Chapter 7

Cumulative Impacts to Wetlands and the Need for a New Approach

"Evidence in increasing that the most devastating environmental effects may result, not from the direct effects of a particular action, but from the combination of individually minor effects of multiple actions over time." (Council of Environmental Quality 1997)

7.1 Reader's Guide to This Chapter

This chapter introduces the concept of "cumulative impacts" to represent the incremental losses and degradation of wetlands that continue in spite of all the existing regulatory and non-regulatory actions we are taking to protect them. The chapter discusses different types of cumulative impacts and the loss of wetland area as the most easily assessed measure of cumulative impacts. It goes on to present some of the causes of cumulative impacts in Washington.

The synthesis of the scientific literature in Chapters 2, 3, and 4 has clearly established that wetlands do not function in isolation from the landscape that surrounds them. A wetland's ability to provide certain functions is influenced by the conditions and land uses within their contributing basins, especially by the patterns of water flow and movement that can be changed by different land uses. Existing wetland regulations usually are structured so decisions are made on an application by application basis. There are no provisions for assessing or considering the implications of individual decisions on the resource in general. The information presented in previous chapters demonstrates that project-by-project decisions cannot adequately address the complexities of wetland systems, and new approaches are needed to reduce the continued impacts to wetlands.

7.1.1 Chapter Contents

Major sections of this chapter and the topics they cover include:

Section 7.2, Loss of Wetlands as an Indicator of Cumulative Impacts describes the total wetland losses in Washington and three studies in the Pacific Northwest that illustrate more recent loss.

Section 7.3, Types of Cumulative Impacts describes how cumulative impacts result from disturbances related to geography and time that are not adequately managed. It lists types of cumulative impacts such as fragmentation and time lags.

Sections 7.4, Causes of Cumulative Impacts in Washington describes how the current approach to wetland management and protection results in cumulative impacts. The causes discussed include case-by-case permitting, lack of consistency between jurisdictions, and implementation of local programs for protecting wetlands through regulations. Different types of cumulative impacts are listed along with examples of possible causes from inadequate protection at the local level.

Section 7.5, Chapter Summary and Conclusions ties together the major concepts presented in the chapter.

7.1.2 Where to Find Summary Information and Conclusions

One summary is provided at the end of the chapter, along with the authors' conclusions. The reader is encouraged to remember that a review of the entire section preceding the summary is necessary for an in-depth understanding of the topic.

7.1.3 Sources and Gaps in Information

Much of the literature published on the topic of cumulative impacts is not specific to wetlands. Most of the research has been focused on environmental processes that affect biodiversity (i.e., habitat loss, fragmentation, metapopulations). The available information is weighted toward the impacts of some types of land use (urbanization and forest practices), with less information available on the impacts from other types of land use (agricultural practices, mining).

The 1997 Council of Environmental Quality report (Executive Office of the President) is a key document on cumulative impacts in general, and it provides a good summary of how land uses can cause cumulative impacts. This document is available on the internet at: http://ceq.eh.doe.gov/nepa/ccenepa/ccenepa.htm . This information can be applied to the protection and management of wetlands in the state.

The information available that specifically addresses wetlands is very general in nature and addresses cumulative impacts to wetlands only in terms of direct loss of wetland area, not the changes in functions that might result from changes in environmental processes at the landscape scale.

There is a significant gap in information regarding the cumulative impacts to wetlands and their functions resulting from the current approaches to managing wetlands at any level of government. The gap regarding the cumulative impacts and local protection programs is especially significant. The legal framework within Washington State (see Chapter 2 in Volume 2), delegates the decisions about land use, including comprehensive planning, designation of zoning, and regulation of critical areas, to local governments. As the information synthesized in Chapters 2-4 of this document has shown, decisions that change land uses can cause impacts to wetlands. However, little research has been conducted on the effectiveness of local efforts in effectively planning for and protecting wetlands, thereby preventing cumulative impacts. Only two studies were found that

review the effectiveness of local protection programs for wetlands, and they dealt with specific topics relating to regulations: standards for compensatory mitigation in King County and buffer requirements in the critical area ordinances of local jurisdictions in Washington in 1999 (See section 7.4.3).

