WHO IS AFFECTED BY
WETLAND MITIGATION BANKING?
A SOCIAL AND GEOGRAPHIC EVALUATION OF
WETLAND MITIGATION BANKING IN
BENTON, LANE, LINN AND POLK COUNTIES, OREGON

by

TIMOTHY WILLIAM BRASS

A THESIS

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Marc Schlossberg, Chair of the Examining Committee

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Date

Committee in Charge: Marc Schlossberg, Chair
Scott Bridgham
Don Holtgrieve

Accepted by:

Dean of the Graduate School

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Approved: ________________________________

Marc Schlossberg

Over the past 25 years wetland mitigation banking has emerged as an increasingly popular market-based regulatory system designed to offset wetland losses through the use of pre-constructed, government-approved wetland mitigation banks. While research highlighting the biophysical effectiveness of this approach is prevalent, little is known about the spatial and social characteristics of mitigation sites when compared to sites of permitted wetland loss.

This study used wetland mitigation banking records from four Oregon counties to determine the extent to which wetland displacement has occurred, if social characteristics differ between sites of wetland loss and bank sites and if the density of wetlands near permits differs from banks. Results suggest that banks have been located an average of 11 miles from the removal-fill site. Additionally, when compared to removal-fill sites, populations living near banks were wealthier, less densely populated and less ethnically diverse.

CURRICULUM VITAE

NAME OF AUTHOR: Timothy William Brass

PLACE OF BIRTH: St. Paul, MN

DATE OF BIRTH: May 1, 1984

GRADUATE AND UNDERGRADUATE SCHOOLS ATTENDED:

University of Oregon, Eugene, OR
University of Wisconsin, Stevens Point, Stevens Point, WI

DEGREES AWARDED:

Master of Community and Regional Planning, 2009, University of Oregon
Bachelor of Science in General Natural Resource Management, 2006, University of Wisconsin, Stevens Point

AREAS OF SPECIAL INTEREST:

Environmental Planning
Public Use of Natural Resources

PROFESSIONAL EXPERIENCE:

Planning and Zoning Intern, City of Marshfield (WI), 2005

Forest Inventory Specialist, University of Minnesota, 2006

Project Coordinator, Cities of Monmouth and Independence (OR), 2006-2007

Graduate Research Fellow, University of Oregon, 2007-2008

Graduate Teaching Fellow, University of Oregon, 2008-2009

GRANTS, AWARDS AND HONORS:

Oregon Transportation Education and Research Consortium Scholar, University of Oregon, 2008

Deans Fellowship Award, University of Oregon, 2009

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CHAPTER I

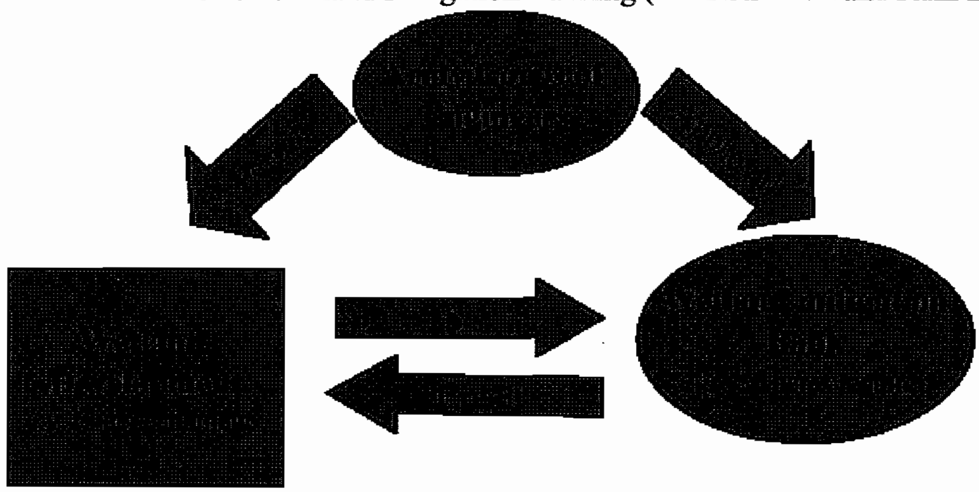
INTRODUCTION

Wetland Mitigation Banking and the Provision of Ecosystem Services

Wetlands are important cultural resources that provide people with provisions, serve as natural regulators and support life in a variety of ways (Millennium Ecosystem Assessment 2005). The services that wetlands provide to people are often collectively described as "ecosystem services" (for a summary of ecosystem services provided by wetlands, see Appendix A). These services have great value to people, yet, until recently, the value of these services has been excluded from traditional fiscal markets.

In the United States, wetland mitigation banking has developed as one of the first operable government-regulated environmental markets. Mitigation banking allows developers to off-set a loss in wetland services through a monetary exchange with a mitigation banker who has developed a wetland which provides a comparable level of services. Government agencies (Army Corps of Engineers, Environmental Protection Agency and state environmental regulatory agencies) are then responsible for: issuing wetland removal-fill permits, overseeing the development of wetland mitigation banks and monitoring the transaction between permittee and banker through the exchange of what is typically referred to as a "mitigation credit." Figure 1 provides a graphical representation of how the mitigation banking system works.

Figure 1: The Practice of Wetland Mitigation Banking (from Salzman and Ruhl 2006)



The wetland mitigation banking concept has gained increasing attention from developers and governmental agencies alike because it has been viewed as an improvement from on-site mitigation or one-time off-site mitigation. Governmental agencies charged with protecting wetlands have found wetland mitigation banking to be a more administratively effective way to regulate compensatory mitigation than permittee-responsible mitigation (Field 2008). Additionally, mitigation banking programs have been said to:

> …reduce uncertainty over whether the compensatory mitigation will be successful in offsetting project impacts; allow for the consolidation and acquisition of extensive financial resources, planning, and scientific expertise; reduce permit processing times and provide more cost-effective compensatory mitigation opportunities; and enable the efficient use of limited agency resources in the review and compliance monitoring process. (United States Environmental Protection Agency 2009)

As a result of its prospective benefits, mitigation banking has gained popularity. A recent study conducted by the United States Army Corps of Engineers (2006) showed that 33 percent of nationwide wetland mitigation occurred through the use of banks.

While wetland mitigation banking offers some benefits over traditional forms of wetland mitigation, most research indicates that mitigated wetlands fail to function in a manner comparable to natural wetlands. For instance, in a review of research on the performance of mitigation projects throughout the United States, Turner, Redmond and Zedler (2001) suggested that less than fifty percent of all mitigated wetlands were "ecologically viable." This study is part of a large body of research which has focused on the ecological performance of wetland mitigation projects.

To date, most research on wetland mitigation banking has focused on site-level biophysical evaluations as indicators of a wetland's functional capability to provide services to people. Yet, the value of a wetland's services is as dependent on its location in the landscape as it is on its biophysical characteristics. As affirmed by Mitsch and Gosselink (2000),

> (wetlands) have value because many of their functions have proved to be useful to humans…The reasons that wetlands are often legally protected have to do with their value to society, not with the abstruse ecological processes that occur in wetlands… perceived values arise out of the functional ecological processes… but are also determined by human perceptions and wetland location.

Hence, to evaluate the extent to which wetland mitigation banking policies have preserved the services and values provided by wetlands, sites of wetland loss/gain must be analyzed in relation to the spatial distribution of people. The purpose of this study was to determine: a) the extent to which wetland displacement has occurred, b) if social characteristics differ between sites of wetland loss and bank sites, and c) if the density of wetlands near permit sites differs from banks. It was hypothesized that when compared to mitigation banks, removal-fill permit sites would be more prevalent in urban areas and therefore urban populations would incur the majority of wetland losses, while rural populations would receive most wetland gains. This hypothesis is important because any affirmation of it could indicate that wetland mitigation banking has caused wetland services to be redistributed in a socially inequitable manner. If urban populations incur significant losses of wetlands in lieu of rural gains, what urban service-values might be lost? And, is a rural gain in services indeed commensurable? These two questions are central to this thesis.

Evidence suggests that services provided by wetlands to people are not spatially 'fungible' (King 1997) and that the biophysical functionality of a wetland cannot be used to measure social benefits (Boyd and Wainger 2003). Yet, wetland mitigation banking policies focus on measuring the effectiveness of mitigation through the biophysical functionality of a wetland. Policies are also designed to contain mitigation within service districts which allow wetlands to be mitigated 10, 20, 30 and sometimes 40-plus miles from the site of fill. Lastly, it has been argued that mitigation banking policies fail to consider which populations are affected by wetland losses and they generally operate in disregard for the common failure of markets to distribute resources in an equitable manner.

For mitigation banking to effectively off-set losses of wetland services, mitigation sites must be reflective of the social characteristics sites of wetland loss. This is important because urban wetlands provide important cultural services that rural wetlands do not, and vice versa. For example, the value of open space provided by an acre of urban wetland can generally not be compensated by the creation of an acre of rural wetlands, where open space is prevalent, and thus where the value is much less. While at the same time, the loss of the value of duck hunting opportunities provided by an acre of rural wetland can generally not be replaced through urban mitigation. While it is imperative to understand the extent to which such social losses/gains have occurred as a result of mitigation banking, little research has been done on this topic.

Results from this study can be used to determine the extent to which mitigation banking policies currently effect the social and spatial provision of ecosystem services. This information derived from this study is especially important because "as market-based strategies continue to proliferate in other environmental policy arenas, such as biodiversity (Bruggeman et al. 2005), habitat (Fox and Nino-Murcia 2005), and greenhouse-gas abatement (Daily et al. 2000)...lessons from wetland banking" (in Robertson and Hayden 2008) will continue to be used to inform future policy development. Results from this study can and should be used to inform the development of market-based environmental regulatory systems that are both environmentally sensible and socially just.

Because all existing comparable research on the geographic and social aspects of wetland mitigation banking has focused largely on urban areas, it was important to ensure that the sample was taken from an area with diverse development patterns and land uses. The study area includes a mix of rural (outside UGB) and urban (inside UGB) land.

Organization of Paper

This paper begins with a literature review which is intended to embed existing research on wetland mitigation within the more far-ranging literature on market-based environmental regulation. The remainder of this section is intended to illustrate how and why the social and spatial context of a resource affects the value of the services that it provides.

Following the literature review is a description of how the wetland mitigation banking system evolved into its current state. A description of the legal framework through which wetland mitigation banking systems operate is then provided. Lastly, the social and environmental characteristics of the selected study area are described.

The methods chapter proceeds the background information. This chapter describes the process and analytical techniques employed in this study. A synthesis of descriptive and statistical comparisons between wetland mitigation banks and removal-fill permit sites is then provided in the results chapter.

The discussion chapter describes the importance of the results. Each result is then discussed in the context of previous applicable research.

Last but not least is a chapter which focuses on the policy implications of results from this study. This chapter concludes with a description of potential policies that could be used to limit the social and spatial displacement of wetlands caused by mitigation banking. Note that each chapter is intentionally divided into sections which correspond to each distinct analysis included in the study.

CHAPTER II

LITERATURE REVIEW ON THE DELIVERY OF ECOSYSTEM SERVICES THROUGH WETLAND MITIGATION BANKING

The Value of Ecosystem Services

Research has clearly demonstrated that wetlands provide valuable ecosystem services to people (Costanza et al. 1989; Mitsch and Gosselink 2000; King and Bohlen 1994; Lupi, Kaplowitz, and Hoehn 2002). This research has focused on the quantification of economic equivalencies for services provided by a given area of wetland. While such economic evaluations are useful, most neglect to account for important determinants of value, such as: the spatial location of the people assigning value to a given wetland (Perrings and Hannon 2001), temporal variation in the services provided by a wetland (Rosenberger and Phipps 2001; Milon and Scrogin 2006; BenDor and Brozović 2007; Brody et al. 2008), area population density (Brander, Florax, and Vermaat 2006), availability or scarcity of alternative comparable services (Mitsch and Gosselink 2000) and the socioeconomic characteristics of the population valuing a wetland (Milon and Scrogin 2006; BenDor and Brozović 2007).

To accurately account for the value of ecosystem services provided by a wetland, the extent to which each of these factors affects the provision of services by the resource must be well-understood. Moreover, if state and federal protection programs/ regulations are to mitigate the loss of "bio-physical functions and human-use values of wetlands ... from anticipated development" (Oregon Department of State Lands 2000), an sound understanding of the factors which affect both the actual and perceived value of the resources is also necessary.

The following literature review begins with a description of the discourse between researchers and regulators as our understanding of 'ecosystem services' has evolved to both support and refute the legitimacy of a growing interest in the use of market-based ecosystem service regulatory devices. The subsequent sections focus on the factors which impact the values associated with the services that wetlands provide. More specifically, the value of wetland services is described as a function of landscape characteristics which include: spatial context, population density, availability of alternative resources, and socioeconomic characteristics. Each value-determinant is then described in the context of current wetland mitigation banking policies.

Market-Based Regulation of Ecosystem Services

While not the first, the most well-known economic evaluation of ecosystem services was by Costanza et al. (1997). In this controversial study researchers sought to quantify the value of all services provided by nature, world-wide. Results showed that wetlands and waters were particularly valuable providers of ecosystem services. Costanza's paper also popularized the concept of "ecosystem services." Since this paper was published, over 500 papers have been published on the topic (Costanza 2007). To say the least, ecosystem service valuation has become a hot topic.

To quantifiably understand the value of ecosystem services that wetlands provide, one must first define and describe the bundle of services provided by wetlands. In one of the first studies that focused on quantifying the value of ecosystem services provided by wetlands, Costanza et al. (1989) looked at people's willingness to pay for the following services: commercial fishing and trapping, recreation, and storm protection. In Costanza et al.'s (1997) later work, the categories of wetland valuation were expanded to include: gas regulation, disturbance regulation, water regulation, water supply, waste treatment, habitat, food production, raw materials, recreation and cultural resources. More recently, the Millennium Ecosystem Assessment (2005), a product of the Ramsar Convention on Wetlands, described wetlands as: providers of food, fresh water, and fiber and fuel; regulators of climate, hydrologic flows, water quality, erosion, natural hazards, and pollination; cultural resources for spiritual practices, recreation, aesthetics, and education; supporters of soil formation and nutrient cycling. From this record of past research it is clear that our understanding and recognition of the services provided by wetlands to people has improved over time.

As the body of research on ecosystem services has continued to mature, policies, regulations and markets have developed in response to the idea that non-market ecosystem services can indeed be assigned monetary value. Carbon markets, payments for carbon sequestration, conservation easements, and payment-to-provide habitat for biodiversity are just a few examples of market-based environmental regulation polices that have developed in recent years (Daily et al. 2000). Through market enclosure, such policies are assumed to capture values associated with the non-market services that nature provides - services which might otherwise be externalized from traditional cost-benefit analyses (Costanza et al. 1997).

While growth in markets for ecosystem services has occurred at an exponential rate, this growth has not been met with full support. In fact, critics are both prevalent and boisterous. Some have used Karl Polanyi's (1944) idea of "fictitious economies" – that nature cannot "be detached from the rest of life, be stored or mobilized" – to argue that any attempt to craft policy which tries to commodify a single part of nature will ultimately fail to capture the true value (Robertson 2000). Similarly, Daily et al. (2000) highlighted the problems associated with using indirect, contingent, replacement and preference valuation techniques to arrive at a set value which is applicable over space and time. Others have expressed concern that paying people to do the right thing, while failing to award those who voluntarily do good, will result in negative repercussions (Bulte et al. 2008). Still others have argued that while paying select individuals to provide ecosystem services can promote economic efficiency, economic efficiency does not guarantee that services are provided in an effective or equitable manner (James Salzman and J. B Ruhl 2006). For the most part, critiques of the market-based regulation of ecosystem services focus upon problems related to the quantification and delivery of the values of nature's services.

While evaluations and critiques of market-based ecosystem service regulation are prevalent, most remain largely theoretical as most relevant policies and markets are still quite young. At the same time, wetland mitigation banking has received particular attention because, despite its infancy, "it is the most mature effort yet to create commodity markets in ecosystem services in the United States" (Robertson 2004). Mitigation banking has been used on an informal basis since the 1970's, but has only been institutionalized since the early 1990's (See Chapter 3 for further description). Because wetland mitigation banking has been used for some time, data, while quite limited, is available to perform macro-scale empirical analyses.

Most existing research on wetland mitigation has focused on traditional on-site and off-site permittee-responsible forms of mitigation. As previously mentioned, most of this research has often focused on evaluating the environmental functionality of mitigation wetlands, which often has been measured using one or more of the following factors: development of soil organic matter (Zedler and Callaway 1999; Shaffer and Ernst 1999); richness of hydric plant species (Kentula et al. 1992); diversity of plant communities (Campbell, Cole, and Brooks 2002); and hydrological characteristics (Cole and Brooks 2000). Results indicate that on-site and off-site permittee-responsible mitigation projects typically fail to achieve desired or proposed ecological functions (Allen and Feddema 1996; Ambrose; Balzano, Kaplan, and Fanz 2002; Confer and Niering 1992; Mary Kentula et al. 1992; M. E. Kentula 1992; Redmond 2000; Shaffer 1999; Turner, Redmond, and J. B. Zedler 2001). Such studies have improved our understanding, or lack thereof, of the various wetland restoration processes; however, ecological evaluations largely neglect to account for measures of societal value. This is important because "even if functional losses are met with equal functional gains, the functions will have different social benefits depending on their location in the human and natural landscape" (Boyd and Wainger 2002). This point serves as the heart of this study.

Spatial and Social Determinants of the Value of Services Provided by Wetlands

Value and the Spatial Distribution of Natural Resources

The premise of spatial discounting is that distance is a determinant of the value of non-market natural resources (Perrings and Hannon 2001). When applied to non-market goods and services this means that as the distance between a resource and a person increases, the value of that resource generally decreases.

