United States
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Identifying and Protecting Healthy Watersheds

Chapter 1. Introduction

February 2012

1. Introduction

Introduction

This chapter introduces the Healthy Watersheds Initiative, discusses the characteristics of a healthy watershed, and reviews the benefits of protecting healthy watersheds. This chapter also describes the purpose, target audience, and intended use of this document.

Overview of Key Concepts

This chapter describes the healthy watersheds conceptual framework. It then discusses, in detail, each of the six assessment components – landscape condition, habitat, hydrology, geomorphology, water quality, and biological condition. A sound understanding of these concepts is necessary for the appropriate application of the methods described in later chapters. This chapter concludes with a discussion of watershed resilience.

Examples of Assessment Approaches

This chapter summarizes a range of assessment approaches currently being used to assess the health of watersheds. This is not meant to be an exhaustive list of all possible approaches, nor is this a critical review of the approaches included. These are provided solely as examples of different assessment methods that can be used as part of a healthy watersheds integrated assessment. Discussions of how the assessments were applied are provided for some approaches. Table 3-1 lists all of the assessment approaches included in this chapter.

Healthy Watersheds Integrated Assessments

This chapter presents two examples for conducting screening level healthy watersheds integrated assessments. The first example relies on the results of a national assessment. The second example demonstrates a methodology using state-specific data for Vermont. This chapter also includes examples of state efforts to move towards integrated assessments.

Management Approaches

This chapter includes examples of state healthy watersheds programs and summarizes a variety of management approaches for protecting healthy watersheds at different geographic scales. The chapter also includes a brief discussion of restoration strategies, with focus on targeting restoration towards degraded systems that have high ecological capacity for recovery. The results of healthy watersheds integrated assessments can be used to guide decisions on protection strategies and inform priorities for restoration.

1.1 Background

The stated objective of the Clean Water Act (CWA) is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (33 U.S.C. Section 1251(a); CWA Section 101(a)). Since the 1972 amendments to the CWA (known then as the Federal Water Pollution Control Act), federal water quality regulations have led to significant reductions in pollutant levels in many impaired lakes, rivers, and streams. Further, significant efforts have been undertaken to restore aquatic ecosystems in our nation's impaired watersheds. Despite these efforts, our aquatic ecosystems are declining nationwide (Figure 1-1). This trend has been documented by many, including the Heinz Center (2008) and the American Fisheries Society (Jelks et al., 2008). Further, the rate at which new waters are being listed for water quality impairments exceeds the pace at which restored waters are removed from the list (Figure 1-2), and restoring impaired waters is costly (Table 1-1). In addition to pollution, threats such as loss of habitat and its connectivity, hydrologic alteration, invasive species, and climate change continue to increase. A better strategy is needed if we are to achieve the objective of the Clean Water Act.

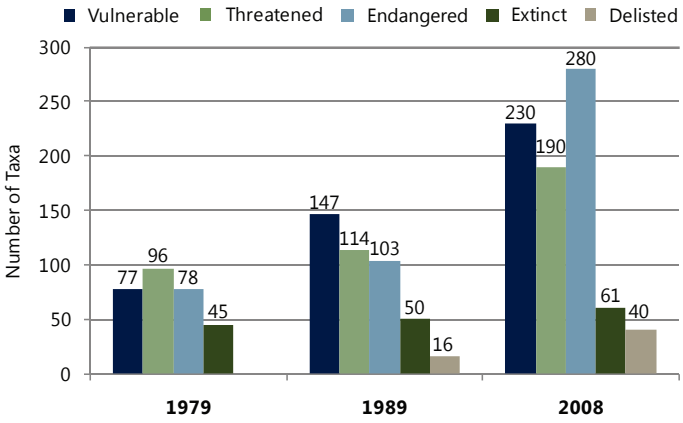


Figure 1-1 Numbers of imperiled North American freshwater and diadromous fish taxa (modified from Jelks et al., 2008).