Some hypotheses about the effectiveness of local programs, however, can be made by correlating the findings of the relevant literature with different aspects of the regulatory framework for wetlands used by local governments. The scientific information provides ample guidance on what is needed to protect wetland functions (e.g., planning to address and protect landscape processes, providing adequate buffers, modifying current practices of compensatory mitigation). A comparison of this information to the usual standards found in current programs can provide insights about the effectiveness of these programs. If they do not provide the range of measures for protection that are suggested by the scientific literature, it can be hypothesized that those programs may not be providing adequate protection to prevent cumulative impacts and assure long-term sustainability of wetlands.

What are Cumulative Impacts?

Cumulative impact, as defined by the Council on Environmental Quality, "is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." http://ceq.eh.doe.gov/nepa/regs/ceq/1508.htm#1508.1

Cumulative impacts also have been described by Hemond and Benoit (1988) as follows: "Wetlands are frequently subject to multiple impacts over time and/or space; the effects of such multiple impacts may be simply additive, or the total effect may be more severe than the sum of the effects of the individual impacts alone. Cumulative impact as used here refers to multiple impacts whose effects on the wetland cannot be predicted by simply adding the effects of all the individual impacts."

7.2 Loss of Wetlands as an Indicator of Cumulative Impacts

The loss of wetland area that continues to occur as a result of human activities is a general indicator that cumulative impacts are occurring. A net loss of wetland area and the functions it supports is a measure of the incremental impacts of human activities that are not adequately addressed. At the national level, wetlands continue to be lost, according to a report released by the National Research Council (1995). The U.S. Environmental Protection Agency states that although wetland loss rates are slowing, the United States continues to lose approximately 70,000 to 90,000 acres (28,300 to 36,400 ha) of wetlands on non-federal, rural lands each year (U.S. Environmental Protection Agency 2002).

Here in Washington, the state has lost an estimated 31% of its 1.35 million acres (55 million ha) of wetlands up to the 1980s (Dahl 1990). Recent data on total wetland losses in the state are not available, but three studies in the Pacific Northwest illustrate that the loss of wetlands continues:

- Bell (2002) studied sphagnum-dominated peatlands that were originally mapped by Rigg in the early 1950s in King County. Bell found a 69% loss of these wetlands since 1958. Of 26 sites, six remained relatively undisturbed. Eight showed a decline in acreage and quality of plant communities. Five wetlands are now highly disturbed with no sphagnum moss present. The remaining seven wetlands were either drained or filled. Of the 406 acres (162 ha) present in 1958, only 125 acres (50 ha) remain today. The losses were due to agricultural conversion, development, and peat mining.
- A study of recent losses of wetlands within the Willamette Valley, Oregon, found that from 1981/1982 to 1994 there was a loss of approximately 9,500 acres (3,800 ha) of wetlands, representing approximately a 2.1% loss of wetlands within the Willamette Valley study area. They found that 70% of the loss was attributable to agriculture, 6% was associated with the impacts of urbanization, and 24% was attributable to other unidentified causes (Bernert et al. 1999).
- A study conducted by Holland et al. (1995) in the greater Portland, Oregon, area found that 40% of the wetlands identified in the National Wetland Inventory of 1981/1982 were missing in 1992. They attributed most of the loss to the impacts of urbanization, yet they still attributed 31% of the losses to agricultural conversion. One conclusion of their study was that small, often isolated wetlands were lost due to decisions regarding single-project permits that did not take into account the overall pattern of wetland loss.

In addition to the direct loss of wetlands, alterations have occurred from human activities such as diking, draining, and agricultural practices (Washington State Department of Natural Resources 1998). These changes, even if apparently small on an individual basis, can have a cumulative impact on the functions of wetlands.

7.3 Types of Cumulative Impacts

Cumulative impacts result from the spatial (geographic) and temporal (time) crowding of disturbances that are not adequately managed. The impacts of a disturbance can be compounded when a second disturbance occurs at a site before the ecosystem can fully recover from the effect of the first disturbance (Council of Environmental Quality 1997). The scientific community has not yet agreed on a standard definition or method for assessing cumulative impacts because of the diversity of disturbances, the complexity of environmental processes, and the diversity of impacts possible (Council of Environmental Quality 1997). Nonetheless, the Council was able to identify eight scenarios (types of cumulative impacts) by which cumulative impacts occur (Table 7-1). These types are discussed further in Section 7.4.4 (Table 2) in relation to various causes of cumulative impacts in Washington.

