal	0	0	0	0	3 140	3 140
Total	**94 607**	**11 571**	**5 336**	**111 513**	**83 513**	**195 026**

Source: ERS compilation of 1992 NRI data.

Because organisms may depend totally or partially on wetlands for shelter, feeding, or breeding habitat, losses can cause declines in biodiversity or threaten the sustainability of remaining species, populations, and ecosystems. Some examples from the literature for the US include:

- Hudson (1991) found that high wetland losses in California have threatened 220 animal and 600 plant species.
- Ohmart and Anderson (1986) showed that availability of riparian areas and wetlands is the primary factor explaining breeding bird density at higher elevations in central Arizona.
- Weller (1988) interprets prairie pothole wetlands as islands in a terrestrial sea and suggests that bird diversity follows the rules of island biogeography.
- Leibowitz and others (1992) concluded that waterfowl species are sensitive to reductions in area, patch size, density, and proximity of wetlands, particularly smaller wetlands.
- Harris (1988) interprets long-term (1955-85) records for waterfowl dependent on wetlands to show that declines of mallard (35 per cent) and pintail (50 per cent) are related to wetland losses.
- Minckley and Douglas (1991) report that 41 US fish species have become extinct in the past century, and 28 per cent of freshwater fish species are seriously reduced in abundance and distribution.

Since 1930, most of the reduction in waterfowl populations has been attributed to loss and degradation of wetlands and the loss of suitable upland habitat surrounding wetlands (Bellrose and Trudeau, 1988). Wetland degradation can affect ecosystem functioning in many ways, including:

- altering amounts and periodicity of water supplies;
- modifying the quality of water flows into and through a wetland;
- reducing the flows of sediments or freshwater to coastal marshes;
- stabilising water levels in wetlands typically undergoing beneficial drawdown or fluctuation;
- altering wetland vegetation by harvest, introduction of exotic species, or alteration of nutrient flows, making it less valuable for wetland dependent species (Stewart, 1996).

The conversion of wetlands has affected ecosystems in many parts of the United States. Tiner (1984) identified nine wetland areas in the continental US where wildlife are most threatened by wetland conversion. The main contributing factor in six of the nine is agricultural conversion.

- South Florida Palustrine Wetlands: these wetlands cover a 9 000 square mile area that includes the Everglades National Park and associated areas. Freshwater run-off from this area is essential to maintaining the salinity balance of coastal estuaries, which support 85 per cent of Florida's offshore fishery. Also, southern Florida is a breeding ground and a wintering area for many species of birds, and provides habitat for several endangered species. Agricultural drainage and flood control were the major factors in past wetland conversions in the area. The hydrologic regime of the Everglades has been disrupted, which threatens the biological integrity of the Everglades National Park.
- Prairie Pothole Emergent Wetlands: the Prairie Pothole region is North America's most valuable waterfowl breeding ground. This 227 000 square mile area of Canada and the United States produces between one-half and two-thirds of the ducks raised in North America, but comprises only 10 per cent of all available duck nesting habitat. Most ducks now breed on farm fields converted from the former wetlands. In drought years, waterfowl populations are severely affected. Breeding habitat is lost when wetlands dry out and farmers can cultivate wetlands and plow closer to remaining wetlands, removing valuable nesting cover. As more wetlands are drained, waterfowl are forced onto fewer and fewer remaining areas, which has led to decreased reproduction and increased disease problems.
- Nebraska's Sandhills and Rainwater Basin: these two areas are critical migratory stopovers for waterfowl in the central flyway and for sandhill and endangered whooping cranes. Eighty per cent of North America's sandhill cranes use the Sandhill region of the Platte and North Platte rivers during spring migration, and the endangered whooping crane also migrates though the area. The Rainwater basin is a spring stopping ground for 2.5 million ducks and geese. Agricultural drainage, filling for pivot irrigation, and lowered groundwater levels from irrigation pumping have affected wetlands in this area. Upstream diversions of the Platte River have changed the vegetation of the area and reduced the number of suitable roosting areas for cranes, increasing the likelihood of disease or weather fatalities. There have

been outbreaks of avian cholera in the Rainwater basin because of waterfowl overcrowding.

- Forested Wetlands of the Lower Mississippi Alluvial Plain: these wetlands are prime wintering habitat for waterfowl, and provide fish spawning and nursery grounds, flood storage, and water quality maintenance. Agricultural conversion has been the predominant cause of wetland loss.
- North Carolina's Pocosins: pocosin wetlands provide habitat for a variety of species, stabilise water quality, and balance salinity in estuaries abutting the Outer Banks. Major timber companies own large tracts of pocosin wetlands, but much of the land was cut over and converted to agricultural production.
- Western Riparian Wetlands: riparian wetlands are lands along the floodplains and margins of ponds and lakes in arid and semiarid regions. These narrow strips of vegetation are disproportionately important to wildlife, supporting a great variety of species. The riparian wetlands form an integrated system with adjacent uplands, and are therefore difficult to distinguish. Crop conversion, overgrazing, dam construction, and groundwater pumping have altered, severely damaged, or destroyed riparian wetlands to the point where they are considered the most modified habitats in the West. For example, 44 per cent of the cottonwood communities in Arizona have been lost, and 98 per cent of original riparian forest along California's Sacramento River is gone. Remaining riparian lands suffer from poor water quality and reduced streamflow.

4. IMPACTS ON ECONOMY AND WELFARE

Direct economic losses from the loss of US wetlands have not been systematically measured. The most well-documented estimates are those of the marginal value of wetlands for commercial coastal fisheries. The mean value per acre from 7 studies in Florida, Louisiana, Michigan, and Virginia was found to be $733 (in 1992 dollars), with estimates ranging from $7-1 390 (Table 3; Farber and Costanza, 1987; Lynne, et al, 1981; Fischer, et al, 1986; Bell, 1989; Batie and Wilson,1979; Farber, 1996; Amacher, et al, 1989; summarised in Heimlich, et al, AER). With losses of marine and estuarine wetlands totalling 370 900 acres in 1954-74, 118 900 acres in 1974-83, and 83 800 acres in 1982-92, these values imply losses of $421 million since 1954.

Economic values of non-marketed goods associated with species dependent on wetlands include values for general recreation, recreational fishing, and hunting. Mean estimated recreation values from 4 studies averaged $2 710 per acre (in 1992 dollars), ranging from $105-9 859 (Farber and Costanza, 1987; Farber, 1996; Leitch and Hovde, 1996). Estimated values for fishing in 7 studies averaged $6 571 per acre, ranging from $95-28 845 (Amacher, et al, 1989; Thidodeau and Ostro, 1981; van Vuuren and Roy, 1993; Bell, 1989; Farber, 1996). Values for waterfowl hunting from 8 studies averaged $1 244 per acre, ranging from $108-3 101 (van Vuuren and Roy, 1993; Thibodeau and Ostro, 1981; Gupta and Foster, 1975; Farber, 1996). Assuming all wetlands have these values, losses of 12.9 million acres in 1954-92 imply losses of $34.8, $84.4, and $15.9 billion for general recreation, recreational fishing, and waterfowl hunting, respectively, associated with wetland losses since 1954.

