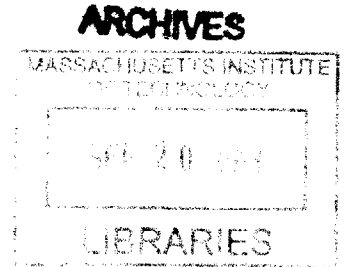


Trading Places:
The Development of Markets for Ecosystem Services in the United States
By

Mattijs J. van Maasakkers

Master in City Planning
Massachusetts Institute of Technology, 2009

M.Sc. Political Science
University of Amsterdam, the Netherlands, 2006



Submitted to the Department of Urban Studies and Planning
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy in Urban and Regional Planning

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

September 2013

© 2013 Mattijs J. van Maasakkers.
All Rights Reserved

The author here by grants to MIT the permission to reproduce and
to distribute publicly paper and electronic copies of the thesis
document in whole or in part in any medium now known or
hereafter created.

Author _____

Department of Urban Studies and Planning
August 30, 2013

Certified by _____

Professor Lawrence Susskind
Department of Urban Studies and Planning
Dissertation Supervisor

Accepted by _____

Professor JoAnn Carmin
Chair, PhD Committee
Department of Urban Studies and Planning

Trading Places:
The Development of Markets for Ecosystem Services in the United States
By

Mattijs J. van Maasakkers

Submitted to the Department of Urban Studies and Planning
in partial fulfillment of the requirements for the degree of
Doctor of Philosophy in Urban and Regional Planning

ABSTRACT

The concept of ecosystem services has become ubiquitous in environmental planning and policy. One way of turning the insight that society depends on nature for a wide range of benefits into practice is by creating markets for ecosystem services. Despite much enthusiasm and research, relatively few such markets have been implemented successfully. The basic question that this dissertation seeks to answer is why has it been so difficult to create successful markets for ecosystem services in the United States? Based on an in-depth analysis of efforts to create markets for ecosystem services in the Willamette River basin and the Chesapeake Bay watershed, I have identified three important challenges to ecosystem service market (ESM) creation. The first is push back from people care deeply about particular places. It is hard to honor such concerns when basic market logic assumes that environmental qualities can and should be easily moved from place to place. The second reason is dissatisfaction with measurement systems used to calculate how many credits a particular project or place is worth. Since many of the participants in a proposed market have different interests, the demands they create on these measurement tools are incompatible. The third and final reason it has been so difficult to create markets for ecosystem services in the United States is that it is difficult to bring together all the relevant stakeholders and give them a chance to participate in decisions regarding market design. Who should participate, what form this engagement should take and who has the authority to initiate a market are all questions that are exceedingly difficult to answer. I offer several suggestions regarding ways of overcoming these three challenges.

Dissertation Supervisor: Lawrence E. Susskind
Title: Ford Professor of Urban and Environmental Planning

TABLE OF CONTENTS

Chapter 1: Introduction	7
1.a. The Promise(s) of Markets for Ecosystem Services	8
<i>The Basic Elements</i>	9
<i>Environmental Markets and Payments for Ecosystem Services</i>	13
<i>Early Success and Emerging Challenges</i>	19
1.b. Why Are Markets for Ecosystem Services So Difficult to Create?	25
<i>Failure to Launch</i>	26
<i>Economics and Policy</i>	29
1.c. How to Study Markets for Ecosystem Services?	34
<i>Practical Methods</i>	35
<i>People and Markets</i>	38
<i>The Chesapeake Bay Watershed and the Willamette River Basin</i>	42
1.d. Chapter Overview	43
Chapter 2: Creating Places for Markets	45
2.a Places versus Markets	47
<i>A Sense of Place</i>	48
<i>The Market in Environmental Policy</i>	52
2.b. Ecological Outsourcing in Oregon	55
<i>From the Tualatin to a Marketplace</i>	56
<i>Localized Resistance</i>	60
2.c. Moving Matter out of Place in Pennsylvania	65
<i>The First Market in the Chesapeake Bay Watershed</i>	67
<i>Poultry Manure and the Boundaries of Trading</i>	71
2.d. Markets as Displacements	75
Chapter 3: Counting Ecosystem Services	77
3.a. How to Measure Ecosystem Services for Markets?	79
<i>Towards a Theory for Measurement Systems?</i>	81
<i>A Brief Overview of Models, Metrics and Measurement Tools</i>	84
3.b. Models and Baselines in the Chesapeake Bay	88
<i>Baselines and Additionality in Practice</i>	89
<i>Nutrient Models in the Chesapeake Bay Watershed</i>	91
<i>The First Baseline in Pennsylvania</i>	93
<i>Maryland and Virginia Develop Two More Baselines</i>	95
3.c. Banking on Ecosystem Services in Oregon	99
<i>Wetland Mitigation Banking and Ecosystem Services</i>	101
<i>Quantification and Simplification: The ORWAP Spreadsheet</i>	104

<i>Problems and Challenges for ORWAP</i>	108
<i>Conservation Banking and Ecosystem Services</i>	114
<i>Ecosystem Services and Biodiversity: Strange Bedfellows?</i>	119
3.d. Conclusions	121
Chapter 4: Participation and Negotiation	124
4.a. Three Basic Questions about Participation	126
<i>Who Is Invited?</i>	127
<i>How Do Participants Interact?</i>	129
<i>What Kind(s) of Authority Do Participants Have?</i>	131
4.b. Getting Together in the Willamette River Basin	132
<i>Selecting Participants for Counting on the Environment</i>	133
<i>Negotiating in Counting on the Environment</i>	136
<i>Moving from Agreement to Pilot Projects In Oregon</i>	138
4.c. Nutrient Net and an Effort to Create Trading at the Bay Scale	141
<i>Participation and Communication to What End?</i>	143
<i>Questionable Authority in the Chesapeake Bay</i>	147
4.d. Building the Bay Bank	149
<i>An Emphasis on Forestry</i>	151
<i>Designing the Bay Bank</i>	153
<i>Moving from Regulatory to Voluntary Markets</i>	155
4.e. Conclusions	157
Chapter 5: Conclusion	160
5.a. Declaring Success in Medford	162
<i>Shade Credits Come to the Rogue River Basin</i>	163
<i>Scale and Control</i>	166
5.b. From Challenges to Possible Changes	171
<i>Displacing Nature and Adaptive Management</i>	171
<i>Measurement and Double-loop Learning</i>	173
<i>Participation and Facilitated Leadership</i>	175
5.c. Moving Beyond Economic Imaginations	176
<i>Creating Integrative Oversight</i>	177
<i>Ecosystem Summits</i>	178
<i>Dedicated Funding</i>	179
<i>Professional Facilitation</i>	181
5.d. Final Thoughts	181
References	183
List of Interviews	197

Chapter 1: Introduction

On Sunday, September 7th 2008, the federal government took control of *Fannie Mae* and *Freddie Mac*, which was a dramatic moment in the financial crisis that originated in the housing market.¹ Estimates of the cost to the government of this extraordinary action ranged around \$25 billion.² This event, and the broader financial crisis it was a part of, made longtime proponents of the markets that had just collapsed question the most basic assumptions underlying those institutions.³

Three days after this takeover, a group of people gathered in Ellicott City, Maryland, a short drive from Washington, D.C., to discuss the creation and expansion of a very different kind of market. The official title of the event was the *Market-Based Conservation Incentives Workshop* but in the following years, this now annual gathering was renamed the *Ecosystem Markets Conference*. This first meeting brought together over 100 participants from diverse groups, including environmental advocates from the Environmental Defense Fund and Defenders of Wildlife, government officials from the United States Department of Agriculture and the Fish and Wildlife Service, as well as private forestry managers and landowners. The description of the first session outlines the basic premise of the workshop: “Ecosystem services provided by working forests - such

¹ The Federal National Mortgage Association and the Federal Home Loan Mortgage Corporation, as Fannie Mae and Freddie Mac are officially known, were important in the expansion of the market in mortgage-backed securities. For an accessible analysis of the role of these institutions in the financial crisis, see: <http://hereandnow.wbur.org/2012/01/12/fannie-freddie-financial> last accessed on 07/30/2013. Ecosystem services credits share only the broadest elements with mortgage-backed securities, but the takeover of these two financial institutions was at the heart of a profound discussion about basic tenets of economic thinking like rational behavior and market actors’ abilities to protect their interests.

² This estimate was published by the Congressional Budget Office, and considered low by some. See: Labaton, S. and Andrews, E. *In Rescue to Stabilize Lending, U.S. Takes Over Mortgage Finance Titans* in the New York Times on 09/07/2008.

³ Probably the most widely known example of this kind of questioning is Alan Greenspan’s testimony to the U.S. House of Representatives on Oct. 23, 2008, but he was certainly not the only one. The full text is available at: <https://house.resource.org/110/org.c-span.281958-1.pdf> last accessed on 07/30/2013.

as clean water, species habitat, and carbon sequestration - have always been undervalued. Ecosystem markets are increasingly recognized as a way to capture the value of these benefits and address natural resource issues.”⁴ It’s clear from the program and the informal reports of some of the participants that creating markets for ecosystem services was a broadly shared ambition. The goal of the workshop was neatly summarized by the title of the second day’s sessions: “Moving Ecosystem Markets Forward.” Participants discussed successful examples of ecosystem markets, but mainly focused on efforts to expand them and create new markets.

This dissertation is about efforts to develop ecosystem service markets (ESMs) in the United States, and more specifically about why it has proven to be very difficult to do so successfully. But before trying to understand the challenges associated with creating these markets, we have to address the basic question of why someone would even try to create such markets. The enthusiasm regarding markets for ecosystem services reflected in this workshop is striking given the broader context in which the meeting was taking place. So why did the participants of the ecosystem market workshop come together to discuss the creation of a whole new category of market-institutions at the very moment when conventional markets were undergoing such a dramatic failure?

1.a. The Promise(s) of Markets for Ecosystem Services

To understand the appeal of ESMs, it is helpful to begin with a deeper look at both practical and theoretical considerations involved in creating such markets. There are three major reasons why markets for ecosystem services are considered promising. The

⁴ The title of this session was *The State and Trends of Ecosystem Markets* and was hosted by Katherine Hamilton, the director of Ecosystem Marketplace, a project dedicated to providing information on markets for ecosystem services.

first is that for many organizations and individuals involved in environmental issues, including those represented at this workshop, ESMs have the potential to solve very important practical problems in environmental management. The second reason is that the theoretical underpinnings of the calls for this new kind of institution are both deeply entrenched and increasingly prominent in economic scholarship. The third reason is that at the time of this workshop, some nascent attempts to create markets for ecosystem services showed promise in meeting the practical and theoretical expectations described below.

The Basic Elements

The diversity of definitions of what a market for ecosystem services is, or should be, means that the participants in this workshop had varied ideas about what they were precisely trying to “move forward.” Ecosystem services can be defined as “the conditions and processes through which ecosystems, and the species that make them up, sustain and fulfill human life” (Daily, 1997: 3). Following that definition, creating *markets* for ecosystem services provides a new way in which environmental protection and restoration can be organized, measured and incentivized. Different approaches to buying, selling and measuring ecosystem services have been developed, but each one of these activities provides some insight into the popularity of the idea of creating markets for ecosystem services for particular groups.

In most versions of the market-idea, the sellers of ecosystem services are landowners. So for a tree farmer attending the Ecosystem Market workshop, the creation of new markets represents the potential for a new stream of revenue. Traditionally,

forestry management has focused on producing revenue through the sale of timber. However, while those trees are growing they can also provide a lot of additional ‘services’, like capturing carbon dioxide and reducing erosion by fixing soils. If certain individuals or organizations are willing or required to invest in those ‘services’, that farmer might be able to gain additional income. This might seem like a far-fetched idea, but there is an oft-repeated example, which was presented at the 2008 ecosystem markets workshop in Maryland, of this type of payment.⁵ This is the so-called Catskills story. While the facts underlying this case are still disputed (Glenna 2010; Sagoff 2002), it is typically recounted as a successful effort by the City of New York to fund land conservation and restoration around the sources of its water supply, far outside the city limits in the Catskills Mountains, to protect the quality of its drinking water. It is easy to see why this story would be appealing to landowners, since the quality of urban water supply is a widespread concern, and the changes required in land management practices to receive those payments possibly quite minimal.

The idea of a big city paying for land conservation or restoration far outside of its own jurisdiction to avoid the costs of additional mechanical filtration explains some of the appeal of ESMs for environmental advocates. Many environmental organizations buy land to protect or restore landscapes, and the potential for local governments and other organizations to contribute to environmental conservation and restoration is highly attractive. The prospect of cities protecting their interests by investing in environmental protection makes it easy to imagine many more restoration and conservation projects being implemented because there is simply much more funding available than is currently

⁵ The executive director of the Watershed Agricultural Council, Tom O’Brien, gave a presentation titled: *A Watershed Model for Water Quality Services and Rural Economies in New York*.

raised through philanthropy. Cities or private companies trying to protect the quality of their water supply or the level of flood protection they enjoy are additional hoped-for buyers of credits for forests or wetlands in the view of some environmental groups.

The second reason that ESMs appear particularly promising for environmental advocates, besides the hope of making more money available for environmental protection, is that a functioning market can provide a powerful brake on the development of rural lands. Many private rural landowners, like farmers and foresters, are facing a constant choice between continuing their work and selling their land to real estate developers who will turn farms and forests into shopping malls or suburbs. An additional steady stream of revenue, separate from commodities markets for grains or timber, might convince some of those landowners that farming continues to be preferable over selling their land to developers.⁶ A closely related argument for environmentalists is that the existence of this type of market mechanism will help advocacy organizations reach out to private landowners to convince them that environmental stewardship is a worthwhile endeavor (Bean et al. 2003).

The government representatives at the ESM workshop in Maryland came primarily from the Department of Agriculture, but also from the Environmental Protection Agency and the Department of the Interior. Given the different roles and tasks of these organizations, official views on ESMs vary.⁷ The Department of Agriculture was

⁶ These broad reasons for the enthusiasm about markets for ecosystem services among environmental advocates can be found in some form in a variety of books and reports (Scarlett and Boyd 2011; Majanen, Friedman, and Milder 2011). At the Ecosystem Market workshop in 2008, Robert Bonnie of the Environmental Defense Fund gave the opening address and his expression of these arguments can be found as early as 2003, when he co-authored a report titled: *The Private Lands Opportunity: The Case for Conservation Incentives* (Environmental Defense).

⁷ To get a detailed sense of some of the differences in emphasis, it is interesting to compare the three factsheets these departments produced on a single, relatively well-known, ecosystem services project, the Clean Water Services Tualatin Shade-trading program: The Department of the Interior's Fish and Wildlife

directly instructed by Congress to work on the development of markets for ecosystem services. The Food, Conservation and Energy Act of 2008, generally referred to as the Farm Bill, included section 1245, titled *Ecosystem Services Markets*. This section requires the Secretary of Agriculture to promote and develop a range of ESMs. In response, Agriculture created the Office of Ecosystem Services Markets. Now known as the Office of Environmental Markets (OEM), this unit focuses on and promotes the precise measurement of ecosystem services production. The potential for precise and specific measurement of the *environmental performance* of land conservation and restoration is regularly invoked as a benefit of market creation, and the Office for Environmental Markets is actively involved in the development of several of these measurement systems.

Generating and selling credits based on environmental restoration involves the quantification of the specific volume of a service that has been produced. For example, rather than simply saying that one tree equals a carbon credit, markets for carbon dioxide rely on detailed measurement systems that convert variables like the width and height of planted trees to a volume of carbon dioxide ‘captured’ as a result of their growth (García-Oliva and Masera 2004).

The thought of expanding this sort of detailed accounting to other types of ecosystems and the movement to include services beyond capturing greenhouse gasses have gained popularity, and not just inside of the Department of Agriculture (Stephenson

Service factsheet can be found at:

http://www.fws.gov/oregonfwo/LandAndWater/Documents/ESMflyer_Dec2011.pdf

and the Department of Agriculture’s at:

http://www.fs.fed.us/ecosystemservices/pdf/Watershed_Services.pdf

and an EPA factsheet on the Tualatin program can be found at:

http://www.epa.gov/npdes/pubs/wq_casestudy_factsht4.pdf

All accessed on 04/19/2012.

and Bosch 2003). The Environmental Protection Agency convened a series of meetings on ecosystem valuation and its role in decision-making as early as 1991. These meetings were organized “for the purpose of advancing the state of the art of ecosystem valuation methods” (Bingham et al., 1995). Scholars and government officials consider these measurement tools as a way to include a more complete accounting of the value of the environment in Natural Resource Damage Assessments, Environmental Impact Assessments and Cost-Benefit Analysis (Salzman 1997; National Research Council (U.S.) 2005).

The three most basic elements of markets for ecosystem services, namely measuring, buying and selling credits hold different kinds of promises for specific groups and organizations. This does not mean that the ESM workshop was simply an exercise in wishful thinking. The theoretical foundations upon which these hopes and expectations were based are well established, yet also not completely uniform.

Environmental Markets and Payments for Ecosystem Services

ESMs did not suddenly appear as a brand new idea in the early 2000s. Despite their popularity, and some agreement about their most basic elements, there is no clear consensus about the exact definition of what a market for ecosystem services is, or should be. The concept has roots in at least two fields of scholarship, namely, environmental economics and ecological economics. The similarities and differences between these two fields is itself a topic of academic study (cf. Munda 1997), but together they provide the theoretical foundations for the tools, approaches and expectations related to the creation of markets for ecosystem services. Much of the foundational work in environmental

economics in the 1960s and 1970s focused on the creation of markets and property rights regimes to deal with issues of pollution, typically from readily identifiable sources like factories and water treatment plants. Ecological economics, which rose to prominence decades later in the 1990s, has taken the production of benefits through ecosystem functions and processes as its starting point. These two ideas are not mutually exclusive, but have resulted in a situation where the precise theoretical underpinnings of the expectations about markets for ecosystem services can be hard to pinpoint.

The market is a foundational concept in modern economics and its basic definition and underlying assumptions have been debated since Adam Smith's *Wealth of Nations* (1999 [1776]). Using markets is often associated with two important goals in neo-classical environmental economics: minimizing the overall costs of reducing environmental pollution and encouraging technological innovation. The idea of achieving environmental protection by deliberately creating markets dates back to at least 1968, when the economist John Dales published a book entitled *Pollution, Property and Prices*. This now classic essay laid out the idea of creating a market in "pollution rights" as an efficient way of reducing pollution without the need for "heavy-handed" government intervention. In the decades following Dales' publication, his idea gathered academic, (Ackerman & Stewart, 1987) and political support (Freeman & Kolstad, 2007). A number of markets in pollution rights were developed, the earliest focusing on air pollution (Ellerman, 2000).

Starting in the early 1990s, multiple "pollution rights" markets and similar arrangements have been established to achieve environmental goals. The popularity of these market-based instruments provides a strong basis from which to argue that neo-

classical economic theory can be harnessed in concrete ways to achieve environmental goals. The sulfur dioxide emissions trading scheme under the Clean Air Act probably remains the prototypical environmental market in the United States following the principles laid out by Dales (Stavins 1998; Tietenberg and Lewis 2012). Reduced to its most basic components, this market relies on the government first establishing an emission standard for a pollutant, in this case sulfur dioxide, which causes acid rain.⁸ Factories discharging that pollutant are then made aware of the standard. When a factory reduces its emission of the pollutant, for example by installing a filter, it can receive *emission reduction credits* for that action. If a different factory exceeds the standard, because of an increase in its emissions resulting from an expansion or when the legal emission standard is made more stringent, it can purchase the credits from the factory that reduced its emissions to compensate for going over the standard. Therefore, reducing pollution below a facility's allocated amount produces the equivalent of money in the bank, with credits available for sale when the market produces opportunities.

The key benefit of this mechanism is that there is a clear incentive to reduce pollution, which is likely in turn to promote new and potentially cheaper emission reduction technologies (Tietenberg 1990). However, this kind of environmental market requires an enforceable standard set by a government agency, based on regulation, and is largely agnostic when it comes to the type of technology that is used to secure the emissions reduction, since innovation in technology is expected.⁹ Accordingly, much of

⁸ For a more detailed description of the problems associated with that standard-setting, as well as the relationship between scientific advice and regulatory influence, see: (Jasanoff 1994).

⁹ There is environmental economic scholarship on environmental markets in the absence of regulatory limits as well, sometimes referred to as *Free Market Environmentalism*, which is also the title of a seminal text in this field (Anderson and Leal 1991). Much of this work is associated with the Property and Environment Research Center (PERC). See: <http://perc.org> last accessed on 07/31/2013.

the enthusiasm and many of the goals for markets for ecosystem services, for example to encourage the protection of existing ecosystems, do not immediately emerge from this type of institution.

The second set of theories and expectations about markets for ecosystem services derives from the popularization of the ecosystem services concept in the late 1990s (Costanza et al., 1997; Daily, 1997), although its origins can be traced to earlier academic work (Westman, 1977). Ecological economics generally emphasizes the value of existing ecosystems to human survival and presumes that it is possible to precisely measure the production of specific services by (parts of) ecosystems and landscapes. An important publication in that context is *Nature's Services: Societal Dependence on Natural Ecosystems*. Gretchen Daily, the book's editor, describes the origins of these ideas in a meeting of a group of Pew Fellows in Conservation and the Environment around 1993. She writes in the preface: "A small group gathered informally to lament the near total lack of public appreciation of societal dependence upon natural ecosystems" (1997: xv). The second key publication on ecosystem services from that period, with Robert Costanza as lead author, was a 1997 article titled "*The Value of the World's Ecosystem Services and Natural Capital*" published in the journal *Nature*. The authors estimate that total average value of global ecosystems services at approximately \$33 trillion annually, providing a compelling economic argument for the protection of those ecosystems (1997, 259). This article has been cited a whopping 10,089 times, attesting to its huge influence.¹⁰ The central insight of both of these popular works is the notion that existing ecosystems provide specific benefits to human beings and societies.

¹⁰ The number of citations is clearly a crude indicator of an article's influence or importance, but this very large number of citations, also in comparison to almost any other publication in *Nature*, does give a sense

It is hard to overstate how popular and widespread the concept of ecosystem services has become. The ecosystem services concept, and the sub-discipline dedicated to studying it, namely *ecological economics*, rapidly gained acceptance in academic circles, evidenced by the creation of professorships,¹¹ journals,¹² and departments and programs at universities.¹³ The number of academic publications mentioning this concept has increased exponentially over the last 15 years (Fisher, 2009). Outside of academia, a number of large international research projects that explicitly focus on ecosystem services have been created, like the United Nations-initiated *Millennium Ecosystem Assessment* (or MA, www.maweb.org) and *The Economics of Ecosystems and Biodiversity* (or TEEB, www.teebweb.org). These projects involve thousands of academics and other researchers, and have resulted in a vast number of publications on the state of ecosystems and the goods and services they provide around the world. The wide circulation of the idea is likely to have contributed in large measure to the enthusiasm and optimism among the people at the Maryland ecosystem markets workshop.

The popularity of the concept shifted attention from *whether* markets should be created to *how* they should be implemented: “Around the world, leaders are increasingly

of the popularity of the ecosystem services concept. This specific number was found using scholar.google.com on 07/30/2013.

¹¹ For example at the University of Bayreuth in Germany, see: <http://www.pes.uni-bayreuth.de/en/publications/topics/index.html> last accessed on 05/14/2012.

¹² Besides *Ecological Economics*, the journal that has been the flagship journal of the International Society for Ecological Economists since its creation in 1989, the *International Journal of Biodiversity Science and Management* was renamed the *International Journal of Biodiversity Science, Ecosystem Services and Management* and since 2012 a new journal titled *Ecosystem Services* has been published by Elsevier.

¹³ Prominent examples are the Gund Institute for Ecological Economics at the University of Vermont, the Ecosystem Services for Urbanizing Regions program at Portland State University and the Natural Capital Project at Stanford University. Many other programs are less prominent, but often explicitly connected to ecosystem services. These can be found at: <http://www.ecoeco.org/content/education/graduate-opportunities/> and <http://www.aashe.org/resources/academic-programs/discipline/economics> both accessed on 05/14/2012.

recognizing ecosystems as natural capital assets that supply life-support services of tremendous value. The challenge is to turn this recognition into incentives and institutions that will guide wise investments in natural capital, on a large scale.” (Daily and Matson 2008, p. 9455). The literature on ecosystem services began to focus on implementation through the creation of payments and markets for ecosystem services, rather than more abstract valuation studies (Gómez-Baggethun et al. 2010). A widely used definition of the *Payments for Ecosystem Services* (PES) approach is: “A voluntary transaction in which a well-defined environmental service (or a land use likely to secure that service) is bought by (a minimum of) one buyer from (a minimum of) one provider if and only if the provider continuously secures the provision of the service.” (Wunder, 2005, p. 3).

Some important scholars within the field of ecological economics (cf. Mayrand and Paquin 2004; Sommerville, Jones, and Milner-Gulland 2009) consider this vision of PES to be too closely connected to neo-classical environmental economics, as opposed to ecological economics (Farley and Costanza 2010; Muradian et al. 2010). Despite these scholarly disputes, what this definition highlights is the need to define a specific environmental service or land use, which is one element that sets PES apart from the traditional environmental market. The focus is on the ability of an ecosystem to produce outcomes that are desirable for human beings, as opposed to the ability of humans to reduce their adverse impacts on the environment (e.g., pollution). Precise definitions of markets for ecosystem services are even more difficult to find, and several well-known scholars simply use “markets for ecosystem services” as a catchall phrase that covers a variety of schemes including PES, pollution credit trading, and sometimes even

agricultural subsidies (cf. Salzman 2005; Achterman and Mauger 2010; Womble and Doyle 2012).

The fields of environmental and ecological economics provide a diverse set of theoretical foundations for the impetus to create ESMs. Salient, and some would say fundamental, differences exist between these two academic disciplines. For example, the above definition of payments for ecosystem services emphasizes the voluntary nature of the transaction, whereas much of the work on pollution trading in environmental economics assumes a regulatory standard to initiate trading. These kinds of theoretical arguments and disagreements do not automatically diminish the appeal of the idea of markets for ecosystem services. It's perhaps more useful to think of *markets for ecosystem services* as a hybrid concept that combines environmental and ecological economics, and the central preoccupations within those fields, in new, sometimes uncomfortable ways. In practice, descriptions and definitions of markets for ecosystem services vary, but some of the key preoccupations described here, such as achieving efficiency through credit trading and the precise measurement of environmental attributes, typically return again and again.

Early Success and Emerging Challenges

The third major reason for belief in ESMs in workshops and meetings like the Ecosystem Markets Conference is that there are some tangible examples that display some of the promises of markets for ecosystem services being fulfilled.

One prominent example is in the Tualatin River watershed in Oregon where, as is the case in much of the Pacific Northwest, multiple species of salmon are struggling for

survival. This is due at least in part to significant increases in water temperatures over the last decades. Warm water adversely affects survival rates of spawning and smelting salmon (Richter and Kolmes 2005). The conventional method to cool wastewater after it has been treated is to construct mechanical “chillers”, which are expensive both to build and to maintain. The water resources utility in the Tualatin, named Clean Water Services (CWS) instead developed a water cooling program that includes payments to landowners who plant riparian trees. The ecosystem service these trees provide is shade, or more specifically the temperature reduction in the water over which the trees cast shade, which in turn is expected to increase salmon survival rates.

Shade trading as it is sometimes called combines several elements found in the literatures on markets and ecosystem services and this specific program has been described extensively in academic journals (Achterman and Mauger 2010; Cochran and Logue 2010). Shade trading has also been approvingly mentioned in policy reports about ecosystem services from national environmental organizations like Resources for the Future (Scarlett & Boyd 2011: 7) and Forest Trends (Stanton et al. 2010: 69). The regulatory impetus for the shade-credit program means it does not fall under the definition of a PES scheme as advanced by some scholars,¹⁴ but this has not prevented others from arguing, “The CWS permit epitomizes the promise of ecosystem service markets.” (Achterman and Mauger 2010: 304).

This program is the basis for much enthusiasm about creating markets for ecosystem services, but it also reveals some of the challenges of making markets work in practice. These challenges are the core subject of this dissertation. Those that the Clean Water Services overcame in the development of this program can be categorized under

¹⁴ The most obvious and influential example is the definition cited earlier (Wunder 2005).

three broad rubrics, which help structure the arguments advanced in the rest of this dissertation. The first was that the logic of markets is at odds with the central role of place in the way many people experience the environment. A tree is planted next to a stream in a city park might be inconsequential for its effect on water temperature, whereas one planted by a stream running through farmland may produce economically beneficial cooling. But choosing one over the other has a range of non-economic effects as well. It is difficult yet important to incorporate those considerations into the construction of ESMs. The second challenge that was overcome in the Tualatin case but is more problematic in general is that developing the measurement system that performs the calculation of the credits, a task that is complicated and often controversial. The third and final challenge was that a lot of people were involved in or affected by the creation of this market in different ways. Reaching a basic level of agreement, or at least avoiding explicit disapproval expressed through litigation, proved to be difficult.

The Clean Water Services overcame the first challenge by the decision to target its tree planting efforts in a very deliberate fashion, taking into account a range of considerations, not purely market-based ones. CWS developed a detailed *Temperature Management Plan* consisting of several elements that mix voluntary and regulatory approaches, as well as infrastructural and ecosystem-based water temperature reduction strategies. The element that is most commonly highlighted is the tree-planting program offered to landowners in the watershed. A second feature of the CWS approach is a tree-planting program in urban areas, the so-called *Community Tree Planting Challenge*. Outlined in the Clean Water Services' *Healthy Streams Initiative*,¹⁵ this challenge sets a

¹⁵ The Healthy Streams Plan, which outlines the Community Tree-Planting Initiative, contains a detailed analysis of tree-planting options (p. 30) highlighting opportunities that emphasize public lands and

goal of planting two million trees over 20 years. This will be executed primarily on public lands with extensive help from volunteers and community groups. Getting volunteers to plant trees in urban parks to satisfy the requirements outlined by a legal permit is a creative solution. It also shows that the realization that ecosystems provide benefits can result in new and productive arrangements and collaborations.

The challenge of developing a measurement system to calculate the number of credits was overcome through the creation of an instrument known as the Shade-a-Lator. This is a spreadsheet-based tool that calculates the shadow produced by a tree-planting project in terms of the reduction in the amount of solar energy entering the water, or kilocalories per day. Information about only a few key variables, such as the width of the stream, its direction in relation to the sun and its depth need to be entered into the spreadsheet to calculate the number of “credits” produced. The Shade-a-Lator is a fairly simple measurement tool, in the sense that it is easy to gather the necessary data and only calculates a single value. The most complex element of the Shade-a-Lator is probably the *Heat Source* model,¹⁶ which simulates the transfer of heat energy to stream temperature. This simulation model was created for a master’s thesis at Oregon State University (Boyd 1996) and used by the Oregon Department of Environmental Quality to create the Shade-a-Lator. This combination of existing and new models and calculators is characteristic of many ecosystem service measurement systems, and points to some of the tensions between precision, practicality, innovation and reliability inherent in creating them.

proximity to urban areas. Available at: <http://www.cleanwaterservices.org/Content/Documents/Healthy%20Streams%20Plan/Healthy%20Streams%20Plan.pdf> Retrieved on: 08/02/2013.

¹⁶ Documentation on the Shade-a-lator, including comments on the Heat Source model and a detailed description of the development of both can be found at: <http://www.deq.state.or.us/wq/trading/trading.htm> Retrieved on: 08/02/2013.

The third and final challenge of creating a process to reach agreement about the market's design and functioning with relevant authorities and stakeholders is incredibly complex and hard to implement successfully. The competing logics of markets and place, as well as the difficulty of creating measurement systems, make it complicated to figure out who needs to be involved in the new market, when, and how. Certain actors, such as permitting entities in a regulatory context, need to agree with the basic design and the specific rules of the market. Others, like landowners, need to actively participate by developing credits on their land to make trading work. Yet another category of actors to keep in mind consists of any group or individual who might oppose the market so vehemently that a legal challenge or other blocking action is likely if they are excluded.

In the Tualatin example, overcoming the threat of opposition required a lengthy negotiation between multiple organizations, persistent intermediary efforts by the relevant state agency and some creativity. There is a regulatory reason why CWS has to reduce the water temperature, stemming from the Clean Water Act. This means that the central features of the *shade-credit* trading scheme are outlined in a 70-page legal document officially called a "National Pollution Discharge Elimination System (NPDES) Watershed-Based Discharge Permit," issued by the Environmental Protection Agency and the Oregon Department of Environmental Quality (ORDEQ).¹⁷ Those two agencies therefore needed to provide their explicit approval of the trading program.

The Department of Environmental Quality worked closely with CWS to develop this trading program between 2001 and 2006. The agency created an informal group of

¹⁷ For a basic description of the NPDES program, see: <http://cfpub.epa.gov/npdes/> last accessed on: 08/01/2013. A more extensive description of the history and development of the Clean Water Act and the TMDL program is (Houck 2002).

stakeholders.¹⁸ At different stages in the development of the trading scheme, Clean Water Services, the Department of Environmental Quality and some members of the stakeholder group had deeply conflicting views on the appropriate type and level of involvement of those stakeholders. For example, once the basic requirements for shade-trading programs in the state of Oregon were clear, ORDEQ decided to proceed with Clean Water Services to develop the specific permit for its facilities.

The utility viewed this stage of the process as a bilateral negotiation, to be conducted between the regulator and the organization seeking the permit. The members of the stakeholder groups wanted to remain involved and ORDEQ feared resistance from an environmental advocacy organization, the Tualatin Riverkeeper. The agency maintained regular contact with that organization to keep them on board. The profound disagreements over who should participate at what stage(s) of this negotiation process shows that straightforward assumptions about when to involve which stakeholders do not readily translate into the realm of markets for ecosystem services.

In the end, the NPDES permit CWS received in 2005 is widely considered to be innovative and efficient, I believe rightly so, especially given the potential cost of building mechanical “chillers.”¹⁹ However, it does not fulfill all the possible hopes and expectations for markets for ecosystems services emerging from either practical ideals or economic theory. For one, the final element of the Clean Water Services approach draws on traditional “grey” infrastructure rather than planting trees. When added together, the

¹⁸ The Trading Stakeholder Group as well as the broader process to develop the trading program is described in detail in DEQ’s Water Quality Trading Case Study, published in 2007 and available at <http://www.deq.state.or.us/wq/trading/docs/wqtradingcasestudy.pdf> Retrieved on 08/02/2013. Some of the specific challenges associated with the procedural dimension of creating this market are described on pages 8-11.

¹⁹ CWS reports annually on the progress on the various elements of its Temperature Management Program via its website: <http://www.cleanwaterservices.org/> Last accessed on 05/14/2012.

shade activities have achieved between 10% and 30% of the total temperature reduction stipulated in the NPDES permit for the period 2004-2009.²⁰ The other 70-90% is achieved by what CWS calls “Flow Augmentation.” That part of the Temperature Management Plan consists of large releases of water from reservoirs created by dams, to which CWS holds water rights. This more conventional aspect of the Tualatin story is rarely mentioned in the fact sheets,²¹ and publications on markets for ecosystem services (Abdalla 2008).

The Tualatin example, though often relayed in a highly simplified form, was and is very popular among many of the proponents of markets for ecosystem services. It gave the participants in the Ecosystem Markets workshop a concrete example in which some of the promises of this new and exciting idea, or complex of ideas, were being achieved. Upon closer examination, however, this story also reveals a set of challenges to the creation of ESMs, and the ways in which Clean Water Services, the Oregon Department of Environmental Quality and the many other participants were able to overcome them.

1.b. Why Are Markets for Ecosystem Services So Difficult to Create?

Despite the popularity of the idea of ESMs and the concerted efforts of many to create them across the United States, there are still relatively few active and stable

²⁰ See CWS Temperature Management Plan Annual Report 2009. Available at: <http://www.cleanwaterservices.org/Content/Documents/Projects%20and%20Plans/Temperature%20Management%20Plan%20Annual%20Report%202009.pdf> Last Accessed on 05/14/2012.

²¹ The Department of the Interior’s Fish and Wildlife Service factsheet can be found at: http://www.fws.gov/oregonfwo/LandAndWater/Documents/ESMflyer_Dec2011.pdf and the Department of Agriculture’s at: http://www.fs.fed.us/ecosystems-services/pdf/Watershed_Services.pdf and an EPA factsheet on the Tualatin program can be found at: http://www.epa.gov/npdes/pubs/wq_casestudy_factsht4.pdf All accessed on 04/19/2012.

markets of this kind. Even fewer of those existing markets meet the goals of their advocates or live up to the theoretical expectations outlined by various economists. Therefore, the basic question that this dissertation seeks to answer is: *Why are markets for ecosystem services so difficult to create?* Of course, making new institutions is always difficult, so before expanding further on the research question and my approach to answering it, it is important to understand what is specific to this case by looking in detail at the evidence for the limited expansion of markets for ecosystem services. I will then look at two popular explanations for the limited practical realization of markets for ecosystem services: first, that the economic downturn of 2008 prevented their expansion, and, second, that their limited success is an example of well-known implementation problems that come up in any policy setting.

Failure to Launch

In his book *Nature and the Marketplace: Capturing the Value of Ecosystem Services*, Columbia Business School Professor Geoffrey Heal asked how much scope there is for “using markets to manage our interactions with the natural environment.” (2000: 185). In the years since he posed that question, a group of dedicated people has worked hard to create and expand those markets in the United States. More than a decade later, it is hard to argue we live in “a world in which people and institutions appreciate natural systems as vital assets, recognize the central roles these assets play in supporting human well-being, and routinely incorporate their material and intangible values into decision making.” (Daily et al. 2009, 21). Yet, the development and expansion of markets

for ecosystem services has been slow. Setbacks and failed efforts are quite common, and the most successful examples remain the Catskills and Tualatin stories.

Relatively few active and stable ESMs exist in the United States. Widely agreed upon counts of how many exist are difficult to come by, in large part because of the lack of a practical definition of that concept. Ecosystem Marketplace, an organization that is involved in the promotion and expansion of a range of different types of markets for ecosystem services, produces separate analyses for markets primarily related to water (or “Payments for Watershed Services”, in their phrase), those focused on species habitat (referred to as “Biodiversity Markets”), and finally on markets related to carbon sequestration.²²

One type of *Payments for Watershed Services* is Water Quality Trading, the rubric under which the Tualatin shade credit program falls. Not all of the Water Quality Trading programs in the United States allow for the creation of credits through environmental restoration like tree planting. Many of these trading programs primarily consist of trades between water treatment facilities, as a result of technological upgrades in filtration capacity, following the logic of pollution credit trading. However, the development in the overall number of Water Quality Trading programs of this type over time reveals a broad trend related to markets for ecosystem services, namely that many efforts to create them are initiated, few succeed, and even fewer remain active for an extended period of time.

²² The most recent report on watershed payments is: Bennet, G., Carroll, N. and Hamilton, K. “*Charting New Waters: State of Watershed Payments 2012*” published in 2013 by Forest Trends under its Ecosystem Marketplace project. Similar reports on the state of markets for ecosystem services related to carbon and biodiversity are published by Forest Trends on an irregular basis. See: <http://www.forest-trends.org/publications.php> last accessed on: 07/30/2013.

