CHAPTER 4
AFFECTED ENVIRONMENT

Affected Environment—The environmental impact statement shall succinctly describe the area(s) to be affected or created by the alternatives under consideration. (40 CFR 1502.15)

4.1 Introduction

This chapter describes the characteristics of aquatic ecosystems, including wetlands, affected or created as a consequence of Corps-administered permit decisions for discharges of dredge and fill material into waters of the United States and structures in navigable waters. The introduction summarizes the environmental reach and intent of the Corps permit program and the ways that the environment is classified and delineated. Following the introduction, the chapter is divided into four sections: one each on the area, the functions, and the community services and values of the impacted environment, and a final section on cumulative effects. The description of the affected environment pertains to all permit types, but with greatest attention paid to nationwide permits.

4.1.1 Program Intents With Respect To The Affected Environment

The Corps permit program is an important element of the Clean Water Act, which has as its goal, "the restoration of the physical, chemical and biological integrity of the Nation's waters." The Corps permit process is driven by the objectives of the Clean Water Act and other Federal laws. Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbor Act of 1899 are the primary regulatory authorities of the Corps. The Clean Water Act opened non-Federal jurisdiction to the National Environmental Policy Act process. Compliance with the National Environmental Policy Act, Endangered Species Act, and other Federal, state and local laws affect the Corps permit process. Compliance with related laws is described in Chapter 2. Other relevant aspects of Corps authority and management goals are summarized in Appendix C.1.

Corps and U.S. Environmental Protection Agency implementation of the Clean Water Act and associated compliance with the Endangered Species Act and other laws greatly reduces costly environmental impacts associated with the Nation's waters, including wetlands. By placing high value on water resources and endangered species through protective policy these laws guide land and water resource development toward significantly reduced environmental impacts on aquatic resources. The areas described here emphasize the Nation's waters, including wetlands, because the intent of the Corps permit program is to minimize impacts on the geographical area, functions and values of aquatic ecosystems.

Among the Nation's waters, the Clean Water Act identifies special aquatic sites for especially careful attention, including sanctuaries and refuges, wetlands, mud flats, vegetated shallows, coral reefs, and pool and riffle complexes. Wetlands stand out because of additional legislative and administrative attention. Section 307 of the Water Resources Development Act of 1990 sets an interim goal for Corps wetland policy of "no overall loss of the Nation's remaining wetlands base, as defined by acreage and function," and a long term goal "to increase the quality and quantity of the Nation's wetlands, as defined by acreage and function." "Wetland" is the only ecosystem category directly impacted by the permit program that has been identified by Federal administrative order for maintenance under a goal of no overall net loss of function and value. A no overall net loss goal attainment meant establishing an equilibrium between losses and gains nationally. Both the George H. W. Bush and the Clinton administrations adopted this policy goal (White House 1991; 1993) soon after the Congressional mandate in 1990. Because of their unique no overall net loss status, the Corps regulatory program keeps the most complete database for wetland impacts.

The way the policy of no overall net loss of wetlands is carried out is an important determinant of net environmental impact because wetlands make up such a large fraction of the water resources impacted by the Corps permit program. The Corps regulatory policy is to comply programmatically with the "no overall loss" goal; not on a case-by-case basis. The Corps now relies heavily on compensatory mitigation to offset unavoidable wetland losses that result from activities authorized by Corps permits. However, compensatory mitigation became significant relatively recently and has yet to realize its full effect because of lags in compensatory replacement of lost ecosystem structure and function. Compensatory mitigation also is increasingly required for some impacts to open waters, such as for impact to streams.

The Corps permit process seeks to eliminate unnecessary negative impact to the Nation's waters by minimizing total negative impact on all environments and diverting unavoidable negative impact to locations of lower functional value, including some terrestrial locations. Under the Clean Water Act, impact avoidance mitigation typically translates into protecting aquatic ecosystems at some cost associated with functional degradation of natural terrestrial ecosystems. This results because water is more of a public resource than land is and laws protective of terrestrial ecosystems are not nearly as comparable in inclusiveness to the Clean Water Act.

The Corps regulatory program has avoided difficult and costly measurement of functions and values. Instead, it has focused on delineating the boundaries of aquatic ecosystems based on changes in ecological structure and measuring the acreage unavoidably impacted and mitigated "in kind" (similar ecological structure). Because structure and function usually are closely associated, functions are assumed to be replaced with in-kind replacement of structure. Similarly, value is assumed to be defined by structure and function. The degree to which these assumptions are met has much to do with determining the impact of the permit program alternatives. Terrestrial systems comprise over 93% of the conterminous United States and most are abundant compared to aquatic ecosystems, which make up the remainder (Dahl 2000). Because of this focus on water and other public resources, the Corps record of regulatory impact does not include acreage of terrestrial impact incurred on private lands.

Of course, some terrestrial systems exhibit natural functions of superlative value, usually indicated by protective legislation. In those cases, terrestrial impacts are avoided through compliance with provisions of the Endangered Species Act, Clean Water Act, the National

Historic Preservation Act, and other Federal laws—conditions that must be satisfied to obtain a Corps permit. Through those laws, the Corps permit process encourages protection of certain important terrestrial resources, such as critical habitat for endangered species, public sanctuaries and other public holdings. To a practicable degree (limited by knowledge, economic forces and other social considerations) the permit process also encourages mitigating impacts on those marginal terrestrial ecosystems immediately adjacent to aquatic ecosystems that provide a protective buffer for the natural functions underlying aquatic ecosystem services.

The Corps permit process has become integrated into private and public resource development planning processes. Ideally, it guides development planning to direct impacts away from alternatives that infringe upon the public interests to alternatives that confine impacts to the private realm while minimizing costs to both private and public interests. Evaluating alternatives for optimally protecting both public and private interests, including minimization of environmental impacts, requires an assessment of affected geographical areas, ecological functions, environmental services and environmental values, as well as private and public community costs.

Because it is designed to reduce impacts to the Nation's waters, the Corps permit program has positive impacts on the environment of aquatic ecosystems for the most part. While local impact minimization is essential, some local impacts are unavoidable and can have significant cumulative effects if not offset through compensatory mitigation. The emphasis here is on the cumulative impacts resulting from all mitigation efforts extended under the Corps permit program. Without permit requirements, private development would be significantly less motivated to mitigate negative effects to significant natural service values in the national interest when their activities have no net negative impact on their own interests.

Undoubtedly, more losses of area and valued aquatic functions would have occurred without passage of the Clean Water Act. Exactly how much more is not easily documented. Even so, there is always room for some Corps program improvement and some possibilities are identified here.

4.1.2 Classifying The Nation's Waters

The affected environment is described here using the widely accepted classification scheme of Cowardin et al. (1979). It places virtually all of the Nation's waters into habitat categories, each with unique functions, including many waters occupying artificial basins and channels. It is the classification basis for the U. S. Fish and Wildlife Service's National Wetland Inventory, which is the major source of information about cumulative wetland impacts. Since 1997, all Corps regulatory data for nationwide permit activities have been classified by this approach at the level of aquatic systems, which include palustrine, riverine, lacustrine, estuarine and marine systems. For standard permits, letters of permission, and regional general permits, Corps districts are not required to track the Cowardin systems that are impacted by activities authorized by those permits.

The Cowardin et al. (1979) system designation in the Corps database is the sole indicator of ecological function of areas impacted by activities authorized by nationwide permits. Wetlands exist as classes in each of the five systems of the Cowardin et al. (1979) classification. Each class exhibits different functions and provides different human services important for determining environmental impact. Whereas the palustrine system contains several wetland classes, each of the other systems have wetland classes that make up small but functionally important fractions of those systems.

Consistency and precision are important aspects of determining cumulative impacts based on available information, which is categorized by system, subsystems and classes. Corps districts inconsistently categorize by subsystem or class, but differentiate Corps-defined wetlands from other aquatic ecosystems (i.e., other waters, such as streams, lakes, ponds, and playas). Because different wetland subsystems or classes function differently, the coarseness of classification in Corps databases limits assessment of changes in ecosystem function through cumulative impacts, including possible differential mitigation effectiveness (see Appendix C.3 for identified needed information that is now absent from the Corps database).

Cowardin et al. (1979) and Corps-defined wetlands do not match exactly. A large subset of the Cowardin et al. (1979) wetland classes meets Corps criteria for wetlands defined in the Corps regulations. The difference derives from the separation by the Clean Water Act of areas categorized as wetland by Cowardin et al. (1979) into special aquatic sites, which differentiate wetlands from other areas that would be classified as such by Cowardin et al (1979). The special aquatic sites identified as different from wetlands in EPA rules and regulations (Federal Register 1980) are mudflats and vegetated shallows. The Corps-defined wetland is restricted to areas with emergent vegetation and excludes mudflats and permanently flooded areas with submerged vegetation, such as ponds. The resulting difference in area is about 6% more than the area that qualifies as Corps defined wetlands. It includes mostly ponds, mudflats and sandbars. Tiner (1999) also provides a comprehensive review of wetland definition, classification and delineation. Delineation differences are described in more detail in Appendix C.2. Probable delineation errors for Corps data are described in Appendix C.3.

4.2 Impacted Geographical Area

4.2.1 Classifying the Impacted Environments

To remain consistent with Corps, U. S. Fish and Wildlife Service, and other agency classification of waters, we describe the affected environment using the Cowardin et al. (1979) classification. More detailed descriptions of the Cowardin et al. (1979) system attributes used for determining geographical boundaries and areas, general functions, and natural services are provided in Appendix C.4. The *palustrine* system includes the largest reported area in acres directly impacted by discharges of dredge and fill material. It includes inland wetlands in permanently and periodically flooded waters dominated by persistent woody or non-woody plants in areas where ocean-derived salinity is below 0.5 ppt (500 mg/liter). While often referred to as freshwater wetlands, a small fraction attains quite high salinity in arid areas.

Most of the remaining area directly impacted under the nationwide permit type is in the *riverine* system. It includes all channeled deep waters and wetlands except where ocean-derived salinities exceed 0.5 ppt (500 mg/liter) and wetlands are dominated by persistent, emergent non-woody, or woody plants.

Minor direct impact of nationwide permits occurs in the *lacustrine* system. It occurs in naturally or artificially inundated basins that are virtually uninfluenced by oceanic salinity (up to 0.5 ppt) and have no more than 30% coverage by persistent, emergent, woody or non-woody vegetation.

Little direct impact occurs under the nationwide permits in the *estuarine* system. It is transitional and tidal, existing in drowned river mouths and lagoons between non-tidal inland waters and marine-system environments. Salinities are typically between 0.5 and 35 ppt, but may exceed 35 ppt in certain semiarid or arid estuaries.

Least impacted under the nationwide permits is the *marine* system, which includes ocean extending from high-tide coastline and estuaries out to the edge of the continental shelf. Most program impact is close to shore. Salinity is about 35 ppt.

4.2.2 Pre-program Historic Impacts

The Nation's waters have undergone significant and extensive change through human-caused impacts. Lacustrine systems have increased markedly as a consequence of reservoir construction. As a consequence, thousands of riverine miles have undergone conversion to lake systems and thousands more have been confined in artificial channels and levees. Estuarine and marine systems have changed relatively little in total area compared to other aquatic systems. None of the Nation's waters have undergone more conversion to other use through filling and draining than wetlands, which in FY 1998 accounted for about 80% of Corps permitted impacts.

Table 4.2-1 summarizes estimates of historical wetland acreage in the contiguous United States based on the classification of Cowardin et al. (1979) and the National Wetland Inventory conducted by the U. S. Fish and Wildlife Service. Over the past several decades annual rates of wetland conversion have been estimated from photography and land-use studies conducted under aegis of the U. S. Fish and Wildlife Service (e.g., Frayer et al 1983, Dahl and Johnson 1991, Dahl 2000). Additional study has been conducted by the Department of Agriculture (e.g., Heimlich et al. 1998 and NRCS 2000). The different estimated rates of change are based on the same databases, but with different assumptions and interpretations (Heimlich et al. 1998). While improved over the estimates of change before 1954, highly precise national estimates remain elusive because of methodological limitations (Heimlich et al. 1998). The U.S. General Accounting Office (1998) concluded in a report to the U. S. Senate that: "The consistency and reliability of wetlands acreage data reported by Federal agencies are questionable….Consequently, a single set of wetlands acreage numbers that could be used to evaluate progress made in achieving the goal of "no net loss" of the nation's remaining wetlands is not available." More recently, differences between the agencies have been minimized (Dahl 2000 and NRCS 2000).