Economic losses from non-user's willingness to pay (WTP) for existence and option values of wetlands per person are estimated to average $118 per year, ranging from $12-280 (Whitehead and

Blomquist, 1991; Loomis, et al, 1990; Poor, 1997). The per capita WTP yields an estimate of $462.5 billion for nonuser values. Per acre values estimated from 4 studies have a mean value of $121 471 per acre (in 1992 dollars), ranging from $1 155-347 548 per wetland acre. Assuming that all wetland losses affect these non-user values implies an economic loss of $1.6 trillion for wetland losses since 1954, valued per acre of wetlands lost. Large values per acre result from relatively large willingness-to-pay values per individual derived from contingent valuation studies that are then applied to large populations, and as a result probably overestimate the total values.

Table 3. **Economic losses associated with wetland losses, 1954-92**
(1992 constant $ per acre)

	Number of Studies	Mean	Range	Area affected[1] (1000 acres)	Total economic loss (millions)
Direct economic losses					
Commercial fisheries	7	$733	$7-$1 390	573.6	$421
Damages to public goods – use values					
General recreation	4	$2 710	$105-$9 859	12 850.0	$34 824
Recreational fishing	7	$6 571	$95-$28 845	12 850.0	$84 442
Waterfowl hunting	8	$1 244	$108-$3 101	12 850.0	$15 981
Damages to public goods – non-use values					
Non-user values	6	$121 471	$1 155-$347 548	12 850.0	$1 560 906
Non-user values alternate estimate	4	$118 per capita	$12-$280 per capita	na	$462 576

Note:

1 Based on coastal wetland losses for commercial fisheries and total net losses of 458 000 acres per year in 1954-74, 290 000 acres per year in 1974-83, and 79 000 acres per year in 1982-92 for public goods losses.

Restricting consideration to direct economic losses and losses of public goods by wetland users reduces total estimated economic losses to $136 billion, or an imputed average of $10 558 per acre of wetlands lost. Adding the alternate estimate of non-user values to this brings the total to $598.2 billion, or $46 556 per acre lost since 1954.

Agricultural subsidies were one of the largest remaining adverse incentives for wetland conversion as late as 1985. Estimates of the impacts of US agricultural subsidies were made in the late 1980s as part of debates on trade liberalisation under the Uruguay Round of GATT negotiations. Agricultural support programmes prior to 1985 supported commodity prices through a non-recourse loan programme, supported farm incomes through deficiency payments to raise effective prices to a target level, and reduced supply through land set-aside requirements. Because there was no restriction on converting wetlands and other land for crop production, however, these subsidies tended to make agricultural conversion more attractive. These subsidies had other social costs as well, including impacts on efficiency, government budgets, and employment. Simulations of the effects of unilaterally eliminating $30-34 billion in annual US agricultural subsidies (1985-86) estimated increases in gross domestic product of $5-28 billion (Feltenstein, 1989; Robinson, et al, 1989; Hertel, et al, 1989). Federal budget deficits were estimated to decrease $25 to $37 billion. Employment and asset values in the farm

sector were expected to decrease, while in the long run released labour and capital were expected to be employed in more competitive non-farm sectors. In more recent years (1993-96), US government payments to farmers have dropped to $7-13 billion per year.

In addition to the agricultural sector, other landowners in areas where wetlands were a major landscape feature benefited from wetland conversion for flood control and to accommodate development. Construction in low-lying areas of the Southeast and Delta states only became possible as levees were constructed to control periodic floods and wetlands were drained. Those who benefited from wetland developments of all kinds were favoured by inaction or lack of vigorous enforcement of wetland conservation provisions prior to the late 1970s to mid-1980s. Much of this economic activity came at the expense of fish and wildlife habitat that formerly provided wildlife-based recreation.

5. IMPLEMENTATION OF INCENTIVE MEASURES AND CONTENT

5.1 Identification of actual or planned incentives measures

Over the course of the last 25 years, the Federal government of the United States has implemented four major classes of wetland conservation incentive measures. These measures spanned the gamut from direct regulation, through elimination of direct and indirect wetland conversion incentives, to subsidies for wetland conservation. In general, measures adopted in the 1980s and 1990s were implemented in an incremental fashion, on the pragmatic grounds that measures adopted earlier failed to control wetland losses, presented inconsistencies with previous policies, or proved inadequate to support ecosystem functions through conservation alone.

While it might be expected to be a last resort after other measures have been used, direct regulation of wetland conversion was the first measure enacted. Section 404 of the 1972 Federal Water Pollution Control Act Amendments directs US Army Corps of Engineers and the Environmental Protection Agency to regulate discharge of dredged and fill material into “waters of the United States” (P.L. 92-500). Section 404 was preceded by a few State laws, and spawned more, resulting in some form of wetland regulation in 44 of the 50 States (Kusler, et al., 1994).

The second major policy measure was Executive Order 11990, signed by President Carter in 1977. This order directed federal agencies to minimise destruction, loss or degradation of wetlands and to preserve and enhance the natural beneficial values of wetlands in all actions involving federal lands, federally financed or assisted construction projects, and other federal activities affecting land use. The practical impact of the order, as implemented throughout the Executive Branch Departments, was to deny direct subsidies for wetland conversion (USDI, 1988, p. 27).

The third class of incentive policies eliminated important indirect incentives for wetland conversion. Indirect government assistance for wetland conversion – in the form of farm programme benefits and income tax deductions – was largely eliminated by the so-called “Swampbuster” provisions of the 1985 Food Security Act and changes in the 1986 Tax Reform Act (P.L. 99-198 and 99-514; Heimlich and Langner, 1986; Heimlich, 1994). A condition on continued receipt of payments from a voluntary agriculture subsidy programme, Swampbuster provisions deny most farm programme benefits to farmers who choose to convert wetlands. Benefits at risk include direct payments (e.g. production flexibility contract payments), price support loans, agricultural disaster payments, conservation payments,

loans for farm storage facilities, and certain federally insured or guaranteed loans. Benefits may be denied for all fields and all farms in which the violator has a financial interest. Although not specifically directed at wetland conservation, provisions of the Tax Reform Act (TRA) also eliminated preferential tax treatment of conversion costs and preferential capital gains treatment from selling land that had appreciated in value due to drainage.

