Toward a framework for evaluating civic environmental stewardship in the Green-Duwamish watershed, WA

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Abstract

Toward a framework for evaluating civic environmental stewardship in the Green-Duwamish watershed, WA

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This thesis explores civic environmental stewardship and its ecological impacts, using the Green-Duwamish watershed as a case study. This study 1) characterizes environmental stewardship activity in the watershed; and 2) evaluates the effectiveness of ecological monitoring on environmental stewardship sites in measuring and improving ecological outcomes at various scales. Stewardship practitioners were interviewed and responses were analyzed using qualitative coding and guidelines adapted from the Open Standards for the Practice of Conservation. Environmental stewardship was found to be common throughout the lower and middle watershed, distributed proportionally to population density but influenced as well by political boundaries and financial and technical resources. Collaboration among organizations was important, although communication gaps were identified between geographical regions and between ecosystems. Monitoring efforts were unevenly distributed, often unsystematic, and used for management only inconsistently. Future efforts should focus on developing a landscape-scale assessment protocol and incorporating the social impacts of stewardship.

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1 Introduction

1.1 Research summary

This thesis focuses on environmental stewardship from the perspective of its ecological impacts. Using the Green-Duwamish watershed, in the central Puget Sound region of Washington, as a case study, this thesis explores how environmental stewardship, especially civic environmental stewardship, is planned, implemented, and monitored. The research 1) characterizes environmental stewardship activity in the Green-Duwamish watershed; and 2) evaluates the effectiveness of ecological monitoring on environmental stewardship sites in measuring and improving ecological outcomes at various scales.

This thesis contributes to the ongoing process of developing a broader analytical framework that can be used to analyze environmental stewardship as a component of a social-ecological system. This research focuses on ecological elements of the social-ecological system in which environmental stewardship, and particularly civic environmental stewardship, plays a role. Social elements of this system, including the motivations of volunteers, economic factors of stewardship actions, and the benefits of stewardship to the community, are currently being studied by other researchers in parallel.

1.2 Civic environmental stewardship

This study employs a definition of the concept of civic environmental stewardship adapted from Romolini et al. (2012):

Civic environmental stewardship is defined in this study as physical activities on behalf of the environment, conducted by volunteers, on public or quasi-public lands.

This definition invites the examination of three concepts in particular:

1) Impacts to lands that are managed with clear, societally-acceptable environmental goals – publicly owned lands, as well as lands that are managed in the public's interest, for example riparian areas that provide habitat for federally protected Chinook salmon (*Oncorhynchus tshawytscha*);
2) Activities on behalf of the environment conducted by individuals whose actions are motivated largely by non-financial considerations; and
3) Activities that have measurable environmental outputs – as opposed to activities such as education or policy advocacy, which may eventually have significant environmental outcomes but for which the primary outputs are social.

It is important to note that this definition of civic environmental stewardship does not capture the full range of environmental stewardship actions in the Green-Duwamish watershed; rather, it functions as a filter through which to examine the above concepts. Furthermore, some of the actions discussed in this thesis fall outside the narrow definition of civic environmental stewardship, but are closely linked with civic environmental stewardship actions. As researchers continue to develop a broader framework for studying civic environmental stewardship's role

within social-ecological systems, other forms of environmental stewardship, such as actions by private landowners and actions with primarily social outputs, must be included as well.

1.3 Civic environmental stewardship in Puget Sound

Puget Sound is home to a broad diversity of ecosystems, including marine systems, estuaries, freshwater and its associated riparian and wetland habitats, lowland forests and prairies, and lush mountain forests climbing up to alpine peaks. The region is also home to a vibrant, dense, and growing human population of around 4 million (Puget Sound Partnership 2009). Unfortunately, many important components of Puget Sound's ecosystems have recently undergone alarming declines. The populations of many native species are shrinking: 21 species native to the Puget Sound region are listed as threatened or endangered (Puget Sound Partnership 2009). The Washington Department of Ecology lists more than 1,000 rivers and lakes in the region as impaired (Puget Sound Partnership 2009). Forest cover continues to decline – the Sound lost four percent of its forest cover over a recent 10-year period (Puget Sound Partnership 2009).

However, the region's residents and institutions have taken action to address these threats. Government agencies have increased regulatory environmental protections, provided landowners and managers with financial incentives for environmentally-beneficial actions, and offered education, assistance, and support for residents who wish to help protect and restore the environment. Non-governmental organizations (NGOs) have also been integral in taking action on behalf of Puget Sound's ecosystems. A recent study identified 588 groups, including both government agencies and private organizations, conducting environmental stewardship activities in King and Pierce Counties (Brinkley et al. 2010).

There has been a strong response to the need for environmental action from Puget Sound residents, not only on private property – where landowners may be motivated by financial incentives as well as an environmental ethic – but also on public and quasi-public property such as parks, natural areas, and aquatic or marine environments. For example, in King County, residents contributed an estimated 53,140 hours of volunteer service in public lands, parks, and green belts in 2012 (King County DNRP 2013). Similarly, residents of Kent, south of Seattle on the Green River, contribute an average of 10,000 hours of volunteer service on behalf of natural lands annually (Green Kent Partnership 2011; V. Andrews, pers. comm.). As another example, in terms of acres targeted, the Green Seattle Partnership is the largest urban forest restoration effort in the nation, with more than 100 different resident groups registered as volunteers for restoration efforts (Green Seattle Partnership 2006).

1.4 Problem statement: How to measure ecological impacts of civic environmental stewardship?

Although individuals, NGOs, and government agencies alike are conducting and facilitating civic environmental stewardship actions throughout Puget Sound, and although broad-scale ecosystem restoration policies and plans identify such actions as important components in meeting restoration goals, the ecological impacts of civic environmental stewardship are still poorly understood. Indeed, the very nature of civic environmental stewardship as a set of actions makes understanding its impacts difficult. The catalysts for action vary widely, from intrinsically-motivated individuals to coordinated top-down government programs (Wolf et al. 2013). The goals of civic environmental stewardship actions, which affect the characteristics of the physical actions taken, are similarly variable. Finally, the effectiveness of stewardship

actions in meeting their goals can be variable as well (Elman & Salisbury 2010; Wood & Ketcheson 2012).

Addressing the lack of understanding of the ecological impacts of civic environmental stewardship, especially at scales larger than individual sites, is a critical research priority for the development of a framework to study the roles of stewardship in a social-ecological system. Furthermore, increasing knowledge of stewardship's ecological outcomes is important to land management institutions. Little is known about the actual ecological *outcomes* of these actions on the environment, especially at scales larger than individual sites. Given the significant resource investment, both in financial support and labor hours both paid and volunteer, this lack of knowledge about outcomes is troublesome (Koontz and Thomas 2006). Without such an understanding, the managers of landscape-level restoration plans such as the Chinook Salmon Recovery Plan and the Puget Sound Action Agenda risk undervaluing the role of civic environmental stewardship, or misdirecting efforts to support it (Svendsen and Campbell 2008).

1.5 Research objectives: the "stewardship footprint"

This study addresses the need to evaluate the ecological outcomes of civic environmental stewardship at the landscape scale. The research objectives are to:

- Characterize civic environmental stewardship in the Green-Duwamish watershed; and
- Evaluate the effectiveness of ecological monitoring activities on civic environmental stewardship sites in measuring and improving ecological outcomes at various scales.

This study is driven by the following overarching research question:

How can land managers in the Green-Duwamish watershed measure the effectiveness of disparate civic environmental stewardship efforts in recovering ecosystem functions at various scales in the watershed?

The hypothesis implicit in this question is that civic environmental stewardship actions *do* have a measurable positive impact on ecosystem function in the Green-Duwamish watershed, and one of the aims of this thesis is to evaluate the systems in place for measuring these impacts.

The overarching question is addressed through a series of more specific questions, all related to current civic environmental stewardship activities in the Green-Duwamish watershed:

1. *What are the characteristics of civic environmental stewardship activities in the Green-Duwamish watershed?*

    What activities are occurring?

    Where are activities occurring?

    Who (individuals and organizations) are participating in activities, and how are they connected?

2. *What are the characteristics of ecological monitoring activities on civic environmental stewardship sites in the Green-Duwamish watershed?*

    Are there credible conceptual models underpinning monitoring activities?

    Which ecological attributes are being monitored?

    How are monitoring activities chosen?

    What factors influence monitoring activities?

Who is conducting ecological monitoring activities?

How are monitoring data used?

How are monitoring results shared with others?

This study represents a step in the ongoing process of developing a broad, interdisciplinary framework to analyze the dynamics of civic environmental stewardship as a social-ecological interaction, a process that will require significant effort and collaboration among many researchers. An important concept already identified within this framework is the "stewardship footprint" (Brinkley et al. 2010; Wolf et al. 2013). Modeled after the concept of the "ecological footprint" – a framework for analyzing the extent of a society's impacts to the natural world (Wackernagel and Rees 1996) – the stewardship footprint concept seeks to provide a similar framework for analyzing the "positive consequences of human action on the landscape" (Wolf et al. 2013, p. 15). The ecological footprint framework uses the concept of natural capital: "any stock of natural assets that yields a flow of valuable goods and services into the future" (Costanza & Daly 1992). While the ecological footprint concept largely views human society as a drain on natural capital, the stewardship footprint concept acknowledges the possibility for human society to provide positive contributions to natural capital as well.

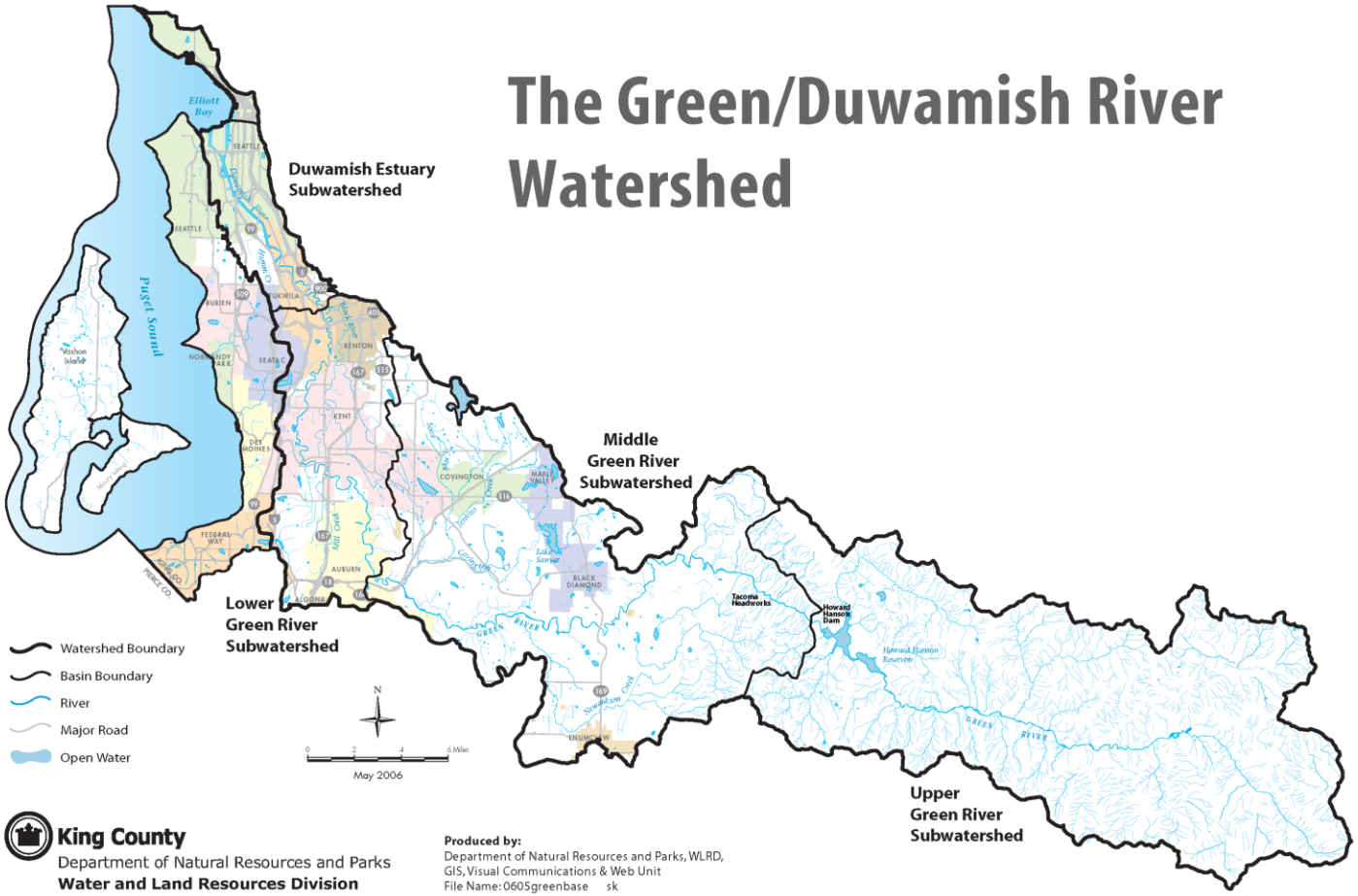
Environmental stewardship is generally acknowledged as a societal response to environmental degradation, although the specific dynamics within this interaction are still poorly understood (Wolf et al. 2013). This thesis examines one element of the social-ecological dynamic of civic environmental stewardship – the ecological impacts of stewardship behaviors – through a case study examining the current status and characteristics of ecological monitoring on stewardship sites. Wolf et al. (2013) identify a need for ecological monitoring, at multiple geographical scales, associated with environmental stewardship. This thesis explores the state of monitoring in

the watershed, to determine the extent to which existing monitoring activities and circumstances could be applicable to measuring the impacts of stewardship at the landscape scale.

Although not the focus of this thesis, another important element of civic environmental stewardship is its social impacts at the individual, community, and societal scales. Other research threads that will contribute to an analytical framework for civic environmental stewardship include investigations of the social, cultural, and ecological conditions that affect participation in stewardship activities, as well as the reciprocal effects of stewardship activities on social and cultural conditions.

The overarching objective of this broader body of research is to "build a comprehensive understanding of how [civic environmental stewardship] is conducted, methods for identifying gaps in [civic environmental stewardship] activities, and how [civic environmental stewardship] efforts could be better mobilized to address concerns of urban ecosystem health and sustainability" (Wolf et al. 2013, p. 15). This objective is in line with calls from the scientific community to better integrate social and biophysical processes so as to understand the relationships between people and the natural environment (Pickett et al. 2001; Liu et al. 2007; Marzluff et al. 2008; Wolf & Kruger 2010).

Figure 1.1 The Green-Duwamish watershed (King County Department of Natural Resources and Parks)



1.6 Description of the Green-Duwamish watershed

1.6.1 Overview

The Green-Duwamish watershed is located in southern King County and abuts the east-central shores of Puget Sound (see Figure 1.1). The Green River originates in the alpine snowfields of Snoqualmie National Forest, and flows among extensive productive commercial forestry operations in the upper watershed before being controlled by the Howard Hanson Dam about 30 miles downstream of its headwaters. The river then runs through agricultural lands, then growing suburbs, and finally into the urban core and industrial hub of Seattle where the river – at this point referred to as the Duwamish Waterway – empties into Elliott Bay. Over about 93 river miles, the Green-Duwamish traverses nearly the entire spectrum of land uses in Puget Sound, from a pristine alpine environment to a heavily engineered industrial landscape.

At the time of European settlement, the upland habitats in the watershed were densely forested, and the valley bottoms contained extensive forested and non-forested wetlands, subject to frequent large floods and major movements in the river channel. Soon after the turn of the 20th century, however, European settlers began drastically altering the river systems and surrounding lands. While many fragments of intact natural habitats remain, much of the watershed has been transformed. Today, the watershed is home to over 630,000 residents, and economic centers such as the Port of Seattle that are critical to the region's social wellbeing. The watershed also provides billions of dollars in ecosystem services, but these services can only be generated if the watershed's natural ecosystem processes continue to function at an adequate level (WRIA 9 Steering Committee 2005a). Unfortunately, urban development and habitat conversion for

agriculture and timber production have greatly reduced the quantity and quality of the watershed's natural lands.

1.6.2 Historical habitat alterations

Historically, the watershed that drained into the Duwamish Estuary was comprised of the Duwamish, Black, White, Cedar, Green, and Sammamish Rivers, as well as Lakes Washington and Sammamish. In the early 1900s, massive engineering projects – including diversion of the White southward into the Puyallup (making permanent the river's presumably temporary diversion after a large flood event in 1906); diversion of the Cedar into Lake Washington; and drying of the Black after the ship canal connecting Lake Washington to Puget Sound was constructed – reduced the watershed area by 70% (WRIA 9 Steering Committee 2005a). At about the same time, further upriver, in 1911 the City of Tacoma installed a diversion dam which began siphoning water to the south to meet that city's growing needs. Then, in 1964, the Howard Hanson Dam was completed at River Mile 64.5, protecting the Green River valley from seasonal floods and fundamentally changing the river's hydrological patterns once again.

1.6.3 Land use and habitat conditions

See Figure 1.2 for an illustration of land cover in the watershed as a whole. The following is a narrative description of current land use and habitat conditions, by sub-watershed.

The Upper Green River sub-watershed, above Howard Hanson Dam, consists of a patchwork of land managers including the US Forest Service, private timber companies, and Tacoma Public Utilities, which has management agreements with the other land managers in the watershed to allow the city of Tacoma to rely on the upper watershed for clean drinking water (Tacoma Water

2008). Nearly all of the upland forested habitat is subject to timber harvests. The public is granted very limited access to the watershed, and there are no active permanent residences other than those provided for government agency staff (Tacoma Water 2008). The habitat in the Upper Green is primarily early and mid-seral coniferous forestland. Late-seral stands are rare, largely limited to very steep slopes and the riparian zone of headwater streams (WRIA 9 Steering Committee 2005b). The mainstem river of the Upper Green provides higher-quality aquatic habitat than anywhere further downstream (WRIA 9 Steering Committee 2005b). Although Howard Hanson Dam currently prevents salmonids from naturally reaching this habitat, the Muckleshoot Indian Tribe annually releases Chinook salmon fry upstream of the dam (WRIA 9 Steering Committee 2005a), and the US Army Corps of Engineers is currently constructing a downstream fish passage facility (WRIA 9 Coordination Team 2012).

The Middle Green River sub-watershed, which includes the steep-walled Green River Gorge as well as the wider Green River Valley, is subject to a variety of land uses. Seventy four percent of the Green River Valley just downstream from the Green River Gorge is designated part of the King County Agricultural Production District, and an estimated 50% of the formerly forested lands on the valley bottom have been converted to agriculture (WRIA 9 Steering Committee 2005a). Further downstream, agriculture gives way to residential development, while an additional 27% of the land base is devoted to forestry (WRIA 9 Steering Committee 2005a). Dozens of levees and revetments have constrained the river's natural dynamics in much of the valley, although in the Green River Gorge, the river's channel area is largely unchanged (WRIA 9 Steering Committee 2005a). The Middle Green, as well as its two major tributaries, Soos and Newaukum Creeks, currently provide the spawning grounds for a significant portion of the Green-Duwamish Chinook salmon population (WRIA 9 Steering Committee 2005a).

The wide, flat valley of the Lower Green River sub-watershed was historically a dynamic landscape of forests and wetlands, fed by the Green, White, and Black Rivers, which frequently flooded. Today, the landscape is almost entirely transformed: about 60% of the valley floor has been subject to low or high-density urban development, and while some forests (about 13%) and wetlands (about 60%) remain, they are often disconnected from the main river (WRIA 9 Steering Committee 2005a). Invasive species are the dominant vegetation along most river edges.

The Duwamish sub-watershed, once a shallow estuary flanked by forested hills, is today a densely-developed urban waterway. The riverbanks are armored over 90% of their length, nearly half of the banks have no vegetation, and the sediment within the river is contaminated from decades of industrial activities (WRIA 9 Steering Committee 2005a). At the same time, the steep slopes that line the west shore of the Duwamish contain the largest contiguous greenbelt in the city of Seattle, forested primarily by native deciduous trees and heavily invaded by non-native plants, but with pockets of intact native forest as well (Elman & Salisbury 2010).