Despite differences in study results, the data in Table 4.2-1 reveal that the wetlands were converted to other use at a very high rate before the 1950s. Wetland loss rate has progressively decreased since then because conversion to other land and water use has slowed and conversion to wetland use has increased. Recent methods have relied mostly on aerial photography with limited on-site sampling. The differences in estimates for the same periods in 1954 and 1974 result primarily from differences in wetland definition and delineation, geographical scope of sampling (e.g., sample sizes and whether Federal wetlands were included), available survey materials, and technical experience (Heimlich et al 1998). Despite differences in wetland inventory estimates, the estimated recent rate of wetland loss differs little. The most recent estimates indicate about 50 to 55% of the wetland acreage existing in 1780 remain in the conterminous United States (Dahl 2000 and NRCS 2000).

The estimated loss rate in the United States in the period before 1954 averaged 814,000 to 887,000 acres annually (Dahl 1990, Heimlich et al. 1998). Even so, net wetland loss rate has decreased at an increasing rate over the past few decades since 1954 and the Nation now appears to be approaching a no overall net loss goal. From 1954-74, the estimated net loss rate was nearly halved from the estimated loss rate before 1954 to about 458,000 acres annually (Dahl 1990, 2000). This decrease was owed in large part to creation and restoration of an estimated 272,000 acres annually. Of the estimated 730,000 acres lost annually in 1974, over 80% was associated with agriculture. From 1974-82, the estimated net loss fell to 63% of what it was in 1954-74, or 290,000 acres lost annually. At that time about half of the net loss of wetlands was associated with agriculture and the remainder was associated with urban development, deepwater management, and other sources. In 1982-92, Heimlich et al. (1998) estimated that the average net loss decreased to about 27% (to about 78,000 acres) of what it had been the previous decade and to about 10% of the rate before 1954. This dramatic decrease was associated with protective and restorative state and Federal legislation, prominently including the Clean Water Act of 1972 and 1977 and the Food Security Act of 1985 ("Swampbuster" provision).

Table 4.2-1. Estimates of total wetland area in the conterminous United States (excluding Alaska and Hawaii) for different periods.

Date	Area (Million Acres)	Reference
Presettlement	215	USDA in Dahl (1990)
Presettlement	224	Dahl (1990)
1922	92.5	Gray et al. (1923)
1954	109.5	Frayer et al. (1983)
1954	125.8-136.4	Heimlich et al. (1998)
1974	100.3	Tiner (1984)
1974	116.7-127.3	Heimlich et al. (1998)
mid 1970s	107.0	Dahl and Johnson (1991)
mid-1980s	104.5	Dahl and Johnson (1991)
1987	106.1	Dahl (2000)
1992	113.3-123.9	Heimlich et al. (1998)
1997	105.5	Dahl (2000)

4.2.3 Recent History

Table 4.2-2 summarizes recent inventories for water resources and their rate of change for the conterminous United States from data reported by Dahl (2000). Data for Alaska would about double wetland estimates, but relatively little change has occurred there. Totals for Hawaii are small and would affect these data little. In 1997 a total of 144.7 million acres of wetland, river, lake, estuary and marine habitat were estimated for the conterminous United States. This was a decrease of almost 536,500 acres (0.6%) over the previous 11 years because of conversion to land uses. Of the total in 1997, nearly three fourths (73.2%), about 105.5 million acres, was wetland according to the Cowardin et al. (1979) classification and nearly 99 million acres (68.6%) was Corps-defined wetland. The difference between Cowardin et al (1979) and Corps-defined wetland was mostly area in shallow ponds (about 5.9 million acres in 1997), which are included among wetlands by Cowardin et al. (1979). Of the water surface other than wetlands, rivers comprised about 6.3 million acres (4.3%), lakes comprised over 14.7 million acres (10.2%), open-water estuaries comprised over 18 million acres (12.7%), and intertidal marine area was about 0.13 million acres (0.09%).

Table 4.2-2. Summary of acres and change in acreage of water resources estimated for the conterminous United States by the U. S. Fish and Wildlife Service for 1985-1997 (Dahl 2000). Categories follow the classification of Cowardin et al. (1979) and may distribute acreages slightly differently between tidal and nontidal waters. Corps-defined wetlands are approximated based on vegetation and intertidal criteria. Emergent palustrine wetlands include riverine and lacustrine fringe wetlands. The Great Lakes are excluded from lacustrine system data.

Aquatic Habitat Category	Estimated Acres, 1986 (1000s)	Estimated Acres, 1997 (1000s)	Acres Change (1000s)	Acres Change/Year (1000s)	Acreage % change 1986-1997
Palustrine	100,799.1	100,165.5	-633.6	-57.6	-0.6
Corps-defined Wetland	95,548.1	94,251.2	-1,296.9	-117.9	-1.4
Emergent	26,383.3	25,157.1	-1,226.2	-111.5	-4.9
Forested	51,929.6	50,728.5	-1,201.1	-109.2	-2.4
Shrub	17,235.2	18,365.6	1,130.4	102.8	6.2
Other waters	5,251.0	5,914.3	663.3	60.3	11.2
Riverine (other waters)	6,291.1	6,255.9	-35.2	-3.2	-0.6
Lacustrine (other waters)	14,608.9	14,725.3	116.4	10.6	0.8
Estuarine	22,841.1	22,859.2	18.1	1.6	0.1
Corps-defined wetland	4,623.1	4,615.2	-7.9	-0.7	-0.2
Other waters	18,218.0	18,244.0	26.0	2.4	0.1
Intertidal	580.4	580.1	-0.3	-0.03	-0.1
Subtidal	17,637.6	17,663.9	26.3	2.4	0.1
Marine Intertidal	133.1	130.9	-2.2	-0.2	-1.7
Total Corps-defined Wetland	100,171.2	98,866.4	-1,304.8	-118.6	-1.3
Total FWS defined Wetland	106,135.7	105,491.7	-644.0	-58.5	-0.6
Total Water Resource	144,673.3	144,136.8	-536.5	-48.8	-0.4

Of the wetland total, as defined by the U.S. Fish and Wildlife Service and Cowardin et al. (1979), 4.9% was intertidal estuarine wetland and the remaining 95.1% was palustrine, lacustrine and riverine wetlands (because techniques do not allow sorting, palustrine estimates include riverine and lacustrine wetlands). About 21% of estuary area is vegetated, intertidal wetland. Of the total wetland area in the conterminous United States defined as wetland under Corps regulations, 4.7% is vegetated intertidal estuarine wetland and 95.3% is palustrine wetland. The fraction of lake and river surface that was fringe wetland probably was less than 10% and probably less than about 3% of the total wetland. Palustrine wetlands dominate the total in the conterminous United States, with over 90%. Of that, most is wooded wetland in forested and scrub-shrub categories (about 69 million acres) and the rest is emergent herbaceous wetlands (about 25 million acres) and ponds (about 5.5 million acres according to Dahl 2000).

During the 11 years from 1985-1997, Corps-defined wetlands decreased 1.3% in acreage, a faster rate than the 0.6% decrease of wetlands as defined by Cowardin et al. (1979) because pond wetland area increased 12.6%. Lake area also increased, but at a slower rate (0.8%). Riverine systems decreased 0.6%, partly because of lake and pond construction. Subtidal estuary area also increased a small amount (0.1%) and total estuary area remained nearly constant.

Vegetated estuarine wetlands decreased a very small fraction (0.2%). Excluding ponds, the palustrine, riverine and lacustrine wetlands decreased 1.4%. Of the total, emergent herbaceous wetland decreased the most (4.9%), followed by forested wetland (2.4%). Scrub-shrub wetland increased by 6.2% reflecting in part conversion of forested wetland to earlier plant succession stages. There was a very small net loss of wooded wetland during 1986-97. The dynamics of palustrine wetlands are complex. Plant succession and human-caused setbacks in plant succession to earlier stages combine to transfer acreage between palustrine classes. Losses of herbaceous emergent wetland in part result in greater scrub-shrub wetland and the slowing of forested wetland loss in recent years results in part from the maturation of shrub-scrub wetland. Dahl (2000) discusses these changes in detail.

Dahl (2000) estimated that the rate of wetland loss over the 11 years preceding and including 1997 had decreased to an average of 58,500 acres annually. This was a decrease of 80 percent from the previous decade. For the last half of that period, from 1992 through 1997, the NRCS (2000) estimated a net loss of 32,600 acres (including all restoration and creation of wetland as well as all loss), indicating a continuing rate of decrease in loss of wetland area and approaching a no overall net loss goal. Most wetland loss occurred in the Southeast.

Interpretations of the source of changes in wetland area differ somewhat in part because of different time periods examined, but are generally consistent. Dahl (2000) estimated that wetlands converted to land use were a result of 30% urban development, 21% rural development, 23% silviculture, and 26% agriculture. NRCS (2000) found nearly the same total development, less silvicultural conversion and more miscellaneous sources of change. These results have implications for the Corps permit program, which is most associated with development. Based on the most recent NRCS (2000) estimate, about 16,600 acres were lost to development impacts, amounting to 51% of the 32,600 acres of net annual wetland loss.

4.2.4 Corps Permit Impacts In Fiscal Year 1998

The data for the entire Corps program, including all permit types, vary in quality and comprehensiveness. Even so, data on the distribution of acres impacted in wetlands and in other aquatic habitats within each of the four permit types was critical for the analysis of program impacts and comparison to alternative approaches. All available data were used with reservations described in the main body of the report, in Appendix C and elsewhere in the appendices.

A recent representative year, Fiscal Year (FY) 1998, was chosen for analytical emphasis. The FY 1998 data are believed to be generally representative of the mid to late 1990s (see Figure 4.2-1, which presents estimates of permitted wetland acreage and compensatory mitigation acreage for Fiscal Years 1993 through 2000).

As indicated in Section 2.8, the Corps data tracking and reporting system has two components, the Regulatory Analysis and Management System (RAMS) database and the Quarterly Permit Data System (QPDS). QPDS is used to compile data for reporting to Corps Headquarters, which is in turn used by the Corps to report permitting and impact data. Districts generally compile the required data from RAMS (or another data system in the case of three districts) with various degrees of verification.

There are variations in data retrieved from the Regulatory Analysis and Management System database and those reported in the Quarterly Permit Data System Reports. QPDS acreage impact and compensatory mitigation data do not distinguish between types of general permits; nationwide permit data are included in the general permit total. There are also variations within RAMS in impact and compensatory mitigation data collected.

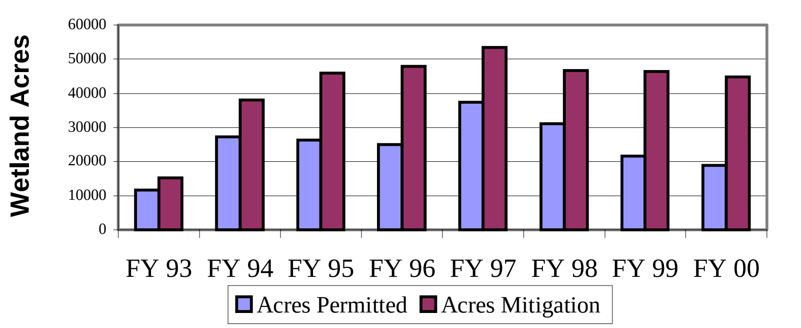
During the study, the Institute for Water Resources found variations between the FY 1998 Quarterly Permit Data System data, reported shortly after the end of the fiscal year, and FY 1998 Regulatory Analysis and Management System data. While there was not much variation in numbers of permits authorized, there were discrepancies in acres permitted for general permits. For the purposes of the PEIS, QPDS data were used when analysis required permit frequency data, especially since some analysis requiring permit frequency used data reported in QPDS and not readily available through retrieval from RAMS. However, RAMS data were used when analysis required impact quantity data. The QPDS data set was a less acceptable data source for acreage of impact because it was later updated, as new information became available.

Depending on data type, from 3 to 6 districts out of 38 total were unable to provide their regulatory database wetland data for the analysis. For analysis, the remaining 32 to 35 reporting districts were assumed representative of the whole and information was reported as an estimate of the entire Corps program.