Within the literature, the concept of spatial discounting is often described in terms of "place-based value" (Brown, Reed, and Harris 2002), "benefit value transfer" (Eade and Moran 1996), or is more generally imbedded within literature on "spatial economics." The concepts of spatial economics are embodied within the broad study of regional science, introduced by Walter Isard in *Location and Space Economy* (1956) and *Methods of Regional Analysis* (1960). Research in the name of regional science has waned since Isard's time, but the concepts introduced by early regional scientists continue to serve as the foundation upon which socioeconomic spatial analyses of non-market natural resources are generally performed.

In regards to the value of services that wetlands provide, research has clearly shown that the theory of spatial discounting holds considerable weight. For example, Mahan, Polasky, and Adams (2000) studied property values in Portland, Oregon to determine if proximity to wetlands had an affect on property value. Results suggest that "reducing the distance to the nearest wetland by 1,000 feet increased the value by $436. And, home values were not influenced by wetland type." Similarly, Doss and Taff

(1996) found that decreasing a property's distance to a wetland by one block increased property value by between $960 and $2900, depending on the type of wetland.

Only a handful of researchers have attempted to evaluate the extent to which wetland mitigation banking policies have affected the geographic displacement of wetlands. In a study of all wetland mitigation banks in Florida, Ruhl and Salzman (2006) found that on average, wetlands were mitigated 17 miles (27.3 km) from the site of wetland fill. In a similar study of wetland mitigation banks in the Chicago area, Robertson and Hayden (2008) found that the average distance between the site of fill and the compensating mitigation bank was approximately 16 miles (25.8 km). Results from the research of BenDor and Brozović (2007) on changes in mitigation practice in Chicago overtime also show that, on average, wetlands have been displaced approximately 16 miles (25.6 km). Evaluations of wetland displacement through wetland mitigation banking policies have focused on portions of Chicago and Florida, which are largely urban areas with high development pressure. Thus, it is unknown if wetland mitigation policies have caused a similar geographical migration of wetlands in other areas.

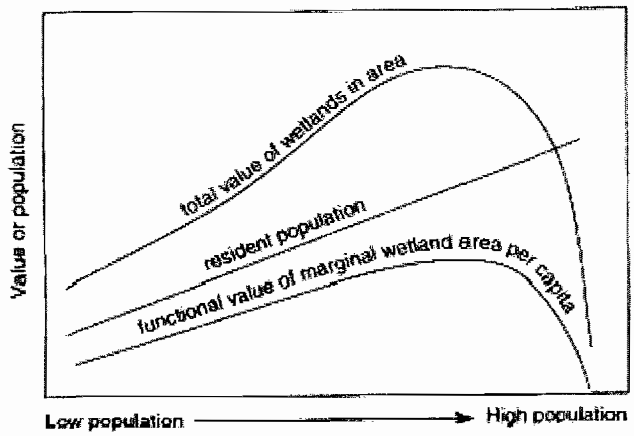
Wetland mitigation policies are generally crafted to contain wetland displacement within predefined "service districts." Service districts are delineated using ecological boundaries in the form of watersheds (United States Environmental Protection Agency 2009), thus mitigation service districts do not necessarily reflect social and cultural values of wetlands. In comparison, urban and neighborhood parks are planned using service area radiuses delineated with radial buffers at a distance determined by the level of recreational, neighborhood identity and amenity values provided by each park. This exercise is based on the notion that a park's level of service is determined by the distance between that park and the location of the population that will benefit from the services provided by that park. Similar to parks, wetlands are providers of important recreation opportunities, open space, and amenity values. However, mitigation bank service districts do not directly account for the distance between people and a wetland. In fact, mitigation banks are often encouraged to be developed in protected areas away from areas of potential human disturbance (Oregon Department of State Lands 2000).

Wetland mitigation banking systems regulate the geographic location of wetland compensation with predefined service districts (United States Environmental Protection Agency 2009) which are delineated using political and watershed boundary lines (Oregon Department of State Lands 2000); thus, service districts largely neglect to account for the societal values that wetlands provide (Ruhl and Salzman 2006). In some sense, because the scale at which mitigation is allowed to occur is dependent upon flow of water rather than development patterns, localized social values are largely neglected. This is problematic because "ecosystems are idiosyncratic; what holds true in one region may not apply well elsewhere" (Daily et al. 2000). In other words, the services that wetlands provide to people are not fungible across space or time (King 1997). Hence, it is important to know whether or not the wetland-products of wetland banking markets reflect the factors which ultimately determine the substitutability of wetlands across space.

Population Density and the Value of Wetland Services

The population density of those living near a wetland can affect the overall value of services provided by a given area of wetland (Brander, Florax, and Vermaat 2006). This is based on the notion that one acre of wetland near an area of high population density will provide a greater overall value of services than one acre of a comparable wetland located near an area of low population density. Figure 2 illustrates the theoretical basis of this point. As reiterated by Mitsch and Gosselink (2000) "as human populations increase from low to high, the marginal per capita value of wetlands increases." However, a tipping point exists at which the value of a wetland no longer increases. For instance, as a wetland is encroached by "urban-suburban sprawl, a wetland's function can easily be overwhelmed" (Mitsch and Gosselink 2000). However, while urban wetlands bordered by high population densities may not always function at ecologically optimal levels, urban wetlands provide other services that are important socially such as recreation, places of education, aesthetic appeal, and community-identity (Boyer and Polasky 2004).

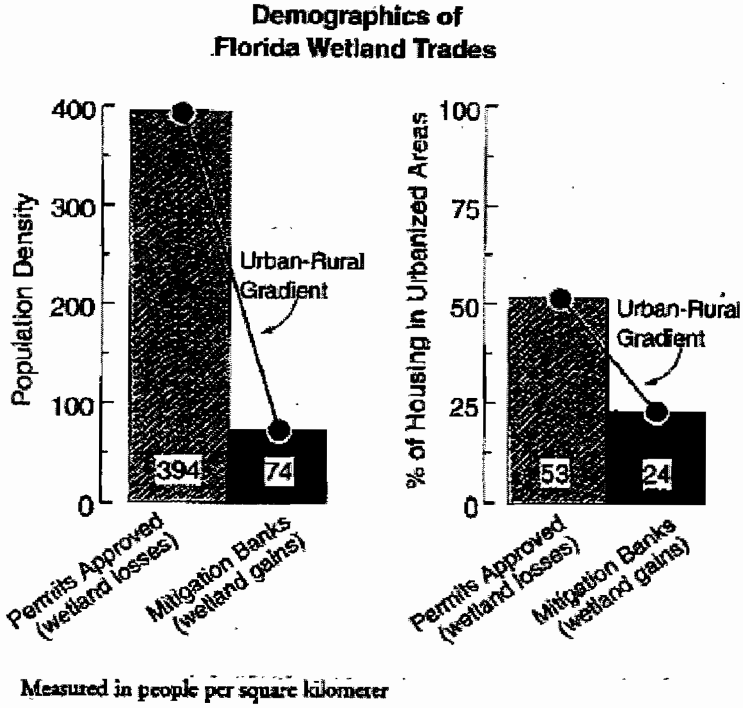
Figure 2: Impact of Population Density on Wetland Values
(from Mitsch and Gosselink 2000)



To date, there is little research which has looked at the affects of wetland mitigation banking policies in relation to where people live. Existing research is limited to wetland mitigation banking projects in Florida. As illustrated by Figure 3, results from this research identified an urban-to-rural shift in the location of wetlands as a result of wetland mitigation banking policies. King argued that this displacement has led to a loss of value. Following up on King's work, Ruhl and Salzman (2006) performed a similar study and found that the "population density around the projects (fill-sites) was on average 934 people per square mile higher than their associated banks."

It is possible that this trend has been driven in part by property values as the cost to develop a mitigation bank in high population areas tends to be significantly greater than in less populated areas; and, higher bank development costs lead to higher mitigation credit prices, which makes mitigation banks in highly populated areas less competitive (Ryan Joseph Bourriaque 2008). Thus, wetland mitigation banking regulatory systems may in fact provide financial incentives to mitigate wetlands away from highly populated areas.

Figure 3: Population Density & Urban Populations near Mitigation Banks and Permits in Florida (from King 1997)



*Population densities were measured using zip codes of sites

Again, these findings are important for a number of reasons. First, the value of a given unit of wetland increase as more people depend upon the services that it provides (Brander, Florax, and Vermaat 2006). And second, the overall availability of ecosystem services tends to decrease in areas with population density increases (Sutton and Costanza 2002).

The Difference between Urban and Rural Wetland Services

As population densities increase, areas become more urban. Moreover, the cultural benefits that an urban population receives from an urban wetland clearly differ from those delivered from a rural wetland to a rural population. For instance, Manuel (2003) found that while respondents may not have regularly visited urban wetlands, most described urban wetlands as important providers of identity and aesthetic values. Manuel's findings highlight two cultural values which are dependent on the spatial context of the population assigning value to a wetland. A person living amongst an abundance of open space will most likely place lesser value in the open space provided by a small wetland than would a person living in a densely urban space.

In contrast, in his research on wetland mitigation banking in the Midwest, Robertson (2000) described a scenario in which the cultural benefits received from the hunting opportunities provided by large wetland mitigation banks overshadowed the less striking benefits associated with the protection of small urban wetlands. Manual and Robertson's research clearly demonstrates that urban and rural wetlands provide different types of services to people. Wetland mitigation banking policies should seek to ensure the preservation of both forms of ecosystem services.

Availability of Alternative Resources and Service Providers

Basic economic principals support the notion that the value of services provided by non-market resources is contingent upon resource availability of alternative non-market "service providers" (Freeman 2003; Perman 1999). Thus, to evaluate the value of services provided by a given acre of wetland, one must have an understanding of the relative abundance of wetlands in the area (i.e. other service providers).

As affirmed by Daily et al. (2000), perhaps "the most important, yet most underrated" principal of ecosystem service valuation is the identification of alternative resources and service providers. In terms of wetlands, alternative resources and service provider can vary depending on the service that is being valued. For example, to determine value of water retention provided by an acre of mitigated wetlands, Boyd and Wainger (2003) compared the proportion of land covered by natural areas and other wetlands to the total area of impervious surfaces within one half mile of each wetland. This provided an index of the value of water retention services provided by the wetland when analyzed in the context of other available service providers (i.e. natural areas and wetlands). This valuation technique assumes the value of a given unit of wetland is contingent upon the supply of alternative services available within a given region of analysis (Brander, Florax, and Vermaat 2006).

While other factors such as the environmental quality of available non-market alternatives and the cost of associated with replicating the services provided by a non-market resource can be included in valuation studies, studies which take these factors into account tend to focus on small geographic units of analysis. For large-scale analyses, measures of wetland scarcity have been used as indicators of wetland value (Boyd and Wainger 2003). The approach is supported by research on the relationship between housing values and prevalence of wetlands, which indicates that "an increase in wetlands acreage in the survey section where the house was located increased housing value by

$19 per hectare of increased wetlands (1989 dollars) and the increase in value for wetland area tended to be greater in areas where there were few nearby wetlands" (Lupi Jr, Graham-Tomasi, and Taff 1991 in Boyer and Polasky 2004).

Why Socioeconomic Characteristics Matter

It is well recognized that people of different socioeconomic backgrounds value wetlands differently. In a meta- regression analysis of wetland valuation studies Brander, Florax, and Vermaat (2006) found that while socio-economic variables are often omitted from valuation analyses, GDP per capita and population density are extremely important in explaining variation in wetland values. The importance of socioeconomic characteristics as a causal factor of value has been stressed by others as well (William J. Mitsch and Gosselink 2000; J. Boyd and L. Wainger 2003; J. B. Ruhl, J. Salzman, and Goodman 2008; Robert Costanza, Stephen C. Farber, and Maxwell 1989; D. M. King and Bohlen 1994; BenDor and Brozović 2007; James Salzman and J. B Ruhl 2006). In general, people of different socioeconomic backgrounds place different types and levels of value on the services provided by nature. Thus, to ensure a loss in ecosystem services is compensated for, the characteristics of the affected population must first be understood.

Research on the affects of wetland mitigation on specific populations is sparse. However, Ruhl and Salzman (2006), King (1997) and Boyd and Wainger (2003) have analyzed the socioeconomic differences between wetland mitigation banks and sites of wetland loss. This research has focused solely on Florida's mitigation banking system. Ruhl and Salzman's (2006) compared median incomes and proportion of minorities and determined that there were insignificant differences between mitigation banks and permit sites. King (1997) and Ruhl and Salzman (2006) were able to show that urban populations in Florida experienced significant wetland losses, while rural populations experienced significant wetland gains. This is problematic because as populations become increasingly urban, urban ecosystem services become increasingly more important (Bolund and Hunhammar 1999).

Most wetland mitigation policies do not currently account for socioeconomic differences between the site of wetland loss and a site of restoration; however, some counties have developed ordinances which require off-sets to occur within their political boundaries. A study of mitigation banks in the Chicago mitigation banks (Robertson and Hayden 2008) showed that local containment policies/ordinances significantly reduced the distance between wetland fill sites and wetland mitigation banks. While Hayden and Robertson did not look at socioeconomic information, such local policies may have had an impact on who was affected by wetland displacement.

CHAPTER III

BACKGROUND

The Historical and Regulatory Framework of Wetland Protection and Mitigation

The Evolution of Wetland Mitigation in the United States

While there is uncertainty about when wetland mitigation was first used, most government records point to Section 404 of the Federal Water Pollution Control Act (FWPCA) (1972) as the foundation of wetland mitigation (United States Environmental Protection Agency 2009). Others contend that the U.S. Army Corps of Engineers (USACE) and the United State Protection Agency (USEPA) have used informal forms of mitigation for public projects since 1968 (Hough and Robertson 2009), thus building the legal framework for the 1972 FWPCA amendments. Hough and Robertson argue that the 1966 amendments to the FWPCA (33 USC 466), which required the United States Fish and Wildlife Service (USFWS) to review the environmental impacts of public projects (1939 Fish and Wildlife Coordination Act), led to contention between USFWS and the USACE in 1966 regarding jurisdictional oversight of water resources (United States Fish and Wildlife Service). As a result of this conflict, the USFWS and the USACE came to an agreement (United States Army Corps of Engineers and United States Fish and Wildlife Service 1967) allowing the USFWS to carry out environmental reviews of public projects. The environmental review process was formalized through a 1968 amendment to Section 10 of the Rivers and Harbors Act (1938). This amendment incorporated USFWS environmental review into the USACE's interpretation of "public interest" (United States Army Corps of Engineers 1968 in Hough and Robertson 2009). Since the Rivers and Harbors Act (1968) amendment excluded a framework for an appropriate wetland mitigation system, "the initial concept (of wetland mitigation) evolved quickly, before it was ever codified as a written document" (Edward T. LaRoe 1986).

In 1972 amendments were made to the FWPCA and the revised law became known as the Clean Water Act (CWA). Section 404 of the Clean Water Act contains the language that served, and continues to serve, as the legal basis for mitigation. It gives the USACE the authority to "issue permits for the discharge of dredged or fill material into the navigable waters at specified disposal sites" (92nd Congress of the United States 1972) pursuant the guidelines contained in Section 404(1)(b) of the CWA. In coordination with these legal changes, the USACE developed a permit program which stated that "the applicant will be urged to modify his proposal to eliminate or mitigate any damage to such resources, and in appropriate cases the permit may be conditioned to accomplish this purpose''(United States Army Corps of Engineers 1973 in Hough and Robertson 2009). While unofficial wetland mitigation may have occurred prior to the 1972 FWCPA in accordance with the aforementioned agreements, 1972 marks the legal birth of mitigation.

On-site and single-project wetland mitigation was used for quite sometime before the concept of mitigation banking was put into practice. As summarized by the

Environmental Protection Agency,

> Guidance from U.S. Fish and Wildlife Service (FWS) in 1983 supported the establishment of the first banks, most of which were sites of advanced consolidated compensatory mitigation for impacts planned by state Departments of Transportation or other state agencies (U.S. Fish and Wildlife Service 1983). The subsequent expansion of mitigation banking was catalyzed by the release of several important reports that challenged the effectiveness of (on-site and single-project off-site) compensatory mitigation practices… (2009)

The UFWS guidance document provided the clarity that the mitigation banking process had previously lacked. Around the same time, a series of related policies and agreements which increased protection of wetlands were passed, including; Executive Order 11988 (Jimmy Carter 1977a): Floodplain Management, Executive Order 11990: Protection of Wetlands (Jimmy Carter 1977b) Food Security Act: "Swampbuster" provisions (1985), "No Net Loss" Policy (1988), North American Wetlands Conservation Act (1989), Memorandum of Agreement between USEPA and USACE concerning mitigation under CWA Section 404(b)(1) (United States Army Corps of Engineers and United States Environmental Protection Agency 1990).

Perhaps the most significant policy in regards to wetland mitigation was President George H.W. Bush's "No-Net-Loss" directive (1988), which was originally met with overwhelming bi-partisan support, but has more recently been scrutinized by academics and public agencies alike. Shortly after Bush popularized the concept of "No-Net-Loss" the US Fish and Wildlife Service (United States Fish and Wildlife Service 1990) developed a Wetland Action Plan, titled "Meeting the President's Challenge." The 1990 Wetland Action Plan sought to ensure a no-net-loss of wetlands through a "three-pronged approach" which included "wetland protection; wetland restoration, enhancement and management; and wetland research, information, and education" (US Fish and Wildlife Service 1990). Additionally, the USFWS and the USACE (1990) developed a long-awaited Memorandum of Agreement (MOA) which set up common guidelines to achieve "No-Net-Loss." The MOA was instrumental in the development of a cohesive wetland mitigation permit system as it solidified inter-agency guidelines which had previously been unclear (see National Wildlife Federation vs. John O. Marsh (1981)). The guidelines stated that wetland impacts were to be avoided to the maximum extent possible, that unavoidable impacts were to be minimized to the extent appropriate and practical and that compensation could be used for the remaining impacts to the extent appropriate and practical (United States Army Corps of Engineers and United States Environmental Protection Agency 1990). The 1990 MOA marked the beginning of an era of inter-agency cooperation and it was the beginning of a series of efforts to improve regulatory oversight of wetland mitigation practices.