The fourth class of policies provided positive incentives for wetland conservation. Included here are various programmes to pay landowners to conserve or restore wetlands, primarily on agricultural land. Not included are programmes for outright purchase of title to wetlands for addition to the National Wildlife Refuge system or National Parks (Stewart, 1996, p. 55-56).

Programmes under the US Fish and Wildlife Service include the Small Wetland Acquisition Program (SWAP), wetland restoration efforts under the Partners for Wildlife Program and co-operative efforts under the North American Waterfowl Management Plan. Agricultural wetland conservation and restoration programmes include the Water Bank, the Conservation Reserve Program, the Wetlands Reserve Program and the Emergency Wetlands Reserve Program. In general, all of these programmes are voluntary efforts to acquire property rights in wetlands varying from short-term rental agreements for 10 years (Water Bank, CRP), through longer-term or permanent easements (SWAP, WRP, EWRP), to outright acquisition (SWAP). All involve some degree of cost-sharing for wetland restoration or enhancement.

5.2 Process of implementation and distribution effects

Conversion of US wetlands to other uses continued at a rapid pace throughout the first half of this century. By the late 1960s, however, scientists, conservationists, and the public were beginning to recognise the unique and important functions and values of wetlands. Public attitudes and public policy began to shift from supporting and subsidising wetland conversion to encouraging wetland conservation and restoration (Carey, et al, 1990; Dahl and Allord, 1996). Public opinion polls found that 58 per cent of respondents thought the government was not doing enough to protect wetlands, and 59 per cent stated a willingness to pay additional taxes to protect them (EOS, 1991; NWF, 1989). Public policy on wetlands has responded to changing values and views, moving from the question of whether they should be protected, to how best to protect them.

Other than programmes to acquire wetlands for the National Wildlife Refuge system and National Parks, the authorisation of the Water Bank programme in 1970 created the first agricultural programme to temporarily protect wetlands. Water Bank provided annual per-acre payments to the owners of eligible wetlands and adjacent uplands who agreed not to burn, drain, fill, or otherwise destroy the character of enrolled areas for the life of the contract. Ten-year contracts provided cost-sharing for the installation of conservation practices designed to maintain vegetative cover, control erosion, improve wildlife habitat, conserve surface water, or manage bottomland hardwoods (USDA-ASCS, 1988; Heimlich et al, 1989; Higgins and Woodward, 1986). At the programme's peak in 1993, there were more than 1 000 Water Bank contracts in 11 states, covering 73 831 acres of wetland and 46 121 acres of associated upland at an average rental cost of $12.28 per acre per year, based on value in agricultural use (USDA-ASCS, 1994). The last Water Bank contracts will expire when their 10-year terms run out, but these lands are eligible to compete for enrolment in the Wetlands Reserve Program.

In the 1970s and 1980s, a shift from conversion to conservation policies became clear. The first changes eliminated economic incentives for wetland conversion and provided a public review process for private wetland conversion decisions. Section 404 of the Federal Water Pollution Control Act

Amendments of 1972 established a permit programme for regulating discharges of dredged and fill materials[3]. Although initial rules limited the scope of regulation to navigable waterways, a Federal district court directed USACE to include "isolated waters", consistent with Congressional intent. Final rules, issued in 1977, explicitly included "isolated wetlands and lakes, intermittent streams, prairie potholes, and other waters". Attempts to narrow the scope of regulation were rejected in the debate over the Clean Water Act (CWA) of 1977.

Early wetland preservation efforts were discovered to be at cross-purposes with continuing federal policies that directly or indirectly subsidised wetland conversion. Executive Order 11990, issued by President Carter in May 1977, gave federal agencies a single guideline to avoid actions that contributed to wetland loss.

Despite this, farm commodity programme benefits remained available for crops grown on converted wetland acres. Tax breaks allowed significant write-off of conversion costs and opportunities to shelter income from taxation through wetland conversion for agriculture. Nearly $170 million in deductions for soil and water conservation (often drainage) and land clearing were claimed on 4 and 2 per cent of returns in 1982, and reduced farmers' taxes by an estimated $27-37 million (Daugherty, 1987). These indirect incentives for conversion were addressed in the 1980s.

Of particular significance for agriculture, important conflicts between federal farm policy and wetland protection were eliminated with the passage of the wetland conservation provisions (or "Swampbuster" provisions) of the 1985 FSA.

The TRA eliminated provisions allowing capital investment in drainage and land clearing to be treated as annual expenses, and preferential tax treatment for capital gains[4]. Although the value of tax

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3 Section 404 regulation is not a narrow, technical regulatory process, but a public review procedure that allows all interested parties to comment on potential adverse impacts from the proposed wetland conversion. In this regard, the Section 404 process acknowledges the public good aspects of wetlands and allows the affected public an opportunity to weigh potential negative externalities against the private interests of the permit seeker. Regulated activities cannot be permitted if a practical alternative exists that is less damaging to the aquatic environment, or if the nation's waters would be significantly degraded. Permit applicants must show that a sequence of all practical steps have been taken to avoid, minimize, and, as a last resort, to mitigate unavoidable wetland impacts. For specific activities which impose minimal impacts both individually and cumulatively, USACE may issue nationwide general permits (NWPs) which allow certain activities to go forward without a case-by-case permit review. Some NWPs are being phased out, to be replaced with activity-specific permits.

4 Prior to TRA, drainage costs were treated as conservation costs and could be immediately deducted, up to 25 per cent of gross farm income. Land clearing costs were deductible up to the lesser of $5,000 or 25 per cent of net farm income. Any unused deductions could be carried forward to subsequent years. For farmers and landowners with income that could be offset, deductibility amounted to a federal government cost share on wetland conversion activity. The increase in the value of the land due to drainage and clearing (the capital gain) was taxed only when the land was sold and at only 40 per cent of the rate of regular income (if the land was held for at least 10 years following conversion). Investment in wetland conversion for agriculture provided an opportunity to shelter regular income from taxation by converting it to a capital gain, reducing the tax rate and delaying taxation until the land was sold. The economic context of the 1970s was particularly conducive to the use of these tax mechanisms. Agricultural returns were relatively high (including capital gains through land value inflation) and real interest rates were low, holding down the annualized cost of conversion. Favorable tax treatment further enhanced the value of investing in the conversion of wetland for agricultural production.

incentives varies significantly with producers' incomes, these changes significantly increased the after-tax cost of wetland conversion for agriculture, and largely eliminated opportunities to shelter non-farm income from taxation through investment in wetland conversion for agriculture in some areas of the country (Heimlich and Langner, 1986; USDI, 1994).