Data for impacts to other waters were most complete for nationwide permits in the Regulatory Analysis and Management Systems database. Only two Corps districts recorded impacts to other waters for activities authorized by standard permits, letters of permission, and regional general permits. There was no reason to suspect that those data were incorrectly collected and they were used to estimate the relative distribution of impacts to other waters among the four permit types even though the two districts are not representative of all Corps districts. As a consequence of being less representative, the estimates for impacts to other waters should be considered more approximate than the wetland data. Analytical methods, including assumptions and data limitations, are described in Appendix C.3.

As also indicated in Section 2.8, the Corps is taking steps to improve the data tracking and reporting system.

Figure 4.2-1. Wetland Acreage Impacts and Mitigation FY1993 to FY 2000



Impact mitigation is central to the Corps permit program. The 1990 Memorandum of Agreement on Standard Permit mitigation policy sets up a sequence of actions to be taken (EPA-Army 1990), starting with the applicant showing that development must take place near or in a wetland. The applicant also must show that the project is the least damaging practicable alternative meeting development purposes. A condition of permit issuance is applicant avoidance of impacts where possible and compensatory mitigation where necessary.

For general permits, which are not included in the 1990 Memorandum of Agreement, the process is more discretionary and requires less detailed analysis as long as authorized development results in minimal adverse effect on the aquatic environment, both individually and cumulatively. General permits usually require on-site avoidance and minimization of impacts to the maximum extent practicable, but analysis of off-site alternatives ordinarily is not required of the permit applicant.

Table 4.2-3 summarizes Corps program activities for FY 1998 using data from RAMS. During FY 1998 the Corps issued over 88,000 permits for nearly 39,000 acres of requested impacts and permitted permanent impacts to over 30,000 acres of the Nation's waters, of which over 26,000 acres were wetlands. Based on these data, the Corps program reduced impact through conference with applicants by about 8,000 acres, or about 21%. This is a minimum estimate of Corps program effect, which undoubtedly caused many applicants to minimize their initial requests for wetland impacts. There is, however, no estimate of the dimension of that influence. It is believed by some regulators to be more important than the negotiated reduction of impact from that requested and perhaps greater than the total permitted impact.

Of all measured acreage impacted by the Corps permit program in FY 1998 (Table 4.2-3), a disproportionate impact occurred in Corps-defined wetlands (85% versus the 66% that wetlands comprise of the total water resource reported in Table 4.2-2). However, some impacts to other waters were recorded in linear feet, which reduces the estimated percentage of Corps impact in wetlands to about 80%, as described later. Only a small fraction of the total impacted wetland was tidal (mostly estuarine wetland). This proportionality of impact might incorrectly suggest that tidal wetlands are no more protected from filling than nontidal wetlands. However, the high human population density in areas near tidal wetlands and the high associated potential for impact indicate that the total impact in those wetlands probably would have been greater without the protections provided by a combination of Federal and state laws that extend exceptional protection to tidal wetlands.

Table 4.2-3. Estimated total numbers of permits issued, total (wetland and other waters) acres requested, total (wetland and other waters) acres permitted, total numbers of permits denied, wetland acres of permitted impact, and wetland impacts mitigated for the entire Corps regulatory program in FY 1998 (analytic methods are described in Appendix C.3).

Impact Category	Total Program
Number of permits issued	89,857
Acres of permanent impact requested (excludes linear-feet requests)	38,849
Acres of permanent impact permitted (excludes linear-feet requests)	30,880
Tidal wetland acres of impact permitted	1,384
Nontidal wetland acres of impact permitted	24,824
Total wetland acres of impact permitted	26,208
Approximate percent of all acres permitted for impact in wetland	85
Percent reduction of requested impact to actual amount permitted	20.5
Acres impacted/permit with permanent impact (zero impacts excluded)	1.30
Percent of all permit requests denied[1]	0.25
Total wetland acres with compensatory mitigation initiated	41,390
Total wetland acres mitigated/acres impacted	1.58[2] (1.30)[3]
Percent of wetland permits mitigated	6.6
Percent of all permits issued that were nationwide permits	46.6
Percent of all acres impacted under nationwide permit	26.4

1. Denials include the sum of all permits denied with and without prejudice under all permit types and general permits reclassified as standard permits.
2. Mitigation ratio for all permits.
3. Mitigation ratio when Nationwide Permit 27 is removed from the analysis.

Given the difficulty in precisely determining acreage and sources of change over the entire conterminous United States, the RAMS and Dahl (2000) estimates are reasonably close and mutually affirming. Tidal wetland impacts identified in RAMS for FY 1998 were more than the estimated average rate of estuarine wetland loss summarized in Dahl (2000) and in Table 4.2-3 (718 acres compared to 1,285 acres filled in 1998). Dahl (2000) estimated that about 680 acres of tidal wetland were lost annually due to fill between 1986 and 1997. The difference may result because the FY 1998 fill rate recorded in RAMS is overestimated for reasons discussed later in the report. It is also possible that loss rates differed in FY 1998 or that Dahl (2000) underestimated fill impacts. The NRCS (2000) estimate of about 16,600 acres per year of wetland lost to development is substantially less than the 26,200 acres estimated filled in FY 1998 in the RAMS database. The difference could be a result of several factors, including a possible increase in fill from earlier rates, illegal fill, draining or other activities outside Corps permitting authority, compensatory mitigation effectiveness, or overestimated impacts, as described later.

Of the permits applied for, a small percentage of permits were reclassified as standard permit or denied with or without prejudice (0.25%). Most of the Corps denials are “denials without prejudice”, meaning that some other authorization, such as water quality certification or coastal zone consistency determination, had either not been issued or had been denied by the appropriate authority. The Corps cannot authorize work under permit until those requirements are met. Standard permits that are determined to be contrary to the public interest by the district engineer are “denied with prejudice”. However, the applicant can modify the proposed activity and ask the district engineer to reconsider the denial.

The mean impact size for permits where at least some acreage was permanently impacted was 1.30 acres. A large fraction of permits requested had known zero impact (28%) and the mean size of impact including those of zero impact would be substantially smaller. However, the exact number of zero-impact permits is unknown because of a high fraction of non-responses (blanks left in the impact column). These non-responses were a combination of impacts to other waters (including zero impact) which did not have to be recorded in the database, and some unknown number of zero entries that were left blank in lieu of entering a zero.

In FY 1998, compensatory mitigation required for wetlands exceeded 38,000 acres—a permit mitigation/impact ratio of 1.58 assuming RAMS data are accurate (Table 4.2-3). A possible source of error associated with nationwide permit 27, described later and in Appendix C.5, may reduce that ratio to as low as 1.30. Mitigation was required for a relatively small percent of impacts amounting mostly to the largest impacts. Nearly half (46.6%) of the permits issued were nationwide permits, but because of their relatively small average size only 27.6% of the total area impacted by all permits was authorized under nationwide permits.

The Corps inspects a fraction of permit activities to assess and enforce permit compliance (Table 4.2-4). Small percentages of the total number of issued permits were inspected in FY 1998. The inspections were not random; they targeted sites where noncompliance was most likely to occur based on various sources of information. Even so, a very small percentage of the inspected sites were not in compliance, indicating that the estimated acreage was in fact impacted. A much larger fraction of the permits requiring compensatory mitigation were inspected (Table 4.2-4). Whereas some of these inspections may have included measures of compensatory mitigation success, most simply affirmed that an acceptable plan was in place.

Based on the NRCS (2000) estimates, about half of the 32,800 acres lost annually in the mid 1990s was associated with development, much of which was the object of Corps permit program. The estimated 26,500 acres of wetland impacted under the Corps permit program is substantially more than the 16,000 acres per year of net impact associated with development identified in the National Wetland Inventory. Measurement error is one explanation for the difference. The scale of measurement for the National Wetlands Inventory on which Dahl's (2000) analysis is based is much coarser than the Corps data and wetland impacts smaller than 1 acre are much more likely to be missed in the National Wetland Inventory. The difference also might in part be explained by compensatory mitigation. But compensatory mitigation initiated in FY 1998 could not have compensated much, even for the small fraction of sites where creation or restoration of wetlands was actually initiated on site. Earlier mitigation actions required by the Corps may have showed up in the National Wetland Inventory estimates by the mid 1990s. However, compensatory mitigation success is one of the more uncertain aspects of recent wetland accounting for a no overall net loss goal, as is described in the next section.

Table 4.2-4. Estimated compliance inspection of permitted impacts for the entire Corps program in FY 1998 based on reports of 35 out of 38 districts (See Appendix C3 for analytic methods).

Action	Number of Permits	Acres of Impact Permitted
Total inspected	1321	1233.7
In compliance	1254	1214.5
Non-compliance	67	19.2
Percent in compliance	94.9	98.4
Percent inspected of permitted	1.5	4.0
Percent inspected of mitigated	22.8	3.0

4.2.5 Mitigation Success

Because much of the Corps strategy for minimizing impacts is based on the concept of in-kind mitigation, the Corps has operated under the assumptions that the average impact on system function and value is compensated by the average mitigation action as long as the wetland or open-water impact is compensated with development of the same habitat type as defined by Cowardin et al. (1979). The cumulative impact of the permit process depends on the success of mitigation action, especially for wetlands. Mitigation also is monitored to varying extent by the different Corps districts for periods typically up to 5 years. Performance criteria used for monitoring compensatory mitigation projects vary between districts.

The history of extensive compensatory mitigation under the Corps permit program is relatively short. Required mitigation increased steeply in the early 1990s (Figure 4.2-1), probably in part in response to the national goal of no overall net loss of wetlands. Monitoring activity has only recently been established and a comprehensive analysis of mitigation success has yet to be completed and published for Corps projects. Because mitigation effectiveness often is difficult to judge in less than several years following mitigation action (because of the time lag required for vegetation colonization and succession) mitigation success for permits issued in FY 1998 is not yet ready for evaluation. Given the time lag in compensatory mitigation response and the relatively low mitigation requirement of the early 1990s (Figure 4.2-1), Corps wetlands permitted in FY 1998 for fill probably were continuing to be lost at a faster rate than compensated, even if mitigation success was high.

More likely, however, mitigation success has not been high, if studies outside the Corps are indicative. A number of studies conducted during the past decade suggest that mitigation success is less than 100%, but may be improving (e.g., Ambrose In Press, Johnson et al. 2000). Appendix C.6.2 provides a more detailed review.

No consistent standards existed for past studies of mitigation success, which adds to the uncertainty of success estimates. The collective results of qualitative (no exact measures) studies of mitigation success indicate that complete failures based on achieving wetland vegetation structure are relatively few—that is, most mitigation actions result in a vegetated wetland of some type as defined by Cowardin et al. (1979). Based on these studies, functional success is commonly 50 to 75%, indicating that the overall mitigation ratio for Corps projects in 1998 would be adequate for ultimate replacement of unavoidably lost wetlands. A 50% success with a 1.30 mitigation ratio would fall below complete impact compensation and a 75% success would just about compensate. More quantified assessment appears less encouraging, however, indicating a higher functional failure rate than qualitative methods. Compensatory mitigation may not generate much more than 50% of the self-sustaining function expected program-wide, even for wetlands that have undergone substantial research. Study results and Corps program experience indicates that restoration of the hydrology to the original state is a critical prerequisite for complete wetland restoration. In many locations the seed source is still viable and planting may not be necessary. However, in many urban and suburban areas, nonnative species proliferate even in natural wetlands (Magee et al. 1999)

4.2.6 Area Impacted by Nationwide Permits In Fiscal Year 1998

All impacts to Corps-defined wetlands were measured in acres and the data summarized in Table 4.2-4 are relatively accurate estimates of impacts in tidal and non-tidal wetlands. Impacts on waters other than wetlands were entered into the Corps data base as acreage for some impacts and linear feet for other impacts, complicating estimates of impacts to other waters and total impact in acres.

Table 4.2-5 summarizes the acreage impacted in FY 1998 for wetlands and other waters under the nationwide permit program in the five different aquatic systems of Cowardin et al. (1979). Wetland impacts were estimated entirely in acres and 7,200 acres of wetland impacts were permitted in FY 1998. Most of the impact was in palustrine wetlands. Less than 1% of the identified impact occurred in tidal waters of estuarine and marine wetlands. Riverine systems were impacted most after wetlands.

The impacts to other waters were measured in a mix of acres and linear feet, making it difficult to make direct comparisons without some estimate of the average width of impact and conversion to acres. No average width information was recorded when the impacts were reported in linear feet. Impacts recorded in linear feet typically affect a narrow strip. Two of the most common examples are nationwide permits for bank stabilization (nationwide permit 13) and utility crossings (nationwide permit 12). These typically involve a strip a few feet wide. We assumed the average impact width was 5 feet to convert linear measures to acres.