Since 1990, there has been a significant amount of academic and governmental research which has highlighted issues related to the need for increased ecological performance of mitigation projects. As a result of this research and other growing concerns about the "consistency, predictability and equitability" of existing mitigation guidelines and practices, the USACE and USEPA (2008) developed new wetland mitigation guidelines which call for improvements in: ecological monitoring, dissemination of public information, provision of financial assurances and public input on mitigation-related decisions (40 CFR 230).

Federal Jurisdiction of Wetlands

Under the Clean Water Act (1977) federal jurisdiction of wetlands is limited to "navigable waters of the U.S." In the late 1970's this was interpreted to include

> virtually all waters within the aquatic system, from low order small streams and their surrounding wetlands, to geographically separated waters like prairie potholes and playa lakes, to the often dry washes of the arid West, and to man-made (and man-altered) ditches, canals, and similar structures that either replaced or, in many respects, acted like natural tributaries" (Murphy 2006).

However, recent Supreme Court cases, including *Solid Waste Agency of Northern Cook County (SWANCC) v. U.S. Army Corps of Engineers* (2001) and *Rapanos v. United States* (2006), have resulted in more conservative interpretations of the law. As a result of these cases, the extent of wetland protection under the CWA has been limited to wetlands which have a demonstratable "significant nexus" with permanent navigable water bodies. The USACE's has thus been tasked with making case-by-case determinations on what constitutes a jurisdictionally protected wetland. This has led to problems in states which rely on federal policies for the protection of wetlands. However, states which have their own wetland protection regulations, including Oregon, have been more-or-less immune to these changes.

Jurisdiction of Wetlands in Oregon

In addition to federal protection of "navigable waters" provided by Section 404(b)(1) of the CWA (1977), the State of Oregon protects wetlands and waterways through a number of statutes and regulatory programs. The Oregon Revised Statutes (ORS 196.800 - 196.990, 2007) gives the Department of State Lands (DSL) jurisdiction to regulate the removal or fill of "waters of the state." Additionally, the Oregon Statewide Planning Goals (1973) provide supplemental protection to wetlands: Goal 5 mandates protection of wetlands identified by the National Wetland Inventory and/or Local Wetland Inventories (OAR 660-015-0000(5)), Goal 16 regulates protects designated estuaries (OAR 660-015-0010(1)) and Goal 17 protects coastal shorelands (660-015-0010(2)).

Because Oregon has its own statewide wetland-protection program, both DSL and USACE are responsible for reviewing wetland-fill permits; however, USACE is responsible for reviewing permits for wetlands protected under the Clean Water Act (CWA), while DSL is responsible for reviewing removal-fill permits which affect "waters of the state." In contrast to "waters of the United States", "waters of the state" are defined to include water bodies and delineated wetlands, regardless of their navigability. And, protected wetlands are defined by Oregon Statute to include "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (ORS 196.800(16) and OAR 141-085-0010). Thus, all wetlands protected under the CWA are also protected by Oregon statute. In addition, DSL has the authority to regulate wetlands which the USACE does not have jurisdiction over. It is primarily for this reason that DSL is responsible for administration of the Oregon wetland mitigation banking system (Oregon Department of State Lands 2000).

History of Wetland Mitigation Banking in Oregon

The West Eugene Wetlands Mitigation Bank, approved in 1992, was the first wetland mitigation bank in the state of Oregon (City of Eugene, Oregon 2008). The state of Oregon did not adopt formal rules on wetland mitigation banking until the summer of 1996 (OAR 141-85-400 - 141-85-445) and so the West Eugene Wetlands Mitigation Bank operated independent of state rules for a number of years. When first adopted, the Oregon Administrative Rules intentionally lacked detail. This was done to accommodate adaptive and diverse management strategies and because the state did not have "enough experience to address all the aspects of such a relatively new concept" (Oregon Department of State Lands 2000). To compliment the OAR's and provide greater direction to wetland mitigation bankers, the Department of State Lands (DSL) organized a Mitigation Guidebook Committee which was responsible for developing one of the first statewide comprehensive mitigation banking guidebooks in the nation.

Since the early 1990's, 19 mitigation banks have been approved and are operable. Another seven banks are currently under development (Oregon Department of State Lands 2009). All existing mitigation banks occur within the Willamette Valley; however, additional banks along the Coast and in Central Oregon are currently under development. In Oregon and across the nation, wetland mitigation bankers tend to locate banks near areas of moderate to high development pressure – where requests for wetland removal-fill permits are common – and thus where the greatest markets for mitigation banking exist.

The Oregon Wetland Mitigation Banking System

In Oregon, wetland mitigation banks are established through a formal process which is headed by a Mitigation Review Team commissioned by the Department of State Lands (DSL). The process of bank establishment is further described in Appendix B. The Mitigation Review Team includes representative from the United States Army Corps of Engineers (USACE), United States Fish and Wildlife Service (USFWS), Oregon Department of Environmental Quality (DEQ), Oregon Department of Land Conservation and Development (DLCD), and local planning staff. Once a wetland mitigation bank has been approved the respective mitigation banker is allowed to sell a prescribed number of "mitigation credits", equivalent to the total number of acres restored, protected, enhanced, or created wetland within their mitigation bank. Credit ratios establish the maximum number of credits that a banker may sell the total acres of wetlands included in his/her mitigation bank. As displayed in Table 1, ratios are contingent upon the type of mitigation bank that is created. Additionally, bankers may only sell mitigation credits to permittees who have filled or removed the same wetland type as that which has been developed in the bank.

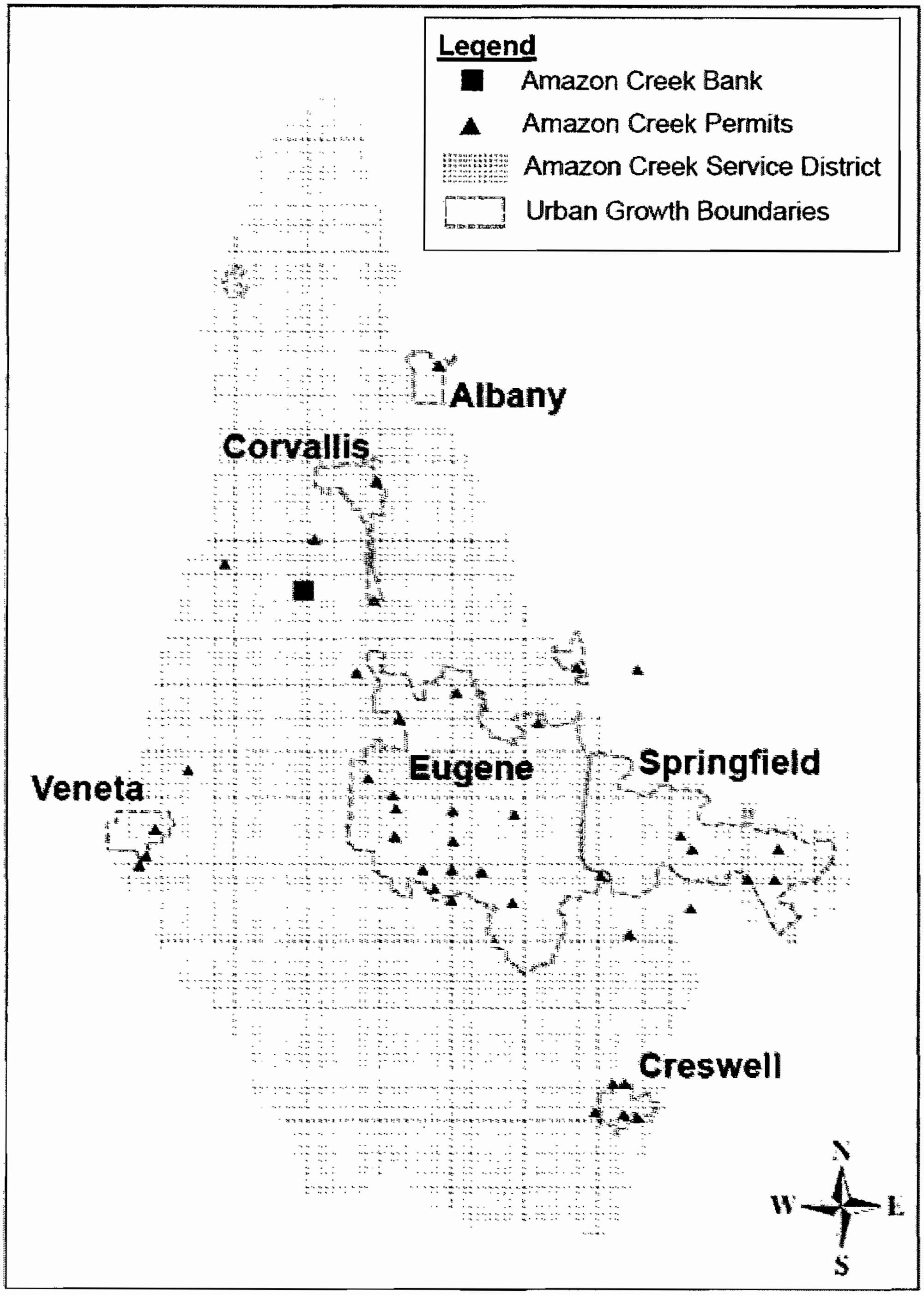
Table 1: Oregon Mitigation Credit Ratios

Mitigation Type	**Credit Ratio** (Mitigated : Lost)
Restoration	1 : 1
Creation	1.5 : 1
Enhancement	3 : 1
Enhancement of Cropped Wetlands	2:1

The sale of mitigation credits to removal-fill permittees is geographically confined by "service districts." Each bank has its own service district within which mitigation credits can be sold. Service district areas are developed by DSL and are intended to reflect "boundaries of the watershed in which the mitigation bank site is located, ecological unit boundaries and distance from the bank site to the likely sources of credit demand" (Oregon Department of State Lands 2000). An example of what a typical service district might look like is displayed in Figure 4. This image was taken from within the study area and it includes all corresponding permits, banks and urban growth boundaries.

Once a bank has been approved and a service area has been delineated, bankers can sell mitigation credits to wetland removal-fill permittees who have demonstrated that no other wetland mitigation or preservation alternatives exist (Oregon Department of State Lands 2000). It should be noted however, that while this is the stated policy, mitigation banks have been described by some as the "instrument of choice" (Salzman and Ruhl 2006). Finally, all mitigation credit transactions are contingent upon approval by DSL.

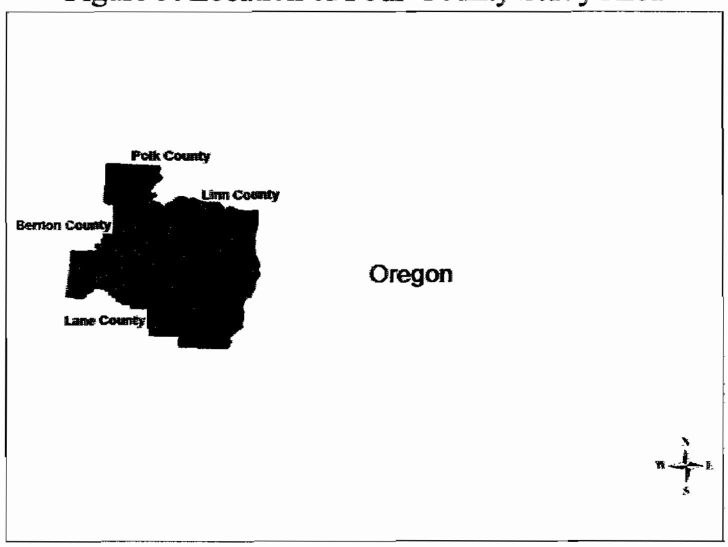
Figure 4: Example of Wetland Mitigation Bank Service District



Description of the Study Area

The selected study area includes all wetland mitigation banking service districts within Benton, Lane, Linn and Polk Counties. Figure 5 identifies the location of the four-county study area within the State of Oregon.

Figure 5: Location of Four-County Study Area



Wetlands and Natural History

The wetland mitigation service districts within the study area occur largely within the South-Central Willamette Valley, an area once dominated by an upland-wetland prairie vegetative complex. However, largely as a result of agricultural conversion, only one percent of all native wetland prairies remain (Wilson 1998). While not as abundant as the palustrine prairie wetlands, riverine wetlands were also prevalent within the study area, particularly within the Willamette River floodplain (Cowardin et al. 1979). Dam construction and river channelization has led to substantial riverine wetland losses. Over time, 70 percent of wetland loss in the Willamette Valley has been attributable to agriculture, six percent to urbanization, and 24 percent has been lost to other changes (Bernert et al. 1999). The wetland mitigation banks included in this study are located at sites which were once dominated primarily by these wetland types.

Wetland Mitigation Banking within the Study Area

Within the four-county area, as of October 2008, eight mitigation banks had been approved and were operable and another two were under development. For all operable mitigation banks within the study area, Table 2 provides a description of: the county that each bank is located in, city nearest to each bank, the total mitigation credits approved by DSL and available for sale (for credit equivalencies see Table 1) and the total number of mitigation credits that have been sold. Figure 6 provides an illustration of where the location of banks and permit sites within the study area and Figure 7 provides an illustration of the area in which mitigation service districts exist. Note that this illustration only shows the overall area served by mitigation districts.

Table 2: Description of Operable Wetland Mitigation Banks within Study Area

Bank Name	**County**	**Nearest City**	**Available Credits**	**Total Credits Sold Within Study Area**
Amazon Creek	Lane	Junction City	41.08	31.58
Evergreen	Benton	Philomath	85.00	8.02
Frazier Creek	Benton	Corvallis	13.00	5.82
Mid-Valley	Benton	Adair Village	21.50	15.31
Mud Slough	Polk	Rickreall	112.00	9.15
Oak Creek	Linn	Lebanon	31.18	15.10
One Horse	Linn	Lebanon	67.00	15.24
West Eugene	Lane	Eugene	200.00	63.73
Total			570.76	163.95