Table 7-1. Types of cumulative impacts (modified from Council of Environmental Quality 1997)

Type of Cumulative Impact	Main Characteristics	Examples of Cumulative Impacts
Time crowding	Frequent and repetitive disturbances before the ecosystem has recovered from previous disturbance	Changes in the water regime that increase the depths of water and duration of flooding that, in turn, drowns vegetation not tolerant to prolonged inundation
Time lags	Impacts of disturbance are delayed from the time the disturbance occurs	Changes in water regime that causes a slow shift in the vegetation to species not suitable as sites for laying amphibian eggs
Space crowding	Impacts are occurring in close physical proximity to each other	Construction of new roads and commercial land uses on opposite sides of a wetland, resulting in increased human disturbances, such as noise, lighting, and less upland habitat
Cross-boundary	Impacts occur away from the source	Eutrophication in wetlands and lakes that results from discharges of nutrients in upper watershed
Fragmentation	Changes in the pattern of ecosystems across the landscape	Construction of a subdivision with roads interrupts the natural pathways used by animals for movement between patches of habitat
Compounding effects	Impacts arising from multiple sources or pathways	A small buffer reduces the upland habitat needed for wildlife that is closely associated with wetlands and that allows intrusion by humans and domestic pets
Indirect effects	Additional disturbances that result from changes in human activities that themselves are a result of the initial disturbance	The additional impacts that result from development after roads or other infrastructure are built. The building of a road has direct impacts but also changes human activities that cause additional ones.
Thresholds and triggers	The accumulation of disturbances causes a fundamental change in the behavior of the ecosystem	Changes in land use result in increased surface runoff that causes streams to become incised. As a result, wetlands become disconnected from the floodplain.

7.4 Causes of Cumulative Impacts in Washington

Some of the causes of cumulative impacts on wetlands stem from how wetlands are regulated in Washington State, and how local governments plan for future land use and development. Local city or county governments generally have the authority to plan for, manage, and otherwise regulate land uses within their jurisdictional boundaries, including those within and adjacent to wetlands. They may regulate what occurs directly in a wetland and, in many cases, they regulate land uses adjacent to a wetland and its buffer (see Volume 2). Federal and state agencies may regulate many direct impacts to wetlands. However, state and federal agencies do not regulate all activities that take place in wetlands and do not regulate land uses in the uplands around a wetland. They also don't provide the comprehensive planning and inter-jurisdictional coordination that affects cumulative impacts. Thus, federal and state agencies that regulate wetlands do not manage, and cannot protect, all wetlands nor many of the landscape processes that influence the functions that wetlands provide.

7.4.1 Case-by-case Permitting as a Cause of Cumulative Impacts

Wetlands in Washington are primarily managed by local jurisdictions through regulations that are implemented on a case-by-case or permit-by-permit basis. Proposed actions are often reviewed and approved without a legal authority or mechanism to assess how previous, relevant decisions may have impacted wetlands and caused cumulative impacts. Each action also is not typically reviewed in the context of impacts to associated landscape processes that may result in cumulative impacts.

On a national level, there is information on the relation between case-by-case decision-making and cumulative impacts. One of the reasons often cited for the failure of site-specific management to adequately protect aquatic resources is the inability of such an approach to address cumulative impacts (Johnston et al. 1990, U.S. Environmental Protection Agency 1999, Dale et al. 2000).

The literature has clearly identified that environmental regulations that are implemented on a permit-by-permit basis have a substantial cumulative impact. This occurs because the permit-by-permit approach fails to identify and account for the landscape processes that create and maintain wetlands (Wissmar and Beschta 1998). In the late 1980s, Bedford and Preston (1988) observed, "The incongruity between the regional scales at which wetland losses are occurring and the project-specific scale at which wetlands are regulated, and also studied, has become obvious." Failure to address the landscape processes results in two types of cumulative impacts (see Table 7-1) that are based on larger, geographic scales - cross-boundary impacts and fragmentation.