1.6.4 Society

The Green-Duwamish watershed is part of a dynamic demographic area. South King County has experienced rapid growth over the past two decades, accounting for half of King County's total growth in the 1990s and continuing to grow since (King County Office of Management and Budget 2008; see Figure 1.3). This growth is typical for the region as a whole, from Olympia, WA north to Vancouver, British Columbia (Auch et al. 2004). Notably, growth in South King County has included a dramatic increase in ethnic diversity (King County Office of Management and Budget 2008). As an example, the Tukwila School District was recently identified as the most ethnically diverse in the country (New York Times 2009). The watershed provides tens of

thousands of jobs to the region, many in the industrial sector. For example, 80% of Seattle's industrial land base is located along the banks of the Duwamish (Duwamish River Cleanup Coalition 2009).

At the same time, the Green-Duwamish watershed is also the location of many low-income communities. The median income of South King County is the lowest of the four sub-areas identified in King County under the Growth Management Act (Felt 2013). Associated with this income disparity is inequality in terms of environmental health: residents of the Duwamish Valley were identified as the most at risk for disproportionate negative health impacts from environmental factors. For example, surveys indicated that many residents of the Duwamish Valley, especially those of Vietnamese and Cambodian descent, rely on harvesting fish and shellfish from the heavily polluted river as an important source of food (Duwamish River Cleanup Coalition 2009). Residents of the neighborhoods of Georgetown and South Park have an estimated life expectancy that is eight years shorter than the Seattle and King County average (Gould & Cummings 2013).

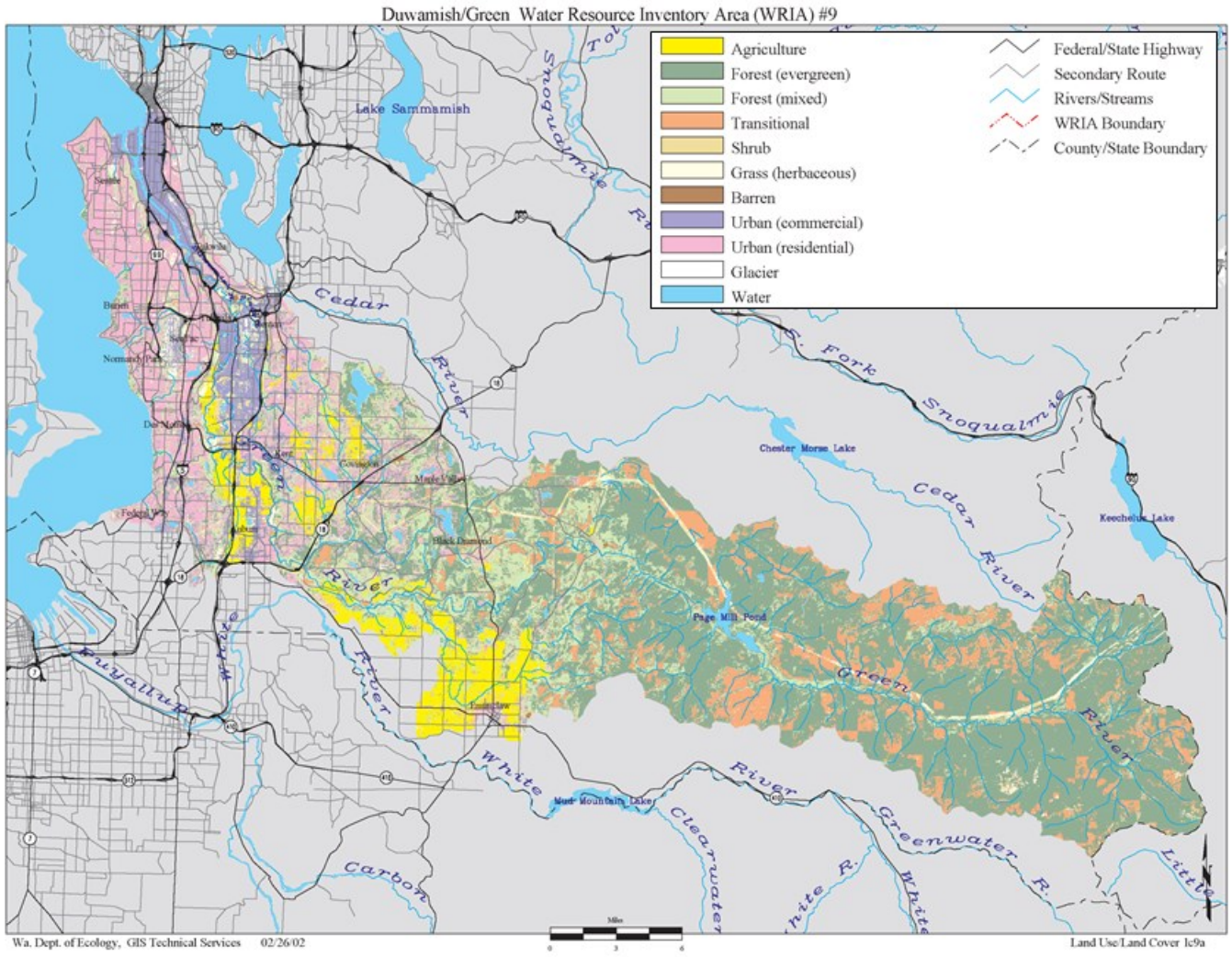


Figure 1.2 Land cover, Green Duwamish watershed (WA Department of Ecology 2002).

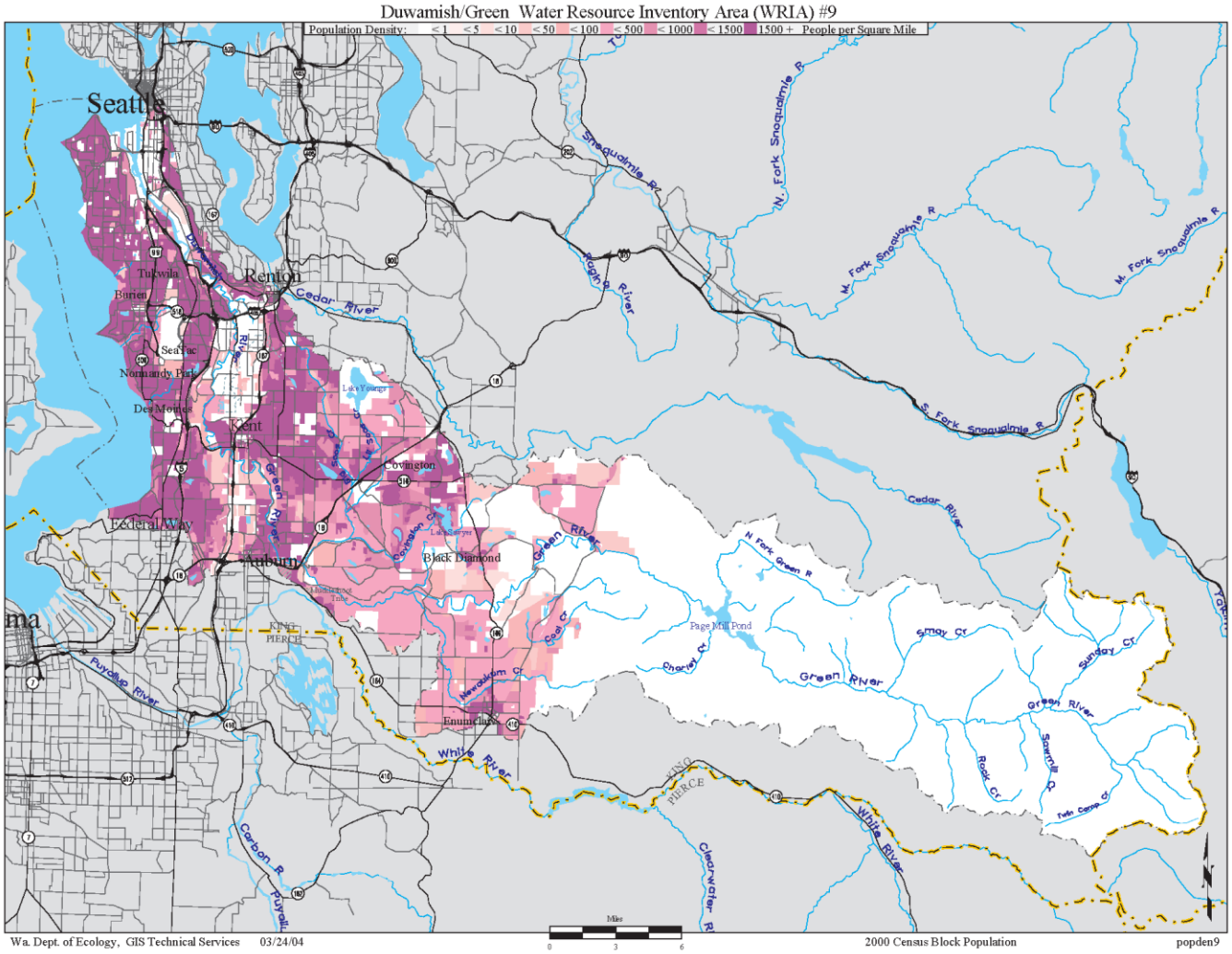


Figure 1.3 Population density, Green-Duwamish watershed (WA Department of Ecology 2004).

1.6.5 Ecosystem threats

There is a broad spectrum of ecological pressures to the Green-Duwamish watershed, related to the ecological diversity of the watershed as well as the diversity of land uses present. First and foremost, the watershed is home to two salmonid fish species listed as Threatened under the federal Endangered Species Act: Chinook salmon and bull trout (*Salvelinus confluentus*). One of the most significant pressures to both of these fish species in the Green-Duwamish is the degradation of freshwater and estuarine habitat through land use and water use practices (WRIA 9 Steering Committee 2005a). Specific habitat-related factors that threaten these fish, as well as aquatic ecosystems in general throughout the watershed, include: reduced water quality; modifications to hydrological processes; altered sediment transport; altered physical habitat features such as river channels, river banks, and instream woody debris; degraded riparian habitat; reduced sediment quality; physical barriers to fish passage; and the invasion of non-native species to both aquatic and riparian ecosystems (Kerwin & Nelson 2000).

The severity of these pressures varies between locations in the watershed. The most significant physical barriers to passage, for example, are in the upper watershed: Howard Hanson Dam, Tacoma Water's diversion dam, and numerous culvert-constrained tributaries. Alterations to channel structure and banks, primarily through channel straightening and bank armoring, become more significant in the lower watershed, where land uses are increasingly residential, commercial, and industrial. Of special note in the Duwamish sub-watershed, sediment quality has been degraded to extremely toxic levels in some cases, prompting the Environmental Protection Agency to designate the Duwamish Waterway a Superfund site. Although less acute

than the pollution in the Duwamish, nonpoint source pollution from stormwater runoff is another major contributor to reduced water quality in the watershed (Puget Sound Partnership 2009).

In upland areas of the watershed, one of the most significant ecological pressures is also habitat degradation through land use practices, similar to aquatic habitats. Again similar to aquatic habitats, the specific types and severity of habitat alterations vary between locations. Timber harvest, with its associated road construction, is the most significant immediate localized pressure to habitats in the upper watershed. In the Middle Green sub-watershed, agriculture and residential development have forced more permanent and significant habitat degradation, leaving remaining habitats fragmented and more vulnerable to invasion by invasive species. Habitat fragmentation and invasive species become increasingly problematic further downstream. Furthermore, many of these ecosystem pressures have shown worrisome trends. For example, throughout the watershed, working forests and farmlands continue to be developed into residential areas, making habitat degradation more severe and permanent (Puget Sound Partnership 2009).

1.6.6 The Green-Duwamish as a case study

The watershed, as a landscape, provides a valuable case study for research for a number of reasons. First, the scale of the watershed – a landscape that is connected by hydrology as a unifying biophysical feature – is large enough to capture a diversity of habitats in which stewardship activities may be similarly diverse, but small enough to be at least theoretically manageable as a single unit for ecosystem restoration purposes. In particular, the watershed scale is a unit at which collaboration for ecosystem management often occurs (Margerum & Whitall 2004).

In fact, and as the second reason for examining the Green-Duwamish as a specific case, the watershed is already recognized by numerous government institutions as a single unit, referred to as Water Resource Inventory Area 9 (WRIA 9), for the restoration of habitat for Chinook salmon and bull trout. Both of these characteristics of the watershed make it valuable in answering this study's overarching research question: How can land managers measure the effectiveness of disparate civic environmental stewardship efforts in recovering ecosystem functions at various scales?

The Green-Duwamish is also interesting for other reasons related to its specific characteristics. Its relatively compact size leads to steep gradients, both ecologically – from alpine habitats to estuary – and in terms of land uses – from uninhabited wilderness to dense urban development (see Figures 1.2 & 1.3). Further, there is a broad diversity of socioeconomic conditions in the watershed. The diversity and complexity of ecological and social conditions within a relatively small, ecologically and socially connected area, offer potential opportunities to study numerous aspects of social-ecological phenomena such as civic environmental stewardship (Pickett et al. 2001). Finally, lessons learned through research in the Green-Duwamish may be applicable to other watersheds in Puget Sound or elsewhere, especially with respect to developing an analytical framework for studying the social-ecological dynamics of civic environmental stewardship (Wolf et al. 2013).

1.7 Thesis structure

This thesis is divided into five chapters. The first chapter outlined the research objectives and provided a description of the watershed. In the second chapter, relevant literature on environmental stewardship, especially civic environmental stewardship, is reviewed. To provide

context for the research objective of evaluating monitoring activities in the watershed, literature on ecological monitoring is reviewed as well. The second chapter concludes with a summary and review of the framework used to evaluate monitoring activities, the Open Standards for the Practice of Conservation. The third chapter describes the methodology used to examine the research questions: semi-structured interviews of key informants in the watershed. The third chapter also identifies the specific elements of the Open Standards framework used to evaluate monitoring activities as they were described in interview responses. The fourth chapter reports on the results of interview analysis, including characterization of civic environmental stewardship activities in the watershed, and a comparative evaluation of monitoring activities. The fifth chapter synthesizes the results of the interview analysis to address this study's research questions. The thesis concludes with a discussion of potential applications for the results of this research, and potential directions for research and management in the future.

2 Background and literature review

2.1 Defining environmental stewardship and civic environmental stewardship

2.1.1 Conceptual definitions

There is no authoritative definition of the concept of environmental stewardship in the literature of the social or natural sciences. Wolf et al. (2013) use the general description of "social interactions on behalf of the environment," but note that the actual activities and – importantly – goals behind actions commonly identified as environmental stewardship are highly variable. For the purpose of guiding further research on the dynamics of the activities commonly referred to as "environmental stewardship," researchers are currently exploring the common elements that link these activities. In a review of the literature describing environmental stewardship activities, Romolini et al. (2012) identify four elements in particular that may help in understanding the concept of environmental stewardship: 1) the importance of an ethic or perceived responsibility to steward the land; 2) the motivations that drive individuals to stewardship action; 3) the processes – at multiple scales – that are inherent in stewardship actions; and 4) the outcomes of stewardship.

One important variable in defining environmental stewardship is the ownership status of the sites that are the subject of stewardship (Wolf et al. 2013). While stewardship of private property may be influenced by similar ethics or values, the specific motivations, processes, and outcomes may be distinct from those present in environmental stewardship actions on public or quasi-public

lands. Indeed, activities referred to as "environmental stewardship" in rural and wildland areas are most often the purview of private landowners (Romolini et al. 2012). While private lands can certainly be managed according to an ethic of environmental stewardship (Ryan et al. 2003; Fischer & Bliss 2008; Ryan 2009), landowner motivation to do so is inextricably connected to personal considerations as well, including motivation from financial (Hajkowicz & Collins 2009; Zammit 2013), aesthetic (Plieninger et al. 2012), and resource-extraction (Plieninger et al. 2012) concerns.

On the other hand, *civic* environmental stewardship – voluntary actions on behalf of the environment taken on public or quasi-public lands – can be considered a unique phenomenon in terms of the ethics, motivations, processes, and outcomes that drive it. Similar to stewardship of private lands and resources, civic environmental stewardship is place-based (Fisher et al. 2012), although the scale of the "place" varies widely, from landscapes (Weber 2000) to small urban plots (Svendsen 2009). Distinct from the stewardship of private lands, however, the nature of civic environmental stewardship is fundamentally communal. Civic environmental stewardship is a reflection of local residents claiming responsibility for some level of governance of public lands and resources, in collaboration with their neighbors and other stakeholders (Fisher et al. 2012). As such, understanding the concept of civic environmental stewardship requires understanding its social dynamics. The ethics, motivations, processes, and outcomes of civic environmental stewardship are all colored by its communal, collaborative nature, and the importance of the social aspects of civic environmental stewardship become all the more significant in urban settings (Romolini et al. 2012).

2.1.2 Motivations and influencing factors

Descriptions of a stewardship ethic often use Aldo Leopold's description of a "land ethic" as a foundational philosophy:

> *In short, a land ethic changes the role of* Homo sapiens *from conqueror of the land-community to plain member and citizen of it. It implies respect for his fellow-members, and also respect for the community as such (Leopold 1949, p. 204).*

From such an ethic comes a perceived responsibility to care for the environment, whether this responsibility is considered moral, religious, or simply personal (Carr 2002; Dearborn & Kark 2009). Feeling a responsibility to care for the environment appears frequently as a motivator for the initiation and continuation of civic environmental stewardship efforts. When surveyed about their motivations for participating in stewardship actions, volunteers in numerous studies cited some form of "helping the environment" most frequently (Grese et al. 2000; Bruyere & Rapp 2007; Moskell et al. 2010).

While concern for the environment is usually the proximate cause for stewardship groups to begin their work (Romolini et al. 2012), recent research indicates that social factors play a significant role as well, in catalyzing and especially in sustaining stewardship efforts (Romolini et al. 2012; Asah & Blahna 2013). Research has indicated that concepts related to community – creating, sustaining, and strengthening communities either local to a site of stewardship, or a community of people with common environmental goals – are especially important motivators for environmental stewardship volunteers (Carr 2002; Svendsen 2009; Moskell et al. 2010; Romolini et al. 2012). At an even more basic level, volunteers cite the joy of affiliation with

others as an important motivating factor (McPherson 1993; Miles et al. 1998; Grese et al. 2000; Bruyere & Rapp 2007; Asah & Blahna 2012).

Research also indicates that many of the motivating influences for environmental stewardship volunteers are primarily personal (Asah & Blahna 2013). Some motivating factors are related to the site of stewardship: the desire to improve a familiar space (Carr 2002; Bruyere & Rapp 2007; Svendsen 2009), as well as the more general desire to connect with the natural world (Miles et al. 1998; Grese et al. 2000; Krasny & Tidball 2012). Volunteers in numerous studies cited the satisfaction of achievement, or gaining new knowledge (McPherson 1993; Grese et al. 2000; Bruyere & Rapp 2007; Moskell et al. 2010). The simple opportunity to get exercise is a powerful motivator for some (Miles et al. 1998; Bruyere & Rapp 2007; Asah & Blahna 2012). In addition, some researchers have identified the role that environmental stewardship plays in personal growth (Miles et al. 1998), personal restoration (Svendsen 2009), and the enhancement of self-esteem or ego (Bruyere & Rapp 2007; Asah & Blahna 2012).

In contrast to earlier scholarly descriptions of local environmental "movements" (Kempton et al. 2001), civic environmental stewardship organizations may arise from grassroots efforts (Krasny & Tidball 2012) or be initiated by government agencies attempting to harness the support and energy of volunteers (Miles et al. 1998; Asah & Blahna 2012). Stewardship efforts may be catalyzed by "tipping point" events such as natural disasters or societal conflicts (Krasny & Tidball 2012), although non-urgent, ongoing environmental concerns are often sufficient cause for the formation of stewardship organizations (Hunter 2011; Romolini et al. 2012). Once initiated, civic environmental stewardship efforts can be sustained only as long as participants remain engaged (Asah & Blahna 2012). This engagement, or commitment, is linked to the benefits that stewards get out of the work: positive outcomes for the volunteers can strengthen

the initial motivation (Ryan & Grese 2005; Romolini et al. 2012). On the other hand, volunteers who are not fulfilled by the work are unlikely to continue. Thus, having volunteer events that address the specific motivations of the volunteers – often primarily personal and social, rather than environmental – may be an important factor in sustaining civic environmental stewardship efforts (Asah & Blahna 2013).