Table 4.2-5. Estimated geographical area (acres) and mean acres per permit (mean size) directly impacted by discharges of dredge or fill material into the Nation's waters under the nationwide permit program. For wetlands, the data are based on reports from 35 Corps districts, assuming the three remaining districts had proportional impacts. The estimate of the acreage of other waters relied on reports by 32 districts (See Appendix C.3 for methods).

SYSTEM	WETLAND			OTHER WATERS			TOTAL
	TIDAL	NONTIDAL	TOTAL	TIDAL	NONTIDAL	TOTAL	
Palustrine							
Acres	3.81	5236.94	5240.75	0	461.58	461.58	5702.33
Mean Size	0.12	0.73	0.73	0	0.36	0.36	
Miles						416.10	
%			72.8			24.95	
Riverine							
Acres	3.22	1039.97	1043.19	15.37	120.59	135.96	1179.15
Mean Size	0.63	0.36	0.36	0.10	0.10	0.10	
Miles						972.64	
%			14.5			58.32	
Lacustrine							
Acres	0	133.11	133.11	0	11.44	11.44	144.55
Mean Size	0	0.31	0.31	0	0.03	0.03	
Miles						143.09	
%			1.9			8.58	
Estuarine							
Acres	29.37	33.51	62.88	10.79	0.27	11.06	73.94
Mean Size	0.22	0.32	0.26	0.04	0.01	0.04	
Miles						31.87	
%			0.8			2.27	
Marine							
Acres	4.31	1.63	5.94	152.42	27.25	179.67	185. 61
Mean Size	0.18	0.25	0.43	0.30	0.51	0.28	
Miles						51.70	
%			0.1			3.10	
None							
Acres	2.09	713.59	715.68	0.27	123.82	124.09	839.77
Mean Size	0.06	0.40	0.39	0.01	0.69	0.59	
Miles						46.36	
%			9.9			2.78	
Total							
Acres	42.80	7158.75	7201.55	178.85	744.95	923.80	8125.35
Mean Size	0.15	0.57	0.57	0.17	0.24	0.22	
Miles						1667.77	
%			100.0			100.0	

Nearly 1,700 miles of other waters were directly impacted in FY 1998. More than half of this impact was riverine, but significant reaches were also influenced in other systems, including the permanently flooded vegetated shallows of pond waters in palustrine systems. If linear impacts average 5 feet wide, 1,010 acres of total impact occurred as linear impact in FY 1998. Added to the estimated acreage of other waters, the total direct impact on aquatic ecosystems other than wetlands is about 1,900 acres (20.6%). This compares to about 7,200 acres of wetland impact (79.4%). If the linear conversion is a reasonable estimate, in total, about 9,100 acres of wetlands and other waters were impacted under the nationwide permit program. The relative uncertainty associated with the estimate of the area of other waters and the total area impacted is high because of the linear data recorded in the Corps database.

We assumed acreage and linear feet estimates were accurate. Some error is associated with all field measurements, however (see Appendix C.5). No statistical measures of delineation precision are available to indicate statistical error in the RAMS data. The care taken in delineating impacted areas varies within and among permits and districts, but is not documented. The delineation of wetland boundaries incorporates error associated with interpreting hydrologic, soil, and plant indicators. If the errors vary randomly about the actual boundary, the estimates in Table 4.2-5 are likely to be accurate portrayals of impacted sites. However, interviews of regulators indicates that where there is doubt about the exact boundary location, applicants err toward overestimating impacted area to avoid potential violations.

4.2.7 Impact Below Threshold Size For Nationwide Permits

Some impacts to the Nation's waters do not require a permit. Individual permits have no lower threshold for required notification and all impacts should be accounted for. For general permits, some impacts fall below threshold sizes requiring Corps notification. The notification thresholds for nationwide permits are stated in the text of those permits. Notification requirements for regional general permits vary widely among districts.

Under nationwide permits, below-threshold actions contribute to the total conversion of waters, including wetlands, and reduce the mean size of impact. For example, in 1998 nationwide permit 26 had a preconstruction notification threshold of one-third acre, below which no notification was required. The total number of actions that fall below the notification threshold therefore is not known. However, for several reasons, developers using nationwide permits often request verification for activities with impacts less than the notification threshold (the estimated extent is described in more detail in a later section).

Based on the experience of selected Corps regulators, many developers request verification that an activity is not regulated by the Corps—a practice that raises permit processing costs but also assures the developers so that they do not commit an unintentional violation. Utilities have to report all temporary impacts, which sometimes are recorded as permanent impact, depending on the district. Utilities and transportation agencies appear most likely to report all impacts regardless of whether notification to the Corps is or is not required.

The high fraction of verifications issued for zero impact provides additional evidence that a high proportion of below-threshold impacts were processed for Corps verification of minimum impact. Of all the nationwide permit requests, as few as 58% and as many as 87% were requests for activities resulting in zero permanent impact. The actual percentage probably is closer to 87%. The uncertainty results in the high percentage of empty data fields in this data column, probably a result of an improper use of blanks for zero entries as previously described and as detailed in Appendix C.5. Some of the zero records may have been required for activities such as temporary impacts associated with transmission lines and the small impacts associated with pilings, buoys and other activities outside wetlands. Others appear to be unnecessary reports. The zero-impact reports are well below the lower reporting thresholds for permanent impacts required for many of the nationwide permits. If developers are reporting zero-impact actions to ensure compliance with the law, they also are likely to report impacted acreage below requirement thresholds.

Analysis of the patterns of verified acreage (Appendix C.3) also supports the belief by some regulators that many if not most impacts below thresholds are in fact verified and reported in the Corps database. Assuming that the relative reporting rates of impacts in size categories above and below the reporting threshold would have the same distribution pattern if all impacts below threshold were being reported, we estimated that only nationwide permit 26 stood out for not requesting verification of all of the below threshold impacts. Based on this extrapolation from larger size categories, about 355 acres, or about 5% of the nationwide permit impact requested for verification in acres, was impacted by filling.

This 355 acres would expand the total impact estimated in Table 4.2-5 to about 8,475 acres for those impacts measured in acres. We assume a similar small percentage would fall below the threshold for impacts to other waters measured in linear feet, but the data were not nearly as reliable. These thresholds were below 500 feet. If they average 5 feet wide, the acreage impact threshold would be 0.06 acres (2,500 square feet). Thousands of such impacts would have to occur to accumulate substantial acreage. Because many of those impact types were associated with utility and transportation development, we suspect they too were documented through a requested verification of impact.

In sum, the total below-threshold area impacted is not as great as it would be if developers did not request permits for many below-threshold areas to verify the impact and avoid possible regulatory infractions. This appears to be somewhat more than 355 acres in total, mostly associated with nationwide permit 26. These extrapolations are uncertain estimates of authorized impacts below threshold limits. The most reliable way to estimate this impact would be by randomly sampling sites developed near wetlands. Such data do not exist to our knowledge.

4.3 Ecosystem Functions Impacted

4.3.1 Definition of Ecosystem Function

National policy seeks no overall net loss of wetland function. The environmental impacts of activities in waters of the United States modify ecosystem function to varying degrees depending on ecosystem type and intensity of impact. For wetlands, Smith (1995) defined function as "a normal or characteristic biophysical activity that takes place in a wetland ecosystem." Wetland functions typically are highlighted in wetland texts (Mitch and Gosselink 2000). Ecosystem functions are those many processes that make an ecosystem work, such as the work done to transform energy, nutrients, water and other materials into and out of biomass through natural community production, consumption and decomposition. Ecosystem function is interdependent with ecosystem structure, which is the material form produced by ecosystem function, including all its material diversity (National Research Council 1992). Even though ecosystems function in the absence of humans (Novitski et al. 1996) functions often are confused with the many services they provide to humans.

A summary of state and Federal wetland assessment definitions by Bartoldus (1999) shows that functions often are confused with service. The Coastal Method of wetland assessment, for example, defines function as "practical measurable (either qualitatively or quantitatively) values of wetlands".

Wetland functions and the environmental services they provide are much better understood in general concept than in specific context. The hydrogeomorphic method (Smith 1995) comes closest of any index to characterizing functional links to different wetland types using functional indices. It is becoming an important tool for assessing wetland mitigation effectiveness (Sudol 1996, Ambrose In Press). King et al. (2000) describe how these functional indices link to human service and value. This differentiation of function and service has emerged over the past decade. Before that, the value-neutral definition of function often was used synonymously with a value-loaded definition of function. This continues to be true for some wetland literature (e.g., Dennison and Schmid 1997).

Because ecosystem functions are so numerous and interactive, descriptions typically lump them into functional aggregates, such as energy flow and partitioning functions, nutrient cycling functions, water transport functions, materials storage functions, process stabilization functions, and so on. Sather and Smith (1984), Bergstrom and Brazee (1991), Mitsch and Gosselink (2000), National Research Council (1995), and Heimlich et al. (1998) provide examples of wetland functions. Some wetland functions and associated structure are listed in Table 4.3-1.

Table 4.3-1. Examples of wetland function and associated structure (See Mitsch and Gosselink 2000 for further discussion).

WETLAND FUNCTIONS	WETLAND STRUCTURE
Carbon cycling and storage	Living biomass, peat, dead wood
Wind, wave & flood alteration	Vegetation, roots, basin/channel form
Water retention and transmission	Basin form, links to aquifer, vegetation
Soil and sediment retention	Roots, basin form, debris dams
Materials sequestration and decomposition	Vegetation form, biomass, sediment/soil form, basin form
Predation, disease, competition	Community species composition
Plant and animal production	Biomass, soil, air, water, nutrients
Production of raw materials	Wood, peat, shell, fiber
Process diversification	Species diversity, threatened & endangered species
Wildlife production	Wildlife biomass & diversity

4.3.2 Functional Differences Among Aquatic Systems

System functions are described in more detail in Appendix C4. Palustrine system functions are most widespread and are most commonly impacted by activities authorized by Corps permits. Except where they intergrade with other wetland types in freshwater fringes, the functions of palustrine wetlands differ substantially from other wetlands in other systems because they often occur at higher elevations in watersheds and often are isolated from riverine, estuarine, lacustrine, and marine waters. The functional differences between palustrine, lacustrine and riverine wetlands are particularly important, but frequently are not differentiated. Wetlands of non-persistent vegetation that are routinely inundated by rivers and lakes are not palustrine by definition (Cowardin et al. 1979) and function differently. Even so, riverine and lacustrine wetlands are not consistently differentiated from palustrine wetlands for the National Wetland Inventory because of difficulty identifying them using remote-sensing imagery.

Palustrine wetlands are much more likely to moderate water-level fluctuation in rivers and lakes than riverine and lacustrine fringe wetlands because they intercept runoff in the watershed before it reaches the rivers and lakes. In diverting surface flow to storage, palustrine wetlands also function to retain materials and recycle them more completely than fringe wetlands. Lakes and oceans also store waters and materials effectively; much more so than rivers and estuaries, which function mostly as transport systems for water and materials.

The degree of physical isolation of ecosystems has much to do with how they function. Being on average more isolated hydrologically, many palustrine wetland habitats dominated by emergent plants do not support large aquatic species requiring extensive surface connection to other aquatic sites, such as many large fish. Also, they are more likely to support unique, locally distributed species that have evolved in isolation and often are quite sensitive to predation by larger aquatic species. Freshwater wetlands grade into small lakes and share some common characteristics. Many existing wetlands formed in small lake basins and are continuing to do so in somewhat larger lakes as they fill with material. Persistent lakes typically have higher exchange rates, are more connected to river systems, and are less likely to support locally distributed unique flora and fauna. Some larger lakes and their tributaries, mostly in the western United States, are geographically isolated and do support unique populations. Salinity is a major determinant in differentiating the suitability of estuarine and marine habitats from inland, freshwater habitats, and as an isolating mechanism. Because of land, salinity, and other barriers, riverine systems in the United States also are biogeographically isolated and have evolved unique faunas of mollusks, crustaceans and small fishes, which make their species-level functions especially unique. In addition, rivers and their riparian habitats serve as connecting habitats for migratory species, including high-profile fish species and numerous passerine bird species passing through semiarid and arid environments. Estuarine and oceanic systems tend to be interconnected along the Nation' s coastlines and more likely to share species along temperature and salinity gradients. They are less likely, therefore, to support locally unique species.