A wave of wetland policies followed, focused primarily on voluntary programmes that provide incentives to landowners to conserve and restore wetlands. Under the Small Wetland Acquisition Program (SWAP), FWS can either purchase a wetland and surrounding upland acreage outright or enter into a permanent easement agreement restricting wetland use. Compensation is made on a one-time basis, with the payment varying according to agricultural land values in the immediate area and the development potential of the wetland. SWAP currently has 1.2 million acres of wetlands under perpetual easement in Montana, Nebraska, North Dakota, and South Dakota, at a cost of $46.7 million or $38 per acre. The programme also holds an additional 76 300 acres in associated grassland easements at $4.9 million or $64 per acre (Hartmann, 1993).

The Partners for Wildlife programme has initiated voluntary restoration projects totalling approximately 400 000 acres for little more than the cost of the restoration work, with no property interests acquired. Partnerships funded under the North American Wetlands Conservation Act of 1989 (P.L. 101-233) include projects involving 940 723 acres of wetlands acquired, restored, and/or enhanced as of September 1996, at a combined federal and non-federal cost of $359 million.

The Conservation Reserve Program (CRP) was enacted in the 1985 FSA to idle environmentally sensitive land from crop production. While it was originally focused on highly erodible cropland, cropped wetlands were made eligible for 10-year contracts in 1989. Some 410 053 acres were enrolled, mostly in the Northern Plains and Delta states (Osborn et al, 1995). In the 1990 Food, Agriculture, Conservation, and Trade Act (P.L. 101-624), Congress created the Wetlands Reserve Program (WRP) to purchase permanent easements on former wetlands that had been converted to crop production, and to restore them as wetlands (Carey, et al, 1990; ERS-USDA, 1994). Beginning in 1992 as a pilot programme in 9 states, WRP has since been expanded to the entire nation. WRP was supplemented with an Emergency Wetland Reserve Program (EWRP) authorised after the 1993 Midwest floods to buy out flood-damaged croplands converted from wetlands that would be too expensive to protect through levee repairs. WRP is capped at a maximum enrolment of 975 000 acres, with just over 400 000 acres enrolled as of January 1997. In the 1996 Federal Agricultural Improvement Act (FAIR), WRP was broadened to include cost-sharing and 30 year term agreements, in addition to permanent easements.

Bearers of Costs and Beneficiaries of Incentives

Research assessing the role of Swampbuster and TRA in changing economic incentives for wetland conversion employs simulation models developed for specific locations. For example, models for both the Delta and Prairie Pothole Regions, using 1975-1984 as a baseline for prices and yields, are reported in *The Impact of Federal Programs on Wetlands, Volume 1* (USDI, 1988). In the Prairie Pothole region, six representative farms were simulated. Results indicate that ending tax breaks on wetland conversion would have virtually no impact on the whole farm net present value (NPV) of returns to farms that drain wetlands. The withdrawal of other federal benefits including price and income support would reduce NPV by six to 66 per cent, with an average reduction of 14 per cent for the six representative farms studied. Even so, NPV of the "*drained without* price and income supports" scenario exceeded that of the "*undrained with* price and income supports" scenario for all six representative farms because increased production with drainage at then-current market prices exceeded the value of farm programme benefits. This result makes it difficult to argue that Swampbuster would have been effective during this period.

In the Delta region, loss of tax benefits and farm programme support was more significant. Elimination of tax breaks would reduce the per acre NPV of wetland conversion by between six and 46 per cent, averaging 14 per cent over the four representative farms simulated. Withdrawal of farm programme benefits would reduce NPV of wetland conversion by between 17 and 35 per cent, with an average of 26 per cent. Although the authors of the Delta study conclude that Swampbuster and tax reform have significant potential to reduce returns to wetland conversion, they also argue that inclusion of additional, per acre general farm overhead costs would render wetland conversion only marginally profitable in any case.

Heimlich and Langner (1986) simulated representative farms in North Carolina and North Dakota for economic conditions and policies in place in 1986-1991. They found that Swampbuster sanctions would reduce the net cash income in both cases, by 26 per cent for the North Carolina farm and by 180 per cent for the North Dakota farm. Tax incentives were found to be important to the North Carolina farm but not the North Dakota farm.

The Heimlich-Langner results vary significantly by region and, with respect to Swampbuster, compared with the US Department of the Interior (USDI) studies for 1975-84. Principal reasons for these differences are differences in economics and policy over the time periods studied. Key differences between the North Carolina and North Dakota cases were the acreage of wetland converted relative to total farm size, and the financial size and structure of the farms. Converted wetland was 32 per cent of previous crop acreage in the North Carolina farm but only 1 per cent in the North Dakota farm. Similarly, USDI simulations in the prairie pothole region assume that wetland conversion is 10 per cent of cropland acreage.

Kramer and Shabman (1993) simulated per acre returns to wetland conversion for representative counties in Louisiana, Arkansas, and Mississippi for 1985 and 1987 (before and after implementation of Swampbuster and tax reform). Under 1987 conditions, returns to wetland conversion were quite low in two of the three counties, even without the loss of farm programme benefits on non-wetland acres. In the third county (in Arkansas), wetland conversion could be profitable, but the loss of programme benefits on as little as 1.03 non-wetland acres would fully offset returns to wetland conversion. That is, wetland conversion without programme benefits would net $266 per wetland acre, but Swampbuster provisions would deny $264 in programme benefits on all non-wetland acres. In each of the three counties, loss of farm programme payments due to Swampbuster was 150 to 275 per cent greater than the increase in tax liability due to tax reform, even without counting losses of farm programme benefits on non-wetland acres.

The simulation studies provide estimates of the effect of Swampbuster on returns to wetland conversion over a range of economic, policy, and geographic circumstances and configurations. Based on the results from these studies, there is little question that Swampbuster significantly reduces these returns. A more difficult question is whether Swampbuster makes the critical difference between deciding to convert or conserve wetlands with agricultural potential.

USDI studies were based on data from 1975-84, when market returns to crop production were relatively high and farm programme benefits were a smaller share of farm income. Results show that Swampbuster would not have been effective, particularly for the Prairie Pothole region. Changes in commodity economics led Heimlich and Langner to conclude that Swampbuster would be a significant deterrent to wetland conversion in the late-1980s, especially in the Prairie Pothole region. Kramer and Shabman (1993) argued that returns were unfavourable to wetland conversion, even without Swampbuster and TRA. However, their results suggest that Swampbuster penalties were severe in the economic and

policy context of the late-1980s. Even if returns to wetland conversion were high, Swampbuster sanctions easily drove returns to negative levels, suggesting that the deterrent potential of Swampbuster was quite high.