2.1.3 Actions

Civic environmental stewardship can take many forms, as the discussion of its conceptual definitions above indicates. Stewardship actions may be as holistic as collaborative participation in environmental governance (Weber 2000; Shandas & Messer 2008), or as narrowly-focused as tending a community garden (Svendsen 2009). Civic environmental stewardship groups are frequently involved in some type of ecological restoration (Miles et al. 1998; Carr 2002; Moskovits et al. 2004; Measham & Barnett 2008; Shandas & Messer 2008). Restoration activities often include planting native plants, removing invasive species, and maintaining sites in restoration (Stevens 1995; Romolini et al. 2012). In urban areas, habitat restoration actions may be complemented or replaced by urban forestry activities, primarily planting and maintaining trees (Moskell et al. 2010), and installing and maintaining communal gardens (Svendsen 2009).

Another frequent mode of stewardship action is activism (Kempton et al. 2001; Measham & Barnett 2008), through advocacy either from within or outside governing institutions. Organizations have been reported engaging in education on important environmental issues (Kempton et al. 2001; Measham & Barnett 2008), and monitoring environmental parameters through “citizen science” efforts (Cohn 2008; Measham & Barnett 2008; Krasny & Tidball

2012) frequently accompanies other stewardship actions, but may be the *raison d'etre* for some organizations. In addition, some well-funded civic environmental stewardship groups focus on purchasing land for conservation (Kempton et al. 2001).

In Seattle, representatives of environmental organizations identified "tools" for stewardship at both the individual and organizational level (Romolini et al. 2012). Individual actions could include behaviors or actions such as using a reusable mug, picking up trash, planting native plants, and recruiting others to participate in these actions as well. Organizational tools for stewardship included organized tree plantings and invasive species removal efforts, advocacy and education, resident engagement in stewardship actions, and collaborating with other organizations to work towards shared goals.

2.1.4 Collaborative environmental stewardship

At a broader scale than individual sites and individual organizations, the practice of civic environmental stewardship often occurs within collaborative partnerships and coalitions (Moskovits et al. 2004; Ernstson et al. 2008; Romolini et al. 2012). Collaboration can take many forms. Some examples include: individuals spontaneously coming together to manage a shared resource (Ostrom 1990; Svendsen & Campbell 2008); loose affiliations of individuals who communicate and share knowledge about an environmental concern (Sendzimir et al. 2007); or stakeholders within a landscape brought together through a government program (Schneider et al. 2003; Koontz et al. 2004). Under the proper circumstances, collaborations have been shown to be excellent venues for facilitating learning and knowledge-sharing, and for resource mobilization and allocation (Bodin & Crona 2009).

Furthermore, at a broader scale, collaborative networks can be important in broader issues of environmental governance. Collaboration within various types of networks can be helpful in setting the stage for large transformations in environmental management (Olsson et al. 2006), developing novel ideas for ecosystem management through knowledge sharing (Sendzimir et al. 2007), overcoming distrust in the government as a barrier to cooperation from stakeholders in addressing environmental concerns (Schneider et al. 2003), and providing a venue for conflict resolution (Ostrom 1990).

At the same time, certain characteristics of collaborative efforts can also make them ineffective as governing tools, including the diversity of interests represented and disparities in power between them (Bidwell & Ryan 2006), the incentives network members have to participate (Schneider et al. 2003), and the potential for increased polarization rather than increased trust between stakeholders (Olsson et al. 2006).

In the case of civic environmental stewardship, collaborative networks have been shown to facilitate connections between an existing pool of volunteers and multiple groups working on stewardship projects (Stevens 1995), and facilitate coordination between organizations in planning their specific actions on a landscape (Moskovits et al. 2004). In many cases, in fact, the scope or severity of an environmental concern prevents any single group from addressing it effectively, necessitating coordination between multiple organizations (Svendsen & Campbell 2008). In Seattle, a study of the network of environmental stewardship organizations (Romolini 2013) found the network's overall cohesion was very low – as predicted, based on the network's large size – and that it was largely decentralized rather than concentrated around a few large, influential groups. Both of these characteristics have the potential to negatively affect information transfer within the network, but also allow for greater flexibility and more

participation from each group (Romolini 2013). Researchers have demonstrated that positive environmental outcomes are more likely in civic environmental stewardship efforts with high levels of participation from all groups (Kramer 2007).

2.2 Monitoring environmental outcomes for management

2.2.1 The importance of monitoring environmental outcomes

Monitoring the outcomes of environmental projects and programs is important for a number of reasons. First and foremost, having good monitoring data is the basis for effective environmental management – monitoring can identify conditions in which a project is likely to succeed or fail, provide validation that a project is effective, and indicate when a project is headed in the wrong direction (Stem et al. 2005). Monitoring environmental outcomes is also critical for demonstrating impact to stakeholders in a project, whether funders, interested individuals, or regulatory agencies (Bennear & Coglianese 2005; Stem et al. 2005). Furthermore, monitoring is an important component in generating knowledge to share with other environmental practitioners and to make future projects more successful (Conservation Measures Partnership 2013; Wortley et al 2013).

2.2.2 Status & trends in monitoring

Unfortunately, environmental monitoring for project or program evaluation is inconsistent at best. On the one hand, among restoration projects globally, the practice of outcomes monitoring has increased significantly over the past 20 years (Wortley et al. 2013). On the other hand, a recent survey of NGOs engaged in biodiversity conservation indicated that only 5% of these organizations' projects are managed with a robust "results-based management" framework (Muir

2010). Similarly, a nationwide survey of river restoration projects indicated that only 10% of projects used a robust evidence-based assessment process to determine project success (Bernhardt et al. 2007). In the Pacific Northwest specifically, less than half of the river restoration projects surveyed identified any monitoring protocols to determine project success (Rumps et al. 2007). Finally, the monitoring of socioeconomic outcomes of restoration projects lags substantially behind ecological monitoring (Wortley et al. 2013).

Some of the obstacles identified to effective monitoring for environmental projects include a lack of funding, time, or staff, a lack of clear mandates to measure success, as well as a perception that monitoring is prohibitively complex (Koontz & Thomas 2006; Rumps et al. 2007; Muir 2010). Interestingly, restoration projects that have a high level of volunteer or community involvement may in some cases have more comprehensive monitoring and documentation of project outcomes than projects implemented with contractors and with little community involvement (Palmer et al. 2007).

2.2.3 Open Standards for the Practice of Conservation: management using environmental outcomes

In order to maximize its potential benefits, monitoring must be part of a broader planning effort, which clearly identifies the intended outcomes, strategies for achieving them, and ways to determine whether the strategies employed are leading to progress toward the intended outcomes (Teofili & Battisti 2011; Conservation Measures Partnership 2013). Furthermore, in order to effectively share knowledge with other organizations conducting similar projects – for example, the various organizations conducting civic environmental stewardship in the Green-Duwamish

watershed – a certain amount of standardization in monitoring processes and parameters is required (Atkinson et al. 2004).

There are numerous conceptual models and planning frameworks that could serve as a common framework for monitoring environmental outcomes among multiple organizations (e.g. Margules & Pressey 2000; Atkinson et al. 2004; Stem et al. 2005; Pressey & Bottrill 2009; Tallis et al. 2010; Wortley et al. 2013). One planning framework in particular is becoming popular for landscape-scale conservation efforts in Puget Sound: the Open Standards for the Practice of Conservation. The Puget Sound Partnership, a government-led collaborative effort to implement the Puget Sound Action Agenda (PSAA), is implementing the Open Standards as an integral part of planning, monitoring, and implementing the conservation programs outlined in the PSAA (Hook & Knauer 2012). In the Green-Duwamish watershed specifically, the consortium of government agencies and NGOs tasked with recovering habitat for Chinook salmon are adopting the Open Standards for project planning and monitoring as well (Puget Sound Recovery Implementation Technical Team 2013). Beyond Puget Sound, there are other calls to use the Open Standards framework more broadly in order to improve the effectiveness of conservation projects, programs, and policies (Teofili & Battisti 2011; Alexander & Hess 2012).

The Open Standards framework, developed by a partnership of conservation-focused NGOs, guides the design, management, and measuring of impacts for conservation actions (Dietz et al. 2010). The Open Standards framework emphasizes measuring outcomes, identifying assumptions about how particular strategies can reach these outcomes, adapting these strategies in response to monitoring results, and sharing data and lessons learned with the larger community of conservation practitioners (Conservation Measures Partnership 2013).

The five major elements of a conservation project in the Open Standards framework are: 1) conceptualizing the project; 2) planning; 3) implementing and monitoring; 4) analyzing and adapting; and 5) sharing the lessons learned. These elements form a cyclical process through which conservation projects can be planned, implemented, and improved.

2.2.4 Considerations for monitoring environmental outcomes

In applying the Open Standards framework, there are a number of important considerations identified in the literature; most of these considerations would apply equally to many other conservation planning tools (Stem et al. 2005). First, it is important that project managers clearly identify the intended outcomes of their project (Hatry 2006). While this may seem like an obvious step in conducting an environmental project, and projects are almost always driven by at least general goals, such as "creating healthy green spaces" (Romolini et al. 2012), effective monitoring of project outcomes requires more specificity. Particularly for projects that consist of ecological restoration, the specific intended outcomes can be controversial: restoration projects require identifying a target ecosystem state, but researchers often disagree on what that state should be (Stevens 1995; Hobbs & Norton 1996; Clewell & Aronson 2006). Similarly, projects may report different intended outcomes to certain stakeholders, such as funders, than are used internally (Rumps et al. 2007). Furthermore, in planning and measuring environmental projects, there is often confusion between outputs – the direct products of an organization's environmental work – and outcomes – the effects of these outputs on environmental conditions (Koontz & Thomas 2006).

A second major consideration for measuring environmental outcomes is establishing clear links between the intended outcomes of the project, the actions taken to reach those outcomes, and the

environmental parameters that will be used to indicate progress. A variety of terminology is used to describe these logical linkages, for example, "logic models" (Hatry 2006), "conceptual frameworks" (Stem et al. 2005), "conceptual models," and "results chains" (Conservation Measures Partnership 2013). Using a model to illustrate the links between project actions, outputs, and outcomes allows managers to determine what environmental variables to monitor: the variables that will provide information about the key links in the model (Thomas & Koontz 2011).

A third set of considerations relates to using the monitoring data collected, both internal to a project and in sharing knowledge with others. With respect to using data internally, the Open Standards framework emphasizes an adaptive management approach – examining the results of actions and changing future actions in response, in an iterative, experimental cycle (Salafsky et al. 2001). The adaptive management process is anchored in a clear conceptual approach described above, and requires timely data collection and analysis as well as a shared willingness among project participants to experiment. These latter two requirements can be problematic for implementing an adaptively-managed project or program (Lee 1999).

With respect to sharing knowledge with others, the issues of terminology and coordination are both crucial. As implied in the previous paragraph, the concepts embedded in the design and implementation of a monitoring system can be referred to using a plethora of terms, resulting in confusion (Kentula 2000; Stem et al. 2005; Koontz & Thomas 2006; Schwartz et al. 2012). One of the aims of the Open Standards framework is to provide a common set of terms for the conservation field (Stem et al. 2005; Conservation Measures Partnership 2013), although diffusion of this terminology into the field, even among Open Standards users, is still incomplete (Hook & Knauer 2012; Schwartz et al. 2012).

Effectively sharing data with others, especially practitioners eager to gain knowledge, also requires coordination of goals, assumptions, and monitoring protocols. Cooperative work at the landscape scale or between organizations conducting similar projects requires some kind of common framework (Kentula 2000; Atkinson et al. 2004; Margerum & Whitall 2004).

3 Research design

3.1 Data collection

This research was based on semi-structured, key-informant interviews with civic environmental stewardship practitioners throughout the Green-Duwamish watershed. Romolini et al. (2012) studied environmental stewardship in Seattle and emphasize the value of engaging program leaders as a means for understanding a "significant, but likely underestimated, environmental action community across urban landscapes" (p. 13). The interview process was partially oriented as an elaborated case study – an exploration of civic environmental stewardship in a specific watershed – and partially oriented as an evaluation of the monitoring process. Rubin and Rubin (2005) describe the goal of an elaborated case study as "to be able to generalize broader processes, to discover causes, and to explain or understand a phenomenon" (pp. 6-7). The same authors describe the purpose of evaluation research as "to discover if programs and policies are working, for whom they are working, and what could be improved" (p. 9).

The study focused specifically on an initial characterization of stewardship and environmental monitoring in the watershed according to the perceptions of the practitioners themselves. Qualitative interviewing provided an opportunity to collect in-depth data, from knowledgeable individuals, with fewer predetermined constraints (Patton 2002). Taking an exploratory approach was appropriate for this case because the pool of organizations conducting on-the-ground stewardship activities in the watershed is itself not fully described, let alone the data sources required to formally evaluate stewardship actions and monitoring.

3.1.1 Sample population

An initial pool of potential interviewees was assembled based on two sets of criteria, organizational and individual. First, sampling focused on organizations conducting civic environmental stewardship (physical activities on behalf of the environment on public or quasi-public lands), in the Green-Duwamish watershed, as one of their core activities. While the priority was to interview representatives from organizations that were primarily engaged in environmental stewardship conducted by volunteers, organizations for which the primary labor force for stewardship activities was paid crews were included as well, in order to capture information on collaboration and other interactions between paid crews and volunteers. The pool of target organizations was focused such that there was representation from each of three organizational categories: 1) organizations that play the role of coalition leaders, managers of multi-organization programs, or highly effective facilitators of civic environmental stewardship actions; 2) organizations or individuals that are active members of a larger coalition that cites civic environmental stewardship as a major focus; and 3) organizations or individuals that conduct civic environmental stewardship actions independently of close coordination in a broader coalition.

The sample population of organizations was largely compiled from a census of environmental organizations throughout King and Pierce Counties (Brinkley et al. 2010), with one additional organization added at the outset based on prior knowledge. These census data were sorted to identify organizations that work within the Green-Duwamish watershed, conduct environmental stewardship as a core activity, and report that they conduct monitoring as well. From this sorted list, 10 organizations were chosen that, based on Internet research and prior knowledge, fit the organizational criteria identified.

For each of the 10 organizations potential interviewees were identified, based on Internet research, prior knowledge, and referrals from other interviewees, who were knowledgeable about 1) civic environmental stewardship activities in the Green-Duwamish watershed; and 2) ecological monitoring at and near the sites of stewardship actions. In some cases, one individual at an organization was more knowledgeable about one of these topic areas, and another individual was more knowledgeable about the other; in these cases, both individuals were contacted for an interview. During each interview, interviewees were prompted to identify other potential subjects to add to the sample pool, a technique referred to as snowball sampling (Patton 2002). A total of 14 individuals were identified, each representing a distinct program within one of 10 organizations – 3 government land and resource management agencies, 2 government programs not tied to specific parcels of land, and 5 non-profit organizations.

Throughout the process, interviewees repeatedly referred back to organizations and individuals that were already in the sample pool, and while not all of these referrals were ultimately contacted due to time limitations, the interviews that were conducted provided sufficient insight, from each of the organizational perspectives identified above, for the study's research questions. See Appendix 1 for a list of organizations interviewed.

3.1.2 Interview process

Interviews were semi-structured: questions were asked according to a standard thematic outline (see Appendix 2), but in most interviews, questions were tailored to the specific circumstances and extended follow-up questions were asked.

There were three major lines of inquiry in the interviews:

1. characterizing the subject's contribution to civic environmental stewardship actions in the watershed;
2. characterizing the ecological monitoring activities being conducted at and near stewardship sites that the subject had knowledge of; and if applicable,
3. evaluating whether and how data from these sites are used and shared with others.

Twelve of the 14 interviews were conducted in person, and two by phone. With each subject's permission, the interviews were recorded to a digital file. Interviews were conducted according to a protocol approved by the University of Washington's Institutional Review Board.

3.1.3 Interview analysis

Each recorded interview was transcribed verbatim. Interview data were then coded and analyzed using the qualitative data analysis software package nVivo. First, an *a priori* provisional coding scheme was applied to interview transcripts. During provisional coding, responses were categorized according to the initial topics of interest for this research, including characteristics of stewardship actions, characteristics of monitoring activities, and evaluation of monitoring activities, discussed in further detail below. Responses in each provisional category were then further analyzed through an iterative process of additional coding, which illuminated themes and emergent patterns. The full coding outline is included as Appendix 3.

3.2 Characterizing civic environmental stewardship in the watershed

Interviewees were asked to provide information helpful to characterizing civic environmental stewardship in the watershed. In particular, interviewees were asked about:

- The sites of stewardship actions that their organizations participated in
- The specific activities that volunteers or paid crews conducted on stewardship sites
- Organizations that they collaborated with, and the nature of those collaborations

When interviewees referred to specific documentation of stewardship activities, these documents were acquired and reviewed when possible to provide further context to interview responses.

3.3 Evaluating monitoring activities

3.3.1 Evaluation framework: Open Standards for the Practice of Conservation

Using interview data, and where applicable including documents that interviewees referred to, monitoring activities associated with civic environmental stewardship were evaluated with respect to the potential for measuring the ecological outcomes of stewardship at the landscape or watershed scale. The Open Standards for the Practice of Conservation (Conservation Measures Partnership 2013) were used as a basic framework to evaluate monitoring activities. In particular, the following characteristics of monitoring were of interest:

- The conceptual models on which stewardship actions and monitoring are based
- The relationship of monitoring protocols to the conceptual model of stewardship actions, including identification of ecological goals, strategies for reaching these

goals, and measurable objectives and indicators for assessing progress toward goals

- The extent to which monitoring data are used for adapting stewardship actions to improve their outcomes
- The extent of coordination within organizational networks with respect to identifying shared goals, conducting compatible measurements, and sharing the results of monitoring and analysis

While the Open Standards framework was originally designed as a planning tool for established organizations or partnerships to use when designing or improving conservation projects, many of its elements are nevertheless applicable to less formally organized projects (Schwartz et al. 2012). Other elements of the framework are less applicable, such as internal organizational considerations. Nevertheless, using a common framework to compare the ongoing actions of multiple organizations is useful for evaluating each organization's activities alone, as well as identifying existing common elements between organizations, and opportunities to improve monitoring protocols through future collaborations.

Interview transcripts were coded to identify when interviewees discussed their stewardship projects in terms of the project elements identified in the Open Standards framework. In the sections that follow, the specific elements of interest are identified, and the Open Standards definition for each is provided. The Open Standards manual provided additional guidance in the coding process through lists of ideal outputs from each step in the Open Standards framework, and criteria for many of the elements identified. A complete list of these ideal outputs and criteria can be found in Appendix 4.

For each section of the evaluation methods described below, responses from different organizations were compared, to identify commonalities as well as differences in each of the Open Standards' project elements used for evaluation. When possible, it was noted whether or not project elements such as indicator measurements or project objectives could theoretically be synthesized to scale up monitoring results beyond the site level. Aspects of monitoring activity that would be conducive to scaling up include: targets, goals, and objectives in common between organizations, consistent and transparent monitoring methods, and effective sharing within collaborative networks.

3.3.2 Evaluating conceptual models

The first step in the Open Standards framework is "conceptualizing" a project. The elements of this step that were used to evaluate monitoring activities included:

- Defining the conservation targets for action
    - A conservation target is defined as "an element of biodiversity at a project site, which can be a species, habitat, or ecological system that a project has chosen to focus on."
- Identifying the threats that affect these targets
    - A threat is defined as "human actions that immediately degrade one or more conservation targets, or natural phenomena altered by human activities."

Building on the targets and threats identified, the Open Standards framework then calls for an "action plan," which includes goals, strategies, assumptions, and objectives. While the Open Standards framework includes the action plan as part of the second step, "Planning" (discussed

below), the open-ended nature of interviews generally led to interviewee responses that blended elements of an action plan with the elements of project conceptualization discussed above. Therefore, for the purpose of this research, "conceptualizing" and "developing an action plan" were analyzed together.

The Open Standards guidelines (Conservation Measures Partnership 2013) define the elements of a conceptual model as follows:

- Goals: "a formal statement detailing a desired impact of a project, such as the desired future status of a target."
- Strategies: "a set of actions with a common focus that work together to achieve specific goals and objectives."
- Assumptions: "the logical sequences linking project strategies to one or more targets."
- Objectives: "formal statement[s] detailing a desired outcome of a project such as reducing a critical threat."

Monitoring activities were evaluated and compared according to these elements as inferred from interview responses.

3.3.3 Evaluating & comparing the monitoring planning process

The Open Standards framework identifies "planning" as a second step. The elements called for in this step build from the elements identified in the "conceptualizing" step.