Because compensatory mitigation is a crucial means for attaining goals of no overall net loss of wetland acreage, function and value, assurances that lost functions are replaced starts with targeting the same wetland class for creation or restoration. As such, Cowardin et al. (1979) wetland classes and HGM classes (Smith et al. 1995) should be routinely recorded for impact and mitigation data. Those data alone are insufficient, however, because functions vary within classes depending on the location of a water body in ecosystems and with respect to other ecosystems. Especially important, is the location of waters with respect to watershed sources of water, nutrients, organic matter and other materials necessary for sustaining functional integrity of reestablished or preserved waters and wetlands. These data, including watershed condition, also need to be evaluated with respect to classifications for improved understanding of function.

4.3.3 Sources Of Error For Estimating Functional Impacts

Other than classifying the impacted areas in broad ecosystem categories (the “systems” of Cowardin et al. (1979)), the Corps does not gather data on ecosystem function because of the complexity and expense. There are no standard methods accepted and used by the Corps for assessing ecosystem functions. Rather, guidance generally directs compensation for unavoidable cumulative impact with “in kind” compensatory mitigation, based on acres or linear feet, either on site or off site, determined by professional judgement and qualitative analysis. This approach alleviates the need to judge equivalency of different functions. However, it requires broad assumptions about functional variation within very broad system categories and the net effect of bias, if any, on cumulative impacts. It also assumes that the state of compensatory mitigation science actually enables replacement of in-kind functions. The degree of functional impact indicated by acres in the Corps RAMS database may be over or underestimated from several sources of error. Also, there is no documentation of the quality of the affected wetlands. There is a high probability that at least some of the wetlands where fill is being planned had already been degraded to some extent.

Because impact often is not total, the Corps database may overestimate natural loss of ecosystem function. Natural function is rarely totally eliminated even though the Corps database assumes so where impact acreage is recorded. The different types of Corps regulated activities impact ecological functions in different ways, some more functionally destructive than others. Filling aquatic ecosystems replaces many natural functions with functions more characteristic of upland ecosystem functions, if not totally converted to artificial structure. However, even when the area becomes occupied by artificial structure, some of the original natural functions may remain, albeit altered, such as water catchment, heat absorption and radiation, erosion moderation, water filtration, materials sequestration and release, and habitat (e.g., roosts and cover) for certain species. Thus, the assumption that filling a wetland or other aquatic ecosystem results in all loss of natural function often is incorrect. Databases, such as the Corps RAMS data, that categorize impacts as all or nothing may inaccurately overestimate the negative impact to natural functions and values.

Indirect impacts on ecosystem functions are difficult to measure and are not included in the Corps RAMS database. However, many indirect impacts take the form of water quality changes regulated by other agencies through other sections of the Clean Water Act. The edge of indirect effect typically is very difficult if not impossible to measure. Regardless of ecosystem type, in general as any materials and energy disperse from a Corps permitted impact site their indirect impacts attenuate rapidly. Indirect impacts on off-site ecological functions are typically less intensive and more extensive than the direct impacts resulting from discharges of dredged or fill material. In general, the ability of ecosystems to assimilate impacts, without significant alteration of function, increases as the effect of impact disperses and becomes less intense. Even so, the lack of data on indirect effects could result in an underestimate of negative impacts to natural functions and values.

Ecosystem functions also have varying capacities for recovery from impact once disturbed. Functional impacts vary from temporary to permanent. Indirect impacts caused by the transport of materials or energy (e.g., heat) off the impact site typically are temporary. In their data keeping, Corps districts are somewhat inconsistent about inclusion of "temporary" impacts and exactly when temporary becomes permanent also is impossible to determine. Some districts treat temporary impacts the same as permanent impacts (by counting those impacts as losses) whereas other districts record only permanent impacts as losses. The extent to which any bias enters into assessment of impact edge and permanency is an important consideration for decisions involving small but numerous impact areas. Classifying permanent impacts as temporary underestimates impacts while categorizing temporary impacts as permanent overestimates impacts. Considering the practice in FY 1998 overestimation of functional impact appears to have been more likely than underestimation in the RAMS database.

4.3.4 Functional Representation of Mitigation Ratios

The mitigation ratios summarized in Appendix Table C.5.-1 for nationwide permit types suggest that all wetland functions are not being sustained as expected under a no overall net loss policy and the programmatic impact on wetland function and value may not be minimized according to the no overall net loss policy. The assumption that average functions and values are sustained through the Corps permit program depends on the mitigation actions taken in different ecosystem types under the different nationwide permits. Even though individual mitigation actions are typically "in kind" replacements, a differential rate of mitigation requirements among the nationwide permits probably results in programmatic losses of riverine, lacustrine, estuarine, and marine wetlands at a greater rate than losses of palustrine wetlands. This result suggests that all wetland functions may not be sustained according to a no overall net loss policy because wetland functions differ among the systems.

This possibility is indicated by high mitigation ratios in only a few nationwide permit categories. Only three nationwide permit activities have mitigation ratios above 1.0: nationwide permits 21, 26, and 27. The vast majority of wetlands affected by nationwide permits 21 and 26 are palustrine. Nationwide permit 21 activities impact wetlands associated with coal-mine locations and nationwide permit 26 authorizes activities in headwaters and isolated waters. Nationwide permit 27 authorizes discharges of dredged or fill material associated with the restoration and creation of wetlands and could apply in any of the systems. However, there are potential problems with the nationwide permit 27 accounting system, discussed in Appendix C.5 and Chapter 5, which call into question the recorded mitigation contribution of this permit type. Other activities with small mitigation ratios, especially nationwide permits 12, 13, and 14, are associated more with systems other than the palustrine system. These permits are more commonly associated with the riverine system, and less often with the shores of lake, estuarine and marine systems. As a consequence of low mitigation ratios in nationwide permits 12, 13 and 14, and high mitigation ratios in nationwide permits 21 and 26, the impacts in rivers and shores of lakes, estuaries and marine systems seem less likely to be mitigated than impacts in the palustrine system. Because impacts to the palustrine system are more commonly mitigated than impacts to other systems, existing mitigation ratios appear not to be compensating as effectively as they might for the functional loss of scarcer systems. This may be a deficiency in the Corps program that results in some replacement of lost habitat in estuarine, lacustrine, and riverine systems with habitat in the palustrine system.

4.4 Human Communities Affected by the Nationwide Permit Program

4.4.1 Geography and Demographics

The affected human communities occur nationwide. Few if any people go unaffected by the natural services derived from the functions of the Nation's aquatic ecosystems. King et al. (2000) defined a natural service as "a beneficial outcome of...a function." All ecosystems provide natural services through their natural function, but wetland ecosystems have been particularly studied. Certain environmental services associated with the impacted areas are global (they have no regional boundaries), such as those associated with endangered species protection and regulation of greenhouse gases. Other services are more local and regional--such as flood protection, water quality improvement, recreational fish and wildlife habitat, and water supply. Few, if any, are confined within local political boundaries. Many of the natural services of waters, including wetlands, are diffuse and widespread. They often have subtle effects on human well being and are frequently unrecognized or taken for granted by most of the public. Examples are provided in Table 4.4-1.

The largest concentrations of waters and wetlands occur in and around the Great Lakes; the glaciated areas of the northern Midwest; Northeast and high western mountains; the oceanic coastlines, the floodplains of the larger rivers; and the lowlands of the southeastern United States (NRCS 2000). Population densities vary among these regions. Most urban settlements are located along coasts and riverbanks where navigation and water supply for domestic and industrial use were important settlement considerations. Yet water also plays an important role in rural communities, especially for agricultural and recreational uses. While one might expect that the communities most impacted by local services are located in areas rich in surface water, the services associated with water are especially scarce and in high demand in arid environments. A large fraction of the listed threatened and endangered species are associated with aquatic and riparian environments. In sum, virtually all human communities are impacted by a national program affecting the natural service provision of water resources, such as the Corps permit program.

Human communities are not all equally distributed with respect to water distributions, including wetlands. Because of this uneven distribution of people with respect to water resources, demand for aquatic ecosystem services is not equally distributed among aquatic sites. Where water resources are abundant with respect to demand, the willingness to trade off those resources is greater than where the resources are relatively scarce. Because of this variation, the service values of sites with similar functions can vary dramatically.

Table 4.4-1. Examples of wetland aquatic ecosystem services and associated types of values (See Heimlich et al 1998, Daily 1997). The ecosystem services and values are listed in the order of associated functions and structure shown in Table 4.3-1.

ECOSYSTEM SERVICES	ECOSYSTEM VALUES
Climate regulation	Reduced damage
Disturbance regulation	Reduced damage
Water supply	Water price
Sediment control	Reduced damage
Waste treatment	Water price
Biological pest control	Reduced damage
Food production	Food price
Raw materials	Commodity price
Genetic information maintenance	Resource development potential
Recreation and esthetic	Experience value

4.4.2 The Natural Services Impacted By The Corps Permit Program

In this analysis, we assumed that the most meaningful ecological functions to consider during impact analysis are those that are indirectly valued through the natural services they support. The concept of natural environmental goods and services has emerged most clearly during the past decade (e.g., Daily 1997, Costanza et al. 1997, Bergstrom and Brazee (1991) and Heimlich et al. (1998)) provided some common examples of natural services. While the definitions and general relationships existing among ecosystem functions, services, and values are now generally recognized and accepted in the theory of ecological economics, confusion continues to exist in application.

Environmental impacts intensify or diminish natural services. While activities authorized by Corps permits may destroy some functions that have relatively little or no service value (if such exist), their environmental impact is registered through impacts to the ecological services such as those listed in Table 4.4-1 for wetland ecosystems. Unlike ecosystem functions, services exist only where humans can benefit from ecosystem functions. Services link ecosystem functions and the values assigned to ecosystems.

Other than classifying the impacted areas in broad ecosystem categories (the “systems” of Cowardin et al. 1979), from which some inferences can be made, the Corps does not gather data on ecosystem services because of the complexity and expense. As for functions, guidance generally directs compensation for unavoidable cumulative impact with “in kind” compensatory mitigation. Service value, which usually varies with distance from population centers and other factors, is assumed to "average out" over the areas impacted. However, if the net effect of loss and mitigation is to replace waters with similar functions but lower demand for their natural services, the values of those waters will cumulatively diminish. King et al. (2000) are developing an assessment approach, integrated with the hydrogeomorphic method of assessment (Smith et al. 1995), to help regulators prevent such trends from occurring.

4.4.3 Differences In System Services

Palustrine services differ substantially from the services of other systems, including their wetland classes. Rivers provide relatively less dependable water supply and little flood storage service compared to lakes and palustrine wetlands. Palustrine systems are more likely to contribute to riverine flood control service than riverine wetland classes. However, wetlands in rivers and floodplains may sometimes make flooding worse because they displace water and create sediments less able to infiltrate water into riverine aquifers. Riverine floodplains dampen flood energies, but vegetation in floodplains may raise water levels more than if not present. Lakes also intercept and store flood waters much better than rivers. Palustrine wetlands are less likely to provide storm protection services than fringe wetlands of other aquatic systems, which also reduce shore property erosion.

Palustrine systems are excellent traps for nutrients and usually are much more effective as a natural water treatment service than are the fringe wetlands of other systems. In addition, palustrine wetlands, especially bogs and fens, are more effective regulators of carbon dioxide as a consequence of their peat storage. Lake basins also are good flood control systems and effective traps for sedimentary nutrients, such as phosphorus and iron, if not overloaded and eutrophied. Rivers are poor at trapping sediment, nutrients and organic matter, but provide critical materials delivery services for sustaining water quality, sediment, nutrients and detrital nourishment to downstream habitats, including lakes, estuaries and oceans. Conversion of rivers to lakes often augments certain natural services while diminishing other natural services in complex ways that require careful tradeoff analysis.

The isolation of palustrine wetlands nearly eliminates any organic matter export service in support of valued species off site, such as in estuarine and marine systems. Sport and commercial fisheries production are relatively unimportant services of isolated palustrine wetlands because large fish typically need connection to deeper waters to flourish.

All of the systems provide sustenance for genetically unique species, but certain riverine systems and isolated palustrine wetlands stand out.