In 2008, Ecosystem Marketplace counted 66 Water Quality Trading Programs, or at least efforts to create such a program, in the United States. Forty-five of those programs identified had either never been active (31) or no information could be found about them (14). Of the remaining twenty-seven programs, only 12 had seen actual credit trades occur in 2008, meaning that the other 15 programs had either collapsed permanently or simply did not have any activity that year (Stanton et al. 2010: 56). This analysis also included a look at the development in the number of Water Quality Trading programs over time, and found that the number of programs that had seen trading activity before 2000 was thirteen, and that between 2000 and 2008 the average number of 'active programs' was between eleven and twelve. In 2013, this analysis was updated using slightly different methods, and 23 active Water Quality Trading programs were counted, almost doubling the number found in 2008 (Bennett, Carroll, and Hamilton 2013: 58). Upon closer inspection, that same report shows that only 15 programs actually registered trading activity in 2011, the most recent year about which information was available. Another way to compare the overall scale of water quality trading is to look at the transaction volume in terms of the actual money spent, and in 2008 the total dollar value of credits transacted in North America was \$10.7 million. In 2011 the value of credits transacted was \$7.7 million showing that the total value of financial activity in water quality markets decreased between those years (Bennett, Carroll, and Hamilton 2013: 59).

These numbers are influenced by overall economic activity, and perhaps even the achievement of some of the efficiency goals associated with market creation, assuming individual credit prices were dropping in some markets. But more broadly, they reflect

the simple conclusion that markets for ecosystem services, while continuing to be popular in theory, are not expanding or growing significantly. A separate, broader review of the implementation of ecosystem services programs in the United States and Canada concludes that “Many of the PES schemes are still in the “proof-of-concept” stage, with initial or annual payments from the government or other parties needed to instigate changes in behavior and land management practices” (Molnar and Kubiszewski 2012: 53).

A final example of the limited expansion of markets for ecosystem services is the shade-credit trading program in the Tualatin River watershed itself. So far, one city in Oregon has received its own NPDES permit that includes shade trading.²³ A few other cities continue to consider the shade credit approach. Almost a decade after Clean Water Services received its permit that allowed this type of trading, this approach has not expanded widely despite consistent and well-funded efforts to promote it. All of this makes clear that the optimism about markets for ecosystem services has not been translated into widespread implementation.

Economics and Policy

The realization that markets for ecosystem services have not taken the United States by storm has not escaped the community of people most dedicated to this idea. The most recent Ecosystem Markets Conference merged with a more research-oriented conference on ecosystem services research, at least in part as a result of declining sponsorship. At this newly merged conference, popular sessions included “Taking Ecosystem Service Markets to Scale: What Will It Take?” and “Where Buyers Are

²³ See: <http://www.deq.state.or.us/wq/trading/trading.htm#Rep> Last accessed on: 08/01/2013.

Coming to the Market: Moving Beyond Pilot Trades.”²⁴ These sessions reveal that markets apparently have not “gone to scale” (yet), and that many efforts have remained in the pilot project-stage, sometimes for years.

In conversations and publications on markets for ecosystem services, two reasons for this stagnation are most commonly given. The first is that the financial crisis and ensuing recession, which coincided with the emergence of ecosystem service markets as a viable approach, drastically reduced the momentum and success of many of the market-making projects. The second is that the implementation of any policy idea is complicated, will take a long time and is pretty likely to fail. These arguments are so widespread that it is worth describing their basic logic in some detail, as I do in the following sections.

These accounts describe developments and obstacles that have added to the complexity of making markets for ecosystem services work, but they fail to make sense of the more fundamental challenges that are embedded in the idea of markets for ecosystem services. In later chapters, I will turn to those more specific challenges, which were recognizable even in the Tualatin “success story.”

The economic downturn may explain some failures but certainly not all. The basic distinction between voluntary and regulatory markets is important in this connection. In voluntary markets, individuals or organizations decide to invest in ecosystem services because they believe it to be in their interest. It is plausible to argue that the overall decline in investment affected the creation of such markets for ecosystem services. Before the financial crisis, there was a lot of excitement about private investors entering markets for ecosystem services in a significant way. A cover story on payments and

²⁴ This conference, titled ACES and Ecosystem Markets 2012 was held in Ft. Lauderdale, FL from Dec. 10-14. The conference program and additional information can be found at: <http://www.conference.ifas.ufl.edu/aces/> Retrieved on: 08/02/2013.

markets for ecosystem services in *The Economist* magazine declared, “All these payments and new markets have not gone unnoticed in the City of London, and other financial centres.”²⁵ The most specific example in that article was that “banks such as ABN AMRO plan to start selling new environmental financial products.” Also in 2005, Goldman Sachs created its Center for Environmental Markets and declared the organization would “aggressively seek market making and investment opportunities in the environmental markets.”²⁶ After the financial crisis, this type of talk, let alone action, by major banks entering into environmental markets became more rare. ABN AMRO was acquired by the Dutch government in 2009, which resulted in a drastic reduction in its activities outside the Netherlands. Goldman Sachs maintains its Environmental Markets Group and the Center for Environmental Markets, but its main commitment to markets has remained to the European Union Emissions Trading Scheme, a regulatory market.

The economic downturn is not as clearly an explanation for stagnation in the creation of markets in which trading is required, or enabled, by a specific legal standard. For example, in water quality trading, the impetus to develop a market mechanism is regulatory and not directly connected to the overall level of economic activity in a watershed or state. A water utility in Oregon facing a permit renewal which includes a temperature standard might be expected to pursue a trading strategy even more aggressively in economically depressed times, given the cost difference between building a mechanical chiller versus purchasing shade credits. The economic downturn might

²⁵ See: *The Economist*, “Environmental Economics: Are You Being Served?” 2005.

²⁶ See Goldman Sachs’s Environmental Policy Framework, available at: <http://www.goldmansachs.com/citizenship/environmental-stewardship-and-sustainability/environmental-policy-framework/gse-environmental-policy-framework-pdf.pdf> Retrieved on: 08/02/2013.

explain low trading volumes in certain existing markets. For example, a water treatment facility might process less water as a result of lower industrial water use in its service area, since production levels in a local factory are down. This could mean that the utility buys fewer credits in a given year, or does not even meet the “cap” and buys none. However, since many of the markets for ecosystem services are driven by existing regulation, the basic establishment of markets is less directly connected to the larger economy. So while the lack of increased trading volumes might be directly related to the recession in the United States, the enduring problems associated with the establishment of new markets for ecosystem services cannot be explained so easily. Moreover, the recession is only relevant to the difficulties of making markets since the beginning of the financial crisis, around 2007. Many of the efforts to create markets, including some analyzed in this dissertation, started years before the downturn and their failure must have other explanations.

The second popular reason for limited success, which has been advanced by prominent legal scholars as well as practitioners, is that the absence of durable implementation is primarily related to the reliance of ESMs on existing laws and policies. These cases fall, in other words, under the well-known heading of implementation failures. This argument is primarily relevant to regulatory markets. In the literature on public policy, the fact that laws and policies are hard to implement is well established (Bardach 1977; Pressman 1984). Of course, the very idea of creating markets as policy tools is in part a reaction to problems of regulatory implementation. (Stavins 2003) An example of this kind of reasoning, specific to Water Quality Trading, is the statement that “realizing the potential of market-like approaches will require moving beyond

promotional rhetoric and developing workable options for the barriers erected by the interpretation and implementation of regulatory programs called for under the CWA [Clean Water Act]” (Stephenson and Shabman 2011, 16).

This line of argument is at odds with the fact that some of the key factors that would lead us to expect successful implementation are present. For one, many important officials have expressed support for this approach,²⁷ and a group of committed professionals has worked for years to implement it. Significant resources have been leveraged, including millions of dollars in federal grants and subsidies.²⁸ Secondly, the EPA has written extensive guidance on water quality trading and it is obviously working in some places, like the Tualatin.²⁹ Simply pointing to the general implementation problem obscures the more specific, and I will argue fundamental, challenges that emerge when trying to create markets for ecosystem services.

The economic and policy implementation arguments do not adequately explain why motivated and well-funded practitioners have struggled so hard to implement markets, when there is compelling evidence that these markets promise to facilitate cost-effective, environmentally friendly permit-compliance. In order to unearth better reasons, I followed a somewhat unconventional research strategy.

²⁷ An obvious example is the language in the 2008 Farm Bill instructing the USDA to work on the development of these markets. A more recent, and perhaps more visible example is a speech by President Obama in 2012, in which he described a shade-credit program in Oregon in glowing terms. This speech will be described in more detail in Chapter 2, and can be found in its entirety at: <http://www.whitehouse.gov/photos-and-video/video/2012/03/02/president-obama-speaks-conference-conservation> Retrieved on: 08/02/2013.

²⁸ Both the EPA and USDA have supported the creation of markets for ecosystem services through grants. The EPA’s Targeted Watershed Grant program and especially the USDA’s Conservation Innovation Grant program have funded many efforts going back to 2002. In 2012, the USDA funded 12 projects related to water quality trading, at a cost of roughly \$7 million. For the EPA program, see: http://water.epa.gov/grants_funding/twg/initiative_index.cfm and the USDA: <http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/cig/> Last accessed on: 08/02/2013.

²⁹ See: <http://water.epa.gov/type/watersheds/trading.cfm> Last accessed on: 08/04/2013.

1.c. How to Study Markets for Ecosystem Services?

To explore why it has proven to be so difficult to create markets for ecosystem services, I chose to look at the practical efforts to create those markets in two regions in the United States: the Chesapeake Bay watershed and the Willamette River basin. The methods I used to analyze markets for ecosystem services, and how I came to select these two locations as the focus for this dissertation, are deeply connected and require some explanation.

The most straightforward reason to focus on practice in a limited number of places is that theoretical expectations for ESMs can be found in many bodies of thought and are not uniform. Making a market for ecosystem services is not simply an economic activity for which the main challenges can be explained by theories about externalities; nor is it purely an ecological activity, where the most relevant insights can be drawn from theories about appropriate habitats for an endangered species or other such phenomena. Rather than starting from a narrow set of theoretical expectations, I analyzed the creation of markets for ecosystem services by concentrating on the people who are actively trying to get these institutions up and running, and the policies, processes, and products they are developing in that effort.

Following this approach, it is natural to choose the Chesapeake Bay watershed and the Willamette River basin, since these are the regions in which the most prominent and well-resourced attempts at market creation have taken place. These are the two places where the community of market proponents and enthusiasts has exerted most of its efforts to make markets work in ways that meet their lofty hopes and aspirations. Efforts in both

of these regions were intended to lead to trading in multiple types of credits and different kinds of ecosystem services, seeking to fulfill the promise of a more complete accounting of the full breadth of the environmental benefits that nature provides to humans. The ideal of multiple credit types also appeals to the goal of many landowners and their advocates, to enable a reliance on multiple streams of revenue. My choice to study actual market-creating practice, as well as the connection between my chosen methods and the studied markets, are relatively uncommon and are described in some detail in the following sections.

Practical Methods

The idea of practice as I use it here emerges from interpretative policy analysis, where it has become a central concept that brings together the rules and structures of institutions with the behavior and actions of individuals.³⁰ In focusing on practices, I do not follow any theory-derived rules or definitions to understand what a market for ecosystem services should be or to analyze why a market is or is not meeting those standards. Instead, I argue that the people working to develop and expand markets for ecosystem services are in fact negotiating their goals and rules as they create them. The phenomenon in short gains definition through the actual work of the actors.

³⁰ For detailed arguments about why *practice* can be seen as central to the way in which people experience and shape policy, and should therefore be at the center of policy analysis see: Fischer & Forester, 1993 and Hajer & Wagenaar, 2003. The older and related idea of *practice* as the place where knowing and doing, or *education and experience*, come together can be found in Dewey, 1938. Practice is a complex word with a long history and many definitions. Within the field of policy analysis, influenced by the work of French sociologist Pierre Bourdieu (1977; Bourdieu & Wacquant, 1992), it has come to be used over the last twenty years to describe the connections between action, methods and theory, in that order, as opposed to starting from theory, and then moving to methods and action (Corburn, 2005, p. 9).

The methodology I have used to study markets for ecosystem services can be described as a sort of multi-sited ethnography.³¹ I do not use the term ethnography to imply that I set out to describe the cultural elements of markets for ecosystem services. Rather, I started with the observation that the practitioners who are working on the creation of markets for ecosystem services are part of a single, highly connected network of people.

The core group that has worked on the development of markets for ecosystem services in the United States can most easily be identified by looking for people who have organized and attended the Ecosystem Markets Conference since its inception. Some of them have moved to different organizations since the first workshop, but have continued to work on the creation of markets for ecosystem services. One of the organizers of the first workshop, held in 2008, Todd Gartner, did so in his capacity as manager of conservation incentives at the American Forest Foundation. He is now a senior associate in the Ecosystems and People program at the World Resources Institute, and continues to be deeply involved in efforts to create markets and the organization of the conference. Bobby Cochran, an environmental marketplace analyst with Clean Water Services who presented on the Tualatin program during the first workshop in 2008, is now the executive director of the Willamette Partnership, the primary organization working to create markets in Oregon. So to study the challenges associated with the

³¹ The history of this approach is connected to the emergence of globalization, and the questions this raises for conventional anthropology. In their chapter "Taking Account of World Historical Political Economy: Knowable Communities in Larger Systems" (1986) anthropologists George Marcus and Michael Fisher make the argument that this approach is especially needed to make sense of large-scale political and economic processes, which I take the marketization of ecosystems to be. A more detailed and extensive description of this approach was later produced by George Marcus, in his "Ethnography Through Thick and Thin" (1998).

creation of markets for ecosystem services, I basically *follow the actors*,³² in this case the advocates, officials and entrepreneurs working on the creation of specific markets for ecosystem services.

To develop a detailed and accurate understanding of what the challenges of creating ESMs, I relied on combination of interviews, ethnographic accounts and document-analysis. I conducted 52 semi-structured interviews with people involved in the creation of the three markets I studied. Besides interviewing these individuals, I had the opportunity to observe some of them in action. Given the important role played by a relatively limited number of people, I decided to attend and participate in several conferences where the community gathered, such as the Ecosystem Market Conferences in 2011 and 2012. This allowed me not only to observe the arguments that key thinkers in the field are inclined to make, but also how experiences and ideas about emerging best practices move around from place to place.

Since the ecosystem service markets I studied in detail have the active support and involvement of public agencies, most of the documentation related to these two cases is public. This meant I could look at minutes and sometimes transcripts of key meetings. Finally, I visited some of the restoration sites and gained a first-hand sense of the products these markets are producing. I did not observe what was happening at these sites with the goal of evaluating restoration efforts from an ecological point of view. Rather, my goal was to understand what environmental restoration actually looks like in the context of an ESM.

³² This technique can be traced to classic anthropological accounts (Malinowski 1922) but has become popularized and immediately relevant to this analysis through its use in Science and Technology Studies (Latour 1987).

My study methods reflect the fact that this is not the kind of situation in which a traditional comparative case study – looking at similarities and differences between cases – is likely to be very instructive. Simply put, experiences in one effort to create a market are typically relayed rapidly to actors in other places, and some individuals work actively in multiple, geographically dispersed, market creation projects. A straightforward comparison of markets in various regions would render these connections invisible, when they are in fact quite central to the ways in which the market creation work has developed over the last decade.

People and Markets

The market creation efforts central to this dissertation are the Bay Bank and the Nutrient Trading Program, both in the Chesapeake Bay watershed, and the Willamette Marketplace in Oregon. The Chesapeake Bay watershed covers (parts of) six states, namely, New York, Delaware, Pennsylvania, Maryland, Virginia and West Virginia. There are three major reasons for the selection of these markets, despite their differences in scale and scope. The first is that they can be considered, for somewhat different reasons, to be the most ambitious attempts to bring to fruition the hopes, expectations, and enthusiasm regarding ESMs. The second reason, related to the first, is that these three efforts have consistently received a lot of attention at the Ecosystem Markets Conference and in related publications. The third reason is that the protagonists in these efforts have become leaders in the ESM community, with considerable influence over central design elements and important challenges in market making.

The Willamette Marketplace and Chesapeake Bay Bank the two most advanced, if not the only, efforts to create markets in which multiple types of ecosystem service credits can be traded in the United States (Madsen, Carroll, and Moore Brands 2010: 21). This makes them an obvious choice for analysis, since they explicitly seek to achieve the most exacting promises of the market concept. The Willamette Marketplace and the Bay Bank are closely connected in that they share a single web-based credit registration platform,³³ and their developers have also shared experiences at joint meetings. The Bay Bank is in some ways modeled after the Willamette Marketplace, although some work, such as the creation of the credit registration platform happened simultaneously in the two markets.

The third program is a combination, or more accurately a *hoped for* combination, of water quality trading programs in Pennsylvania, Maryland, Virginia and West Virginia. The Chesapeake Bay Nutrient Trading program, as this effort is sometimes called, is based on a traditional water quality market, in which pollution credits can be traded by industrial facilities without any type of ecosystem-based conservation or restoration activity. This makes the program a slightly less obvious choice for analysis in this study. Its ambition lies in part in the sheer scale at which trading ecosystem services is imagined, from the State of New York to Virginia. More importantly, serious efforts have been undertaken to enable the creation of credits by investing in environmentally based projects, such as the construction of riparian buffers. In addition, some advocates of this market have also envisioned it as a multi-credit market, and taken steps in that direction.

³³ See: <http://willamettepartnership.ecosystemcredits.org> and <http://baybank.ecosystemcredits.org> Both accessed on: 08/04/2013.

The Willamette Marketplace and Bay Bank have been at the center of sessions in each of the Ecosystem Market Conferences since the first one in 2008, and the Nutrient Trading program has featured prominently in the last few years. Two of the most important organizations in this community, the USDA's Office for Environmental Markets and the World Resources Institute, invested significant resources in the creation of advanced measurement systems and tools for the Chesapeake Bay Nutrient Trading program, making it a testing ground of sorts.

The third reason for selecting the Willamette Marketplace, the Bay Bank, and the Chesapeake Bay Nutrient Trading program is that the organizations behind these efforts have become thought leaders in the field. The creator of the Oregon-based market, the Willamette Partnership, has become a highly visible organization, theorizing "best practices" through the publication of reports and presentations. In recent years, the USDA Office of Environmental Markets has contracted the Partnership to author reports on measurement systems for biodiversity markets³⁴ and water quality trading.³⁵ That second report was co-authored by the Pinchot Institute, the central developer of the Bay Bank, and the World Resources Institute, the organization behind some key elements of the Bay's Nutrient Trading program. The World Resources Institute has long been a leader in the realm of ecosystem services, and it developed a widely used set of definitions of specific services.³⁶

³⁴ This report, titled "Measuring Up: Synchronizing Biodiversity Measurement Systems for Markets and Other Incentive Programs" can be found at: <http://willamettepartnership.org/measuring-up/> Last retrieved on: 08/04/2013.

³⁵ This report, titled "In It Together: A How To Reference Guide for Building Point-Non-Point Water Quality Trading Programs" can be found at: <http://willamettepartnership.org/in-it-together/> Last retrieved on 08/04/2013.

³⁶ See: <http://www.wri.org/project/mainstreaming-ecosystem-services/about> Last accessed on: 08/02/2013.

A Brief Introduction to the Chesapeake Bay watershed and the Willamette River basin

The efforts to develop markets for ecosystem services in the Chesapeake Bay and Willamette River basin are related to long histories of both the environmental issues and relevant organizations in those places. The Chesapeake Bay watershed is formed by dozens of rivers and streams flowing into the Chesapeake Bay, stretching from southern New York to Virginia. As the United States' largest estuary, it covers over 60,000 square miles. The Bay is over 200 miles long. Large urban centers, including Annapolis, Maryland and Norfolk, Virginia are within the drainage area that flows into the Bay. The agricultural activities within the watershed have caused an increase in the level of phosphorous and nitrogen discharged into the Chesapeake Bay, resulting in the decline of marine life. Combined with pollution from urban and industrial areas and overfishing, this decline in water quality has adversely affected the Chesapeake Bay ecosystem. Algae blooms are one detrimental consequence of these developments. The tourism and fishing industries, along with important economic activities around the Bay, have suffered as a result.

Organized efforts to protect and restore the Chesapeake Bay watershed date back to at least 1967, with the creation of the Chesapeake Bay Foundation. From the Alliance for the Chesapeake Bay to the Chesapeake Bay Commission, a variety of new entities and forums have been created to improve the state of the Bay. In 1983 the Chesapeake Bay Agreement created the Chesapeake Executive Council as the primary policy-making authority. The first widely publicized call for the creation of markets to reduce pollution in the Bay was a report from the World Resources Institute (Faeth 2000). The organization has been closely involved in the development of trading programs in West

Virginia, Pennsylvania and Maryland, primarily through the creation of different versions of Nutrient Net, a tool that facilitates the development of credits.

The Chesapeake Executive Council called for additional action in its 2007 Forest Conservation Directive.³⁷ This resulted in the Chesapeake Bay Bank, a marketplace that allows landowners to realize financial benefits for the provision of specific ecosystem services. In addition, an independent verification system was created, to make sure that the services provided as a result of landowner actions are credible and measurable. These efforts to create markets for ecosystem services in such a large watershed are among the most ambitious in the United States. They have received significant political attention, in part as a result of its location encompassing Washington, DC.

The Willamette River is a 187-mile long tributary of the Columbia River in the North West of the United States. Parts of the river basin are densely populated, including urban areas like Portland and Corvallis, but much of the watershed is fertile agricultural land. Channelization and dredging for navigation purposes, dam construction for electricity generation and water use for irrigation of agricultural crops are only a few of the interventions that have significantly altered the Willamette over the last 100 years. The salmonids and resident fish species have been adversely affected as a result of these interventions, and have subsequently been listed under the Endangered Species Act.

After the listing, Governor John Kitzhaber created the Willamette Basin Taskforce in 1996, followed by the Willamette Restoration Initiative in 1997. This organization was made up of representatives from federal and state agencies, business leaders, environmental advocates, and scientific experts. The Willamette Restoration Initiative announced its comprehensive strategic restoration plan in 2001. In an attempt to

³⁷ See: http://www.chesapeakebay.net/content/publications/cbp_27761.pdf Retrieved on: 08/04/2013.

create an independent organizational base for the group's work, the Restoration Initiative filed for 501(c)(3) not-for-profit status and changed its name to the Willamette Partnership. The restoration of the Willamette River basin is a complex process, given its ecology, the multiplicity of water uses, and the range of interests at stake. Methods to optimize restoration efforts in the basin have been pursued by the Partnership, using the ecosystem services framework to create a series of markets for specific ecosystem services.

1.d. Chapter Overview

The three central challenges for the creation of markets for ecosystem services encountered in the Tualatin case are the lack of attention to place in the basic logic of these markets, the tension between creating precise, usable and acceptable measurement systems, and the problem of getting the right people to agree to and participate in the market. These challenges provide the core of my answer to my research question as well as the structure of this dissertation. The second chapter concerns the challenges of dealing with place in the creation of markets for ecosystem services. Here, I focus on the expansion of the shade credit trading program in Oregon and the water quality trading program in the Chesapeake Bay, especially in Pennsylvania. The third chapter analyzes the challenges associated with creating measurement systems that can be used in markets for ecosystem services. It looks in detail at the measurement systems for wetlands and prairie in the Willamette Marketplace, and those used to enable the creation of ecosystem service credits in the Chesapeake Bay Nutrient Trading program. The fourth chapter focuses on the problems of finding and engaging the appropriate stakeholders in the

development and expansion of these markets. The attempts in relation to the Willamette Marketplace and the Bay Bank are central to this chapter. Finally, in the conclusion, I summarize what can be learned from the analysis of these challenges and I describe their implications for the practice of creating ESMs.

Chapter 2: Creating Places for Markets

The efforts to create ESMs have encountered a range of challenges. Despite well-organized attempts to introduce and implement this idea in multiple places, it remains difficult to point to successful markets for ecosystem services in the United States beyond the Tualatin story or the Catskills example.

This chapter argues that a central challenge in creating markets for ecosystem services is the importance that many people attach to place. People care deeply and for a variety of reasons about specific locations. So, when markets for ecosystem services treat places as equivalent, and allow exchanges to happen between them as if all places are fungible, people get upset. For example, a market might allow environmental degradation in one place by discharging warm water into a salmon-carrying stream, to be compensated by environmental restoration somewhere else, for example by planting trees upstream of the water treatment plant. In purely ecological terms, such compensation is noncontroversial. The trade-off benefits the environment: average water temperature is reduced along the entire length of the stream. But for people living right next to a water treatment facility, or adjacent to a tree-planting project, the impacts will differ dramatically. Such differences can lead to strong opposition, even if a market exchange produces net benefits.

In order to achieve the promises associated with markets, such as efficiency or an overall reduction in the cost of environmental improvement, it is necessary to displace environmental “bads” from one location to another. In fact, operating at a large geographical scale is one of the basic principles of ecosystem service market creation, since this brings down transaction costs and guarantees a sufficient “supply” of credits.

The development of markets for ecosystem services in Oregon and the Chesapeake Bay states has shown how hard it is to deal with the social and cultural meanings of place when making markets. In Oregon, this was evident in the lack of support for an ambitious attempt to expand the Tualatin shade-credit trading program. The new effort was designed to enable trading at a larger scale and to cover multiple kinds of ecosystem services. But despite many negotiations and much hard work, two key actors decided not to participate in the market: the City of Portland, widely considered one of the “greenest” cities in the United States, and the National Marine Fisheries Service (NMFS), the agency tasked with the protection of endangered salmon species. Both declined to pursue credit trading in the Willamette River basin. Their reasons were related, in part, to concerns about place: Portland preferred to invest in environmental restoration within its city boundaries and NMFS argued that some unique locations are simply critical to the survival of an endangered population of fish.

In the Chesapeake Bay watershed, EPA officials and environmental advocates used arguments about place to criticize the first state to implement an active trading program. They were upset because the market in Pennsylvania consisted of moving chicken manure from polluted areas to other watersheds. Ecologically, the move could be easily justified. Soils in the reception area could be shown to lack the nutrients present in chicken manure. However, the very thought of moving around chicken manure, coded as a pollutant in many people’s minds, as a credible environmental solution aroused significant resistance to Pennsylvania’s market.

The developers of markets for ecosystem services are well aware of this tension between protecting place and making markets, and have tried to deal with it primarily by

creating rules, sometimes called protocols, about where credit development can happen, which practices can be used to generate credits, and where negative impacts should be avoided completely. Rulemaking has turned out to be complicated, though. It requires incorporating the meaning of specific places – and more generally people’s connections to the places they live, work, and play – into the design and operation of markets. All of this runs counter to a central promise of markets: they are supposed to be a policy tool requiring relatively few rules as compared to more traditional “command-and-control” policies and plans.

4.a. Places versus Markets

Before turning to the analysis of the resistance to markets in Oregon and Pennsylvania, I want to provide a more detailed examination of the idea of place. Markets for ecosystem services are designed to attach value to particular places. To function, markets in effect create dis-placements, by which I mean that the market moves specific elements of one place to another. This can become controversial in different ways. The first, most obvious tension grows out of the observation that there are certain unique or even transcendental places that people believe simply ought to be protected against any kind of degradation. National parks are the most immediate example of this type of concern, as are unique habitats and sacred spaces. A second, related source of tension is that many public parks and urban greenspaces have specific meaning for residents and users and are deeply valued where they are. While such places are not quite as obviously deserving of preservation as Yosemite Valley or the Grand Canyon, the value these parks have to local communities does not very easily lend itself to translation in an ESM.

Finally, even places that are already part of an explicitly economic logic, such as agricultural lands and abandoned mines, do not always lend themselves to being incorporated into a market for ecosystem services. Removing a polluting source from one place to another can affect the meaning of both places in unexpected ways.³⁸

A Sense of Place

To explain the strong objections to trading ecosystem credits across geographical locations, it is instructive to start with the movement to protect landscapes in the United States. Some of the most significant and enduring efforts to preserve landscapes took place in the Potomac River basin in Pennsylvania and Maryland. This river connects much of the Chesapeake Bay watershed. Its tributaries in Pennsylvania, West Virginia, and Virginia flow into its main stem. Early landscape preservation efforts in the Potomac River basin started during the American Civil War and were a direct result of it. Two years after the Battle of Antietam, named after the eponymous creek that runs through the center of the battlefield and flows into the Potomac, a plan was introduced to create an official national cemetery in that location.³⁹

The successful attempt to preserve this unique place, and comparable efforts in Gettysburg, Pennsylvania and elsewhere, were in some ways a precursor to the creation of much larger national parks such as Yellowstone and Yosemite (Sachs 2013). At Antietam, Gettysburg, and other battlefields, the federal government assumed responsibility for the preservation of significant tracts of land in unprecedented ways

³⁸ This argument is widely associated with Mary Douglas' work on pollution, but can also be found in Michel Callon's analysis of an attempt to grow scallops in St. Brieuc Bay (Callon 1986).

³⁹ For a brief description of the history of the national cemetery at Antietam, see: <http://www.nps.gov/anti/historyculture/antietam-national-cemetery.htm> Last accessed on: 08/10/2013.

(Faust 2008, 99–100; Mackintosh 1987). The protection of Antietam Creek and its surrounding areas, where the bloodiest single day of the Civil War took place, reveal an important element of what planning scholars refer to as “socio-spatial relations” (Graham and Healey 1999). This refers to the fact that people attach profound importance to the way in which particular locations are put together. In the case of Civil War memorial sites, historical significance defines the unique meaning of those locations.

Decades after the Civil War, the need for a national imperative to protect particular places (now for their environmental significance) was central to John Muir’s writings on Hetch Hetchy and the Yosemite Valley (Muir 1912). More recent examples of ethical arguments for the protection of more mundane places can be found in Aldo Leopold’s (1949) “Land Ethic” and the school of thought known as “deep ecology” (Devall & Sessions, 1985; Naess, 1990). Leopold, Naess and others believe that certain locations are inherently worth protecting. Therefore, disturbances of all kinds should be avoided in these locations. This ethical point of view has well-developed theoretical underpinnings that go beyond mere environmental activism. To those who believe in the uniqueness of places, whether for historical, ecological or ethical reasons, swapping environmental “goods” and “bads” is problematic. The particular *socio-spatial* configuration of a place, be it a battlefield or an esthetically pleasing valley, carries moral significance which, in the minds of many, should not be altered.

Place is also important in environmental thinking because proximity to nature matters, even (or especially) when speaking about small parks in urban settings. Small green spaces are just as important to some people as great national parks, such as Antietam or Yellowstone, are to others. A classic philosophical argument about being

able to retreat to natural areas with relatively little human activity goes back to Thoreau's *Walden* (2008 [1854]). In his famous account, the ability to spend time in nature is at the heart of a quest to lead a simple, deliberate life. More recently, proximity to parks and gardens, and their presence in urban areas, has been central to writing about "good" city planning (Lynch 1981; Spirn 1984). Advocates of urban parks and the protection of city landscapes argue that these are important to the well-being of communities and to public health (Frumkin 2003). This line of reasoning emphasizes the need for green spaces close to where people live, because it makes them more social as they meet each other in public parks and more healthy as they walk through these spaces. This reasoning highlights a potential problem regarding markets for ecosystem services. Trading the degradation of urban green spaces for the restoration of rural landscapes, while potentially effective from a trading perspective, may have a disproportionate adverse impact on populations in cities.

A third source of questions about the feasibility and desirability of markets for ecosystem services in relation to place is linked to the dynamics of change. The anthropologist Mary Douglas (1966) first suggested that something becomes *pollution* once it is viewed as "*matter out of place*." This view of pollution emphasizes the importance of local values in determining environmental "goods" and "bads." Douglas' approach to understanding pollution explains why simply moving "matter" to a different "place" is not necessarily a cure. From her point of view, warm water cannot be considered environmentally "good" or "bad" without taking into account its location and the meaning it holds in that location. Warm water is not generally considered a pollutant. It only becomes one, for example in the Tualatin river and much of the Pacific Northwest

of the United States, once it enters into a stream that is used by fish that require cold water for survival. This paradox is recognized in the law: water temperature becomes “polluting” once it enters a stream that is considered “impaired” under the Clean Water Act, and then only if it surpasses the “Total Maximum Daily Load” allocation.

The question of displacement – in each of the three ways I describe – is at the heart of many environmental controversies. It helps to explain enduring conflicts in environmental policy and rulemaking. For example, with regard to air quality regulation:

attempts to resolve one environmental problem (for example, by building tall smokestacks to reduce local pollution) often simply exacerbate another kind of problem (for example, long-distance pollution such as acid rain). (Paehlke & Torgerson, 2005, p. 85).

Since markets for ecosystem services rely on this same logic, even if proponents can show efficiency gains and overall effectiveness, it is not surprising that moving matter in and out of place arouses some resistance to the creation and reliance on such markets.

In summary, the importance of place can manifest itself in three ways in the design and implementation of ESMs. The first is when people simply believe a location is unique for historical, ecological or any other reason, and therefore reject possible changes in that place. The second grows out of concern about the benefits of proximity to nature, especially for urban populations. The third is based on the idea that altering a set of “socio-spatial relations,” by moving “matter” from one place to another, might create new forms of pollution. These longstanding debates raise practical questions about what the appropriate geographic location is for each credit and debit traded in a market, and which elements should and should not be moved around. All of this runs counter to the logic of matching supply and demand in the most flexible way to efficiently achieve specific environmental goals.

The Market in Environmental Policy

An important starting point for ESMs was the work on regulatory pollution markets by John Dales in 1968. But since the late sixties, the ideas and ideals associated with the use of markets have transcended the realm of environmental regulation (Sandel 2012). More recent theoretical approaches to policy implementation, like the *new governance* (Salamon & Elliott, 2002; Salamon & Lund, 1988) and *new public management* (Dunleavy & Hood, 1994; Hood, 1986, 1991) call for a wide range of market and market-like elements. In these lines of thinking, markets are still contrasted with “command-and-control” or tax-based approaches to regulation, but cap-and-trade systems are not the only envisioned alternatives. A more diffuse set of ideas, including the use of private sector management styles, performance controls, and output measures, has become part of the lexicon associated with markets (Wu and Babcock 1996; Cashore, Auld, and Newsom 2004). Outside of academia, the rise of the “New Right” of Ronald Reagan and Margaret Thatcher is usually seen as the moment when the supposed superiority of markets and the private sector over state regulation gained widespread political popularity (Conniff 2009; Hood 1991; Layzer 2012).

It is not surprising given this history of broad support for “market values,” that the goals and promises associated with the creation of markets for ecosystem services have been wide-ranging. They sometimes differ dramatically, though, in the eyes of groups or organizations involved in creating new ecosystem service market. Whenever groups like the Willamette Partnership and the World Resources Institute try to create markets for ecosystem services, they key their proposals to reduction of direct government control,

increasing efficiency, or stimulating innovation – and sometimes to all three. The exact ways in which ESMs can or will achieve these and other goals are not always clearly spelled out. Further complicating matters is that whether or not these goals are achieved is hard to measure (Chichilnisky and Heal 2000). This has led some scholars to argue that there is too much “rhetoric about cost-effectiveness, revenue production and environmental improvement that is largely disconnected from practice” (Stephenson & Shabman, 2011).

The official statements of main proponents of the creation of markets in Oregon and the Chesapeake Bay states reflect this lack of clarity about how to connect the theoretical goals of market creation to their actual functioning. For example, the Willamette Partnership, the organization most actively working on the creation and expansion of ESMs in Oregon, describes what “ecosystem services markets do” as follows: “They [ESMs] marry the economy and the environment, creating new business opportunities while increasing the pace, scope, and effectiveness of conservation and restoration.”⁴⁰ Exactly what this marriage looks like, though, or whether there is an equal division of household chores between the spouses, is not clear. Increased effectiveness does imply that more conservation and restoration can be achieved with the same amount of money or less.

While not explicitly promising an overall reduction in regulatory burdens on private landowners and investors, the Partnership also presents the ESM as an alternative way of meeting regulatory standards: “Environmental regulations set standards to protect natural resources. Industries, businesses, developers, and individuals who change the land

⁴⁰ For this and other goals of ecosystem services markets described by the Willamette Partnership, see: <http://willamettepartnership.org/about-markets> Last accessed on: 04/25/2013.

or water must either meet these regulatory standards or compensate for the impacts they cannot avoid.”⁴¹ Again, it is not immediately clear how the relationship between the theoretical market and its operational rules is supposed to work.

Similarly, an important group of officials from the various states involved in the effort to create nutrient trading programs in the Chesapeake Bay has written:

Environmental markets show promise for protecting and restoring clean air and water, wetlands, healthy wildlife, and a suite of other environmental benefits while encouraging innovation and private investment, improving accountability, reducing costs, and expanding conservation opportunities for landowners.⁴²

Efficiency, innovation and private participation without governmental requirements are explicitly mentioned here as well.

These broad claims about the reduced need for government intervention, increased efficiency and potential innovation associated with the use of markets have been translated into ideas for how to design markets for ecosystem services in Oregon and the Chesapeake Bay states. The tension between these broad goals and the importance of place in the history of environmental thinking and advocacy might not be immediately apparent. But, the implementation of market goals has, in both regions, emphasized the need to create significant flexibility in determining where exactly ecosystem service credits are generated and debits are incurred. The focus has been on creating markets at a large enough geographic scale to encourage new ways of developing credits by moving specific elements of nature from place to place. These design guidelines follow theoretical market values and logic, but are at odds with the

⁴¹ See: <http://willamettepartnership.org/about-markets> Last accessed on: 04/25/2013.

⁴² The Chesapeake Bay Environmental Markets Team is an intergovernmental collaboration of 12 federal agencies, established as a result of Executive Order 13508. For the full text of the Charter, see: http://www.usda.gov/oce/environmental_markets/files/FY%2010-11%20CB%20EMT%20Charter_final.pdf Last accessed on: 4/24/2013.

ideals of place that have emerged as part of environmental theory over the last 150 years. The following sections describe how these tensions played out in Oregon and the Chesapeake Bay states.

2.b. Ecological Outsourcing in Oregon

To understand the importance of place in efforts to develop real markets for ecosystem services, it is instructive to return to Oregon, in 2004, when the first shade-market was created. In that year, Clean Water Services received its permit allowing the development of shade credits, thereby avoiding the need to build an expensive “chiller,” as described in the previous chapter. In 2005, the Willamette Partnership, the organization that would later become a central member in the national community of proponents of ecosystem service markets, received a “Targeted Watershed Grant” from the EPA.⁴³

The primary goal of the work to be funded with this \$779,000 grant⁴⁴ was to create a program based on the success of the Clean Water Services shade market, but now in the much larger Willamette River basin.⁴⁵ The Tualatin River is 83 miles long, and its drainage area covers 712 square miles. In comparison, the Willamette River is 187 miles long, and its basin covers more than 11,500 square miles.⁴⁶ The scale of the Willamette

⁴³ This “National Pollutant Discharge Elimination System” permit is described in Chapter 1 as being central to the “Tualatin story”.