Elements from this step that were used to evaluate monitoring activities included:

- Developing an action plan, incorporated into the "conceptualizing" step as described above
- Developing a monitoring plan, including identifying the intended audiences, choosing indicators, and developing methods
    - An audience is defined as "those individuals or groups a project team is trying to reach."
    - An indicator is defined as "a measurable entity related to a specific information need such as the status of a target/factor, change in a threat, or progress toward an objective."
    - A method is defined as "a specific technique used to collect data to measure an indicator."

3.3.4 Evaluating & comparing monitoring implementation and use of monitoring data

The third and fourth steps in the cycle of the Open Standards framework are "implementing," and "analyzing, using, and adapting." These steps are the most action-oriented aspects of the project cycle described in the Open Standards framework, and include the implementation of the conservation actions themselves – in this case, environmental stewardship activities. While it was expected that interviewee responses would also include substantial commentary on the implementation of actions themselves, the primary focus was on the implementation of monitoring activities, as well as how the results of these monitoring efforts were used by the organizations conducting stewardship. Therefore, the actual implementation of stewardship

actions was not evaluated using the Open Standards framework; interviewee responses were evaluated with respect to action implementation as described earlier in this chapter (characterizing civic environmental stewardship).

Elements from these Open Standards steps that were used to evaluate monitoring activities included implementing a monitoring plan; preparing data for analysis; analyzing results; and adapting strategies, assumptions, or other elements of the project plan.

3.3.5 Evaluating collaboration

The final step in the Open Standards project cycle is "capturing and sharing learning." The Open Standards manual emphasizes the importance of documenting and sharing the lessons learned during a project cycle, both within and outside of organizations, as well as more generally, creating a learning environment within organizations and organizational networks. All of these project elements are nested within the dynamics of collaboration between stewardship organizations throughout the watershed. The extent and patterns of collaboration within the watershed were described and evaluated, with a particular focus on elements of collaboration that could contribute to scaling up the results of monitoring. These elements included: evaluating shared goals, conducting compatible measurements, and sharing the results of monitoring and analysis.

3.4 Research limitations

3.4.1 Defining "environmental stewardship"

While focusing specifically on civic environmental stewardship is helpful for examining, in detail, certain aspects of stewardship in the Green-Duwamish, the trade-off to this narrow focus is that other closely related activities in the watershed are ignored. In particular, environmental stewardship activities on private lands, which make up the majority of the watershed's land area, are largely excluded from this study, but are no doubt significant from the perspective of tracking the overall environmental health of the watershed. In addition, the focus on volunteer-oriented activities largely excludes stewardship actions that rely on paid crews. While paid crews and volunteers sometimes overlap on stewardship sites, the significant contributions of restoration crews are not fully captured in this research, especially with respect to large "capital projects" such as riverbank engineering. Finally, the focus on physical stewardship activities ignores the potential contributions of other important actions described in the literature such as education, outreach, community-building, and advocacy. These actions, which are often included within studies of civic environmental stewardship as a social phenomenon, may have significant environmental effects, albeit harder to measure directly.

3.4.2 Sampling bias

The criteria used to identify the pool of potential interviewees presented further limitations. First, the assumption that civic environmental stewardship organizations can be appropriately categorized as facilitators of coalitions, organizations that operate within broader coalitions, and organizations largely independent of coalitions, is untested. Furthermore, the decision of which of these categories each potential interviewee represented was subjective. These factors may

have skewed the interviewee pool toward an overrepresentation of groups participating in collaborative efforts.

Second, the interview process was not exhaustive of all organizations identified in the initial pool and additional organizations identified during interviews. Had time allowed, further attempts would have been made to exhaust the interviewee pool. For example: It is possible that the Duwamish River Cleanup Coalition (DRCC), which is the organization delegated as a community partner for the EPA-led Superfund clean-up effort, would have been able to provide a unique perspective on the role of civic environmental stewardship in the Lower Duwamish. DRCC was not interviewed. As another example, cities such as Auburn and Tukwila, which were not participants in a Green Cities partnership program (as opposed to Seattle and Kent, both Green Cities participants) but led stewardship actions independently, may have provided information that would more fully illuminate the roles of local municipalities in influencing civic environmental stewardship.

Finally, given this study's focus on physical actions on behalf of the environment, interviewees were biased toward organizations that included physical actions as a major element of their activities. Many organizations have been identified in the watershed that conduct environmental stewardship actions but do not focus primarily on physical activities (Brinkley et al. 2010; Romolini et al. 2012). This study was intended to provide information on one layer of environmental stewardship's overall impact on the landscape, but it must be acknowledged that activities with primarily social outputs likely contribute significant additional layers of environmental impact.

4 Findings

4.1 Civic environmental stewardship in the Green-Duwamish watershed

The major characteristics of civic environmental stewardship identified in the interview process are described in this section, which is divided into three sub-sections: the environmental stewardship activities that occur in the watershed, the locations and distribution of stewardship sites, and the individuals conducting stewardship activities.

4.1.1 Activities

Interviewees were prompted to discuss the specific activities that volunteers, or paid crews, conduct on stewardship sites. The two objectives for these questions were 1) to contribute to a basic typology of civic environmental stewardship actions in the watershed; and 2) to collect information to use in evaluating the monitoring protocols conducted on stewardship sites.

The most common type of stewardship activity discussed was ecological restoration. Restoration, as defined by the Society of Ecological Restoration International (2004, p. 1), is "an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity, and sustainability." All interviewees mentioned *removing invasive plant species* as a major restoration activity. Most interviewees mentioned Himalayan blackberry and English ivy as specific targets of invasive removal. Other upland invasive species mentioned included English holly, English laurel, and Norway maple. In discussing restoration projects in wetland and aquatic habitats, interviewees mentioned Japanese knotweed, reed canary grass, and buttercup as well. Manual, mechanical, and chemical removal methods were all mentioned; the specific methods required for a particular site often determined whether project managers

assigned volunteers or paid crews to clear invasive vegetation. Invasive removal activities were seasonally-driven: numerous interviewees categorized invasive removal as a springtime activity.

All interviewees also identified *native plant installation* as a major restoration activity. The general planting plans for each site, and the specific plants installed, varied depending on the goals identified for that site. Especially for upland sites, planting plans appeared to be the most frequently-adjusted element of restoration projects. Many interviewees identified plant installation as an especially appropriate activity for volunteers. However, one interviewee offered the contrasting view that for wetland plants, successful installation required a level of technical expertise that volunteers could not necessarily supply. Plant installation was seasonally-influenced, similar to invasive removal: organizations generally conducted planting activities in autumn.

Many interviewees further identified a number of activities that can be categorized as *site maintenance*. On upland restoration sites, this included mulching and soil amendment, additional invasive vegetation control, watering new plants, and additional planting especially to replace plants that did not survive.

The interviewees whose organizations participated in the Green Cities Partnership program – a network of partnerships between the NGO Forterra, city governments, and other local stewardship organizations – all discussed restoration work used common terminology. The Green Cities network includes the cities of Seattle and Kent, each with extensive land in the watershed, and also includes the cities of Tacoma, Kirkland, Redmond, and Everett.

Interviewees whose organizations were involved in the Green Seattle or Green Kent Partnership divided restoration work into phases, which were defined as:

- Phase 1: Invasive plant removal
- Phase 2: Planting and secondary invasive removal
- Phase 3: Plant establishment, including site maintenance
- Phase 4: Long-term monitoring and maintenance

Two interviewees also mentioned *restoration forestry* – selectively removing trees from a forest stand in order to change that stand's successional trajectory – as a restoration activity.

In the aquatic environment – the main channel of the Green River, side channels and tributaries, and wetlands on the valley floor – restoration projects often required significant *site engineering* as a major project component. These projects were frequently referred to as capital projects. Engineering activities included improving fish passage through culverts, levee setbacks, construction of side channels, creation of shallow-water habitat, large wood installation, and gravel replenishment. While the engineering aspects of these projects were always conducted by paid crews, there were occasionally volunteers involved in later phases of the project. One example, identified by multiple interviewees, was the project at North Wind's Weir in the Duwamish sub-watershed, a collaborative project of King County and the US Army Corps of Engineers. The first phase of this restoration project, conducted by paid crews, was the excavation and re-grading of a portion of the Duwamish shoreline in Tukwila, and the installation of several large wood structures to create more shallow-water habitat for juvenile salmon. Once construction activities were complete, volunteers installed native plants to

establish wildlife habitat on the newly-created riverbank and tidal mudflat. These wetland and riparian sites have since been maintained largely by volunteers.

A few interviewees mentioned *environmental monitoring* as a stewardship activity *per se*, both on sites in restoration, and in other natural areas – sometimes to collect data to be used in measuring the outcomes of stewardship, and other times to contribute to answering other ecological questions. However, most did not mention monitoring during discussions of their organization's stewardship activities, rather during later questions about monitoring specifically.

While all interviewees were presented with the narrow definition of civic environmental stewardship that guided this research, interviewees were nevertheless encouraged to discuss other activities that interviewees considered stewardship as well. Activities with primarily environmental goals, but no direct environmental outputs, included land acquisition, the recruiting and training of volunteers and stewards, public outreach, political advocacy, and participation in environmental governance. Activities with primarily social goals included trail building and maintenance, community-building activities, and leadership development.

These results are consistent with a recent study of stewardship organizations in Seattle, in which organizations that conducted environmental restoration or maintenance as primary activities reported similar activities. Organizations in this study also mentioned other categories of activities they considered as environmental stewardship, including youth engagement, education and outreach, land acquisition/conservation, developing relationships, and advocacy (Romolini et al. 2012).

4.1.2 Site locations

This section describes themes related to the location and distribution of stewardship sites. Interviewees were asked to describe the distribution of stewardship sites that their organizations worked on. The intention of this question was not to compile a comprehensive map of stewardship sites in the watershed, but to gain an understanding of the general patterns and influences of distribution for stewardship work. Specific foci for these questions included: patterns or characteristics of the distribution of sites throughout the watershed; how organizations chose the specific sites they worked on; and considerations for future efforts to compile a more comprehensive spatial representation of stewardship activities, such as data availability.

Some interviewees were able to provide comprehensive, detailed maps or GIS files illustrating each site (selected maps are available in Appendix 5), while others gave a more general description of their sites.

Interviewees mentioned more than 50 distinct sites of environmental stewardship, 15 of which were mentioned by multiple interviewees. While in many cases, organizations appeared to share the same general definitions of the stewardship sites that had organizational overlap, a few potential issues with site definitions were identified. First, some sites were referred to by more than one name. Second, different organizations appeared to conceptualize stewardship sites at different scales. Representatives of land management agencies most frequently discussed stewardship actions in the context of the parks or natural areas in which sites resided, or in the context of jurisdiction-wide or landscape-scale programs. On the other hand, interviewees from NGOs more often referred to individual sites. EarthCorps' site monitoring process for Green Seattle Partnership sites provides the best example of this: each site under active stewardship

within the partnership is presented with a unique identifier in a public-accessible database called the Interactive Habitat Map (http://www.earthcorps.org/interactive-map-popup.php). While in written plans, the City of Seattle uses these unique identifiers as well, the interviewee from the City of Seattle primarily discussed site distribution at the park and citywide scales.

As expected, stewardship sites appeared roughly distributed in the same footprint as the distribution of public lands in the watershed. Much of the public land in the Duwamish and Lower Green sub-watersheds is owned by cities. Natural lands are sometimes distributed among multiple city departments, so citywide coordination of stewardship activities on public lands requires inter-departmental collaboration. Most of the public lands within the watershed that are not managed by cities are managed by the King County Parks Department, although Washington State Parks controls a large block of land in the Middle Green. This area, known as the Green River Gorge Conservation Area, includes Flaming Geyser State Park as well as a number of more recent land acquisitions.

In urban areas, public lands in the watershed are mostly distributed as small, non-contiguous patches, although there are a few large swaths of natural areas or connected patches such as the West Duwamish Greenbelt. In rural areas, public lands are largely concentrated in a few County- or State-protected natural areas, especially on and in the immediate vicinity of the Green River and its tributaries.

Interviewees did mention some stewardship sites on private lands as well, including volunteer-driven activities. The private lands mentioned were primarily in the Middle Green sub-watershed, in rural areas, with a few riverbank sites in the Duwamish and Lower Green as well.

The practice of volunteer-driven stewardship on private lands was unexpected. An interviewee representing King Conservation District described the circumstances of some of these projects:

> *Ninety percent of [the landowners contacted by KCD] are stoked about doing it [a riparian buffer restoration project]. They've moved to the property and it was all blackberries, or they grew up on the property and they remember the creek being there, and then they inherited it from their grandparents or their parents, and they're like, "now there's weeds everywhere!" Everyone's got their own story behind what's driving them to do the project or be involved in the project.*

The density of stewardship sites also appeared roughly proportional to population density in the watershed, with the densely populated Duwamish and Lower Green sub-watersheds appearing to contain the majority of stewardship activity identified during interviews. One interviewee lamented this phenomenon, associating a dearth of stewardship projects in the Middle Green sub-watershed with a smaller number of local NGOs compared with further downstream:

> *I have felt… that [the Middle Green River] has not received as much attention, in regard to receiving large-scale public funding for open space acquisition, large capital projects, as other basins. It's sort of the, I wouldn't call it the underdog basin, but we don't have a lot of groups down there who are advocating for those projects.*

Site distribution was also clearly driven by political boundaries: stewardship sites appeared much more abundant in the two cities that participated in the Green Cities program, Seattle and Kent.

Interviewees identified a wide spectrum of considerations for choosing specific sites on which to focus for stewardship actions. Projects conducted within the Green Cities program use a habitat assessment model referred to as "Tree-iage," which relies on rapid assessments of the vegetation

conditions – forest structure and composition, and invasive species cover – to categorize sites for their existing habitat value and threat level. Both the Green Seattle Partnership and the Green Kent Partnership initially prioritized sites with high habitat values. Projects coordinated by the Watershed Ecosystem Forum – the coalition of government agencies responsible for salmon habitat recovery in WRIA 9 – were also initially prioritized using ecological factors: an assessment of threats to salmon in the watershed identified spawning, rearing, and transition habitats as the highest priority habitat type, and transition habitat in the Duwamish sub-watershed was identified as the first priority.

However, in both of these cases, as well as for other interviewees who were not working within either of these broader programs, non-ecological factors were as important as or more important than ecological ones. The level of community involvement or community support was a major influence for choosing sites, especially for volunteer-driven activities. This is consistent with previous findings (Brinkley et al. 2010; Wolf et al. 2013) that emphasized the importance of both involving and contributing value to the community in the context of environmental stewardship actions.

The availability of funding was often a critical driver as well. Interviewees frequently discussed funding sources that were tied to specific parcels of land, in some cases land that would not otherwise be prioritized for stewardship action. One interviewee from EarthCorps, which participates in stewardship activities using both an in-house paid crew and by organizing volunteer events, noted that the organization was attempting to lessen the influence of funding as a prioritizing force:

We have a very specific goal of trying to shift these proportions [prioritization based on funding vs. site-based ecological factors] around, being more place-based around where we work, as opposed to being driven by funding. I mean, because to a certain degree, we say, "Oh, who has money?" and that's how we decide where we can work, just a fact of necessity. And so we're trying to figure out how we can shift that more.

4.1.3 Participants and collaboration

This section describes the characteristics of participants in stewardship activities, and discusses themes that emerged during the interview process, especially the prevalence of collaboration in the watershed.

4.1.3.1 Types of participants

From interview responses, three general types of individual participants in stewardship actions were identified: 1) occasional volunteers, 2) volunteer stewards, and 3) paid crewmembers. Volunteer stewards, as opposed to occasional volunteers, were described as assuming clear responsibility for restoration work on their sites, and generally showing a high level of commitment. Numerous organizations in the watershed have adopted formal programs that interested volunteers sign up for, where a facilitating organization provides training and resources and in exchange, volunteer stewards take responsibility for conducting stewardship actions on individual sites. The Green Cities programs in Kent and Seattle in particular rely heavily on the "steward" model. King County Parks has a similar program, identifying volunteer stewards as "Park Ambassadors," and EarthCorps' Sound Stewards program (which was run by the now-defunct organization People for Puget Sound until 2012) also uses volunteer stewards to take responsibility for wetland sites on the Duwamish.

While the steward model is important, the majority of volunteer labor appears to come from occasional volunteers, who are not delegated responsibility for any particular site. Within this category of participant, however, interviewees identified a wide spectrum of dedication to the work, from volunteers who are very frequent participants with accumulated experience and skills, to young children on a school outing who have never participated before.

The third major category of stewardship participant mentioned in interviews was paid crews. Stewardship actions conducted by paid crews do not fit into the definition of civic environmental stewardship that initially framed this research, but it became clear as interviews progressed that from the perspective of exploring the monitoring of ecological outcomes of stewardship, ignoring the contributions of paid crews would be extremely difficult. Every interviewee mentioned that their organizations relied, to varying extents, on paid crews to conduct stewardship actions. In some cases, paid crews are assigned to different sites than volunteers, but in many other cases, paid crews are assigned specific activities on sites that volunteers contribute to as well.

4.1.3.2 Deciding between volunteers and paid crews

The decision made by organizations between using volunteers and paid crews was an important theme of discussion. First, interviewees identified the necessity of an active base of volunteers before organizations could even consider volunteer work. In densely populated areas, particularly the Green Cities programs of Seattle in Kent, interviewees did not mention a lack of volunteers as a major issue. However, interviewees whose organizations conducted work primarily in rural areas identified this as a serious obstacle to conducting volunteer projects. This obstacle may be more significant in the Green-Duwamish watershed than neighboring

watersheds: interviewees who had familiarity with stewardship work in other watersheds noted that South King County has shown a particularly low rate of success in recruiting volunteers for stewardship activities.

Another factor in this decision, identified by most interviewees, was the safety and comfort of volunteers. Interviewees identified a number of unsafe site conditions that were common in the watershed, including steep slopes, swift water, and thick vegetation that made travel difficult. Each of these scenarios was inappropriate for volunteers but often workable by skilled crews. As one interviewee put it: "Volunteers: Ya don't wanna lose 'em!"

Even for sites that were determined safe enough for volunteers, some interviewees were concerned with giving volunteers tasks that would prove difficult, uncomfortable, or frustrating. An interviewee representing salmon recovery efforts in the watershed described one of her organization's criteria for assigning volunteers to a site as "How overwhelming is it going to be?" A representative of the Green Kent Partnership quipped that while he had one dedicated group of volunteers who would come out repeatedly for "blackberry torture sessions," he found that "not too many other volunteer groups are very excited about digging blackberries out."

The effectiveness of volunteer labor compared to crew labor was another common factor, but there was not a consensus on which labor source was more effective. Interviewees generally agreed that crews could conduct restoration activities over a larger area, more quickly, than volunteers. However, interviewees seemed to disagree whether covering a large area necessarily translated to greater effectiveness.

For example, some interviewees argued that paid crews, with more powerful tools and theoretically greater expertise, do a better job of removing invasive vegetation than volunteers.

However, other interviewees argued that volunteer work, while covering a smaller area, tended to be more thorough than crew work:

> *Often [crews] are just doing like, triage effort to stave back the invasives, and they don't really have the time or the staff support to do a very thorough, complete job of Phase One. So they'll kind of do half of Phase One again and again and again. Often that's like mowing blackberry down but not grubbing the roots out, so you just come back again and again and again.*

Cascade Land Conservancy (now Forterra) commissioned a study comparing the effectiveness of paid crews and volunteers on stewardship sites in Seattle and Tacoma (Elman & Salisbury 2010). This study found that paid crews could clear invasive vegetation twice as quickly as volunteer groups. However, volunteer-cleared sites tended to be maintained more frequently after initial clearing, leading to better outcomes in invasive reduction over time.

Interviewees also pointed to the relative expertise of paid crews in comparison to volunteers as a component of relative effectiveness. For plant installation, interviewees seemed to agree that the expertise required to install plants successfully favors crew labor in some cases, especially for emergent wetland plants:

> *I mean, as far as planting wetland plants, per se. I've planted millions of them, and it's very difficult to get it right. So that's typically something that we've done more with paid crews.*

At the same time, interviewees often mentioned that volunteers tend to prefer planting to other activities such as invasive removal, so from the perspective of maintaining volunteer interest, it makes sense to include volunteers in planting as much as possible.

Regulatory constraints were another factor in determining whether or not to use volunteers. For example, activities in wetland environments are more strictly regulated than upland areas, and the special training required for working in wetlands often favors trained crews. Regulations also constrain the use of herbicides, which are required for effectively removing certain invasive plants.