Figure 6: Location of Permit Sites, Banks and Major Cities within the Study Area

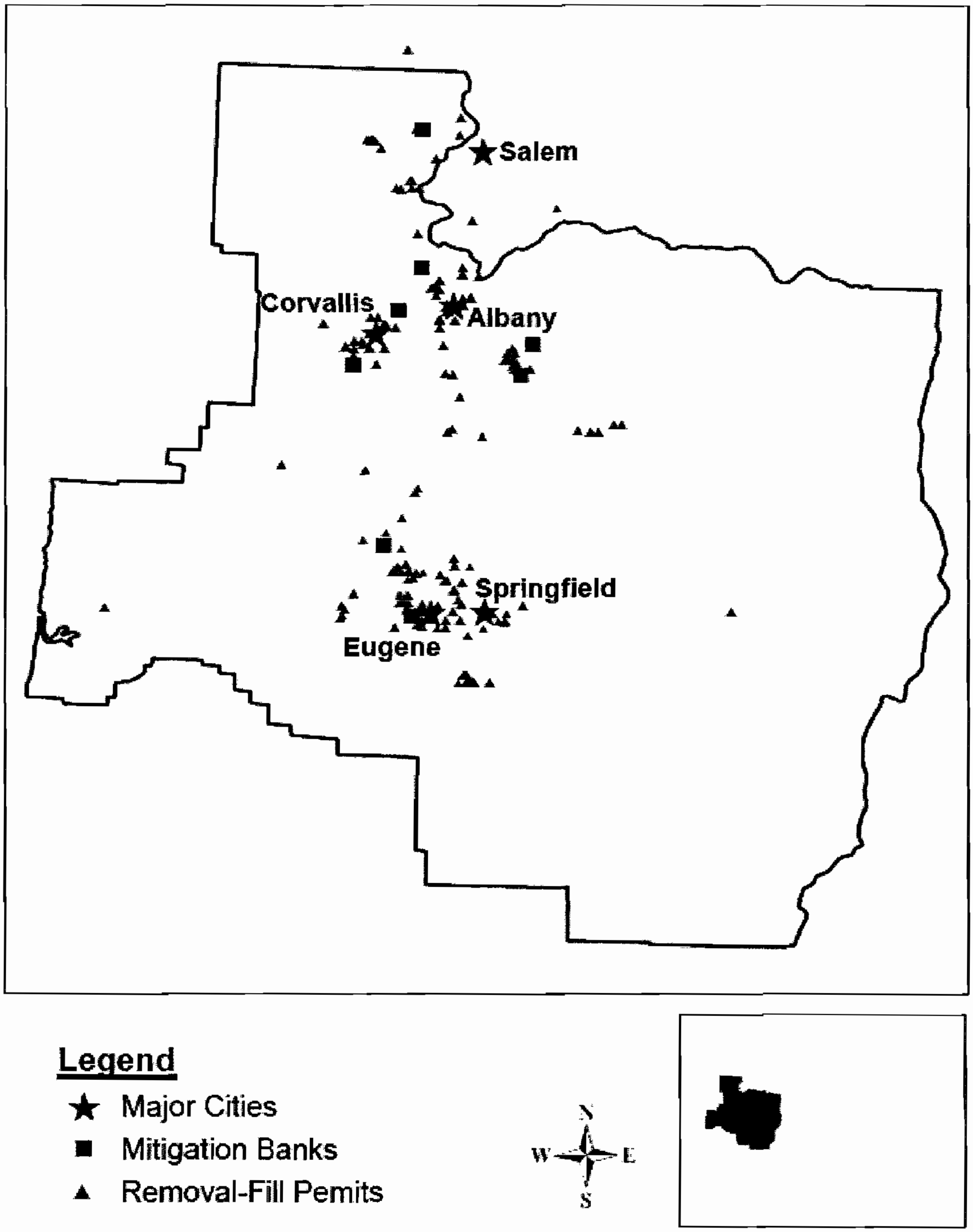
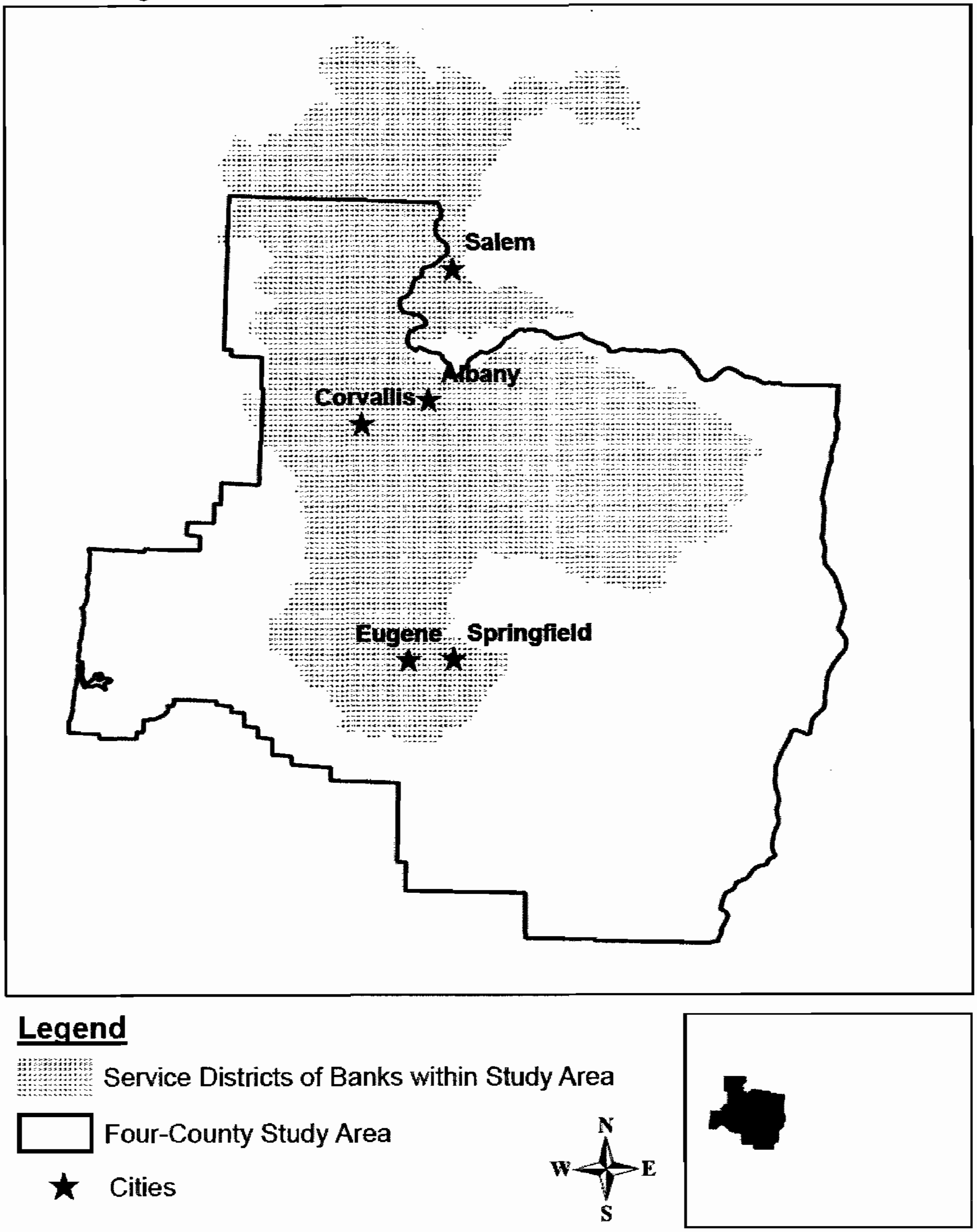


Figure 7: Location of Service District Boundaries within Study Area



CHAPTER IV

METHODOLOGY

Background Information

Overview

The purpose of this research was to quantifiably describe the social and spatial differences between sites of wetland loss (removal-fill permits) and sites of wetland gain (wetland mitigation banks). By quantifying these differences we can begin to understand the extent to which wetland mitigation banking systems affect the provision of ecosystem services and benefits provided by wetlands, to people.

This comparative and descriptive evaluation incorporated the following analytic procedures: a) calculating the average distance between removal-fill sites and their respective sites of mitigation; b) describing the spatial context of each permit/bank site in relation to designated areas of population growth (UGB's); and c) depicting differences in socioeconomic characteristics around each permit/bank site, including differences in: population density, percent of total population that is white, percent of total population considered "urban" and median household income d) quantifying the availability of alternative natural assets (wetlands) around each permit/bank site.

Results from the measures described above were expected to illustrate the extent to which wetlands have been spatially displaced through wetland mitigation banking, which populations have been affected by said displacement, and whether or not such social and spatial displacement is significant enough to have an effect on the delivery of ecosystem services and benefits to the affected populations. While the measures used are not intended to fully describe all of the social, spatial or environmental characteristics at each permit/bank site, each measure should provide for a greater understanding of the social effects of wetland mitigation banking policies. Further, there is currently a very limited body of literature that has focused on the spatial facets of the market-based delivery of ecosystem services. Results from this study should provide one of the first reasonably large-scale descriptions of the spatial patterns of wetland distribution, as generated through a government-regulated market for ecosystem services. Lastly, results should be unique from what little comparable research exists, as the study sample was taken from an area subject to comparatively strong state-wide regulations concerning the protection of natural resources.

Description of Selected Sample and Study Area

The selected study area includes all of Lane, Linn, Benton and Polk counties (Oregon). Mitigation service districts served as the unit of analysis. The selected sample includes 8 of the state's 19 (42 percent) approved and operable mitigation banks and 233 of the 370 (63 percent) removal-fill permits approved and recorded by the Department of State Lands (DSL), through the use of mitigation banks from 1994 to October 2008. The study area includes a disproportionate amount of the state's total permits because banks in the area have been in operation for a greater period of time than in other areas and because there is a greater demand for wetland mitigation banking services within the study area (Field 2008). At the time of data collection three additional banks were under development within the study area, but because they were not yet operable, they were excluded from the sample.

This area was selected because: it includes both relatively large (Eugene-Springfield) and small (Corvallis) metropolitan areas; the area is comprised of a mix of urban, suburban and rural areas; enough mitigation banks (n, 8) and corresponding wetland-fill permit records (n, 233) exist within the four-county area to perform a meaningful analysis; and, mitigation bank service districts within the study area largely correspond with county jurisdictional boundaries. A total of three removal-fill permits located outside of the four-county area were mitigated inside of the four-county area. Each of these removal-fill permits was omitted from the analysis.

Of the eight wetland mitigation banks within the study area, all but one; the West Eugene Wetlands Enhancement (WEW) Mitigation Bank, occur on private property, outside of Urban Growth Boundaries (UGB) (Field 2008). This is representative of mitigation banks statewide; however, of the banks in Oregon, WEW is the only operable bank located within a UGB and/or on public property. Thus, the selected study area includes one mitigation bank which may not be representative of other mitigation banks within the State of Oregon. However, because individual service districts serve as the unit of analysis, this potential outlier should not significantly alter the results.

Description of Data Sources

Data for wetland removal-fill permits was collected from the Wetlands and Waterways Division of the Oregon Department of State Lands (DSL). Within this database of removal-fill permits different techniques were used to identify the geographic location of each permit site. Some permits were identified using Township, Range and Section references while others were identified by x/y coordinates. Unfortunately, staff at the Department of State Lands were not able to identify any pattern in the techniques used (Miles 2008). Thus, to map this data, permits which had been identified by Township, Range and Section were assigned x/y coordinates equal to the centroid of the section or quarter section by which they were identified. Once each permit had been assigned an x/y coordinate, the permits were mapped using GIS.

Permits identified by the centroid of the section could have been located a maximum of .7 miles from the actual site of fill. Figure 8 illustrates how this maximum error was calculated. While such an error could have been significant for some permits, most permit sites were already identified by x/y coordinates and thus did not have to be identified by the centroid of the section. Additionally, as illustrated by Figure 9, assuming permits were normally distributed within each section, 78.5 percent of the area within each section is within one half mile of the centroid of the section. Thus, most permits identified by the centroid of the section were likely located within one half mile of the centroid used.

Figure 8: Illustration of Permit Site Error Calculation for Centroid of Section

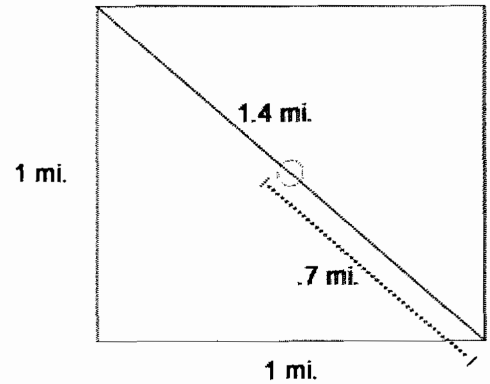
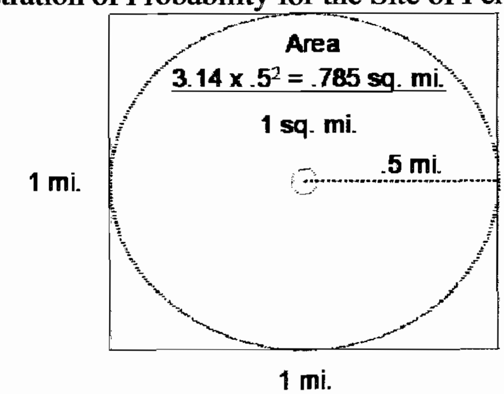


Figure 9: Illustration of Probability for the Site of Permit-Relocation



While wetland removal-fill permit information was not available in a mappable format, GIS shape files were available for all wetland mitigation banks and corresponding service districts approved prior to October, 2008. This data was also obtained from DSL. Descriptive information from the Department of State Lands' "Mitigation Bank Regions and Mitigation Contacts" reference document (2009) was added into the existing GIS geodatabase. A description of this information is available in Appendix C.

To evaluate the availability of alternative resources (wetlands) in the area of each permit and bank, a record of existing inventoried wetlands was needed. Unfortunately, the only such record available which covered the entire study area was the National Wetlands Inventory (NWI) (United States Fish and Wildlife Service 2008). Limitations of using the NWI include the age of the imagery used to inventory wetlands in Oregon (1982) and the scale at which the inventory was performed (1:24,000). Additionally, wetlands in agricultural areas less than two acres are often excluded. Lastly, the general accuracy of the NWI for wetlands in Oregon (Gwin, Kentula, and Shaffer 1999) and elsewhere has been criticized.

Nonetheless, the NWI serves as the most comprehensive and most widely used source of reference data for large-scale research on wetlands. A digitized NWI geodatabase was obtained and mapped for analysis. A description of the information available within this geodatabase is available in Appendix C.

To analyze the socioeconomic characteristics of populations living near each removal-fill or mitigation bank site, block group level census data was downloaded for each county. The data downloaded at the block group-level using Summary File 3 (SF 3) (2000) census data included: total population, total population white, total population urban and median household income. A summary of the definitions of each of the measures used can be found in Appendix C. Summary File 3 data includes a sample of social, economic and housing information for one in every six households within each block group.

For mapping and analysis purposes, block group shape files for the entire four-county area were obtained using the Census Bureau's Topologically Integrated Geographic Encoding and Referencing database (TIGER) (United States Census Bureau, Geography Division 2008). Using GIS, data tables from Summary File 3 were then joined to each TIGER block group shape file within the four-county sample area using the "STFID" unique identifier field.

Lastly, urban growth boundary (UGB) shape files were downloaded from Census Bureau's TIGER database (Geography Division 2008). UGB shape files were obtained to provide for additional geographic analysis on the location of permits and banks in relation to population centers.

Analytical Approach

The focus of this study was to describe and compare the social and geographic characteristics around each site of wetland creation (wetland banks) and each site of loss (removal-fill permits). It was thus assumed that proxies for the benefits of the ecosystem services delivered by wetlands could be derived from landscape and demographic data (Boyd and Wainger 2003). The demographic and landscape information analyzed in this study was by no means intended to be exhaustive of all factors which affect wetland values, as this research was not concerned with quantifying monetary values of ecosystem services provided at sample site; nor was it concerned with estimating the delivery of ecosystem services from a biophysical standpoint. Rather, the analysis was designed to determine the extent to which wetland displacement has occurred as a result of wetland mitigation banking practices; and, by coupling this information with demographic and landscape proxies, whether or not social and spatial determinants of wetland value differ between sites of wetland loss (permits) and sites of wetland gain (banks). Table 3 describes the evaluations, measures and data sources that were used to compare the social and spatial characteristics of permit and bank sites. Census definitions for each measure used are included in Appendix D.

Table 3: Description of Analysis Techniques, Measures and Data Sources

Evaluation	Measure	Data Source
Population Density of Area Around Each Site	Population Per Square Mile	Census 2000
Affect on Minority Populations	Percent of Total Population White	Census 2000
Affect on Urban/Rural Populations	Percent of Total Population Urban	Census 2000
Socioeconomic Characteristics of Affected Population	Median Household Income	Census 2000
Prevalence/Supply of Alternative Resources (Wetlands)	Total Acres of Wetland Within One Mile of Site	NWI
Proximity in Relation to Population Centers	Distance from UGB	GIS Analysis
Extent of Spatial Displacement	Distance from Permit to Respective Bank Site	GIS Analysis

Because different datasets were used for each type of evaluation, the analysis was performed in distinct parts. However, while analysis techniques varied based on the subject of evaluation, wetland mitigation bank service districts (i.e. banks) served as the unit of comparative and descriptive analysis throughout the study.

To allow for both empirical and statistical comparisons to be made between the characteristics of permit sites and mitigation banks, results from each analysis were summarized with: descriptive statistics, average-value comparisons, two-sample t-test evaluations and graphical illustrations. The following is a description of the analytic processes used to produce these results.

Distance between Removal-Fill Sites and Banks

To determine the average distance between each approved removal-fill permit site and the location of the mitigation bank used by the permittee, removal-fill records were grouped by the applicable mitigation bank and then separated into individual shape files.

This approach follows the methodology used in previous spatial analyses of mitigation banking in Illinois (BenDor and Brozović 2007; Robertson and Hayden 2008) and Florida (Ruhl and Salzman 2006; King 1997). The purpose of this calculation was to determine the average distance that wetlands have been mitigated from their respective site of fill.

With removal-fill permits organized by mitigation bank, "near distance" was calculated within ArcGIS. From this calculation a new record was created for each removal-fill permit which corresponded to the distance between the permit site and the location of the mitigation bank used. For each bank, the average distance of all corresponding permits was then calculated.

Secondly, the proximity from permit/bank sites to urban population centers was calculated. The purpose of this calculation was to determine whether or not spatial differences exist between permit sites and bank sites in relation to their proximity to areas of designated urban development. Again, in Oregon, these areas are designated by Urban Growth Boundaries (UGB's). To perform this calculation UGB's were mapped and then buffered at a distance of one mile (1.609 km). It was then determined whether each permit/bank was inside a UGB, within one mile of a UGB or outside of both the UGB and the one mile buffer and a record of this information was made for each permit and each bank. The approach employed was unique in that no existing research had looked at permit/bank sites in relation to designated urban growth areas; largely because Oregon has delineated urban boundaries while Florida and Illinois do not.

Analysis of Socioeconomic Characteristics

Prior to carrying out the socioeconomic analysis, it was necessary to evaluate the location of each permit/bank in relation to the study area boundaries. Through this process, it was recognized that three removal-fill permits were mitigated outside of the four-county area. None of the three permits were within one mile of a county boundary; therefore all three were excluded from the analysis of socioeconomic characteristics.

Additionally, census block group data was only extracted from areas inside the four-county area. One limitation of using this approach was that four removal permits were less than one mile from the outer boundary of the four-county study area – three which were mitigated at Mud Slough (0.69 mi (1.11 km), 0.13 mi (0.21 km) and 0.87 mi (1.4 km) from boundary) and one that was mitigated at Oak Creek (0.54 mi (0.87 km) from boundary). Data for block groups within one mile of each site, but outside of the four-county study area was not included in the analysis. While the census data used to describe each site may not be fully representative of the site-area, the intersected block group area consisted of more than 75 percent of the total buffered site-area. Thus, the average census block group value calculated at each site is likely representative of most of the people that live around each permit site.

The social characteristics of the area around each permit and bank site were described with census block group level data. The data collected included median household income, percent of total population that is white and percent of the total population that is considered urban.

Using the census' TIGER database, block group shape files for each county were mapped and the socioeconomic data tables from Summary File 3 of the 2000 census were joined to each block group shape file. Thereafter, using GIS each mitigation bank and removal-fill permit point was buffered at a distance of one mile (1.609 km). Next, each buffered removal-fill permit and each bank site was intersected with all block groups which touched the buffered area. The product of this analysis was a database which included records for all census block groups within one mile of each permit site and each bank. For both banks and permits, this data was summarized with descriptive statistics.