Finally, TRA had a smaller overall impact on returns to wetland conversion than the Swampbuster provisions did. Simulation studies of the Prairie Pothole region carried out for different time periods and circumstances show that tax incentives were never an important factor in wetland conversion. For other regions, however, tax reform may have played an important role in reducing overall incentives for wetland conversion. Regional differences in the value of tax breaks in wetland conversion are due at least in part to variations in the capital intensity of conversion activities (Heimlich, 1986). In the Prairie Pothole region, conversion costs are low and conversion can often be accomplished using farm machinery during slack seasons. Differences in the level and composition of farm operators' incomes are also important in understanding the effects of tax reform on wetland conversion.

Current distributional impacts of the Swampbuster provisions can be assessed based on a simulation of wetlands profitable to convert to agricultural production in the absence of Swampbuster (Heimlich, et al, 1997a and b). Changes in US agricultural income support programmes begun in the 1996 FAIR Act may lead to elimination of farm programme payments that leverage Swampbuster sanctions. One stated goal of the FAIR act is to phase out farm commodity programmes entirely. The payments authorised by the Act are scheduled to expire after the 2002 season, unless re-authorised. Although Swampbuster remains intact under the Act, an eventual end to farm programme payments could render it meaningless for lack of an effective sanction.

In the absence of Swampbuster provisions, wetland conversion or improved drainage for crop production would be profitable on an estimated 5.8 to 13.2 million acres (Table 4). Cropped wetlands would account for 7-15 per cent of likely converted wetlands, while forested wetlands would make up more than 60-75 per cent. After adjustment to commodity price changes, an estimated 2.2-5.0 million acres of additional land would be retained in crop production. These figures represent 0.7 to 1.5 per cent increases over the ten major field crop baseline of 328.3 million acres planted. The long run acreage planted increases would be about 40 per cent of the potentially convertible acres, and reflect the fact that at lower market prices caused by the increased supply, acreage planted will not increase by the total amount of potentially convertible wetland acres.

However, gross conversion of wetland to crop production may not be limited to the long run increase in crop acreage. Wetlands may be initially converted and then removed from production as crop prices fall or other marginal land that had been in production are removed from production as prices fall. At long run equilibrium (lower) prices, 71-88 per cent of the wetland acreage estimated to be profitable to convert remains profitable. This suggests that other marginal land is likely to leave production while converted wetlands remain in production. Even if converted wetlands are removed from production, there is little reason to believe that they would be effectively restored to wetland condition.

Nationally, aggregate net farm income is estimated to drop by $1.6-3.2 billion if these wetlands are converted, a reduction of 2.2-4.9 per cent. Farm income also declines in most farm production regions, indicating that increased returns on converted acres (the output effect) is outweighed, in aggregate, by reduced returns on other land due to price declines. However, the Southeast, Delta, and Appalachian regions would enjoy small increases in aggregate net farm income. These regions have small existing cropland bases on which to suffer losses due to the price effect, and large amounts of potentially convertible wetland. The largest aggregate reduction in income would be suffered in the Corn Belt, where few unconverted wetlands remain and the existing cropland base is large and highly productive.

Substantial declines in farm income would also occur in the Northern Plains, Southern Plains, and Lake States. Ending Swampbuster would have the largest impact on bottomland hardwood forests in the Delta States, Appalachian, and the Southeast regions.

Table 4. **Wetland acreage and annual farm income changes from USDA baseline levels**
(by farm production region, low and high wetland conversion scenarios)

	Low wetland conversion			**High wetland conversion**		
Farm production region	Potential wetland conversion (mio. acres)	Long run change in crop acreage (mio. acres)	Long run change in farm income (mio. $ p.a.)	Potential wetland conversion (mio. acres)	Long run change in crop acreage (mio. acres)	Long run change in farm income (mio.$ p.a.)
Northeast	0.5	0.4	-17.9	0.9	0.6	-27.3
Lake State	0.6	0.1	-209.3	1.4	0.2	-402.5
Corn Belt	0.4	-0.3	-835.5	0.5	-1.3	-2 072.3
Northern Plains	0.8	0.0	-371.8	0.8	-0.7	-870.6
Appalachia	0.7	0.5	8.8	2.1	1.7	162.3
Southeast	1.0	0.8	150.6	4.1	3.3	722.7
Delta States	1.5	1.1	76.1	2.8	1.9	3.2
Southern Plains	0.2	-0.2	-236.4	0.4	-0.5	-452.8
Mountain States	**	0.0	-74.8	**	-0.1	-115.7
Pacific Coast	0.1	0.0	-104.8	0.1	-0.1	-153.1
US	5.8	2.2	-1 614.9	13.2	5.0	-3 206.3

Source: Economic Research Service, USDA.

Note:

** fewer than 50 000 acres.

The potential decline in farm income of 2.5 to 4.9 per cent demonstrates that farmers and landowners who do not drain wetlands have a significant economic stake in the fate of wetlands. Farmers who actually drain wetlands for crop production are likely to see their incomes rise. However, these individuals are a small minority of agricultural landowners. Other producers would suffer reduced incomes due to lower commodity prices. Although land use restrictions have never been popular among farmers or landowners, Swampbuster restrictions are consistent with the economic interests of a large majority of farmers and landowners.

Enforcement and Compliance

The role of Section 404 (USACE regulation) as a deterrent to wetland conversion is often asserted, but is difficult to assess. In fiscal year 1994, USACE received 48 292 applications for permits to dredge or fill wetlands. Of these, 43 753 (91 per cent, affecting 17 200 acres) were authorised. Another 4 184 (9 per cent) were withdrawn, about half of which qualified for general permits (which allow conversion), administrative adjustments, or did not require permits. Only 358 permits applied for (less than 1 per cent) were denied, including only 30 agricultural permits (0.9 per cent). USACE estimates that

an additional 50 000 activities are authorised each year by general permits that do not require the public to notify USACE (USACE, 1995). Some cite the small number of permits denied as evidence of lax enforcement. However, as the requirements of the permit process have become widely known, there is evidence to suggest that they have deterred individuals from making applications which are not likely to pass USACE review without substantial and costly revision (Albrecht and Goode, 1994; Alvayay and Baen, 1990).

The Swampbuster provision, like the Section 404 permit programme, also has deterrent effects on wetland conversion beyond the actual violations processed. USDA's Farm Service Agency (FSA) reports that over $11 million in benefits were denied to producers on 351 tracts representing over 15 000 acres between 1987 through 1996. There is debate concerning whether the small number of violations indicates a successful deterrent, or inadequate enforcement of the Swampbuster provisions. Although it is impossible to estimate the number of wetland conversions that were not undertaken during this period because of potential loss of farm programme benefits, it is likely to be large. Dependence on farm programme payments during the latter half of the 1980s and low agricultural conversion rates in the 1982-92 NRI support this conclusion.