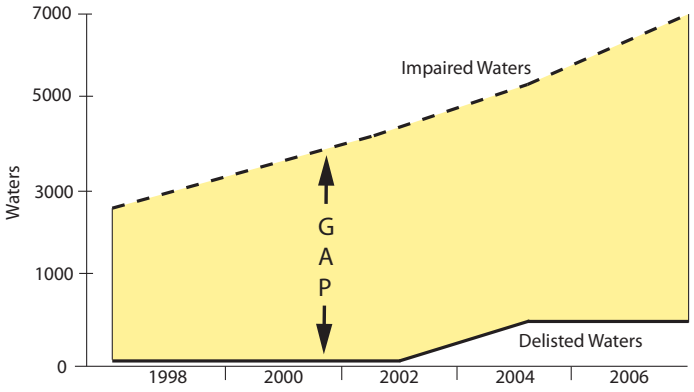


Figure 1-2 Gap between impaired and delisted waters in EPA Region 3.

Table 1-1 Estimated cost of pollutant cleanup in the Chesapeake Bay Watershed (EPA Region 3).

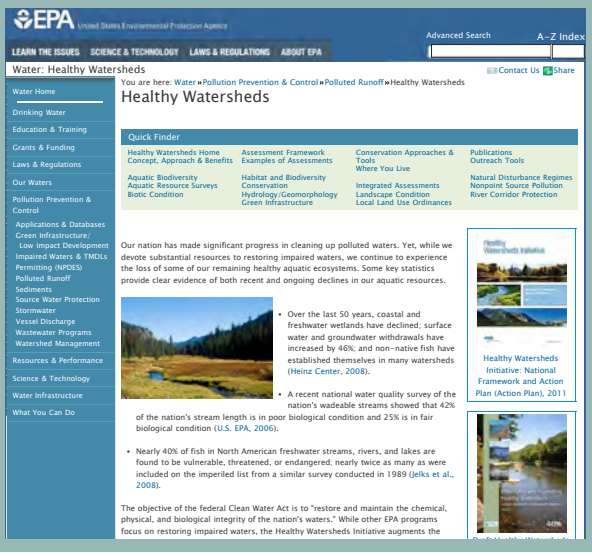
Water Body	Impairment	Miles	Cost	Average Cost/Mile
Corsica River, MD	Nutrients	7.6	$17,500,000	$2,302,632
Little Laurel Run, PA	Metals	3	$1,048,013	$349,338
Conewago Creek, PA	Nutrients	17	$4,300,000	$252,941
Bear Creek, PA	Metals	5	$964,000	$192,800
Catawissa Creek, PA	Metals	57.9	$3,500,000	$60,449
Thumb Run, VA	Bacteria	17	$2,450,000	$144,118
Willis River, VA	Bacteria	30	$2,794,160	$93,139
Muddy Creek, VA	Bacteria	9	$2,612,000	$290,222

1.2 Healthy Watersheds Initiative

The Section 101(a) objective of the CWA is "…to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The Committee Report written in support of the 1972 Federal Water Pollution Control Act amendments clarified that the term *integrity* "…refers to a condition in which the natural structure and function of ecosystems is [sic] maintained," rather than simply improving water quality in a narrow sense (U.S. Government Printing Office, 1972; Doppelt, Scurlock, Frissell, & Karr, 1993). The U.S. Environmental Protection Agency (EPA), in partnership with others, launched the Healthy Watersheds Initiative to protect and maintain remaining healthy watersheds having natural, intact aquatic ecosystems; prevent them from becoming impaired; and accelerate restoration successes. This initiative is being implemented by promoting a strategic, systems approach to identify and protect healthy watersheds based on integrated assessments of habitat, biotic communities, water chemistry, and watershed processes such as hydrology, fluvial geomorphology, and natural disturbance regimes. Once healthy watersheds or healthy components of watersheds are identified, priorities can be set for protection and restoration, with the best chances of recovery likely to be in waters near existing healthy aquatic ecosystems (Roni et al., 2002; Norton et al., 2009; Sundermann, Stoll, & Haase, 2011).