On the other hand, most interviewees identified numerous benefits to choosing volunteers rather than paid crews for conducting stewardship work. In some cases, organizations use volunteers as a cost saving measure. This is especially the case for organizations that rely on a steward model, as some paid staff responsibilities can be delegated to volunteers. However, a few interviewees pointed out the need to have paid staff available to manage volunteer programs, but for organizations that do not already have staff available to dedicate to volunteer management, these cost savings appear to evaporate. Importantly, most, although not all, of the organizations represented in this study had stated goals of engaging, educating, or inspiring local communities. These interviewees recognized the value of volunteer stewardship work in meeting these goals, and these goals were often a major influence in deciding between paid crews or volunteers.

4.1.3.3 Organizational characteristics

Organizations participating in stewardship that were discussed in interview responses can be categorized into the following groups:

- Government agencies at the local, regional, and state levels, responsible for land management, especially parks and designated natural agencies
- Government agencies responsible for managing or regulating specific natural resources, such as fish, wildlife, and water

- Government agencies that primarily provide technical and financial assistance
- NGOs that are focused on stewardship actions at one site or small group of sites
- NGOs that focus on broader spatial scales or environmental issues that affect sites across the watershed
- Corporate landowners
- Individual landowners
- Non-environmental groups with a strong environmental ethic such as businesses, schools, and community-focused NGOs

Stewardship actions in the watershed appear to be primarily agency-led, most frequently through coalitions that include multiple public and private partners. In most cases, these coalitions are managed collaboratively, and coalitions often appear to include organizations that were conducting environmental stewardship actions independently in the past. For some formal coalitions that include both public and private organizations, it is not clear whether the impetus for formation was from the public or private sector, and it is possible that NGOs initiated or currently lead these collaborations. Some agencies also facilitate stewardship actions independent of formal coalitions, especially in rural areas. Similarly, a few independent NGOs were identified that conduct stewardship actions. While the independent NGOs interviewed for this study primarily worked in rural areas, interviewees mentioned some stewardship work being conducted by independent NGOs in more densely populated areas as well.

4.1.3.4 Collaboration and network connections

Interviewees identified three formal coalitions for which facilitating volunteer stewardship was a major focus: Green Seattle Partnership, Green Kent Partnership, and the Duwamish Alive!

coalition. Salmon habitat recovery, which is a major focus of restoration activities in the watershed, is largely coordinated by the Watershed Ecosystem Forum. This coalition facilitates significant environmental stewardship but does not have a specific focus on volunteer activities. Other formal collaborative efforts were identified as well, including the Restore the Duwamish Shoreline Challenge led by Forterra, and the annual Day of Caring volunteer event led by the United Way of King County.

Interviewees identified a number of benefits from partnerships and collaborations, including: increased access to financial, technical, and labor resources; increasing the impact of stewardship actions; and opportunities for learning. As an interviewee representing the Middle Green River Coalition noted,

> *You tend to get a lot more work done, and it tends to be sustainable over a much longer haul. So that's what we're interested in seeing, is helping work with both community and with government, and building some of these models and implementing them. And learning from mistakes we make as well as the successes that we have. And working with other groups, throughout our region that we work in, to achieve similar results, and use similar concepts and metrics.*

However, interviewees also identified a number of challenges inherent in collaboration. A few interviewees noted the increased administrative energy required – through meetings, paperwork, and planning – to achieve the benefits of collaborative efforts. Another challenge identified related to inequalities with respect to the resources that different organizations were willing and able to bring to the table.

While the collaborative efforts in the watershed provided venues for the connection of numerous organizations that may not otherwise interact, there were two notable gaps in the types of connections identified in interviews. First, there were relatively few connections between organizations whose primary focus was stewardship actions in upland habitats, and organizations that primarily focused on aquatic habitat. There were some exceptions: Nature Consortium is a major part of Duwamish Alive! shoreline restoration efforts, and EarthCorps' acquisition of the Sound Stewards program set the stage for incorporation of aquatic and upland efforts within that organization. However, although many interviewees recognized the interconnectedness of these two ecosystem types within the watershed, most interviewees acknowledged little cross-ecosystem collaboration.

The second notable gap was a relative lack of collaboration between the Duwamish and Lower Green sub-watersheds and the Middle Green, where a few interviewees indicated there was an informal, locally-focused collaborative network of stewardship organizations. The threats facing the densely-populated lower sub-watersheds are, of course, different from those facing the more rural Middle Green, but it is possible that more connections between groups focusing on each of these areas could benefit stewardship work throughout the watershed. Even within salmon habitat recovery efforts, one interviewee reported difficulties in synthesizing data from the lower sub-watersheds with data from the Middle Green:

> *We have different goals for each sub-watershed, so when you're wrapping it up to a whole watershed level, we just don't really report things on a watershed level as much.*

4.1.4 Summary of civic environmental stewardship in the watershed

The most common type of physical stewardship activity discussed in interviews was ecological restoration, although there were many other activities that would generally be considered environmental stewardship mentioned in interviews as well. Restoration projects occurred primarily on public lands, but occasionally on private lands as well, and site density appeared to be correlated to population density.

While volunteers did conduct stewardship actions throughout the watershed below Howard Hanson Dam, a significant portion of stewardship work was conducted by paid crews. In cases where land managers had the opportunity to choose between a paid crew or volunteer labor in conducting a restoration project, decision factors included funding availability, the characteristics of sites and activities, and organizational goals including both ecological and social goals.

Numerous types of organizations were involved in stewardship actions, including government agencies, NGOs, and businesses, and most organizations participated in broader collaborative efforts. While collaboration appeared to be an important element of environmental stewardship in the watershed, there were communication gaps between geographic areas, as well as between upland-focused and aquatic-focused restoration projects.

4.2 Evaluating monitoring

The status of ecological monitoring, and themes related to monitoring identified in the interview process, are discussed in this section. Additionally, this section includes comparative evaluations of important elements of the planning and monitoring process, using the Open Standards for the Practice of Conservation as evaluation guidelines. This section is divided based on the steps identified in the process described by the Open Standards, including the development of

conceptual models, creating monitoring plans, implementing monitoring and using monitoring data, and participating in a network of sharing and learning.

4.2.1 Describing conceptual models

This section describes and compares the elements of a conceptual model that were discovered in the interview process. The conceptual model elements that this study focused on include: environmental targets, threats to these targets, ecological goals, objectives, and strategies for meeting these objectives and goals.

4.2.1.1 Stewardship targets and environmental threats

Four general categories of conservation targets were inferred from interviewee responses: holistic or place-based targets, species-related targets, biophysical targets, and ecosystem services targets. Most interviewees did not explicitly identify these concepts as targets; rather, their responses to questions related to intended project outcomes were interpreted and common targets were inferred. See Table 4.1 for a full list of targets identified or inferred in interviews.

Table 4.1 Conservation targets.

Holistic or place-based targets	Landscape restoration Forest habitat health (including urban forests) Aquatic habitat health (including wetlands & riparian areas) Wildlife habitat health

Species targets	Salmon population parameters Animal communities Biodiversity
Biophysical targets	Water quality Air quality Natural river movement
Ecosystem services targets	Carbon sequestration Stormwater mitigation Air quality

Interviewees did discuss explicit conservation targets occasionally. For example, multiple interviewees discussed the relative merits of targets based on specific species – in the case of the Green-Duwamish, federally listed Chinook salmon – compared to targets based on more holistic habitat-quality goals. A few interviewees specifically characterized their targets as more "holistic" than the salmon-specific focus also prevalent in the watershed. In fact, one interviewee expressed a clear preference for a holistic approach:

> *I think that one of the things that kind of drives me nuts about the… endangered species stuff, is that looking at these situations in a vacuum, through a single-species lens, is just not, in my view, all that useful. What I think is much more useful is to look at the situation on more of a landscape level.*

Another interviewee, discussing the perception of staff working with the Watershed Ecosystem Forum's salmon-focused recovery efforts, saw the potential for these two target types to coexist:

> *So that's where there's a little bit of disconnect, if you would, but I would say it's a happy disconnect, it's not something that causes a lot of friction. Because I think that the salmon recovery staff recognize that there are other really important things to do in the watershed besides directly implementing Chinook and steelhead projects. That restoring these upland sites are actually beneficial to salmon, Chinook and steelhead. Maybe more indirectly, but preserving those lands and restoring them is ultimately going to benefit the watershed, so that's going to help.*

A few interviewees identified ecosystem services targets in their responses, although it was clear that these organizations did not consider ecosystem services to be the primary conservation target for stewardship projects; rather, that restoring habitat functionality on natural lands, for the intrinsic benefit of the ecosystem, would also increase their ecosystem services value as a corollary benefit:

> *…this idea of having a mature forest in the city, I think that it's been determined that this type of ecosystem is maximizing the benefits that I was talking about [ecosystem services]. But I almost feel like that might have been driven the other way around: Like, we had this idea of what a healthy, mature ecosystem would be like, and then we found out what benefits came from that… I don't think anybody decided, "Well what do you want to get out of your forests? Clean air, clean water, whatever… What kind of forest would maximize that?" I think it came the other way.*

Interviewees also mentioned a number of targets that were primarily social in nature. These included:

- Creating an attachment to place
- Bringing legitimate uses to a blighted site
- Building a connection to nature
- Building community
- Environmental education
- Improving quality of life
- Influencing youth
- Inspiring environmental values
- Inspiring land protection
- Inspiring leadership
- Inspiring stewardship behavior
- Raising awareness
- Supporting underprivileged populations

The role of these social targets in monitoring the impacts of stewardship was not investigated in this study, but future research following up on whether and how these targets are monitored would be advisable.

Similar to the conservation targets inferred above, a list of environmental threats to the watershed was inferred from interviewee responses. Although interviewees were not asked specifically about environmental threats, many discussed their targets, as well as their stewardship strategies, in terms of the threats these strategies addressed. Inferences were guided

by Puget Sound Partnership's taxonomy of threats to Puget Sound (2009). See Table 4.2 for a full list of threats identified or inferred.

Table 4.2. Threats Environmental threats identified or inferred.

Threat category	**Specific threats**
Agriculture & aquaculture	Agriculture Livestock Hatchery practices Logging Illegal logging
Natural system modifications	Dams Water flow modifications Shoreline modification Loss of riparian cover Unsustainable successional trajectory
Biological resource use	Salmon harvest
Recreational use	
Development	Residential Industrial
Pollution	Litter Water pollution
Invasive species	

Threat category	Specific threats
Water withdrawals & diversions	
Climate change	

Invasive species were the most common threat mentioned in interviews. Other threats that could be addressed through stewardship actions included water pollution, development, and water flow modifications. On the other hand, many of the threats mentioned in interviews cannot be appropriately addressed through civic environmental stewardship, such as biological resource use, and many of the threats related to agriculture and development.

4.2.1.2 Evaluating & comparing "action plans"

In discussing the intended outcomes of stewardship actions, interviewees also discussed the concepts of goals – defined in the Open Standards framework as statements of the desired future impacts of a project, such as the future status of a conservation target. During this discussion, interviewees were also prompted to elaborate, when possible, their assumptions of the logical sequence of events that would link their stewardship actions to the eventual achievement of these goals. The Open Standards framework expresses this logical sequence of events in a "results chain," described as "a causal ('if-then') progression of expected short and long-term intermediate results that lead to long-term conservation results" (Conservation Measures Partnership 2013, p. 21). Examples of results chains expressed or inferred from interviewee responses are described later in this section. A full list of the goals mentioned or inferred from

interviewee responses, categorized the same as the conservation targets listed earlier, can be found in Table 4.3.

Table 4.3 Goals identified or inferred.

Holistic, or place-based goals	Land in active restoration Diversity of habitats Habitat connectivity Wildlife habitat health Forest composition (target forest types) Reduced invasive vegetation
Species goals	Habitat use by salmon Habitat use by wildlife Vegetation diversity Native vegetation health
Biophysical goals	Water temperature Dissolved oxygen in water River-to-floodplain connectivity River sinuosity

Interviewees did not mention any goals directly related to ecosystem services, despite ecosystem services being mentioned as a target. Similarly, interviewees did not mention any specific air-quality goals although air quality was identified as a target.

In the Open Standards framework, results chains also include strategies and intermediate objectives as elements in addition to goals and assumptions. Objectives are desired outcomes that are intermediate "steps" in a results chain that ends in achievement of a goal, and strategies are a set of actions that are assumed to lead to the objectives and goals in a results chain. Strategies, as conceptualized in the Open Standards framework, are most often designed around reducing a threat. Therefore, the results chains discovered in this study are readily categorized according to the threats identified and discussed in the previous section.

A few interviewees laid out specific causal progressions of results in their responses. For those that did not, causal links were inferred when possible. Table 4.4 provides examples of the results chains identified or inferred from interviewees. Selected quotes are provided to illustrate the nature of the results chains identified in interviews. As indicated on this table, there were a number of threat categories identified or inferred in interviews that were not mentioned as subjects for environmental stewardship strategies, including agriculture and aquaculture, biological resource use, and water withdrawals and diversions.

Table 4.4 Results chains identified or inferred

Threat category	Results chains identified or inferred	Example quotes
Agriculture & aquaculture	-	
Natural system modifications	*Dams, water flow modifications, shoreline modification:* • Re-connecting the river to parts of the floodplain (through side channels and shallow-water habitat) will encourage exchange between surface water and groundwater, which will reduce water temperatures • Creating off-channel salmon habitat will provide more refuges for juvenile salmon, which will increase salmon survival to spawning age • Reducing obstacles to fish passage will expand the amount of habitat available for salmon *Removal of riparian cover:* • Planting native riparian vegetation will lower water temperature and increase dissolved oxygen, provide an invertebrate food source, and introduce woody debris to the river, all of which will improve aquatic habitat quality and therefore improve salmon population parameters*	*The more habitat in the more places that [juvenile salmon] can hang out and avoid the fast current of the river, the predators that are in the deep part of the river, and feed on the appropriate invertebrates that they need to, which tend to hang out on the vegetation on these side channels, then the bigger and the healthier and the more likely they're gonna survive when they do go out.*

Threat category	Results chains identified or inferred	Example quotes
	Unsustainable successional trajectory: • Removing disproportionately represented tree species will redirect the forest's successional trajectory toward a target forest type	
Biological resource use	-	
Recreational use	• Building official trails will reduce the use of social trails, which will increase habitat health	
Development	• Restoring vegetated riparian buffers in developed areas, using established Best Management Practices, will increase water quality and provide habitat for fish and wildlife • Acquiring natural lands will protect habitat from future development • Onsite stormwater management will reduce the speed and quantity of runoff from developed lands • Increasing habitat connectivity will benefit wildlife communities	*The buffer guidelines that we use are from NRCS, which is the Natural Resource Conservation Service. And they have gone through and done some scientific work saying this buffer, and these widths, with this makeup of different species, has a positive effect on X, Y, and Z.*

Threat category	Results chains identified or inferred	Example quotes
Pollution	• Restoring urban forests will reduce polluted runoff, which will increase water quality • Restoring urban forests will increase air quality for local communities • Onsite stormwater management will reduce polluted runoff, which will increase water quality	*…creating a living filter, and a living buffer, between that sound pollution and air pollution that's happening down there. And creating that healthy forest as something sustainable to filter all of it before it gets to the communities above.*
Invasive species	• Removing invasive groundcover will set the conditions for the establishment of native plants, which will improve forest health* • Removing invasive species will slow their spread within the watershed, which will protect native vegetation communities	*The ideas in removing invasives and putting in new plants is to sort of create some trends of succession in forest states, or succession in habitat types, that are going to be sustainable, or fit in with sort of the natural progression that happens.*
Water withdrawals & diversions	-	
Climate change	• Planting drought-tolerant tree species will improve forest resilience to climate change • Increasing biodiversity will improve ecosystem resilience	

* Results chains with an asterisk are also illustrated in Figures 4.2 and 4.4.

4.2.1.3 Examples of conceptual models and results chains

The coalition of organizations responsible for the development of the Open Standards developed a software program, called Miradi, which guides the user through the Open Standards process of planning and implementing a conservation project (Foundations of Success and Beneficent Technology, Inc., 2013). Miradi was used to visualize and aid in inferring the conceptual models and results chains mentioned in interview responses. Figures 4.1, 4.2, 4.3, and 4.4 were generated in Miradi and provide examples of conceptual models and results chains related to two commonly-identified conservation targets: forest health, and salmon population parameters.

Figure 4.1 Simplified conceptual model, generated in Miradi, related to forest health.

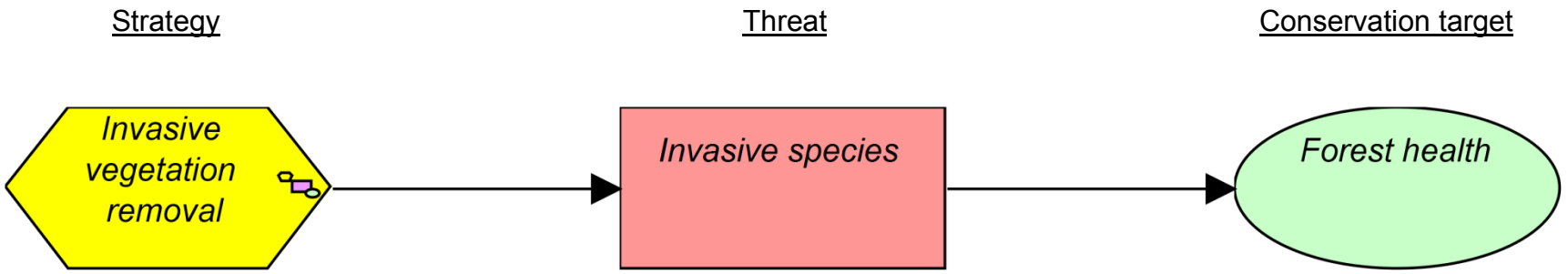


Figure 4.2 Results chain, generated in Miradi, related to forest health.

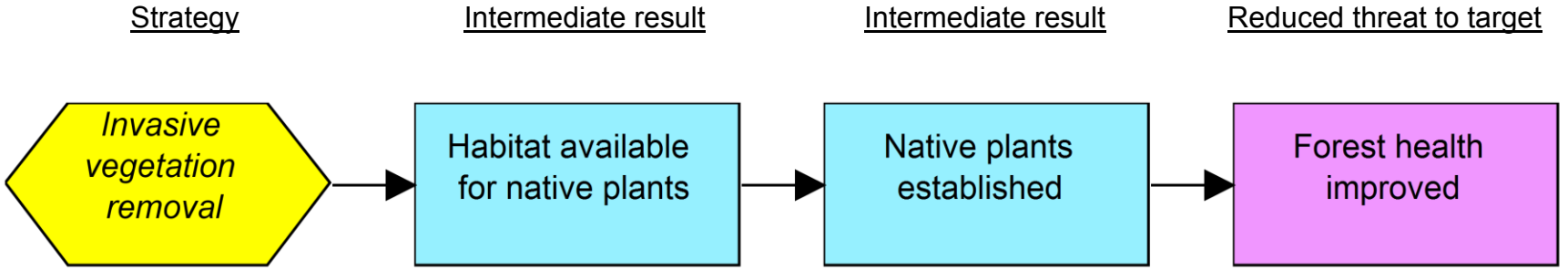


Figure 4.3 Simplified conceptual model, generated in Miradi, related to salmon population parameters.