⁴⁴ See the EPA Factsheet on Targeted Watershed Grant for Willamette River Basin. EPA840-F-07-001H. Available at: http://water.epa.gov/grants_funding/twg/upload/2007_04_04_watershed_initiative_2005_willamette_river.pdf Last accessed on: 07/08/2013

⁴⁵ These goals are cited on the same EPA Factsheet. EPA840-F-07-001H. Available at: http://water.epa.gov/grants_funding/twg/upload/2007_04_04_watershed_initiative_2005_willamette_river.pdf Last accessed on: 07/08/2013

⁴⁶ For detailed spatial and environmental information on the watersheds in Oregon, see: <http://oregonexplorer.info> Last accessed on: 08/10/2013.

River basin, and the desire to reduce transaction costs, led the Willamette Partnership to pursue an ambitious integrated marketplace, including multiple types of ecosystem services and credits. After much effort was expended to convince the relevant organizations and officials, two important representatives nevertheless decided not to support implementation of this marketplace, citing considerations related to the idea of place.

From the Tualatin to a Marketplace

Initially, much of the work under the EPA's Targeted Watershed Grant focused on the expansion of the temperature credit program. To deal with the issue of scale, and to prioritize the need to ensure significant supply and achieve efficiency, the Willamette Partnership proposed two ways in which concerns over place would be dealt with, namely the designation of *service areas* and *priority areas*.

Service areas set geographic boundaries within which trades must be made. They specify the overall scale of the market. For example, a water treatment facility in need of shade-credits can only purchase them if the restoration project in question is located within the relevant service area. The Willamette Basin was divided into three "service areas." Each was framed in terms of the water quality standards set by the Oregon Department of Environmental Quality following the requirement in the Clean Water Act. These standards are outlined in a document called the "Total Maximum Daily Loads," or TMDL. Within each area, the Willamette Partnership emphasized the need to provide as much flexibility as possible regarding where credits should remain in order to minimize the scope of government control (Primozych 2008, 49).

To encourage implementation in certain places, however, priority areas were defined. These places were considered important for environmental reasons; restoration projects in these areas were considered particularly valuable. To achieve this kind of targeting, the Willamette Partnership and its partners suggested percentage requirements that had to be met. This means that a specific proportion of the credits a water treatment utility like Clean Water Service purchased would have to come from tree planting projects in priority areas. These conditions were described in detail in the final report submitted to the EPA (Primozych 2008).

The completion of the EPA grant-project and publication of this document did not, however, result in the establishment of a shade market in the Willamette Basin. Instead, participants tried to create a more integrated “*marketplace*,” including markets for wetlands, carbon and endangered species habitat (Primozych 2008: 51). Both wetland banking and species banking mechanisms already existed under the Clean Water Act and the Endangered Species Act. They allow project developers who destroy wetlands or habitat to compensate by restoring similar ecosystems elsewhere.⁴⁷

Integrating such markets raised new difficulties, especially with regard to measurement and participation. Given their diverse legal histories and ecological objectives, integration of such trading schemes was a highly complicated proposition. The Willamette Partnership’s final report to the EPA explains why they nevertheless sought this expansion in scope:

Two types of costs predominate in most markets. One is the payment made to sellers to compensate them for providing the good or service. The other is payments to intermediaries or other costs such as time, processing, fees, and appraisals. The latter are called transaction costs. A fundamental

⁴⁷ A more detailed description the histories between wetland species, habitat or conservation banking will be provided in Chapter 3.

requirement for markets to emerge is that there must be gains from trade for the buyer and seller, after adding up the costs to participate. (Primozech 2008, 52)

This emphasis on transaction costs, a central concept in economic theory, (Coase 1937; Williamson 1981) highlights the way in which the Willamette Partnership and its supporters followed market-based economic theories to achieve environmental goals. The incorporation of wetland banking, carbon markets and endangered species habitat proved formidably complicated, but the underlying economic argument – that transaction costs should be minimized – was compelling enough to lead them to try.

Before their report was published, the Willamette Partnership had already received the next large federal grant supporting further development of the ecosystem services market in the Willamette River basin. This was a Conservation Innovation Grant (CIG) from the Department of Agriculture's Natural Resources Conservation Service (NRCS). It was awarded in 2007.⁴⁸ This new effort was named *Counting on the Environment*, or COTE. This was a stakeholder involvement process led by a professional mediator,⁴⁹ Deb Nudelman, in response to the large number of state and federal agencies, municipalities, and advocates involved. The diversity of stakeholders reflected the broad scope of COTE. Its goals included incorporating markets for wetlands, carbon and endangered species into a single *marketplace*. COTE involved several daylong negotiation sessions in 2008 and 2009 involving approximately thirty agencies, advocacy groups, and municipalities.

⁴⁸ For a brief description of the original goals and size of the grant, see the NRCS website: <http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/?ss=16&navtype=SubNavigation&cid=stelprdb1044500&navid=1001202900000000&pnavid=1001200000000000&position=Not%20Yet%20Determined.Html&ttpe=detailfull&pname=2007%20Conservation%20Innovation%20Grants%20Awards%20%20NRCS> Last Accessed on: 07/19/2012.

⁴⁹ Mediation of complex environmental decision-making processes is a professional field in Oregon. A description of a variety of processes that have been supported in this way, including the Counting on the Environment process can be found at: <http://www.orconsensus.pdx.edu> Last accessed on: 08/13/2013.

These negotiations resulted in the *Pilot General Credit Protocol: Willamette Basin Version 1.0*.⁵⁰ This document described the service and priority areas in some detail, not only for shade credits, but also for wetland credits, salmon habitat credits, and prairie credits.⁵¹ Instead of percentage-based requirements regarding the purchase of credits from priority areas, the report suggested ratios. The ratio-based approach incentivized the protection as well as the restoration of priority areas. For example, if an environmental impact occurred in a priority area, the developer would have to purchase credits on a 1:2 ratio, meaning two credits would compensate a single “debit.” A similar ratio was applied to the development of credits, meaning that a landowner who was restoring in a priority area would effectively receive more credits to sell than a landowner implementing a similar restoration project outside of the priority area. This approach still left ample flexibility about exactly where impacts and restoration projects would occur. The fact that this new *marketplace* included multiple types of credits based on different laws meant that each credit type had its own service and priority areas, and sometimes required different ratios. The overall logic was consistent across the different markets,

⁵⁰ The protocol as well as the supporting documents and the formal agreement can be found at: <http://willamettepartnership.org/ongoing-projects-and-activities/nrcs-conservation-innovations-grant-1/counting-on-the-environment> Last accessed on: 08/09/2013.

⁵¹ The marketplace envisioned in this document included several types of ecosystem credits. Therefore it also relied on different laws and regulations that established the need to “offset” the impact of a project, and thus different service and priority areas. These regulations have different implications for the scale at which trades could take place, and which areas were considered most important. For example, the requirements to compensate for the discharge of warm water in much of Oregon as well as the requirement to compensate for the destruction of a wetland almost anywhere in the United States are both based on the Clean Water Act. But for wetlands, restoration projects generally have to be within the so-called *4th field hydrological unit*, which are sub-basins with an average size of 700 square miles, comparable to the Tualatin river watershed. Temperature trading is driven by a different section of the Clean Water Act, and the scale at which trades can potentially take place under this section varies dramatically, from the Tualatin Basin to the Chesapeake Bay watershed. For prairie habitat, the suggested area within which trades could take place was based not on a law, but on the idea of an eco-region, as defined by The Nature Conservancy’s Eco-Regional Plan. The Nature Conservancy also publishes an integrated priority area map, which included different priorities for preservation and conservation of natural areas.

reflecting the prioritization of efficiency and flexibility over place-based concerns, but the inclusion of priority areas and trading ratios reflected a realization that not all places could be treated the same way.

The main organizers of the COTE process were the Willamette Partnership's executive director at the time, David Primozych and a Clean Water Services representative, Bobby Cochran, who now directs the Partnership. These two men worked to formalize the protocol and got agencies and representatives to sign an *agreement in principle* to test and pilot the marketplace. Representatives from the various organizations and agencies that had participated in COTE viewed this as an important symbolic moment in which they would move from negotiation to implementation. It was also, finally, an attempt to move from theory to practice.

Localized Resistance

Despite the initial enthusiasm and publicity around the Healthy Streams Initiative in the Tualatin basin, and the extensive participatory efforts generated by the EPA-funded project and the ensuing COTE process, it was difficult to find places where ecosystem services could be created and traded in the Willamette River basin. Two important entities, both of which had been involved throughout the market design processes, eventually declined to participate or sign the *agreement-in-principle*. These were the National Marine Fisheries Service (NMFS) and the City of Portland. To illustrate how place proved to be a formidable obstacle to market creation, I will review their objections in some detail.

The NMFS representative was the first to make clear that he would not sign the

agreement. NMFS is the primary federal agency tasked with developing and implementing recovery plans for salmon populations under the Endangered Species Act. In addition, salmon are a central species to many broader environmental preservation efforts in the Pacific Northwest (Taylor 1999). Indeed, the shade-credit market is indirectly driven by concerns over salmon survival and water temperature. So, the refusal of the agency primarily responsible for the protection of endangered salmon to participate in the creation of the new marketplace was a major blow to the market's success. When asked why he would not sign, the NMFS representative pointed to the significance of place or, more accurately, of certain unique places:

In Willamette Valley alone, we have over 107 populations listed of threatened and endangered salmon and steelhead, so we don't really feel that a site with a certain characteristic of water temperature and riparian conditions are the same throughout the Willamette. (Interview with author, 07/26/2011)

Thus, his argument was that adverse impacts on certain salmon species, given their very specific locations in the valley, are virtually impossible to compensate for in other places. Moreover, if improvements elsewhere would degrade water quality in Portland, this would harm every species:

The fact is that every individual of all of those 107 populations still has to go through downtown Portland and it just doesn't make sense to trade physical habitat improvements that are not necessarily the limiting factors for recovery of those populations in exchange for further degradation of water quality here which is the bottleneck to the entire basin. (Interview with author, 07/26/2011)

Regulations have not been issued to implement the salmon habitat credit. It seems unlikely to become an approved method of compensating impacts on rivers and streams in the Willamette River watershed. NMFS believes that certain places have unique environmental properties and cannot be "traded away." This reasoning echoes the

arguments of John Muir about the ecological and moral significance of the Yosemite Valley, though on a more modest scale. A system of priority areas and trading ratios, however sophisticated, is fundamentally inadequate to protect concerns about uniqueness.

The second representative whose signature did not end up on the agreement-in-principle, the City of Portland, was also an important player in environmental efforts in the Pacific Northwest. Again, concerns related to place were at the heart of the city's opposition. Portland is a highly progressive city when it comes to sustainability (cf. Popular Science, 2008) and environmental stewardship (Shandas & Messer, 2008). Portland's Bureau of Environmental Services, the agency responsible for water quality and storm water management, was directly involved in both the EPA-funded process and COTE. In the end, though, Portland decided not to sign on. While a representative of the Bureau of Environmental Services participated in training sessions explaining how market tools can be used, the City has taken no further steps to purchase or develop ecosystem services credits under the Willamette Partnership's marketplace or any other trading regime.

Portland's unwillingness to enter the marketplace is somewhat surprising given the city's history of investment in the creation of ecosystem services. In fact, in the December 2008 edition of the American Planning Association's magazine, Portland was described as one of four American examples of successful investments in *green infrastructure*, defined as

the interconnected network of open spaces and natural areas – greenways, wetlands, parks, forest preserves, and native plant vegetation – that naturally manages storm water, reduces the risk of floods, captures pollution, and improves water quality. (Wise, 2008, p. 1)

In short, Portland invested heavily in the development of so-called *green infrastructure*, a form of ecosystem services, yet declined to enter the market, either as a buyer or seller of ecosystem service credits. Given Portland's importance in the Willamette River Basin, economically, environmentally and politically, as well as its reputation as an environmental leader, it is important to understand the city's reservations, especially since the city's view reveals underlying concerns about the role of place, and investments in place, in an ecosystem services market.

A set of interlocking concerns drove the city's decision. These began with worries about losing environmental "goods" and having them replaced by restoration activities in rural areas far from the city:

I will tell you one of the big reasons why the city also declined to sign it [the final agreement of Counting on the Environment] was they were unsure. It was the offsite mitigation requirement. The city wanted to be focusing their mitigation and protection and restoration requirements within the city and not having them shipped out to these pilot sites that were outside of city boundaries. (Mike Reed, Interview with author, 08/05/2011)

This reflects a concern about the scale at which environmental mitigation should take place. Some people in Portland argued that environmental restoration should occur near the location of whatever environmental destruction was happening. This concern is not unjustified. The creation of markets for wetlands repeatedly illustrates a pattern of replacing urban with rural wetlands (BenDor, Brozović, & Pallathucheril, 2007; BenDor & Brozović, 2007; Womble & Doyle, 2012; Ruhl & Salzman, 2006). The logic is purely economic: developers prefer to build (and thus drain or fill wetlands) in urban areas with higher land values, and then create wetlands for mitigation purposes in more rural areas, where land values are lower and connectivity to larger green spaces can be established

more easily.

So Portland's reluctance to compensate the destruction of marginal green spaces in urban areas with significant environmental improvements in rural areas, even at lower cost, is directly linked to the meaning of place. Residents of urban areas, at least in Portland, value proximity over efficiency. They like green spaces in their city for reasons that are not captured by a guarantee that the ecosystem services they stand to lose will be provided somewhere else:

We have a larger population that is beginning to become more vocal about wanting to see green and sustainability and fish and wildlife in these urban areas. (Mike Reed, Interview with author, 08/05/2011)

Such concerns can be understood as the inverse of what planning scholar Sarah Dooling has called "*ecological gentrification*" (2009). This is a process by which environmental amenities, specifically urban green spaces, are increasingly concentrated in wealthy areas, or where access is restricted for low-income residents, especially the homeless. In this case, a reluctance to participate in the ecosystem services market is stimulated by a fear of something that we might call "*ecological outsourcing*." It is unacceptable to city residents and the officials who represent them to lose the benefits of a valued, and proximate, ecosystem. For example, the water-cooling effect of a tree can be "enjoyed" at any point downstream from that tree, but to sit underneath the tree and enjoy the shade it casts requires being right next to it. By "outsourcing" water temperature reduction to an area outside the city, residents are effectively prevented from enjoying the ancillary benefits of the trees near them.

This unwillingness of NMFS and one of the "greenest" cities in the country to participate in the implementation of an ecosystem services market at the watershed scale

highlights the challenge of taking account of concerns about place. The fundamental logic of market-based thinking offers no solution to this problem. Both NMFS and Portland's Bureau of Environmental Services participated actively in the preliminary negotiations, but in the end, their concerns about salmon and for the needs of city residents could not be assuaged by the promise that bureaucracy would be cut back and economic efficiency enhanced.

2.c. Moving Matter out of Place in Pennsylvania

Many environmental concerns in the Chesapeake Bay watershed revolve around nutrients such as phosphorous and nitrogen entering the Bay and causing algae blooms and *hypoxia*, a shortage of oxygen in the water that can kill great numbers of fish. Agricultural activities throughout the watershed, especially those that cause fertilizer and manure to enter the streams that eventually flow into the Chesapeake Bay, have significant cumulative impacts on water quality in the Bay. This dynamic is well known, and efforts to clean up the Bay have long focused on agricultural activities in rural areas far upstream of where the Potomac and Susquehanna enter the Atlantic Ocean (Dauer, Ranasinghe, and Weisberg 2000).

The Commonwealth of Pennsylvania was first in the Chesapeake Bay watershed to develop and implement a water quality-trading scheme. Its goal was to improve its rivers, as well as the Chesapeake Bay. Water treatment utilities and factories that discharge water into rivers and streams are allowed to achieve water quality standards in multiple ways. One involves a nutrient trading scheme between point sources and non-point sources. The former are facilities with distinct outlets, such as water treatment

facilities and industrial water users, that discharge water into streams. Government agencies can set a quantitative standard and allow point sources to trade credits with each other. As one facility decides to upgrade its technology, it can swap the value of the pollution reduction it produces with a plant that is not yet ready to make such an investment. This falls squarely under the logic of *pollution markets*.

Non-point sources refer to diffuse discharges of water into streams. Such run-off after rainfall can contain pollutants from a whole variety of sources. Market schemes that allow trading between point sources, which need credits, and non-point sources, which can generate credits by planting riparian buffer-zones or grass strips between crops, follow the logic and promise of ecosystem service markets.

Pennsylvania's market allows point sources to buy credits from each other, and from non-point sources as well. A central concept in the development of non-point source credits is the idea of "Best Management Practices," or BMPs. These are expected to reduce levels of nitrogen and phosphorous entering the water. In Pennsylvania, fifteen BMPs were approved.

The successful implementation of a Best Management Practice on a farm or field generates credits for landowners that can then be sold. One of the most popular practices was known as *manure transport*. This consisted of transporting chicken manure out of watersheds connected to the Chesapeake Bay, namely the Potomac and Susquehanna River basins, into the Ohio River basin, which eventually drains into the Gulf of Mexico via the Mississippi River. This practice quickly became very popular among credit brokers and landowners.

The First Market in the Chesapeake Bay Watershed

The World Resources Institute published an influential report proposing water quality trading in the Chesapeake Bay watershed as early as 2000 (Faeth 2000) although this was not the first time such an approach was suggested (Stephenson, Kerns, and Shabman 1995). Elsewhere in the US, local experiments with water quality trading began as early as the 1980s. Many focused on trades between point sources (McGinnis, 2001). The Environmental Protection Agency developed a draft framework to support watershed-based trading in 1996, and encouraged pilot projects anywhere in the nation. A review of those efforts, titled “Will Nutrient Trading Ever Work?” counted thirty-seven proposed trading schemes, and revealed that only three included point source and non-point source trading (King and Kuch 2003). In the wake of this mixed review of pilot programs, the EPA released its formal *Final Water Quality Trading Policy* in 2003.⁵² WRI began working with the Commonwealth of Pennsylvania to develop water quality markets for nutrients shortly after this policy was issued.

It took until 2006 for Pennsylvania’s Trading Guidance⁵³ to be released. This followed an extensive stakeholder participation process.⁵⁴ More than thirty representatives of environmental organizations, municipalities and state agencies participated in various working groups. These committees focused on issues ranging from

⁵² For the complete policy, see: <http://water.epa.gov/type/watersheds/trading/finalpolicy2003.cfm> (last accessed on 08/03/2012).

⁵³ The basic goal of this guidance, and most others like it, was to inform the citizenry about the specific way an agency, in this case PADEP, interprets and plans to implement formal policy in practice, meaning Pennsylvania’s Water Quality Trading Policy here.

⁵⁴ For extensive summaries of the workgroup meetings, the listening sessions and the guidance itself, see: <http://www.portal.state.pa.us/portal/server.pt/directory/chesapeake/8051?DirMode=1> Last accessed on: 08/03/2012.

legacy sediments⁵⁵ to baseline determination. They typically met two to three times during the summer of 2006 leading up to publication of the guidance document. WRI's efforts focused on developing Nutrient Net, a web portal that enables landowners to calculate, register, and sell credits, and permits entities to post bids and buy credits to offset their impacts.

As was the case in Oregon, it was difficult to move from designing the basic outlines of a market on paper to actually generating credits and managing transactions. The potential credit buyers in the Pennsylvania market are the more than 800 large (municipal) sewage treatment facilities and industrial wastewater treatment plants. Since 2010, they are required to reduce their emissions in line with limits specified in each of their NPDES permits. By reducing emissions beyond the limits stipulated in their permits, they can also become credit sellers. The Bay-wide TMDL had not yet been issued in 2006. This created some doubt about the overall viability of the market since it was based on water quality standards that exclusively applied to, and were effectively enforced by, the Commonwealth of Pennsylvania.

To generate credits, landowners could implement one of more than fifteen Best Management Practices. These reduce or eliminate nutrient and/or sediment runoff, and consist of practices ranging from the creation of riparian grass buffers to the permanent installation of mortality composters.

⁵⁵ This term refers to sediment that has accumulated over decades, sometimes centuries, behind dams and in constructed ponds. After the removal of many of those dams, the sediment largely remains in place in stream banks, trapping phosphorous and nitrogen and sometimes other pollutants like heavy metals. River restoration activities that increase flow or generate more fluctuation in water levels often result in the erosion of those stream banks, releasing large quantities of those pollutants. For a description about legacy sediments in Pennsylvania, see: http://www.bayjournal.com/article/legacy_sediments_may_pose_threat_to_bay_cleanup Last accessed on: 08/19/2013.

Each BMP is associated with an effectiveness estimate or *efficiency* level specifying the expected reduction in nutrient or sediment runoff that the BMP is intended to generate. For example, the mortality composter is associated with a nitrogen efficiency of fourteen percent. This means that composting carcasses in a controlled facility, using manure to aid in the process and applying it to the land as a source of nutrients, is presumed to generate a fourteen percent reduction in nitrogen runoff. These BMPs, and their associated efficiencies, are used to calculate the reduction in nutrient runoff on a specific farm or field, to produce an exact number of credits. These are then expressed in pounds of nitrogen or phosphorous, per year, that will not reach the Chesapeake Bay as a result of BMP implementation.

The complexity of credit calculation was an important barrier to getting the market started. The logic of an ecosystem service market requires credits that are measurable and affordable, or at least more affordable than infrastructure upgrades like new filters or storage basins. Just as decision makers tried to reduce transaction costs by increasing the scale and scope of the markets for ecosystem services in the Willamette River basin, PADEP was looking for ways to make the market work by generating trades and reducing transaction costs. An agricultural consulting company, Red Barn, suggested a new way to reduce runoff. Red Barn's CEO, Peter Hughes, described his discussion about trading with PADEP:

We came to this point of, well all right, what if we do this or if we do that BMP, like what about fencing or what about riparian buffers? All of this stuff was really hard, and no science to back it up. We were sitting down and were like, piles of poultry manure, what if we took that out?
(Interview with Author, 01/30/2013)

Hughes proposed to truck poultry manure out of the impaired watershed so it could be

deposited elsewhere, a BMP that became known simply, if unpoetically, as *manure transport*. PADEP formally describes this BMP as: “Transport of livestock manure from areas of high concentration to areas of low concentration, or the transport of manure out of the Chesapeake Bay watershed.”⁵⁶

The relative ease with which the reductions could be measured, simply by weighing the trucks as they left the watershed and conducting a basic chemical analysis of the manure to determine nitrogen and phosphorous levels, was a key reason why this BMP represented a breakthrough. Hughes vividly remembers the reaction from PADEP officials at the time: “That sounds great, you just can’t take it East, you have to take it West.” (Interview with author, 01/30/2013). This proposal about where to take the manure, as well as the lack of oversight over where the manure went, proved to be important.

At the time, given the enthusiasm for trading, it is not surprising that Pennsylvania observed a quick rise in the number of credits generated under the new “manure transport” BMP. Between 2006 and 2010, the overwhelming majority of pollutant reduction projects in Pennsylvania’s market consisted of poultry manure export. Of the fifty-two projects that the Pennsylvania Department of Environmental Protection certified before 2010, forty-four were based on simply trucking chicken manure from the “impaired” river basins to the Ohio River basin, with little publicly available documentation about where that manure was deposited.⁵⁷ This practice was immediately

⁵⁶ Pennsylvania Department of Environmental Protection, list of approved BMP descriptions for the Chesapeake Bay Watershed model, available at: <http://www.dep.state.pa.us/river/nutrienttrading/calculations/docs/BMPDescriptions.pdf>

⁵⁷ The overview of credited projects available on PADEP’s website does not indicate where exactly the manure is deposited, and the “Nutrient Trading Evaluation Report”, commissioned by Penn Future indicates that little to none of this information is publicly available. The full report is available at:

controversial. The EPA and an environmental advocacy group, PENN Future, ultimately challenged it.

Poultry Manure and the Boundaries of Trading

Hauling manure out of areas with excess had been a subsidized practice in Delaware and Maryland long before the creation of any trading scheme in the Chesapeake Bay. EPA was on record of disapproving of this method of addressing nutrient problems in the Chesapeake Bay: “Ultimately, applying manure on agricultural land is a quick fix, but not a long-term solution. You have stricter regulations coming down, you have reduction in land, and eventually your soils are going to become phosphorus saturated.” (Gary Shenk, Chesapeake Bay Program, quoted in Blankenship, 2005). But the creation of the trading scheme in Pennsylvania contributed to the popularity of manure transport, at least in that state.

In June 2010, an influential advocacy organization, PENN Future, released a technical assessment of the nutrient trading program. The report was clearly negative about the viability of manure transport as a strategy for addressing water quality problems. The export of nutrients to other basins was likely to adversely affect water quality over time there as well. Referring the transport of manure to the Ohio River, which flows into the Mississippi, the report stated that there were already serious hypoxia concerns in the Gulf of Mexico, and that the EPA had made it clear that water quality improvement efforts were likely to begin sooner rather than later in those parts of Pennsylvania where creeks and streams were located that eventually drained into the Gulf

of Mexico (Century Engineering 2011, 26–27).

In October 2010, a few months after the release of this highly critical report, Pennsylvania’s official nutrient credit trading regulation came into effect.⁵⁸ Coinciding with this new framework, a new calculation method for credit generation was introduced. It dramatically reduced the profitability of manure transport. While much of the transported manure counted directly towards credit generation, this new method required attention to the attenuating effect on the water the nutrient would seep into. This meant that nutrients removed from land further away from the Chesapeake Bay produced fewer credits. After a few years of rapid growth, the introduction of this new credit calculation method in Pennsylvania dramatically reduced the number of “manure transport” credits generated.⁵⁹ Regardless of this decline, manure transport projects continued, and the hope of credit developers like Red Barn was that a potential drop in fuel prices would make the BMP more profitable again.

Later in 2010, EPA released its pollution standard, or TMDL, for the entire Chesapeake Bay.⁶⁰ This meant that Pennsylvania’s trading program now fell directly under EPA’s authority, and would be reviewed under a set of guidelines described in an Appendix to the TMDL.

This led to an EPA-review of all trading programs in the Chesapeake Bay watershed. The outcome was that Pennsylvania’s Department of Environmental Protection no longer supported manure transport as a creditable BMP. PADEP’s exact

⁵⁸ The regulation is 25 Pa. Code § 96.8, entitled “Use of offsets and tradable credits from pollution reduction activities in the Chesapeake Bay Watershed,” and is available at:

<http://www.pabulletin.com/secure/data/vol40/40-41/1927.html> Last accessed on: 01/11/2013.

⁵⁹ In 2011, six manure transport projects were credited by PADEP, out of a total of 26 pollutant reduction activities. In 2012, 56 projects were credited, none of which included manure transport. See:

<http://www.dep.state.pa.us/river/nutrienttrading/projects/index.htm> Last accessed on: 07/14/2013.

⁶⁰ See: <http://www.epa.gov/chesapeakebaytmdl/> Last accessed on: 08/09/2013.

reasoning is not fully transparent. In EPA's formal review of Pennsylvania's trading program, manure transport is not mentioned.⁶¹ PADEP organized a meeting with stakeholders to explain the outcomes of EPA's review and the changes that would be made in the trading program, along with enhancements that PADEP was likely to implement as a result. At this meeting, or *enhancement workshop*, the following decision was made, as described by Peter Hughes from Red Barn Trading:

At this enhancement workshop, which was held by [Pennsylvania] DEP, it was in the powerpoint, a thing that said no more manure hauling. (emphasis mine, interview with author, 01/30/2013)

There was little further explanation of why this decision had been reached, but Hughes went on to describe his own reaction to this announcement:

I understand it, and that will just drive the market, or us to come up with newer and better and more defensible (sic) [BMPs], even though I think I can defend it all day and be quite serious about it. But that does not mean it [the manure hauling] is the right thing to do. If there is enough momentum that says that it's wrong, I'm quite willing [to stop]. (Interview with author, 01/30/2013)

His mention of momentum refers to the repeated criticism of this BMP by EPA officials, along with those from other states, at meetings and workshops about nutrient trading in the Chesapeake Bay. Hughes was not surprised by the "notoriety" of manure hauling in the community working on nutrient trading in the Chesapeake Bay: "Do I understand all of the criticism of it? Of course!" (Interview with Author, 01/30/2013).

This understanding reveals that the developer of the manure transport BMP was aware that, while hauling manure was perfectly in line with the market logic prevailing within PADEP, it was not acceptable to those outside that circle. A second point that

⁶¹ The EPA conducted a review of all the trading programs in the Chesapeake Bay states in 2011. The results of this review, as well as the responses by the states, can be found at: http://www.epa.gov/reg3wapd/pdf/pdf_chesbay/Phase2WIPEvals/Trading_Offsets/PortfolioOfReports.pdf Last accessed on: 07/14/2013.

emerges from his description was that he fully expected the same dynamic to persist, with credit brokers coming up with *newer and better and more defensible* BMPs, and others either supporting or attacking them.

This brief overview of the contentious history of a single BMP shows that the challenges associated with place in the creation of ecosystem service markets were not limited to the moral imperative to protect unique places, or the desire to facilitate proximity to green spaces for urban dwellers. While “*moving matter out of place*” was politically acceptable in Pennsylvania for a few years, it was never accepted as a BMP in Maryland or Virginia, and was ultimately denied in Pennsylvania as well. From my standpoint, this suggests that reactions to displacing *socio-spatial arrangements* can lead to varying market-making practices between states and over time.

The challenge of incorporating concerns about place into the ESM in Pennsylvania did not result in a collapse of the market. Pennsylvania’s Nutrient Trading program remains the most active water quality market in Chesapeake Bay Watershed, based on the volume of trades.⁶² In early 2013, a total of 160 pollutant reduction projects had been credited, totaling 5,181,482 lbs. of nitrogen, and 389,153 lbs. of phosphorous. Prices for these credits have ranged from \$1.22 to \$4.00 per pound (lb.) of avoided nitrogen or phosphorous run-off.⁶³ In the Chesapeake Bay Watershed, Pennsylvania’s market is considered relatively well established and remains significant in size.⁶⁴ But the

⁶² For the details on the publicly available trades, see: <http://www.markit.com/en/products/environmental/auctions/pennvest.page>
Last accessed on: 01/11/2013.

⁶³ This was calculated using the registry: <http://www.markit.com/en/products/environmental/auctions/pennvest.page>
Last accessed on: 01/11/2013.

⁶⁴ The credit-generation projects that have been certified by the Department of Environmental Protection can be found on their website at: <http://www.dep.state.pa.us/river/nutrienttrading/projects/index.htm> Last accessed on: 07/13/2013.

manure transport BMP is frequently mentioned as an obstacle to the potential integration of the emerging nutrient markets in Maryland and Virginia with Pennsylvania's. As such, it has become an example of the risks associated with following the desire to reduce transaction costs to its logical extreme.

2.d. Markets as Displacements

Moving environmental "goods," such as urban green spaces in Portland, and environmental "bads," such as poultry manure in Pennsylvania, may make sense in ecological terms. Such moves may make even more sense in economic terms. But these kinds of actions undermine carefully managed socio-spatial arrangements, or *places*. While the goals of ecosystem services markets in general, and in the Chesapeake Bay watershed and the Willamette River basin in particular, are rather broad, the underlying logic of markets makes it difficult to take place-specific concerns into account. These examples show why attempts to create places for ecosystem services markets, both in the Willamette River Basin and in the Chesapeake Bay watershed have met significant resistance.

The implementation of markets results in a transfer of environmental goods, or bads, from one place to the other. In Pennsylvania's manure hauling example this happened in a very physical sense, but Portland's and NMFS' refusal to even enter the marketplace shows that the possibility alone can raise barriers to market creation. The experiences in Oregon and Pennsylvania show that the movement toward ESMs or the installation of Best Management Practices should be evaluated from more than a purely ecological point of view. There are political and social effects associated with market

creation that make for significant challenges to the fundamental premise of these markets: that displacing certain (parts of) ecosystems can result in broad gains, which reduce the tension between environmental and economic goals.

If the proponents of markets for ecosystem services want to create durable institutions that can generate the support they need from the communities involved, they will need to take into account the connections people feel to the places in which they live and work. Perhaps what is surprising is that questions about place, for example which places should be excluded from any market activity, or the spatial distribution of ecosystem services, were not addressed more carefully during the design of these new institutional arrangements.

Place has received insufficient consideration in ESMs, in part because these endeavors have been pushed by the logic of the market that views trade-offs as always possible, and ratios and priority areas as sufficient to buffer any lingering concerns. Portland and NMFS did not agree with this optimistic assessment. The PADEP's reaction to complaints about the role of places, or displacement was different. The agency adjusted its calculation method to reduce the appeal of manure transport. This response highlights the second important element, and source of the second key challenge, of markets for ecosystem services, namely the measurement systems that determine the exact quantities and qualities of the credits at the center of these markets. It is this second challenge I turn to in the next chapter.

Chapter 3: Counting Ecosystem Services

A second recurring challenge to the creation of markets for ecosystem services is the need for appropriate measurement systems. For an ESM to work, some way must be found or created to determine *equivalence*, that is, the calculation that proves that, for example, planting a number of trees in one place actually compensates for a specific quantity of discharged warm water in a different location. It is important to establish a single “currency,” in this case a number of kilocalories per day. Both the water treatment facility’s discharge and the planting of trees can be translated into this common unit, making exchanges possible. But simply sticking a thermometer in the water below a recently planted tree does not provide useful information on the water-cooling effect of that tree. Water moves through a river channel in exceedingly complex ways and individual trees can grow in unexpected forms, or fail to grow altogether. So to calculate the number of kilocalories per day that a tree planting project produces, which is generally considered a relatively simple ecosystem service to quantify, it is necessary to develop a more elaborate form of measurement.

The specific measurement system for this ecosystem service, at least in Oregon, is the Shade-a-Lator, a spreadsheet which synthesizes the growth-rates of particular tree types in different soils, air-water interactions and solar radiation into a single number. For this to happen, all kinds of assumptions and simplifications must be made. For instance, trees have to grow and remain standing for 20 years, the duration of the “credit” in Oregon and the basis for the calculation of the “daily” shade production, which is an average. Credit calculations, incorporating numerous assessments of this kind, are at the center of financial transactions the value of which can amount to millions of dollars.

Measuring complex environmental phenomena like tree growth is difficult (Hirt 1996). And, when these measurements provide a basis for legal decisions about permit compliance, additional pressures arise. Information not only has to be accurate, but it must also be in line with the relevant legislation and jurisprudence. In case of litigation, all too common in the environmental realm, the calculation method and its outcomes have to be robust enough to be considered legitimate in the courts (Jasanoff 1995). In an ESM measurements inform tangible and financially significant decisions, for example about whether to build a costly chiller or invest in planting trees for a 20-year period. A large circle of people, like regulators, landowners, utility managers and environmental advocates, has to be familiar with and willing to abide by the outcome of such calculations. These challenges often lead to the direct involvement of ESM proponents in the lengthy development of measurement systems. Some of those efforts will be described in more detail, to highlight the tricky balancing act these measurement systems have to achieve.

This chapter begins with a review of the basic requirements that measurement systems have to meet in the context of markets for ecosystem services. In some ways, these requirements are deeply contradictory. Then, I will provide an overview of the specific measurement techniques that are being used to establish the Willamette Marketplace and Nutrient Trading schemes in the Chesapeake Bay watershed. In Pennsylvania, Maryland and Virginia the methods of establishing the so-called *baseline*, have failed to produce consistent, reliable or widely accepted outcomes. Two of the measurement systems in Oregon, for wetlands and for prairie habitat, have gone largely unused, and only a few credits based on their calculations have been developed. I will

conclude by returning to the broader question of why it has been so challenging to create successful markets for ecosystem services, and how these failures to create uncontroversial measurement systems contrast with the Shade-a-Lator, the seemingly successful and widely hailed system used in the Tualatin River basin.

3.a. How to Measure Ecosystem Services for Markets?

It is difficult to develop measurement systems that meet the needs and desires of the different actors in an ESM. The “buyers” of credits want a way of calculating the credit production of a restoration project that provides a high level of certainty that by buying credits they will meet their legal obligations. For example, a wastewater treatment utility that invests millions of dollars in riparian restoration needs its investment to compare favorably to installing new chillers or nutrient filters in terms of the risk the organization is taking on. Since many credit buyers are required by law to purchase credits to retain or get a permit, buyers need to know that by buying particular credits they will meet their legal obligations. When a “chiller” at a water treatment facility does not reduce the water temperature sufficiently, or completely breaks down, it is likely that the utility will quickly notice this, and can get it fixed. But when a storm downs a number of trees next to a small creek, the utility is far less likely to notice this, or be able to quickly intervene. Yet at least in principle, both situations could jeopardize the utility’s compliance status with the federal and state regulations, and open up the possibility of fines or litigation. So the measurement systems’ calculations, and the assumptions they build on, need to provide a high level of regulatory certainty for the buyers.

The civil servants tasked by the federal or state government with enforcing these requirements, typically at the state and federal level, also have to be sure that credit calculations reflect meaningful progress, in terms of improved water quality, species' survival or the like. This means that these regulators are likely to push for ways of measuring such progress, including regular site-visits. Frequently, market-based approaches to regulatory compliance are the subject of close scrutiny by environmental groups, who worry that reliance on markets is merely a way to relax environmental protection standards.⁶⁵ So, they too want to know that appropriate objectives are being met. State and Federal agencies often view rigorous and detailed monitoring systems, developed by well-known experts in relevant scientific fields, as the best way of demonstrating that they are doing their jobs.

The sellers of credits want to be certain that they can sell the credits that have been issued based on the restoration efforts they make. This means they will want performance review metrics that are easy to use, since the onus is typically on the credit developer to prove that restoration projects qualify. Many landowners are not enthusiastic about frequent visits from regulators or credit verifiers. This means that a virtual credit calculation system, that uses information provided by farmers and existing data-sources like aerial photography are often most popular among this group.

These three broad categories of actors – buyers, regulators and sellers – all have slightly different concerns about the performance of the measurement technologies used to calculate ecosystem services production. This makes it complicated to develop a

⁶⁵ See for examples relevant to the efforts in Oregon and the Chesapeake Bay states: <http://northwestenvironmentaladvocates.org/water-quality-trading-innovation-or-hoax/> and <http://www.foodandwaterwatch.org/pressreleases/nearing-40th-anniversary-of-the-clean-water-act-advocacy-groups-challenge-national-water-pollution-trading-model/> Both accessed on: 08/16/2013.

system that meets all of their concerns. An added challenge, and one that all three groups face together, is the fact that once investments are made and regulatory approval is given, continued support for the way measurements are made is necessary to maintain the viability of the trading system. Many of the contracts between landowners and credit brokers or regulated water treatment plants are for long periods, like ten or twenty years. Once a credit has been approved, the underlying measurement system has to remain operational for the duration of that restoration project.

Towards a Theory of Measurement Systems?