EPA's Healthy Watersheds Website

www.epa.gov/healthywatersheds



The key components of the Healthy Watersheds Initiative are as follows:

1. Partnerships are established to identify and protect healthy watersheds.
2. Healthy watersheds are identified state-wide using scientifically-sound integrated assessment techniques.
3. Healthy watersheds are listed, tracked, maintained, and increased in number over time.
4. Healthy watersheds are protected and enhanced using both regulatory and non-regulatory tools.
5. Progress on protecting healthy watersheds is measured and tied to achieving the overall goals of EPA's Water Program and Strategic Plan.

While the Healthy Watersheds Initiative is intended to be implemented to support strategic statewide and tribal decisions, the assessment data and other information generated as part of a healthy watersheds assessment can also be used to inform management decisions at the basin or local watershed levels, including implementing water quality and other programs. The anticipated outcomes of the Healthy Watersheds Initiative are integrated aquatic ecosystem protection programs that maintain and increase the number of healthy watersheds in our nation.

1.3 Characteristics of a Healthy Watershed

A healthy watershed is one in which natural land cover supports dynamic hydrologic and geomorphic processes within their natural range of variation; habitat of sufficient size and connectivity supports native aquatic and riparian species; and water quality supports healthy biological communities. An interconnected network of natural land cover throughout a watershed, and especially in the riparian zone, provides critical habitat and supports maintenance of the natural flow regime and fluctuations in water levels. It also helps to maintain natural geomorphic processes, such as sediment storage and deposition, which form the basis of aquatic habitats. Connectivity of aquatic and riparian habitats, in the longitudinal, lateral, vertical, and temporal dimensions helps to ensure that biotic refugia are available during floods, droughts, and other extreme events. In addition to connectivity, redundancy of ecosystem types helps to ensure that the characteristics of a healthy watershed will persist into the future. Processes that are maintained within their natural range of variation, connectivity, and redundancy are thus critical characteristics of healthy watersheds.

1.4 Benefits of Protecting Healthy Watersheds

Motivation to protect ecosystems comes from a variety of sources, including intrinsic value, the services ecosystems provide to humans, and legal mandates. There is growing recognition that functionally intact and biologically complex freshwater ecosystems provide valuable commodities and services to society (Baron et al., 2002). In 2000, the United Nations Secretary General Kofi Annan called for a global assessment of ecosystems and implications for human health and well-being. The resulting Millennium Ecosystem Assessment documents worldwide trends in ecosystem integrity and the services they provide (Millennium Ecosystem Assessment, 2005). Ecosystems provide raw products, including food, fuel, fiber, fresh water, and genetic resources. They regulate processes affecting air quality, climate, soil erosion, disease, and water purification. Non-material cultural benefits derived from ecosystems include spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences (Millennium Ecosystem Assessment, 2005). Research indicates that the short-term economic benefits from exploiting natural resources pale in comparison to the long-term loss of ecosystem services (Daily et al., 1997).

New York City Watershed: Economic Benefits and Cost Savings of Protecting the Clean Water Supply

A case study in the Natural Resources Forum Journal (Postel & Thompson, 2005) captured how New York City was able to protect their drinking water source through a unique agreement that links ecosystem service providers and beneficiaries. The New York City case study demonstrates that watershed protection can be a highly cost-effective alternative to technological treatment in meeting water quality standards that can work for both upstream and downstream parties.

New York City was faced with building an estimated $6 billion filtration plant with an annual operating cost of $300 million to ensure compliance with the Safe Drinking Water Act. However, the City had the option of requesting a waiver if they could demonstrate that they can meet water quality standards through protection of their source watersheds. The City went through a long agreement-building process with the private landowners and communities within the Catskill-Delaware watersheds, which supply the City with 90% of its drinking water.