5.3 The role of information and uncertainty in the implementation process

Two kinds of information have been critical in implementing US wetland conservation programmes. The first involves the process of drawing a jurisdictional line around wetlands that are characterised by high ambiguity between dry and wet conditions. Wetland regulations and sanctions for conversion only apply if an area is jurisdictionally delineated as a wetland. The second kind of information concerns economic valuation of wetlands and the biodiversity they support.

Technical Information: Wetland Delineation

Wetlands can be *defined* in broad terms, but *delineation* of a wetland's boundaries on the ground requires the application of specific criteria at a particular site. Despite recent controversies, concepts of wetland definition have been nearly constant since at least 1977. All current definitions include one or more of four essential factors: integration of physical, chemical, and biophysical aspects in the environment as an ecosystem; the central role of water as a defining feature; the presence of substrate or soils formed under saturated conditions (hydric soils); and the presence of vegetation adapted for saturated conditions (hydrophytic vegetation).

A National Research Council (NRC) committee charged with investigating wetland definitions provided a reference definition:

> *A wetland is an ecosystem that depends on constant or recurrent, shallow inundation or saturation at or near the surface of the substrate. The minimum essential characteristics of a wetland are recurrent, sustained inundation or saturation at or near the surface and the presence of physical, chemical, and biological features reflective of the recurrent, sustained inundation or saturation. Common diagnostic features of wetlands are hydric soils and hydrophytic vegetation. These features will be present except where specific physicochemical, biotic, or anthropogenic factors have removed them or prevented their development.* NRC, 1995 p. 55.

Although there has been considerable agreement on how to *define* wetlands, great controversy has surrounded the application of criteria and indicators of the essential factors in the reference definition (e.g. depth and duration of saturation or inundation), as are necessary to *delineate* wetlands on the ground. Federal agencies with responsibility for wetland programmes did not explicitly develop rules or manuals for wetland delineation until 1987. Since then, reaction to varying degrees of inclusion or exclusion and to varying requirements for direct evidence of wetland characteristics resulted in a dialectic series of proposed manuals, rather than a smooth evolution toward agreed standards. Differences between delineation manuals used by different agencies led to the development of an inter-agency manual in 1989, but controversy over exact delineation criteria resulted in another attempt in 1991 that also failed to find consensus. This led to a National Research Council study of wetland delineation and a retreat to earlier manuals.

Field tests of the 1991 and 1989 delineation manuals by Federal, joint Federal and State, and State field teams under a variety of conditions indicated that 30 to 80 per cent of land delineated as wetlands in the 1989 manual were excluded by the 1991 manual (EDF/WWF, 1992). Areas that would have been excluded by the latter include cottonwood and willow wetlands in riparian areas of the Rocky Mountains and Southwest, most bogs in the Northeast and Midwest, and many prairie potholes in the Dakotas. Also excluded would be high coastal marsh along the Pacific coast, some of the remaining private wetlands surrounding the Florida Everglades National Park, and as much as 80 per cent of the Great Dismal Swamp in Virginia and North Carolina. Similar results were obtained in comparisons of the 1987 USACE manual and changes proposed to the CWA in 1995 (National Wetlands Newsletter, 1995).

Wetland definitions and delineation criteria for programme purposes also differ from definitions and criteria used for scientific inventories (NRC, 1995; Cowardin, et al, 1979). Estimates of national and regional wetland acreage and wetland losses and gains are based on scientific definitions (Frayer, et al, 1983; Dahl and Johnson, 1991). Programmatic or jurisdictional wetlands are not comprehensively inventoried, but are delineated by USACE, USDA, or contractor technicians if and when permit or other regulatory action is pending. Although general writing treats “wetlands” as a homogeneous class of lands, the reality is a diverse set of landscapes with different hydrology, vegetation, and soil substrates that provide a widely varying set of natural functions (NRC, 1995; Cowardin, et al, 1979; Tiner, 1996).

Information About Economic Aspects: Wetland Values

There are bioeconomic linkages among wetland functions, services generated by those functions, and socially-valued outcomes. A wetland performs a biologic, hydrologic, or geologic function that produces a good or supports an ecological service. Some wetlands perform many such functions, but some may perform only one or none. Many of the services provided are joint products, provided simultaneously in varying degrees by the same wetland function, based on the quality and characteristics of the wetland. Human populations value the flows of goods and services produced by natural wetlands, some of which are traded in markets. Estimates from available economic studies of wetland valuation from the US and abroad are collected, organised, and summarised in Table 5. Although the values vary greatly, even within a category, some useful generalisations are possible.

Values for marketed goods[5] from wetlands, including fish and shellfish, are generally lower than values for non-marketed goods from wetlands. Values per acre elicited from people who do not use the wetland directly are generally higher than values elicited from wetland users. This is complicated by

5 This does not include the values of marketed goods that might be produced by draining or filling a wetland

certain nationally or internationally known wetlands (Florida's Everglades or Virginia's Great Dismal Swamp) that may have non-use values for persons thousands of miles away. The range in values shown, even within specific functional categories, arises partly from the range in wetland characteristics that are almost unique from wetland to wetland. More importantly, variation arises from the social and economic context within which the valuation studies were conducted. That is, identical wetlands, providing identical functions and services, will be less valued in remote, isolated areas surrounded by other similar wetlands than in densely populated areas with few remaining wetlands.

Values of ecological services based on replacement costs of artificially supplied alternatives can be large. In reality, areas undergoing wetland conversion often forego the services once provided by natural wetlands, risking increased flood damages and enduring periodic water shortages and reduced water quality. Economic valuation techniques attempt to estimate the marginal value of small losses or gains of wetlands. However, even within a given wetland complex, differences in hydrologic and landscape position mean that some wetland acres are more critical in providing functions and services than others. Conversion of these key wetlands can result in discontinuous changes that drastically affect the functions and services provided by the remaining wetlands. Threshold effects create other complications in which incremental conversion of wetlands causes no discernible diminution of services until a threshold is reached, dropping function and service flows to near zero. Examples include effects on flood storage and nutrient filtering dependent on discharge stage and minimum habitat size, shape, and connectedness requirements for fish and wildlife species.

The array of values displayed in Table 5 is impressive and clearly indicates that wetlands are valued resources. However, little of this information has been incorporated into policy-making, or even routinely into deliberations on wetland permits or potential restoration sites. In general, US wetland programmes are run without much reference to wetland valuation, relying on the professional judgements of scientists and technicians running the programmes. Where compensation is required or where permits may affect asset values, market appraisals of the land may inform decisions.