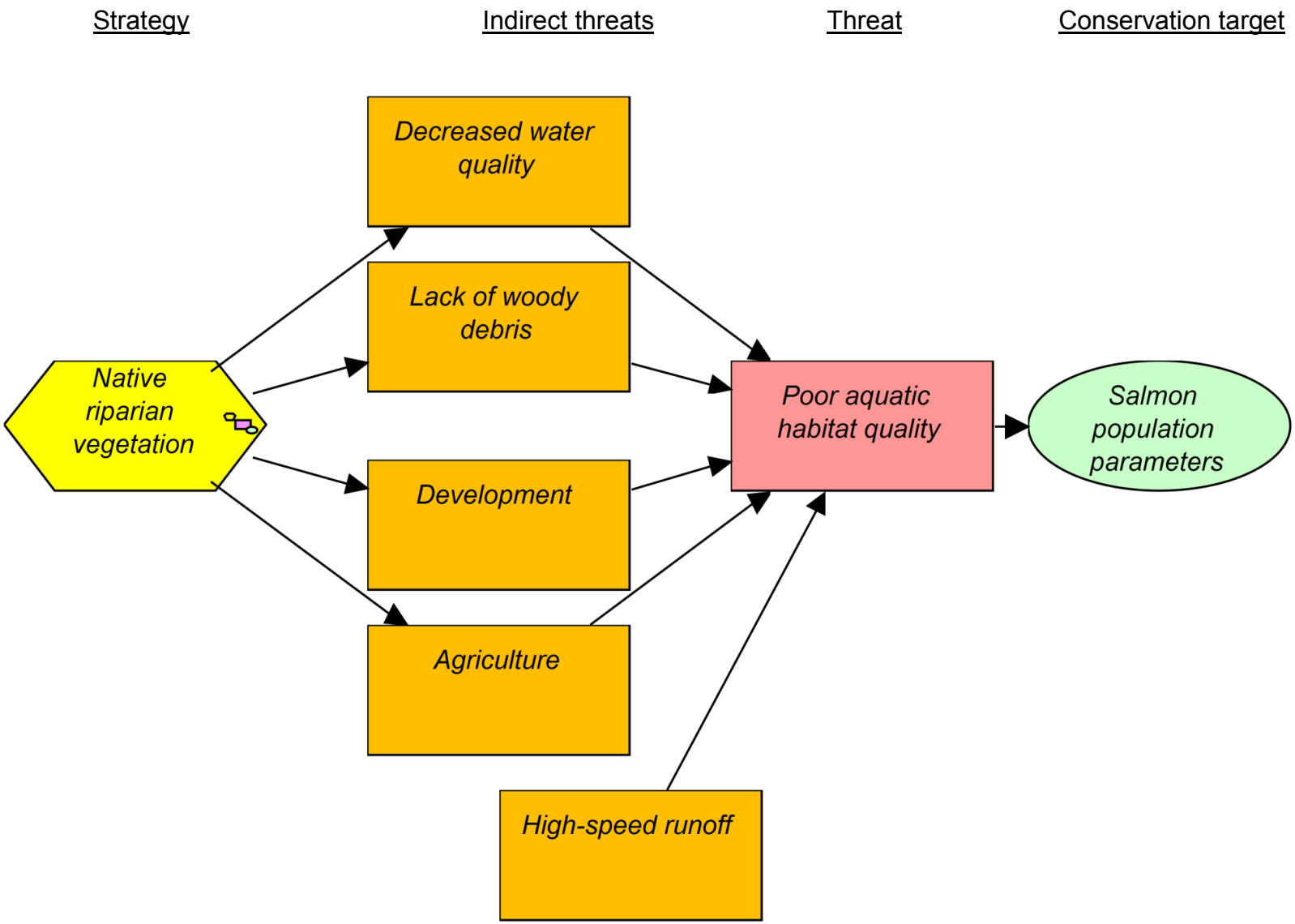
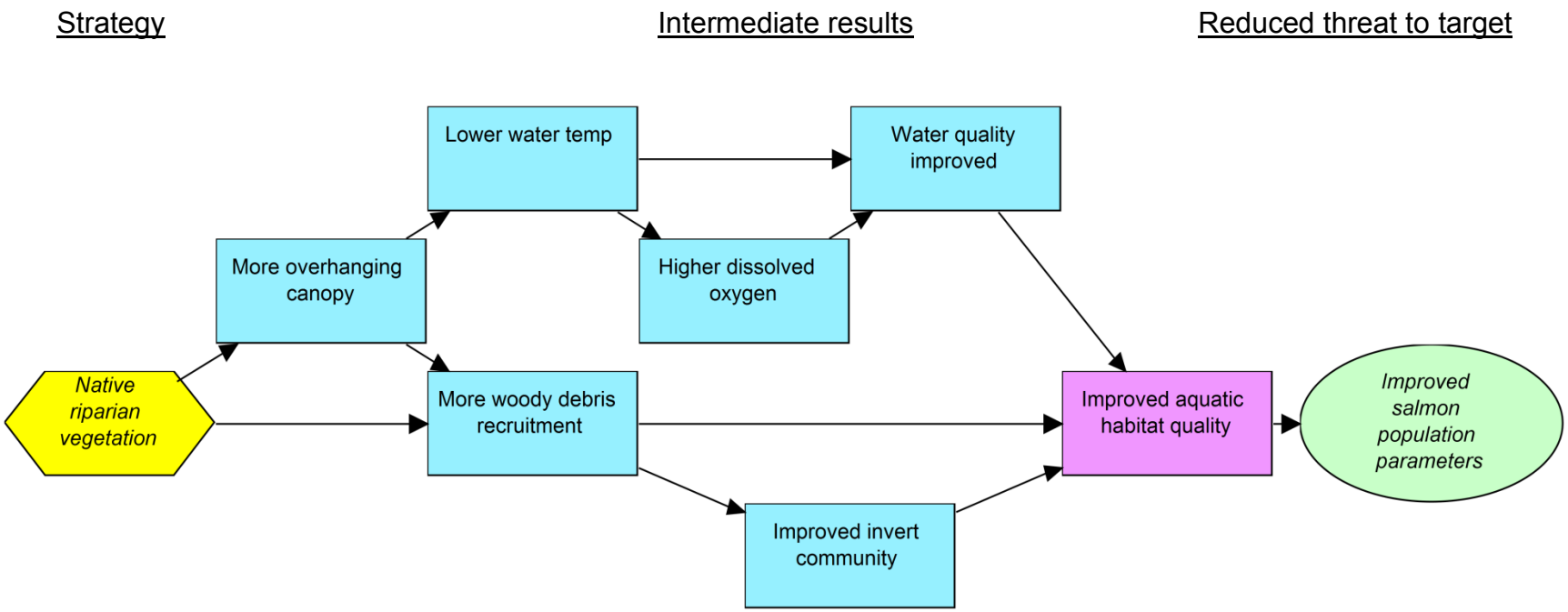


Figure 4.4 Results chain, generated in Miradi, related to salmon population parameters.



4.2.1.4 Comparative evaluation of conceptual models

There were a few common themes identified among the conceptual model elements identified or inferred from interviews. The most common element was the identification of invasive species as a major threat for stewardship actions to focus on. Another common element was the goal of increasing habitat connectivity. In particular, interviewees whose organizations worked on multiple stewardship sites across the landscape often cited connectivity between sites under stewardship as a major goal and a driver for planning stewardship actions.

One significant theme in which conceptual models differed was the breadth and complexity of the targets, goals, and strategies identified to meet these goals. Some interviewees conceptualized their work narrowly, focusing on habitat improvements on a site-specific basis. On the other hand, other interviewees mentioned targets that were quite broad in scope: for example, improving ecosystem services, increasing habitat connectivity across the watershed, or improving multiple types of salmon habitat. These broad aims often require multiple intermediate outcomes distributed over space and/or time. However, it was unclear from interview responses whether some of the broad targets identified were in fact considered legitimate targets for the scope of stewardship actions, or if they were simply mentioned as potential corollary outcomes. For example, a few interviewees working in forest lands mentioned ecosystem services, including air pollution reduction and carbon sequestration, as targets. However, none of the interviewees mentioned specific goals, objectives, or strategies that were designed to improve ecosystem services. Rather, interviewees discussed forest habitat improvements as major project goals, implying that ecosystem services benefits from improved forest habitat would be incidental to the scope of stewardship actions.

Similarly, the results chains inferred from interview responses identified potential gaps in the logical structure of interviewees' intended outcomes. For stewardship actions with salmon as a conservation target, the results chains presented in interviews and also elaborated in documentation of the watershed's Salmon Habitat Plan were fairly complete: specific strategies, assumptions, and goals were identified and linked. For upland restoration projects, however, it appeared that results chains were more difficult to identify. For example, planning for upland restoration projects generally includes describing a target vegetation community, based on an existing "reference ecosystem," when possible. However, the specific characteristics of the reference ecosystems identified for many upland projects were sometimes unclear or undecided. For example, Seattle Parks had provisionally classified all of its natural lands according to a set of different target forest types, providing a blueprint of sorts for restoration planning. However, it was unclear to what extent these target forest types were actually being used as references for restoration planning on individual sites. Meanwhile, for other stewardship actions outside of Seattle, no interviewees mentioned a reference ecosystem in nearly as much detail.

4.2.2 Evaluating and comparing formal and inferred monitoring plans

This section describes and compares the monitoring plans, both formal and informal, that interviewees described. The elements of a monitoring plan identified by the Open Standards framework and discussed in this section include: intended audiences, ecological indicators measured, and data collection methods used. A discussion of influencing factors in deciding whether and how to conduct monitoring is also included.

4.2.2.1 Audiences identified for monitoring

The Open Standards recognize that organizations may focus on measuring different project attributes depending on the intended audiences of the data and conclusions that result. For example, other restoration practitioners may be most interested in the relative outcomes of different restoration strategies, while project funders would likely be more interested in whether the outcomes they expected were being achieved, and at what cost. Interviewees were asked about their motivations for ecological monitoring, and the intended audiences for monitoring data were inferred from these responses as well as throughout the interviews.

Interviewees most frequently indicated the measurements were collected for internal use within an organization. Data were collected to share with other members of a coalition with similar frequency, especially for organizations participating in one of the Green Cities partnerships. Interviewees mentioned funders as an audience for monitoring data, but less frequently than expected. Finally, a few interviewees, especially for organizations conducting stewardship actions in aquatic environments, collected data to be submitted to regulatory agencies.

4.2.2.2 Indicators and other ecological attributes monitored

Interviewees were asked what ecological attributes their organizations measured, framed as an open-ended question. The primary objective was to collect information to use in evaluating monitoring protocols. Specifically:

- Identifying patterns within and between organizations with respect to which ecological attributes are measured most frequently, and why;
- Identifying written documentation of monitoring protocols; and

- Collecting information to determine the extent to which organizations are measuring ecological attributes that would indicate progress toward ecological goals.

The Open Standards framework emphasizes the importance of choosing monitoring activities strategically, based specifically on a project's goals and objectives, as well as the intended audiences of monitoring results. Indicators should be tied explicitly to goals and objectives and demonstrate progress toward achieving them. Interviewees also frequently mentioned project attributes that were most useful for reporting on project implementation rather than ecological effectiveness. Implementation monitoring is particularly relevant for specific audiences such as funders. The attributes inferred from interview responses are listed in Table 4.5 below, categorized by which goals they are logically linked to. When appropriate, notes are made regarding the frequency with which particular attributes were mentioned.

Table 4.5 Environmental attributes identified or inferred.

Implementation-related attributes (mentioned by most interviewees)
Land area affected
Number of plants installed
Amount (often mass) of litter removed
Person-hours contributed
Mass of invasive vegetation removed

Ecological or physical attributes

Intermediate ecological outcomes (measured at some sites):	Plant survival over time (specific species identified at some sites, but not all)
	Percent invasive vegetation cover over time (specific species identified at some sites, but not all)
	Time-series photos (implemented at a few sites)
Attributes related to forest structure (measured at only a few sites):	Canopy density (in percent)
	Species composition
	Tree ages
	Tree regeneration
	Down woody debris
Attributes related to forest habitat health	Plant diversity
	Native overstory vs. invasive overstory (percent cover)
	Native understory vs. invasive understory (percent cover)
	Wildlife use (at only a few sites)
	Fungal diversity (mentioned once)
	Soil conditions

Attributes related to aquatic habitat health	Riparian canopy cover
	Native riparian vegetation vs. invasive vegetation
	Large woody debris
	Benthic invertebrate community
	Water quality
	Sediment flow
	Water flow characteristics
Attributes related to landscape restoration	Vegetation cover
Attributes related to salmon	Egg-to-migrant survival
	Fish counts

Nearly all interviewees also discussed qualitative monitoring of stewardship sites. Some interviewees indicated that, from the perspective of using ecological information to assess progress, most site managers used primarily qualitative monitoring. An interviewee describes the qualitative monitoring that occurs on her organization's stewardship sites as

> *"…just more anecdotal. What are they noticing, what's coming back, what worked where, what didn't work where, and do we need to revise the planting plan."*

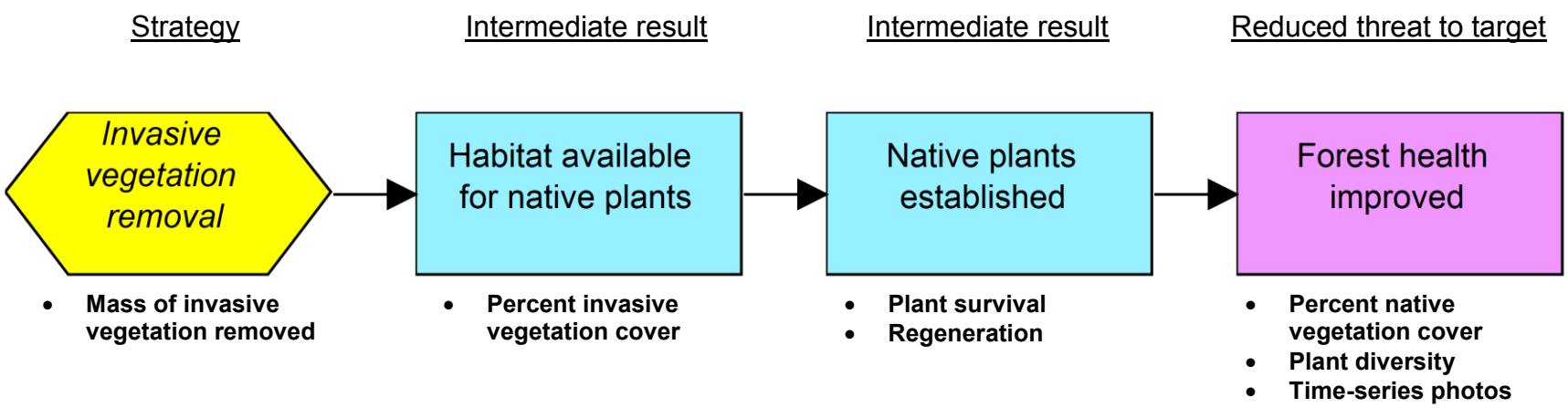
Many interviewees saw significant value in this kind of qualitative assessment. For example:

> *Honestly, sometimes I think it's more important to get people attached to the site, and have that feeling of place, and be able to go there enough that they do qualitative monitoring, and just to know when things are going right and when they're not going so well.*

In some cases, interviewees credited their years of experience with restoration projects as the primary source of criteria for determining a site's progress toward goals. At the same time, other interviewees expressed a desire to move away from qualitative assessments to systematic monitoring of quantifiable indicators.

A few interviewees were explicit in their concern that the attributes chosen for monitoring were not always appropriate as indicators for progress toward their goals; rather, they were collected based on a standardized protocol, or based on the rationale that it is better to collect too much information than not enough. However, others were able to link the attributes mentioned with specific goals and objectives. Figure 4.5 illustrates one example of ecological attributes that could function as indicators of progress toward each step in the results chain from Figure 4.2.

Figure 4.5 Ecological attributes (in bold, at bottom) identified in interviews that could function as indicators to measure progress within a Miradi-generated results chain, related to forest health.



No interviewees described a monitoring plan that was fully conceptualized according to the Open Standards framework, although the formal coalitions working in the watershed, specifically the Green Cities partnerships and salmon habitat recovery efforts, had many elements present. Both the Green Seattle and Green Kent partnerships had formal monitoring plans, although some of the attributes identified in these plans were not explicitly linked to goals or objectives. While the Salmon Habitat Plan identified a clear conceptual model for salmon habitat recovery, and had written guidance for some general monitoring protocols as well as formal protocols for many individual projects, there was no unified monitoring plan in place watershed wide.

4.2.2.3 Monitoring methods

Along with discussion about attributes measured, interviewees often mentioned specific monitoring methods. In addition, interviewees often referred to written monitoring protocols that their organizations used. One type of monitoring frequently mentioned, especially for organizations participating in the Green Cities network, was initial assessments of habitat condition. For the Green Cities, these initial assessments primarily focused on percentage of native canopy cover and percentage of invasive ground cover, and were used to prioritize sites for restoration. King County Parks has also experimented with baseline habitat assessment of natural lands.

For monitoring ecological progress – to compare to earlier baseline data as described above, in some cases – interviewees mentioned two basic methods, either collecting data across an entire site or using representative plots or transects. For organizations that were interested in monitoring the ecological conditions on multiple sites across the landscape, representative sites

were chosen as well. The frequency and duration of data collection from monitored sites varied. The monitoring plan for Green Cities sites recommends annual monitoring for three years, and then data collection every five years afterwards. For the North Wind's Weir aquatic restoration project, monitoring intervals are set at 1, 2, 3, 5, 7, and 10 years – more frequent monitoring than the Green Cities protocol after the initial three years, but no monitoring after 10. A few interviewees stated that monitoring protocols varied from site to site. This appeared to be particularly true for government agencies that were accountable to regulatory requirements for restoration projects, in which different regulations require different monitoring protocols.

The specific methods used also depended on who conducted monitoring activities. For the Green Cities partnerships, for example, monitoring protocols were designed such that volunteers with only a basic level of training could set up monitoring plots and collect data effectively. Many interviewees mentioned similar constraints – making monitoring protocols simple enough for volunteers to implement effectively. On the other hand, some organizations relied on paid crews or even academic researchers to conduct in-depth data collection or even rigorous experiments on stewardship sites. While interviewees mentioned a number of instances in which data were collected with significant scientific rigor, all interviewees acknowledged that these were special cases. Most interviewees stated clearly that scientific rigor was not a realistic goal for monitoring in the context of civic environmental stewardship. Nevertheless, some interviewees saw a conundrum in this situation: in order for monitoring data to be useful, a minimum level of consistency and precision was required, and a few interviewees specifically mentioned the challenge of reaching this level of rigor without "going overboard."

4.2.2.4 Whether and how to monitor: Influencing factors

Within the questions about monitoring protocols, interviewees were also probed about the circumstances surrounding monitoring, including:

- What motivating influences organizations have to conduct monitoring, such as an organizational commitment to adaptive management, reporting obligations to funders or partners, adherence to larger-scale environmental planning efforts, or regulatory requirements;
- The challenges and obstacles associated with conducting monitoring, for example resource constraints or lack of organizational support; and
- Aspirations for implementing or improving monitoring protocols in the future.

Interviewees cited a number of motivating influences for conducting monitoring, both internal and external. Most interviewees identified policies within their organizations that called for a certain amount of monitoring. Another common driver for conducting monitoring was to meet terms set by a partnership or broader coalition. For example, participants in the Green Seattle Partnership were asked to provide monitoring data as part of a partnership-wide effort. A third common driver for monitoring was regulatory requirements. This was particularly relevant for government agencies, and appeared to be most frequently associated with projects in the aquatic environment. A few interviewees mentioned the need to demonstrate to volunteers that the stewardship work they were doing was having a positive environmental impact, and cited this as a motivating factor for monitoring. While demonstrating success to funders was mentioned occasionally, it was a surprisingly uncommon factor within interview responses.

A representative from Nature Consortium noted this lack of funder interest in demonstrating the results of stewardship actions as a factor in her organization's lack of monitoring activities until recently:

> *No one [of our funders] has really been asking for monitoring data. And to me that kind of indicates, maybe, a reason why there hasn't really been any sort of solid monitoring program in place at Nature Consortium, is because no one's ever asked for it.*

There were two consistent themes among interviewees with respect to obstacles to monitoring the results of stewardship actions. The one most commonly mentioned, not surprisingly was a lack of financial, technical, and labor resources. Funding limitations were mentioned by nearly every interviewee, from organizations that relied mostly or entirely on volunteer labor to government agencies with ecologists on staff. A lack of available technical expertise was of particular concern as well, especially for organizations that depend primarily on volunteers. The other common theme was that organizations often appeared to lack an institutional culture that encouraged monitoring. Interviewees stated that monitoring was often considered secondary to physical restoration activities, maintaining a base of volunteers, or other activities related to stewardship. When prioritizing organizational actions, more than one interviewee remarked that "monitoring is unsexy."

When asked about their aspirations for improving the monitoring process in the future, interviewees identified a number of methods and ecological attributes of interest. For example, a few interviewees mentioned a desire to incorporate GIS data into monitoring work. In upland environments, interviewees appeared interested in collecting more data on wildlife use, while in aquatic environments, data on water quality was of interest. A few interviewees also mentioned

the potential power of increased photo-based monitoring, especially to illustrate ecological changes to non-scientific audiences.