Bedford and Preston (1988) note that making decisions on a project-by-project basis fails to evaluate the potential impacts within the spatial and temporal scale within which ecosystems function. They state that, although project-by-project decision-making

> *. . . allows evaluation of the local impacts on resources, it does not allow evaluation of impacts of the project on these resources as a whole, of the total impact on these resources from all anthropogenic disturbances, or of secondary impacts resulting from the interaction of impacts from the project with other anthropogenic disturbances. This is true because the spatial and temporal boundaries of the analysis have not fully enclosed spatial and temporal dynamics of the environmental resources of concern and the anthropogenic activities influencing them.*

These authors recognize that impacts can be generated not only from project-specific actions, but they can also result from actions that occur out of time and outside the vicinity of the activity that may be under scrutiny for a particular project. This results in two types of cumulative impacts described on Table 7-1, time-lags and indirect effects.

Others, such as Everard (1999), are concerned that regulating wetlands and other aquatic resources without considering landscape processes creates the illusion that the resources are being protected by case-by-case management decisions. The ramifications of this misconception include:

- Assumptions by the public that current land-use regulations and management decisions are adequate to protect aquatic systems
- The public perception that protection of aquatic resources is an ongoing financial burden
- The assumption that current regulations are adequate eliminates any incentive or perceived need to assess or modify existing policies and/or regulatory programs

Cumulative effects of decisions made project-by-project: An analogy

Understanding the implication of cumulative impacts from a project-by-project perspective rather than one at a landscape scale may seem abstract given the complexity of how the environment functions in the landscape. The following analogy is offered to provide an alternative description of cumulative effects and the need to manage natural resources using a landscape approach. Credit for the following analogy was given to Gosselink and Lee by Preston and Bedford (1988):

Imagine a Renaissance mosaic of a mother and child, composed of beautiful tiles of various shapes and colors. As it has aged the mosaic has begun to lose tiles. As managers responsible for the mosaic, we have to determine which of the tiles to preserve and reinforce, which to attempt to restore, and which we will allow to be further damaged or even destroyed. Our objective is to attempt to preserve the highest value for the mosaic. Using a tile-by-tile decision method (the project-by-project impacts assessment), each tile would be assessed separately and individually for its intrinsic value. Each decision for a tile would not consider the other nearby tiles, nor even how the tiles fit into the whole image. This strategy would very likely not preserve the image of the mother and child. Yet, it is the image that gives the mosaic its inherent value, not the sum of the individual tiles. If one is to preserve the value of the image, then one needs to be able to determine the relative significance of each individual tile relative to each other tile and to the image as a whole.

7.4.2 Lack of Consistent Plans and Regulations between Jurisdictions as a Possible Cause of Cumulative Impacts

The approach of managing wetlands on a permit-by-permit basis described in the previous section is the best documented cause of cumulative impacts. There are other aspects, however, of the regulatory framework in Washington that can be hypothesized to cause cumulative impacts. A possible source of cumulative impacts is the lack of consistent regulations between jurisdictions to protect and manage landscape processes that occur across jurisdictional boundaries. One jurisdiction may manage water flows from impervious surface, but another one that is further upstream may not manage such flows. Or, one jurisdiction may provide a 200-foot buffer on a reach of riparian wetlands while the adjacent jurisdiction may only provide a 50-foot buffer on the same reach.

In Washington State, most local jurisdictions have development codes that establish the regulatory framework for land use in all areas including wetlands. These codes are based on the objectives developed for each jurisdiction. Adjacent jurisdictions may have quite different objectives for managing the resources and therefore adopt distinctly different codes and regulatory protection. A common inconsistency in regulatory protection is the use of different wetland rating systems that result in variable levels of protection. For example, the city of Tukwila in King County has adopted a rating of wetlands into three categories (Critical Areas Ordinance #2074, December 13, 2004) while King County has adopted a four category rating system (Final Critical Areas Ordinance 15051, Adopted

October 29, 2004). The levels of protection assigned each of the wetland categories is also different. Disparities between rating systems may result in different levels of protection to different portions of the same wetland if it crosses jurisdictional boundaries. It is also quite possible that different buffer widths and different ratios for compensatory mitigation could be required for different parts of the same wetland in adjacent jurisdictions. Such discrepancies therefore can result in cumulative impacts across boundaries.