Table 5. **Economic values of wetland functions**

Wetland function valued	**Number of studies**	**Median**	**Mean**	**Range of means**
			Dollars per acre	
Marketed goods				
Fish and shellfish support	8	$702	$6 132	$7-$43 928
Fur bearing animals	2	na	$137	$13-$261
Non-marketed goods				
General-nonusers	12	$32 903	$83 159	$115-$347 548
General-users	6	$623	$2 512	$105-$9 859
Fishing-users	7	$362	$6 571	$95-$28 845
Hunting-users	11	$1 031	$1 019	$18-$3 101
Recreation-users	8	$244	$1 139	$91-$4 287
Ecological functions	17	$2 428	$32 149	$1-$200 994
Amenity and cultural	4	$448	$2 722	$83-$9 910

Source: Heimlich, et al., 1997a.

Policy analysts and decision makers are interested in using existing valuation studies to estimate benefits in other areas, a method called benefits transfer (Scodari, 1990). This compilation of values illustrates several limitations on possibilities for benefits transfer. First, wetland values in the interior of the US and in agricultural areas generally are largely missing from the literature. Second, other than for users of fish and wildlife habitat services, most other functional categories are poorly represented. Third, there may be little opportunity to adjust wetland valuation estimates for differences in landscape and socio-economic context. Finally, the geographic scope over which benefit estimates can be extrapolated is unclear, despite its critical role in determining the total and per acre level of benefits, particularly from non-users.

A much more comprehensive, consistent, and systematic effort will be needed to produce valuation estimates that could form the basis of a realistic benefits transfer scheme that could be used in wetlands programmes. A similar assessment was reached by Paul Scodari, who concluded that "even the very best of the wetland value estimates produced to date do not shed much light on the welfare implications of wetland conversions beyond the specific wetland areas studied." (Scodari, 1997, p. 76). Although greater use of economics could improve estimates of private benefits subject to wetland regulation in specific cases, it is unlikely that economic valuation estimates could be deployed rapidly enough and with sufficient sensitivity to usefully inform cost/benefit considerations for any but the largest wetland conversion proposals.

5.4 Framework and context of implementation

The legal framework for land ownership in the United States consists of a "bundle of rights", not all of which are necessarily held by an individual landowner. Society generally reserves certain rights in each parcel of land, including the rights of eminent domain (the right to take property for public use, with compensation) and police power (the right to prevent actions that harm others). The appropriate balance between these rights and the rights of individual landowners is the subject of considerable debate.

The rights of private landowners are protected by the Fifth Amendment to the Constitution, which states that private property shall not be taken for public use without just compensation. In addition, the Fourteenth Amendment states that no State shall deprive any person of property without due process of law. However, in 1922 the Supreme Court ruled that regulations restricting land use might constitute takings as well, if they went "too far"(Pennsylvania Coal Co. v. Mahon, 260 US 393, 415-416). Just how far is "too far" has been debated ever since, although the courts have generally held that a landowner must suffer near-complete loss of the economic use of an entire property before a regulation is judged to be a taking.

According to the Congressional Research Service, of 135 federal takings cases between 1990 and 1994, only 21 were found to be takings (Meltz, 1995). The ratio is similar with respect to wetlands cases. As of 31 May 1993, only 28 cases involving takings claims had been filed with the US Court of Federal Claims as a result of regulatory actions under the CWA's Section 404 permit programme (GAO, 1993). Ten of these cases were decided in favour of the federal government, 3 were determined to involve takings, 1 was settled before a decision was rendered, and 14 were still pending as of 31 May 1993. Since 1993, over 30 new takings cases have been filed against the federal government under the 404 programme (Rugiel, 1996). Five additional cases have been decided to date, only one of which was found to involve a taking (Meltz, 1994, 1995, and 1997).

Advocates of property rights reform have pressed Congress for legislation requiring compensation whenever Federal actions – particularly those restricting the conversion of wetlands and

endangered species habitat – diminish property values by more than a threshold percentage. There have been several attempts to repeal or severely restrict the scope of Swampbuster and other wetland provisions (Heimlich, et al, 1997b; Zinn and Copeland, 1996). Section 404 survived Clean Water Act reauthorisation legislation in 1977 and 1987. In 1989-92, the Bush administration considered proposals to change delineation procedures in order to substantially limit Section 404's scope, but these changes were not adopted. Legislative changes to Section 404 were passed by the House of Representatives in 1995, but were not sustained in the Senate. Similarly, several proposals to eliminate or revise Swampbuster provisions were considered in the 1990 and 1996 omnibus farm legislation debates, but were not enacted.

State governments have had a major role in wetland conversion since colonial times. State policies concerning wetlands followed an evolution similar to that of Federal policies, moving from exploitation to conservation as remaining wetlands disappeared and wetland functions and values became appreciated. Beginning with Massachusetts in 1963, state legislatures passed regulations governing the circumstances under which wetlands could be drained, dredged, or otherwise converted (Council on Environmental Quality, 1978, p. 53). Other states followed, particularly after passage of Section 404 in 1972. By 1978, 15 states had legislation specifically regulating wetlands. As of 1984, OTA found that all 30 coastal states (including the Great Lakes states) had programmes that directly or indirectly regulated coastal wetlands, although usually not inland wetlands (OTA, 1984, Chapter 9).

The Association of State Wetland Managers identified key issues and trends in state wetland programme adoption (Kusler, et al., 1994). Currently, 44 states have wetland statutes or laws, including 18 that regulate both coastal and freshwater wetlands, 7 that regulate only coastal wetlands, and 4 that regulate coastal and part of their freshwater wetlands. Forty-six relate wetland policies to water quality policies, such as CWA Section 401 water quality certification programmes or other state water quality standards. Forty-six states have wetland definitions that are comparable with those used in Federal programmes. However, enforcement of these policies is less widespread: 40 have staffing for their programmes, 33 track and enforce wetland permits, and only 26 states have penalties for violation of their wetland laws.

A US Geological Survey report shows important federal, state and private organisational ties in state programmes (USGS, 1996). Participation by state agencies in wetland-related management, regulation, restoration and creation, and delineation and inventory is detailed. More difficult to obtain is insight as to what powers of co-ordination are exercised and what financial resources are available to carry out concerted programmes with Federal agencies and, within the state, with local governments. One of the most important avenues for State involvement in wetlands policy is through joint participation with Federal agencies, particularly with USACE related to Section 404.

Sections 404(g) and (h) of the Clean Water Act give states the authority to assume administration of the Section 404 programme in lieu of USACE where the states have, among other things, instituted wetland permitting programmes that are at least as stringent as the federal wetlands programme. To date, only two states - Michigan and New Jersey - have assumed responsibility for the Section 404 programme. States may take responsibility for parts of the Section 404 programme without assuming complete responsibility. Twenty-one states have investigated assuming some Section 404 powers in operating their own regulatory programmes, and 13 have carried out detailed technical reviews.