In order to count ecosystem services so that credits can be traded, it is rarely enough to choose among existing methods and tools developed by academic scientists. While the growth of ecological economics as an academic discipline⁶⁶ has produced an array of measurement technologies, the systems used in ESMs have typically required modification to produce outcomes appropriate to each market. This places the origins of these tools squarely in the realm of *regulatory science*, (Jasanoff 1994) meaning that the

⁶⁶ As I described in the first chapter, the history of ecological economics as an independent field is roughly three decades old, and closely tied to some key people like Herman Daly, Richard Norgaard, Gretchen Daily and Robert Costanza. Daly's work is well-known for its emphasis on the flaws of Gross Domestic Product as an economic indicator, so many early measurement systems emerging from this line of work were intended to replace those, like an "Index of Sustainable Economic Welfare" or ISEW. His 1997 book "*Beyond Growth: The Economics of Sustainable Development*" remains perhaps his most widely read publication, but this index was first published in his 1989 book "*The Common Good*" and continues to influence efforts to implement "green accounting" for governments. The following decade saw a shift to valuation techniques, many of them based on replacement cost or willingness to pay surveys, often for specific ecosystems. The most prominent study of this kind is Robert Costanza et al.'s oft-cited "*The value of the world's ecosystem services and natural capital*," published in the journal *Nature* in 1997. Since the formal, practical uptake of these approaches by national governments remained limited, as Gretchen Daily described in a special issue of the Proceedings of the National Academies of Science in 2008, the most recent decade has seen an increase in attention to mechanisms to encourage direct Payments for Ecosystem Services, or PES. Here, the measurement systems are focused on quantifying a specific service, and its price is not calculated, but determined through negotiation. In that same year, a special issue of the journal *Ecological Economics*, edited by Sven Wunder, Stefanie Engel and Stefano Pagiola was dedicated to PES systems and the measurement technologies associated with them.

constraints under which they were developed did not match idealized norms of scientific independence and fundamental inquiry. Instead, experts created these models and techniques to solve specific problems at a particular point in time, and in this process social and political judgments often factored into the specific design decisions. Environmental complexity and the constraints of the regulatory environment are not the only challenges for the designers of ESM measurement systems.

The geographer Morgan Robertson has described the function of such measurement systems in terms of producing “nature that capital can see” (Robertson 2006). In his view, ecosystem services metrics, and the ecological functions they make visible, exist at the nexus between science, state and market. Not only do these measurement systems need to meet scientific and regulatory criteria, they also need to function effectively within a market context. This provides an additional set of challenges and demands.

To highlight the precarious place of metrics caught between science, policy and economics, Robertson describes numerous interactions between members of wetland review teams and “bankers,” in which they, often jokingly, disagree about the presence of a specific plant or critter, since it might make the wetland more valuable in ecological as well as economic terms. The presence of a specific plant in the wake of a restoration effort could increase the number of “credits” allowed and therefore the amount an owner can make selling the credits. At the same time, the relative value, expressed in the number of points allotted for a specific species is often influenced by its presence on a list of rare, threatened or endangered species. These lists reflect state or federal policies and not just scientific judgments.

In Oregon, I observed wetland ecologists engaged in a protracted debate about whether or not beaver were present on a site, and if so, how likely they were to prevent certain species of trees from growing. The relevance of the calculation of the potential number of shade credits expected on the site was profound, since tree growth is the key determinant in whether or not water-cooling shadows are produced. Even a single pair of beaver can quickly reduce the number of standing trees, and therefore the amount of shade, in a riparian zone. This conversation took place during a practice-run of the Shade-a-Lator, and highlights the uncertainties associated with environmental restoration work. It also reveals the problematic nature of the assumption embedded in the measurement system that most of the newly planted trees will mature and remain standing for the duration of the “credit” period, which is twenty years. On-site verification, in part because of the cost associated with sending an independent agent to every restoration site, only happens once every five years in the shade credit market. This means that the risk of beaver, or other disturbances of tree planting projects, can go unnoticed for years.

The divergent logics of science, state and market, when they come together in a measurement system, can result in a lack of stability. Not only does a measurement system need to meet the requirements flowing from these different domains, their outcomes are likely to be challenged based on one or more of the logics that apply in each domain. Regulators, advocates and credit buyers and sellers have challenged the measurement systems in Oregon and the Chesapeake Bay on all of these grounds, often simultaneously, meaning that the same system was considered too onerous by one group, yet not rigorous enough by another. These disagreements and the attempts to overcome

them are described on more detail in the following sections, after a more detailed description of the origins of the measurement systems in use.

A Brief Overview of Models, Metrics and Measurement Tools.

The origins of these measurement systems shows that these were not simply flawed tools that were asked to perform tasks they were not designed for. Instead, many of the basic elements of these measurement systems are closely connected to historical efforts to protect certain environmental qualities.

In Oregon, the attempt to integrate different types of ESMs into a single institution during the Counting on the Environment (COTE) process meant that four measurement systems were crucial to the Willamette Marketplace (see table 3.1).

Table 3.1 Willamette Marketplace Ecosystem Service Credit Types and Metrics⁶⁷

Market	Metric	Developed By
Water Temperature	Shade-a-lator	OR Department of Environmental Quality
Wetlands	OR Rapid Wetland Assessment Protocol	Paul Adamus
Salmon Habitat	Ecometrix	Parametrix
Upland Prairie	Upland Prairie Habitat Calculator	Paul Adamus

The Shade-a-lator was created by the Oregon Department of Environmental Quality (ODEQ) to calculate the shade-credit program in the Tualatin watershed. The second metric in the Willamette Marketplace is ORWAP, the Oregon Rapid Wetland Assessment Protocol. This is based on one of the first ecosystem accounting methods for wetlands in the United States, namely the Wetland Evaluation Technique (WET) (P. R.

⁶⁷ These four markets and the accompanying metrics were agreed upon during the Counting on the Environment process in 2009. Since then, several new metrics have been in development, but so far, none of those new metrics has received the kind of formal and explicit support like these four.

Adamus and Stockwell 1983). Paul Adamus, a well-known wetland scientist affiliated with Oregon State University, developed both WET and ORWAP. The earlier measurement system was developed at the request of the Federal Highway Administration in the early 1980s, and was used to improve that agency's environmental impact assessment capabilities.

The third measurement system in the Willamette Marketplace is "Ecometrix." This futuristic name refers to a suite of spreadsheets that can be used to assess an entire range of ecosystems, like wetlands, forests and prairie. The engineering firm Parametrix originally developed this system in 2002 for Oregon's Department of Transportation. It was created to help the agency monitor the adverse environmental impacts of a large-scale bridge repair and replacement program and to provide appropriate compensation for those impacts.⁶⁸ All three of these measurement systems were largely in place before the formal creation of the Willamette Marketplace in 2009. The fourth metric in the Willamette Marketplace, the Upland Prairie Habitat Calculator was modeled after ORWAP, and developed by the same person, yet differs substantially from ORWAP. This metric was the only one created entirely during COTE.

All of these measurement systems were developed to assess the characteristics of radically different types of ecosystems in different contexts, and for different purposes. So while ORWAP, the Shade-a-Lator, Ecometrix and the Prairie Calculator take the form of spreadsheets and now perform a somewhat similar function within the ecosystem

⁶⁸ This program is an integrated effort to repair, replace or improve over 300 bridges in Oregon. The goal of creating Ecometrix was to enable integrated compensation of the environmental impacts of these repairs. Rather than replacing all unavoidable impacts at the site of each bridge, the goal was to invest in larger, more integrated environmental conservation and restoration efforts. To ensure a rough equivalency between the environmental impacts and those compensation efforts, a measurement system had to be developed. For a description of this integrated mitigation effort, see: http://ecosystemcommons.org/sites/default/files/odot_bdp_case_study_final.pdf Last accessed on: 07/10/2013.

services marketplace, they are very different tools, from a scientific, economic and regulatory point of view. Whereas the Shade-a-Lator is only relevant in riparian areas, the wetland and prairie metrics are based on landscape categories. Ecometrix is applicable to a variety of ecosystem types, but in the context of the COTE process, it was adjusted to assess salmon habitat.

The measurement systems developed in the context of the Chesapeake Bay water quality-trading program are quite different again. Here, two models and a calculation method, with more conventional names, are at the center of measuring and crediting ecosystem services, i.e. the Chesapeake Bay Watershed Model, the Nutrient Tracking Tool and Nutrient Net (see table 3.2). Each performs different, although sometimes overlapping, functions in measuring and trading credits.

Table 3.2 Chesapeake Bay Watershed Water Quality Trading Models and Calculators

Primary Purpose	Model	Developed by
Water Quality Monitoring	Chesapeake Bay Watershed Model	Environmental Protection Agency
Modeling Nutrients	Nutrient Tracking Tool	Tarleton State University
Calculation of Credits	Nutrient Net	World Resources Institute

The Chesapeake watershed’s measurement systems differ from those in the Willamette Marketplace in basic appearance. They are not spreadsheet-based lists that can be readily accessed or altered. Instead, they are complex computer models, into which a user can enter data via an online form. The underlying calculations that produce the output occur on a server as far afield as Texas.

As in Oregon, these technologies have a long and complex history. The Chesapeake Bay Watershed Model was created in 1982, largely by engineering firms Hydrocomp, Inc. (Donigian et al. 1976) and Camp, Dresser and McKee, now CDM

Smith (Hartigan, Quasebarth, and Southerland 1983). The EPA funded the development of the models, and while the first version was proprietary, all subsequent versions have used public domain code (Linker et al. 2002). Despite early criticism (Schnabel and Gburek 1985) and countless upgrades and refinements, the model has been in continuous use ever since.

The Nutrient Tracking Tool (NTT) is an optimization model that calculates both environmental and economic trade-offs inherent in agricultural management practices, primarily at the level of an individual farm. The Texas Institute for Applied Environmental Research at Tarleton State University produced the first version of the model in 2009, with funding from the Department of Agriculture's Office of Environmental Markets. The heart of the model, the Agricultural Policy Environmental eXtender (APEX) was originally applied to dairy farming in Texas and Iowa, as part of an EPA-funded project started in 1992 (Osei et al. 2000).

The third part of the measurement systems central to the efforts to create markets in the Chesapeake Bay is Nutrient Net. The not-for-profit World Resources Institute created it in 2007 as part of an effort to develop a voluntary water-quality trading system in collaboration with a Native American tribe in Michigan.⁶⁹ This EPA-funded attempt to start a market in the Kalamazoo watershed did not result in any actual trades, but Nutrient Net calculators have since been tailored for use in Pennsylvania, West Virginia and Maryland. These versions of Nutrient Net differ, and still another version is under development to enable trading at the scale of the entire Chesapeake Bay watershed,

⁶⁹ For a description of the project, see this factsheet written for the EPA's Targeted Watershed Grant program:
http://water.epa.gov/grants_funding/twg/upload/2007_07_09_watershed_initiative_2004_kalamazoo-2.pdf
Last accessed on: 07/10/2013.

including Delaware, New York and the District of Columbia. The different versions of Nutrient Net perform somewhat different tasks in each state, but the most recent version essentially translates inputs from landowners into data that the NTT and CBWM can use to produce credit calculations.

This acronym-filled overview of the history of the measurement systems in the Willamette River basin and Chesapeake Bay watershed reflects the complicated regulatory environment in which measurement systems have to function, as well as the fact that different efforts under the broad rubric of creating ESMs have in fact led to different approaches to measuring ecosystems services. The increasing diversity of measurement systems has not gone unnoticed in the academic and professional communities that follow the development of ESMs. Repeated calls for standardization have been voiced (Boyd and Banzhaf 2007; Willamette Partnership, Pinchot Institute for Conservation, and World Resources Institute 2012). The reasons such standardization is difficult to achieve, however, becomes apparent if we look in more detail at the adjustments that have been made in trying to make these systems work in practice in Oregon and the Chesapeake Bay states.

3.b. Models and Baselines in the Chesapeake Bay

To determine how many ecosystem service credits should be awarded for a specific restoration project, the first step is to determine the *baseline* condition at a specific site, plot or farm. Baseline determination is crucial since the potential for perverse incentives in ecosystem service markets is significant. For example, a forest landowner with a productive forest regularly harvests his trees, sells them as timber and

then replants. But as he becomes aware that a market is being created, it could be tempting for to use the moment he plants new trees to generate ecosystem service credits instead, essentially generating an additional source of revenue. So, the baseline has to reflect the current environmental state of a site, as well as any ongoing land management practices, or what is known as Business As Usual (BAU). A linked concept is *additionality*. This refers to the requirement that only moving above a baseline generates credits. A credit is allocated when a landowner implements a new restoration activity or significantly expands an existing practice, for example by widening a riparian buffer from 35 to 100 feet.

Baselines and Additionality in Practice

How to determine the pre-existing level of ecosystem service production is not straightforward. Land management practices change constantly, and certain aspects of land use are already regulated. This means that many landowners have an existing legal obligation to maintain riparian buffers of a certain width and to refrain from applying fertilizer within 100 feet of creeks or rivers. To award the landowner credits for the installation or maintenance of such practices that are already required would effectively turn an ESM into a subsidy for landowners to meet their legal obligations. Many environmental organizations view this as a deeply problematic approach, since the creation of an ESM would provide little additional environmental improvement.

In addition, a wide variety of management practices aimed at improving water quality can generate credits in the Chesapeake Bay, making it difficult to develop consistent and reliable estimates of how effective they are. Whereas the only calculation

the Shade-a-Lator performs is to translate tree planting into kilocalories per day, the environmental activities that can generate credits in a nutrient trading scheme encompass a much broader range. Trading programs for non-point sources include the potential to reduce runoff and generate credits by planting trees or grass. These can be regarded as “ecosystem service-based management practices,” but require assumptions about tree and grass growth, as well as maintenance. Other management practices, like constructing fences that keep livestock away from streams, preventing manure from entering streams, also generate credits in these trading systems. These might be somewhat easier to calculate, but still involve dynamic ecological processes like nitrogen uptake and dispersion in water bodies.

The combination of different interventions creates a problem for accurate and detailed calculations of credits, but what makes measuring additionality for market purposes even more complicated is that the implementation of different kinds of Best Management Practices on a single farm can be funded by different sources, and is sometimes required in one county but not in the next. So, to determine the eligibility and quantity of credit generation requires combine ecological, financial and regulatory information that can vary dramatically from farm to farm.

Establishing an accurate baseline and taking account of additionality are both legal and scientific issues in the Chesapeake Bay. There was a basic trade-off made in designing a way to determine the baseline in each area. This required handling the tension between cost and uncertainty.⁷⁰ A sophisticated, comprehensive, and therefore often more expensive, measurement system can decrease uncertainty about the exact

⁷⁰ A good example of this kind of presentation of baselines is Marshall and Weinberg 2012, an economic brief prepared by the United States Department of Agriculture’s Economic Research Service.

level of ecosystem service production before and after any intervention, while a simpler system might be cheaper but is likely to increase the level of uncertainty. Adding variables about the filtration effect of specific plants or grasses is a complex affair, which requires serious investments. In the following section, I will further elaborate on this tension by comparing baseline assessment procedures, and the role that various measurement systems play in them, in Pennsylvania and Maryland.

Nutrient Models in the Chesapeake Bay Watershed

The four states in the Chesapeake Bay Watershed that enable landowners to claim credits on their land by reducing run-off use different methods to determine the baseline and the number of credits that will be offered. Given these differences, the various models that have been developed to assess nutrient and water quality levels are used to calculate the number of credits in different ways (see Table 3.3). The primary “currency” in all of these water quality markets is the number of pounds of nitrogen or phosphorous per year delivered to the tidal waters of the Chesapeake Bay. Current levels of nitrogen and phosphorous runoff levels, as well as estimates of future levels after the implementation of Best Management Practices, are incorporated into baseline estimates and credit calculation in ways that vary substantially among the states. Since no credit trades have taken place in West Virginia and this trading scheme exclusively exists on paper, I will not describe it beyond its inclusion in the table that follows.

The specific methods that have been developed to create and facilitate the water quality trading schemes in these states are quite different (see table 3.3). While this is not surprising, it is contrary to the formal goal of the EPA to create an integrated market for

the entire watershed.⁷¹ The existence of state programs means that the different histories and capabilities lead to different models being incorporated in different ways.

Table 3.3 Chesapeake Bay States Baseline and Credit Calculation Methods⁷²

State	Baseline	Credit Calculation
Maryland	Number of lbs. per acre based on CBWM	Combined Model based on Nutrient Tracking Tool and Nutrient Net
Pennsylvania	Meeting existing state regulatory requirements	Nutrient Net (PE version)
Virginia	Meeting portion of state TMDL goal, based on implementing specific BMPs	Set of tables based on CBWM
West Virginia	Number of lbs. per acre based on Tributary Strategies	Nutrient Net (WV version)

In the Chesapeake Bay watershed, the legally mandated water quality goals, or “cap” in the market context, are based on the Chesapeake Bay Watershed Model (CBWM) (Linker et al. 2002) and set for each state and major river basin within those states. The model is connected to an extensive network of water quality monitoring stations, so it is calibrated and updated regularly. The CBWM calculates runoff at the scale of “land segments,” loosely based on the 254 counties and incorporated cities in the watershed.⁷³ The average size of each segment is approximately 66 square miles. This is

⁷¹ See for example:

http://www.epa.gov/reg3wapd/pdf/pdf_chesbay/Phase2WIPEvals/Trading_Offsets/PortfolioOfReports.pdf last accessed on: 08/15/2013.

⁷² The information in this table is adapted from the World Resources Institute’s Fact Sheet “Comparison Tables of State Nutrient Trading Programs in the Chesapeake Bay Watershed”, May 2011, available at: http://www.chesbay.us/Nutrient%20Trading%20Media/comparison_tables_of_state_chesapeake_bay_nutrient_trading_programs.pdf Last accessed on 06/03/2013.

⁷³ There are actually 309 land segments in the current version of the model, since certain counties were further divided. For a detailed description of the creation of the segments, and maps of the segmented watershed, see Section 3 of the EPA’s 2010 report in Phase 5.3 of the Watershed Model, available at: ftp://ftp.chesapeakebay.net/modeling/P5Documentation/SECTION_3.pdf Last accessed on: 06/03/2013.

too coarse to determine an individual landowner's contribution to the phosphorous and nitrogen loads in a stream. So, state trading programs have developed methods to set baselines that will help to achieve standards set using the CBWM, but cannot rely exclusively on this model.

The First Baseline in Pennsylvania

Pennsylvania's trading program sets the baseline from which credits can be developed at the existing implementation of specific, required management practices for farmers, like having installed riparian buffer zones and a formal nutrient management plan. So the first step towards developing credits is the determination of whether or not the current management practices on a farm comply with existing regulatory requirements, a so-called "practice-based" baseline. This baseline is easy to assess since all that is required is a site visit and a brief review of existing documentation, like a nutrient management plan. If the level of implementation of those management practices is adequate, a landowner can be issued credits for the implementation of additional Best Management Practices, like fencing riparian areas to prevent livestock from entering the water or widening buffer zones. Since all states in the Chesapeake Bay watershed already require some form of riparian buffer zone, in most cases increasing the width of the vegetated buffer, from 35 feet to 100 feet, for example, can generate credits, whereas widening it from 25 feet to 35 feet, is simply considered necessary to "get to baseline" in Pennsylvania.

However, this "practice-based" baseline is generally seen as easy to reach, and not providing reasonable assurance that credits actually represent meaningful water quality

improvements. Uncertainty over the best way to establish the baseline is limiting the success of the market. As an influential credit broker in the region describes:

We still think the Pennsylvania market right now is squirrely just because we know of all the markets it's probably the one that has the least high baseline and the most concern from the resource agencies and the environmental community. So those pricings to me reflect that. (George Kelly, interview with author, 11/20/2011)

His statement is essentially a simultaneous political and legal evaluation of the baseline-setting method in Pennsylvania. It anticipates resistance from regulators and advocacy groups. This view was correct, since not only the EPA, but also a prominent environmental organization, Penn Future, were unhappy with this approach.⁷⁴ The advocacy organization suggested that Pennsylvania develop a new baseline method more similar to the one implemented in Maryland following a detailed review of the Pennsylvania's program..⁷⁵

In its 2012 review of the water quality trading schemes in the Chesapeake Bay states, the EPA's first and most prominent request for Pennsylvania was to provide a quantitative demonstration that its baseline meets the standards set in the TMDL.⁷⁶ Pennsylvania's Department of Environmental Protection did not provide such a demonstration. It argued instead that it used the quantified models, i.e. the CBWM and Nutrient Net appropriately in the calculation of credits, not in baseline determination. The

⁷⁴ For the EPA's assessment of the baseline method, see its Final Report on the Phase 2 Watershed Improvement Plans, pp. 3, available at:

http://www.epa.gov/reg3wapd/pdf/pdf_chesbay/Phase2WIPEvals/Trading_Offsets/PAFinalReport.pdf
Penn Future's assessment was based on an evaluation prepared by Century Engineering. See pp. 14 available at:

http://www.pennfuture.org/UserFiles/File/Water/RespFarm/Report_NutrientTradingEval_20110919.pdf
Both accessed on: 08/15/2013.

⁷⁵ See the report mentioned in the previous note and in particular pp. 14-15.

⁷⁶ For the entire review, see:

http://www.epa.gov/reg3wapd/pdf/pdf_chesbay/Phase2WIPEvals/Trading_Offsets/PortfolioOfReports.pdf
Retrieved on: 08/15/2013.

Department went on to assert that the baseline determination method could be expected to produce significant water quality improvements, at least in part since “trading, in and of itself, inspires higher levels of compliance by nonpoint sources due to the possibility of financial rewards for selling credits.”⁷⁷ The argument here is that a baseline, which is easy to reach for landowners, is likely to achieve environmental quality improvements since many farmers will participate.

In response, the EPA simply reiterated its request for some kind of evidence to back up this assertion, leaving it unclear exactly what would happen if Pennsylvania continued to use its method of calculation. While data are not yet available regarding water quality trading activities in Pennsylvania following EPA’s formal challenge, the expectation among credit brokers was that water treatment utilities would prefer to purchase credits from other point sources, to avoid a potential legal challenge to the legitimacy of their compensation methods. This disagreement over the way baselines should be calculated in Pennsylvania is a serious threat to the overall viability of its non-point source credit system, the part of its market-creation effort that most closely conforms to the elements of an ESM.

Maryland and Virginia Develop Two More Baselines

In Maryland, the proposed method of baseline determination is completely different. The Maryland Department of the Environment (MDE) released its nutrient trading policy in January 2008, and has been working with WRI to develop its version of

⁷⁷ *Supra* note. The response from the Pennsylvania Department of Environmental Protection is on pp. 30.

Nutrient Net, specific to that state's policy and associated regulations.⁷⁸ Despite these efforts, the trading scheme has actually not been used to generate credits. No trades have taken place.⁷⁹ Here, the inverse situation seems to be true. The baseline is fully quantified and provides some assurance that efforts to go above it will result in real water quality improvements. However, this has made it so difficult to generate credits that no landowners have tried. This lack of "credit supply" is frequently mentioned as a key obstacle to further development of this ESM.

The Maryland baseline is "performance-based," meaning that a quantitative standard for nutrient discharge is set for each plot. Only after this standard is met, can a farmer become eligible to generate credits for additional BMPs. The method to establish the quantitative standard starts with segment-based CBWM calculations. The model estimates a number of pounds per acre for a specific plot, based on the TMDL. That standard is then compared to a number of pounds per acre calculated by WRI's Nutrient Net and the USDA's Nutrient Tracking Tool models. The second number is based on field-specific data entered into an online site that requests information about current land management practices, soil types and other highly local data. If the current estimated runoff, in pounds per acre, based on the Nutrient Net/NTT calculation, is higher than the estimate generated by the CBWM, the landowner does not meet baseline, and cannot be issued credits for any improvements.

This method of baseline determination has been criticized for making it too difficult to attain baseline, preventing trades from actually occurring. While the EPA

⁷⁸ For a brief overview of this program, see: http://www.dnr.state.md.us/es/pdfs/nutrient_trading.pdf Last accessed on: 08/03/2012.

⁷⁹ Two credit generation proposals can be found on Maryland's credit registry: <http://nutrientnet.mdnutrienttrading.com/trade/projects.app> Both were submitted in 2011, and have not been purchased as of 08/15/2013. Last accessed on: 08/15/2013.

supports this approach, a well-known credit broker, Doug Lashley from Greenvest, Inc, believes it's far too stringent to generate sufficient credits based on short-term BMPs like riparian buffer zones:

So, I know there's a lot of science behind it, but it's all temporary; it's all for temporary measurements the Nutrient Net. So we're going to try to advocate something else, because if they use Nutrient Net, they'll never have banking in Maryland at all. They just won't, there's no economic incentive to do it. (Interview with author, 11/14/2011)

Lashley favors permanent conversion of land uses to justify credit generation. This is an approach that has been strongly discouraged in Maryland to protect the agricultural sector and prevent urban sprawl through tax incentives and easements.⁸⁰ He mentions a second reason why he opposes this method of establishing a baseline - to limit the number of assessment and monitoring visits to a farm required during the life of a restoration project:

They [farmers] don't want to invite the regulators out there to nose around, peek under the tent we call it, because once you peek under the tent you've got to let a regulator out there; they say that's wrong, that's wrong, that's wrong, and all of a sudden it cost money to correct all of that. (Interview with author, 11/14/2011)

His comments highlight how difficult it is to develop measurement systems that are considered adequate. This idea of requiring a detailed calculation of the *performance-based* baseline is criticized on both economic and regulatory grounds. Although the exact formulation of the reasons might vary, other credit brokers have voiced similar reactions to this baseline determination method.⁸¹

⁸⁰ For more information on the easement program at the state level, see: <http://www.malpf.info/facts.html> Information on the tax-assessment, see: <http://www.dat.state.md.us/sdatweb/agtransf.html> Both accessed on: 08/16/2013.

⁸¹ Specifically, both Peter Hughes and George Kelly expressed the belief that credit trading with nono-point sources would remain extremely limited under this method.

In Virginia, a third method has been developed to establish baseline and support credit calculations. As in Maryland, a specific number of pounds of nitrogen or phosphorous must be calculated, but in Maryland this is based on the state's goal for runoff reduction in that part of the watershed. To calculate the number of credits that a landowner receives for the implementation of a BMP, Virginia uses a set of static tables based on the BMP effectiveness estimates in the CBWM. These allocations are not tailored to the specific location of land, and as of July 2013, no trades have taken place using this regime either. The state is actively working to revise its nutrient trading rules, and while baseline determination is a prominent concern, a method for making the calculation has not been finalized.⁸² While there have been water quality trades in Virginia, they have occurred between point sources. Water treatment facilities have installed upgrades and sold the excess capacity to other facilities that lack those upgrades. In order for landowners to enter this trading scheme and receive credit for the installation of BMPs, substantial changes will have to be made.

While the CBWM plays an important part in establishing runoff standards at the state (and county) level, it is used in different combinations with NTT and Nutrient Net to establish the baseline for credit calculations. Baseline conditions have been defined in particular ways in each of the states. Pennsylvania has seen a significant number of trades, but is under pressure from the EPA to alter its baseline estimation method. Maryland has developed a calculation procedure that can count on EPA's approval, but has not seen any trading activity. Virginia has only seen trades between point sources. Its baseline method for non-point sources remains untested.

⁸² See: http://www.dcr.virginia.gov/other/deq/laws_and_regulations/lr6.shtml Last accessed on 07/10/2013.

The baseline determination methods in Pennsylvania and Maryland are fully developed, but continue to undergo adjustments in response to numerous sources of criticism. While each state has to respond to unique challenges, they all face profound difficulties in creating measurement systems that satisfy regulators, credit developers and credit buyers.

The extended timeline in Maryland and Virginia, as well as the serious criticism of the baseline method in Pennsylvania, have contributed to a strong sense of instability facing many potential actors in these markets. Stakeholders continue to advocate radical changes in key elements of measurement systems and their implementation, sometimes based on experiences in other states, but frequently because they do not see how what has been proposed makes economic or environmental sense. Given that water quality trading for non-point sources in the Chesapeake Bay was first proposed in 1995, and that the initial baseline method for agricultural sources was established in 2006 in Pennsylvania, it's easy to see that creating a measurement system for an ESM is exceedingly difficult.

3.c. Banking on Ecosystem Services in Oregon

The problem of creating a satisfactory method of determining the baseline from which credits can be generated shows that the most basic elements of measurement in ESMs can easily become contested. Even when a method to calculate the basic elements of a potential credit generating restoration project exists, the specific requirements of ESMs necessitate simplifications and adjustments. These alterations can become problematic enough to prevent widespread use or acceptance of any measurement system.

In Oregon, the developers of the Willamette Marketplace worked on four types of ESMs, which they hoped to integrate into a single Marketplace. Two focused on specific landscape types, namely wetlands and upland prairies. Contrast this to systems like the Shade-a-Lator or the Nutrient Tracking Tool, developed to credit individual ecosystem services, like water-cooling or nutrient removal. The intent of landscape-based measurement is to establish equivalence between locations where wetlands or prairies have been damaged or removed and those locations where wetlands or prairies have been restored or created.

The Oregon Rapid Wetland Assessment Protocol (ORWAP) and the Prairie Habitat Calculator, as they are known, are different from the models and calculators in the Chesapeake Bay, although they do face many of the same challenges. During the Counting on the Environment process and since then, much work has been done to create, adjust and improve these measurement systems.

The outcomes of this work show that the easy-to-use credit measurement tools envisioned by ESM creators are incredibly difficult to implement in practice. The tensions between simplicity and detail as well as cost-effectiveness and thoroughness were hard to handle. Ultimately, despite extensive negotiations and the continued evolution of elaborate credit calculation procedures, both the regulating agencies and experienced restoration professionals remained deeply ambivalent about ORWAP and the Prairie Habitat method. In the case of ORWAP, implementation has been limited to state-funded projects. There is substantial uncertainty about its future. The Prairie Habitat Calculator has not been used to develop any credits within the context of an ESM or any kind of similar institution.

Wetland Mitigation Banking and Ecosystem Services

Oregon has allowed *wetland mitigation banking*, a practice to protect and restore wetlands under the Clean Water Act and Oregon's Removal-Fill program, for many years.⁸³ In general, anyone who fills, drains or otherwise degrades a wetland is required to compensate for the damage they cause if it cannot be avoided or minimized. Compensation can be achieved by restoring wetlands in some other location or by simply buying *wetland credits* from someone else that has already restored or built a wetland. Wetland banking, as it is sometimes called, is a complicated field with a long history.⁸⁴

Rather than trying to create a completely new approach, the participants in the COTE process decided to build on a measurement system that was already under development. They selected the Oregon Rapid Wetland Assessment Protocol, or ORWAP, and the participants in the COTE process intended to use it to calculate the "ecosystem service production" of wetlands. They hoped to ensure the precise equivalence of a wetland destroyed and one restored as a means of compensation. ORWAP was originally developed at the request of the Oregon Department of State Lands. This agency oversees Oregon's wetland mitigation banking program. Given the long history of wetland banking, ORWAP was not the first or only effort to ensure the equivalence between impact and restoration in Oregon.

⁸³ See: <http://www.oregon.gov/DSL/PERMITS/Pages/r-fintro.aspx> Last accessed on: 08/16/2013.

⁸⁴ For a description of the complicated history of wetlands regulation, definition and classification, see (Lewis 2001).

The “*hydrogeomorphic*” or HGM method predates ORWAP and remains in use in Oregon and much of the rest of the United States today.⁸⁵ It is based on a characterization of *reference standard* sites. It highlights any deviation from those ideal-typical conditions at a potential restoration site. The HGM method identifies five basic types of wetlands along with local and regional variations. Establishing locally specific reference standards and comparing particular wetlands across these types and local standards is difficult. In practice, a ratio is often applied to determine how many acres of wetlands need to be restored. For every acre of degraded wetland, three acres have to be restored. This ratio-based approach to mitigation is common throughout the United States, but is also allows low quality wetlands, from an ecological point of view, to be used to compensate for the destruction of highly valued ones. This has resulted in a series of legal challenges,⁸⁶ as well as an extensive study by the National Research Council (2001). That study, conducted by a panel of renowned experts in the field of wetland ecology, revealed that many of the restored wetlands were poorly maintained and of limited ecological value.

These legal challenges, the National Research Council’s broad critique of wetland restoration, and the fact that reference standard sites are only available for a limited number of wetland types and locations in Oregon, motivated the development of a more

⁸⁵ For an introduction to the HGM approach, see: <http://el.erdc.usace.army.mil/wetlands/overview.html>
Last accessed on: 08/17/2013.

⁸⁶ A useful overview of the history of litigation that is relevant to wetlands can be found on Prof. Morgan Robertson’s personal website, morgan-robertson.com. Important cases with direct implications on the determination of what is and is not a “jurisdictional” wetland include: *United States v. Ashland Oil* (1974), *NRDC v. Callaway* (1975), *United States v. Riverside Bayview homes* (1985). Together, these and other cases emphasized that the Clean Water Act applies to waters that are “navigable”, or “adjacent” to “navigable” waters. Navigable and adjacent wetlands are protected by the Clean Water Act and fall under the purview of the federal government as a result of the Commerce Clause. This means that the establishing a hydrological connection between wetlands and waterways, as well as physical proximity is an important part of the measurement systems used in wetland protection and banking.

comprehensive and precise measurement system for wetlands in Oregon. The Department of State Lands received funds from the EPA to work on ways of assessing all five types of wetlands, facilitating quantitative comparisons throughout Oregon.

The perceived low environmental quality of compensatory wetlands continues to motivate efforts to improve the environmental effectiveness of wetland mitigation banking. The creation of ORWAP is an example of one such effort, in both environmental and legal terms. While wetland mitigation banking predates the emergence of the ecosystem service concept,⁸⁷ an important part of the literature on ESMs in the United States refers to wetland mitigation banking as an important example of an ESM. (Womble and Doyle 2012; Shabman, Stephenson, and Shobe 2002)

The development of, and later adjustments to, ORWAP highlight the challenges to creating measurement systems for ESMs. The original goal of this metric was to produce a detailed and reliable accounting of the functions of a wetland, both before and after any adverse impact, and especially before and after restoration. The calculation of the ecosystem services provided by a wetland was added later in an attempt to simplify the outcome of the measurement system and produce a single numerical score. In other words, ORWAP is an attempt to connect the decades-long history of wetland mitigation banking to the requirements of ESM. In addition, ORWAP significantly influenced the development of measurement tools in other emerging ecosystem service markets.

Nevertheless, an analysis of the current wetland credits available for sale in Oregon shows that out of 22 wetland restoration “banks,” only three have used

⁸⁷ The first wetland mitigation bank, the Tenneco LaTerre Mitigation Bank in Louisiana, was established in 1984. For two very different timelines of the history of mitigation banking in the United States, see: <http://www.msusa.com/timeline/> (developed by a mitigation banking firm) and http://blog.as.uky.edu/robertson/?page_id=197 (developed by Morgan Robertson). Both accessed on 05/21/2013.

ORWAP's ecosystem service-based method to calculate credits.⁸⁸ Those three have all been undertaken by the State of Oregon, meaning that the uptake of this new measurement system among private and municipal wetland bankers has been non-existent.

Quantification and Simplification: The ORWAP Spreadsheet

At the center of ORWAP are a series of functions, coded into an excel spreadsheet. To count the ecosystem services produced by a particular wetland, ORWAP users rely on aerial photography to delineate the wetland. Then they gather additional data using a variety of online tools (like the soil type using the NRCS soil survey). Finally they fill out ORWAP "data forms" (Adamus, Morlan, and Verble 2009). These forms are essentially long lists of questions about the wetland, like what kind(s), if any, of non-native aquatic animals can be found, (F31) which herbaceous species are dominant, (F42) and whether or not the timing of water flow into the wetland has changed recently. (S5) Once those data forms, which include 140 such indicators, are completed, the excel spreadsheet calculates a set of outcomes.⁸⁹

⁸⁸ See: http://www.oregon.gov/dsl/PERMITS/Pages/mitbank_status.aspx Last accessed on: 08/15/2013.

⁸⁹ Each ecosystem function or value score is calculated based on the relevant indicators, using a specific "scoring model". For example, the Pollinator Habitat score is estimated as the average of three groups of indicators, namely (1) the average of: percent of surrounding area comprised of native vegetation, proximity to closest patch of native vegetation, and size of that patch; (2) the average of: percent cover of native (vs. non-native) herbaceous plants and especially non-graminoids, percent cover of native (vs. non-native) woody plants, extent of downed wood, extent of snags and large-diameter trees, and presence of regionally uncommon herbaceous plants; and (3) the average of: percent of wetland not submerged by persistent water, infrequent fires and vegetation removal, vegetation height diversity, intermediate ground cover, large extent of microtopographic variation, presence of nearby rocky areas, and minimal soil disturbance. In slightly more mathematical terms, this is expressed as: (POL) =

$$[\text{AVERAGE}(\text{natveg}, \text{natvprox}, \text{natvacres}) + \text{AVERAGE}(\text{gramin}, \text{herbsens}, \text{herbrare}, \text{woodynn}, \text{woodydbh}, \text{downwood}) + \text{AVERAGE}(\text{lomarsh}, \text{persist}, \text{firehay}, \text{htunif}, \text{gcover}, \text{girreg}, \text{cliff}, \text{soildisturb})] / 3$$

All the scoring models are described in these narrative and mathematical terms in Appendix B of the ORWAP Manual, along with the results of the repeatability and sensitivity analyses. The Manual is

These calculations include a whole host of assumptions and simplifications which have very little to do with “pristine” wetlands. In fact, the scoring is more like a composite report card grade than an actual measure of the disturbance that a wetland has experienced. As the ORWAP manual clearly indicates:

“The numeric estimates ORWAP provides of wetland functions, values, and other attributes are not actual direct measures of those attributes, nor the products of validated mechanistic models of ecosystem processes. Rather, they are estimates of those attributes arrived at by using standardized scoring models that systematically combine well-accepted indicators.” (Adamus, Morlan, and Verble 2009b, 4)

This means that the inclusion (and exclusion) of indicators is important. And, the way in which indicators are transformed into a score, which is the basis on which “credits” are bought and sold, is highly subjective. The developers are keenly aware of this. Paul Adamus emphasizes the need for close review of the methods used in ORWAP:

“Because there is a lot of subjectivity in that we don't – these are not mechanistic models. They are not deterministic models. They are more heuristic, expert system type models and because of that, it's hard to come down and say yes, this is absolutely correct or this is absolutely incorrect.” (Interview with Author, 07/15/2011)

He raises questions about who’s involved in the creation of a measurement system. He is also asking, implicitly, about the ability of non-experts to challenge or at least question the assumptions embedded in the measurement process.

To most casual observers the complexity of these calculations obscures the assumptions and subjectivity involved. The ORWAP spreadsheet includes more than 140 indicators and calculates scores for sixteen ecosystem functions. (see table 4.1 for the complete list) These include *water storage & delay (WS)* and *water bird nesting habitat (WBN)*. These scores are, much like a report card, on a 0-10 scale. Water storage is

available at: http://www.oregon.gov/dsl/WETLAND/docs/orwap_manual_v2.pdf Last accessed on: 07/11/2013.

commonly considered an ecosystem service, but here it is only a small part of a much larger calculation of functional acreage. *Water storage & delay*, as well as the other fifteen functions is scored based on the relative *effectiveness* with which a wetland “produces” them. In addition, the relative *values* of those 16 functions are calculated (see tables 3.4 and 3.5).