Terms of the agreement included that the City would not condemn any land through the state's health eminent domain process. The City would also purchase properties for their actual face value from willing sellers and pay taxes on the properties so that it would not erode the local tax revenues. The total amount of land purchased was estimated at $94 million, which doubled the area of the protected buffer. The overall investment was estimated to be $1 billion. The City also initiated other programs and a trust fund within the area to promote best management practices. These practices, along with the protected lands, increased property values, provided additional income, created healthier streams and habitats, and provided additional recreational opportunities. Future protection of this area will be dependent on population and development growth and any future regulations.

Watersheds are coupled social-ecological systems, meaning that the health and well-being of human societies are dependent on the health and well-being of the watersheds they live within, and vice versa (Bunch, Morrison, Parkes, & Venema, 2011). Key to maintaining this relationship is a diverse ecological and social structure, as well as the ability to adapt to the change and uncertainty characteristic of natural processes (Berkes, 2007). A systems approach for understanding social-ecological systems forms the backbone of sustainability science and modern-day adaptive management (Berkes & Folke, 2000). The healthy watersheds approach draws from and builds on this work to protect the ecological infrastructure that society depends on.

The Economic Impact of Recreational Trout Angling in the Driftless Area

The Driftless Area is a 24,000 square-mile area that stretches across the boundaries of Minnesota, Iowa, Wisconsin, and Illinois. According to a study by Trout Unlimited and Northstar Economics (2008), direct spending of $647 million per year on recreational angling, plus a "ripple effect" of nearly $3,000 per angler, in the Driftless Area generates a $1.1 billion annual economic benefit to the local economy. The ripple effect is a result of the money spent by anglers flowing through the local economy, stimulating additional spending by local businesses. Trout Unlimited attributes these economic benefits to the natural potential of the Driftless Area streams, good land stewardship, public access, and wise investment in restoration. Trout fishing has very limited impact on natural resources. Anglers tend to treat the Driftless Area with respect, and many release the fish they catch back to the stream. It is clear that the thriving economy of the Driftless Area is at least partially supported by clean water, resilient streams, and healthy fish populations.

There are many economic benefits to protecting healthy watersheds, including the avoidance of expensive restoration activities. Healthy watersheds sustain water-related recreation opportunities, such as fishing, boating, and swimming, and provide hiking, birding, hunting, and ecotourism opportunities. Vulnerability to floods, fires, and other natural disasters is minimized, thereby reducing costs to communities. Healthy watersheds can also help to assure availability of sufficient amounts of water for human consumption and industrial uses. By protecting aquifer recharge zones and surface water sources, costs of drinking water treatment may be reduced. A survey of 27 drinking water utilities found that for every 10% increase in forest cover of the source area, chemical and treatment costs decrease by 20% (Ernst, 2004). The functions that healthy watersheds provide, and the benefits they create, are often taken for granted when they exist in natural systems, but are difficult and expensive to achieve when they must be reproduced (Table 1-2).

Table 1-2 Estimated range of values for ecological services provided by healthy watersheds (Smith, de Groot, Perrot-Maître, & Bergkamp, 2006).

Service Provided	Estimated Value ($/acre/year)
Drinking Water	$18 - $3,035
Fisheries	$81
Water quality control	$24 - $2,711
Flood mitigation	$6 - $2,227
Carbon sequestration	$53 - $109
Recreation and tourism	$93 - $1,214

The recognition of climate change as a serious threat to ecosystem structure and function provides additional motivation to protect healthy watersheds. Natural vegetative cover (including forests, wetlands, and grasslands) sequesters large amounts of carbon, and the soil resources that this vegetation maintains can hold even larger amounts of carbon. Protection of these resources can help to mitigate increased carbon dioxide emissions (U.S. Environmental Protection Agency, 2011a).

Water is the primary medium through which climate change will be seen and felt. Both droughts and large storm events are expected to increase in frequency and severity in some parts of the country. Wetlands and forested areas have a profound effect on watershed hydrology, regulating flows during droughts and large storm events. This regulating function has far-reaching effects on provision of drinking water, flood reduction, and other natural hazard reductions. Protection of watershed processes can help to maintain and increase resilience to climate change (e.g., keeping ecosystems healthy can reduce management costs to sustain these benefits).