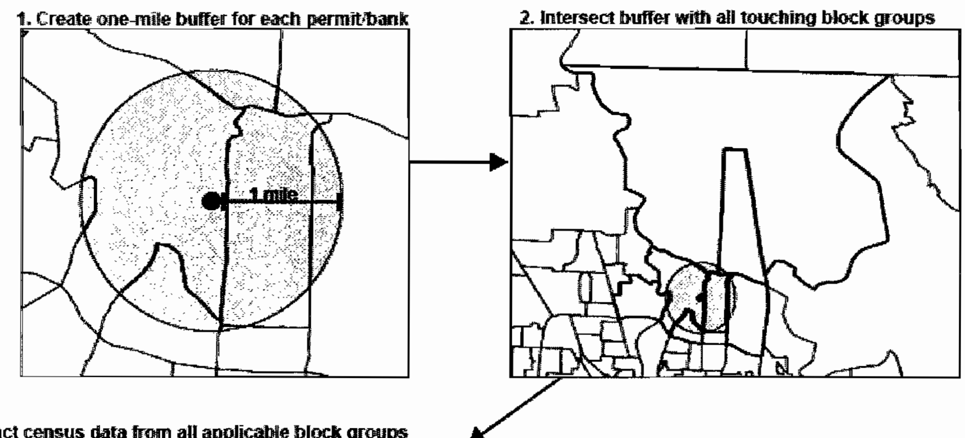
To both summarize and analyze the census block group data, it was necessary to derive averages for both permits and banks. For permits, a two-step process was required. First, census block group data was averaged for each individual permit. Second, for each mitigation bank, an average of all applicable permits was calculated. Thus, the resulting table of permit census data was organized by the mitigation bank used and it represented an average of all census block groups proximal to each of the bank's permits.

For mitigation banks, it was only necessary to derive an average value from block groups within one mile of each bank. These values were then comparable to the average census values of all permits mitigated at each respective bank. Figure 10 illustrates the process used to collect and summarize this data.

For socioeconomic comparisons to be made to the larger area in which wetland mitigation banking has been designated to operate, census data was also collected for each mitigation bank service district. An average of values from all block groups within each service district and within each county was calculated and the information derived was used to make comparisons to data from removal-fill and mitigation bank sites. Finally, to determine if statistically significant differences existed the range of permit values was compared to banks values using a two-sample t-test.

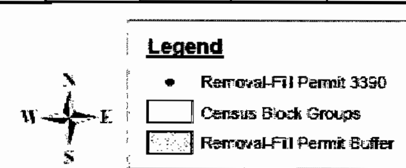
Figure 10: Illustration of Data Collection Process

Explanation of Census Data Extraction



3. Extract census data from all applicable block groups

Mit Proj N	Latitude	Longitude	Credits Sold	Bank Used	Buff Dist	blockgrp	Pop SQ MI	Total Pop	Total Urban	Total Rural	Total White	Med Income
M0003390	44.59	-123.26	3.00	Mid-Valley	5280.01	33	5552.37	1247.00	1247.00	0.00	993.00	34063.00
M0003390	44.59	-123.26	3.00	Mid-Valley	5280.01	34	5082.36	1395.00	1395.00	0.00	1154.00	12915.00
M0003390	44.59	-123.26	3.00	Mid-Valley	5280.01	35	7370.30	1387.00	1387.00	0.00	1196.00	32917.00
M0003390	44.59	-123.26	3.00	Mid-Valley	5280.01	36	5300.94	967.00	967.00	0.00	788.00	33911.00
M0003390	44.59	-123.26	3.00	Mid-Valley	5280.01	37	5915.24	1341.00	1341.00	0.00	1231.00	36359.00
M0003390	44.59	-123.26	3.00	Mid-Valley	5280.01	39	3389.09	765.00	765.00	0.00	775.00	45278.00
M0003390	44.59	-123.26	3.00	Mid-Valley	5280.01	40	11204.71	839.00	839.00	0.00	669.00	12544.00



Analysis of Population Density

Using census block group shape files and data from Summary File 3, population density was calculated for each block group. First, using ArcGIS, the total area of each block group was calculated in square miles. The "total population" field from Summary File 3 was then divided by the block group area. A population density record was then created for each block group. Again, a one mile (1.609 km) buffer around each permit and bank was used. Thereafter, the same process used to assemble socioeconomic data was applied.

Analysis of Wetland Scarcity

Scarcity is an important determinant of a resource's value (Perman 1999; Freeman 2003). To determine if differences in scarcity existed between permit and bank sites, the total wetlands acres completely within one mile of each permit/bank was calculated.

Again, a one mile (1.609 km) buffer around each permit and banks was used. Each buffered area was then intersected with all wetlands in the area, as identified by the National Wetland Inventory (NWI). The sum of all wetlands contained within each buffered area was then calculated and a record of this information was added to each respective permit and bank. For permits, an average of the total area of wetlands within each one mile area was calculated and summarized by the mitigation bank used. This average permit value was then compared to the total acres of wetlands within one mile of each respective bank. Finally, a two-sample t-test was performed to determine if, on average, wetland densities around mitigation banks differed from removal-fill permit sites.

Limitations of the Analysis

Overview

The analysis approach employed in this study was effectively designed to provide large-scale comparative descriptions of the spatial, social and environmental characteristics at wetland mitigation banking sites and removal-fill permit sites within the study area. Results are intended to inform regional planning and policy making decisions and should. Therefore, it should be noted that the purpose of this study was to identify differences between permit and bank sites within each mitigation bank's market area, i.e., the service district.

The scale of the analysis was adequate to show significant differences between mitigation banks and permit sites; however, because service districts served as the unit of analysis, results can only be inferred to be representative of wetland mitigation banking at the service-district scale. Further, the analysis is bound by the scale of the NWI and census data used. In recognition of this, data was collected at the smallest available scale. Even so, the scale of the available socioeconomic and wetland data was a fundamental limiting factor. While smaller-scale data were available for portions of the study area, it was necessary to use data which was consistent across the entire study area.

The analysis was also confined by the available wetland mitigation banking data. The unit of analysis – mitigation service districts, or more generally, banks – required the characteristics of many removal-fill permits (n 233) to be compared to a limited number of mitigation banks (n 8). While this is not inherently problematic, to make such a comparison, an average of all permit data had to be averaged for each mitigation bank. In general, the average-of-the-average permit values are being compared to average bank values. Through this analytic process it is likely that some variability within the permit data was lost. To account for this variability, descriptive statistics for both banks and permits were computed for each type of analysis. Additionally, the two-sample t-tests employed in this study are designed to measure differences in average values. Results from this statistical test provide additional support for the observations which can be made empirically.

Variances from Study Area Boundaries

The selected study area follows county jurisdictional boundaries. County boundaries were used in part because Department of State Lands' staff was only able to collect removal-fill permit data at the county level. This was not a major problem because the mitigation service districts included in the four-county area primarily followed county boundaries. One exception was the Mud Slough service district (Mud Slough) which extended beyond the four-county study area. Removal-fill permits located inside of the Mud Slough Service District, but outside of the four-county area, were omitted from the analysis. Thus, it is possible that sample used is not fully representative of all permits that have been mitigated at the Mud Slough Mitigation Bank. Nonetheless, all of the removal-fill permits approved in Polk County (n, 16) were mitigated at the Mud

Slough bank and so it was necessary to include Mud Slough permit data in the sample.

Socioeconomic Analysis: Problems with Relying on Census Data

Socioeconomic data from Summary File 3 of Census 2000 was the only reliable and mappable data source available at a desirable and consistent scale. One limitation of using the Census 2000 dataset was that it represents a measurement of the population at a static point in time, while wetland removal-fill permits were approved over an extended period of time. More specifically, the census dataset is valid for the population in 2000, while the removal-fill permit data was valid for permits approved from 1982 through October of 2008. Thus, the socioeconomic data used to describe areas around permits/banks approved either before or after 2000 may not precisely describe the population affected by the permit at the time that the permit was approved. However, one could argue that the gain or loss of a wetland affects future populations around each site, thus it would be prudent to use the most up-to-date population data available.

Using this logic and assuming that most areas within the study area experienced population growth between 2000 and 2008, it is probable that measures of population density and urban population were underestimated for removal-fill sites inside or near Urban Growth Boundaries (UGB's). Nonetheless, because the purpose of this portion of the study was to *compare* the socioeconomic characteristics around removal-fill sites to wetland mitigation bank sites, the temporal socioeconomic differences described do not jeopardize the reliability of the results from the socioeconomic analysis carried-out.

The socioeconomic analysis was also restrained by the scale of available data.

Block group data was used because it is the smallest scale at which census data from Summary File 3 is available. Because block group size varies greatly depending on the size of the population living within the area, rural areas had much larger block groups. Thus, population data was not necessarily taken from areas of comparable size (see Figure 10 for an illustration of this issue). While it would have been optimal to extract socioeconomic data from only within each one-mile permit/bank buffer, no such small-scale socioeconomic data was available. Further, because this was mostly a comparative analysis, and because the same method of analysis was used at both bank and permit sites, any data inaccuracies should be consistent for both permits and banks alike; thus the methods employed do not jeopardize the results of the socioeconomic analysis.

While it may have been possible to only extract census data from block groups mostly covered by each buffered area, to account for a permit or bank's proximity to urban-rural transitional areas, it was important to include all block groups with boundaries within one mile of each permit/bank site. Alternatively permit/bank buffers could have been intersected only with census block groups which had their centroid within the each buffer. However, if this technique had been used, some buffers would not have intersected with any block groups. Thus, given the census datasets utilized, the applied method was the best available.

Analysis of Wetland Density: Problems with Using the National Wetland Inventory

The scale of the data used to perform the wetland density analysis served as a major limiting factor. In fact, after performing the analysis and observing major gaps in the data, it should be noted that results from this portion of the study may exhibit considerable inaccuracies.

Previous research on wetlands in Oregon has shown that, due to the scale at which the National Wetland Inventory (NWI) was completed, the NWI neglects to account for many small and seasonal wetlands in the area (Kentula et al. 1992). From the mapped removal-fill permit sites it was apparent that permits had been approved at locations which were not identified as wetlands by the NWI. The Oregon Department of State Lands (DSL) explained this discrepancy as "expected" because, in rural and agricultural areas the NWI often neglects water bodies smaller than two acres (Field 2008). Further, as a matter of policy, agricultural areas were largely un-inventoried within the Willamette Valley. At the same time, if a development application is submitted for a rural or agricultural property where wetlands are likely to occur, the State of Oregon can require a private wetland delineation to be carried out. This means that removal-fill permit sites may not always be identified as wetlands by the NWI. As a result, in rural and agricultural areas, the abundance of wetlands may be underestimated by the NWI. Therefore, the resulting wetland density calculations for rural permits and banks may have been underestimated.

While wetlands may have been underestimated in rural areas, in cities that have an approved Local Wetland Inventory (LWI) (See Appendix E for list of cities within the study area that have LWI's), wetland density may have been overestimated. Inside of UGB's, LWI's provide cities and developers with a more comprehensive and reliable source of delineated wetlands than is available through the NWI. LWI's are carried out at a smaller scale than the NWI and therefore LWI's account for small wetlands which might not otherwise be identified through the NWI. As a result, cities which have LWI's may have a greater number of inventoried-wetlands. Additionally, through the identification of pre-approved mitigation opportunities, LWI's can provide increased flexibility and transparency for development proposals affecting identified and classified wetlands. This too could have increased the number of observed permits filed within cities that have LWI's.

The presence of LWI's may also be indicative of greater wetland protection in select urban areas. This could have also led to a disproportionate number of urban-permit observations.

While LWI's may have affected the number of removal-fill permits within cities that had LWI's, to ensure that wetland data was consistent throughout the study area, LWI's were not used because; individual LWI's were completed at different scales and thus were not comparable; rural-urban comparisons could not be made because LWI's were only available for urban areas; and, LWI GIS data was not available. Thus, the NWI was the best data source available to compare the wetland densities of both rural and urban areas. Despite the aforementioned limitations of relying on the NWI for wetland density evaluations, it is assumed that the NWI was sufficient to identify general differences in wetland density.

CHAPTER V

RESULTS

Overview

Results from this study indicate that there are numerous statically significant differences between removal-fill permit sites and wetland mitigation banks. Results show that: wetlands are mitigated an average of 10.3 miles (16.56 km) from the site of fill; most wetlands have been lost in or near areas of urban growth, but have been mitigated at least one mile away from areas of designated urban growth; population densities near removal-fill sites are greater than near wetland mitigation banks; people living near wetlands mitigation banks have a higher median household income than people living near of removal-fill sites; wetland density near wetland mitigation banks is lower than it is near removal-fill sites. Results also indicate that the percentage of minorities living near removal-fill sites is not significantly different from populations living near mitigation banks. The following is an explanation of each these key findings.

The Extent of Wetland Displacement

To determine the average distance of displacement between sites of wetland fill and sites of wetland gain, the straight-line, or "near distance" between each removal-fill permit site and each respective site of mitigation was calculated. Results from this calculation indicate that wetlands within the four-county study area have been mitigated an average of 10.3 miles (16.56 km) from the site at which they are filled (see Table 4 and Table 5). The average distance of wetland displacement described within the study area was significantly less than what has been identified for wetland mitigation banks in Florida (17 mi) (Ruhl and Salzman 2006) and Chicago (16 mi) (BenDor and Brozović 2007; Robertson and Hayden 2008).

Table 4: Average Distance between Removal-Fill Permits and Mitigation Banks

Bank Name	**Distance From Bank (MI)**	**Distance From Bank (FT)**
Amazon Creek	11.22	59,258
Evergreen	15.17	80,099
Frazier Creek	6.79	35,835
Mid-Valley	12.64	66,765
Mud Slough	7.85	41,434
Oak Creek	13.18	69,573
One Horse	7.55	39,859
West Eugene	7.96	42,055
Grand Total	**10.30**	**52,737**

Table 5: Descriptive Statistics for Distance between Removal-Fill Sites and Each Corresponding Mitigation Site

Measure	Amazon Creek	Evergreen	Frazier Creek	Mid-Valley	Mud-Slough	Oak Creek	One Horse	West Eugene	Average of All
Mean	11.22	15.17	6.79	12.64	7.85	13.18	7.55	7.96	10.30
Standard Error	1.01	1.93	1.13	1.60	1.08	1.20	1.58	1.37	1.36
Median	10.26	14.27	6.57	11.62	7.19	12.68	3.98	5.84	9.05
Mode	9.45	17.69	6.57	17.50	7.69	1.27	3.98	0.93	8.13
Standard Deviation	7.52	5.09	4.51	7.66	4.85	6.67	6.14	11.16	6.70
Sample Variance	56.52	25.94	20.38	58.73	23.54	44.50	37.65	124.49	48.97
Kurtosis	11.66	1.04	7.55	0.17	10.67	-0.40	-0.11	20.19	6.35
Skewness	2.48	-0.19	2.14	0.76	2.86	-0.38	1.13	4.10	1.61
Range	49.62	16.43	21.28	29.43	24.97	25.29	18.68	73.14	32.36
Minimum	0.02	6.66	0.00	2.87	0.88	0.19	2.61	0.82	1.76
Maximum	49.64	23.08	21.28	32.30	25.86	25.49	21.29	73.96	34.11
Sum	617.27	106.19	108.59	290.83	156.95	408.47	113.24	525.69	290.90
Count	55.00	7.00	16.00	23.00	20.00	31.00	15.00	66.00	29.13
95.0% C.I.	2.03	4.71	2.41	3.31	2.27	2.45	3.40	2.74	2.92

Proximity of Banks and Permits to Urban Growth Boundaries

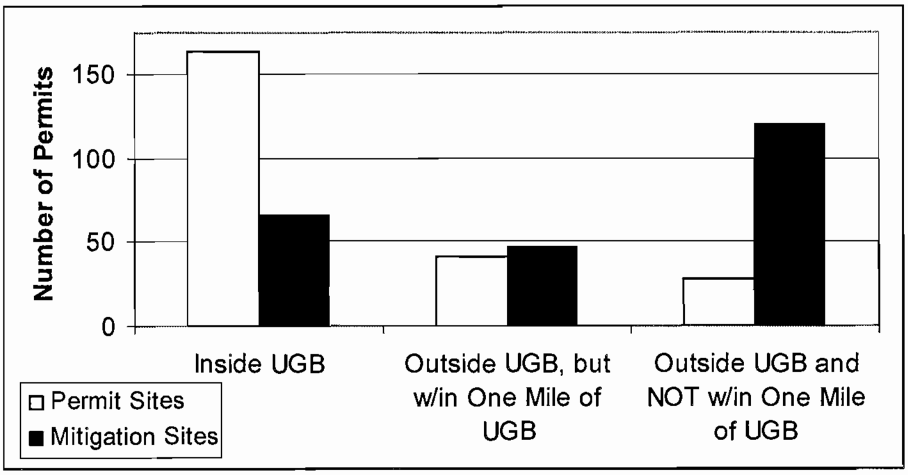
In addition to calculating the distance between removal-fill permits and mitigation banks, removal-fill permit sites were categorized based on their proximal distance from the nearest Urban Growth Boundary (UGB). Locations of removal-fill permit sites were then compared to their respective sites of mitigation. Table 6 and Figure 11 provide summaries of differences in the proximal location of permits and mitigation sites in relation to UGB's (a tabular comparison of permit and mitigation location, organized by mitigation bank can be found in Appendix F).

Most removal-fill permits (n 165; 70 percent) have been approved at locations inside of UGB's, while the majority of permit-mitigation has occurred outside of UGB's (167; 72 percent). Additionally, there were slightly more permits mitigated within one-mile of a UGB (47; 20 percent) than were approved within one mile of a UGB (41; 18 percent).

Table 6: Comparison of Location between Removal-Fill and Mitigation Sites

Location	Removal-Fill Site	Mitigation Site
Inside UGB	164	66
Outside UGB, but w/in One Mile of UGB	41	47
Outside UGB and NOT w/in One Mile of UGB	28	120
Total Permits	233	233

Figure 11: Comparison of Location of Removal-Fill Permit and Mitigation Sites



Comparison of Socioeconomic Characteristics & Population Density

Census data from all block groups which touched a one-mile buffer around each permit and bank site was collected to determine if any socioeconomic differences existed between sites of wetland loss and sites of wetland gain. Results indicate that there statistically significant socioeconomic differences exist between the locations where wetlands have been filled and the locations where wetlands have been created.