The failure to address the landscape processes consistently can result in two types of cumulative impacts (see Table 7-1) that are based on larger geographic scales - cross-boundary impacts and fragmentation. The differences in rating systems can result in "cross-boundary" impacts while the example of the different buffers for riparian wetlands would cause impacts from fragmentation.

7.4.3 Implementation of Regulatory Programs at the Local Level as a Possible Cause of Cumulative Impacts

Currently, there is little published information on the possible cumulative impacts that may result from the implementation of regulatory programs by local jurisdictions. For example, there is no documentation on the impacts of:

- Exempting wetlands from protection based on size (e.g., wetlands smaller than ¼ acre are not being regulated at all). Such exemptions can be hypothesized to cause cumulative impacts such as fragmentation and exceeding thresholds of ecosystem viability if there are many small wetlands within a jurisdiction.
- Exempting wetlands based on isolation (e.g., isolated wetlands are those that do not have a surface water connection to other water bodies). Such exemptions can be hypothesized to cause cumulative impacts such as fragmentation and exceeding thresholds of ecosystem viability if there are many isolated wetlands within a jurisdiction.
- Inadequate provisions for protection (e.g., inadequate buffer widths). This can be hypothesized to cause cumulative impacts such as "compounding effect" where an inadequate buffer reduces the habitat for species that need the buffer, as well as by introducing additional disturbances from adjacent development.
- Using standards for compensatory mitigation that are inadequate to ensure replacement of wetland area and/or function. This will result in all types of cumulative impacts because there is a continued loss of wetlands and their functions.

Scientific information synthesized in this document provides guidance on what should be used to effectively protect wetland functions (e.g., landscape approaches, buffers, mitigation standards). See Volume 2 in this two-part series for details regarding specific recommendations. To assess the effectiveness of local programs, we can, therefore, compare the requirements developed by local jurisdictions against what natural resource experts say is needed. The information available suggests that local programs do not

provide the level of planning and protection needed to maintain existing functions and address cumulative impacts.

Two studies in Washington provide more direct information regarding this issue. A King County study (Mockler et al. 1998) concluded that standards for compensatory mitigation implemented by the county were significantly less than what was necessary to meet the goal of no net loss of function or area. In addition, data from the Washington State Department of Community, Trade and Economic Development (CTED) addresses the adequacy of buffer requirements by local governments in Washington. The department collects data on the buffer requirements in critical area ordinances of cities and counties in Washington. In the last such survey in 1999 (Chris Parsons, CTED, personal communications 1999, data are available on request from CTED), the buffers for wetlands were considerably narrower than what the scientific information indicates is necessary to protect many functions. Of the 128 jurisdictions in Washington that specify a numeric buffer width, 99 had buffers of 100 ft or less on wetlands that rate high for their habitat functions. The summary of the scientific information provided in Chapter 5 indicates, however, that most habitat functions are not adequately protected by this buffer width.

Additionally, no city or county in Washington has developed and implemented a landscape-based approach to assessing and protecting wetlands. The scientific information summarized by the Ecological Society of America (Dale et al. 2000) and by the Council of Environmental Quality (1997) indicates that a landscape-based approach is necessary to minimize cumulative impacts.

Thus, it is reasonable to hypothesize that existing wetland protection programs, as implemented in Washington, are not adequately protecting wetland functions and values, and cumulative impacts are resulting.

7.4.4 Relating the Types of Cumulative Impacts to Measures Taken by Local Governments

The list of types of cumulative impacts listed in Table 7-1 can be related to inadequacies of the measures taken to protect wetlands at the local level that have been documented or that can be hypothesized. Examples of the different types of cumulative impacts and examples illustrating these inadequacies are provided in Table 7-2. The inadequacies span the realms of planning, coordination, and regulation.