States can also participate in federal wetlands permitting by exercising their authority under CWA Section 401 to grant or deny water quality certification for individual or general federal Section 404 permits (Kusler, 1994, p. 45). States adopt surface water quality standards and wetlands water quality standards to protect their waters, and are free to make these standards as stringent as they wish. States

may place conditions on any Section 404 permit that fails to meet state water quality standards, exercising effective veto power over most permit applications.

Finally, some states participate in federal wetlands regulation through state programme general permits (SPGPs; Kusler, 1994, p.50). The CWA does not specifically authorise USACE to issue SPGPs. However, USACE relies upon its general permit authority in Section 404(e) to issue state-wide permits that are "piggy-backed" onto the existing state wetlands permitting programmes. USACE has also issued programmatic permits on a local basis. At present, USACE has issued approximately 60 SPGPs and local programmatic permits, including permits in New Hampshire, Maine, Wisconsin, North Carolina, and Maryland.

6. POLICY RELEVANT CONCLUSIONS

Lessons Learned

The yardstick against which recent US policy has been judged is the “no net loss” of wetlands goal, first enunciated by President Bush in 1989 and reiterated in President Clinton’s 1993 wetland plan. The antecedent of the "no net loss" goal in Federal wetlands policy was the National Wetland Policy Forum:

> *Although calling for a stable and eventually increasing inventory of wetlands, the goal does not imply that individual wetlands will in every instance be untouchable or that the “no net loss” standard should be applied on an individual permit basis – only that the nation's overall wetlands base reach equilibrium between losses and gains in the short run and increase in the long term. The public must share with the private sector the cost of restoring and creating wetlands to achieve this goal.* (Conservation Foundation, 1988)

Progress toward the “no net loss” goal has been rapid. Estimates from 1974-84 and 1982-92 show that wetland conversions, particularly to agricultural uses, have been reduced. Added to these more recent trends, since 1992, wetlands that have been drained are now being restored by federal, state, and private programmes. On the basis of partial data, Tolman (1997) claims that wetland restoration in 1994 exceeded the rate of wetland conversion. Problems in accounting for restoration activity make it difficult to confirm Tolman’s assertion, but there is little doubt that the United States is moving closer toward “no net loss”, at least in acreage terms.

What remains unclear is whether either the low rate of gross wetland conversion, the high rate of wetland restoration, or both, can be sustained over the long term. Improvements in the agricultural and non-agricultural economy, proposals to exempt wetlands from current conservation and regulatory programmes, phasing out of farm programme benefits that motivate the Swampbuster provisions, and continuing budgeting issues could increase wetland conversion from the low rates observed in 1982-92, reduce restoration activity, or both. These actions would move the US away from the “no net loss” target.

Four lessons can be learned from wetland policy development in the US:

First, public sentiment for wetlands conservation moves through stages of exploitation, preservation, and restoration based on the relative scarcity of wetlands and needs for economic development. Evolution of these public attitudes can perhaps be hastened by education and dissemination

of scientific knowledge about the functions and values of wetlands, but there must also be sufficient alternative opportunities for development to spare wetlands.

Second, a variety of approaches to wetland conservation, ranging from direct regulation by individual permits, through nation-wide general permits, to voluntary economic incentives for conservation and restoration, may be needed to deal with the variety of conversion pressures and their differing physical, cultural, and institutional setting. The variety of mechanisms employed in US wetland policy allows for flexibility in meeting landowners' needs and situations and provides a measured and appropriate response to impacts with differing extents and significance.

Third, each type of policy approach is costly in its own way. Whether their costs are chiefly political and legal (e.g. Section 404 regulation), or financial (e.g. easement purchase in WRP), some mix of these public costs is unavoidable in correcting a market failure.

Fourth, existing subsidy programmes for agricultural and other activities may be recast to offer significant leverage for environmental performance in the service of biodiversity conservation. Changes in the design of US agricultural price and income support payments converted an indirect incentive for agricultural wetland conversion into a powerful incentive for wetland conservation.

Transferability of the Experience

United States experience may well offer a guide for wetland policies in other countries, in large part because almost all approaches to wetland conservation have been tried in the US. The usefulness of US experience is likely to differ greatly, however, for developed and developing countries. Obviously, most of the US efforts could be relevant for other OECD countries, especially those with well-developed agricultural sectors with a history of environmentally "perverse" incentives.

Heavy subsidies for agriculture are common in many OECD Member countries. However, countries with less advanced agricultural sectors – as found in some OECD countries with low subsidy levels – may not be able to implement similar policy changes. Many developing countries lack minimum institutional requirements for implementing positive incentives (e.g. political support, financial resources, or the ability to monitor and enforce complex property transactions over time). Elimination of indirect negative incentives may not be possible if they are informal or *ad hoc* arrangements by governments in power, not institutionalised as procedures subject to processes of reform.

Nonetheless, direct regulations, such as Section 404, and policies denying government support for wetland conversion, similar to Executive Order 11990, could be used by many countries within and outside of OECD. The evolution of public sentiment regarding wetlands in the US may be particularly instructive for developing countries. Knowledge of the US conversion of wetlands for development, combined with current scientific knowledge of wetlands benefits, can help guide development policies that will be sustainable and will conserve valuable wetland resources that would be better spared from development.

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OECD Case Studies on the Design and Implementation of Incentive Measures for the Conservation and Sustainable Use of Biodiversity

All case studies are available on the OECD Internet Site at http://www.oecd.org.

Country	Case study title
Australia	A Revolving Fund for Biodiversity Conservation in Australia
Austria	Austrian Case Study on Economic Incentive Measures in the Creation of the National Park Neusiedler See - Seewinkel: Summary
Austria	The Austrian Programme on Environmentally Sound and Sustainable Agriculture: Experiences and Consequences of Sustainable Use of Biodiversity in Austrian Agriculture
Canada	Revealing the Economic Value of Biodiversity: A New Incentive Measure to Conserve and Protect It
Canada	Using the Income Tax Act of Canada to Promote Biodiversity and Sensitive Lands Conservation
Denmark	Economic Incentives for the Transformation of Privately Cultivated Forest Areas into Strict (Untouched) Forest Reserves
Finland	The Act of the Financing of Sustainable Forestry and the Development of Forest Certification
France	A Cost-Benefit Analysis of Biodiversity Conservation Programmes in the Garonne Valley
Germany	UNESCO Biosphere Reserves Schorfheide-Chorin and Rhön
Greece	Incentives for the Conservation of the Nesting Grounds of the Sea Turtle *Caretta caretta* in Laganas Bay, Zakynthos, Greece
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