Table 7 shows that the median income of households residing in the area of mitigation banks is, on average, $6,793 greater than households living near removal-fill sites (p = .0300). Both banks and permits have been located in areas where median household incomes were $9,355 (p = .0142) and $2,562 (p = .0589), respectively, greater than incomes within mitigation service districts.

Table 7: Average Median Household Income near Permits, Banks and within each Service District

Mitigation Bank	Mitigation Bank*	Removal-Fill Permits**	Service District***
Amazon Creek	$40,781	$42,706	$39,458
Evergreen	$59,884	$48,440	$40,174
Frazier Creek	$50,877	$48,490	$41,832
Mid-Valley	$65,929	$43,754	$42,440
Mud Slough	$57,902	$42,562	$40,971
Oak Creek	$42,061	$42,627	$41,595
One Horse	$38,377	$35,094	$40,277
West Eugene	$45,230	$43,020	$39,452
Average of Totals	**$50,130**	**$43,337**	**$40,775**

*Average values of all block groups within one-mile of each individual bank
**Average values of all block groups within one-mile of each permit, averaged by the mitigation bank used
***Average of all block groups within each mitigation bank's service district area

Overall, the density of populations living near removal-fill sites is much higher than near it is near mitigation banks. On average, the population density near removal-fill sites is 1,060 people per square mile greater than it is near mitigation banks (p = .0038).

From the findings of this study, it is important to note that the one mitigation bank with a population density that is greater than that of its respective permits, West Eugene, is located inside the City of Eugene's UGB. Also take note of the fact that both banks and permits have been located in areas which have population densities that are 2,280 (p = .0015) and 1,148 (p = .0001), respectively, less than their particular districts. This means that, within the areas that wetland mitigation banking is permitted, most wetland mitigation banking activity has occurred outside of core populated areas.

Table 8: Average Population Density per Square Mile near Permits, Banks and within each Service District

Mitigation Bank	Mitigation Bank*	Removal-Fill Permits**	Service District***
Amazon Creek	51	1,744	3,579
Evergreen	39	1,262	3,321
Frazier Creek	1,186	2,036	3,263
Mid-Valley	92	1,436	2,664
Mud Slough	20	1,626	2,087
Oak Creek	1,016	1,925	2,924
One Horse	440	2,079	1,907
West Eugene	2,867	2,086	3,631
Average of Totals	**714**	**1,774**	**2,922**

*Average values of all block groups within one-mile of each individual bank
**Average values of all block groups within one-mile of each permit, averaged by the mitigation bank used
***Average of all block groups within each mitigation bank's service district area

Populations near wetland removal-fill sites are significantly more urban than populations living near wetland mitigation banks (see Table 9). On average, only 38.7 percent of people living near mitigation banks were considered urban, while 70.4 percent of people living near removal-fill sites were urban, a difference of 31.7 percent (p = .0161).

The percent of urban people living near permit sites was not significantly different than the percent living within each respective mitigation service district (p = .1410). At the same time, urban populations near banks made up 36 percent less of the total population than was observed in their individual service districts (p = .0150).

It is important to note that population densities around both West Eugene and Frazier Creek mitigation banks had population densities which were greater than their respective permits. This is because both banks were developed on the urban-rural fringe, within one-mile of census block groups with urban characteristics. Socioeconomic descriptive statistics of permits and banks can be found in Appendix G.

Also notice that the percentage of urban people living near a number of banks (Amazon Creek, Evergreen and Mud Slough) is equal to zero. This skews the bank average. However, even if the zeroes are omitted from the calculation, the overall percentage of population is still significantly less than it is for both permits and service districts (61.9 percent).

Table 9: Average Percent of Total Population that is Urban near Permits, Banks and within each Service District

Mitigation Bank	**Mitigation Bank***	**Removal-Fill Permits****	**Service District*****
Amazon Creek	0.0	66.4	83.1
Evergreen	0.0	64.1	76.3
Frazier Creek	91.5	78.7	76.1
Mid-Valley	25.7	55.7	68.3
Mud Slough	0.0	72.7	73.2
Oak Creek	63.3	71.9	74.0
One Horse	49.6	81.5	64.8
West Eugene	79.3	72.3	83.4
Average of Totals	**38.7**	**70.4**	**74.9**

*Average values of all block groups within one-mile of each individual bank
**Average values of all block groups within one-mile of each permit, averaged by the mitigation bank used
***Average of all block groups within each mitigation bank's service district area

Because it was assumed that larger proportions of non-white populations live in urban areas, the affects of mitigation banking on urban populations were expected to correspond with impacts on non-white populations. While some differences existed between the percentage of non-white populations living near permits and banks ($p = .0867$) and between permit sites and service districts ($p = .0927$), the differences were minor (see Table 10). At the same time, the difference in the ethnic composition of populations living near mitigation banks was quite different ($p = .0146$) than that of the service districts. The ethnic composition of populations near wetland mitigation banks (i.e. areas of wetland gain) are 2.3 percent more white than areas within the bank's service district.

Table 10: Average Percent of Total Population that is White near Permits, Banks and within each Service District

Mitigation Bank	Mitigation Bank*	Removal-Fill Permits**	Service District***
Amazon Creek	91.2	91.1	90.1
Evergreen	96.5	92.9	90.4
Frazier Creek	90.0	91.5	89.7
Mid-Valley	92.8	92.8	91.3
Mud Slough	94.2	87.2	89.3
Oak Creek	94.6	92.1	91.1
One Horse	95.5	93.0	93.4
West Eugene	89.1	90.6	90.0
Average of Totals	**93.0**	**91.4**	**90.7**

*Average values of all block groups within one-mile of each individual bank
**Average values of all block groups within one-mile of each permit, averaged by the mitigation bank used
***Average of all block groups within each mitigation bank's service district area

Table 11: Two-Sample T-Test of Socioeconomic Characteristics

Measure	Banks & Permits	Permits & Service Districts	Banks & Service Districts
Median Houshold Income	0.0300	0.0589	0.0142
Population Density	0.0038	0.0015	0.0001
Percent Population White	0.0867	0.0927	0.0146
Percent Population Urban	0.0161	0.1410	0.0150

Wetland Density

To evaluate potential differences in wetland density at removal-fill permit sites and mitigation banks, the sum of all wetland acres located completely within a one mile buffer of permits and banks was calculated. Contrary to the hypothesis, results indicate that, on average, there are 3.64 ($p = .0234$) more acres of wetlands within one mile of removal-fill permits than within the same distance of mitigation banks (see Table 12).

Table 12: Average of Total Acres of Wetland within One Mile of Permits and Banks

Bank Name	Permits	Banks
Amazon Creek	10.09	2.12
Evergreen	5.66	5.23
Frazier Creek	7.29	5.45
Mid-Valley	8.49	5.23
Mud Slough	5.45	2.53
Oak Creek	4.26	5.24
One Horse	15.13	3.15
West Eugene	13.66	11.98
Average	8.75	5.11

CHAPTER VI

DISCUSSION

Overview

Results from this study show that wetlands are mitigated an average of 10.3 miles from the site of loss. This spatial displacement led to significant social differences between sites of wetland loss and gain. Results suggest that on average, populations living near wetland mitigation banks have greater household incomes (difference of $6,793), are less dense (difference of 1,060 people per square mile) and are less urban (difference of 36 percent) than populations living near removal-fill permit sites (see Table 13). In general, lower-income urban populations incur most wetland losses while higher-income rural populations receive the most wetland gains.

Table 13: Summary of Socioeconomic and Wetland Comparisons between Permit and Bank Sites

Measure (Averages)	Banks	Permits	p value
Pop. Per Square Mile	714	1,774	0.003
Percent of Pop. White	93%	91%	0.086
Percent of Pop. Urban	39%	70%	0.016
Median Household Income	$50,130	$43,337	0.029
Acres of Wetlands	8.75 ac.	5.71 ac.	0.023

Mitigation Banking and Wetland Displacement

Results from this study indicate that, on average, wetland mitigation banks are located an average of 10.3 miles from the site of wetland fill-sites. While this distance of wetland displacement is by no means trivial, it is considerably less than what has been depicted for the Chicago area, where wetlands have been mitigated more than 16 miles from the sites of fill (BenDor and Brozović 2007; Robertson and Hayden 2008) and in Florida, where the average distance was over 17 miles (Ruhl and Salzman 2006). There are a number of possible explanations as to why the distances between permit and bank sites were less in Oregon than in other states.

According to King and Bohlen (1994), the distance of wetland displacement can be explained as a function of the scale of economic costs associated with the mitigation of a given unit of wetlands. In general, King and Bohlen have argued that because the costs associated with developing a wetland mitigation bank are higher in areas where actual or prospective development is prevalent, banks tend to locate some distance away from areas the areas where wetland removal-fill permits are common – areas with reasonable development pressure. By comparing the location of removal-fill permits to the location of mitigation banks, King (1997) demonstrated that in Florida "wetland permits are being requested in areas where people want to live and mitigation banks are being sited where land is relatively inexpensive…" Following this logic, it is possible that wetland displacement distances are lower in Oregon as a result of the state's urban containment policies (e.g. the presence of UGB's). Oregon's UGB's have reduced rural property values by limiting speculation of rural land of land outside of UGB's (Arthur

1992; Knapp and Nelson 1988). Thus, in Oregon, it should be more economically feasible to site a wetland mitigation bank near an area of designated growth than in states with less rigorous growth containment policies. This assumes that land value is an integral part of a banker's site selection decision making process – an assumption backed by a survey of mitigation bank managers which showed that site selection is in fact the most important aspect of developing a successful mitigation bank (Kaplowitz and Lupi 2008). Future research could explore land values as potential casual factors of wetland displacement.

For bankers, the bank site selection process is a matter of economic success or failure; for the remainder of the population site selection redefines the level of wetland-services provided by wetlands to people living in a given area. The use of mitigation banks essentially guarantees that some populations will benefit at the expense of others, as the presence of a bank facilitates the migration of wetlands from many locations to one selected location. While regional biophysical improvements may be made, the loss of localized cultural benefits is inevitable. Put differently, the regional planning approach employed through mitigation banking system fails to capture the "many wetland benefits (that) can only be appreciated while in close proximity to the wetland itself…such as local flood protection, provision of recreational opportunities and open space amenities" (National Research Council 2001; Environmental Law Institute 2002; W. J. Mitsch and Gooselink 2000).

To ensure that such cultural values are maintained, mitigation banking should only be used when on-site wetland preservation is impractical. Oregon's Removal-Fill

Law (ORS 196.800 - 196.990) states a preference for on-site or in-kind mitigation; however, mitigation banking has been used at an increasing rate, with new banks being developed each year. The problem however is not so much that wetland mitigation banking is being used, but rather that banks have located in areas which are not socially comparable to the areas where removal-fill permits are most commonly approved. In the future, mitigation banks should be strategically sited to ensure that wetlands can be mitigated in or near urban areas.

Wetland Mitigation Banking and the Distribution of 'Wealth'

While little comparable research has focused on wetland mitigation banking, there is a substantial body of research which has focused on the valuation of wetlands. Unfortunately however, "...socio-economic variables, such as income and population density, are often omitted from such (valuation) analyses (even though they) are important in explaining wetland value" (Brander, Florax, and Vermaat 2006). To fill this gap in the literature, Brander, Florax, and Vermaat (2006) performed a meta-analysis of wetland valuation studies and incorporated income and population density values. Their results suggest there is a significant positive relationship between income and wetland value, where a 10 percent increase in per capita income resulted in a 12 percent increase in wetland value. Others have shown that people who with higher incomes are willing to pay more for the restoration of wetlands than people with lower incomes (Milon and Scrogin 2006).

If these results are extrapolated to the wetlands analyzed in this study, it could be surmised that mitigation banks have been developed in areas where the overall economic value of wetlands is higher. However, there are two major problems with accepting such a determination. First, many other factors which affect the value of benefits that a wetland provides must also be accounted for. And second, to take natural resources from lower-income populations in order produce higher valued resources in areas where higher-income populations live through a market-based regulatory system could be construed as a form of environmental racism, or simply as unjust policy.

Discrepancy in income-levels of populations affected by wetland mitigation banking alludes to the inevitable social inequalities associated with reliance upon market-based environmental regulatory systems. Such injustice has frequently been described as the general downfall of neoliberal market-based environmental regulation (Heynen 2007; Himley 2008; Robertson 2004). In general, critics of market-based regulation argue that while markets may improve the efficiency of environmental protection, they simultaneously lead to spatial, temporal or social inequalities in the distribution of resources. Results from this study support this critique by showing that populations impacted by wetland losses, tend to have lower-incomes than populations living near areas of wetland gain.

Since time was not controlled for in this study, it should be mentioned that differences in income levels could be an effect of the presence or absence of a wetland. In other words, people with higher incomes may either choose or have the means to live near wetlands, while people with lower incomes do not. For if it is true that the presence of wetlands indeed inflates home values (Mahan, S. Polasky, and Adams 2000; Doss and Taff 1996), such an effect might be expected.

The Urban-to-Rural Migration of Wetlands

Because most services that wetlands provide to people are supplied through direct or indirect human use (Costanza, Farber, and Maxwell 1989), it was assumed that population density could serve as an indicator of the overall value of services a given area of wetland provides (as affirmed by Brander, Florax, and Vermaat 2006). This approach is supported by economic theory, as resources for which there is a greater demand tend to have greater value (assuming a constant supply). Even so, the market value of a wetland mitigation credit does not reflect differences in such population-based demand. Instead, to compete with other mitigation bankers, bankers must develop mitigation banks at the lowest possible cost. Considering that bank site selection is the single most important factor in developing a successful bank (Kaplowitz and Lupi 2008), it would be economically sensible to locate where land is generally less expensive – typically in less densely populated areas. Results from this study and others (King 1997; Ruhl and Salzman 2006) suggest this to be true.

Of the sites examined, 70.4 percent of populations living near removal-fill permits were urban while only 38.7 percent of people living near banks were urban. These findings are in line with analysis of population density where the average removal-fill permit was located in an area that had 934 more people per square mile than its associated bank.

Meanwhile, the population density of each service district was greater than both the permit and bank sites. These results suggest that both permits and banks tend to be located outside of the most densely populated areas. There are a couple of possible explanations for this. First, most densely populated areas have already been developed and thus there are few remaining wetlands which haven't already been retained and protected; and/or, most development is occurring on peripheries of the already-populated areas.

Irrespective of the cause of differences in population density, the information gathered clearly illustrates that potentially problematic social differences exist between sites of wetland gain and sites of fill. Most notably, few are benefiting at the expense of many. If one assumes that each person receives an equal level of services from wetlands, the shift of wetlands from areas of high to low population density could point toward a net-loss of wetland services. Many have actually argued that the value of ecosystem services provided by wetlands to a person living in an urban area is actually greater than for someone living in a rural area (King 1997; Bolund and Hunhammar 1999; Manuel 2003; Brander, Florax, and Vermaat 2006). Table 14 shows that while the extent of services provided by a given acre of wetland does not always increase as population density increases, the overall value of services provided does. In other words, as more people rely on the services provided by of a wetland, the overall value or social importance of that wetland increases.

Moreover, a handful of studies have clearly demonstrated that home values increase as their distance from wetlands decreases (Mahan, Polasky, and Adams 2000;

Doss and Taff 1996). Using this information, it seems that by allowing wetlands to be filled in urban areas and mitigated in places where less people live, regulators are doing a disservice to the majority of the population.

It must be noted that values associated with specific services such as habitat for environmentally sensitive species, or for recreational activities like hunting, may decrease or be non-existent in highly populated areas. For this reason, the Oregon Department of State Lands encourages mitigation banks to be developed "away from high intensity land uses." While this policy may benefit select interests, overall wetland value can be maximized by distributed banks spatially "across a landscape that is not dominated either by cities or agriculture, but one that balances nature and human enterprises" (William J. Mitsch and Gosselink 2000).

Table 14: Effects of Population Density on Wetland Services and Values (from King 1997)

Wetland Functions	Typical Related Services	Will Greater SERVICE Result from Greater Nearby Population Density?	Will Greater VALUE Result from Greater Nearby Population Density?
Fish Habitat	Recreational/Commercial Fishing	No	Yes
Waterfowl Habitat	Hunting, Birdwatching	No	Yes
Fur-bearer Habitat	Hunting, Wildlife Viewing	No	Yes
Vegetation	Extractive Industries	No	Yes
Pollution Assimilation	Water Quality, Habitat Protection	Yes	Yes
Storm-water/ Runoff Retention	Flood Prevention, Habitat Protection	Yes	Yes
Floodwater Storage	Property Damage Avoidance	Yes	Yes
Sediment/Nutrient Trapping	Water Quality, Habitat Protection	Site Dependent	Site Dependent
Storm Surge/ Wave Protection	Property/Shoreline Damage Avoidance	Yes	Yes
Groundwater Recharge/Discharge	Drinking Water Quality	No	Yes
Natural Area/Open Space	Recreation, Education, Aesthetic Enrichment	Yes	Yes
Climate Control	General	No	No
Biodiversity Support	General	No	No

Wetland Density

To determine how wetlands have been distributed across the landscape as a result of the Oregon mitigation banking system, the density of wetlands near removal-fill sites was compared to the density of wetlands near mitigation banks. Contrary to what was expected, areas of wetland-fill had higher wetland densities than areas of wetland gain. Assuming that the wetland inventory data used was accurate (for discussion on potential data limitations see section on "Analysis Limitations"), there are a number of possible explanations for the observed differences in wetland density. The most likely explanation is that mitigation banks have concentrated in rural agricultural areas – a land use which has been ascribed with causing 70 percent of the overall wetland loss in the Willamette Valley (Wilson 1998).