4.4.4 Values of Natural Services

The tradeoff values are the ultimate kinds of information needed for decision making in the Corps permit process. An efficient permit process results where the sum of developed service value and natural ecosystem service value is the greatest of possible alternative values. This should lead to the cumulative result having the greatest positive impact on human communities existing in the United States. Natural ecosystem values are expressions of the relevancy and meaning of ecosystem process to human beings. King et al. (2000), for example, state that wetland service value is “a measure of the relative importance that individuals or groups place on a wetland service.” This importance may be indicated by the willingness to pay for ecosystem services (e.g., Barbier et al. 1997) either directly through the market or indirectly.

Some values, however, cannot be fully estimated in monetary units but are indicated by protective law, public opinion, technical opinion or other social forces that limit opportunities in order to protect the value. The Endangered Species Act is an outstanding example of an investment in the benefits derived from sustaining the Nation's diverse living resources. When hard decisions are made to protect a species by denying profitable take or critical habitat development, evidence of value is sometimes revealed in high opportunity costs foregone to enforce the Act.

Ecosystem services can be most valued as they are, such as the natural service rendered in support of sustaining endangered species and wildlife-based recreation, or they can be valued more highly once the service is artificially enhanced, such as by dredging rivers and coastal waters for navigation improvement or filling wetlands for housing development.

Average values for natural services taken from studies summarized by Costanza et al. (1997) are summarized in Table 4.4-2. The results support the notion that average values of wetland natural services exceed the value for other waters, which exceeds the average value of natural services of upland ecosystems.

As indicated in Table 4.4-2, wetlands and estuaries average about an order-of-magnitude higher monetary value for their natural services than other waters (inland waters) and nearly two orders of magnitude higher monetary value than uplands. Non-monetary benefits associated with endangered species maintenance are not included in these estimates. The process accounts for endangered species by assuring their protection under authority of the Endangered Species Act. The range of results among studies is very high, indicating the high uncertainty associated with national valuation. This reflects the fact that some wetlands and other waters may be of low value while some upland areas may be of high value. The full range probably is not represented because of the low overall sample size.

The Corps does not attempt to estimate and record the values of impacted and mitigated ecosystem services because of the complexity and cost. Corps policy is based instead on the assumption that compensating for functional impact will result in proportional compensation in value. From the standpoint of the different permit types, it also assumes there is no systematic difference in mitigation effectiveness pertaining to ecosystem function and value. Heimlich et al. (1998) summarized economic studies of wetland monetary values and found a wide range of estimated prices (converted to 1992 dollars). Data for wetlands in the United States are summarized in Table C.9.2-1 according to the service provided. The values in Table C.9.2-1 come from a total of 25 different citations reviewed by Heimlich et al. (1998). The available data are quite variable in sample size and in the average value estimated in each study. Of the wetlands in the United States evaluated, most were coastal wetlands (mostly estuarine) and a few were lacustrine and riverine. Of those that could be identified to system, palustrine wetlands were least studied.

Table 4.4-2. Estimated mean monetary value of natural ecosystem services based on economic values reported in Costanza et al. (1997) from review of economic literature. Estimates do not include non-use values, such as those associated with endangered species protection.

Ecosystem Category	*Mean $ per Acre*	*$ Value Range*
Nontidal Wetland	14,690	3,434- 25,576
Tidal Wetlands	7,360	600 –18,708
Estuary/Coast	8,210	7,601-13,533
Inland Waters	3,400	1,462-5,336
Floodplain/riparian	1,630	50-4,883
Upland	120	104-136

The low incidence of economic study of palustrine wetlands may indicate less concern for their value, given their relatively great abundance in the contiguous United States (over 90% of conterminous United States wetland from data in Mitsch and Gosselink (2000)). Yet the average of estimates compiled in the review by Costanza et al. (1997) and summarized in Table 4.4-2 indicates otherwise. The explanation may be related to growing recognition of inland wetland values or it may simply reflect the large variation that occurs in such data.

High variation in results from valuing wetlands reveals how greatly wetlands vary in function and the demand for their services. This variation precludes any confident ranking of average wetland service values. Table C.9.2-1 illustrates this variation clearly. Mean wetland value estimates varied from $40 per acre for groundwater recharge (one study) to over $120,000 per acre for habitat non-use value (6 studies). Other services valued highly included flood damage reduction (about $35,000 mean of 2 studies) and water treatment (about $15,000 mean of 4 studies).

The highest valued services are among the most controversial with respect to estimation. Water treatment and flood damage reduction valuation depends greatly on assumptions made about difficult to define processes. Non-use valuation depends on contingent valuation methods that often result in high estimates that cannot be substantiated by other means. The data do not appear to be additive. For example a comparison of a total for sportfishing mean value and waterfowl hunting mean value of $6,300 is more than twice the mean value for total fish and wildlife recreation ($2,700). The studies were not done randomly and there could be a bias toward doing studies where values were expected to be exceptional for all categories of services.

The large variation makes discrimination of value differences among any types of wetlands unlikely. Wetlands are likely, however, to average significantly higher value per acre than other waters. All waters are likely to average significantly higher value than uplands. These data do support existing national policy, which in effect places a priority on protecting the natural services of wetlands over other natural waters, and waters over uplands except where endangered species and other special circumstances dictate otherwise.

Because of estimation difficulty and high variation among studies, it is more questionable that palustrine wetlands are more valuable per acre than are estuarine wetlands. However, the more controversial water treatment, riverine-flood damage reduction, and nonuse values of palustrine wetlands probably exceed the value of those services rendered by estuarine wetlands where less controversial recreation, food production, and shore protection values do not sum quite as high. The estimated higher economic value of palustrine wetlands is not reflected in state and Federal law, which is more likely to protect estuarine wetlands. Economic values are discussed further in Appendix C.10.

4.4.5 Service Value From Mitigation

The uncertainty in compensatory-mitigation success has a large effect on the estimated acres and relative value of wetland and other water resources impacted by the nationwide permits. As has been described above, mitigation success has varied (see Appendix C.6). In general, results of studies suggest that a range of compensatory-mitigation success commonly falling between 30% and 90% can be expected depending on conditions. The ability to create and restore aquatic ecosystems varies depending on the system and the extent of restoration experience that has resulted. While preservation is the most assured tactic for success, it does not reverse losses of the aquatic ecosystem. However, careful preservation acts to stabilize wetland acreage and function and, in some cases, to make possible restoration of other wetlands in an ecosystem, which otherwise would be limited by altered hydrology and other altered landscape-scale relationships.

Table 4.4-3 indicates the importance of compensatory-mitigation success in judging the impact of nationwide permits on wetland values, assuming mean estimates are accurate. The data in Table 4.4-3 are estimated by calculating the difference between the direct-impact acreage and compensatory-mitigation acreage initiated at different success rates. These data do not include linear measures because of the uncertainties associated with the mitigation data, which were probably confused with linear-feet measures. There is, however, no indication from the FY 1998 RAMS data that mitigation for linear feet measures of impact compensate any more than the acreage data that have been more confidently monitored. For dollar values, the average estimated value per acre of each type of wetland and other waters, summarized in Table 4.4-3, was multiplied times the acreage in each type of wetland and other waters present in each system category.

Given the relative abundance of other waters, their dynamics, and the care taken in the permit process, impacts to other waters resulting from activities authorized by Corps permits appear to be minimal. The small, unavoidable loss of deepwater aquatic ecosystem and unvegetated shallows is economically infeasible to make up through in-kind compensatory mitigation and background environmental changes may be compensating serendipitously. At such small rates of impact, changes in mean water level may be greater and possibly compensating for impacts to other waters. For marine ecosystems, deepwater replacement of shallow habitat probably is increasing at a relatively rapid rate as sea levels rise. The precision and accuracy of existing data are insufficient to demonstrate with confidence whether or not a net gain or loss of unvegetated, unconsolidated sediment and rocky aquatic ecosystem occurred in the marine system in FY 1998.

Wetlands, however, are a different issue. If mitigation occurs at a high success rate of 90%, the permit process results in a substantial positive gain in wetland acreage and value for those known impacts. This also could hold true for all impacts, including sub-threshold impacts, if sub-threshold losses are as small as suspected. At low and intermediate estimates of compensatory mitigation success, a net loss of wetland acreage and value occurred in FY 1998. About 81% success was needed in FY1998 to “break even” across all wetland acreage, independent of the variety of function and value. Studies of mitigation success indicate that a relatively high level of success was unlikely, however (see Appendix C.6).

Even if mitigation success was high enough to compensate, the mitigation does not occur uniformly among aquatic systems. Wetlands in palustrine systems are the only ones to be fully compensated if mitigation success is high. In all other systems even 100% mitigation success would not completely compensate for the direct impacts that occurred in 1998. While these are small areal impacts compared to palustrine impacts, the wetlands occurring in riverine, lacustrine, estuarine and marine systems are relatively rare. The palustrine wetlands commonly created and restored in compensatory mitigation are among the most common wetlands and some do not conform to the Corps definition of wetlands.

While it is conceivable that losses of natural service values may be more effectively mitigated than the underlying sustaining functions, it is unlikely given that mitigation criteria rarely target values. In addition, mitigation success is now relatively low when habitat is either created or restored. In many instances, compensatory mitigation might be more definitely accomplished by either protecting or enhancing existing wetlands instead of relying on uncertain creation or restoration of wetlands. Preservation of imminently threatened or special wetlands through

Table 4.4-3. Relative monetary value ($millions) of annual impact based on estimated average wetland values (from Table 4.4-2) and compensatory mitigation at low (30%), average (60%) and high (90%) success rates.

Category	Mitigation Success					
	30%		60%		90%	
	Acres	$Million	Acres	$Million	Acres	$Million
Palustrine	-2813.17	-41.32	184.99	2.72	2965.16	43.56
Riverine	-842.90	-11.02	-506.64	-6.62	-170.40	-2.23
Lacustrine	-102.10	-1.39	-59.64	-0.81	-17.18	-0.23
Estuarine	-53.93	-0.40	-33.92	-0.25	-13.92	-0.10
Marine	-185.56	-1.52	-185.51	-1.52	-185.47	-1.52
Subtotal	-3997.66	-55.65	-600.72	-6.48	2578.19	39.48
No System Identified	-643.91	unknown	-448.04	unknown	-252.17	unknown
Total	-4641.57		-1048.76		2326.02	

conservation easements or other forms of legal protection makes more sense than enhancement, however. If the science remains uncertain for restoration and creation, it may not be any more certain for enhancement of natural services.

A preservation requirement, on the other hand, relies on identifying existing natural services and requires only the science associated with knowing what watershed and other resources must be protected to assure full protection of the wetlands. The functions and values of existing wetlands can be more certainly evaluated than the function and value of created or restored ones at the time the permits are issued. Based on existing uncertainty of mitigation success, a preserved wetland may be worth two or more "restored" ones.

For certain wetland and water resources, preservation is the only effective action. Present Corps databases make it difficult to identify these wetlands, such as bogs and fens, because they are not classified at the subsystem or class level. They could be undergoing progressive loss even as mitigation ratios suggest otherwise.

Preservation is presently de-emphasized in Corps policy because environmental organizations claim that a preserved wetland cannot be declared a gain even though a destroyed one that could have been preserved is definitely a loss. The environmental concern is that preservation will be used in cases where threats are not real or imminent. Corps policy needs to assure that this is a critical issue in choosing preservation for mitigation purposes. But Corps policy also needs to recognize the possible shortcomings of restoration and creation and the need for additional research required for successful creation and restoration projects.

A problem with preservation has to do with Corps authority being defined by surface-water boundaries and not by the environmental factors that sustain aquatic functions. Since watershed function is often key in sustaining the quality of wetlands, full protection requires inclusion of the effective wetland watershed as well. But the Corps has no authority over uplands in the watershed no matter how much they determine aquatic ecosystem functions. The Corps is authorized to regulate only those discharges of dredged or fill material into aquatic ecosystems except for the standard permit requirement for alternative plans that might involve uplands. Preservation of wetlands in the upper watershed may be the most effective means available to the Corps for sustaining aquatic functions lower in the watershed.

The lack of statutory authority to regulate activities in uplands also adds to the uncertainty of mitigation by creation, restoration and enhancement as well as by preservation. Any actions taken to mitigate in a watershed undergoing extensive change from development are less likely to meet with success than actions taken in protected watersheds. Urban sprawl is particularly difficult to contend with given present and probable future limits of authority. However, off-site mitigation in areas where there is more reasonable assurance that necessary watershed conditions will be sustained makes more sense than any mitigation action required within a watershed undergoing rapid alteration by development.