1.5 Purpose and Target Audience

The purpose of this document is to provide state water quality and aquatic resource scientists and managers with an overview of the key concepts behind the Healthy Watersheds Initiative, examples of approaches for assessing components of healthy watersheds, integrated assessment options for identifying healthy watersheds, examples of management approaches, and some assessment tools and sources of data. With this information, scientists and managers will be able to conduct healthy watersheds assessments and initiate protection programs. The results of healthy watersheds assessments can be used by local land use managers to inform protection priorities. This document is not a guide, nor does it provide step-by-step instructions, but it does identify example approaches and sources for scientists and managers to obtain detailed information on assessment methods and management tools. Finally, this document is not EPA program implementation guidance, but rather a resource that states and other entities may choose to use for assessing, identifying, and protecting healthy watersheds.

1.6 How Does the Healthy Watersheds Initiative and this Document Relate to What Others are Doing?

The book *Entering the Watershed* (Doppelt et al., 1993) outlines many of the concepts necessary for a truly holistic approach to riverine ecosystem protection. Since its publication, various aquatic ecosystem assessment approaches and protection strategies have been developed. Some of the many examples include the Ecological Limits of Hydrologic Alteration, The Nature Conservancy's Active River Area and Freshwater Ecoregional Assessments, Virginia's Conservation Lands Needs Assessment, Ohio's Primary Headwaters Habitat Assessment, and State Wildlife Action Plans (see Chapters 3 and 5). The Healthy Watersheds Initiative builds on this body of work. The integrated assessment approaches presented in Chapter 4 expand the value of other approaches by linking the assessments of biota, habitat, and functional processes together to evaluate aquatic ecosystem integrity within a watershed context. The Healthy Watersheds Initiative also includes strategic implementation of protection and restoration measures to maintain and increase the number of healthy watersheds. Many state agencies and other organizations are already implementing initiatives that are similar to the healthy watersheds approach, and this document highlights their projects as examples. Further, complementary approaches have also been adopted by other federal agencies. For example, along with the Association of Fish and Wildlife Agencies, the U.S. Fish and Wildlife Service and National Marine Fisheries Service developed and are implementing the National Fish Habitat Action Plan, which takes a holistic systems approach to protecting and restoring fish habitat (Association of Fish and Wildlife Agencies, 2006). Also, the U.S. Forest Service developed the Watershed Condition Framework, which employs an integrated, systems-based approach for classifying watershed condition based on an evaluation of the underlying ecological, hydrologic, and geomorphic functions and processes (U.S. Forest Service, 2011). The U.S. Forest Service is using the results of a national reconnaissance-level assessment of watershed condition, based on the Framework, to identify high priority watersheds on national forests and grasslands for restoration starting with the "best" watersheds first.

1.7 How to Use this Document

Every organization has a unique combination of strengths in aquatic ecosystem assessment and protection. Many have solid grounding in the field of water quality, while others have strengths in landscape ecology or biodiversity conservation. This document should be used as a reference for expanding capabilities beyond a specific area of expertise to include a holistic approach for identifying and protecting healthy watersheds. It is recommended that all users read Chapter 2 to familiarize or refresh themselves with the concepts underlying the Healthy Watersheds Initiative. Chapter 3 provides examples of assessment approaches in use across the country, and Chapter 4 provides examples of ways in which integrated assessments can be conducted and used to identify healthy watersheds and set protection priorities. Chapter 5 presents some of the many management approaches that can be used at the national, state, or local level to protect healthy watersheds. Appendix A contains assessment tools, Appendix B identifies sources of data, and Appendix C includes a compilation of resources and sources of information mentioned in this document for use in assessing and protecting healthy watersheds. Readers can navigate between these chapters depending on their needs and priorities.