Table 3.4: Oregon Rapid Wetland Assessment Protocol Function and Value Scoresheet⁹⁰

WETLAND FUNCTIONS	Relative Effectiveness of the Function	Relative Values of the Function
Water Storage & Delay (WS)	3.20	7.29
Sediment Retention & Stabilization (SR)	4.65	5.40
Phosphorus Retention (PR)	4.79	6.26
Nitrate Removal & Retention (NR)	5.18	5.75
Thermoregulation (T)	5.28	2.50
Carbon Sequestration (CS)	2.83	
Organic Matter Export (OE)	6.36	
Aquatic Invertebrate Habitat (INV)	4.74	7.00
Anadromous Fish Habitat (FA)	0.00	4.67
Non-anadromous Fish Habitat (FR)	3.09	3.33
Amphibian & Reptile Habitat (AM)	5.71	8.00
Waterbird Feeding Habitat (WBF)	4.67	4.67
Waterbird Nesting Habitat (WBN)	3.89	3.50
Songbird, Raptor, & Mammal Habitat (SBM)	5.28	6.67
Pollinator Habitat (POL)	4.29	5.00
Native Plant Diversity (PD)	5.34	7.00

These sixteen *functional effectiveness* scores, as well as the *values* scores, are translated into more workable lists of “grouped scores.” Combining the maximum outcomes of the list of original scores produces this number (see table 3.5). The move to simplify is intended to make it easier to see the overall quality of a wetland in a single view, as opposed to having to parse effectiveness and value scores for each of the sixteen wetland functions. These scores are also standardized so that they fall between 0 and 10.

A significant amount of work is required to gather all the necessary information.

⁹⁰ The scores in this table are based on the training materials provided by the Willamette Park during the verification training. The wetland is located in Starker Park, just outside of Corvallis, OR.

An EPA official described that state of ORWAP’s development as: “ORWAP is a very robust tool, and even though we designed it to be rapid, in reality it is not very rapid. It does take a fair amount of work, both field and office work, in order to plug things in.” (Vallette, Interview with Author, 11/07/2011).

Table 3.5 Oregon Rapid Wetland Assessment Protocol Grouped Scoresheet⁹¹

GROUPED FUNCTIONS	Group Scores (functions)	Group Scores (values)	Calculation Descriptions
Hydrologic Function (WS)			(identical to Water Storage and Delay function and value scores)
	3.20	7.29	
Water Quality Group (WQ)			(maximum of scores for SR, PR, NR, and T)
	5.28	6.26	
Carbon Sequestration (CS)			(identical to Carbon Sequestration score above)
	2.83		
Fish Support Group (FISH)			(maximum of scores for FA and FR)
	3.09	4.67	
Aquatic Support Group (AQ)			(maximum of scores for OE, AM, INV, WBF, and WBN)
	6.36	8.00	
Terrestrial Support Group (TERR)			(maximum of scores for PD, POL, and SBM)
	5.34	7.00	
Public Use & Recognition (PU)			
		5.38	
Provisioning Services (PS)			
		0.00	

It is difficult to trade ecosystem services credits based on multiple grouped functional effectiveness scores or other grouped value scores. In order to enable trading, the proponents of the Willamette Marketplace, together with Paul Adamus, decided to calculate the average of the grouped functional effectiveness scores so they could produce a “*functional acreage*” score between 0 and 1. The idea of “functional acreage” assumes that one acre of “pristine” wetland hypothetically produces a score of 1 functional acre. At the same time, one acre of a completely degraded or developed wetland would produce zero functional acres. By calculating this composite score before and after a restoration effort, an increase would mean that wetland “functions” had been created. These newly produced functions can be used to compensate wetland damage or a

⁹¹ See the previous note for an explanation of where the specific scores in this example originated.

“loss of function” somewhere else. To calculate the overall functional acreage of a wetland, that composite score is multiplied by the total acreage of the wetland (see table 3.6 for this calculation based on the scores in tables 3.4 and 3.5).

Table 3.6 Counting On The Environment ORWAP Wetlands Credit Calculation

GROUPED FUNCTIONS	Baseline Effectiveness	Post-enhancement Effectiveness	
Hydrologic Functions (WS)	3.20	3.20	
Water Quality Function (WQ)	5.28	5.80	
Fish Support (FISH)	3.09	3.09	
Aquatic Support (AQ)	6.36	6.36	
Terrestrial Support (TERR)	5.34	7.22	
Average Scores * 0.1	0.47	0.51	
* acres	6.47	6.47	
Functional Acres = Credits	3.01	3.29	0.28

To determine the number of credits that will be issued, functional acreage is calculated before any restoration activity is undertaken. This establishes a baseline. After restoration, or *enhancement*, a new ORWAP assessment is produced, typically generating a higher functional acreage score. The difference between these two, multiplied by the acreage, produces the number of “credits” generated by the restoration activity (see table 3.6). The same process can also be used before and after the (partial) filling of a wetland, to calculate how many wetland-credits a developer has to purchase.

Problems and Challenges for ORWAP

The final step in ORWAP credit calculation requires a number of non-trivial judgments. First, the value scores are completely excluded from the final score. This

means that certain considerations, like *public use and recognition* (PU) and *provisioning services* (PS), which are considered ecosystem values, not functions under ORWAP, are not incorporated into the overall determination of functional acreage. The exclusion of a score for *public use and recognition* is understandable from an ecological point of view. Such a score is based on indicators like what percentage of the wetland is visible from public spaces (F65) and how accessible the wetland is for the public. (F67) That makes the score qualitatively different than an indicator like the number of pieces of downed wood longer than 6 feet in length (F59) present in the wetland. The overall calculation of “functional acreage” is somewhat analogous to a wetland’s Grade Point Average (GPA). The ORWAP manual clearly states that the individual function and value scores are more like a report card score than a straightforward calculation of a wetlands’ ecological functioning. So why not include public access in that GPA?

Given the complexity of the actual calculation, it makes little difference whether 5 or 6 grouped scores are used to compute the average. However, it is likely that the difference is meaningful to those who would make a distinction between nature and culture. The five scores included in the final outcome are all *natural functions*, in that they are described and calculated in a way that excludes important elements of human intervention or valuation. If we look closely we can see a subtle redrawing of the nature versus culture distinction. The indicators that relate directly to human use, like public access, are ignored. This is ironic, since the entire exercise is about ecosystem services, a concept that describes the relationship between the environment and humans. This choice shows the persistence of a “naturalized” understanding of what environmental restoration should include and perhaps even the limits to the ecosystem service discourse. Regardless

of the fact that the entire process is based on the idea that ecosystems provide tangible services for people and that such services can be bought and sold, public access does not count.

Secondly, the functional score for *carbon sequestration* (CS) is included in the group scores, but not in the overall functional acreage score. Thus, it too is left out of the wetland credit calculation. This can be explained by the emergence of a scoring method connected to mitigation banking under the Clean Water Act. When the Willamette Partnership, Paul Adamus and the participants in the Counting on the Environment process were developing the “functional acreage” calculation method, there was strong hope among environmentalists and many policy-makers that a national “cap-and-trade” policy for carbon dioxide would be implemented.

Including this function in the development of a wetland score would make it very complicated to enable a landowner to sell wetland credits as well as “carbon credits,” using the same restoration project. This is known as “credit stacking.” (Cooley and Olander 2011; Jessica Fox, Gardner, and Maki 2011; J. Fox 2011) So excluding the carbon sequestration score from the overall functional acreage calculation made sense given the expectation that a separate carbon dioxide “value” would be generated for many of the same projects.

The exclusion of these elements of the ORWAP calculation from the final “credit-score” of a wetland is certainly defensible, but it is also arbitrary. A different group of experts, under slightly different circumstances, might reasonably have come to a different agreement on whether or not to include *public use and recognition* or *carbon sequestration*. Of course, the use of quantification in environmental decision-making

inevitably requires choices about what to take into account, and what to leave out (Porter 1995). In this case, it is not the ORWAP spreadsheet itself that is used to calculate the functional acreage, but rather a synthetic procedure developed during the collaborative Counting on the Environment process. Using maximum scores to calculate the group score for a wetland, or taking the average of the functional effectiveness scores to calculate “functional acreage” of a wetland is not inherently better or worse than adding functional scores to calculate a group score, or weighting certain scores more heavily than others. These choices were extensively discussed during the Counting on the Environment process. In the end, the key stakeholders in the wetlands working group supported this approach.

Wetland biologist Dana Hicks, with the Oregon Department of State Lands, the agency overseeing Oregon statewide wetland mitigation-banking program explains that this was not an easy decision: “The thing we were stuck on the most was how do you compare – how do you get your final number of credits” (Interview with author, 07/18/2011). The reason it was so difficult was because the members of the working group considered a specific scenario undesirable:

So if we go to a function-based system and somebody has to get – has to replace two acres of fairly high-quality habitat, they can get there by doing 20 acres of kind of low-quality replacement, and that's the issue that we've been – that caused the most discussion, I think, and the most heartburn over how it's being done. (Interview with author, 07/18/2011)

The negotiated solution that resolved this dispute was based on two principles. The first was a series of additional ratios for *priority areas*. This reflects that even highly elaborate measurement systems cannot readily solve the problem of effectively protecting special places into the design of ESMs. In fact, even a sophisticated and “robust” measurement

system like ORWAP was still not trusted to accurately take into account the ecological characteristics that could make a certain wetland simply too special to allow its degradation.

The second principle the participants adopted to counter the limited ability of their measurement system to prevent the destruction of the most special wetlands was a final bureaucratic check, namely

So what we decided was a peer-functioned scoring system doesn't take the review of the mitigation plan and the ability to say yes or no away from the agency, it's just another step that we have to do and evaluate.
(Interview with author, 07/18/2011)

While this appears to be a straightforward reassertion of bureaucratic discretion, the participants realized the complexity of adding a further decision-making step:

But it's hard then to argue with, say, a mitigation banker that comes in with a proposal and they want to apply the math and get this many acres – this many credits, you know, for their mitigation bank, and you have to do that before you really know what the impacts are going to be. (Interview with author, 07/18/2011)

In Hicks' view, an important reason why this additional check on mitigation banker ambition is discomfoting is the fact that a professional mitigation banker can do the math. This would place Hicks, or her colleagues, in a situation where she would have to argue with developers and mitigation bankers about the equivalence between wetland impact and wetland restoration, notwithstanding the existence of ORWAP.

If Hicks is to deny a wetland permit based on this broad review of the mitigation plan, she has to argue that the ORWAP score calculated by a mitigation banker indicates “equivalence” between restoration activities and impacts. She knows that such equivalence has not conclusively been established. In a context where rationality, science and precision are highly valued, there is serious discomfort about relying on a market

framework - supply and demand of supposedly fungible credits - to determine the location and acceptability of wetland restoration projects.

Despite all of this work, and the general agreement reached on this calculation method, some of the professionals involved in the creation of wetland restoration sites are not very excited about ORWAP. The scores before and after the restoration tend not to be very far apart. Basically, when using ORWAP to calculate the credits for a specific restoration project, the outcomes reflect very little increase in the production of ecosystem services by that wetland. To stick with the report metaphor, it's hard to go from a C to an A in ORWAP. Most of the scores are clustered around a B-. Eric Wold, the Natural Resources Manager for the City of Eugene, which runs its own mitigation bank, describes this problem as: "One of the things I've learned from the ORWAP methodology is that it's very insensitive to restoration efforts." (Interview with Author, 08/18/2011) Eugene developed a new, award-winning wetland bank after the ORWAP methodology had been developed, but decided to calculate credits under the old calculation method.⁹² In the end, for this credit developer, a simple comparison between ORWAP and the older, simpler and ratio-based so-called HGM-approach was all that was needed: "And so we ran both the HGM methodology and the ORWAP to see, what did each one say in terms of how many credits we would generate, and the HGM approach came out generating way more credits than the ORWAP." (Interview with Author, 08/18/2011)

The low credit estimates produced by the measurement system, combined with the regulator's ambivalence about letting its output function as the primary means of making permitting decisions, have resulted in a situation where the mitigation bankers are

⁹² See: http://www.oregon.gov/dsl/Pages/pr1209_slb_awards.aspx Last accessed on: 08/15/2013.

understandably reluctant to invest significantly in its use. In the case of ORWAP, there was an existing credit-determination system, based on ratios, already in place. Perhaps it is to be expected that such a system is hard to replace with a more rigorous and demanding approach to measurement.

Conservation Banking and Ecosystem Services

The Upland Prairie Calculator is modeled after ORWAP. It is also a spreadsheet-based calculation of *functional acreage*, developed primarily by Paul Adamus and discussed extensively during the Counting on the Environment process.⁹³ The experience of tailoring ORWAP to increase its ease of use for wetland banking informed the development of the Prairie Calculator. Like ORWAP, the Prairie calculator was regarded as a way to further develop a “banking” practice in Oregon. But Federal law does not explicitly protect prairie as a type of landscape in the way that the Clean Water Act has protected wetlands. Rather, the Prairie Habitat calculator was designed to improve and popularize “wildlife conservation banking” also known as “species banking” or “biodiversity banking.” The creation of the Prairie Habitat Calculator is directly and deeply informed by the ecosystem services discourse and the goal of creating a market. While the calculator has rarely been used to facilitate actual transactions, it does provide a window into the constraints and opportunities associated with developing ecosystem service measurement tools for markets. Specifically, the story of the Prairie Habitat calculator shows that an emphasis on reducing transaction costs creates pressure to

⁹³ Unlike ORWAP, the Upland Prairie Habitat Calculator was not formally published, and primarily exists online on the Willamette Partnership’s website, together with a brief manual for its users. Both can be viewed here: http://willamettepartnership.org/ecosystem-credit-accounting/prairie/copy_of_upland-prairie-habitat Last accessed on: 06/03/2013.

reduce the complexity of the measurement system involved. The goal is to make implementation possible with only a brief visit to the restoration site.

From the point of view of market proponents,, the Endangered Species Act (ESA) operates much like the Clean Water Act. The ESA, once a particular species is listed as endangered, can be used to require compensatory actions to offset adverse impacts on the habitat of that species. The basic logic of conservation banking mimics wetland banking. A developer who destroys an environmentally sensitive area can be required to compensate for that destruction by restoring or conserving (in perpetuity) a landscape elsewhere. However, there are important differences between the Endangered Species Act and the Clean Water Act. The Endangered Species Act is focused on the preservation of populations of a species, which can often move around, while the Clean Water Act, at least as it relates to wetlands, is primarily about the protection of geographically defined places.

Conservation banking emerged in the 1990s, around the same time as wetland banking.⁹⁴ However, this type of environmental banking is much less common than wetland banking. It is primarily used in California⁹⁵ where conservation banking has become fairly routine. In 2011, there were 89 active conservation banks in California, compared to 20 in the rest of the United States.⁹⁶ Only one of those 20 conservation

⁹⁴ A useful source of up-to-date information on conservation banking is the website: speciesbanking.com. The State of California issued guidance on conservation banking in 1995, available at: <http://ceres.ca.gov/wetlands/policies/mitbank.html> Following the growth of conservation banking, the United States Fish and Wildlife Service issued national guidelines in May, 2003. This is available at: http://moderncms.ecosystemmarketplace.com/repository/moderncms_documents/Federal%20Guidance%20on%20Conservation%20Banking%202003.pdf Last accessed on: 06/03/2013.

⁹⁵ For the most up-to-date official information on the type and number of wetland and conservation mitigation banks in the United States, the U.S. Army Corps of Engineers' Regulatory In-lieu Fee and Bank Information System (RIBITS) is available at: <http://geo.usace.army.mil/ribits/index.html> Last accessed on: 05/28/2013.

⁹⁶ See note 10.

banks was in Oregon. Given the variety of endangered species to which conservation banks apply, there are a great many credit types involved, both for habitats and individual species.

In the case of wetlands, 40 years of jurisprudence and scientific efforts to define and categorize them informed the creation of ORWAP. In addition, the five basic categories of wetland have become relatively well established during that period. By contrast, the listing of individual species as endangered drives biodiversity banking. Some of the species involved are relatively obscure, like the Fender's Blue butterfly. There are only a handful of people dedicated to studying them full-time. Biodiversity banking has also not been the subject of the kind of litigation that wetland banking has. This means that questions about the exact definition of how to establish jurisdiction or define the geographic extent of a habitat have not been settled in the kind of public, detailed and formal way that the Supreme Court has for wetlands.

In Oregon, the participants in COTE wanted to increase the feasibility of species banking, by developing the Prairie Habitat metric and the associated rules for generating credits. As Bobby Cochran from the Willamette Partnership, at that time still working for Clean Water Services, describes the composition of the prairie working group: "We wanted to make sure U.S. Fish and Wildlife Service and the Oregon Department of Fish and Wildlife were there. They had to say yes." (Interview with author, 07/08/2011) Eric Wold, also a member of that working group and an employee of the City of Eugene, describes the relationship between the development of a measurement system and its potential policy implication as follows:

"We do have an endangered butterfly. It's called the Fender's blue butterfly, it occurs in upland prairies. And then there's its host plant, the

Kincaid's lupine which is also listed under the Endangered Species Act. And so there was some discussion of okay, there's not a market for it yet. You're trying to create a new mechanism or a new market for it and at the same time there is an avenue via wetland banking." (interview with author, 08/18/2011)

Wold is referring to the possibility of incorporating the presence of the Fender's blue and the Kincaid's lupine into ORWAP, by giving "extra points" for protecting those species in a wetland. In fact, both species are represented in ORWAP's supplemental datasheet,⁹⁷ showing the artificiality of the boundaries between categories of wetlands and uplands.

The Prairie Habitat Calculator was eventually developed to assess the "functionality" of a prairie related to the habitat requirements of several listed species, but mainly focused on Fender's blue butterfly (*Icaricia icarioides fender*). This butterfly is only found in certain parts of the Willamette Valley. It was listed as endangered in 2000.⁹⁸ Creating a useful calculator was something of an experiment since this particular type of landscape has not received the level of scientific, legal and political scrutiny that wetlands have. Paul Adamus, the wetland scientist responsible for ORWAP, was also in charge of the work on the Prairie Calculator. This is not his area of expertise, and he quickly determined that it would be difficult to model the Prairie Calculator after ORWAP:

The first thing we decided was that there was not enough science to parse out the individual ecosystem services of upland prairies but rather what we thought was a more realistic objective was to just have one overall score for an upland prairie and that score would be based on things that we thought would kind of generally indicate upland prairies that are most functional and of highest value. (Interview with Author, 7/15/2011)

⁹⁷ Kincaid's lupine can be under the nitrogen fixing plants, row 50 and Fender's blue under rare invertebrates, row 46. This sheet can be downloaded at: http://www.oregon.gov/DSL/WETLAND/Pages/or_wet_prot.aspx Last accessed on: 07/10/2013.

⁹⁸ For more information on the Fender's Blue Butterfly and its listing, see: <http://www.fws.gov/oregonfwo/Species/Data/FendersBlueButterfly/> Last accessed on 06/03/2013.

This led to a far simpler metric as compared to ORWAP. There are about twenty indicators that have to be filled out in the Upland Prairie Calculator spreadsheet. The final score is only expressed in functional acreage, meaning that there are no specific scores for particular ecosystem functions or services. Some participants regard this simplicity as an important benefit, since it means that field-visits can be relatively short. Other participants believe that certain important indicators, like the presence of housing near the site, should have been incorporated (K. Daniels interview with author, 07/18/2011). Much of the discussion in the working group that developed and reviewed the relevant metrics concerned the preservation of existing prairie and encouraging the restoration of landscapes so that they functioned as effective prairie habitats. As one of the participants describes these conversations:

There was a desire to score highly the highest quality upland prairie sites. It became more of a discussion of well shouldn't – what should this metric be measuring? Should it be measuring the amount of uplift you could get from restoring a degraded site or do we want to actually weight this whole thing so that protecting those few remaining high quality sites gets scored high? And so it might not actually be geared towards restoring like the wetland banking world is, but rather conserving.
(Eric Wold, City of Eugene, Interview with Author, 08/15/2011)

Several indicators can easily be recognized as examples of an emphasis on preservation. The presence of non-native herbaceous vegetation (Question 8 in the calculator) and the extent to which soil has been disturbed through compaction or plowing (Question 11) are both worth more “points,” potentially, than the current land management regime (Question 10). The latter might present an easier opportunity to render the prairie more habitable for particular species like the Fender’s Blue Butterfly, but that was not the priority of the participants when the calculator was created.

Unlike ORWAP, the Upland Prairie Calculator is not based on three decades of regulatory and scientific work. Thus, it is much more likely for prairie experts to find elements of the measurement system with which to disagree. Essentially, after the COTE process, there was no further organized scrutiny of this metric, by experts, stakeholders or the public. Yet, the Prairie Habitat metric did not completely disappear when the COTE process was over. The measurement system became something of a model for a much larger, at least in terms of geographic scale and overall ambition, effort to measure other parts of ecosystems. Given the fact that the Prairie metric was never used for its intended purpose, this is somewhat surprising.

Ecosystem Services and Biodiversity: Strange Bedfellows?

The fact that little disagreement has emerged over the Prairie Habitat metric can be attributed to the fact that it has hardly been used, in Oregon or anywhere else. Conservation banking, for Fender's Blue Butterfly or any other endangered species, is an exceedingly rare practice in Oregon, or anywhere outside of California. The United States Department of Agriculture, through its Office of Environmental Markets, funded a review of existing measurement systems for conservation banking (and similar practices outside of the United States). This Willamette Partnership produced this report, titled *Measuring Up: Synchronizing Biodiversity Measurement Systems for Markets and Other Incentive Programs* (Cochran and Robinson Maness 2011). They only found three successful endangered species mitigation stories outside of California in Georgia, Florida and Alabama.

Since the publication of that report, Paul Adamus has created habitat metrics for

Oak Savannah, Floodplains and Sagebrush,⁹⁹ but none has been used in a market context. These new measurement systems have primarily been developed under the auspices of the environmental advocacy organization Defenders of Wildlife, as part of their long-term effort to develop incentives for biodiversity conservation (Casey et al. 2006). This organization, under the leadership of Sara Vickerman, a longtime advocate for ESMs and a regular presence at conferences and workshops on the topic, has developed the *Conservation Registry*.¹⁰⁰ This is an online database describing and mapping all conservation, restoration and protection projects in the United States.

By convincing people to use the Conservation Registry, Defenders of Wildlife encourages restoration and conservation professionals to promote the use and evaluation of habitat metrics throughout the United States. While a number of well-known organizations, like the American Forest Foundation, The Nature Conservancy and the United States Geological Survey, have all pledged to support the Conservation Registry database, it's not clear how this effort will shape the future of conservation banking. The director of the Oregon Biodiversity Information Center at Oregon State University has indicated that these metrics, specifically the Prairie Habitat and the Oak Savannah calculators, but also ORWAP, do not include all the important invasive species that are possible habitat threats. There are also sensitive native species that could provide important indicators of habitat quality that have been left out. As a reason for these omissions, he pointed to the highly localized expertise prevalent among academic ecologists and botanists:

As always, when you do work in places, everybody knows the places

⁹⁹ For a description of these newer metrics, and to download the spreadsheets and user guides, see: http://marketplace.conservationregistry.org/about/habitat_metrics_guides Last accessed on: 06/03/2013.

¹⁰⁰ To view the registry, go to: <http://conservationregistry.org> Last accessed on 06/03/2013.

they've done work on, and in Oregon, as with everything else in the Willamette Valley, everybody's done a lot of work in and around the university towns. Since Corvallis and Eugene happen to be where the University of Oregon and Oregon State are, most of the people who worked on this thing were in and around those two places. (Interview with author, 08/15//2013)

This appraisal is clearly at odds with the national ambitions of the Conservation Registry. It also seems to deny the usefulness of a more generalized set of indicators. So far, the Upland Prairie Habitat metric, as well as the Oak Savannah, Floodplains and Sagebrush calculators, have only been used in pilot projects by the Willamette Partnership and Defenders of Wildlife. It is not clear if this combination of functional assessment methods and incentives for biodiversity conservation will increase in popularity and change landscape management practices or not. The overwhelming majority of conservation projects listed on the Conservation Registry do not report whether environmental outcomes are monitored, let alone what type(s) of measurement systems are used. What the development of the Prairie Habitat metric, and the Oak Savannah, Floodplains and Sagebrush metrics show is that encouraging the development of this type of measurement procedure is relatively easy, but ensuring their acceptance and use is incredibly difficult.

3.d. Conclusions

While many proponents describe the emergence of standardized measurement and elaborate accounting systems as a key benefit of ESMs, practical experience in the Willamette River basin and Chesapeake Bay watershed suggests that such systems are difficult and often costly to create, and that there are significant barriers to their use. The basic premise of all ESMs is that it is possible to establish credible equivalencies,

between different places, such as two wetlands, or different environmental impacts, like water discharge from a treatment facility and water filtration by a riparian buffer. It is only after some measurement system has shown that these places or impacts are *similar enough*, that trading to achieve efficiency, innovation and cost-reduction are possible.

This chapter has shown that the development of elaborate measurement systems in conjunction with ESMs in the United States has been significant, difficult and ultimately not very successful. While the national financial crisis hurt many sectors in the United States during the same period, the development of these measurement systems was funded through USDA and EPA grants. Well-known academic experts and non-profit organizations succeeded in creating sophisticated tools and methods to assess a range of elements and processes. Yet very few, if any, have become widely accepted or relied upon.

Efforts to measure credits and promote ESMs are likely to continue. Organizations like WRI and the Willamette Partnership are still leading attempts to stimulate the measurement systems' acceptance, although in some situations they have simply started over and are trying to develop completely new metrics and systems. As long as foundations and government agencies are willing to support the development of measurement systems, organizations will probably be willing to create more tools and techniques for ESMs. All the hard work that has been done over the last decade, however, has not produced very many lessons about how to develop stable and useable measurement systems. In fact, given all the effort and financial resources that have been expended, it seems like only the Shade-a-Lator, given its unique simplicity, ease of use and widespread acceptance is at all instructive. Given that much of the promise of ESMs

has been touted as their ability to foster trading of multiple ecosystem services, and to capture the complexity of the interactions between different services, the fact that the Shade-a-Lator captures a single aspect, seems to undermine one of the oft-repeated goals of ESMs.

Chapter 4: Participation and Negotiation

In March 2013 the Idaho Conservation League together with two other environmental advocacy groups filed an open records request to gather more information on what it called “secret meetings to develop regional trading policies.”¹⁰¹ The meetings in question were organized by the Willamette Partnership to create a “Joint Regional Water Quality Trading Agreement” between Idaho, Oregon and Washington. A \$1.5 million grant from the USDA’s Conservation Innovation Grant program funded the effort.¹⁰² One of the groups that filed the request, Northwest Environmental Advocates (NWEA), indicated that it was not against all forms of water quality trading, just Oregon’s shade-trading program which it thought violated EPA regulations. NWEA had long been highly critical of Oregon’s water quality policies, and has successfully challenged elements of those policies in court.¹⁰³

Resistance to “closed-door” meetings (between Idaho, Washington, Oregon and well-known market proponents like the Willamette Partnership and the World Resources Institute) highlights the third major challenge facing markets for ecosystem services (ESMs). As the efforts in Oregon and the Chesapeake Bay states show, assembling the appropriate people, communicating effectively and reaching agreement on the creation of ESMs is complicated. NWEA’s suspicions about the regional discussions and its strong opposition to the shade-trading program certainly made them a difficult partner when trying to reach consensus on the creation of an ESM. Their success in the courtroom and

¹⁰¹ See: <http://northwestenvironmentaladvocates.org/water-quality-trading-innovation-or-hoax/> Last accessed on: 08/20/2013.

¹⁰² For the Willamette Partnership’s Press Release, see: <http://willamettepartnership.org/news-and-publications/willamette-partnership-receives-1-5-million-cig-grant-from-usda/> Last accessed on: 08/20/2013.

¹⁰³ See for example: http://www.northwestenvironmentaladvocates.org/nweafiles/2013/04/Order-on-NPS-and-ESA-Remedies_201301.pdf Retrieved on: 08/20/2013.

their ongoing scrutiny of all market-creating efforts, suggest that ignoring them would be a mistake. There is no handbook indicating how to create an ESM at the watershed scale. Nor is there agreement on who should take the lead in trying to start one, or how to go about developing appropriate leadership (Engel, Pagiola, & Wunder, 2008; Johnson, White, & Perrot-Maitre, 2000; Salzman, 2005).

In this chapter I analyze three negotiations about the creation of ESMs. I focus on disagreements or tensions that emerged regarding 1) participant selection, 2) communication among the stakeholders and 3) who should have final authority. In Oregon, the Willamette Partnership only invited individuals who were not explicitly opposed to the idea of ESMs to Counting on the Environment (COTE). Yet, even among these participants, questions about how to interact and make decisions were not easily resolved.

I look at two negotiations in the Chesapeake about proposed ESMs. The first examines recent efforts to create a single water quality market for the entire watershed. The goal is to merge the markets in Pennsylvania, Maryland and Virginia. This negotiation has run into problems associated with the sheer scale of the ESM they have in mind. They had trouble, because of the scale, determining who should be involved at which stage of the negotiation. Trying to work across state boundaries also created communication and coordination problems. The second negotiation pertains to the Bay Bank. The Willamette Partnership's COTE process inspired the proponents of this ESM. They struggled, though, to include proposed buyers of the specific credits they were trying to develop.

4.a. Three Basic Questions about Participation

The challenge of participation and negotiation between participants is connected to the ESM design and measurement problems analyzed in the previous chapters. For example, determining which towns, agencies or groups to bring to the table during the design process is clearly connected to the question of delimiting the geographic areas in which markets will be located, and the selection of specific priority areas.

The complexity of the measurement systems influences the type and level of expertise participants will need in order to communicate effectively about ESM design. The examples in this chapter also show that participation and negotiation problems are connected to basic assumptions about markets. Expectations that credit developers will innovate and come up with new management practices to generate credits or that new areas will be designated as priorities mean that ESMs will keep changing. That makes it hard to stick to any agreement that is reached. As the ongoing efforts in Oregon and the Chesapeake Bay states show, ESMs require ongoing negotiations about complex incentive structures.

The work of political scientist Archon Fung helps to illuminate the participation difficulties facing ESM designers. He shows that “public participation at its best operates in synergy with representation and administration to yield more desirable practices and outcomes of collective decision making and action” (Fung, 2006, p. 66). So, to reach a politically meaningful policy innovation like an ESM and implement it effectively, collective decision-making and shared action are required. To enable such synergy, Fung suggests a “three-dimensional framework” based on key questions that can be asked of virtually any participatory process, including attempts to create of ESMs.

Who is Invited?

An important theoretical feature of ESMs is that they create links between people and organizations who degrade or destroy ecosystems to landowners who have an option of managing their resources in a way that provides additional ecosystem services. If these two groups can find each other, they both stand to benefit. Landowners can gain financial benefits, while credit buyers can meet legal obligations at the lowest possible costs. How to help them find each other and how to involve them in the design of ESMs does not follow directly from these theoretical assumptions about market dynamics. It is typically impossible, for logistical reasons, to involve every landowner in order to convince them to consider developing ESM “credits.”

The distinction between regulatory and voluntary markets is one thing to consider in deciding whom to invite. If extensive laws and regulations govern a market, it is probably better to invite representatives of as many credit buyers and sellers as possible to participate in helping to draft those rules. If a market is voluntary it suggests that fewer groups need to be involved in ESM design.

Most of the efforts in the Chesapeake Bay and the Willamette River basin have been aimed at the creation of ESMs in the context of existing policies, like wetland mitigation banking,¹⁰⁴ and water quality trading.¹⁰⁵ These approaches tend to be characterized as *regulatory markets* (Freeman & Kolstad, 2007). Within the broad category, the guiding hand of a government is assumed to operate in setting the environmental standards that need to be attained.

¹⁰⁴ See for example these materials from the US EPA:

<http://water.epa.gov/lawsregs/guidance/wetlands/workshops.cfm> Last accessed on: 07/11/2012

¹⁰⁵ See this example: <http://water.epa.gov/type/watersheds/trading.cfm> Last accessed on: 07/11/2012

Other expected participants in the creation of regulatory markets are landowners, since they have the potential to “supply” ecosystem services through the ecosystems present on their land. On the demand side of the market, regulated entities, like water utilities in need of a NPDES permit, are also expected participants, since they can be expected to potentially buy ecosystem service credits.

Voluntary markets involve transactions between private entities unrelated to regulation. A well-known example of a voluntary market is the opportunity to purchase carbon credits when buying a plane ticket (Gössling et al., 2007). In the creation of voluntary markets, the involvement of government actors should not automatically be assumed, beyond perhaps guaranteeing that contracts are enforceable through the legal system. Other participants in voluntary markets are also less obvious, although landowners are still viewed as “service-providers.”

In creating the Willamette Marketplace and the Nutrient Trading program and Bay Bank in the Chesapeake Bay, the ESM designers were not always as clear about the distinction between regulatory and voluntary markets. The market proponents in these cases sometimes tried to develop a measurement system and a set of rules for credit trading without a clear regulatory driver, meaning that no government agency was requiring an environmental impact to be compensated.

The hope was that by creating a credit trading system in anticipation of a potential endangerment listing, for example, the regulators would be more likely to simply use that method to implement the Endangered Species Act. This makes identifying sources of demand, and thus knowing whom to invite to participate much less straightforward.

How Do Participants Interact?

Inviting stakeholders to a meeting, or even a series of meetings, without a clear sense of what has to be achieved, who is authorized to make decisions and more generally how the group will work together, is unlikely to result in the outcome desired by the proponents of ESMs. Process design in the field of environmental policy-making and planning is much discussed and debated (Carpenter & Kennedy, 1988; Sabatier, 2005; Susskind et al., 1999; Wondolleck & Yaffee, 2000). After the question of who participates, political scientist Archon Fung considers a second dimension critical in his analysis of process design (Fung, 2006). He has named this the “*modes of communication and decision*” (2006, p. 68). Different process designs can treat the public simply as listeners or spectators, or it can treat them as “experts” who can contribute perspective, expertise or experience. Finally, the public can be included as stakeholders who have a “right” to participate in negotiations.¹⁰⁶ It is not clear which the best approach for the creation of ESMs.

Whether market proponents simply invite people to listen to an explanation of how an ESM is expected to operate, or if they invite participants to enter into detailed negotiations about the rules and regulations of a proposed ESM are two fundamentally different forms of interaction. The choice for one or the other, or some different form of interaction altogether, has practical implications, like how market proponents are likely to deal with reactions by, or incorporate concerns of participants. Given the potentially

¹⁰⁶ The strengths and weaknesses of, and the differences and similarities between various approaches to participation in decision-making in the public sphere are at the center of a longstanding debate within professional and academic circles. An early contribution was Sherry Arnstein’s 1969 article “A Ladder of Citizen Participation” in the *Journal of the American Institute of Planners*. More recently, the International Association for Public Participation (www.iap2.org) has developed a “spectrum” of participation methods, outlining different approaches to participation. This in turn has been raised criticism, for example for including information sharing as a form of participation, which can be considered a purely passive form of “engagement,” rather than participation. See: (Carson 2008).

significant outcomes of the creation of an ESM, like the concentration of investments in environmental restoration outside of a city's borders or the continued environmental degradation of specific places inside of them, the choice for a specific form of interaction also has more broadly democratic implications. How do residents who live near degraded streams, or those who live near potential restoration sites engage with the creation of an ESM? Do they merely have to be informed that they can object to a permit that includes a trading provision, since it is uncertain if the development of a credit generating restoration project will be close to them? Or should residents, community groups and advocacy organizations be actively involved in how and where to achieve environmental improvements? Do such groups even want to be involved in such discussions, or is it sufficient if the water treatment utility simply decides how to proceed on behalf of its ratepayers and informs them of its decision afterwards? The uncertainties that these questions pose, which I explain in more detail in this chapter, illustrate reasons why ESMs are so difficult to create successfully, related to participation and negotiation. The Idaho Conservation League's open records request indicates that not all groups are going to agree with a very basic level of information provision.

The measurement systems in many ESMs are quite complex, and often highly technical. This makes it difficult for some participants to interact meaningfully in discussions about their design or use. So, even when a meeting or process is intended as an opportunity for a candid exchange of ideas, it is not always possible for all the participants to communicate effectively. In the creation of regulatory markets, a second source of profound complexity and miscommunication can emerge. This is the long history of specific laws and pre-existing regulations that cannot be ignored. To use the

example of wetland mitigation, this field originated with the Clean Water Act in 1972 and has seen a steady stream of regulatory decisions, legal actions and reactions, creating a long list of considerations and requirements for subsequent efforts to innovate in the wetland-banking arena. Whether it is best to focus on specific details or search for agreement on broad principles in the development of an ESM related to wetlands is hard to determine. From an ideological standpoint, different stakeholders or participants will have competing views. From a technical standpoint, there are also likely to be diverse perspectives on this question depending on the disciplinary orientation of the individuals involved.

Finally, from a legal standpoint, even knowledgeable land use lawyers are likely to disagree on how much deference ought to be paid to existing rules and regulations. Efforts to simplify the agenda, in order to facilitate communication, can backfire. Concentrating on technical specifications only, and limiting who is invited to experts only, can result in implementation problems later on when certain stakeholder groups charge that they have been left out or that wrong assumptions have been made about their interests.

What Kind(s) of Authority Do Participants Have?

The third dimension of participatory process design mentioned by Archon Fung is related to what he calls the “*extent of authority and power*” (Fung, 2006, p. 69). Juxtaposing two extremes helps to illustrate the scope of this dimension. Does the outcome of an ESM design process reveal anything more than the preferences of the participants (who have no authority beyond perhaps changing their individual opinions)?

Or, do key stakeholders have authority to implement what they design by virtue of their political or legal authority? The difference between a group engaged in brainstorming, which might result in little more than a report, and a rule-setting negotiation, in which outcomes are legally binding, is important when trying to create an institutional arrangement, let alone one as complex as an ESM.

Who has the power to set a market in motion? Should landowners simply begin restoration activities in the hope that buyers will find them, or should wastewater treatment plants contact individual landowners to persuade them to plant trees? Intermediaries, or so-called credit brokers, have often played an important role. In Pennsylvania, Red Barn Trading has served as a de facto representative of large groups of landowners, as have soil conservation districts. Despite the existence of middlemen and informal representatives, moving ESMs from the drawing board to actual trading activity has turned out to be much more difficult than ESM advocates expected. The fact that no single organization or representative can simply force a market to form has been at the heart of this challenge.

4.b. Getting Together in the Willamette River Basin

The Willamette Partnership and Clean Water Services, the water utility that received the first shade-credit based NPDES permit, organized a series of five two-day workshops on the creation of the Willamette Marketplace. They called this effort Counting on the Environment (COTE). Meetings took place between November 2008 and August 2009. Beyond the formal outcome of this process, the *Pilot General Credit Protocol: Willamette Basin Version 1.0* and the refusal by the City of Portland and

NMFS to sign on this this protocol, as described in Chapter 2, a more in-depth look at the problems of participation that emerged reveals the challenges of bringing stakeholders together to design and implement ESMs.