Table 7-2. Types of cumulative impacts and examples of factors at the local level that might cause the impacts.

Type of Cumulative Impact	Main Characteristics	Examples of Cumulative Impacts	Examples at the Local Level That Might Cause This Impact
Time crowding	Frequent and repetitive disturbances before recovery has occurred from previous disturbance	Reoccurring flooding that drowns vegetation that is not adapted to prolonged inundation	Inadequate storm-water regulations that do not address impacts on wetlands of changes in water regime
Time lags	Impacts of disturbance are delayed	Exposure to toxics	No provision for regulating the use of chemicals on residential lawns draining to wetlands
Space crowding	Impacts are occurring in close proximity to each other	Construction of new highways and high-density commercial zones on both sides of a wetland, resulting in increased noise, lighting, and human presence	No provision for planning at the landscape scale that allows the identification and adequate protection of critical landscape linkages between habitats
Cross-boundary	Impacts occur away from the source	Eutrophication in wetlands and lakes that results from nutrient discharges in upper watershed	Lack of coordination among jurisdictions in controlling nutrient inputs to a watershed
Fragmentation	Changes in the pattern of ecosystems across the landscape	Distribution and size of wetlands across the landscape is reduced	No planning at a landscape scale that identifies key landscape processes and incorporates appropriate management options. Permits are issued on a case-by-case basis
Compounding effects	Impacts arising from multiple sources or pathways	Construction of roads, stormwater facilities, and high density commercial development after an approved rezone	The lack of authority to adequately assess potential long-term effects to landscape processes when changing the potential land use of a parcel or area
Thresholds and triggers	The accumulation of disturbances causes a fundamental change in the behavior of the ecosystem	Increased surface runoff causes streams to be incised and wetlands become disconnected from the floodplain	Permit-by-permit decision making precludes the ability to regulate known or anticipated cumulative effects, unless the regulatory framework is in place

7.5 Chapter Summary and Conclusions

Loss of wetland area and alteration of wetland functions due to human activities are indicators that cumulative impacts are occurring. Wetland losses continue to occur on a national level. The few studies done in the Pacific Northwest suggest that losses continue to occur in the region as well.

The Council on Environmental Quality has identified seven types of cumulative impacts: time crowding, time lags, space crowding, cross-boundary, fragmentation, compounding effects, thresholds and triggers.

Some of the causes of cumulative impacts include the following:

- Permit decisions made on a case-by-case basis. The scientific information available has clearly identified that environmental regulations that are implemented on a permit-by-permit basis have substantial cumulative impacts.
- Lack of consistent regulations between jurisdictions. Local governments vary in the protection they provide to wetlands or to different parts of the same wetland if it crosses political boundaries. Therefore, the same wetland may be subject to a variety of policies and regulatory standards. Differing standards can result in cumulative effects and loss of wetland functions across the landscape.
- Insufficient protection at the local level. Most cities and counties in Washington have historically required buffers that are considerably less than what the research indicates are necessary to protect functions.
- The lack of planning at a larger geographic scale. The scientific information shows that a landscape-based approach is needed to effectively manage wetlands. However, no local government in Washington has developed and implemented a landscape-based approach to assessing and protecting wetlands.

Based on the synthesis of the scientific literature, combined with the knowledge of the standards for protection and how land-use decisions are currently made, it can be hypothesized that current protection programs result in cumulative impacts to wetlands.

Improvements in the way wetlands are protected and managed, and therefore how cumulative impacts can be avoided, is the subject of the second volume in this two-part series. It provides guidance in regard to:

- Implementing a four-part framework for protecting and managing wetlands
- Analyzing the landscape and its wetlands
- Using landscape information in developing plans and policies, and incorporating these into comprehensive planning
- Developing and improving tools typically used in local regulations (rating, buffers, compensatory mitigation, etc)

- Developing and improving non-regulatory tools such as preservation, conservation, and restoration
- Identifying the risks from proposed or existing programs
- Implementing programs
- Monitoring wetland protection and management measures that have been implemented, and adapting programs to address the inadequacies identified

The reader is referred to Volume 2 for suggestions regarding solutions to the problem of cumulative impacts.