Only so much can be accomplished in the short run by resorting to more mitigative preservation. Ultimately creation and restoration techniques need to be improved and mitigation ratios set in the mean time to reflect the probability of success. Much has been learned about wetland functions and services over the past two decades. Ultimately, offsetting unavoidable impact requires that we must learn to compensate through improved protection, enhancement, creation and restoration techniques. Ambrose (In Press) suggests that improved mitigation compliance standards based on function and improved enforcement of those standards will result in improved success.

In the meantime, when creation and restoration actions are necessary, they probably should be counted on mostly for certain herbaceous emergent wetlands. A number of Corps districts have established compensatory mitigation guidelines to help permit applicants plan and implement acceptable compensatory mitigation for activities authorized by Corps permits. Use of mitigation banks is progressing toward greater assurance that the wetland banks are appropriately located for in-kind replacement, and that financing is assured before permits are issued. In some districts watershed studies have been conducted to assure that created and restored wetlands are well situated. Progress is uneven across districts, however, and the program appears fragmented and uneven at the national level. Chapter 3 presents other options to improve mitigation success.

4.5 Permit Applicants Affected by the Nationwide Permits

Nationwide permits impose various costs upon those required to comply with program requirements. These costs, for the purposes of this discussion, are referred to as compliance costs. Compliance costs are applicant expenses associated with preparation and completion of the permit application.

Nationwide permit compliance costs are expected to be less than individual permits because of reduced delay cost and paperwork—reflecting the goal of program efficiency. As mentioned in Chapter 2, nationwide permits allow the Corps to spend more time on impacts that cause more than minimal effects.

4.5.1 Compliance Costs

Compliance costs incurred by permit applicants can be divided into two types: direct (cash) costs and indirect (opportunity) costs.[1]

4.5.1.1 Direct Costs

Direct costs reflect the out-of-pocket expenses necessary to complete permit applications and comply with permit conditions, including required compensatory mitigation. Additionally, permit applicants may incur costs associated with state or local permit program requirements (e.g., other information required for Section 401 water quality certification such as best

[1] Environmental regulations often impose various direct and indirect costs (see: Jaffe et al., 1995).

management practices or mitigation requirements for local permit programs). Permit applicants may incur costs for the following actions as part of permit application: delineation and survey of special aquatic sites; project impact drawing; alternatives analysis; mitigation proposal; and application submission.

4.5.1.2 Indirect Costs

The indirect costs of compliance with the Section 404 program largely represent "opportunity costs" that are not necessarily reflected in out-of-pocket expenses. Opportunity costs include permitting time costs and any development values foregone as a result of the Corps application of the 404(b)(1) "sequencing" rules. Opportunity costs increase with the time it takes for the Corps to process permit applications. The sequencing rules, which say that permit applicants must take all practicable steps to avoid, minimize and mitigate impacts, are often used to require permit applicants to re-design projects and reserve portions of project sites for the provision of compensatory mitigation. Requirements for vegetated buffer adjacent to open waters located at project sites also may cause applicants to set aside a portion of a project otherwise planned for development. Such mandated project alterations indirectly increase compliance costs by reducing potential development value of the project site.

4.6 Costs Incurred by the Federal Government to Administer the Nationwide Permit Program

Review of nationwide permit applications requires Corps expenditures. While costs to review permits are also borne by other Federal agencies as well as state and local agencies, this discussion focuses on those costs incurred by the Corps. Chapter 2 discusses the nationwide permit review process which includes coordination with other agencies for pre-construction notifications. The total regulatory budget for FY 1998 was $107 million of which an estimated $80 million was spent on processing and reviewing permit applications.

4.7 Cumulatively Impacted Environment

4.7.1 Compensatory Mitigation

Even though impact avoidance and minimization appear to be effective, substantial impact results from legal filling of the Nation's waters under the Corps permit program. Compensatory mitigation is the most important element remaining in the Corps permit process as a means for reducing or eliminating cumulative impacts from permitted fill. Compensatory mitigation may occur on site (in close ecological proximity) or entirely off-site (ecologically remote location). Compensatory mitigation typically involves in-kind compensation. This usually means compensating with the same system and subsystem or class type (e.g. palustrine emergent) as described in Cowardin et al. (1979).

Cumulative impact on the environment results from the incremental addition of regulated impacts, including compensatory mitigation, to other past, present, and reasonably foreseeable future actions. The choice of time period depends on the "foreseeable" future condition. For many social/legal actions, the foreseeable future is less than a decade, but for important ecological actions the foreseeable future extends over a much longer time frame. Because so much of the ultimate cumulative impact of the Corps permit program depends on compensatory mitigation effectiveness through restoration and creation practices, the length of time needed to fully recreate a compensatory wetland or other ecosystem is an important criterion for time selection. Among the more important considerations is the time needed for plant succession to fully reestablish the lost wetland functions. This may take a century or more for forested wetlands and more than a decade even for those herbaceous emergent wetlands that recover relatively rapidly once proper conditions are provided.

Compensatory mitigation also depends on the reliability of past ecological conditions extending indefinitely into the future. Therefore, changes in climate and watershed from either natural or anthropogenic sources are important considerations for assessing mitigation success and impact minimization in the long run. Projected changes in climate and sea level, for example, whether certain or not, provide insight into the relative certainty of compensatory mitigation activities and resulting impact trends. The usual time frame for making projections about climate and sea level is 50 to 100 years. Where sustainability of ecosystem function and value is an important concern, as it is in National Environmental Policy Act determinations and present national wetland policy, the period chosen for analysis needs to be long enough to judge whether or not present strategies are in fact likely to result in the protection, restoration, and enhancement of the environment. Based on these considerations, we used a 100-year time frame.

Using the simplest assumption of constant trend and estimating the total cumulative impact projected from FY 1998 RAMS data is instructive for indicating the importance of compensatory mitigation success (Table 4.7-1). We assumed no compensatory mitigation for impacts to other waters, which is pessimistic because some impacts to other waters are now mitigated, and provide estimates for wetlands ranging from 30% to 90% success at the present mitigation rates. These estimates provide a benchmark for establishing the dimensions of basic impact with respect to present environmental status. We realize that a constant trend and uncorrected low mitigation success are unlikely over the next century and present Table 4.7-1 as a pessimistic example that may suggest future mitigation strategies.

The Corps permit program impact data were compared to the 105 million acres of wetlands estimated as a mean from data presented by Dahl (2000); the 3.7 million miles of river, 41.5 million acres of lake, and 57.9 million acres of estuary tabulated by the U.S. Environmental Protection Agency (U.S. EPA 1998); and the 90,000 miles of oceanic shore estimated by the National Oceanic and Atmospheric Administration.

Uncertainty in estuary estimates is indicated by the range of values reported from U. S. Fish and Wildlife studies (Dahl 2000) and U.S. EPA (1998) for estuarine area. Dahl (2000) reported 23.1 million acres of estuary, or nearly one third of the EPA estimate. The difference can result from relative emphasis on topography, salinity, and other variables in the delineation of area.

4.7.2 Impacts to Other Waters

Based on interpretation of RAMS data for FY 1998, about 923 acres (1.4 square miles) of marine, lake, riverine, and estuarine waters were impacted, of which about half was classified as vegetated shallow water (permanently flooded palustrine) and half was non-vegetated and/or deeper waters. In addition, nearly 1,700 miles of shore (Table 4.2-5) were impacted mostly through control of bank erosion, utility installation and road construction activities, which are typically narrow impacts. About 58% of these impacts were riverine and 34% were in unvegetated lake shores or deeper lake waters. Mitigation actions for these impacts were less than 1 to 1 and the mitigation success was generally unknown. Low success of scientifically researched creation and restoration of natural ecosystems suggests that a conservative estimate of effectiveness in sustaining function and value is appropriate at this time.

4.7.2.1 Palustrine Pond Impact. Some of the 105,000,000 acres of estimated wetlands are comprised of palustrine ponds, which are not Corps-defined wetlands and do not function entirely like Corps-defined wetlands. However, they have many valued functions, which are considered in the Corps permit process. A relatively large projected impact to open water palustrine ecosystems is indicated by 1998 impact rates, if that rate should continue over the next 100 years. These are shallow waters less than 20 acres in surface area, which may or may not have vegetated bottoms. The fraction of projected loss is about 1.3% percent per century. However, if mitigation is resulting in pond creation instead of intended Corps-defined wetland, pond loss would not be as great as indicated and the loss of jurisdictional palustrine wetland would be greater than indicated.

Failure to mitigate in kind for Corps-defined wetlands may result in creation or restoration of more ponds, as found by Kentula et al (1992) and Magee et al. (1999). This inadvertent conversion of Corps-defined wetland to ponds would diminish to an unknown degree the projected cumulative loss of pond function and value, and to that end would result in some measure of success. Dahl (2000) and Table 4.2-2 indicate that pond and other nonvegetated palustrine area increased an average of over 57,000 acres per year from 1986 to 1997, suggesting that mitigation for this loss is of questionable value. No data exist to determine the extent that mitigation actions intended for replacing lost Corps-defined wetlands are contributing to this increase in pond area.

It is important to point out that measures of mitigation success and failure are typically based on meeting structural performance indicators, such as the establishment of specified wetland plants. The criteria do not necessarily reflect degree of functional success and provision of desired natural services. Ponds for example may provide services similar to Corps-defined wetlands, sometimes approaching or exceeding them in value. Depending on exchange flows, base water storage, and surface and groundwater interfaces, ponds may be better or worse retention reservoirs for flood waters, sediment, some nutrients, and for groundwater recharge. Also depending on location and specific habitat quality, ponds may provide more recreational and aesthetic service value than wetlands of comparable size. Depending on circumstance, they may also provide more appropriate habitat for endangered species. Certain ponds could become more

Table 4.7-1. Estimates of water resource abundance and the cumulative 100-year impact of nationwide permits assuming FY 1998 rates hold constant over the next century. The 100-year cumulative impact was calculated by multiplying the observed gain or loss of resource acreage during FY1998 or linear feet. For other waters, no compensatory mitigation was assumed to occur.

Ecosystem Type and Measure	Total Length/Area	100-Year Cumulative Impact	
		Miles/Acres	%
Other waters			
Palustrine (Pond) Acres	5,200,000	-71,400	-1.37
Riverine Miles	3,700,000	-125,000	-3.38
Riverine Acres	Unknown	-75,750	unknown
Lacustrine Acres	41,500,000	-9,800	-0.02
Estuarine Acres	57,900,000	-3,000	-0.01
Coastal Zone Acres	120,000,000	-21,400	-0.02
Wetland Acres	105,000,000		
30% mitigation success			
Nationwide permits		-464,240	-0.44
All permits		-1,720,000	-1.64
90% mitigation success			
Nationwide permits		+232,600	+0.22
All permits		+1,040,000	+0.99

effective carbon sinks than certain Corps-defined wetlands. A gradual conversion to pond acreage is not necessarily undesirable in the short run, depending on the functions and services that result.

Eventually, however, a failure to replace wetland loss in kind as a consequence of restoration or creation incompetence, is likely to result in diminished environmental service and value. This is especially likely for those endangered species and recreational/aesthetic services unique to Corps-defined wetlands. Successful restoration or creation of targeted aquatic functions and values should remain a management objective if for no other reason than learning how to do it right when needed and ultimately for control of negative cumulative impact. The present mitigation approach too often leaves too much to chance for it to be of much confident value in forecasting cumulative impacts.

4.7.2.2 Riverine Impacts. The largest fractions of Corps permitted impact were riverine. Based on linear feet measures alone, about 1,250 miles of stream were impacted under Corps permits in FY 1998. Over a century of constant annual impact, 125,000 miles would be impacted—about 3.4% of the total length—assuming no successful mitigation took place. Riverine impact is the largest of estimated fractional impacts to ecosystem types. It is also among the least well documented because of the mix of acreage and linear-feet measures of impact and mitigation. The Corps permitted fill impact in FY 1998 was equivalent to the loss of a small river 30 miles long averaging 200 feet wide. Destruction of 100 such rivers over the next century may not be viewed as an insignificant cumulative impact depending on services rendered. The Corps regulatory program has recently directed its attention toward reducing loss of stream habitat.