Interviewees also identified a number of aspects of the monitoring process itself in which they wanted to see improvements. Perhaps in contrast to the aspirations above, a few interviewees mentioned a desire to see monitoring activities be focused more narrowly, and chosen more strategically: "... [to] make sure that they're really targeting their monitoring activities to address the actual project goals. Rather than, oh, we just always collect bugs, so let's do that here, because it might indicate something…"

Many interviewees also mentioned the need to make monitoring activities more consistent over time, citing the difficulty of analyzing data from sites in which monitoring protocols have changed numerous times.

4.2.3 Evaluating & comparing monitoring implementation & use of monitoring data

This section describes and compares where and how organizations in the watershed are conducting ecological monitoring, as well as how the results of monitoring activities are analyzed and used. With respect to how monitoring results are used, this section examines the extent to which adaptive management – an important element in the Open Standards framework – is occurring in the watershed.

4.2.3.1 Distribution of monitoring activities

Following up on the theme of stewardship site distribution, interviewees were asked about the extent of environmental monitoring on specific sites, as well as the individuals or organizations

conducting monitoring. The objectives for these questions were to identify patterns or characteristics of the distribution of monitoring activities, build an initial description of the role of organizational collaboration in environmental monitoring, and identify considerations for future efforts to synthesize monitoring data from multiple sites.

All interviewees mentioned at least some monitoring activities on stewardship sites, although the extent of monitoring varied widely. In general, the participation of two different organizations, Forterra and EarthCorps, appeared to significantly influence the distribution and amount of monitoring on stewardship sites in upland environments. Both of these organizations participate in the Green Cities program, and both have done extensive work developing standardized monitoring protocols to be applied on stewardship sites.

However, these organizations were not the only influences of stewardship distribution. Stewardship projects in the city of Seattle appeared to have the most expansive monitoring associated with them, by far. While not every site under stewardship in Seattle was monitored, interviewees reported multiple levels of monitoring efforts occurring throughout the city's natural areas. In contrast, while the city of Kent, another member of the Green Cities program, appeared to have a large number of sites under stewardship, monitoring activities were reported to be much less extensive than Seattle. For other upland stewardship sites in the watershed, the extent of monitoring was driven largely by organizations' internal monitoring protocols.

In the aquatic environment, especially for capital projects, sites were frequently monitored throughout the watershed, primarily in response to regulatory requirements. Overall, it appeared that at least some monitoring data were available for stewardship sites throughout the watershed. However, both the quality of the data, and the extent to which monitored sites were

representative of ecological outcomes of stewardship on the watershed as a whole, were unknown.

Interviewees differed in their organizations' approaches for implementing monitoring. The Green Cities programs, for example, included volunteer-staffed monitoring efforts coordinated by EarthCorps as a significant source of monitoring data, especially for Green Seattle Partnership sites. Similarly, sites on the Duwamish shoreline stewarded by People for Puget Sound, now under EarthCorps, used volunteers for most monitoring efforts. At the same time, organizations that used volunteers to conduct monitoring also often appeared to use paid staff or crews to collect monitoring data, sometimes on the same sites that volunteers were monitoring. In some cases, this overlap was a result of multiple monitoring efforts with different aims, but in other cases, using trained, paid technicians was a means of assuring the data quality coming from volunteer-led efforts.

Monitoring for aquatic habitat quality appeared to be shared across a number of organizations, mostly using paid or contracted technicians. Given the regulatory requirements of many aquatic restoration projects, the quality of data collected appeared particularly important. Multiple interviewees mentioned recent and ongoing research by academic institutions on the status of ecological attributes on aquatic stewardship sites. In addition, there appeared to be numerous organizations who conduct aquatic monitoring throughout the watershed, not necessarily only on stewardship sites, as a major activity. Most of these monitoring efforts were focused primarily on salmon.

4.2.3.2 Analysis and use of monitoring data

The analysis and use of monitoring data appeared to be a major challenge for most organizations interviewed. Challenges arose at each step of the process, from storing and preparing data, to analysis, to application of results. For organizations that had been collecting data for many years, interviewees reported that data were often difficult to synthesize: monitoring protocols had changed over the years, data had been recorded inconsistently, and older data were stored in hard copy while more recent data were stored electronically.

Interviewees participating in the Green Cities programs provided insight on the difficulties associated with collecting data in a centralized, standardized way for ease of later analysis. On sites in the Green Seattle Partnership, data from implementation monitoring were uploaded and available through a recently-developed online platform known as CEDAR, and additional data, especially ecological information, were available to stewardship participants and the general public online. The Green Kent Partnership, on the other hand, collected and stored their more limited monitoring data internally. Interviewees from both the Seattle and Kent programs made clear that the process of sharing data in a centralized location was difficult for a number of reasons: There was a high financial cost associated with developing and maintaining such a system; the process of standardizing data collection methods sometimes failed to take into account the unique circumstances and available resources of each of the many stewardship sites in these two Green Cities programs; and dedicating resources to centralized data collection was perceived by some participants as a low priority in comparison to physical stewardship work.

As one interviewee put it:

> *One major problem was that… with CEDAR, [and] with the [Green Cities] monitoring plan… with a lot of similar… tools or resources: because they're all so new, and because each city is different, it's hard to put an exact price tag on any of these things… There's the sticker shock, and then there's this… vagueness that's… hard for people to get on board with, even if they can get past the sticker shock.*

Data analysis appeared similarly challenging for many organizations. Multiple interviewees pointed out that the lack of technical expertise inherent in relying on volunteer labor is even more problematic for data analysis than for data collection. In many cases, years of monitoring data had been collected, but not yet analyzed due to a lack of technical resources or funds to contract out the analysis. Multiple interviewees mentioned the need to find grant funding specifically to conduct data analysis. A few interviewees mentioned a reliance on academic researchers, with independent funding, to analyze monitoring data. One particularly common scenario mentioned in interviews was that data analysis occurred in the context of narrow studies, such as comparisons of different restoration methods or ecological progress at specific sites. Comprehensive analysis at the level of multiple sites was rare.

The Open Standards framework emphasizes using monitoring data to inform an adaptive management process, in which project elements are adjusted iteratively based on monitoring results.

One interviewee acknowledged that adaptive management was part and parcel of ecological restoration:

> *You know, this whole area's a relatively new science. So one of the things that we have found is that there aren't any real exact answers about… put this tree here, put that tree there, and shazam! 20 years later or 50 years later you have this type of forest… So, at one level, all of this is kind of an experiment.*

However, interview responses indicated that the results from monitoring efforts were used inconsistently for making management decisions. On the one hand, most interviewees discussed using the results from monitoring activities to improve ecological outcomes on individual sites. This was often described as a fairly qualitative process: site stewards would use data on plant survival, or even a qualitative "sense" of plant survival, to inform plant selection for future years' plantings. For interviewees whose organizations covered multiple, ecologically similar sites – King Conservation District buffer enhancement projects, for example – qualitative plant survival data were used to inform planting choices at numerous sites.

On the other hand, interviewees seldom mentioned circumstances in which the results of ecological monitoring were applied to assess an organization's conceptual model or strategic plan with respect to stewardship. While at the level of site-specific plans and protocols, the results from other similar sites quite often informed planning for future sites, no examples were found of program-level or landscape-level adjustments in response to monitoring results.

The negative consequences of this lack of adaptive management were apparent to one interviewee:

> *The big question always was, we know that there's hundreds of thousands of hours of volunteer work being done in these parks. There's also hundreds of thousands of dollars of contracted crew work happening in these parks. And there's all of this effort being put into these natural areas, and there's very little way of saying, is it successful? And to what degree is it successful? And could we be more targeted, or are there areas we're missing? Are we looking at the wrong things? And there was just no really good way to track that.*

4.2.5 Evaluating collaboration and sharing learning in monitoring activities

This section describes themes identified in the interview process related to sharing the results of monitoring, communicating with other organizations in the watershed, and participating in learning environment.

Interviewees were asked about the nature and extent of their organizations' information-sharing practices. As reported earlier, the Green Cities programs and associated organizations are actively working on sharing data and results with partners and the public. Similarly, salmon recovery projects coordinated by the Watershed Ecosystem Forum provide monitoring results, generally in the form of technical reports, to the public on a project-by-project basis. However, most other interviewees indicated that their organizations did not emphasize sharing results. In fact, some interviewees stated that reporting on results was uncommon even within organizations. There was no indication from interview responses that any organizations had a

policy of keeping data and results private; rather, it appeared that the challenges discussed above with data analysis and use resulted in a paucity of substantive results to share with others.

Some interviewees mentioned further challenges with sharing the results of monitoring activities: The lack of standardization in monitoring protocols, the wide variety of attributes monitored, and differences in project goals, each made results difficult to synthesize or learn from for projects elsewhere in the watershed. For example, one interviewee discussed differences between government agencies conducting restoration projects in the watershed:

> *Different governments have different systems. And even within a particular unit of government, you'll have different sections within a particular agency, different departments and what have you, that all have, sort of, turf, or ways that they do things. Their guidebook, or bible, of how they do their work. And those aren't always compatible. So sometimes, you'll move from agency to agency, or from government to government, and run into this lack of commonality. Which can make it pretty difficult as a group, to try and do things, you know?*

Finally, the gaps within the network of stewardship organizations discussed earlier – between the upland and aquatic environments, and between the lower and upper sections of the watershed, were evident in the context of sharing the results of monitoring activities.

4.2.6 Summary: ecological monitoring of stewardship sites

The preceding section described the findings from an evaluation of ecological monitoring in the watershed, including conceptualizing, planning, implementing, and analyzing the results of monitoring actions. While many organizations conceptualized similar environmental targets, there was nevertheless a broad range of targets identified. Of the threats to these targets that

interviewees identified, some but not all were being addressed with environmental stewardship actions. Organizations frequently identified specific goals and intermediate objectives for improving the status of environmental targets, although it appeared that not all targets had goals associated with them.

Interviewees identified a long list of ecological attributes monitored on stewardship sites, although these attributes were not necessarily chosen as specific indicators of progress toward a goal. The monitoring methods used, and the quality of monitoring data collected, were fairly inconsistent, although there were certainly some examples of consistent, strategically-planned monitoring efforts in the watershed. Organizations were driven to monitor by internal and collaborative policies and guidelines, regulatory requirements, and a need to demonstrate progress to volunteers and funders.

Data from ecological monitoring was analyzed inconsistently, and used to adjust stewardship actions and strategies only at the level of single sites, not at the landscape scale. While organizations did share data within collaborative efforts and with the general public, data sharing appeared to be difficult and costly. Furthermore, the lack of network connections between different geographies and ecosystems in the watershed presented further difficulties with sharing data.

5 Discussion and Applications

5.1 Overview

This research was framed by three central questions. First, *what are the characteristics of civic environmental stewardship activities in the Green-Duwamish watershed*? Second, *what are the characteristics of ecological monitoring activities in the watershed*? Third, and overarching the research in general, *how can land managers measure the effectiveness of disparate civic environmental stewardship efforts in recovering ecosystem functions at various scales in the watershed*? This section discusses the findings of interviews and analysis with respect to these three questions, and concludes with a discussion of possible applications of these findings to management and future research.

5.2 Characterizing civic environmental stewardship

With respect to the first research question – characteristics of civic environmental stewardship in the watershed – this study indicated that the definition of civic environmental stewardship chosen at the outset was problematic in terms of capturing the actual environmental stewardship actions occurring. First, the initial definition – physical activities conducted by volunteers on public and quasi-public lands – did not capture the many non-physical environmental stewardship activities conducted by volunteers, such as environmental education and political advocacy, which may have environmental impacts in the medium to long term (Krasny et al. 2010). This limitation is consistent with other research on the concept of environmental stewardship (e.g. Romolini et al. 2012; Wolf et al. 2013), which makes clear that physical activities on behalf of the environment are just one element of stewardship behavior. Additional

interviews with groups in the watershed that focused on environmental stewardship activities other than physical actions, such as the Duwamish River Cleanup Coalition, would have likely provided valuable further insight into the roles that these groups play within the network of organizations in the watershed.

Furthermore, the interview process revealed that volunteers were conducting physical stewardship actions on private as well as public lands, indicating that this study's initial definition of civic environmental stewardship failed to capture the full environmental impacts of volunteer labor. Finally, paid crews appeared to play a critical role in the implementation of environmental stewardship actions in the watershed. Volunteers and paid crews often worked on the same sites under stewardship, or in close proximity, making the task of measuring the impacts of volunteer labor alone extremely difficult.

Of course, there was substantial activity in the watershed that did fit this study's definition of civic environmental stewardship. Ecological restoration projects, conducted by occasional volunteers and dedicated volunteer stewards, were distributed throughout the watershed on public lands, although the density of stewardship activities appeared to decrease substantially in proportion to population density. This apparent pattern of distribution associated with population density is not surprising, given the need for a substantial pool of potential volunteers who are willing and able to visit sites under stewardship frequently. At the same time, recent research elsewhere in King County (J. Daniels, unpubl. data) has indicated that in some cases, volunteers travel long distances to participate in stewardship events, which would imply that proximity to population centers is not always a prerequisite for volunteer stewardship activities.

Also with respect to the density of stewardship sites, this study found an apparent relationship to political boundaries: cities that were participants in the Green Cities network appeared to have more stewardship actions occurring within their borders than nearby locations. However, this relationship was not formally tested. Future research in this area should include interviews or similar data collection from adjacent cities that were not Green Cities participants, such as Tukwila.

5.3 Evaluating ecological monitoring

With respect to the second research question – characteristics of ecological monitoring activities in the watershed – this study found that monitoring was unevenly distributed, often unsystematic, and used for management only inconsistently. Monitoring activities appeared to be fairly common: all interviewees mentioned at least some monitoring. However, much of this monitoring was qualitative in nature. While qualitative assessments of project success can be very useful for management at the site level, quantitative measures are necessary for application to broader scales. Furthermore, numerous interviewees expressed concern over the consistency and quality of data collection efforts. Some of this concern was based in the challenge of engaging non-scientists in collecting credible scientific data. Citizen science has been shown to be useful for management decisions (Cohn 2008; Dickinson et al. 2010), but its effective use relies on careful data management and quality control, as well as careful identification of monitoring protocols that can be implemented with minimal training (Litle et al. 2009).

This study identified a number of comprehensive, conceptually credible monitoring plans in place for stewardship actions in the watershed. Nevertheless, it appeared that the majority of monitoring actions were being undertaken without a strategic action and monitoring plan with

specific goals and objectives identified; rather, sites were often monitored based on general organizational guidelines or requirements from regulatory or funding bodies. At the same time, while all interviewees were asked about the existence of formal monitoring plans, and these plans were reviewed when available, it is nevertheless possible that this study failed to capture the full extent of systematic monitoring on stewardship sites.

While multiple formal collaborative networks were identified, the process of coordinating monitoring efforts within these networks often appeared difficult and challenge-laden. The difficulty that numerous interviewees mentioned with the implementation of CEDAR in the Green Cities programs provides a notable example. It appeared that the main challenges facing this effort were the high transaction cost of developing and implementing a data repository, and the relatively low priority that many organizations assigned to monitoring and data analysis. The presence of transaction costs in collaboration is consistent with other research, which has noted that the cost of initiating and developing connections with other organizations can hinder collaboration (Schneider et al. 2003; Margerum & Whitall 2004). Furthermore, the two major network gaps identified in this study, between upland and aquatic environments and between geographic areas of the watershed, likely make collaboration and information dissemination difficult.

5.4 Measuring the outcomes of civic environmental stewardship at the landscape scale

With respect to the overarching research question – measuring the effectiveness of civic environmental stewardship at various scales – the results of this study indicated that assessing landscape-scale environmental outcomes of stewardship based on the current status of ecological

monitoring activities in the watershed would be prohibitively difficult. The inconsistent nature of data collection and use, challenges with collaboration among organizations conducting stewardship, and the current distribution of sites being monitored, all provide obstacles to inferring landscape-scale effects based on current monitoring efforts.

There was significant overlap between organizations in terms of basic ecological attributes monitored, including percentage of native and invasive vegetation cover, native plant survival over time, and for aquatic environments, fish use over time. However, the apparent quality of monitoring data collected by various organizations was highly variable, which indicates that synthesizing data from multiple sites would likely be difficult (Atkinson et al. 2004). Furthermore, scaling up site-level monitoring efforts to the landscape scale would require collaboration among multiple organizations to establish a unified monitoring framework (Atkinson et al. 2004). However, the current state of collaboration among stewardship participants in the watershed may make coordinating and synthesizing these data prohibitively difficult. Finally, inferring landscape-level impacts from site-level monitoring requires that sites be chosen using ecological criteria (Kentula 2000). This study indicated that a range of different ecological attributes are being monitored in association with stewardship actions. However, the distribution of monitored stewardship sites in the Green-Duwamish did not provide a representative picture of ecosystems in the watershed; instead, monitoring activities appeared to be distributed based on organizational, financial, and regulatory dynamics.

5.5 Future directions

5.5.1 Applications for management

The overarching question for this thesis was oriented toward the management of natural lands and ecosystems. Specifically, this study assumed that a better understanding of the ecological impacts of civic environmental stewardship would allow land managers to more effectively apply stewardship as a strategy for meeting landscape-level management goals. The current status of ecological monitoring in the watershed described in this study indicates that more effort toward understanding the impacts of stewardship is needed. Effectively measuring the impacts of stewardship will require an effort that is independent of ongoing monitoring efforts in the watershed. Important elements of such an effort would include the identification of ecological goals and indicators to measure progress toward these goals, systematic implementation of data collection throughout the watershed, and coordination of monitoring efforts at multiple sites.

The careful choice of ecological goals, and a limited number of ecological indicators to measure progress toward these goals, will be important. The watershed's financial and technical resource limitations, as identified in this study, underscore the need to pick only a few key indicators, chosen strategically, in order to make monitoring as cost-effective as possible. Focusing at the landscape scale may make relatively coarse-grained indicators preferable to fine-grained measurements such as the many monitoring sites described in this study. In addition, previous research has identified remote-sensing methods and geospatial analysis – which can provide fine-grained data over a large area – as potentially useful tools for measuring ecological impacts at the landscape scale (Wolf et al. 2013).

Monitoring at the watershed scale to measure the impacts of stewardship will also require systematic planning and implementation of monitoring methods and monitoring sites. This study found that the current distribution of monitoring sites was influenced not only by a desire to measure ecological progress, but also resource availability, regulatory requirements, and organizational policies; in other words, monitoring sites were not distributed strategically to answer landscape-scale ecological questions. Nevertheless, organizations' current capacity for monitoring, as described in this study, could be used in a new strategic monitoring effort.

In order to effectively tap into the existing capacity for site-level monitoring in the watershed, close coordination within the network of stewardship organizations is necessary. Given the current obstacles to collaboration identified in this study, however, new leadership in determining ecological goals and additional resources to lower the transaction costs of collaboration is required. Such resource-intensive collaborative efforts at the landscape scale are most appropriately the purview of a government agency or collaboration of agencies. For collaborative environmental actions such as landscape-scale monitoring, government agencies are positioned to provide a structure for collaboration (Koontz et al. 2004), and to lower the transaction costs of collaboration for NGOs (Schneider et al. 2003). Furthermore, government agencies are more likely to have access to the resources necessary to measure ecological outcomes at the landscape scale, including funding, technical expertise, and infrastructure, than NGOs (Thomas & Koontz 2011).

Landscape-scale, government-led collaboration is already present in the Green-Duwamish watershed, in the form of salmon habitat recovery efforts led by the Watershed Ecosystem Forum. Similarly, at an even larger scale, the Puget Sound Partnership collaborates for ecosystem recovery throughout Puget Sound. The plans for these collaborative programs both

identify civic environmental stewardship as an element in broader ecosystem recovery efforts. Thus, it would be reasonable to incorporate landscape-scale measurement of stewardship impacts into broader management actions within these or similar programs.

5.5.2 Future research

In addition to the need for new approaches to ecological monitoring, as described above, this study highlighted a number of additional areas in which further research would be advisable. Specifically, the present study did not describe many of the human elements of civic environmental stewardship. As a parallel to the present study, a future study could address how to measure the social outcomes of civic environmental stewardship at the watershed scale. While the interview process in the present study was not designed to explore the social impacts of stewardship, it is nevertheless notable that no interviewees mentioned any ongoing monitoring efforts related to these social outcomes. One interviewee explicitly noted this lack of social research:

> *We can measure trees, and we can track how trees are changing, but there's this social component that can't be left out, can't be forgotten. So I think that's something that needs to be emphasized, maybe more than it is.*

This may be indicative of a broader trend in ecological restoration, in which research on social elements lags substantially behind research on ecological elements (Wortley et al. 2013).