Selecting Participants for Counting on the Environment

The Willamette Partnership and Clean Water Services describe their participant selection strategy for COTE in terms of “building support” for ESMs. That’s a very specific orientation toward stakeholder selection and engagement. It raises the question of whether they were open to as wide an array of opinions on markets and market creation as they could have been. The Partnership was already the product of attempts to bring together active players in watershed management in the Willamette River basin. It was formed in 1996, when Oregon Governor Kitzhaber created the Willamette Basin Task Force.¹⁰⁷ In 1998, this became the Willamette Restoration Initiative,¹⁰⁸ overseen by a Board of Directors that included private sector, academia, non-profit and governmental representatives.¹⁰⁹ More than a few of the members of this board, most prominently Bill Gaffi, the manager of the Unified Sewerage Agency (later renamed Clean Water

¹⁰⁷ For some key dates on the history of the Willamette Partnership, see: <http://willamettepartnership.org/about/history> Last accessed: 07/17/2012. For a more detailed description of the process leading up to the formation of the Counting on the Environment program, see Chapter 4 (pp. 105-175) from Stephan Brown’s unpublished dissertation: *Navigating the Edges: An Examination of the Relationship between Boundary Spanning, Social Learning, and Partnership Capacity in Water Resource Management*. Portland State University, 2011.

¹⁰⁸ The Willamette Restoration Initiative was created by executive order, number 98-18. It did not have any formal authority, but was charged with the development of a restoration strategy, available at: http://oe.oregonexplorer.info/WillametteExplorerClassic/publications/pdf/WRS_OVER.pdf Last accessed on: 07/08/2013. In 2012, a new organization has been created with the same acronym and some of the same people involved, the Willamette River Initiative, as a project of the Meyer Memorial Trust. See willametteinitiative.org. Last accessed on: 07/08/2013.

¹⁰⁹ For a complete list of the board-members of the Willamette Restoration Initiative, see their 2001 report “The Willamette Restoration Strategy”. Available at: http://oe.oregonexplorer.info/WillametteExplorerClassic/publications/pdf/WRS_OVER.pdf Last accessed on: 07/08/2013.

Services) and Sara Vickerman, Director of the West-Coast Office of Defenders of Wildlife (Jerrick, 2001), had long advocated the creation of ESMs. They became key actors in COTE as well. (Brown, 2011)

Longstanding connections among some of the central actors in the Willamette Partnership influenced who was invited to join Counting on the Environment. Bobby Cochran, now executive director of the Willamette Partnership, but in 2008-2009 an employee of Clean Water Services, describes how individual participants in COTE were, at least in part, selected based on personal connections with the organizers and influence within their own organizations:

We knew a lot of the people we invited, so between us, and the Governor providing that letter, we were able to get everyone there to the table. There were some instances where an agency wanted to send someone where we said we don't think that's the best person, and that was a little bit of a conversation, but we really thought it was important to get the right individuals there. (Interview with Author, 7/8/2011)

Selecting people familiar with each other is not a bad strategy. But for the purpose of creating an ESM, is it enough? The community of people working on water quality issues in the Willamette Basin is rather small. Thus, it is not surprising that many of the "most important actors" know each other. An obvious risk, however, is that relatively like-minded people often fail to "hear" or take seriously certain counter-arguments. Part of the selection of specific individuals was actually based on their favorable views of markets. As Cochran describes: "We wanted people that we knew didn't have a fundamental knee-jerk reaction against mitigation or market-based approaches. We didn't want people to all be supportive, but we didn't want people just philosophically opposed" (Interview with author, 07/08/2011). This statement indicates that the market proponents explicitly avoided selecting individuals or organizations that had been critical of markets in the

past.

Clean Water Services, the second organization that played a central role in convening the participants in COTE received its NPDES permit in 2004. From that point forward, it had been meeting its requirements. Although the organization has a checkered history of environmental stewardship, it was an effective and powerful participant in the process.¹¹⁰ Its view on whom to invite was directly connected to its own permit experience. Bruce Roll, watershed management director at Clean Water Services describes the evolution from temperature credit trading in the Tualatin to ecosystem marketplace in the Willamette River basin as an attempt to ensure continued regulatory support for shade-credit trading: “The other reason we jumped on the Willamette Partnership stuff and pushing that was that it needed more diversity. It couldn’t be just a singular utility; it needed to be a much broader stakeholder group to help push it” (Interview with author, 2011). The stakeholder group that participated in COTE was certainly broader than a single utility. It included representatives from cities like Eugene, Albany and Portland. On the other hand, it hardly included any vocal critics of markets.¹¹¹

This absence of more critical views of ESMs did not manifest itself as big problem during the process. However, the exclusion of groups that were publicly critical of water quality trading and other types of ESMs probably encouraged them to voice their criticisms later on. Northwest Environmental Advocates, for example, did not participate

¹¹⁰ In 1990, the Northwest Environmental Defense Center reached a settlement with the Unified Sewage Agency of Washington County, which would later be renamed Clean Water Services. The settlement required USA (now CWS) to fund watershed restoration at an unprecedented scale. The full text of the settlement can be read here: <http://elr.info/sites/default/files/litigation/21.20676.htm> Last accessed on: 07/08/2013.

¹¹¹ For a complete list of the participants, see: <http://willamettepartnership.org/ongoing-projects-and-activities/nrcs-conservation-innovations-grant-1/counting-on-the-environment> Last accessed on: 08/22/2013.

in the COTE process nor did the Northwest Environmental Defense Center (NEDC). Both are located in Portland, OR and worked extensively on the environmental issues at the center of the COTE process, like water quality, land use and biodiversity protection. This made their absence noteworthy. In light of their recent criticism of water quality trading, and temperature credits specifically,¹¹² perhaps including them sooner would have allowed market proponents to address their concerns early on and forestall their opposition to market implementation.

Negotiating in Counting on the Environment

The Willamette Partnership and Clean Water Services team that convened COTE divided the participants into different groups to enable them to discuss the various elements of ESMs with which they were most familiar. This meant that there was a working group for each of the measurement systems under discussion. There was also a policy group that was supposed to discuss broader issues related to potential policy changes needed to create the ESM. Bobby Cochran, at the time the representative of Clean Water Services but now the executive director of the Willamette Partnership, was writing his doctoral dissertation about the importance of collaborative processes in environmental market development during COTE.¹¹³ He was keenly aware of many of the “best practices” described in the process design literature. Together with David Primozych of the Willamette Partnership, and mediator Deb Nudelman, Cochran designed

¹¹² See this letter to the EPA on a recent NPDES permit that includes shade-credit trading for a detailed description of NWEA’s reservations about Oregon’s temperature trading program: <http://www.northwestenvironmentaladvocates.org/nweafiles/2013/03/Letter-to-EPA-on-Oregon-trading-3-2013.pdf> Last accessed on: 08/13/2013.

¹¹³ This dissertation was written under Connie Ozawa in the Urban Studies Department at Portland State University, but not published. It is titled: *Giving Process Its Due: Can Collaboration Help Environmental Markets Succeed?* By John Robert Cochran.

an elaborate process, formally described at the outset in some detail:

The central working group includes all of those public and private parties steering the method development part of the project. Their organizational heads are represented by the policy group. The stakeholder coordinating team is composed of some of the founding partners of the project and will provide strategic direction. The practitioner review team, which includes potential buyers and sellers of credits, will comment on the working group's conclusions at key decision points. Finally, the partners that compose the technology development team will design market infrastructure determined essential by the Working Group.¹¹⁴

His description reflects the group's orientation toward rule making and the practical details of the COTE-process. There was a strong desire among many of the market enthusiasts to "make it happen." In practice, the Coordinating Team made up of market proponents did most of the work, based on guidance and feedback from the larger Working Group. Nudelman describes this dynamic as follows:

They set it up so the majority of the work was done between meetings. And it was basically kind of given to the working group, kind of 90 - not 90, but 80 to 90 percent there. And then it was a feedback cycle. So that steering team, that coordinating team was really critical because it guided the project teams work on behalf of the bigger group. (Interview with Author, 7/22/2011)

The members of the coordinating team were central to many of the interactions that occurred during the COTE process. Most of them continue to be directly involved in the creation of ESMs in Oregon. This emphasis on close interaction between a core group of market proponents and experts made it difficult for other participants, with expertise on topics mostly outside of ESMs and ecological measurement systems, to engage in the discussions. For example, the representative of Oregon's Department of Land Conservation and Development, mentioned that she found it difficult to ensure that her

¹¹⁴ From the Counting on the Environment "Kick-off Workshop Materials", pp. 16. Available on: http://willamettepartnership.org/ecosystem-credit-accounting/willamette-ecosystem-marketplace-documents/Final_FullPacket_CountingWorkshop1_4.pdf Last accessed on: 08/07/2012.

agency's concerns over land use got the attention they deserved:

I mean I wasn't able to really participate in the review of the particular scientific criteria that they're using. I really didn't have anything to say about that. I just kept coming back to land use, and knowing how human development patterns - and not just, you know - it's not just the physical footprint of that house. It's the activities of the people in that house, their pets, their vehicles, their septic system leaching into nearby waterways - actually that impact wetlands, salmon, and water temperatures. (Interview with Author, 7/18/2011)

This highlights the challenge of communicating effectively in this kind of ESM-creating setting. The way they chose to calculate ecosystem services in COTE, namely site-based evaluation and calculation of credit production, makes it almost impossible to include variables and dynamics that occur at landscape or watershed scales. Thus, the emphasis on site-specific credit calculation made it hard for those with these concerns to participate effectively.

Moving from Agreement to Pilot Projects in Oregon

The core group of market enthusiasts in Oregon developed a strong vision of the outcome it was trying to achieve. It chose participants based on that vision:

We didn't want trade associations or those that were representatives of broad constituencies; we wanted the people who would actually be doing the work and interacting. And then we specifically targeted individuals within each of those organizations that, one, were kind of mid- to upper-level managers that had enough influence on the policy direction in their organization, that supported their leadership, that they could kind of enact whatever was there; that really were authorized to speak on behalf of the organization. We didn't want - at least, we wanted to minimize the amount of, I need to go back and check with someone. (Bobby Cochran, Interview with author, 07/08/2011).

However, towards the end of the COTE-process, it became clear that a formal agreement between all the participants was unlikely. Even with mostly like-minded participants,

moving from concept to strategy is hard. Stakeholders have too many contending interests. The coordinating team had developed the *Pilot General Credit Protocol: Willamette Basin Version 1.0* and asked all representatives to sign a document stating that they agreed to the protocol in principle. In addition, they were asked to enlist the support of officials within their organizations. In the original version the undersigned were asked to agree to implement the entire framework. This proved untenable, even for many of the organizations that were largely supportive of the protocol. Instead, the final version, which was signed by all of the representatives except those from the Portland and NMFS, expressed support for voluntarily testing the trading framework through a series of pilot projects.

This led to four projects the primary objective of which was “proof of concept.” They did not require the sale of credits. The credits generated by these projects were calculated based on the agreed upon methods. Only the credits from two, though, were actually registered.¹¹⁵ Most of these credits were immediately retired. This means that they were not for sale. Some of the pilot projects occurred on public lands, for example in the Tillamook State Forest,¹¹⁶ and the Oregon Department of Forestry decided not to sell credits from publicly owned lands, mainly because it was not clear if the state legislature would allow it, and in part out of fear for a possible public backlash against competing with private landowners while using public funds (Brandt, Interview with Author, 07/27/2011). The remaining credits, from the largest pilot project called Half Mile Lane have remained for sale, but have still not been purchased.¹¹⁷ So while the pilot projects

¹¹⁵ See: <https://products.markit.com/br-reg/public/index.jsp?q=oregon&s=ci> Last Accessed on: 08/22/2013.

¹¹⁶ See above footnote, the “Gales Creek” project is in the Tillamook Forest.

¹¹⁷ See: <https://products.markit.com/br-reg/public/index.jsp?q=half%20mile%20lane&s=ci> Last accessed on: 08/23/2013.

showed that it was possible to calculate and register credits, they provided little evidence for the broader viability of the ESM approach by generating competition between credit developers or showing that transaction costs were minimal. In fact, the Half Mile Lane project was considered quite expensive and somewhat overdesigned, from a landscape restoration point of view (Guillozet, Interview with Author, 7/12/2011).

The conveners of the COTE process originally set out to create an integrated marketplace for four ESMs in the Willamette River basin. They invited a group of well-known stakeholders to be part of a yearlong effort to achieve that goal. The emphasis was on inviting representatives favorably disposed towards markets, or at least not against markets based in principle. This left out some advocacy organizations that subsequently became highly critical of attempts to implement and expand ESMs. Despite a sophisticated process design, and a great deal of communication among different working groups, some supporters of ESMs found it difficult to be “heard” during these negotiations.

Many of the participants who felt their concerns were only partially addressed did not explicitly oppose the idea of creating an integrated ESM, but despite the ambition of the project they did not feel these ESMs would directly affect their interests or professional priorities. This reflects the still somewhat abstract nature of the ESM idea, and the fact that many people, even after having participated in a year-long process, did not have a clear sense of what this integrated marketplace would actually mean for everyday practice. When the market proponents introduced a final agreement to win the support the formal support of all participants, they settled instead for a limited number of pilot projects. This was a step down from the hoped for broad endorsement of ESMs by

all participants, showing that many stakeholders did not have the authority to simply create an integrated marketplace of this nature. The hoped for outcome of the pilot projects, that regulators, landowners and potential credit buyers would see the promises associated with an ESM come to life, never quite materialized. The salmon habitat and prairie habitat credits remain ideas on paper, as opposed to regularly used methods to compensate for adverse impacts, and most wetland bankers continue to avoid crediting their projects using ORWAP. The broader acceptance of these ESMs has not taken hold.

4.c. Nutrient Net and an Effort to Create Trading at the Bay Scale

The Chesapeake Bay Watershed covers 64,000 square miles and (parts of) Delaware, Maryland, Pennsylvania, West Virginia, Virginia, New York and the District of Columbia. The sheer scale of the Chesapeake Bay watershed means that creating effective participatory processes to develop any kind of joint action covering the entire Chesapeake Bay watershed will automatically be complicated and somewhat disjointed. Despite this broad challenge, WRI received a Conservation Innovation Grant from the USDA in 2010 to develop a version of Nutrient Net covering the entire Chesapeake Bay watershed. It was also supposed to include estimates for carbon dioxide offsets.¹¹⁸ This iteration of Nutrient Net was an attempt to move towards an ESM for the entire Chesapeake Bay watershed. Predictably, it encountered multiple negotiation and participation challenges.

Trading water quality credits across state boundaries is appealing since it creates the possibility for coastal states, like Maryland and Virginia, to extend their efforts to

¹¹⁸ See <http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/programs/financial/cig/?&cid=stelprdb1044496> Last accessed on 08/06/2012.

clean up the Chesapeake Bay beyond their state's boundaries. A significant improvement in water quality in the Chesapeake Bay would benefit Maryland and Virginia most directly, for example through increases in commercial and recreational fisheries and coastal tourism (Talberth et al. 2010). Activities in states like Delaware and Pennsylvania impact water quality in the Chesapeake Bay, but since these states do not adjoin the Bay, there is less immediate concern about those impacts.

Such upstream/downstream dynamics, in which the jurisdictions at the mouth of a river suffer from the declining water quality caused by land uses and discharges upstream, are typical in many river basins and watersheds. Water quality trades between upstream and downstream states would presumably allow considerable efficiency gains (Van Houtven et al. 2012). Pennsylvania's poultry farms contribute a great deal of nutrient pollution to the Chesapeake Bay. It is potentially much cheaper and more effective to achieve significant nutrient reductions related to poultry farming, than it would be to install even wider riparian buffer zones on agricultural land in Maryland, where a 100 ft. buffer zone is already legally required. So when a water treatment utility in Maryland is allowed to buy credits from Pennsylvania, it can achieve more significant nutrient reductions at a lower price than when its only credit options are in Maryland. At this point, since inter-state trading does not happen, these price and effectiveness differences are largely speculative, but extensive research has shown that nutrient reductions in Pennsylvania are potentially very effective, at low cost (Van Houtven et al. 2012).

WRI, together with the Chesapeake Bay Program has worked to expand Nutrient Net and to facilitate buying and selling of water quality credits across state boundaries by

integrating the various state trading programs that exist or are under development. So far, these efforts have not actually resulted in an integrated ESM for the Chesapeake Bay. The profound challenges associated with developing an effective participatory process to create an ESM at this scale may not be possible to overcome.

Participation and Communication to What End?

One of the basic problems of organizing effective participatory processes in the Chesapeake Bay watershed is that there are too many committees, working groups and teams involving somewhat overlapping, yet surprisingly disconnected efforts and not enough clear pressure to make progress on key environmental goals. There are so many committees that many experts and representatives find it difficult to be present at the many meetings, workshops and procedures involved. In addition, coordination of efforts across these groups represents a substantial management problem. In Archon Fung's terms, participant selection and effective (modes of) communication are even more complicated as the number of autonomous jurisdictions involved increases.

Two prominent experts on environmental issues in the Chesapeake Bay have described the longstanding oversupply of committees, working groups and teams as "Collaborating to Nowhere," framing this as a government accountability problem (Steinzor and Jones 2013). In their argument, it is not in the immediate interest of the upstream states, especially Pennsylvania, to reduce nutrient run off dramatically. So until the federal government, through the EPA or by appointing an independent evaluator (which Steinzor and Jones much prefer and describe in some detail), creates a clear incentive for Pennsylvania to meaningfully participate, or a penalty for non-participation,

collaboration and negotiation are unlikely to achieve meaningful results. While it falls outside of the scope of this project to evaluate this claim, it is relevant to point out that the history of attempts to collaborate and negotiate across state boundaries in the Chesapeake Bay is long and controversial, and the attempts to create an interstate water quality market can be seen both as a response to this problem (by seeking to create financial incentives for nutrient reductions in Pennsylvania) as well as adding to it (by creating yet another series of workshops and committees without centralized oversight or strong authority).

The two organizations that are central in the efforts to developing water quality trading in the Chesapeake Bay states at the scale of the entire watershed are the Chesapeake Bay Program and the World Resources Institute. The Chesapeake Bay Program (CBP) is the most important watershed partnership in the region.¹¹⁹ It is led by the Governors of Maryland, Pennsylvania and Virginia, the mayor of the District of Columbia, the EPA administrator and the chair of the Chesapeake Bay Commission through the Chesapeake Executive Council. The CBP grew out of a 1983 agreement among these organizations and its 83 staff members are housed in an office in Annapolis, MD.

The not-for-profit World Resources Institute (WRI) has long played an important role in the promotion of water quality trading in the Chesapeake Bay states, in part because of its work on the development of Nutrient Net.¹²⁰ WRI has provided important logistical and technical support to water quality trading programs in Pennsylvania,

¹¹⁹ For an recent, highly critical analysis of the history of the Chesapeake Bay Partnership, see Steinzor & Jones, *Collaborating to Nowhere: The Imperative of Government Accountability for Restoring the Chesapeake Bay*, In: *Journal of Energy & Environmental Law*, Winter 2013.

¹²⁰ See: www.nutrientnet.org Last accessed on 08/01/2012.

Maryland and West Virginia, although the latter two have not yet seen any trading activity. WRI seeks to enable inter-state trading based on its belief that matching supply and demand requires significant scale (Selman et al. 2010).

The participants WRI's two-year effort to develop a Bay-wide Nutrient Net were primarily state agencies that run the water quality trading programs in the Chesapeake Bay states (except West Virginia and Delaware). These two states chose not to participate for different reasons. West Virginia already had a formal trading policy that was not being used. The state was less than enthusiastic about devoting additional resources to expanding it. Delaware on the other hand has typically adopted Maryland's policies and tools, so the expectation is that whatever ESM design Maryland ends up implementing, Delaware will simply follow. Most of the land in Delaware does not drain into the Chesapeake Bay, making this a minor concern for that state.

Other participants in the Bay-wide Nutrient Net process were two private mitigation bankers from the region, the USDA's Office of Environmental Markets, the Chesapeake Bay Program's policy specialist on trading and offset programs (Selman, Interview with Author, 11/15/2012). The group of stakeholders seems quite small given the number of organizations and people with a direct stake in water quality.

Highlighting the complexity of the collaborative efforts related to water quality trading among states is the fact that shortly before WRI began its effort to develop the Bay-wide version of Nutrient Net, President Obama issued executive order 13508, titled *Strategy for Protecting and Restoring the Chesapeake Bay Watershed*. As part of this order, an interdepartmental *Chesapeake Bay Environmental Markets Team* was

created.¹²¹ This team was made up of federal agencies involved in the conservation and restoration of the Chesapeake Bay, and led by USDA's Office of Environmental Markets. WRI did not participate directly. It is not clear if and how these efforts were coordinated or mutually supportive.

The most significant development related to trading water quality credits in the Chesapeake Bay watershed, coinciding with WRI's effort, was the release of the *Chesapeake Bay TMDL*, or Total Maximum Daily Loads, by the EPA in December 2010. The agency describes it as follows:

The TMDL – the largest ever developed by EPA, encompassing a 64,000-square-mile watershed – identifies the necessary pollution reductions from major sources of nitrogen, phosphorus and sediment across the District of Columbia and large sections of Delaware, Maryland, New York, Pennsylvania, Virginia and West Virginia, and sets pollution limits necessary to meet water quality standards in the Bay and its tidal rivers.¹²²

This means that the EPA now had the authority to review the water quality trading programs in the Chesapeake Bay watershed. States are required to show how their trading programs are likely to meet the standards set by the EPA's TMDL. The Chesapeake Bay Program, led by EPA, developed a forum to discuss trading related to water quality trading following the release of the TMDL. It was called the *Trading and Off-Sets Work*

¹²¹ The *Strategy for Protecting and Restoring the Chesapeake Bay Watershed* was released in 2010, and was a response to Executive Order 13508. For information about the order, the order itself and a report on the progress made, go to: <http://executiveorder.chesapeakebay.net/page/About-the-Executive-Order.aspx>. The Strategy is available at: <http://executiveorder.chesapeakebay.net/file.axd?file=2010%2f5%2fChesapeake+EO+Strategy.pdf> and the Charter of the Environmental Markets Team can be found at: http://www.usda.gov/oce/environmental_markets/files/FY10_11_CB_EMT_Charter_final.pdf All accessed on: 08/08/2012.

¹²² For an overview of the TMDL and associated activities, see: <http://www.epa.gov/chesapeakebaytmdl/>. This quote is from the factsheet, available at: http://www.epa.gov/reg3wapd/pdf/pdf_chesbay/BayTMDLFactSheet8_6.pdf Both accessed on: 08/09/2012.

Group (TOWG).¹²³ Formalized in 2011, it laid out an ambitious work plan.¹²⁴ WRI is on this group, which includes more than fifty representatives of environmental advocacy organizations, state and federal agencies and scholars.¹²⁵

For the participants in WRI's process to create a single Nutrient Net, these simultaneous and somewhat overlapping processes meant that there was no single forum to discuss issues related to technology development or policy coordination for water quality trading across all Chesapeake Bay states. This caused delays and made it hard to schedule meetings. The effort to create a single version of Nutrient Net for the entire Chesapeake Bay watershed was not finished when the USDA grant ended. Additional funding had to be sought.

Questionable Authority in the Chesapeake Bay

The development of Nutrient Net was oriented towards builds the right tools and creating a shared understanding of state trading schemes, rather than consensus on policy questions. The fragmentation of decision-making in the Chesapeake Bay watershed, despite decades of experimentation with Bay-wide institutions like the Executive Council, and now the Trading and Off-Sets Work Group and the Chesapeake Bay Environmental Markets Team, means that authority remains dispersed.¹²⁶

¹²³ For this group's history and charter, see:

http://www.chesapeakebay.net/groups/group/trading_and_offsets_workgroup Last accessed on: 08/23/2012.

¹²⁴ See: http://www.chesapeakebay.net/channel_files/18622/draft_towg_work_plan_08-3-12.pdf Last accessed on: 08/08/2012.

¹²⁵ For the list of participants, see:

http://www.chesapeakebay.net/groups/group/trading_and_offsets_workgroup Last accessed on: 08/23/2012.

¹²⁶ The best place to find a description of these specific committees is the Chesapeake Bay Program's website: <http://www.chesapeakebay.net/about/organized> last accessed on 07/13/2013. A more critical analysis of the history of collaboration and institutional design in the Chesapeake Bay is: Steinzor and

The extent to which the EPA and the Trading and Off-Sets Work Group will be able to force changes to individual State trading systems is unclear. As an official from the agency put it: “It remains to be seen whether sort of how far reaching the charge and impact of this group would be.” (DeBell, interview with author, 11/15/2011) He went on to say more about limitations on the group’s authority:

So I can’t say from that angle what kind of things this group would take on and frankly how much – I use a political science term here, but how much sovereignty any of the states would be willing to give up in that process and how much direction they’d be willing to take. You know, by extension one has to ask how much political will does EPA or any other federal agency have to try to compel the states to comply with the determinations of a group like this. (Interview with author, 11/15/2011)

For now, interstate trading of water quality credits remains virtually impossible. It is unclear how or why this might change as a result of Nutrient Net.

A second complicating factor reveals still another challenge, more specific to the development of ESMs and the effort by WRI to create a single Nutrient Net for all the Chesapeake Bay states. Mindy Selman, a senior associate at the World Resources Institute and the project lead on multiple iterations of Nutrient Net describes the relationship between technology development and policy advocacy as follows:

WRI isn’t an advocacy organization, but we are an environmental think tank. (...) It’s delicate, because by building the tool for the states it is almost - we are never anybody’s - we are not the contractor, they are not our clients, et cetera, although sometimes it becomes like that. (Interview with author, 11/15/2011)

This, somewhat ambivalent, description of the relationship between WRI and the responsible state agencies points to the difficulties surrounding technology development in connection with ESMs. It reveals uncertainty with regard to the roles and

Jones, 2013, *Collaborating to Nowhere: The Imperative of Government Accountability for Restoring the Chesapeake Bay*.

responsibilities of the institutions involved. There are many groups that want to participate in the development of measurement systems, but their involvement in technology development does not constitute a commitment to the implementation of markets in which these technologies might be used.

There is an irony to the fact that the emergence of numerous working groups and teams has made communication more difficult, thus paradoxically, limiting participation. Some organizations and individuals have simply not been able to attend required meetings. Lines of authority are confusing or non-existent. Neither EPA nor any other organization has the authority to implement a Bay-wide water quality market. The long history of efforts to clean up the Chesapeake Bay suggests that this should come as no surprise. Interestingly, the authority of even more limited organizations like WRI, which has long advocated water quality trading for the entire watershed and is an important actor with great standing in the field, is not clear either. While active participation by organizations like the Willamette Partnership and WRI brings with it many resources and expertise, it also raises the question of where the authority ought to set when ESMs cross state and agency boundaries.

4.d. Building the Bay Bank

A second well-known attempt to create an integrated ESM for multiple credit types covering the entire Chesapeake Bay watershed was the Bay Bank. In 2008, another USDA Conservation Innovation Grant supported the creation of technical tools and metrics jointly referred to as the Bay Bank. The organization that led this effort was the Pinchot Institute for Conservation. This institute, named after the first chief of the United

States Forest Service, is a not-for-profit organization based in Washington, D.C., that emphasizes forest conservation research. The institute maintains a strong connection to the U.S. Department of Agriculture's Forest Service (Sample, n.d.).

The idea behind the Bay Bank can be traced back to 2006, when the Forest Service funded a study *The State of the Chesapeake Forest*. This report highlighted the importance of forests to water quality, and suggested: "Bring(ing) ecological services into the market place by establishing forest mitigation and trading systems and a registry to facilitate transactions" (Sprague, Burke, Claggett, & Todd 2006). It's therefore not surprising that the U.S. Forest Service named the creation of the Bay Bank, which was referred to as a "watershed forestry ecosystem marketplace" one of the key goals of its Chesapeake Bay Watershed Forestry Program in February 2007.¹²⁷

The emphasis on forestlands' relationship to water quality was formalized in the Chesapeake Executive Council's directive 06-01, also issued in 2006, which highlighted the importance of forests to the environmental quality of the Chesapeake Bay watershed.¹²⁸ In a 2007 response to its own directive, the executive council explicitly called for "Strong economic incentives for working with forest landowners and working with private and public partners to establish a framework for market-based ecosystem service transactions."¹²⁹ The Forest Service, the Maryland Forest Service, the Pennsylvania Bureau of Forestry, the Virginia Department of Forestry, and the Chesapeake Bay Program responded by developing *Forestry for the Bay*, managed by the

¹²⁷ See: <http://www.na.fs.fed.us/ra/specialinitiatives/chesapeakebay/2007/cb07.html> Last Accessed on: 07/26/2012.

¹²⁸ Directive 06-01 can be found at http://www.chesapeakebay.net/content/publications/cbp_12604.pdf last accessed on 07/25/2012.

¹²⁹ The Chesapeake Executive Council's *2007 Response to Directive 06-01* can be found at: http://www.chesapeakebay.net/content/publications/cbp_27761.pdf and was last accessed on: 07/26/2012.

not-for-profit Alliance for Chesapeake Bay. Forestry for the Bay is a voluntary program that provides education for landowners in the Chesapeake Bay watershed. It promotes healthy woodlands, water quality and how to manage for both. The Bay Bank and a related project named “Land Server” were both developed in close connection to this larger program, and supported by the same organizations and people. The creation of the Bay Bank, much like the Willamette Marketplace, was the vision of a small number of dedicated people. The development of the Bay Bank underscores the challenges associated with limiting the number and type of stakeholders involved in developing an ESM.

An Emphasis on Forestry

The project manager for the *Bay Bank* was Eric Sprague, a program director with the Pinchot Institute at the time and the lead editor of the 2006 *State of the Chesapeake Forest* report. He coordinated the Bay Bank process together with James Remuzzi, a forestry consultant with Sustainable Solutions, LLC. The third person at the heart of the Bay Bank effort was Al Todd. At the time he was in the U.S. Department of Agriculture’s Office for Ecosystem Markets, but he now directs the Alliance for the Chesapeake Bay. Todd was also an editor of the 2006 report.

Approximately fifteen organizations served on the advisory committee for this market-creation effort, including many government agencies along with the Nature Conservancy, the American Forest Foundation, and the Biophilia Foundation.¹³⁰ The last organization primarily provided financial support. It took the form of a grant to develop

¹³⁰ For a more complete list of current “partners”, see: <http://www.thebaybank.org/about/partners> last accessed on 07/26/2012.

protocols for the different kinds of ecosystem service credits that might be traded under the auspices of the Bay Bank.¹³¹

Since the Bay Bank focused on forestry from its inception, the list of participants involved reflects this. Project leaders did not seek outside facilitation assistance in identifying appropriate stakeholders or formulating a work plan. In total, about 30 people participated in meetings and working groups to study the potential of four different kinds of ecosystem credits. At many of the sessions,, project proponents, specifically Al Todd's colleague Becca Madsen, compared buying and selling endangered species habitat to buying and selling Lego blocks via Ebay.¹³² This certainly underestimates the practical problems of implementation. The fact is, they had very few successful models to explain the Bay Bank in straightforward terms to other stakeholders and experts in the Chesapeake Bay watershed.

The types of “blocks” or credits that the Bay Bank team focused on during the expert meetings related to carbon dioxide, water quality, endangered species habitat and forest conservation. The carbon and water quality working groups were primarily made up of experts from the Pinchot Institute. This is somewhat surprising, given the enormous attention to water quality throughout the Chesapeake Bay watershed and the large number of agencies and organizations involved in many efforts to improve it.¹³³ In early discussions, wetlands were also part of the marketplace, but this was later dropped.¹³⁴

The number and range of stakeholders involved appears about the same as in the Willamette, but given the size of the Chesapeake Bay watershed, and the fact it covers

¹³¹ See: <http://www.biophiliafoundation.org/about-current-grants.html> Last accessed on: 07/26/2012.

¹³² Author's personal correspondence with Becca Madsen, 01/23/2013.

¹³³ According to Eric Sprague, in interview with author on 11/17/2011.

¹³⁴ Presentation by Eric Sprague, available online at: <http://www.katoombagroup.org/documents/files/Sprague.pdf> Last Accessed on: 08/01/2012.

parts of six states and the District of Columbia, this is actually very limited representation. The participation of state and federal agencies was largely focused on forestry-specific agencies, and geographically the focus was on Maryland.

Designing the Bay Bank

The people that initiated the process to develop the Bay Bank, namely Eric Sprague of the Pinchot Institute, James Remuzzi of Sustainable Solutions, LLC and Al Todd of the USDA, decided early on to focus on so-called regulatory markets. The Clean Water Act and the Endangered Species Act would drive trading, they believed, since developers and agencies in need of permits would be required to buy credits. Rather than developing markets for ecosystem services from the ground up, they saw what they were creating as an “on-ramp.” They sought to direct landowners to existing programs that would allow them to develop and sell ecosystem credits. As Eric Sprague describes it “Bay Bank was developed not necessarily to create new markets, but to find out how to better facilitate access to them” (Interview with author, 11/07/2012).

To achieve more integrated access to existing environmental markets in the Chesapeake Bay watershed, new forms of interaction or collaboration were needed. The existing markets and legislative frameworks that they hoped would drive trading were defined at the state level, and within states, specific to certain types of land-uses or water-quality impacts. Similarly to the COTE-process, the development of the Bay Bank involved separate working groups.

Working group participation in the Bay Bank process mirrored existing divisions between sectors and states. This is clearly illustrated by the forest conservation working

group. Maryland has a Forest Conservation Act,¹³⁵ which requires compensation for forest stands that are cut for development or other purposes. In this way, the Forest Conservation Act creates an opportunity to develop a trading framework for forested land, although Maryland's Forest Conservation Act does not require one-for-one compensation for every tree or acre of forested land that is lost. The forest conservation working group developed methods for landowners in Maryland to quickly assess the potential of their land to be used for forest restoration under various county-specific Forest Conservation Plans. Since this legislation is unique to the state of Maryland, the working group did not address forest conservation in the rest of the watershed. The participants did try to incorporate forestry priority areas that had been defined in West Virginia. Variations between forest compensation requirements from state to state created obstacles to developing a unified way of generating sellable credits for environmental restoration.

The Bay Bank process achieved limited progress in developing and sustaining new forms of collaboration to continue the implementation of the suggested trading programs among the states and agencies involved in the Bay Bank. The proponents presented an ambitious scope and scale at the outset of the Bay Bank, namely a marketplace for multiple credits for the entire Chesapeake Bay. This vision stands in sharp contrast with the limited participation that took place during the design process. Of course, had a more modest version of the Bay Bank been the goal from the outset, it is far from certain if the actual level and type of participation been more in line with the expectations. Perhaps people simply would not have participated at all in such an effort.

¹³⁵ The Forest Conservation Act is formally known as Natural Resources Article 5 – Subtitle 16: 1601-1603, and was enacted in 1991. It can be accessed here: <http://www.dnr.state.md.us/forests/programapps/newFCA.asp> Last Accessed on: 07/31/2012.

This is an issue that not unique to the development of ESMs, namely that a bold and innovative project proposal is considered necessary to generate interest and resources from relevant (potential) stakeholders, but that lofty expectations can become problematic once a more modest outcome is achieved. The excitement about the promise(s) of ESMs is perhaps nowhere more evident than in the original proposals for the Bay Bank, but in hindsight, so are the challenges of creating ESMs.

Moving from Regulatory to Voluntary Markets

The Bay Bank project began with very modest objectives. It focused on facilitating access to existing markets, rather than on developing new markets. Nevertheless, the habitat-working group did try to develop a new market for two species in the region: brook trout (*salvelinus fontinalis*) and the bog turtle (*clemmys muhlenbergii*). The thought was that a trading system aimed at protecting the habitat of these two species could offer a helpful compensatory scheme for developers who might be involved in destroying existing habitat, in much the same way the proposed prairie habitat provided credits for the Fender's Blue butterfly in the Willamette Marketplace.

The bog turtle has been listed as threatened since 1997.¹³⁶ In 2009, the US Fish and Wildlife Service did not list the brook trout as endangered under the Endangered Species Act when it had a chance to do so.¹³⁷ The habitat working group developed a set of requirements and guidelines, including protocols and metrics, describing how a species banking system might operate. Given the fact that neither of the species was legally

¹³⁶ For the ruling, see the Federal Register Vol. 62, No. 213, available at: http://ecos.fws.gov/docs/federal_register/fr3175.pdf Last accessed on: 08/01/2012.

¹³⁷ For the complete ruling, see the Federal Register, available at: <https://federalregister.gov/a/E9-11527> Last accessed on: 07/31/2012.

endangered, thought, and developers were not required to compensate for the impacts they had on these habitats, the whole scheme would have to be entirely voluntary. Thus, two pilot projects to restore habitat to develop brook trout and bog turtle credits were part of the Bay Bank effort. Both were voluntary, and neither has yet succeeded in selling any credits. Since the Bay Bank's various working groups meetings took place in 2008 and 2009, it is not likely they will ever become active. The simple conclusion is that the availability of a particular type of ecosystem service credit does not mean individuals or organizations are actually willing to spend their money purchasing them. While certain companies have bought other types of "voluntary" credits, often in an effort to bolster their "green" corporate image, this has not been the case in the Bay Bank.

Given the unclear status of species-banking for the bog turtle and the brook trout, perhaps the most visible product of the overall effort is the *Bay Bank* website, where the overall project is described as

The Chesapeake's conservation marketplace, linking landowners with resources to improve and protect the region's natural resources and working lands." And, the Bank "combines the best available tools to enable easy access to local, regional, and national ecosystem markets and conservation programs.¹³⁸

This emphasis on tools and resources makes it clear that changing the way in which stakeholders in the Chesapeake interact and collaborate was never the real focus of the project. Experienced mitigation bankers in the region, like Greenvest LLC, a firm specialized in "creating value in underutilized and environmentally impaired real estate" does not use Bay Bank to develop or calculate credits.¹³⁹ In July 2013, a total of just fourteen projects were listed on the Bay Bank marketplace. Al Todd, one of the early

¹³⁸ See: <http://www.thebaybank.org/> Last accessed on: 07/26/2012.

¹³⁹ See: www.greenvestus.com Last accessed on 08/01/2012.

developers of the Bay Bank and currently the executive director of the not-for-profit

Alliance for the Chesapeake Bay, describes the situation as follows:

I think Bay Bank was kind of built like a big convention hall and then we figured everybody can fit in, but it's not working out that way. So we think that this forest mitigation might be one of those avenues to kind of deconstruct, take a lot of the benefits of the Bay Bank work, reapply them in a fairly focused single purpose way and eventually add elements to it. (Interview with Author, 11/08/2011)

The failure of the Bay Bank shows that it is difficult to create an ESM, even when distinct environmental trading programs already exist and governmental as well as financial support is available. There was simply no demand for the credits that could be generated. The market proponents involved never successfully connected regulatory requirements on real estate developers or municipalities with presumably low-cost ways of meeting those requirements.

4.e. Conclusions

The tension between the importance many people attach to the places they know and the need to move (parts) of places around to make an ESM work, as well as the complexity inherent in most measurement systems for ESMs make it difficult to know whom to engage, and when, in the creation of an ESM. This chapter started with the observation that there is no manual indicating how to develop an ESM at the watershed scale and that efforts to create such ESMs have met with relatively little success. It has also shown that as the scale of potential market areas increases, the need to involve additional stakeholders poses additional changes.

Three elements of *complex governance*, namely participant selection methods, modes of communication and authority to implement decisions reflect the key

considerations in designing a participatory process. While it is not plausible to draw broad lessons about how participation and negotiation can be managed to create stable ESMs, a couple of specific ideas can be identified.