Regardless of why the areas around mitigation banks tend to a lower density of wetlands than permit sites, this finding is important because through the analysis of wetland density the local resources available in each respective area were quantified. This was used as a measure of resource scarcity. Using the market-based approach and disregarding measures of wetland quality, it can be assumed that an acre of wetland in a resource-rich area is less valuable than a commensurable acre of wetland in an area that is resource-scarce. Following this logic, findings suggest that when analyzed in terms of available resources, mitigation banks have been created in more resource-scarce, higher value areas than their respective removal-fill sites.

CHAPTER VII

POLICY IMPLICATIONS & TOPICS OF FUTURE RESEARCH

As wetland mitigation banking continues to evolve, it will receive increasing attention as it remains one of the few fully functioning market-based environmental regulatory systems in the United States. It is often argued that such market-based regulations are necessary as they attach 'tangible' monetary values to non-market resources. Further, supporters argue that nature should be valued for the ecosystem services it provides because without monetary value, the true costs associated with destruction of nature's services are not accounted for. While this may be true, results from this study and others demonstrate that, even with heavy government regulation, markets have failed to distribute resources in a socially or spatially equitable manner. Though balancing social and economic interests with the ecological integrity of a place may be like mixing water with oil, and while the two may never fully mix, mitigation banking systems must guarantee the equitable and sensible distribution of each. For this to occur, it is imperative that social and biophysical indicators be built into the economic system. Results from this study show that this has not occurred, and as a result, the balance has been tipped.

In Oregon, as in most other states, mitigation banking markets are spatially restricted by service districts. These market-districts are developed based on biophysical boundaries, most generally, watershed districts. The problem here is that service districts are often hundreds of square miles in size. Accordingly, consider the implications of the following scenario: a one acre wetland is filled in the 'backyard' of large urban neighborhood and is mitigated at a bank within the service district, located in the middle of a farmer's field, 15 miles from the site of fill. What wetland benefits/services have been lost and which have been gained? The benefits lost by the neighborhood of urbanites tend to be culturally-centered: open space, the sense of identity provided by that space, the backyard environmental schoolyard, the opportunity to observe urban wetland-loving wildlife, etc. And the benefits gained tend be biophysical: improved wildlife habitat, less human-induced ecological disturbance, greater vegetative diversity, etc. Of the mitigation banks analyzed in this study, all but one was located outside of an urban area, while 70 percent of wetland-loss sites were located within urban areas. Thus, it can be concluded that the use of service districts has caused the loss of social benefits in exchange for regionally-based biophysical enhancements.

Using this information, it could be argued that mitigation banking fails to achieve the goal of "no-net-loss" loss of wetlands, because some portion of the wetland's value is often lost. However, while the social losses of mitigation banking may be significant, supporters have shown that mitigation banking can produce more desirable environmental outcomes than the available alternatives. Thus, if mitigation banking policies were adjusted to consider the effects on people, the resulting policy could be environmentally, economically and socially beneficial. Results from this research show that, to date, wetland mitigation banks have been evaluated from economic and environmental standpoint. The social and cultural values that wetlands provide to people must be considered in the evaluation process.

Potential Policy Solutions

To ensure that people are not negatively affected by wetland mitigation banking, the spatial distribution of people across the landscape must integral to the mitigation decision making process. The following is a description of policies which could be implemented to ensure that this occurs. While it would be ideal for these policies to be implemented at the state-level, until that time arrives, local policies can be adopted. Note that any combination of these strategies could be used.

Develop Wetland Buffers within Urban Areas

Cities across the country are developing zoning ordinances which provide buffers around locally inventoried wetlands. The extent of each buffer depends on the quality and location of the wetland. This strategy helps prevent the loss urban wetlands, improves the ecological integrity of the wetland and prevents the urban encroachment on wetlands (Environmental Law Institute 2008). In Oregon, this strategy has been successfully implemented in Oregon City and in Eugene as part of the West Eugene Wetlands Plan. Cities with existing Local Wetland Inventories could adopt such a policy with relatively minimal associated expense (Appendix E for a list of cities with LWI's).

Require Mitigation to Occur Within Jurisdictional Boundaries

Local jurisdictions can adopt policies which require that mitigation occurs within the City Limits or UGB. A number of counties in the Chicago area required that all mitigation occur within their jurisdictional boundaries. As a result, the average distance of wetland displacement was significantly reduced (BenDor and Brozović 2007). This approach could also be used to discontinue the urban-rural migration of wetlands.

Provide for Public Input on Removal-Fill and Mitigation Bank Projects

The most recent EPA/USACE national guidelines on wetland mitigation (40 CFR 280, 2008) includes language which calls for increased public awareness and input on all wetland mitigation projects. In the future, this process could allow specific populations to engage in and affect the decision making process. Moreover, public input could introduce the deliberation of cultural non-market values into the wetland-fill permit review process. While it is unclear if state agencies have responded to the EPA's call for increased public participation, on the federal level, it has been acknowledged as important, which is a step in the right direction.

Additionally, over the last few years the state of Washington has organized and evaluated a wetland mitigation banking pilot program. The pilot evaluation included an extensive public review process through which many important concerns were addressed. For example, people expressed concern about a presumed urban-to-rural shift in wetland distribution (Washington Department of Ecology 2006). This suggests that public input on mitigation decisions could provide the oversight necessary to capture social values.

Develop City-Sponsored Mitigation Banks

Cities can locate areas of pre-existing wetlands or impaired wetlands within or around the city and develop their own wetland mitigation bank. The West Eugene Wetlands (WEW) Enhancement Bank in Eugene, Oregon is an outstanding example of a city-sponsored mitigation bank in which the city turned a development-constraint into a profitable, public natural asset. The WEW is located within the UGB of the City of Eugene and it provides exceptional recreational, educational and amenity values to residents – public opportunities which are not offered by other private banks in the area. Note that WEW was included within the study sample and was an outlier in comparison to other banks.

Topics for Future Research

While the policy recommendations described above could help to limit the spatial and social displacement of wetlands, our understanding of the general practice of mitigation banking remains limited. And, in order for future policies to achieve more desirable outcomes (i.e. to distribute resources in a more equitable fashion) the system causing the problem must be well-understood. Based on the research that is currently available little is known about the large-scale social and spatial impacts of mitigation banking systems. Thus, as mitigation banks continue to crop-up at an exponential rate, it seems imperative that the following questions first be answered: Have the effects of mitigation banking on people differed over time? To what extent do land values affect wetland displacement? Has public input had an impact on mitigation decisions? And, if so, in what ways?

During recent deliberations and congressional hearings on future mitigation banking policies, many of the questions posed above have been mentioned (United States Environmental Protection Agency 2008); however, the information needed to address each of these issues is lacking. In general, to craft policies which limit the future displacement of wetlands, the causes of displacement must be known. Throughout this paper, I have pointed towards land values as a possible cause for displacement. While the assumption made is backed by economic theory and there is some empirical evidence available to validate this point (see Bateman et al. 2002; Bourriaque 2008), the relationship between the social displacement of wetlands and the spatial economics of mitigation banking remains unstudied. If market-based environmental regulatory systems are to guarantee social equity, this relationship must be understood.

Additionally, assumptions were made throughout this paper about the substitution of ecosystem service benefits across space, also referred to as "fungibility." While some have argued that wetland values are not spatially replaceable, mitigation banking is based upon the notion that they can. Thus, some researchers suggest that mitigation banking cannot logically be used to 'compensate' for a loss of the local cultural benefits provided by a wetland. However, it could be argued that while certain types of cultural benefits may not be replaceable, others may be gained. For example, the loss of a small area of urban wetlands may result in the loss of a resident's opportunity to observe red-wing black birds, while a rurally mitigated wetland may provide new hunting opportunities to many of the same urban residents. Because it is quite difficult to evaluate the values associated with these two very different social services, research in this area is limited. Instead, researchers have used biophysical measurements as indicators of the level of services that a wetland provides. There is a great need for research which quantifies and differentiates services provided by wetlands in different spatial/social context. Such research could help to inform the use of spatially-weighted mitigation credit ratios which reflect the social and cultural services provided by each type of wetland.

APPENDIX A

DESCRIPTION OF ECOSYSTEM SERVICES THAT WETLANDS PROVIDE TO PEOPLE

Figure 12: Ecosystem Services Provided by or Derived from Wetlands (from Millennium Ecosystem Assessment 2005)

Services	Comments and Examples
Provisioning	
Food	production of fish, wild game, fruits, and grains
Fresh water[a]	storage and retention of water for domestic, industrial, and agricultural use
Fiber and fuel	production of logs, fuelwood, peat, fodder
Biochemical	extraction of medicines and other materials from biota
Genetic materials	genes for resistance to plant pathogens, ornamental species, and so on
Regulating	
Climate regulation	source of and sink for greenhouse gases; influence local and regional temperature, precipitation, and other climatic processes
Water regulation (hydrological flows)	groundwater recharge/discharge
Water purification and waste treatment	retention, recovery, and removal of excess nutrients and other pollutants
Erosion regulation	retention of soils and sediments
Natural hazard regulation	flood control, storm protection
Pollination	habitat for pollinators
Cultural	
Spiritual and inspirational	source of inspiration; many religions attach spiritual and religious values to aspects of wetland ecosystems
Recreational	opportunities for recreational activities
Aesthetic	many people find beauty or aesthetic value in aspects of wetland ecosystems
Educational	opportunities for formal and informal education and training
Supporting	
Soil formation	sediment retention and accumulation of organic matter
Nutrient cycling	storage, recycling, processing, and acquisition of nutrients

[a] While fresh water was treated as a provisioning service within the MA, it is also regarded as a regulating service by various sectors.

APPENDIX B

DESCRIPTION OF THE MITIGATION BANK DEVELOPMENT PROCESS

The following was taken from a document developed by Warner-Dickason's (2005) on behalf of the Oregon Department of State Lands and Army Corps of Engineers (COE) in response to a banker's request for clarification on the bank development process.

1. The Prospectus

- Initial review: Bank Sponsor meets with the COE and DSL to discuss site suitability and concept for a prospective bank. The sponsor receives a packet of information that includes any updates to existing guidance, an instrument template & checklist, delineation information, and ESA guidance, etc.
- The sponsor prepares a Prospectus that includes the bank goals, Market demand, and general restoration plan for the site. May also include rare species conservation, stream enhancement, and long-term stewardship plan.
- The prospectus is submitted to the COE and DSL for review and comment.
- The sponsor revises prospectus if necessary.

- The COE and DSL determine that the prospectus is adequate and agree that the bank is potentially viable and should go forward through review steps.
- The COE and DSL issue a 30 day **Public Notice** of "Intent to Create Mitigation Bank." Both agencies issue a public notice with same comment period date. Notice is published in statewide and local papers and posted on DSL/COE websites.

2. **Assembling the Mitigation Bank Review Team (MBRT)**

- Within 30 days of the public notice, a bank-specific MBRT is assembled.
- DSL and COE send a letter to prospective MBRT members inviting them to participate.
- The letter includes a copy of the prospectus with request for comment.
- The letter includes a site visit date. Site visit is scheduled to occur at least 30 prior to the next MBRT meeting
- Within 14 days of the site visit, MBRT submits written comments to the COE and DSL for sponsor consideration in preparing the instrument.
- COE and DSL review all comments from the Public Notice and MBRT and prepare a written review for the sponsor within 28 days of the site visit.
- Discussion of the prospectus and comments with sponsor at next MBRT meeting.

3. **Preparation of the Bank Instrument.**

- Sponsor prepares draft bank Instrument incorporating items discussed at the site visit, MBRT meeting, and review prepared by the COE and DSL.
- Sponsor submits a draft Instrument within 120 days of the MBRT meeting
- DSL and COE review the draft for completeness per state & federal rules & guidelines.
- MBRT provides written comments to COE and DSL on the draft Instrument within 30 days.
- At the next MBRT meeting, comments on the draft Instrument are discussed.
- COE and DSL provide written review of all comments to the sponsor within 14 days of the MBRT meeting.
- Subsequent drafts are prepared as necessary.
- Sponsor submits final Instrument and draft MOA within 45 days of the MBRT meeting.
- Instrument & MOA is reviewed for approval at next scheduled MBRT meeting. All legal documents – easement, financial assurances, & long term steward agreement – are readied to finalize.
- Instrument & MOA circulated for agency signatures.
- Sponsor secures any needed permits from DSL and the Corps before construction.

4. **MOA and Public Notice of approved Bank**

- Upon approval of the Instrument and MOA, Public Notice of Mitigation Bank Approval is initiated for 30 days.
- Bank begins construction according to the Instrument. Any construction prior to MOA is at the sponsor's risk.

5. Release of credits and monitoring

- As-builts showing completed construction are sent to the COE and DSL.
- MBRT reviews information for confirmation of first credit release, including site visit to confirm hydrology has been achieved, and confirmation that all legal documents have been properly recorded.
- Initial credit release decision made at next MBRT meeting.
- **Annual monitoring reports**, due by date specified in the instrument, are sent to the MBRT.
- **Annual monitoring site visits** by the MBRT are scheduled to evaluate if site is meeting success criteria and ecological goals.
- MBRT submits written comments to COE and DSL within 14 days of the site visit. The comments shall include recommendations on credit release, credit suspension, and/or remediation needed.
- COE and DSL review the monitoring report and comments received from the MBRT. A written decision on credit release and/or recommendations for remedial work is sent to the sponsor within 30 days of the site visit.

6. **Adaptive Management**

- It's expected that site visits or monitoring reports may trigger review and amendment of the bank instrument to accommodate changes in expectations and results, or discussion of additional phases of a bank. Any amendments will be at the mutual agreement of the MBRT and bank sponsor. Any substantive changes will require revision of the MOA and a new round of signatures.

7. **Transition to Long-Term Steward**

- After all bank credits are sold, the property and management endowment is handed off to the long-term steward identified in the Instrument.

APPENDIX C

INFORMATION INCLUDED IN PERMIT, BANK AND WETLAND DATABASES

Table 15: Data Fields Included in Removal-Fill Permit Geodatabase

Data Field Name	**Example of Data Entry**
Mitigation Project Number	M0003041
Applicant Identification	APP0037424
Applicant	Linn County
County	Linn
Township, Range, Section	13S01E25
Tax Lot	900, 1000, 1100, 1101
Waterbody	Wetland/Foster Reservoir/Santiam R/S Fk
Latitude	44.41014
Longitude	-122.63100
Accuracy of Permit Location	Centroid
Credits Sold	0.15
Mitigation Bank Used	One Horse Mitigation Bank

Table 16: Data Fields Included in Mitigation Bank Geodatabase

Data Field Name	**Example of Data Entry**
Bank Name	Amazon Creek Mitigation Bank
Area	Willamette Valley
Approved	Yes
Nearest City	Junction City
Approval Date	Spring 2002
Notes on Mitigation Credits	Impact site can be located at up to 600 feet elevation, but no higher
Bank Sponsor's Name	Dave Jampolsky
Bank Sponsor's Contact	(541)895-5910
Watershed District	Upper Willamette
Size of Bank (Acres)	78
Available Credits	41.08

Table 17: Data Fields Included in National Wetland Inventory Geodatabase

Data Field Name	**Example of Data Entry**
Field ID (Unique Identifier)	7848
Wetland Classification (Cowardin)	PFOA
Hydrogeomophoric Code (HGM)	<no data>
QAQC Code	NNNNNNNNN
Wetland Type	Freshwater Forested/Shrub Wetland
Wetland Area (Acres	1.201
Description of Code	http://wetlandsfws.er.usgs.gov/NWI/webatx/atx.html

APPENDIX D

CENSUS DEFINITIONS USED FOR SOCIOECONOMIC ANALYSIS

This information was taken from the United States Census Bureau's *Selected Appendixes: 2000, Summary Social, Economic, and Housing Characteristics* report (2003).

"Urban and Rural"

The U.S. Census Bureau classifies as urban all territory, population, and housing units located within urbanized areas (UAs) and urban clusters (UCs). It delineates UA and UC boundaries to encompass densely settled territory, which generally consists of:

- A cluster of one or more block groups or census blocks each of which has a population densityof at least 1,000 people per square mile at the time.
- Surrounding block groups and census blocks each of which has a population density of at least 500 people per square mile at the time.
- Less densely settled blocks that form enclaves or indentations, or are used to connect discontiguous areas with qualifying densities.

Rural consists of all territory, population, and housing units located outside of UAs and UCs. Geographic entities, such as metropolitan areas, counties, minor civil divisions, and places, often contain both urban and rural territory, population, and housing units.

"White"

A person having origins in any of the original peoples of Europe, the Middle East, or North Africa. It includes people who indicate their race as ''White'' or report entries such as Irish, German, Italian, Lebanese, Near Easterner, Arab, or Polish.

"Median Income"

The median divides the income distribution into two equal parts: one-half of the cases falling below the median income and one-half above the median. For households and families, the median income is based on the distribution of the total number of households and families including those with no income. The median income for individuals is based on individuals 15 years old and over with income. Median income for households, families, and individuals is computed on the basis of a standard distribution. Median income is rounded to the nearest whole dollar. Median income figures are calculated using linear interpolation if the width of the interval containing the estimate is $2,500 or less.