To follow on to this study and future research on social elements, research on the dynamics between the social and ecological factors of civic environmental stewardship would be helpful as well for understanding stewardship's role in social-ecological systems. Analysis of interview responses identified dynamic social-ecological interactions that may be appropriate for further

study. For example, it is possible that witnessing localized environmental improvements may motivate additional residents or land users to act as environmental stewards as well. A representative from King Conservation District described this phenomenon for KCD buffer enhancement projects:

> *What's cool… is that you do a project on this neighbor's property, and their neighbor pokes their head over the fence, like, "Oh, what's going on over there? That looks kind of cool." And then we bring them on board, and then bring in another landowner. So that kind of neighbor stewardship, [covering] a larger stretch of stream or aquatic area, is kind of a cool aspect that we've been successful in some areas of the county doing projects.*

Similarly, demographic patterns in the watershed, including socioeconomic and cultural patterns, and their relationship to stewardship activities appeared ripe for analysis. While stewardship density appeared roughly proportional to population density in the watershed, numerous interviewees mentioned that in general, stewardship is at least anecdotally less common in the Green-Duwamish watershed than in nearby watersheds with different demographics.

All of the potential direction for further research described above would contribute to the continued development of a framework for understanding the stewardship footprint – the impacts of stewardship on the landscape and society – as initiated by Brinkley et al. (2010), Romolini et al. (2012), and Wolf et al. (2013). The concept of the stewardship footprint implies that although natural lands are threatened by the negative impacts of human activities (as illustrated in this study with the list of environmental threats identified in interview responses), human society can at the same time exert a positive impact on the natural world, an impact which should not be

discounted in planning ecosystem recovery efforts such as those necessary for the Green-Duwamish watershed. This study sought to make advances toward a framework for evaluating this positive impact, for the Green-Duwamish and for other landscapes in which environmental stewardship activities are underway.

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Appendix 1. List of organizations interviewed

Organization/Program
City of Kent – Parks, Recreation, and Community Services
City of Kent – Public Works
City of Seattle – Parks and Recreation
EarthCorps – Sound Stewards program
EarthCorps Science
Forterra – Green Cities program
Forterra – Green Kent Partnership
King Conservation District
King County – Parks
King County Water & Land Resources – Basin Stewards program
Middle Green River Coalition
Nature Consortium
SHADOW
Water Resource Inventory Area 9

Appendix 2. Interview guide

Thanks for taking the time to talk to me.

1) First, is it OK with you if I record this interview?

I'm researching environmental stewardship in the Green-Duwamish watershed, and as part of that research I'm interviewing representatives of organizations that participate in voluntary actions on behalf of the environment on public or quasi-public lands.

I'm interested in learning about [your organization's] involvement in environmental stewardship actions in the Green-Duwamish, and the goals of these actions. I'm also interested in how involved [your organization] is in monitoring environmental conditions on stewardship sites.

2) For some of these questions, someone else may be able to answer in more detail than you. If this is the case, please let me know.

I'd like to start by asking several questions about [your organization's] involvement in environmental stewardship.

3) I'd like to hear, first, a description of what you do – your roles and responsibilities, especially as they relate to voluntary stewardship activities.
4) I'd like to hear about the specific actions – on the ground – that [you] participate in.
    a) Can you give me a list of major types or categories of volunteer work that [you] participate in?
    b) What are some of the specific on-the-ground actions that make up this work?

5) [if applicable, e.g. groups that also work outside watershed] How much of this work is in the Green-Duwamish?
6) [Referring to a map of all or part of watershed, when possible] Could you describe to me/show me the sites [your organization] has participated in stewardship on?

I'm interested in seeing how these actions link into larger-scale plans.

7) How has [your organization] chosen the sites that you work on in the watershed? [Follow up about possible connections to regional recovery plans, other larger-scale efforts]
8) In what ways does this relate to [your organization's] larger goals?
9) Could you talk a bit more about these goals? I'm especially interested in hearing about specific ecological objectives.

Now, I'd like to ask some questions about how the environmental impacts of your stewardship activities are assessed. This might include keeping data on the amount of restoration conducted on a particular site, or measuring things on a site over time.

10) Does [your organization] collect environmental data at the sites of your stewardship actions?
    a) [If YES, go to "Yes"]
    b) [If NO, go to "No"]

"Yes"

11) Could you describe [your organization's] monitoring plans or monitoring activities?

12) Could you describe the specific things [your organization] monitors?
13) Could you tell me a bit about why these particular things are monitored? [Follow up about possible connections to larger-scale monitoring efforts or recovery plans]
14) Could you tell me a bit about the resources (personnel, financial, etc.) required to conduct the monitoring activities you noted above?
15) What are some of the obstacles, or challenges, with your monitoring activities?
16) How do you incorporate the results of these different kinds of monitoring data into [your organization's] activities and plans?
17) With whom (other organizations, funders, the media, etc.) does [your organization] share the results of environmental monitoring data?

"No"

18) Does another organization conduct monitoring at these sites instead?
    a) [If YES] Are you able to describe the monitoring activities that this other organization conducts? [also follow up using "Yes" questions above]
    b) [If NO, go to next question]
19) Has [your organization] considered incorporating monitoring into your stewardship work?
20) What are some of the reasons that [your organization] doesn't currently conduct monitoring?

Both "Yes" AND "No"

21) If [your organization] had the resources, what [additional] environmental aspects would you monitor?

22) Why would you choose those things?

Great, let's wrap things up.

23) What other organizations does [your organization] work with most frequently, in terms of conducting stewardship actions in the Green-Duwamish?

24) Does [your organization] work with any additional organizations for monitoring the environmental conditions on stewardship sites?

25) Are there other organizations or individuals that you know of, even if you don't frequently work with them, that are engaged in civic environmental stewardship in the watershed?

26) Could you provide me with contact information for the organizations you mention above?

27) Is there anything else you would like to share with me about [your] work in the watershed?

28) Is it OK with you if I use your name in my research? Is it OK if I use an organizational affiliation in addition /instead?

Appendix 3. Coding outline

<table>
<tr><td rowspan="15">Characterizing civic environmental stewardship</td><td colspan="3">Activities</td></tr>
<tr><td rowspan="4">Locations</td><td colspan="2">Sites</td></tr>
<tr><td colspan="2">Land ownership</td></tr>
<tr><td colspan="2">Habitat types</td></tr>
<tr><td colspan="2">Other location parameters</td></tr>
<tr><td rowspan="5">Participation</td><td rowspan="3">Individuals</td><td>crews</td></tr>
<tr><td>stewards</td></tr>
<tr><td>volunteers</td></tr>
<tr><td colspan="2">Organizations</td></tr>
<tr><td colspan="2">Collaboration</td></tr>
<tr><td colspan="3">Drivers</td></tr>
<tr><td rowspan="19">Evaluating monitoring</td><td rowspan="5">Conceptualizing</td><td colspan="2">Conservation targets</td></tr>
<tr><td rowspan="4">Situation analysis</td><td>Conceptual model</td></tr>
<tr><td>Indirect threats</td></tr>
<tr><td>Opportunities</td></tr>
<tr><td>Stakeholders</td></tr>
<tr><td colspan="2">Threats</td></tr>
<tr><td rowspan="7">Planning</td><td colspan="2">Assumptions</td></tr>
<tr><td colspan="2">Goals & objectives</td></tr>
<tr><td colspan="2">Strategies</td></tr>
<tr><td rowspan="3">Monitoring plan</td><td>Audiences</td></tr>
<tr><td>Indicators</td></tr>
<tr><td>Methods</td></tr>
<tr><td colspan="2">Landscape-level planning</td></tr>
<tr><td rowspan="3">Implementing</td><td colspan="2">Monitored sites</td></tr>
<tr><td colspan="2">Monitoring participants</td></tr>
<tr><td colspan="2">Drivers & influencers of monitoring</td></tr>
<tr><td rowspan="3">Using data</td><td colspan="2">Data management</td></tr>
<tr><td colspan="2">Data analysis</td></tr>
<tr><td colspan="2">Adapting plan</td></tr>
<tr><td colspan="3">Sharing & learning</td></tr>
<tr><td colspan="4">Social goals and outcomes</td></tr>
<tr><td colspan="4">Recommended contacts</td></tr>
<tr><td colspan="4">Documents</td></tr>
</table>

Appendix 4. Selected details of the Open Standards framework

Compiled from the Open Standards for the Practice of Conservation (Conservation Measures Partnership 2013).

Recommended outputs from scope/vision/target planning:

- Brief description of the project scope.
- If appropriate, a map of the project area (GIS file or hand sketch).
- Vision statement for the project.
- Selection of conservation targets, including a brief explanation of why they were chosen, and if appropriate, a description and or map showing each target's location.
- Description of the status of each priority conservation target.

Recommended outputs from threats planning:

- Identification of direct threats and if appropriate, a map showing the spatial footprint for each threat.
- Rating or ranking of direct threats to identify critical threats.

Recommended outputs from situation analysis:

- Identification and analysis of indirect threats and opportunities.
- If relevant, selection of human wellbeing targets, including a brief explanation of why they were chosen.
- Assessment of stakeholders and their primary interests.
- Initial conceptual model that illustrates key cause and effect relationships among factors operating at your site.
- Ground-truthing and revision of your model.

Recommended outputs from action plan:

- Goals for each conservation target and, if appropriate, human wellbeing target.
- [Identification of key intervention points and draft strategies or portfolios of strategies.]
- [Prioritization of draft strategies.]
- Results chains that specify assumptions for key strategies.
- Objectives for key intermediate results.
- Finalized strategies, results chains, and objectives.
- Finalized Action Plan.

Recommended outputs from monitoring planning:

- Audiences and their associated information needs clearly defined.
- Indicators and methods defined.
- Finalized Monitoring Plan.

Criteria for a goal:

- Linked to Targets – Directly associated with one or more of your conservation targets
- Impact Oriented – Represents the desired future status of the conservation target over the longterm
- Measurable – Definable in relation to some standard scale (numbers, percentage, fractions, or all/nothing states)
- Time Limited – Achievable within a specific period of time, generally 10 or more years
- Specific – Clearly defined so that all people involved in the project have the same understanding of what the terms in the goal mean

Criteria for an objective:

- Results Oriented – Represents necessary changes in critical threat and opportunity factors that affect one or more conservation targets or project goals
- Measurable – Definable in relation to some standard scale (numbers, percentage, fractions, or all/nothing states)
- Time Limited – Achievable within a specific period of time, generally 3-10 years
- Specific – Clearly defined so that all people involved in the project have the same understanding of what the terms in the objective mean
- Practical – Achievable and appropriate within the context of the project site, and in light of the political, social and financial context

Criteria for a strategy:

- Linked – Directly affects one or more critical factors
- Focused – Outlines specific courses of action that need to be carried out
- Feasible – Accomplishable in light of the project's resources and constraints
- Appropriate – Acceptable to and fitting within site-specific cultural, social, and biological norms

Criteria for an indicator:

- Measurable – Able to be recorded and analyzed in quantitative and qualitative terms
- Precise – Defined the same way by all people
- Consistent – Not changing over time so that it always measures the same thing

- Sensitive – Changes proportionately in response to the actual changes in the condition being measured

Criteria for a method:

- Accurate – The data collection method has little or no margin of error.
- Reliable – The results are consistently repeatable - each time that the method is used it produces the same result.
- Cost-Effective – The method does not cost too much in relation to the data it produces and the resources the project has.
- Feasible – method can be implemented by people on the project team.
- Appropriate – Acceptable to and fitting within site-specific cultural, social, and biological norms.

Recommended outputs from data prep:

- Development and regular use of systems for recording, storing, processing and backing up project data.

Recommended outputs from data analysis:

- Analyses of project results and assumptions.
- Analyses of operational and financial data.
- Documentation of discussions and decisions.

Recommended outputs from plan adaptation:

- Revised project documents.
- Documentation of discussions and decisions.

Recommended outputs from documenting learning:

- Documentation of key results and lessons.

Recommended outputs from sharing learning:

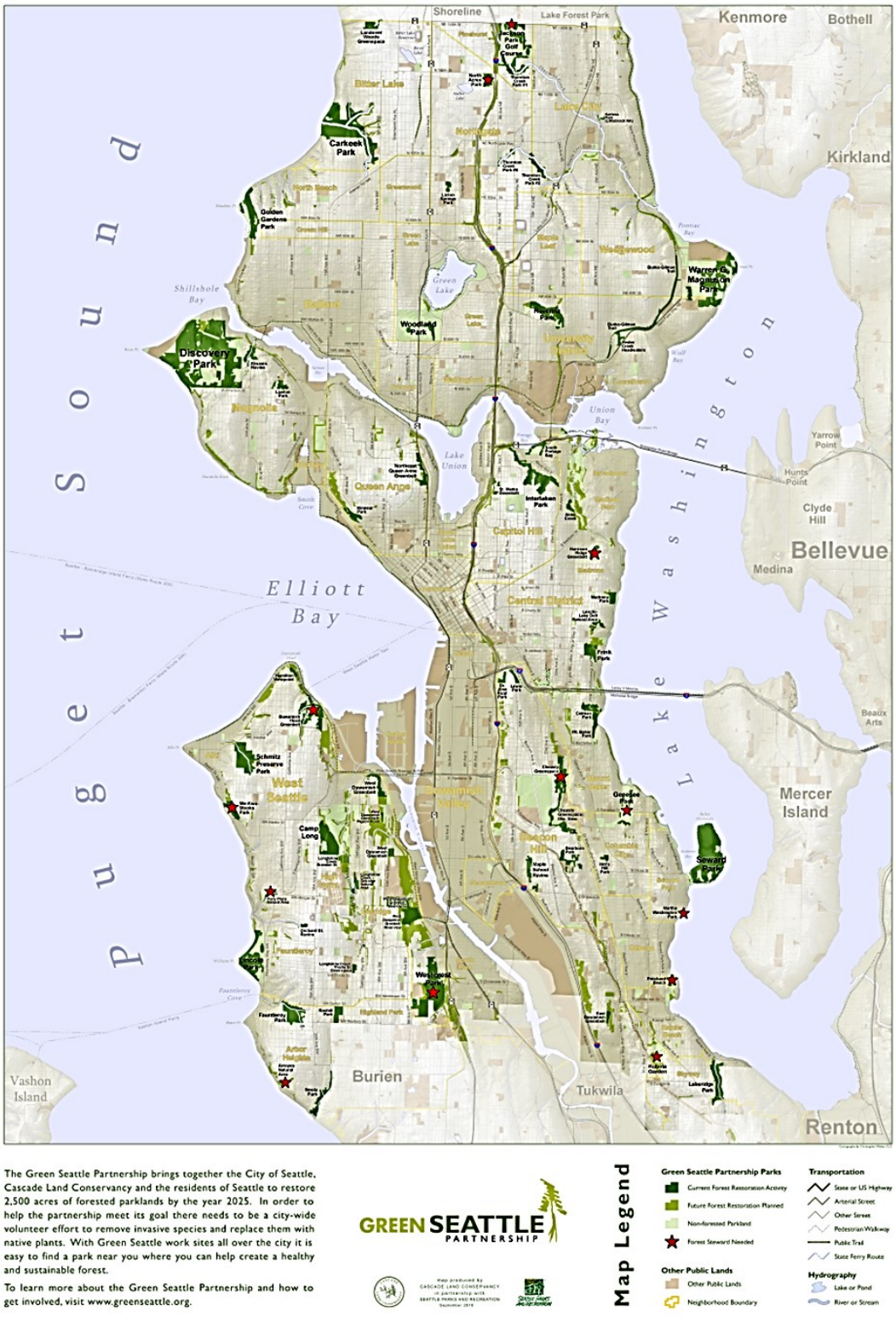
- Identification of key audiences.
- Development of a communications strategy.
- Regular reports or other types of communication to project team members and key stakeholders.
- Development and distribution of appropriate communication products.
- Use of other people's communication products.

Recommended outputs from creating a learning environment:

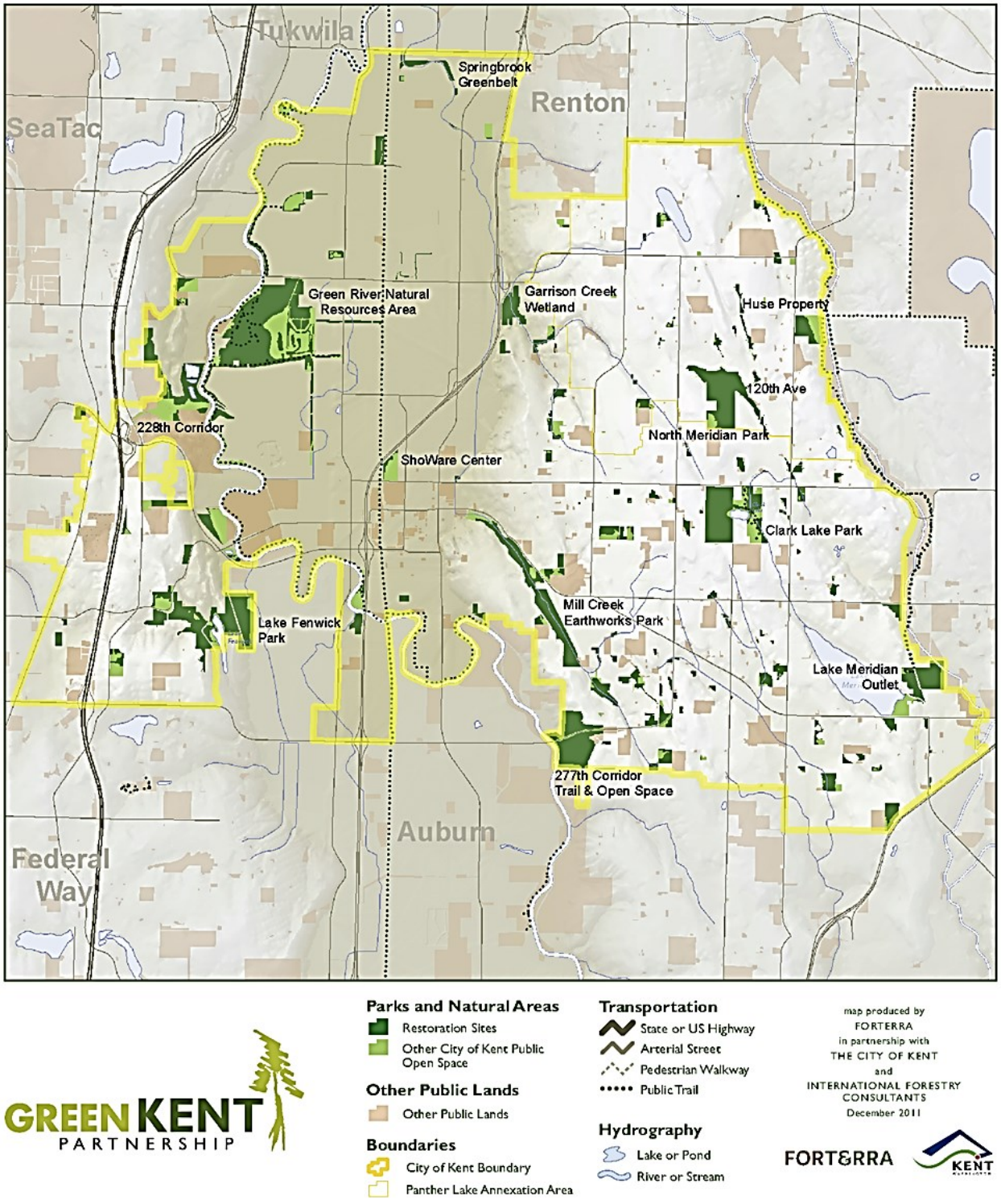
- Regular feedback shared formally or informally.
- Evaluations and/or audits at appropriate times during the project cycle.
- Demonstrated commitment from leaders to learning and innovation.
- A safe environment for encouraging experimentation and questioning the status quo.
- A commitment to share success and failures with practitioners around the world.

Appendix 5. Maps of stewardship in the watershed

Green Seattle Partnership: Program area (Green Seattle Partnership 2006)



Green Kent Partnership: Program area (Green Kent Partnership 2011).



WRIA 9 Salmon Habitat Plan projects (WRIA 9 Steering Committee 2005).