The first point about selection in all of my cases is that market enthusiasts made up most of the participants. This has meant that opponents of ESMs typically emerge at a later point in their development, after an agency has issued a permit that includes trading, or when a credit broker makes a trade. Given the broad range of ecosystems and places that ESMs connect, it is not easy to anticipate what kinds of opposition might emerge, or where it will come from geographically. A more serious commitment to identifying and involving a broader set of potential stakeholder in the early stages of ESM development is probably called for.

My second conclusion about stakeholder participation specific to the development of ESMs is that a strong focus on technology innovation can become an obstacle to inclusiveness and effective communication. Many important assumptions about what to value in an ecosystem are deeply embedded in the design of technical measurement or assessment systems. The inclusion of stakeholders with little ecological or biological training during COTE broadened the range of participants, but made it hard to incorporate their concerns. The models and calculation techniques in the Nutrient Trading program in the Chesapeake Bay are so complex, as is the institutional context in which they must continue to be adjusted, that the limited number of experts who can follow what is going on can hardly find the time to attend all the relevant meetings and discussions. Non-expert participation is therefore limited, even given the scale and population size of the Chesapeake Bay watershed.

My third and final conclusion about stakeholder engagement in ESM design and implementation is that it is frequently unclear who has the authority required to make a market work. The successes and failures in developing ESMs in the Willamette River basin and Chesapeake Bay watershed shows that a dedicated group of political leaders (not just ESM market enthusiasts) is probably needed to make real progress.

Chapter 5: Moving Markets

In the movie “Field of Dreams,” a struggling farmer (played by Kevin Costner) repeatedly hears a voice from heaven whisper to him: “If you build it, he will come.”¹⁴⁰ The specific instruction is to build a baseball field instead of growing corn, in the middle of Iowa. Once the farmer builds the diamond after an enlightening visit to Fenway Park, the ghosts of famous baseball-players start using the field to play baseball. As a result, paying audiences flock to this cornfield, alleviating the farmer’s financial struggles once and for all. In restoration ecology, this quote is commonly used to describe the expectation that when physical attributes, like water flow or elevated ridges, are restored, biotic responses will rapidly follow, without any additional human intervention (Hilderbrand, Watts, and Randle 2005). During my research I regularly heard proponents of ESMs use this phrase to describe the hope, and expectation, that following the creation of a clear set of rules and measurement systems for an ESM, active credit trading would emerge “naturally” and buyers and sellers would “come.” A central finding of this dissertation is that this prophecy, hypothesis or expectation does not bear out when it comes to the creation of ESMs.

I have identified three reasons ESMs have failed to materialize: concerns about place, the difficulty of building adequate measurement systems and the trouble that arises when the wrong people or too many people are invited to the table. This final chapter revisits those three challenges. They do not disappear when an ESM is “built,” and trading begins, or “they come.” Since there are relatively few examples of the successful

¹⁴⁰ A review of this movie is available at: <http://www.rogerebert.com/reviews/field-of-dreams-1989> Last accessed on: 08/27/2013.

creation of ESMs, the first section of this chapter will review the second shade-credit permit issued in Oregon, to the City of Medford.

My purpose in offering this illustration is to show that it is possible to overcome the three challenges I have identified. On the other hand, I do not believe the Medford permit deals adequately with all three challenges. The Medford experience does provides clues as to what might work.

Medford's permit was modeled after the Tualatin example described in the introduction, in the sense that a water treatment facility was allowed to meet its temperature reduction requirement by investing in riparian tree planting. The facility avoided having to build an expensive "chiller." Instead of requiring an elaborate plan regarding the location of tree planting projects, however, and instead of requiring active participation by a variety of community groups, the City of Medford let a non-profit organization determine where tree planting would be focused and who needed to be consulted. This seemed to solve the participation problem, at least at the outset. And, it worked around the location problem. Not surprisingly, though, there was resistance to both of these strategies. So, the case suggests that they overcame the three basic challenges to creating an ESM. In some respects, though, the problems have or might still reappear because they were not solved entirely. Once an agreement is in place, there is a need to confront the issues of place, measurement and participation on a continuing basis. And, if these challenges are not dealt with effectively at the outset, they may become even harder to deal with later on. In the second part of this chapter I will describe several interlocking proposals for dealing with the three major challenges more effectively, in part by relaxing the notion of what a market is or can be.

5.a. Declaring Success in Medford

The city of Medford, Oregon offers a seemingly successful example of how to create an ESM. Medford is located in the Rogue River basin and has a population of about 75,000, making it 8th largest city in Oregon.¹⁴¹ To the extent Medford has a reputation in the United States, it is perhaps best known as the home of *Harry & David* and their Gourmet Gift Baskets. Harry & David pioneered the sales of food, especially fruit, through mail order, but the success of its fruit-filled gift baskets did not prevent the company's bankruptcy in 2011 (Effinger, 2011). A Medford businessman describes the economic climate that overcame them: "There's not a whole lot of positive news for industry around here" (Effinger, 2011).

Yet in March of 2012 Medford suddenly became much more prominent, at least in environmental circles, after President Obama hailed the city in a speech at the White House Conservation Conference by commending the city council's decision to become a site for an ESM. This apparently was good news for business. The President's speech endorses the logic of ESMs and demonstrates the powerful rhetoric that still surrounds the ESM idea. While there are multiple inaccuracies in the President's account of what happened in Medford, here is how he summarized this ESM:

The bottom line is this: There will always be people in this country who say we've got to choose between clean air and clean water and a growing economy, between doing right by our environment and putting people back to work. And I'm here to tell you that is a false choice.¹⁴²

He then proceeded to prove his contention, at least rhetorically, by describing Medford

¹⁴¹ For general information about Medford, see: <https://www.ci.medford.or.us/> Last accessed on: 08/29/2013.

¹⁴² For a video and transcript of the President's entire speech, see: <http://www.whitehouse.gov/photos-and-video/video/2012/03/02/president-obama-speaks-conference-conservation#transcript> Last accessed on 01/05/2013.

becoming a place where ecosystem services are traded:

Every year, the Rogue is filled with salmon swimming upstream to spawn. But because factories were allowed to -- allowing warm water to run back into the river, the temperature was becoming too high for the salmon to survive. So to fix the problem, the town [Medford] could have required the company to buy expensive cooling equipment, but that would have hurt the local economy. Instead, they decided to pay farmers and ranchers to plant trees along the banks of the river, and that helped to cool the water at a fraction of the cost. So it worked for business; it worked for farmers; it worked for salmon.

To those familiar with Clean Water Services' Healthy Streams Initiative in the Tualatin River basin it is clear that this general approach has been around for years. Also, and again similar to Clean Water Services, the warm water was actually discharged by a publically owned and operated water treatment facility, and not by "factories." Medford's success in overcoming the usual challenges associated with ESM creation implies that the problems of place, measurement and participation can be overcome.

Shade Credits Come to the Rogue River basin

The lessons from the shade trading approach in Medford in relation to the challenges to ESMs are threefold. The first is that the spatial allocation of restoration activities requires ongoing attention, regardless of who makes that final decision about where to plant trees or restore habitat. While the City of Medford granted a lot of discretion to an environmental non-profit organization to determine where to focus restoration efforts, the role of other stakeholders did not need to be so limited. The second lesson is that the implementation of an ESM can result in renewed criticism of the approach to establishing baseline, and related aspects of the ESM measurement strategy. It is only logical to expect that it will be necessary to review, and potentially revise,

aspects of any measurement system as the market evolves. The third lesson from the Medford case is that the implementation of an ESM brings with it new opportunities to engage stakeholders in environmental restoration projects. That is, rather than reducing the scope of such opportunities, as has been the case in Medford, ongoing participation can be incorporated into the implementation of an ESM.

To understand the creation of this ESM, it is important to return to Counting on the Environment (COTE). David Primozich was the executive director of the Willamette Partnership from 2003 until 2010, and in that capacity he led the COTE process together with Bobby Cochran from Clean Water Services, through which the protocols and tools for, among others, shade trading in Oregon were established. But after this process, Primozich and Cochran came to the following realization:

“We relished the effort for a couple of months, and then said, you know, if it is nobody’s job to turn these protocols into a real transaction, it’s more than likely not going to happen. So I then worked then closely with the Freshwater Trust, articulated what I thought we needed to do, the way we would probably get there, and made the switch over to the Freshwater Trust as the Director of Ecosystem Services, and immediately initiated contact with NPDES permittees with a pending permit with Thermal Load limits.” (Interview with author, 7/14/2011)

One of those permitted entities was the city of Medford. The city’s permit for the Medford Regional Water Reclamation Facility had expired in 2007.

In 2008, while Medford was working with the Oregon Department of Environmental Quality to apply for a permit for the water treatment facility, the EPA approved the Rogue Basin Total Maximum Daily Load (TMDL). This included temperature allocations and meant the City would have to find a way to cool the water in the Rogue River if it wanted a new permit. By 2010, when Primozich had become the senior ecosystem services director at the Freshwater Trust “a 501(c)(3) not-for-profit

organization that actively works to preserve and restore our freshwater ecosystems.”¹⁴³

Medford had not yet applied for a new National Pollutant Discharge Elimination System (NPDES) permit.

In 2010 and 2011 Primozych was instrumental in convincing Medford’s city council that the best way to meet this requirement would be by planting trees, as opposed to constructing cooling ponds or installing mechanical water cooling equipment. The Freshwater Trust worked closely with the city to decide how many trees could be planted each year, and to convince Oregon’s Department of Environmental Quality, the agency responsible for issuing the permit, that the city could meet its temperature reduction goals.¹⁴⁴

However, in contrast with Clean Water Services, Medford did not develop an extensive public plan to prioritize locations and involve volunteers and community organizations in its tree-planting effort.¹⁴⁵ Instead, the city council issued a Request for Proposals for a “trading partner.” Shortly thereafter Medford signed an exclusive contract with The Freshwater Trust, in Dec. 2011, holding a single public hearing on the proposed thermal credit-trading program. The contract was signed a week before the new NPDES

¹⁴³ This description of the organization is taken from its website, at <http://www.thefreshwatertrust.org/about-us/history> Last accessed on 05/31/2013.

• ¹⁴⁴ This is evidenced by the following paragraph in ORDEQ’s Evaluation of Medford’s permit application: “*Medford RWRf carefully considered available restoration opportunities and the time needed to recruit and contract services with landowners. To develop the schedule and interim milestones, Medford RWRf collaborated with The Freshwater Trust, a not-for-profit organization with extensive experience in both river and stream restoration and working with landowners throughout Oregon.*” (ORDEQ, 2011, p. 34). This evaluation report was made public as the result of an open records request by the Idaho Conservation League. See: <http://northwestenvironmentaladvocates.org/water-quality-trading-innovation-or-hoax/> Last accessed on: 05/02/2013.

¹⁴⁵ The City of Medford, through its membership in the Rogue Valley Council of Governments, has participated in an active tree-planting program in the Bear Creek watershed since 2008, and in the Rogue River since 2010. These tree-planting efforts have engaged volunteer groups like boy scouts and the Lomakatsi Restoration Project. See: http://rvcog.org/MN.asp?pg=NR_Rogue_TMDL Last accessed on 05/31/2013.

permit was issued by Oregon's Department of Environmental Quality. This approach limited the opportunities for opponents to markets to make their case, and for groups interested in participating in the ESM in some fashion but without being the sole "trading partner" to do so.

By signing the contract, Medford committed to paying The Freshwater Trust a little over \$8,000,000 that would be invested in riparian restoration in the Rogue River basin, upstream of the water treatment facility. In doing so, the city council unanimously handed over discretionary authority regarding where restoration would take place, who would oversee restoration activities and who would be allowed to comment on them.¹⁴⁶

Scale and Control

The Rogue River basin extends more than 50 miles outside of the city limits of Medford, making it possible that some of the restoration will occur quite far from the downtown. The Freshwater Trust is free to recruit landowners to plant trees, as long as they are within the watershed, and adjacent to salmon bearing streams that are located upstream of the Medford Regional Water Reclamation Facility. In fact, The Freshwater Trust has developed a sophisticated ecological toolkit called *Streambank*, to determine where to target its restoration efforts.¹⁴⁷ The software is proprietary, and The Freshwater Trust hopes to significantly expand its revenue by monetizing this product, allowing the organization to move away from traditional sources of funding for not-for-profits, like

¹⁴⁶ The agreement was agreed upon as an ordinance, which was approved during the city council meeting on Dec. 1, 2011. For the minutes, see:

<http://www.ci.medford.or.us/Agendas.asp?Display=Minutes&AMID=5037> Last accessed on 05/02/2013.

¹⁴⁷ See: <http://www.thefreshwatertrust.org/conservation/streambank/how-it-works> Last accessed on: 05/02/2013.

grants and donations.¹⁴⁸ In addition, the contract between the City of Medford and the Freshwater Trust stipulates that formal public input on specific restoration projects is not required, as the Department of Environmental Quality states in its fact sheet on the NPDES permit: “To obtain thermal credits, a written planting plan is required for each project. DEQ will not publically notice or receive public comment on individual trades” (ORDEQ, 2011, p. 30).

This means that the decisions about where restoration projects will be located are between the Freshwater Trust and individual landowners, without opportunities for public comment. The only form of review is the technical assessment of the environmental effects of these projects by the Department of Environmental Quality. This is in sharp contrast with Clean Water Services’ approach to thermal credit generation. CWS has developed an extensive plan to guide its riparian restoration efforts that includes repeated and ongoing public participation, which includes broader elements like public accessibility and environmental awareness. The extent to which Medford has entrusted this non-profit organization is significant, and potentially problematic. All the considerations about investments in restoration are essentially left to an organization that is not directly accountable to the population of Medford, and the state’s Department of Environmental Quality is effectively the only monitoring entity.

The development of Streambank shows that the choice for specific locations of tree planting projects need not be left to “the market,” or to landowners is willing to accept the lowest payment for such a project. The Freshwater Trust has developed a sophisticated approach to incorporating the role of particular places in its decisions about

¹⁴⁸ See this article in the Sustainable Business Oregon section of *Portland Business Journal*, at: http://www.sustainablebusinessoregon.com/articles/2010/04/freshwater_trust_is_ready_to_make_a_national_splash.html?page=2 Last accessed on 05/02/2013.

where to target restoration efforts. While I believe, and will argue in the second half of this chapter, that decisions about where to locate restoration projects should be made in a much more transparent way, with active participation from a range of stakeholders, the development of Streambank indicates that it is entirely feasible to bring a range of considerations into the decisions about places that are suitable for restoration.

This new shade deal, while hailed by President Obama, attracted criticism from environmental groups that have long been critical of this approach, primarily the Northwest Environmental Advocates.¹⁴⁹ This organization sent a detailed letter to the EPA arguing that the Medford permit and its contract with the Freshwater Trust did not comply with the Clean Water Act, primarily because NWEA believes landowners already have a legal obligation to protect riparian vegetation. This is in essence a disagreement over the baseline from which credits can be generated. The second objection is about the timeframe within which the shade credits are generated, and the calculation method used to generate credits based on a twenty-year average of shade production.

The Freshwater Trust vehemently disagreed with this characterization of the Medford permit, and the shade credit program more generally in a response to the EPA.¹⁵⁰ While these disagreements are likely to continue for some time, and legal action by NWEA or a similar group looks increasingly likely, the relevant point for this analysis is that the challenges to measurement systems and trading rules continue as ESMs are implemented. Signing an agreement between a municipality, or credit buyer, and an

¹⁴⁹ The letter to the EPA from NWEA can be found here: <http://www.northwestenvironmentaladvocates.org/nweafiles/2013/03/Letter-to-EPA-on-Oregon-trading-3-2013.pdf> Retrieved on: 08/27/2013.

¹⁵⁰ The Freshwater Trust's response can be found online at: http://www.cambridgeforums.com/www.admin/materials/wr/1367355276TFT_Letter_re_NWEA_letter_4_2_2013.pdf.pdf Retrieved on: 08/27/2013.

environmental non-profit acting, as a credit broker does not remove the basic tensions inherent in ESMs, not does it silence their critics. But as the challenge of creating ESMs moves into a new phase in some places, where the struggle is no longer over the basic design and creation of an ESM, but over ongoing trading and restoration activities, new opportunities for active engagement and consensus-building also emerge. So far, the first restoration projects in the Rogue River basin have included a mix of participants, including volunteers like boy scouts and students, but also members of the Southern Oregon Landscapers Association and people recruited through the Jobs Council. This reveals the simple fact that people are willing to work on restoration projects and can be involved in a variety of ways during the implementation phase.

The City of Medford had a different set of concerns than Clean Water Services when deciding how to reduce water temperature to obtain the NPDES permit. According to the Plant Superintendent of the Medford Regional Water Reclamation Facility, Dennis Baker: “We weighed our options, and water quality trading was the lowest cost option, and offered significant environmental benefits. Also, the water quality trading approach had considerable support from DEQ.”¹⁵¹ The consulting engineer for the City was quoted as saying: “This agreement allows Medford to have zero staff dedicated to this program.”¹⁵² For a city like Medford, where unemployment is above the national and state averages, where a large employer has recently gone bankrupt, and where access to green space is readily available, these considerations are easily understood. Clearly, the city council was not very concerned about *ecological outsourcing*, or even economic

¹⁵¹ See the Oregon Association of Clean Water Agencies Winter 2012 Newsletter, pp. 8-9, available at: http://www.thefreshwatertrust.org/sites/thefreshwatertrust.org/files/docs/2012%20Winter%20Oregon-Association-of-Clean-Water-Agencies_Medford-Water-Quality-Permit-Moves-Trading-Forward.pdf Last accessed on: 05/02/2013.

¹⁵² See note 13.

outsourcing, since the fact that no additional staff was required to assess the benefits of the agreement with The Freshwater Trust. This statement raises the question of effective monitoring and oversight. The City of Medford, as the owner of the water treatment facility, is formally responsible to ensure that the water cooling approach it has chosen to pursue meets the requirements spelled out in the NPDES permit. For example, in case of a failed restoration project as the result of circumstances outside of the permittee's control, like a storm that downs a significant number of trees, or a beaver that does the same thing, it is the City that is responsible for the notification of the state regulator, Oregon's Department of Environmental Quality.

So while the City of Medford has successfully avoided hiring new staff to meet the obligations of the NPDES permit, it remains legally responsible for the implementation of that same permit. This kind of liability, and the division of responsibilities between landowners, credit brokers and credit buyers has not materialized or been tested in court yet, meaning no NPDES permittee has been challenged in court for not meeting its obligations under a NPDES permit that included shade credit trading. However, many market proponents believe that it is simply a matter of time before a group, possibly one like the NWEA will seek to clarify the allocation of these responsibilities and liabilities in a legal ruling.

The City of Medford might come to regret its decision to avoid dedicating staff resources to the effective oversight and monitoring of these restoration projects. Given the economic climate in Medford, and the limits on public resources, an alternative way of creating effective and regular oversight of this kind of ESM is desirable.

5.b. From Challenges to Possible Changes

The developments in Medford, as well as the divergent responses from President Obama and the Northwest Environmental Advocates suggest that additional ESMs are likely to be created, and they will probably arouse both enthusiasm and antagonism. Even given the challenges that form the center of this dissertation, it is my guess that market-creation proponents will continue their efforts. The following section returns to each of the challenges I analyzed in the previous chapters and connects these challenges to longstanding ideas in environmental planning theory.

Displacing Nature and Adaptive Management

The experiences in Oregon and the Chesapeake Bay states show that ESMs must be evaluated from more than a technical point of view. For example, it quickly became clear that there are political and social effects associated with practices like moving poultry manure from the Susquehanna to the Ohio River basin, or replacing publically accessible urban wetlands with more rural, privately owned wetlands. So the creation as well as the evaluation of ESMs should emphasize social and political considerations, not just narrow environmental concerns.

From a theoretical perspective, some of this resistance could have been expected. Mary Douglas argued as early as 1966 that the definition of what constitutes pollution, or more precisely dirt, varies between cultures, and thus across time and place. She showed that ideas about dirt are deeply connected to spiritual beliefs, and that the protection of the boundary between pure and dirty is frequently a religious endeavor.

Harvey's *Justice, Nature and the Geography of Difference* is something of a modern classic in human geography and connects geography to historical materialism in the Marxist tradition. Harvey's point, central to this study, is that spatial considerations are critical to the evaluation of social justice. Dooling's development of ecological gentrification as a way of understanding and critiquing the development of particular types of urban green spaces shows that the location as well as the design of green spaces has important social implications, and should be evaluated as such, and not purely in ecological terms. More carefully crafted approaches to spatial allocation are not only possible; they are at the core of spatial planning (McHarg, 1969).

Developing a regional vision of where environmental restoration and best management practices are desirable, not only from an environmental point of view, but also from a social point of view, is entirely feasible as the Healthy Streams Initiative in the Tualatin showed. This connection between social and ecological elements is also at the heart of much recent work in ecology, frequently under the rubric of *adaptive management* (Gunderson and Holling 2001).

Based on the realization that it is difficult if not impossible to predict the outcomes of interventions in so-called *social-ecological systems*, the creators of this approach have suggested using iterations and regular feedback loops. While the implementation of his kind of approach is certainly not always successful (Layzer 2008), the basic insight is relevant to these markets, namely that rules, goals and measurement systems will have to be adjusted over time. Therefore the incorporation of a planned approach to those changes and adjustments is likely to strengthen the stability of an ESM.

Measurement and Double-loop Learning

The development of measurement systems for markets is an important part of creating ESMs. The first broad conclusion based on the analysis of the measurement systems in the Chesapeake and Willamette market-creation efforts is that most of these measurement systems are the result of long and complicated development processes, typically with significant government support. This means that the measurement systems incorporate elements based on determinations that cannot be explained by strictly referring to the potential of a place to produce a particular ecosystem service.

The Prairie Habitat metric, for example, is weighted to value land that has not been altered by human activity over land that has been. As the participants in the development of this metric described, this is not so because that kind of disturbance reduces the potential, or even the current level, of appropriateness to function as habitat. Instead, the developers of the metric knew that its intended use was to determine which type of land would be protected or restored. They had a preference for relatively “undisturbed” parcels and ensured that the metric reflected that judgment.

This kind of complex interaction between policy preferences and measurement systems is not necessarily a new development, or unique to the realm of ecosystem services. For example, the history of mapping and more recently geospatial data-development similarly crosses the boundaries of the scientific, economic and governmental realms.

Furthermore, measuring aspects of ecosystems, from trees to water quantities, has long been a central occupation in environmental management. However, an important argument from recent scholarship on markets for ecosystem services is that the need of

these measurement systems to function simultaneously as regulatory, scientific and economic tools makes them especially vulnerable to criticism and often difficult to use (Robertson 2006).

The likelihood of ongoing disagreements over (elements of) measurement systems indicates a need to explicitly revisit them on a regular basis. So not only should the outcomes of the measurement systems be reviewed, their functioning and the institutional context in which they operate cannot be assumed to remain stable either.

The second theoretical foundation for the suggested institutional innovations is therefore *double-loop learning* (Argyris and Schön 1978). This idea describes the possibility of not simply learning about success or failure in terms that are prevalent in an institution, but also learning about the features of that institution that influence those outcomes. So beyond assessing whether or not the effort to create a market succeeds in economic and ecological terms, I am suggesting procedural interventions that enable participants to analyze these institutions in ways that do not immediately emerge from the logic of ESMs, like (environmental) justice and place. This is why I will outline the development of a monitoring process for ESMs that is broad in scope.

Monitoring of ESM should not only be focused on the purely technical assessment of whether or not a tree is producing the correct amount of shade or a buffer the right level of nutrient reduction, but also on questions about the aggregate effect of an ESM on publicly accessible green spaces in a city, and if economic development goals can be achieved as a result of the ESM.

Participation and Facilitated Leadership

In both Oregon and the Chesapeake Bay states, multiple participatory processes were organized by non-profit organizations to discuss the institutional design of the proposed ESMs. These institutional design processes were largely funded through federal grants from the Environmental Protection Agency and the Department of Agriculture and brought together professional stakeholders and agency personnel.

First of all, the selection of participants in these processes revealed that relatively few “new” actors were actively involved in the institutional design processes in Oregon and the Chesapeake Bay states. Recognizable networks of policy entrepreneurs (Kingdon 1995) around the market idea did emerge, but their members were largely from organizations already engaged in environmental planning in a broad sense.

The second conclusion related to the role of participation in the institutional design processes for ESMs is that the authority of the participants to implement outcomes is rather limited. In environmental planning, it has long been understood that when a small group of people simply decides to locate a specific activity on a piece of land, this does not automatically mean that this decision will be carried out in a straightforward manner (L. E. Susskind 1985). In this light, these ESMs can be seen as sophisticated frameworks that enable and constrain decisions about land use. As with any policy framework, authority is deeply dispersed and implementation ought to be difficult, is rarely immediate and never uncontested.

These problems of participation in ESMs and the experiences in other forms of land use decision-making, inform the third theoretical underpinning of the proposed development of additional oversight for ESMs, namely *facilitative leadership*. (Forester

2009) More specifically, the experiences in Medford and other ESMs highlight the idea that professional assistance can improve decision-making in complex processes (L. Susskind and Cruikshank 1987; L. Susskind, McKernan, and Thomas-Larmer 1999) in specific ways. Some of the most important contributions a facilitative leader can make are the inclusion of relevant stakeholders, fostering creativity and managing emotions. In the suggested approach to monitoring ESMs, I will therefore propose the inclusion of such facilitated leadership. This suggestion is not only based on the limited success of past participatory processes related to ESMs, but also on the understanding that ESMs are dynamic and likely to change, which means that questions about participation will have to be answered repeatedly, and possibly differently, as ESMs continue to develop.

These three challenges, and the potential solutions that can be found in the theory and practice of environmental planning more broadly, form the basis for the next and final section of this dissertation. I outline a set of strategies and interventions to manage ESMs more effectively and democratically based on these three ideas from the environmental planning literature.

5.c. Moving Beyond Economic Imaginations

The goal of the following policy recommendations is twofold. The first is to provide a set of concrete institutional design ideas that can overcome or at least reduce the challenges facing the current efforts to develop ESMs as described in this dissertation. A second, more theoretical goal is to show how a shift in emphasis from markets to planning, can open up new ways of understanding and improving ESMs. These suggestions are intended to generate a more reflective approach to these markets,

especially by those directly involved in their creation, but also by analysts.

Creating Integrative Oversight

The idea that markets provide a whole host of benefits, from fostering innovation to reducing transaction costs, with relatively little oversight remains a powerful idea. However, in the wake of the financial crisis and the collapse of the derivatives market, it has become less plausible to argue that markets can consistently function without effective oversight. Of course ESMs do not match the economic weight of the trading in complex financial products backed by mortgages that was connected to the financial collapse in 2007-2008. Despite this obvious difference, it is worth mentioning that market oversight is rarely if ever mentioned in the literature on ESMs. The fact that most of the attempts to create such markets occur in a regulatory context is a plausible explanation for this lack of theory-development or practical prescriptions in this regard. In part because of this absence, it seems worthwhile to suggest a few possibilities to organize a form of oversight for ESMs that function as a procedural response to the challenges for ESMs described in this dissertation.

The practical starting point for my arguments and suggestions regarding oversight of ESMs is the observation that currently, in Oregon and the Chesapeake Bay, the efforts to create ESMs have met with significant resistance, and once they are created many of the problems that complicated their design persist.

One of the central arguments of this dissertation is that the creation of ESMs potentially affects a broad range of stakeholders in these watersheds by (re)moving places that are cherished for a variety of reasons, only some of what are strictly

“environmental.” Therefore I believe a new, more integrative form of oversight that takes into account social and economic effects of markets, would improve these institutions. This oversight should consist of regular, like annual or biannual, meetings of all relevant stakeholders, during which they discuss and assess the developments of relevance to the ESM. The following paragraphs describe the design principles of this suggested form of oversight in more detail.

Ecosystem Summits

The first element of this kind of review is thus that it has to be participatory, with effective representation of the relevant stakeholders, including both proponents and opponents of the institutional design itself. This would enable stakeholders to get together to review the whole range of emerging outcomes of the trading schemes, including spatial justice aspects, the quality of biophysical monitoring (like actually measuring the temperature in the streams as opposed to a narrow review of the performance of the riparian reforestation) and the role of the brokers, to name a few. To avoid reifying the economic logic associated with ESMs, I suggest thinking of these events, and referring to them, as something like "ecosystem summits." To enhance the chances of effective and meaningful participation, it would be useful to bring in professional mediators with experience in the public sector, much like the Willamette Partnership did for its Counting on the Environment process in the development of the Willamette Marketplace. The key event, or summit, could take place over the course of a single day and would consist of presentations about specific monitoring and evaluation activities that have taken place since the last summit, as well as a facilitated discussion about potential adjustments to the

measurement systems trading ratios or spatial targeting of new restoration projects. The basic idea is that formalizing this kind of broad, participatory review of the entire institutional framework will supplement the more technical scrutiny of individual restoration projects that government agencies are required to perform and generate opportunities for *adaptation* and *double-loop learning*.

Dedicated Funding

The second design element for this new form of oversight is based on the notion that a concentration of legitimate expertise makes effective oversight and *double loop learning* more difficult. To develop and maintain additional and alternative forms of knowledge about the effects of the markets for institutions would be a central goal of these events. The summits would be a venue where ecologists can show the latest alterations to the measurement systems, brokers can explain their recent credit generation projects and community advocates can present their experiences with, or objections to, specific restoration projects or practices. I think there is an important role for the EPA here, as the permit writer in many instances, but also as a potential funder through its Environmental Justice-grants, and perhaps as a more general "watchdog" to balance the broad enthusiasm within USDA for the markets for ecosystem services. Basically, a specific type of grant would be made available for groups and organizations that want to implement a more thorough review of a specific attempt to create a market for ecosystem services. Part of this grant could be used to organize the event and fund the professional mediator or facilitator.

A separate part of the grant however, would have to be dedicated to the

development of information gathering projects related to the ecosystem service market. This part of the grant is allocated at the end of each event, based on project proposals submitted in advance. Basically, the sequence of events would be that a local non-profit, somewhat ambivalent about the creation of a market for ecosystem services, would apply for an *Ecosystem Service Oversight Grant*. The requirements of the grant stipulate that during a 3-year period, at least 3 Ecosystem Summits have to be held, with participants from a broad range of stakeholders. No more than 50% of the grant funds can be spent on those summits, and the remaining funds have to be dedicated to knowledge development projects. Two months before every summit, brief proposals have to be submitted for these research efforts. At the end of the summit, each author of a proposal gets to present on her/his idea, and then the participants discuss which projects should be funded. The idea is that the overall grant would be no larger than about \$150,000, and the individual project grants between \$5,000 and \$15,000. This is to encourage smaller organizations to apply for those research project grants, as opposed to targeting academic scientists or larger advocacy organizations.

These suggested ecosystem summits are intended to operate as inclusive venues to discuss these complicated institutional arrangements, but also as launching grounds for promising approaches to understanding and evaluating their impacts. So besides encouraging participation and double-loop learning, the goal of organizing this type of informal oversight is to foreground the varied epistemological approaches to environmental conservation and restoration. My hope would be that some of these knowledge development projects would result in the kind of *Street Science* first described by Jason Corburn (2005), but I could also envision a more embedded form of reflection

that an action-researcher from a local university or research institute could provide (Duijn 2009).

Professional Facilitation

The third and final concept, *facilitative leadership*, is embedded in this proposal by the presence of a professional mediator or facilitator. This suggestion, while theoretically grounded is also directly informed by my research on the Willamette Partnership's efforts to create the Willamette Marketplace. The Partnership engaged a professional neutral during the Counting on the Environment process, but they have not done so since. There are obviously financial reasons for this, but the efforts by the Willamette Partnership to stay in regular contact with all of the participants in that process have not been easy. While the Partnership continues to work closely with The Freshwater Trust and some of the state agencies, many of the other participants reported having heard little from the Partnership besides occasional newsletters in their conversations with me. I believe this makes future adjustments and improvements to the measurement systems, protocols and other elements of the market design more difficult. A more enduring form of collaboration, as the tasks shift from market design to institutional oversight, would enable a broader group of participants to continue to discuss the development of the market.

5.d. Final Thoughts

The future of ESMs, both as a concept and a realm of practical efforts, is not immediately clear. While I firmly believe the broader ecosystem services concept will

persist for some time to come, as will the popularity of the market as a policy-tool, it's less clear if the kind of federal grants that have funded much of the work that is described in this dissertation will continue to be available for even more attempts to create ESMs. USDA's Office of Environmental Markets is down to a few staffers, and the most recent draft of the Farm Bill did not include any language on ecosystem services.¹⁵³ This raises questions about the feasibility of the kind of participatory oversight process I am suggesting here, but I still believe it is worthwhile to think through what a practical response to the creation of ESMs could look like. While I am aware that a set of procedural suggestions are not going to radically alter the direction or success of these regional policy institutions, I do think that both the proponents and opponents of ESMs are yet to figure out exactly how to engage with each-other. By proposing this type of framework for shared learning and reflection, I hope to have at least made a relevant suggestion.

¹⁵³ The Senate version, available on: <http://www.ag.senate.gov/issues/farm-bill> was retrieved and checked for the presence of any mention of the concept or the office on 07/15/2013. The House version was not reviewed.

References

- Abdalla, C. (2008). Land Use Policy: Lessons from Water Quality Markets. *Choices*, 23(4). Retrieved from <http://www.farmdoc.illinois.edu/policy/choices/20084/theme1/2008-4-05.pdf>
- Achterman, G. L., & Mauger, R. (2010). The State and Regional Role in Developing Ecosystem Service Markets. *Duke Envtl. L. & Pol'y F.*, 20, 291–417.
- Ackerman, B. A., & Stewart, R. B. (1987). Reforming environmental law: the democratic case for market incentives. *Colum. j. Envtl. L.*, 13, 171.
- Adamus, P. R., and L. T. Stockwell. 1983. "A Method For Wetland Functional Assessment: Volume 1 Critical Review and Evaluation Concepts". Washington, D.C.: Federal Highway Administration. <http://trid.trb.org/view.aspx?id=205071>.
- , P.R., J Morlan, and K Verble. 2009a. *Calculator Spreadsheet, Databases, and Data Forms for the Oregon Rapid Wetland Assessment Protocol (ORWAP)*. (version 2.0). Salem, OR: Oregon Dept. of State Lands.
- , P.R., 2009b. "Manual for the Oregon Rapid Wetland Assessment Protocol (ORWAP). Version 2.0." Salem, OR: Oregon Dept. of State Lands.
- Anderson, Terry Lee, and Donald Leal. 1991. *Free Market Environmentalism*. San Francisco; Boulder: Pacific Research Institute for Public Policy ; Westview Press.
- Appadurai, A. (1996). *Modernity At Large: Cultural Dimensions of Globalization*. U of Minnesota Press.
- Arestis, P., & Sawyer, M. C. (2004). *The Rise Of The Market: Critical Essays On The Political Economy Of Neo-Liberalism*. Edward Elgar Publishing.
- Argyris, Chris, and Donald A. Schön. 1978. *Organizational Learning*. Reading, Mass: Addison-Wesley Pub. Co.
- Armsworth, P. R., K. M. A. Chan, G. C. Daily, P. R. Ehrlich, C. Kremen, T. H. Ricketts, and M. A. Sanjayan. 2007. "Ecosystem-Service Science and the Way Forward for Conservation." *Conservation Biology* 21 (6): 1383–1384.
- Bardach, E. (1977). *The Implementation Game: What Happens After a Bill Becomes a Law*. Cambridge, Mass.: MIT Press.
- Bean, Michael, Robert Bonnie, Tim Male, and Tim Searchinger. 2003. "The Private Lands Opportunity: The Case for Conservation Incentives". Environmental Defense. http://www.fws.gov/southeast/grants/pdf/2677_ccireport.pdf.
- Beck, U. (1992). *Risk society: towards a new modernity*. London; Newbury Park, Calif.: Sage Publications.
- BenDor, T., & Brozović, N. (2007). Determinants of Spatial and Temporal Patterns in Compensatory Wetland Mitigation. *Environmental Management*, 40(3), 349–364.
- , T., Brozović, N., & Pallathucheril, V. G. (2007). Assessing the Socioeconomic Impacts of Wetland Mitigation in the Chicago Region. *Journal of the American Planning Association*, 73(3), 263–282.
- Bennett, Genevieve, Nathaniel Carroll, and Katherine Hamilton. 2013. "Charting New Waters: State of Watershed Payments 2012". Washington, D.C.: Forest Trends. http://www.forest-trends.org/documents/files/doc_3308.pdf.

- Benson, D., Jordan, A., Cook, H., & Smith, L. (2013). Collaborative environmental governance: Are watershed partnerships swimming or are they sinking? *Land Use Policy*, 30(1), 748–757.
- Bidwell, R. D., & Ryan, C. M. (2006). Collaborative Partnership Design: The Implications of Organizational Affiliation for Watershed Partnerships. *Society & Natural Resources*, 19(9), 827–843.
- Bingham, G., Bishop, R., Brody, M., Bromley, D., Clark, E. (Toby), Cooper, W., ... Suter, G. (1995). Issues in ecosystem valuation: improving information for decision making. *Ecological Economics*, 14(2), 73–90.
- Blankenship, K. (2005, June). Solutions sought for excess manure piling up on farms. *Chesapeake Bay Journal*. Retrieved from http://www.bayjournal.com/article/solutions_sought_for_excess_manure_piling_up_on_farms
- Bockstael, N., Costanza, R., Strand, I., Boynton, W., Bell, K., & Wainger, L. (1995). Ecological economic modeling and valuation of ecosystems. *Ecological Economics*, 14(2), 143–159.
- Bourdieu, P. (1977). *Outline of a theory of practice*. Cambridge, U.K.; New York: Cambridge University Press.
- _____, P., & Wacquant, L. J. D. (1992). *An invitation to reflexive sociology*. Chicago: University of Chicago Press.
- Boyd, J., & Banzhaf, S. (2007). What are ecosystem services? The need for standardized environmental accounting units. *Ecological Economics*, 63(2–3), 616–626.
- Boyd, M.S. 1996. “Heat Source: Stream, River and Open Channel Temperature Prediction.” Master’s Thesis, Corvallis, OR: Oregon State University. <http://ir.library.oregonstate.edu/xmlui/handle/1957/27036>.
- Brown, S. (2011). *Navigating the Edges: An Examination of the Relationship between Boundary Spanning, Social Learning, and Partnership Capacity in Water Resource Management*. Portland, OR: unpublished dissertation Portland State University.
- Callon, M. (1986). “Some Elements of a Sociology of Translation: The Domestication of the Scallops and St Brieuac Fishermen.” In *Power, Action and Belief*. Sociological Review Monograph 32. London, UK: Routledge and Kegan Paul.
- Carroll, Nathaniel, Jessica Fox, and Ricardo Bayon. 2008. *Conservation and Biodiversity Banking: A Guide to Setting Up and Running Biodiversity Credit Trading Systems*. Earthscan.
- Carpenter, S. L., & Kennedy, W. J. D. (1988). *Managing public disputes: a practical guide to handling conflict and reaching agreements*. San Francisco: Jossey-Bass.
- Casey, Frank, Sara Vickerman, Cheryl Hummon, and Bruce Taylor. 2006. “Incentives for Biodiversity Conservation: An Ecological and Economic Assessment”. Washington, D.C.: Defenders of Wildlife.
- Cashore, B. W., Auld, G., & Newsom, D. (2004). *Governing through markets: forest certification and the emergence of non-state authority*. New Haven: Yale University Press.
- Castree, N. (2008). Neoliberalising nature: the logics of deregulation and reregulation. *Environment and Planning A*, 40(1), 131 – 152.