Population trends and environmental considerations suggest that the past rate of riverine impact could diminish. Because a large fraction of river impact is associated with bank erosion control, the extent of future erosion control is an important uncertainty for consideration. Future road and utility crossings also are important considerations. With projected declines in population growth rate and increasing limits on building near rivers, the need for more erosion control and road construction may be expected to decrease.

However, other environmental changes complicate forecasts. At least in some areas climate change could result in more erratic and higher erosive discharges, which may result in more structural engineering. On the other hand, such change might hasten changes in floodplain and river management policy that result in restoration of natural floodplains and river channels, possibly reversing the loss rate of riverine habitat. More control over development in floodplains and restoration of natural river flow and meander in floodplains is gaining ground in public acceptance and demand. These are factors that would help compensate for cumulative impacts from the discharge of dredged or fill material into riverine systems.

Despite what could become a small but significant cumulative impact on the geographical area of Nation's rivers, concentrated mostly near shore, the impact on natural function and value is more difficult to assess. While the impacted area often changes the local structure, the change rarely if ever results in total elimination of community function. Structural changes may locally alter functions but not degrade overall environmental service provided by natural stream and river communities. However, extensive and uniform structure can decrease spatial diversity resulting in altered habitat form and energetics that diminish natural service value. In other situations, certain natural services, such as those associated with sport fisheries, can be enhanced through modification of the impact activity or through other mitigation.

4.7.2.3 Lacustrine Impacts. Lake impacts in FY 1998 amounted to about 143 miles and 11.4 acres. Much of this impact was due to erosion control structures. All impact was in unvegetated shore zone or water over 6-feet deep. If the linear impacts average 5-feet wide, about 98 acres in total were impacted. This amounts to about 0.02% of the lake surface area in the United States that would be impacted in 100 years if impact continued at the same rate. Dahl (2000) indicated that over 10,000 acres of lake surface were created yearly during recent years, putting a loss of 110 acres per year in perspective. The rate of Corps permit impact may not continue to increase at the same rate for reasons similar to riverine erosion structures. Areal impacts may not indicate a complete loss of aquatic ecosystem function. Fill structure can provide substrate that supports community functions similar to the natural condition. The extent to which this is a mitigating factor, however, is not known.

4.7.2.4 Marine and Estuarine Impacts. Relatively small fractions of impact occurred in marine and estuarine environments. Of the data reported in feet for estuarine and marine shores, about 0.09% of the approximately 90,000 miles of near-shore environment were impacted in 1998. While small, over a century, this could accumulate to over 9% of the marine/estuarine shore, which could be significant depending on how the impact interfaces with shoreline dynamics. The linear measure may overstate the problem, however. If these impacts average about 5-feet wide, the total acreage of impact would be about 50 acres per year or about 5,000 acres over 100 years. However, added to the 191 acres lost yearly through activities authorized by Corps permits in marine and estuarine systems, about 21,000 acres might be permanently impacted over the next century. This is about 0.02% of the oceanic coastal zone as defined for coastal zone management of the conterminous States under the Coastal Zone Management Act. Therefore, activities in deeper waters probably amount to negligible effect on total function and value.

While the impact amounts to about 3.1% of an intertidal zone averaging about 100-feet wide, state laws typically closely regulate intertidal impacts. A common form of such an impact is the installation of erosion control structures, such as shore armoring. Fill structures may not totally negate community function in marine and estuary ecosystems. Depending on conditions, such material can be colonized and perform at least partial to near complete function. However, the extent to which this is a mitigating factor is not known. While this cumulative impact may appear minimal when considered against the dynamic changes associated with shoreline processes, the specific nature of the impact has some bearing as well as probable changes in coastal zone dynamics.

Conversion of shore to armored surface, for example, may interact negatively with possible changes in sea level resulting from climatic warming. Titus et al. (1991) estimated that a one-meter rise in sea level associated with global warming would inundate about 14,000 square miles, of which about half is existing wetland. Because of the rapidity of sea-level rise and the construction of various artificial structures along shore, such as erosion control structures, they anticipated substantial loss of wetlands if nothing were done to counter the effect. Dahl (2000) assigns a significant amount of recent coastal wetland loss to intrusion of deep water. Projections of sea-level rise are based on uncertain estimates of climate change, its impact on relative sea rise, rates of wetland adaptation to the changes, and coastal zone management practices. Compared to the several million acres of wetlands possibly at risk from sea-level rise, the uncertainty of anticipated losses from Corps permitted impacts appears trivial. Also, any mitigation action along shore would face the uncertainties associated with sea-level change. Considering the degree of uncertainty in background conditions determining cumulative impacts, the cost-effectiveness of more accurate accounting and analysis appears unwarranted at this time.

4.7.3 Wetlands Impacts

Table 4.7-1 illustrates that the cumulative impact on wetlands depends greatly on the level of mitigation success realized, assuming that development will continue as it has. If mitigation success is 30%, and all other existing trends remain constant, impacts permitted under the Corps program would result in the loss of over 1.7 million acres of wetland by 2100 AD. Present measures of success vary widely and make it difficult to estimate actual success. Progress is being made, however, both in monitoring success and in making more effective decisions for sustaining wetland area, function and value. If mitigation success can be raised to 80% or more, the Corps program would sustain wetland acreage, all else remaining constant. Meanwhile, the increase in program mitigation ratio in years since FY 1998 has been a move in the right direction for accommodating the uncertainty in mitigation success.

However, even with such success, wetland functions and services may not be sustained across all wetland types equally. Absence of data about wetland impacts in subsystem or class categories makes analyses more uncertain in this respect. Because activities authorized by Corps permits disproportionately cause impacts in palustrine and riverine wetlands, the functions and services associated with those systems are of greatest concern in analyzing environmental impacts. Based on mitigation ratios in different nationwide permit types, mitigation is required most frequently in palustrine wetlands and less often in fringe wetlands of other systems. Even though impacts may be low in estuarine and marine systems, they may actually lose area, functions and values under the Corps permit program, as the palustrine wetlands are sustained or even gained. Less can be discerned about lake and river wetlands, but we suspect they too may be lost as more isolated wetlands are sustained.

The relative values of aquatic natural services suggest that perhaps a bias toward favoring emergent palustrine wetlands is appropriate. Based on monetary values alone, inland wetlands average close to twice the value per acre of tidal wetlands and other coastal ecosystems. Thus, impacts associated with the Nation's waters and wetlands disproportionately affect what appear to be the most valued wetlands, but mitigation appears to compensate most of those wetland types. Values estimation must be considered with caution, however, because of poor representation and sample size of the valued wetlands (see Appendix C.10). There is an obvious need for improved values estimation and accounting, which should influence future willingness to mitigate more effectively, if wetland values remain even a fraction of what some estimates make them to be.

Types of wetlands also vary greatly in relative frequency and extent of occurrence. Some wetland types are quite scarce and localized while others are very widespread. Many of the ecosystems declared endangered by Noss et al. (1995) are wetlands. The unique services of those scarce wetlands also are scarce, such as habitat provision for scarce plant and animal species. Scarcity typically raises the service value of wetlands both because of increasing demand for diminished service and because of the protection value that accrues as the threat of service extinction grows. However, these values are among the most difficult to estimate and cannot be readily translated into monetary terms using widely accepted techniques.

4.7.4 Sources of Error in Cumulative Analysis

Any estimate of cumulative impact compounds any systematic error associated with the impact estimation. As this Chapter has pointed out many times, the uncertainty in estimates is large and derives from numerous sources mentioned in this history and summarized in Appendix Table C.5.10-1.

Direct impacts of nationwide permits in waters other than Corps-defined wetlands are small but could accumulate to significant areas of impact over the next century, especially along river shores. The dimensions of error in impact measurement are substantial, however, and have considerable effect on the estimated cumulative impact. Especially important is the error associated with assumptions that mitigation works effectively to replace ecosystem function, service, and value. Many other sources of error are comparatively minor issues that can be addressed in future database maintenance. In many instances, areas recorded as permanently and totally impacted areas can function at least in part like the previous state. While impacts to other waters appear unlikely to have any more than minimal impact over the next century, mitigation action may not be applied as often and extensively as it could be.

4.8 Chapter Summary

- The ecological environment affected by the Corps permit program includes all of the Nation’s waters and wetlands as defined in the Clean Water Act. Also affected are upland areas that have significant influence on aquatic ecosystem function and often are impacted to mitigate for aquatic impacts.

- The intent of Section 404 of the Clean Water Act is to minimize negative impacts on the Nation’s waters through avoidance, minimization and, when impact is unavoidable, through compensatory mitigation by ecosystem creation, restoration, protection and enhancement.

- Dahl’s (2000) investigation of past rates of change in acreage of aquatic habitat indicates that net loss of wetland has slowed greatly since the 1950s. The NRCS (2000) investigation indicates the most recent rate of loss is about 32,600 acres per year. Emergent herbaceous and forested freshwater wetlands are disappearing most rapidly while open-water pond and lake surface are increasing.

- Data gathered by the Corps permit program in FY 1998 indicates that about 31,000 acres were impacted by fill, of which about 80% was in wetland (impact estimates in wetlands are, however, more reliable than impact estimates for other waters). Compared to an estimated 16,600 acres per year of wetland lost to development, regulated primarily by the Corps, the Corps estimated 26,500 acres of wetland filled under the permit program appears high and may be overestimated.

- The percentages of Corps permitted impacts in tidal and nontidal wetlands are similar even though the totals differ greatly because of the much greater abundance of nontidal wetlands. Nationwide permit impacts amounted to 27% of the total program permitted impact and averaged half as large individually. Standard permits authorized about 65% of the total impact.

- Apparently high unnecessary reporting of zero impacts and extrapolation of the distribution of impacts in impact size categories indicates that perhaps a small total acreage of impacts is authorized under nationwide permit notification thresholds, perhaps 5% more than recorded impacts.

- Compensatory mitigation is an important variable in the accounting of impact and early mitigation efforts required by the Corps permit program may explain part of the lower rate of loss estimated by the NRCS (2000) as a consequence of development. The estimated mitigation ratio for FY 1998 was between 1.30 and 1.58 depending on how estimates are calculated.

- There was no evidence that compensatory mitigation ratios varied with impact size. However, evidence indicated that compensatory mitigation favored palustrine wetlands and was not resulting in in-kind replacement of function and value for other wetland types.

- Corps permit compliance checks indicate high compliance with permit requirements, including initiation of compensatory mitigation. Compensatory mitigation success, however, is quite uncertain based on a review of studies conducted primarily outside the Corps. Estimated success varies widely for both ecological reasons and inconsistent standards used among studies. Most studies indicate between 30 and 90% success.

- All permit types had low permit denial rates, the highest being standard permits with 1.7% of permits denied. Denials for nationwide permits were either “without prejudice” indicating that the permits would eventually be issued once state water quality certifications were obtained or were indication of reclassification to standard permit status. The relatively high standard permit denial rate reflected the determination of greater impact than allowed with the other permit types. Processing of nationwide permits and standard permits worked together to assure denial of permits when irreplaceable resources were threatened.

- Estimated economic values of natural services confirm the importance of wetland ecosystem services compared to other water resource services and to upland ecosystem services. Values within systems vary widely, however. Whereas wetland and deep-water habitats appear to have substantially greater natural service values, the differences between aquatic systems are much less certain.

- Nationwide permits impose compliance costs on permit applicants. Permit applicants incur costs to complete permit applications and comply with permit conditions. They also incur costs associated with delay of the proposed project during permit evaluation. These costs can be referred to as opportunity costs. Applicants may incur other costs associated with foregone opportunity, e.g., when project alteration results in reduced project size and thus reduced potential development value.

- Nationwide permits require Federal expenditures to review those permits. However, the nationwide permit process allows the Corps to spend more time on impacts that cause more than minimal effects. Other agencies (Federal or state) involved in the coordination process also bear costs. The PEIS does not examine those costs.

- High uncertainty in the effectiveness of compensatory mitigation actions and environmental trends makes any assessment of cumulative impact of the Corps permit program highly speculative. Rapid rates of climate change, sea-level change, urbanization, and attitudes toward the environment all contribute to the uncertainty. Improvement in compensatory mitigation success is crucial.

- Even so, impacts continue to accrue depending on compensatory mitigation success. Future improvement of compensatory mitigation action is critical both through elevated mitigation ratios and more emphasis on preservation in the short run (where impact is iminent) and through improved mitigation process in the long run. Increases in program mitigation ratio since FY 1998 indicate recent progress.

- Numerous improvements can be made in Corps program database to better evaluate program effectiveness.