APPENDIX E

CITIES WITH LOCAL WETLAND INVENTORIES

Table 18: Cities within the Study Area that have Local Wetland Inventories

County	City	Year Completed
Benton	Corvallis	2005
	Philomath	1997
Lane	Coburg	2000
	Dunes City	1996
	Eugene	1994, 2005
	Florence	1997
	Springfield	1998
Linn	Albany	1996, 1997, 2001
Polk		

APPENDIX F

LOCATIONAL COMPARISON OF FILL/MITIGATION SITES' PROXIMITY TO URBAN GROWTH BOUNDARIES

Table 19: Comparison of Proximity of Fill Sites and Mitigation Banks to UGB

	Location of Permit Mitigation: Within UGB Boundary				*Location of Permit Mitigation: W/in One Mile of UGB**				*Location of Permit Mitigation: Outside UGB and NOT W/in One Mile of UGB**				
Bank Name	**In UGB**	**Outside UGB, but W/in One Mile of UGB**	**Outside UGB and NOT W/in One Mile of UGB**	**Total**	**In UGB**	**Outside UGB, but W/in One Mile of UGB**	**Outside UGB and NOT W/in One Mile of UGB**	**Total**	**In UGB**	**Outside UGB, but W/in One Mile of UGB**	**Outside UGB and NOT W/in One Mile of UGB**	**Total**	***Grand Total of Permits***
Amazon Creek								**0**	34	12	9	**55**	***55***
Evergreen								**0**	5	1	1	**7**	***7***
Frazier Creek					12	4		**16**				**0**	***16***
Mid-Valley								**0**	17	4	2	**23**	***23***
Mud Slough								**0**	14	4	2	**20**	***20***
Oak Creek					22	5	4	**31**				**0**	***31***
One Horse								**0**	14		1	**15**	***15***
West Eugene	46	11	9	**66**				**0**				**0**	***66***
Grand Total	**46**	**11**	**9**	**66**	**34**	**9**	**4**	**47**	**84**	**21**	**15**	**120**	***233***

APPENDIX G

DESCRIPTIVE STATISTICS FROM SOCIOECONOMIC ANALYSIS

Permits

Table 20: Socioeconomic Descriptive Statistics of Permits from Amazon Creek Bank

Amazon Creek

Measure	*Average Median Income*	*Average Population Per Sq. Mi.*	*Average Percent of Total Population White*	*Average Percent of Total Population Urban*
Mean	42706.35	1744.39	91.13	66.38
Standard Error	800.40	227.93	0.33	4.14
Median	41850.44	856.06	91.16	74.51
Mode	42968.00	399.38	93.72	0.00
Standard Deviation	5881.69	1674.94	2.46	30.42
Sample Variance	34594266.78	2805418.38	6.04	925.35
Kurtosis	1.19	-0.59	1.37	0.15
Skewness	0.58	0.75	-0.90	-0.99
Range	31669.38	5687.28	11.13	100.00
Minimum	28342.00	31.44	84.18	0.00
Maximum	60011.38	5718.72	95.31	100.00
Sum	2306143.11	94197.15	4920.75	3584.27
Count	54.00	54.00	54.00	54.00
Confidence Level(95.0%)	1605.39	457.17	0.67	8.30

Table 21: Socioeconomic Descriptive Statistics of Permits from Evergreen Bank

Evergreen

Measure	*Average Median Income*	*Average Population Per Sq. Mi.*	*Average Percent of Total Population White*	*Average Percent of Total Population Urban*
Mean	48440.26	1261.94	92.91	64.11
Standard Error	4521.03	696.93	0.79	11.60
Median	43939.50	580.85	93.51	64.59
Mode	43939.50	319.94	90.82	64.59
Standard Deviation	11961.53	1843.91	2.10	30.69
Sample Variance	143078188.51	3399996.32	4.40	941.94
Kurtosis	-0.64	5.38	-2.25	3.51
Skewness	1.13	2.28	-0.04	-1.52
Range	30168.88	5272.23	4.99	97.79
Minimum	37561.87	15.99	90.65	1.70
Maximum	67730.75	5288.22	95.63	99.49
Sum	339081.85	8833.61	650.35	448.75
Count	7.00	7.00	7.00	7.00
Confidence Level(95.0%)	11062.57	1705.33	1.94	28.38

Table 22: Socioeconomic Descriptive Statistics of Permits from Frazier Creek Bank

Frazier Creek

Measure	*Average Median Income*	*Average Population Per Sq. Mi.*	*Average Percent of Total Population White*	*Average Percent of Total Population Urban*
Mean	48490.31	2036.29	91.53	78.68
Standard Error	2548.94	520.71	0.72	6.36
Median	48876.07	1030.83	91.32	87.49
Mode	59334.20	366.05	95.17	55.11
Standard Deviation	10195.75	2082.84	2.89	25.42
Sample Variance	103953291.86	4338206.00	8.38	646.33
Kurtosis	-1.21	0.30	-0.68	5.73
Skewness	0.28	1.16	-0.30	-2.23
Range	31295.25	6891.03	9.11	97.63
Minimum	35229.61	44.93	86.15	0.00
Maximum	66524.86	6935.96	95.27	97.63
Sum	775844.97	32580.65	1464.55	1258.88
Count	16.00	16.00	16.00	16.00
Confidence Level(95.0%)	5432.93	1109.86	1.54	13.55

Table 23: Socioeconomic Descriptive Statistics of Permits from Mid-Valley Bank

Mid-Valley

Measure	*Average Median Income*	*Average Population Per Sq. Mi.*	*Average Percent of Total Population White*	*Average Percent of Total Population Urban*
Mean	43754.27	1435.81	92.79	55.69
Standard Error	1707.91	366.43	0.51	7.71
Median	43000.00	580.85	93.50	70.51
Mode	49087.00	74.11	94.44	0.00
Standard Deviation	8190.87	1757.35	2.42	36.97
Sample Variance	67090378.79	3088270.37	5.88	1366.75
Kurtosis	2.26	0.54	1.00	-1.33
Skewness	1.28	1.29	-0.90	-0.56
Range	33972.50	5264.96	10.61	99.49
Minimum	33758.25	23.26	86.15	0.00
Maximum	67730.75	5288.22	96.77	99.49
Sum	1006348.18	33023.67	2134.27	1280.87
Count	23.00	23.00	23.00	23.00
Confidence Level(95.0%)	3542.00	759.93	1.05	15.99

Table 24: Socioeconomic Descriptive Statistics of Permits from Mud Slough Bank

Mud Slough

Measure	*Average Median Income*	*Average Population Per Sq. Mi.*	*Average Percent of Total Population White*	*Average Percent of Total Population Urban*
Mean	42562.08	1626.33	87.21	72.68
Standard Error	2032.98	218.38	1.52	7.10
Median	39699.17	1624.66	89.56	83.50
Mode	39699.17	1272.96	79.79	87.07
Standard Deviation	9091.74	976.63	6.78	31.77
Sample Variance	82659817.49	953800.49	46.00	1009.56
Kurtosis	2.57	-0.40	-1.52	2.48
Skewness	1.62	-0.14	-0.33	-1.99
Range	35901.00	3544.69	21.24	96.71
Minimum	33028.00	20.24	74.44	0.00
Maximum	68929.00	3564.93	95.68	96.71
Sum	851241.54	32526.57	1744.19	1453.53
Count	20.00	20.00	20.00	20.00
Confidence Level(95.0%)	4255.07	457.08	3.17	14.87

Table 25: Socioeconomic Descriptive Statistics of Permits from Oak Creek Bank

Oak Creek

Measure	*Average Median Income*	*Average Population Per Sq. Mi.*	*Average Percent of Total Population White*	*Average Percent of Total Population Urban*
Mean	42626.85	1925.37	92.12	71.95
Standard Error	1519.18	377.91	0.45	5.38
Median	40576.50	1149.76	92.26	83.79
Mode	37561.87	5288.22	90.65	99.49
Standard Deviation	8320.88	2069.89	2.46	29.46
Sample Variance	69237047.93	4284464.28	6.05	867.79
Kurtosis	0.07	0.70	0.76	0.88
Skewness	0.82	1.31	-0.13	-1.37
Range	31733.80	6919.98	11.13	99.49
Minimum	31041.45	15.97	86.76	0.00
Maximum	62775.25	6935.96	97.89	99.49
Sum	1278805.37	57761.11	2763.50	2158.38
Count	30.00	30.00	30.00	30.00
Confidence Level(95.0%)	3107.07	772.91	0.92	11.00

Table 26: Socioeconomic Descriptive Statistics of Permits from One Horse Bank

One Horse

Measure	*Average Median Income*	*Average Population Per Sq. Mi.*	*Average Percent of Total Population White*	*Average Percent of Total Population Urban*
Mean	35093.99	2079.01	93.04	81.53
Standard Error	1992.99	332.08	0.42	4.82
Median	31739.83	2184.72	93.13	84.38
Mode	31739.83	2184.72	93.13	84.38
Standard Deviation	7718.80	1286.14	1.64	18.67
Sample Variance	59579884.96	1654164.87	2.70	348.46
Kurtosis	1.69	1.28	4.20	11.14
Skewness	1.62	0.93	-1.75	-3.16
Range	26064.04	4749.62	7.04	78.79
Minimum	28154.10	23.27	88.44	17.95
Maximum	54218.14	4772.89	95.48	96.75
Sum	526409.90	31185.20	1395.60	1222.92
Count	15.00	15.00	15.00	15.00
Confidence Level(95.0%)	4274.53	712.24	0.91	10.34

Table 27: Socioeconomic Descriptive Statistics of Permits from West Eugene Bank

West Eugene

Measure	*Average Median Income*	*Average Population Per Sq. Mi.*	*Average Percent of Total Population White*	*Average Percent of Total Population Urban*
Mean	43019.93	2086.33	90.57	72.28
Standard Error	848.07	213.21	0.31	3.58
Median	42336.60	2082.14	90.88	86.20
Mode	37866.33	2197.24	88.78	86.21
Standard Deviation	6837.37	1718.98	2.47	28.89
Sample Variance	46749605.44	2954878.84	6.11	834.48
Kurtosis	-0.71	-0.74	1.09	0.08
Skewness	0.24	0.48	-0.74	-1.03
Range	31209.98	6528.97	12.59	100.00
Minimum	28801.40	4.24	83.46	0.00
Maximum	60011.38	6533.20	96.05	100.00
Sum	2796295.75	135611.42	5886.75	4698.15
Count	65.00	65.00	65.00	65.00
Confidence Level(95.0%)	1694.22	425.94	0.61	7.16

Banks

Table 28: Socioeconomic Descriptive Statistics of Amazon Creek Bank

Amazon Creek				
Measure	*Average Median Income*	*Average Population Per Sq. Mi.*	*Average Percent of Total Population White*	*Average Percent of Total Population Urban*
Mean	40781.00	51.28	91.16	0.00
Standard Error	0.00	0.00	0.00	0.00
Median	40781.00	51.28	91.16	0.00
Mode	N/A	N/A	N/A	N/A
Standard Deviation	N/A	N/A	N/A	N/A
Sample Variance	N/A	N/A	N/A	N/A
Kurtosis	N/A	N/A	N/A	N/A
Skewness	N/A	N/A	N/A	N/A
Range	0.00	0.00	0.00	0.00
Minimum	40781.00	51.28	91.16	0.00
Maximum	40781.00	51.28	91.16	0.00
Sum	40781.00	51.28	91.16	0.00
Count	1.00	1.00	1.00	1.00
Confidence Level(95.0%)	N/A	N/A	N/A	N/A

Table 29: Socioeconomic Descriptive Statistics of Evergreen Bank

Evergreen				
Measure	*Average Median Income*	*Average Population Per Sq. Mi.*	*Average Percent of Total Population White*	*Average Percent of Total Population Urban*
Mean	59883.50	39.03	95.91	0.00
Standard Error	5607.50	25.99	1.85	0.00
Median	59883.50	39.03	95.91	0.00
Mode	N/A	N/A	N/A	0.00
Standard Deviation	7930.20	36.76	2.62	0.00
Sample Variance	62888112.50	1350.95	6.88	0.00
Kurtosis	N/A	N/A	N/A	N/A
Skewness	N/A	N/A	N/A	N/A
Range	11215.00	51.98	3.71	0.00
Minimum	54276.00	13.04	94.05	0.00
Maximum	65491.00	65.02	97.76	0.00
Sum	119767.00	78.07	191.81	0.00
Count	2.00	2.00	2.00	2.00
Confidence Level(95.0%)	71250.04	330.23	23.56	0.00

Table 30: Socioeconomic Descriptive Statistics of Frazier Creek Bank

Frazier Creek

Measure	*Average Median Income*	*Average Population Per Sq. Mi.*	*Average Percent of Total Population White*	*Average Percent of Total Population Urban*
Mean	50877.00	1186.24	90.06	91.53
Standard Error	10188.14	716.34	2.27	8.47
Median	50402.50	648.99	89.73	100.00
Mode	N/A	N/A	N/A	100.00
Standard Deviation	20376.27	1432.68	4.54	16.94
Sample Variance	415192430.00	2052560.38	20.59	287.11
Kurtosis	-5.67	3.44	-3.95	4.00
Skewness	0.03	1.81	0.22	-2.00
Range	38703.00	3156.53	9.59	33.89
Minimum	32000.00	145.23	85.60	66.11
Maximum	70703.00	3301.76	95.19	100.00
Sum	203508.00	4744.97	360.26	366.11
Count	4.00	4.00	4.00	4.00
Confidence Level(95.0%)	32423.19	2279.71	7.22	26.96

Table 31: Socioeconomic Descriptive Statistics of Mid-Valley Bank

Mid-Valley

Measure	*Average Median Income*	*Average Population Per Sq. Mi.*	*Average Percent of Total Population White*	*Average Percent of Total Population Urban*
Mean	65928.5	92.190795	92.76593546	25.78610083
Standard Error	5634.5	45.612845	1.051099238	14.9974573
Median	65928.5	92.190795	92.76593546	25.78610083
Mode	N/A	N/A	N/A	N/A
Standard Deviation	7968.386317	64.50630402	1.486478798	21.20960751
Sample Variance	63495180.5	4161.063258	2.209619218	449.8474507
Kurtosis	N/A	N/A	N/A	N/A
Skewness	N/A	N/A	N/A	N/A
Range	11269	91.22569	2.102198477	29.99491459
Minimum	60294	46.57795	91.71483622	10.78864353
Maximum	71563	137.80364	93.8170347	40.78355812
Sum	131857	184.38159	185.5318709	51.57220166
Count	2	2	2	2
Confidence Level(95.0%)	71593.11057	579.5661471	13.35548212	190.5607629

Table 32: Socioeconomic Descriptive Statistics of Mud Slough Bank

Mud Slough

Measure	*Average Median Income*	*Average Population Per Sq. Mi.*	*Average Percent of Total Population White*	*Average Percent of Total Population Urban*
Mean	57902	20.242585	94.2632499	0
Standard Error	11027	5.169135	1.418132056	0
Median	57902	20.242585	94.2632499	0
Mode	N/A	N/A	N/A	0
Standard Deviation	15594.53295	7.310260823	2.005541587	0
Sample Variance	243189458	53.4399133	4.022197058	0
Kurtosis	N/A	N/A	N/A	N/A
Skewness	N/A	N/A	N/A	N/A
Range	22054	10.33827	2.836264113	0
Minimum	46875	15.07345	92.84511785	0
Maximum	68929	25.41172	95.68138196	0
Sum	115804	40.48517	188.5264998	0
Count	2	2	2	2
Confidence Level(95.0%)	140111.3196	65.68008761	18.01907625	0

Table 33: Socioeconomic Descriptive Statistics of Oak Creek Bank

Oak Creek

Measure	*Average Median Income*	*Average Population Per Sq. Mi.*	*Average Percent of Total Population White*	*Average Percent of Total Population Urban*
Mean	42060.83	1015.61	94.58	61.81
Standard Error	4015.49	647.22	0.31	18.66
Median	40273.00	411.80	94.79	78.08
Mode	N/A	N/A	N/A	100.00
Standard Deviation	9835.90	1585.35	0.76	45.71
Sample Variance	96744849.37	2513336.78	0.58	2089.82
Kurtosis	-0.51	5.04	-1.37	-2.10
Skewness	0.73	2.21	-0.66	-0.55
Range	25804.00	4073.00	1.88	100.00
Minimum	31875.00	103.83	93.48	0.00
Maximum	57679.00	4176.84	95.35	100.00
Sum	252365.00	6093.68	567.50	370.83
Count	6.00	6.00	6.00	6.00
Confidence Level(95.0%)	10322.14	1663.72	0.80	47.97

Table 34: Socioeconomic Descriptive Statistics of One Horse Bank

One Horse

Measure	*Average Median Income*	*Average Population Per Sq. Mi.*	*Average Percent of Total Population White*	*Average Percent of Total Population Urban*
Mean	38376.50	439.96	95.47	46.28
Standard Error	3313.29	255.18	1.63	26.89
Median	36877.50	300.53	95.42	42.56
Mode	N/A	N/A	N/A	0.00
Standard Deviation	6626.57	510.36	3.26	53.78
Sample Variance	43911453.67	260465.55	10.63	2892.71
Kurtosis	2.41	-0.59	-2.43	-5.62
Skewness	1.26	0.99	0.06	0.07
Range	15665.00	1083.74	7.34	100.00
Minimum	32043.00	37.52	91.84	0.00
Maximum	47708.00	1121.26	99.18	100.00
Sum	153506.00	1759.84	381.87	185.12
Count	4.00	4.00	4.00	4.00
Confidence Level(95.0%)	10544.35	812.09	5.19	85.58

Table 35: Socioeconomic Descriptive Statistics of West Eugene Bank

West Eugene

Measure	*Average Median Income*	*Average Population Per Sq. Mi.*	*Average Percent of Total Population White*	*Average Percent of Total Population Urban*
Mean	45230.27	2867.08	88.37	74.74
Standard Error	3908.59	893.24	1.69	12.02
Median	39844.00	1265.54	89.37	97.47
Mode	N/A	N/A	N/A	100.00
Standard Deviation	12963.32	2962.53	5.62	39.85
Sample Variance	168047581.02	8776562.60	31.57	1588.25
Kurtosis	-0.87	-1.50	1.18	-0.49
Skewness	0.68	0.58	-1.27	-1.23
Range	38462.00	7489.28	18.28	93.82
Minimum	27944.00	63.60	75.89	6.18
Maximum	66406.00	7552.88	94.17	100.00
Sum	497533.00	31537.92	972.05	822.11
Count	11.00	11.00	11.00	11.00
Confidence Level(95.0%)	8708.87	1990.25	3.77	26.77

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