- Century Engineering. 2011. "NutrientTrading Evaluation Report". 113005.00.
Harrisburg, PA: Penn Future.
http://www.pennfuture.org/UserFiles/File/Water/RespFarm/Report_NutrientTradingEval_20110919.pdf.
- Chichilnisky, G., & Heal, G. M. (2000). *Environmental markets: equity and efficiency*. New York: Columbia University Press.
- Chomsky, N. (1999). *Profit over people: neoliberalism and the global order*. Seven Stories Press.
- Coase, R. H. 1937. "The Nature of the Firm." 2 (November): 386–405.
- Cochran, B., and N. Robinson Maness. 2011. "Measuring Up: Synchronizing Biodiversity Measurement Systems for Markets and Other Incentive Programs". U.S. Department of Agriculture Office of Environmental Markets. Hillsboro, OR
- Conniff, Richard. 2009. "The Political History of Cap and Trade." *Smithsonian Magazine*, August. <http://www.smithsonianmag.com/science-nature/Presence-of-Mind-Blue-Sky-Thinking.html>.
- Cooley, D., and L. Olander. 2011. "Stacking Ecosystem Services Payments: Risks and Solutions". Working Paper NI WP 11-04. Nicholas Institute for Environmental Policy Solutions. Duke University - Nicholas Institute.
- Corbera, E., Brown, K., & Adger, W. N. (2007). The Equity and Legitimacy of Markets for Ecosystem Services. *Development & Change*, 38(4), 587–613.
- Corburn, J. (2005). *Street science: community knowledge and environmental health justice*. Cambridge, MA: MIT Press.
- Cornell, S. (2011). The Rise and Rise of Ecosystem Services: Is "value" the best bridging concept between society and the natural world? *Procedia Environmental Sciences*, 6, 88–95.
- Costanza, R., d' Arge, R., Groot, R. de, Farber, S., Grasso, M., Hannon, B., and Belt, M. van den. (1997). The value of the world's ecosystem services and natural capital. *Nature*, Vol. 387, 253-260.
- Cowardin, Lewis M, Virginia Carter, Francis Golet, and Edward LaRoe. 1979. "Classification of Wetlands and Deepwater Habitats of the United States." FWS/OBS-79/31. Washington, D.C.: U.S. Department of the Interior Fish and Wildlife Service. <http://www.npwrc.usgs.gov/resource/wetlands/classwet/>.
- Cronon, William. 1983. *Changes in the Land: Indians, Colonists, and the Ecology of New England*. Macmillan.
- , William. 1996. *Uncommon Ground: Rethinking the Human Place in Nature*. W. W. Norton & Company.
- Cyert, Richard, and James March. 1963. *Behavioral Theory of the Firm*. Engelwood Cliffs, New Jersey: Prentice-Hall.
- Dales, J. H. (1968). *Pollution, property & prices*. Toronto: University of Toronto Press
- Devall, B., & Sessions, G. (1985). *Deep ecology*. Gibbs Smith.
- Daily, G.C. (ed.) (1997). *Nature's Services: Societal Dependence On Natural Ecosystems*. New York, NY: Island Press.
- , G. C., & Matson, P. A. (2008). Ecosystem Services: From Theory to Implementation. *Proceedings of the National Academy of Sciences*, 105(28), 9455–9456.

- _____, G.C., Stephen Polasky, Joshua Goldstein, Peter M Kareiva, Harold A Mooney, Liba Pejchar, Taylor H Ricketts, James Salzman, and Robert Shallenberger. 2009. "Ecosystem Services in Decision Making: Time to Deliver." *Frontiers in Ecology and the Environment* 7 (1) (February 1): 21–28.
- Dauer, D. M., J. A. Ranasinghe, and S. B. Weisberg. 2000. "Relationships Between Benthic Community Condition, Water Quality, Sediment Quality, Nutrient Loads, and Land Use Patterns in Chesapeake Bay." *Estuaries* 23 (1) (February): 80–96.
- De Groot, R. S., Wilson, M. A., & Boumans, R. M. . (2002). A typology for the classification, description and valuation of ecosystem functions, goods and services. *Ecological Economics*, 41(3), 393–408.
- Dempsey, Jessica, and Morgan M. Robertson. 2012. "Ecosystem Services Tensions, Impurities, and Points of Engagement Within Neoliberalism." *Progress in Human Geography* 36 (6) (December 1): 758–779.
- Devall, B., & Sessions, G. (1985). *Deep ecology*. Gibbs Smith.
- Dewey, J. (1963). *Experience and education*. New York: Collier Books.
- Diaz, D., Hamilton, K., & Johnson, E. (2011). *State of the Forest Carbon Markets 2011: From Canopy to Currency*. Ecosystem Marketplace. Retrieved from http://www.forest-trends.org/documents/files/doc_2963.pdf Last accessed on: 07/17/2013.
- Donahue, J. D. (1989). *The privatization decision: public ends, private means*. New York: Basic Books.
- Donigan, Anthony S., Norman H. Crawford, United States Environmental Protection Agency Office of Research and Development, and Hydrocomp inc. 1976. *Modeling Nonpoint Pollution from the Land Surface*. U.S. Environmental Protection Agency, Office of Research and Development, Environmental Research Laboratory.
- Donlan, Josh. 2005. "Re-wilding North America." *Nature* 436 (7053) (August 18): 913–914.
- Dooling, S. (2009). Ecological Gentrification: A Research Agenda Exploring Justice in the City. *International Journal of Urban and Regional Research*, 33(3), 621–639.
- Douglas, M. (1966). *Purity and Danger: An Analysis of Concept of Pollution and Taboo*. Psychology Press.
- Doyle, M. W., & Yates, A. J. (2010). Stream ecosystem service markets under no-net-loss regulation. *Ecological Economics*, 69(4), 820–827.
- Duijn, Michael. 2009. "Embedded Reflection on Public Policy Innovation: a Relativist/pragmatist Inquiry into the Practice of Innovation and Knowledge Transfer in the WaterINNOvation Program". Delft: Eburon.
- Dunleavy, P., & Hood, C. (1994). From old public administration to new public management. *Public Money & Management*, 14(3), 9–16.
- Effinger, A. (2011, March 31). Harry & David's Bankruptcy Rocks Medford, Oregon. *BusinessWeek: magazine*. Retrieved from http://www.businessweek.com/magazine/content/11_15/b4223051566568.htm
- Engel, S., Pagiola, S., & Wunder, S. (2008). Designing payments for environmental services in theory and practice: An overview of the issues. *Ecological Economics*, 65(4), 663–674.

- ELI. (2007). *Mitigation of Impacts to Fish and Wildlife Habitat: Estimating Costs and Identifying Opportunities*. Environmental Law Institute.
- Ellerman, A. D. (2000). *Markets for clean air: the U.S. acid rain program*. Cambridge, UK; New York, NY: Cambridge University Press.
- Estrada, M., Corbera, E., & Brown, K. (2008). How do regulated and voluntary carbon-offset schemes compare. *Tyndall Centre for Climate Change*. Retrieved from http://files.uniteddiversity.com/Climate_Change/How_do_regulated_and_voluntary_carbon-offset_schemes_compare.pdf Last accessed on: 07/17/2013.
- Faeth, P. (2000). *Fertile Ground: Nutrient Trading's Potential to cost-effectively improve water quality*. Washington, D.C.: World Resources Institute.
- Farley, Joshua, and Robert Costanza. 2010. "Payments for Ecosystem Services: From Local to Global." *Ecological Economics* 69 (11) (September 15): 2060–2068.
- Faust, Drew Gilpin. 2008. *This Republic of Suffering: Death and the American Civil War*. New York: Alfred A. Knopf.
- Fischer, F., & Forester, J. (1993). *The Argumentative turn in policy analysis and planning*. Durham, N.C.: Duke University Press.
- , B., Turner, R. K., & Morling, P. (2009). Defining and classifying ecosystem services for decision making. *Ecological Economics*, 68(3), 643–653.
- Floress, K., Prokopy, L. S., & Allred, S. B. (2011). It's Who You Know: Social Capital, Social Networks, and Watershed Groups. *Society & Natural Resources*, 24(9), 871–886.
- Forester, John. 2009. *Dealing with Differences: Dramas of Mediating Public Disputes*. Oxford; New York: Oxford University Press.
- Fox, J. 2011. "U.S. National Opinion Survey on Stacking Environmental Credits: Definition, Status, and Predictions of Wetland, Species, Carbon and Water Quality Credit Stacking". Palo Alto, CA: Electric Power Research Institute.
- , J., & Nino-Murcia, A. (2005). Status of Species Conservation Banking in the United States. *Conservation Biology*, 19(4), 996–1007.
- , Jessica, Royal Gardner, and Todd Maki. 2011. "Stacking Opportunities and Risks in Environmental Credit Markets." *Environmental Law Reporter* 41 (2) (February):10121–10125.
- Freeman, J., & Kolstad, C. D. (2007). *Moving to markets in environmental regulation: lessons from twenty years of experience*. Oxford; New York: Oxford University Press.
- Frumkin, H. 2003. "Healthy Places: Exploring the Evidence." *American Journal of Public Health* 93 (9) (September): 1451–1456.
- Fung, A. (2006). Varieties of Participation in Complex Governance. *Public Administration Review*, 66, 66–75.
- , A., Wright, E. O., & Abers, R. (2003). *Deepening democracy: institutional innovations in empowered participatory governance*. London: Verso.
- García-Oliva, F., and O.R. Masera. (2004). "Assessment and Measurement Issues Related to Soil Carbon Sequestration in Land-Use, Land-Use Change, and Forestry (LULUCF) Projects Under the Kyoto Protocol." *Climatic Change* 65 (3) (August 1): 347–364.

- Glenna, L. L. (2010). Value-laden technocratic management and environmental conflicts: The case of the New York City watershed controversy. *Science, Technology and Human Values*, 35(1), 81–112.
- Gómez-Baggethun, E., De Groot, R., Lomas, P. L., & Montes, C. (2010). The history of ecosystem services in economic theory and practice: from early notions to markets and payment schemes. *Ecological Economics*, 69(6), 1209–1218.
- Gössling, S., Broderick, J., Upham, P., Ceron, J.-P., Dubois, G., Peeters, P., & Strasdas, W. (2007). Voluntary Carbon Offsetting Schemes for Aviation: Efficiency, Credibility and Sustainable Tourism. *Journal of Sustainable Tourism*, 15(3), 223–248.
- Gunderson, Lance H., and C. S. Holling. 2001. *Panarchy: Understanding Transformations In Human And Natural Systems*. Island Press.
- Gustafsson, B. (1998). Scope and limits of the market mechanism in environmental management. *Ecological Economics*, 24(2–3), 259–274.
- Graham, S., and P. Healey. 1999. “Relational Concepts of Space and Place: Issues for Planning Theory and Practice.” *European Planning Studies* 7 (5) (October): 623.
- Hajer, M. A. (1997). *The politics of environmental discourse: ecological modernization and the policy process*. Oxford: Clarendon Press.
- , M. A., & Wagenaar, H. (2003). *Deliberative policy analysis: understanding governance in the network society*. Cambridge, UK; New York, USA: Cambridge University Press.
- Hansen, J. M. (1991). *Gaining Access: Congress and the Farm Lobby, 1919-1981*. University of Chicago Press.
- Hardy, S. D. (2010). Governments, Group Membership, and Watershed Partnerships. *Society & Natural Resources*, 23(7), 587–603.
- Hartigan, J., T. Quasebarth, and E. Southerland. 1983. “Calibration of NPS Model Loading Factors.” *Journal of Environmental Engineering* 109 (6): 1259–1272.
- Harvey, D. (1996). *Justice, nature, and the geography of difference*. Cambridge, Mass.: Blackwell Publishers.
- Heal, G. M. (2000). *Nature and the marketplace: capturing the value of ecosystem services*. Washington, DC: Island Press.
- Heal, G., Daily, G. C., Ehrlich, P. R., & Salzman, J. (2001). Protecting Natural Capital through Ecosystem Service Districts. *Stanford Environmental Law Journal*, 20, 333.
- Heynen, N. (2007). *Neoliberal environments: false promises and unnatural consequences*. London, UK: Routledge.
- Higgs, Eric S. 1997. “What Is Good Ecological Restoration?” *Conservation Biology* 11 (2): 338–348.
- Hilderbrand, R.H., Adam C. Watts, and April M. Randle. 2005. “The Myths of Restoration Ecology.” *Ecology and Society* 10 (1): 19.
- Hood, C. (1986). *The Tools of Government* (1st American ed.). Chatham, N.J: Chatham House Publishers.
- , C. (1991). A Public Management for All Seasons? *Public Administration*, 69(1), 3–19.

- Hott, L., and D. Garey. 1989. *The Wilderness Idea: John Muir, Gifford Pinchot and the First Great Battle for Wilderness*. Video documentary. Santa Monica, CA: Direct Cinema Limited.
- Jasanoff, S., (1994). *The Fifth Branch: Science Advisers As Policymakers*. Harvard University Press.
- , Sheila. 2004. *States of Knowledge: the Co-production of Science and Social Order*. London; New York: Routledge.
- , Sheila. 2005. *Designs on Nature: Science and Democracy in Europe and the United States*. Princeton, NJ: Princeton University Press.
- , S., & Kim, S.-H. (2009). Containing the Atom: Sociotechnical Imaginaries and Nuclear Power in the United States and South Korea. *Minerva*, 47(2), 119–146.
- Jerrick, N. (2001). *The Willamette Restoration Strategy*. Portland, OR: Willamette Restoration Initiative. Retrieved from http://oe.oregonexplorer.info/WillametteExplorerClassic/publications/pdf/WRS_OVER.pdf Last accessed on: 07/13/2013.
- Johnson, N., White, A., & Perrot-Maitre, D. (2000). *Developing Markets for Water Services from Forests: Issues and Lessons for Innovators*. Washington, D.C.: Forest Trends. Retrieved from http://www.forest-trends.org/documents/files/doc_133.pdf Last accessed on: 07/13/2013.
- King, D., and P. Kuch. 2003. “Will Nutrient Credit Trading Ever Work? An Assessment of Supply and Demand and Institutional Obstacles.” *Environmental Law Reporter* 33: 10352–10368.
- Kroeger, T., & Casey, F. (2007). An assessment of market-based approaches to providing ecosystem services on agricultural lands. *Ecological Economics*, 64(2), 321–332.
- Krugman, P. (2010, April 7). Climate Change - Building a Green Economy. *The New York Times*. Retrieved from <http://www.nytimes.com/2010/04/11/magazine/11Economy-t.html>
- Latour, Bruno. 1987. *Science in Action: How to Follow Scientists and Engineers through Society*. Cambridge, Mass.: Harvard University Press.
- Layzer, Judith A. 2008. *Natural Experiments : Ecosystem-based Management and the Environment*. Cambridge, Mass.: MIT Press.
- , J. A. (2012). *Open for Business: Conservatives' Opposition to Environmental Regulation*. The MIT Press.
- Leach, W., & Pelkey, N. (2001). Making Watershed Partnerships Work: A Review of the Empirical Literature. *Journal of Water Resources Planning and Management*, 127(6), 378–385.
- Lemos, M. C., & Agrawal, A. (2006). Environmental Governance. *Annual Review of Environment and Resources*, 31(1), 297–325.
- Leopold, A. (1949). *A Sand County Almanac*. Oxford University Press, USA.
- Levin, P. S., Fogarty, M. J., Murawski, S. A., & Fluharty, D. (2009). Integrated Ecosystem Assessments: Developing the Scientific Basis for Ecosystem-Based Management of the Ocean. *PLoS Biol*, 7(1)
- Lewis, William M. 2001. *Wetlands Explained: Wetland Science, Policy, and Politics in America*. Oxford; New York: Oxford University Press.
- Linker, Lewis C., Gary W. Shenk, Ping Wang, Katherine J. Hopkins, and Sajan Pokharel. 2002. “A Short History of Chesapeake Bay Modeling and the Next Generation of

- Watershed and Estuarine Models.” *Proceedings of the Water Environment Federation* 2002 (2): 569–582.
- Lynch, K. 1981. *A Theory of Good City Form*. Cambridge, Mass.: MIT Press.
- Mackintosh, B. 1987. “The National Park Service Moves into Historical Interpretation.” *The Public Historian* 9 (2): 51–63.
- Madsen, Becca, Nathaniel Carroll, and Kelly Moore Brands. 2010. “State of Biodiversity Markets: Offset and Compensation Programs Worldwide”. Washington, D.C.: Ecosystem Marketplace. http://www.forest-trends.org/documents/files/doc_2388.pdf.
- _____, Becca, Daniel Kandy, and Genevieve Bennett. 2011. “2011 Update: State of Biodiversity Markets. Offset and Compensation Programs Worldwide.” Washington, D.C.: Forest Trends. http://www.forest-trends.org/documents/files/doc_2848.pdf.
- Majanen, Terhi, Rachel Friedman, and Jeffrey Milder. 2011. “Innovations in Market-Based Watershed Conservation in the United States: Payments for Watershed Services for Agricultural and Forest Landowners”. Ecoagriculture Partners. http://www.ecoagriculture.org/documents/files/doc_362.pdf.
- Malinowski, Bronislaw. 1922. *Argonauts of the Western Pacific; an Account of Native Enterprise and Adventure in the Archipelagoes of Melanesian New Guinea*. London; New York: G. Routledge & Sons; E.P. Dutton & Co.
- Mansfield, B. (2009). *Privatization: Property and the Remaking of Nature-Society Relations*. Wiley.
- March, J. G. 1994. *Primer on Decision Making: How Decisions Happen*. 1st ed. Free Press.
- _____, J. G., and Johan P. Olsen. 1989. *Rediscovering Institutions: The Organizational Basis of Politics*. New York: Free Press.
- _____. 2006. “The Logic of Appropriateness.” In *The Oxford Handbook of Public Policy*, edited by Michael Moran, Martin Rein, and Robert E. Goodin, 689–708. Oxford [England]: Oxford University Press. http://dingo.sbs.arizona.edu/~ggoertz/pol595e/March_Olsen2006.pdf.
- Marcus, G.E., and M. Fischer. (1986). *Anthropology as Cultural Critique: An Experimental Moment in the Human Sciences*. Chicago: University of Chicago Press.
- _____, G. E. (1995). *Technoscientific Imaginaries: Conversations, Profiles, and Memoirs*. University of Chicago Press.
- _____, G.E. (1998). *Ethnography through Thick and Thin*. Princeton, N.J.: Princeton University Press.
- Marshall, Elizabeth, and Marca Weinberg. 2012. “Baselines in Environmental Markets: Tradeoffs Between Cost and Additionality.” EB-18. Economic Brief. Washington, DC: United States Department of Agriculture Economic Research Service. http://www.ers.usda.gov/media/281180/eb18_1_.pdf.
- Mayrand, K., and M. Paquin. 2004. “Payments for Environmental Services: A Survey and Assessment of Current Schemes”. Unisfera International Centre.
- McCormick, John. 1995. *The Global Environmental Movement*. Chichester [England]; New York: Wiley.

- McGinnis, S. L. (2001). Watershed-based pollution trading development and current trading programs. *Environmental Engineering and Policy*, 2(3), 161–170.
- McHarg, I. L. (1969). *Design with nature*. Garden City, N.Y., Published for the American Museum of Natural History [by] the Natural History Press, 1969.
- Molnar, J. L., and I. Kubiszewski. 2012. “Managing Natural Wealth: Research and Implementation of Ecosystem Services in the United States and Canada.” *Ecosystem Services* 2 (December): 45–55.
- Morris, R. K. A., Alonso, I., Jefferson, R. G., & Kirby, K. J. (2006). The creation of compensatory habitat—Can it secure sustainable development? *Journal for Nature Conservation*, 14(2), 106–116.
- Muir, J. 1912. *The Yosemite*. New York: The Century co.
<http://archive.org/details/yosemite00unkngoog>.
- Müller, Felix, and Benjamin Burkhard. (2012). “The Indicator Side of Ecosystem Services.” *Ecosystem Services* 1 (1) (July): 26–30.
- Munda, G. 1997. “Environmental Economics, Ecological Economics, and the Concept of Sustainable Development.” *Environmental Values* 6 (2) (May): 213–233.
- Muradian, R., Corbera, E., Pascual, U., Kosoy, N., & May, P. H. (2010). Reconciling theory and practice: An alternative conceptual framework for understanding payments for environmental services. *Ecological Economics*, 69(6), 1202–1208.
- Naess, A. (1990). *Ecology, Community and Lifestyle: Outline of an Ecosophy*. Cambridge University Press.
- National Research Council (U.S.) (2001). *Compensating for Wetland Losses Under the Clean Water Act*. Washington, D.C.: National Academies Press.
- National Research Council (U.S.). (2005). *Valuing ecosystem services: toward better environmental decision-making*. Washington, D.C.: National Academies Press.
- National Research Council. (2011). *Achieving Nutrient and Sediment Reduction Goals in the Chesapeake Bay: An Evaluation of Program Strategies and Implementation*. Washington, D.C.: National Academies Press. Retrieved from
- Norgaard, R. B. (2010). Ecosystem services: From eye-opening metaphor to complexity blinder. *Ecological Economics*, 69(6), 1219–1227.
- ORDEQ. (2011). *NPDES Permit Evaluation Report and Fact Sheet*. Medford, OR. Retrieved from
http://northwestenvironmentaladvocates.org/nweafiles/WQ_Trading/download_1/MedfordEVAL%5b1%5d.pdf
- Osei, E., P. W. Gassman, R. D. Jones, S. J. Pratt, L. M. Hauck, L. J. Beran, W. D. Rosenthal, and J. R. Williams. 2000. “Economic and Environmental Impacts of Alternative Practices on Dairy Farms in an Agricultural Watershed.” *Journal of Soil and Water Conservation* 55 (4) (October 1): 466–472.
- Paehlke, R., & Torgerson, D. (2005). *Managing Leviathan: environmental politics and the administrative state*. Broadview Press.
- Polanyi, M. (1962). The Republic of Science: Its Political and Economic Theory. *Minerva*, 1(1), 54–73.
- Popular Science. (2008, February 8). America’s 50 Greenest Cities. *Popular Science*. Retrieved April 30, 2013, from <http://www.popsci.com/environment/article/2008-02/americas-50-greenest-cities>

- Porter, T. M. 1995. *Trust in Numbers: the Pursuit of Objectivity in Science and Public Life*. Princeton, N.J.: Princeton University Press.
- Primozich, D. 2008. "Developing the Willamette Ecosystem Marketplace." Willamette Partnership. <http://willamettepartnership.org/publications/MarketplacePubs/developing-the-willamette-ecosystem-marketplace.pdf>.
- Robertson, Morgan M. 2006. "The Nature That Capital Can See: Science, State, and Market in the Commodification of Ecosystem Services." *Environment and Planning D: Society and Space* 24 (3): 367–387.
- Pressman, J. L. (1984). *Implementation: How Great Expectations in Washington Are Dashed in Oakland: Or, Why It's Amazing That Federal Programs Work at All, This Being a Saga of the Economic Development Administration as Told by Two Sympathetic Observers Who Seek to Build Morals on a Foundation of Ruined Hopes* (3rd ed.). Berkeley: University of California Press.
- Primozich, D. (2008). *Developing the Willamette Ecosystem Marketplace*. Willamette Partnership. Retrieved from <http://willamettepartnership.org/publications/MarketplacePubs/developing-the-willamette-ecosystem-marketplace.pdf>
- Richter, Ann, and Steven A. Kolmes. 2005. "Maximum Temperature Limits for Chinook, Coho, and Chum Salmon, and Steelhead Trout in the Pacific Northwest." *Reviews in Fisheries Science* 13 (1): 23–49.
- Robertson, M. 2006. "The Nature That Capital Can See: Science, State, and Market in the Commodification of Ecosystem Services." *Environment and Planning D: Society and Space* 24 (3): 367–387.
- _____, M. 2009. "The Work of Wetland Credit Markets: Two Cases in Entrepreneurial Wetland Banking." *Wetlands Ecology and Management* 17 (1) (February): 35–51.
- _____, M. 2012. "Measurement and Alienation: Making a World of Ecosystem Services." *Transactions of the Institute of British Geographers* 37 (3): 386–401.
- Ruhl, J. B., & Salzman, J. (2006). The effects of wetland mitigation banking on people. *National Wetlands Newsletter, Vol 28, No. 2, 2006, FSU College of Law, Public Law Research Paper No. 179*.
- _____, J. B., Kraft, S. E., & Lant, C. L. (2007). *The law and policy of ecosystem services*. Washington: Island Press.
- _____, J. B. (2010). Ecosystem Services and the Clean Water Act: Strategies for Fitting New Science into Old Laws. *SSRN eLibrary*. Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1666246
- Sabatier, P. A. (2005). *Swimming upstream: collaborative approaches to watershed management*. Cambridge, Mass.: MIT Press.
- Sachs, A. 2013. *Arcadian America: The Death and Life of an Environmental Tradition*.
- Sagoff, M. (2002). On the Value of Natural Ecosystems: The Catskills Parable. *Politics and the Life Sciences*, 21(1), 19–25.
- Salamon, L. M., & Elliott, O. V. (Eds.). (2002). *The Tools of Government: A Guide to the New Governance*. Oxford: Oxford University Press.

- _____, L. M., & Lund, M. S. (Eds.). (1988). *Beyond Privatization: The Tools of Government Action*. Washington, D.C: Urban Institute Press.
- Salzman, J. (1997). "Valuing Ecosystem Services." *Ecology LQ* 24: 887.
- _____, J. (2005). "Creating Markets for Ecosystem Services: Notes from the Field." *NYU Law Review* 80: 870–961.
- _____, J. (2005). The promise and perils of payments for ecosystem services. *International Journal of Innovation and Sustainable Development*, 1(1), 5–20.
- _____, J., & Ruhl, J. B. (2000). Currencies and the Commodification of Environmental Law. *Stanford Law Review*, 53, 607–694.
- Sample, V. A. (n.d.). *The Pinchot Institute at 50: A Brief History*. Pinchot Institute for Conservation. Retrieved from <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.193.6887&rep=rep1&type=pdf>
- Sandel, M. J. (2012). *What money can't buy: the moral limits of markets*. New York: Farrar, Straus and Giroux.
- Scarlett, L., & Boyd, J. (2011). *Ecosystem Services: Quantification, Policy Applications, and Current Federal Capabilities* (Discussion Paper No. RFF DP 11-13). Washington, DC: Resources for the Future. Retrieved from <http://www.rff.org/RFF/Documents/RFF-DP-11-13.pdf> Last accessed on: 07/17/2013.
- Schnabel, R., and W. Gburek. 1985. "Discussion of 'Calibration of NPS Model Loading Factors' by John P. Hartigan, Thomas F. Quasebarth, and Elizabeth Southerland (December, 1983)." *Journal of Environmental Engineering* 111 (1): 103–107.
- Selman, M., E. Sprague, S. Walker, and B. Kittler. 2010. "Nutrient Trading in the Chesapeake Region: An Analysis of Supply and Demand". Washington, D.C.: Pinchot Institute for Conservation. <http://www.pinchot.org/uploads/download?fileId=658>.
- Shabman, L., K. Stephenson, and W. Shobe. 2002. "Trading Programs for Environmental Management: Reflections on the Air and Water Experiences." *Environmental Practice* 4 (3): 153–162.
- Shandas, V., & Messer, W. B. (2008). Fostering Green Communities Through Civic Engagement: Community-Based Environmental Stewardship in the Portland Area. *Journal of the American Planning Association*, 74(4), 408–418.
- Simpson, T., & Weammart, S. (2009). *Developing Best Management Practice Definitions and Effectiveness Estimates for Nitrogen, Phosphorous and Sediment in the Chesapeake Bay Watershed*. University of Maryland Mid-Atlantic Water Program. Retrieved from http://archive.chesapeakebay.net/pubs/BMP_ASSESSMENT_REPORT.pdf
- Smith, Daniel, Alan Ammann, Candy C Bartoldus, and Mark Brinson. 1995. "An Approach for Assessing Wetland Functions Using HGM Classification, Reference Wetlands, and Functional Indices". Technical Report WRP-DE-9. Wetlands Research Program Technical Report. Vicksburg, MS: U.S. Army Engineer Waterways Experiment Station.
- Smith, A. [1776] edited by Skinner, A. S. (1999). *The Wealth of Nations*. London; New York: Penguin.
- Smith, N. (2007). Nature as accumulation strategy. *Socialist Register*, 2007, 16.

- Sommerville, M. M., J. P. G. Jones, and E. J. Milner-Gulland. 2009. "A Revised Conceptual Framework for Payments for Environmental Services." *Ecology and Society* 14 (2): 34.
- Spirn, A. W. 1984. *The Granite Garden: Urban Nature and Human Design*. New York: Basic Books.
- Sprague, E., Burke, D., Claggett, S., & Todd, A. (2006). *The State of the Chesapeake Forest*. Washington, D.C.: The Conservation Fund. Retrieved from <http://www.na.fs.fed.us/watershed/pdf/socf/Full%20Report.pdf>
- Stanton, T., Echavarria, M., Hamilton, K., & Ott, C. (2010). *State of Watershed Payments: An Emerging Marketplace*. Ecosystem Marketplace. Retrieved from http://www.forest-trends.org/documents/files/doc_2438.pdf Last accessed on: 07/17/2013.
- Stavins, R. N. (1998). "What Can We Learn From the Grand Policy Experiment? Lessons from SO2 Allowance Trading." *Journal of Economic Perspectives* 12 (3): 69–88.
- . R. N. (2003). "Chapter 9 Experience with Market-based Environmental Policy Instruments." In *Handbook of Environmental Economics*, edited by Karl-Göran Mäler and Jeffrey R. Vincent, Volume 1:355–435. Elsevier.
- Steinzor, R. I., & Jones, S. (2013). Collaborating to Nowhere: The Imperative of Government Accountability for Restoring the Chesapeake Bay. Retrieved from http://digitalcommons.law.umaryland.edu/fac_pubs/1302/
- Stephenson, Kurt, Waldon Kerns, and Leonard Shabman. 1995. "Market-based Strategies & Nutrient Trading: What You Need To Know". Blacksburg, VA: Virginia Tech.
- , K., and D. J. Bosch. 2003. "Nonpoint Source and Carbon Sequestration Credit Trading: What Can the Two Learn from Each Other?" In *2003 Annual Meeting, July 27-30, Montreal, Canada*. http://www.envtn.org/uploads/stephenson_NPScarbon_2003.pdf.
- , K., & Shabman, L. (2011). Rhetoric and Reality of Water Quality Trading and the Potential for Market-like Reform1. *JAWRA Journal of the American Water Resources Association*, 47(1), 15–28.
- Stone, D. A. (2002). *Policy Paradox: The Art of Political Decision Making* (Rev. ed.). New York: Norton.
- Susskind, Lawrence E. 1985. "The Siting Puzzle: Balancing Economic and Environmental Gains and Losses." *Environmental Impact Assessment Review* 5 (2) (June): 157–163.
- , Lawrence, and Jeffrey L Cruikshank. 1987. *Breaking the Impasse: Consensual Approaches to Resolving Public Disputes*. New York: Basic Books.
- , Lawrence., McKearnan, S., & Thomas-Larmer, J. (1999). *The consensus building handbook: a comprehensive guide to reaching agreement*. Thousand Oaks, Calif.: Sage Publications.
- Talberth, J., C. Jones, M. Perez, M. Selman, and E. Branosky. 2010. "How Baywide Nutrient Trading Could Benefit Maryland Farms." Washington, D.C.: World Resources Institute.
- Taylor, J. E. (1999). *Making Salmon: An Environmental History of the Northwest Fisheries Crisis*. University of Washington Press.
- Thoreau, H. D. [1854] (2008). *Walden*. Shambhala Publications.

- Tietenberg, T. H. (1990). Economic Instruments for Environmental Regulation. *Oxford Review of Economic Policy*, 6(1), 17–33.
- _____, T. H. (2006). *Emissions Trading: Principles And Practice*. Resources for the Future.
- _____, T. H., and Lynne Lewis. 2012. *Environmental & Natural Resource Economics*. Upper Saddle River, N.J.: Pearson Education.
- Tilman, D., Cassman, K. G., Matson, P. A., Naylor, R., & Polasky, S. (2002). Agricultural sustainability and intensive production practices. *Nature*, 418(6898), 671–677.
- Troy, A., & Wilson, M. (2006). Mapping ecosystem services: practical challenges and opportunities in linking GIS and value transfer. *Ecological economics*, 60(2), 435–449.
- Van Der Pijl, K., (1998). *Transnational Classes and International Relations*. Routledge.
- Van Houtven, George, Ross Loomis, Justin Baker, Robert Beach, and Sara Casey. 2012. “Nutrient Credit Trading for the Chesapeake Bay: An Economic Study.” Research Triangle Park, NC: RTI International for the Chesapeake Bay Commission. <http://www.chesbay.us/Publications/nutrient-trading-2012.pdf>.
- Vatn, A. (2010). An institutional analysis of payments for environmental services. *Ecological Economics*, 69(6), 1245–1252.
- Vileisis, Ann. 1999. *Discovering the Unknown Landscape: A History Of America's Wetlands*. Island Press.
- Wellman, J. Douglas. 1987. “Foresters’ Core Values and Cognitive Styles: Issues for Wildland Recreation Management and Policy.” *Review of Policy Research* 7 (2): 395–403.
- Westman, W. E. (1977). How Much Are Nature’s Services Worth? *Science*, 197(4307), 960–964.
- White, Richard. 2004. “From Wilderness to Hybrid Landscapes: The Cultural Turn in Environmental History.” *Historian* 66 (3): 557–564.
- Williamson, Oliver E. 1981. “The Economics of Organization: The Transaction Cost Approach” (November): 548–577.
- Willamette Partnership, Pinchot Institute for Conservation, and World Resources Institute. 2012. “In It Together: A How-To Reference to Building Point-Nonpoint Water Quality Trading Programs”. Hillsboro, OR: United States Department of Agriculture. http://willamettepartnership.org/in-it-together/In%20It%20Together%20Part%201_2012.pdf.
- Wilson, J. Q. (1989). *Bureaucracy: What Government Agencies Do and Why They Do It*. New York: Basic Books.
- Wilson, M. A., & Howarth, R. B. (2002). Discourse-based valuation of ecosystem services: establishing fair outcomes through group deliberation. *Ecological Economics*, 41(3), 431–443.
- Wise, S. (2008). Green Infrastructure Rising. *Planning*, 74(8), 14–19.
- Weber, M. (1968). *From Max Weber: essays in sociology*. (H. H. Gerth & C. W. Mills, Eds.). New York: Oxford University Press.
- Womble, Philip, and Martin Doyle. 2012. “The Geography of Trading Ecosystem Services: A Case Study of Wetland and Stream Compensatory Mitigation Markets.” *Harvard Environmental Law Review* 36: 229–296.

- Wondolleck, J. M., & Yaffee, S. L. (2000). *Making collaboration work: lessons from innovation in natural resource management*. Washington, D.C.: Island Press.
- Worster, D. (2003). Watershed Democracy: Recovering the Lost Vision of John Wesley Powell. *Journal of Land, Resources, & Environmental Law*, 23, 57.
- Wu, JunJie, and Bruce A. Babcock. (1996). "Contract Design for the Purchase of Environmental Goods from Agriculture." *American Journal of Agricultural Economics* 78 (4) (November 1): 935–945.
- Wunder, S. (2005). *Payments for environmental services: some nuts and bolts* (No. 42).

List of Interviews

Organization	Name	Date of Interview
Adamus Resource Assessment	Paul Adamus	07/15/11
Alliance for the Chesapeake Bay	Al Todd	11/08/11
Bonneville Environmental Foundation	Kendra Smith	07/25/11
City of Eugene	Eric Wold	08/18/11
Clean Water Services	Bruce Roll	07/29/11
Defenders of Wildlife	Sara Vickerman	06/12/11
Environmental Banc and Exchange	George Kelly	11/20/13
Forest Trends/University of Maryland	Dan Nees	11/14/11
Greenvest	Doug Lashley	11/14/11
Guillozet Consulting	Peter Guillozet	07/12/11
Institute for Natural Resources	Jimmy Kagan	08/15/11
Kearns and West	Deb Nudelman	07/22/11
Madsen Environmental (then USDA Forest Service)	Becca Madsen	01/22/13
Maryland Department of Agriculture	Susan Payne	11/09/11
Meyer Memorial Trust	Pam Wiley	07/26/11
National Oceanic and Atmospheric Administration	Marc Liverman	07/26/11
Oregon Consensus	Turner Odell	08/04/11
Oregon Department of State Lands	Dana Hicks	07/18/11
Oregon Dept. of Agriculture	Dave Wilkinson	08/03/11
Oregon Dept. of Environmental Quality	Rainei Nomura	05/27/11
Oregon Dept. of Environmental Quality	Ryan Michie	05/27/11
Oregon Dept. of Environmental Quality	Eugene Foster	05/27/11
Oregon Dept. of Forestry	Jeff Brandt	07/27/11
Oregon Dept. of Forestry	Mike Cafferata	07/27/11
Oregon Dept. of Land Conservation & Development	Katherine Daniels	07/18/11
Oregon Watershed Enhancement Board	Renee Davis-Born	07/20/11
Parametrix	Kevin Halsey	06/19/11
Penn Futures	Alissa Burger	03/01/13
Pennsylvania Department of Environmental Protection	Ann Roda	11/17/13
Pinchot Institute	Eric Sprague	11/17/11
Portland Bureau of Environmental Services	Mike Reed	08/05/11
Portland Bureau of Healthy Working Rivers	Heidi Berg	05/26/11
Portland Bureau of Healthy Working Rivers	Rick Bastasch	05/26/11
Portland Bureau of Healthy Working Rivers	Ann Beier	05/26/11
Red Barn Consulting	Peter Hughes	01/30/13
The Freshwater Trust	Scott Peerman	07/21/11
The Freshwater Trust	David Primozych	07/14/11
U.S. Army Corps of Engineers	Jaimee Davis	07/13/11
U.S. Army Corps of Engineers	Bill Abadie	07/13/11

U.S. Department of Agriculture	Carl Lucero	11/10/11
U.S. Environmental Protection Agency	Kevin DeBell	11/15/11
U.S. Environmental Protection Agency	Yvonne Vallette	11/07/11
U.S. Environmental Protection Agency	Matt Weber	07/20/11
U.S. Forest Service	Robert Deal	07/21/11
U.S. Natural Resources Conservation Service	Meta Lofstgaarden	07/22/11
University of Oregon	David Hulse	08/19/11
Watershed Stewardship, Inc.	Tom Simpson	11/10/11
Willamette Partnership	Bobby Cochran	07/08/11
Willamette Partnership	Devin Judge-Lord	05/27/10
World Resources Institute	Todd Gartner	03/04/13
World Resources Institute	Mindy Selman	11/15/11