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COUNTING ON THE ENVIRONMENT: MEASURING AND MARKETING ECOSYSTEM SERVICES IN OREGON

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THESIS

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Arts in the College of Arts and Sciences at the University of Kentucky

By

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Lexington, Kentucky

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ABSTRACT OF THESIS

COUNTING ON THE ENVIRONMENT:
MEASURING AND MARKETING ECOSYSTEM SERVICES IN OREGON

New markets for the conservation of so-called ecosystem services, like the ability of a wetland to mitigate floods, are emerging worldwide. According to environmental economists, these markets require some metric - ecological or otherwise - that names the relevant characteristics of the service to be traded as a commodity. But while this is often assumed to be a simple task of science, I argue that the environmental regulators, eco-entrepreneurs, and conservationists who actually design and implement metrics are not so easily brought into agreement. In "rolling-out" revamped metrics and protocols, regulators and their conservationist allies in one market in Oregon haven't established the conditions for market success so much as they have constrained entrepreneurs. The solutions to ecosystem destruction 20 years ago - privatization, commodification, and commercialization - have become the obstacles which limit the market's future viability. The moments when capitalists find themselves saying "let's sell nature to save it" - or when states say it for them - can spell trouble for capitalists at the same time that they seem like their escape hatch. Still, the short-term and long-term effects of market design may differ; barriers to the market now may prove to be its success later.

KEYWORDS: Ecosystem Services, Neoliberalization, Markets, Political Ecology, Oregon

Multimedia Elements Used: JPEG (.jpg)

_____Eric Nost_____

_____July 12, 2013_____

COUNTING ON THE ENVIRONMENT: MEASURING AND MARKETING ECOSYSTEM SERVICES IN OREGON

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"We value what we price, but nature's services - providing clean air, fresh water, soil fertility, flood prevention, drought control, climate stability, etc. - are, mostly, not traded in any markets and not priced....We cannot manage what we do not measure and we are not measuring either the value of nature's benefits or the costs of their loss."
-Pavan Sukhdev, "Putting a value on nature could set scene for true green economy" in *The Guardian*, 10 February 2010

1.1: Introduction

In this thesis, I argue that the markets in ecosystem services like salmon habitat, wetland water storage and delay, and stream temperature that Sukhdev calls for may not actually have the effect of commodifying and pricing the environment. I explain the legal, scientific, and financial work environmental agency staff, non-profit conservationists, and restoration entrepreneurs have invested into making one such market in the US state of Oregon, showing when and why the task succeeds and fails, and to what end. In these markets, state and federal regulatory agencies allow developers to impact wetlands and streams if they compensate entrepreneurs, or "mitigation bankers," who speculatively restore ecosystems. Two of the most challenging issues market-makers confront are how to measure the success of restoration work and deciding where in the landscape restoration should be done. I share how they have dealt with these issues in a project to introduce new metrics and protocols into the Oregon market, and at one specific restoration site in particular, a testing ground called Half Mile Lane (HML; see Appendix A for a reference of acronyms used here). I argue that the revamped marketplace has failed to live up to its own goals because regulators' and conservationists' new metrics and rules have not worked for the entrepreneurs doing restoration on the ground (and sometimes not even for regulators and conservationists themselves). Even in failing, however, this project of environmental governance strengthens the hand of regulators and their conservationist allies, at least for the current moment. The market right now has proven to be not so much a project of commodifying and pricing ecosystem services, as one of state formation, legitimacy, and power.

1.2: Half Mile Lane

On January 25, 2012, the non-profit conservation group Willamette Partnership (WP) and the Oregon Department of State Lands (DSL), in conjunction with the US Army Corps of Engineers (Corps), authorized the trade of four salmon habitat credits from HML to the Tualatin Hills Parks and Recreation Department (THPRD) (DSL 2012a). DSL did not sell the HML property where it had restored salmon habitat. Instead, it dealt THPRD credits, or units of account representing the quality and quantity of habitat created after DSL replaced a culvert and performed other stream and wetland restoration work at HML. THPRD paid $1,114.32 for these credits so it could tell environmental regulators like DSL that it had adequately compensated for a trail bridge it is building that will degrade habitat elsewhere in the watershed (see figures 1.1 and 1.2).

The credit sale is banal yet remarkable. Suburban housing developers, state Departments of Transportation, and others have traded wetland credits widely for over twenty years. But beyond wetlands, the assessment and trade of other forms of environmental degradation and restoration as credits, like salmon habitat, is only now emerging. DSL's sale establishes and governs nature not simply as a set of coordinates delineating where a stream and salmon habitat exist but as a representation that signals to state agencies that its buyer – the THPRD - has mitigated stream impacts one of its trail extension projects will have caused elsewhere in the watershed in late 2012. In this production of nature as credit, regulators, scientists, and entrepreneurial restorationists are all actively involved in measuring and marketing streams and wetlands.

Bill Cronon (1992) reminds us that the making of nature as an abstract representation (e.g. a credit or a futures contract) is not a new project. But the novelty of the kind of scheme described above is twofold: 1) it is driven by state and federal regulation; 2) the commodity traded is not a "good" so much as it is the "uplift," or improvement, in a "service" provided by a particular ecosystem. In drawing the degradation and restoration of environments within financial circuits, markets in ecosystem services have the potential to reshape how we imagine and relate to the environment (e.g. Sullivan 2012). These new forms of governance, however, are far from unified and well-articulated projects that are identical everywhere in mission and scope; both economists and ecologists are divided in important ways on ecosystem services'

measurement and marketing (Dempsey and Robertson 2012). My aim is to watch how the process of figuring out how to measure and market ecosystem services plays out at HML, in Oregon, a state which is on the leading edge for ecosystem service policy and programs.

Figure 1.2. Half Mile Lane. Source: Author.

1.3: Significance of HML

The accounting behind the HML-THPRD sale represents a significant departure in the governance of water systems not only in Oregon, but the rest of the US as well. While a grand total of only four salmon habitat credits were exchanged for not much more than $1,000, it was one of the first sales from HML. HML, as a "bank" of credits, is the pilot restoration site for WP's innovative Counting on the Environment (COTE) ecosystem service credit/debit accounting system and market protocol (WP 2009). The WP actively promotes COTE nationally as a way to scale-up conservation, and the sale

opens up an important window for watching how the crediting and debiting of nature ascends - and hits sticking points - as a leading form of environmental governance.

The COTE metrics and protocol and their application at HML are remarkable for three reasons. First, HML tests a new measure of restoration success that is explicitly ecosystem services-based. WP had half of the wetland credits from the site calculated with what is called a functional ecosystem assessment. The US state and federal environmental agencies the WP works with are looking to move to measuring wetlands and streams in a way that pulls out and emphasizes the specific functions that allow these ecosystems to provide services to society. Functions are physical, biological, and chemical processes, like the ability of a stream to transport sediment or of a floodplain wetland to store surface water. The idea for many policy-makers and scientists is that functional assessment can improve upon existing ecosystem assessments by clarifying what exactly is lost at impact sites and gained, over time, with compensatory restoration. In early January 2012, Oregon's regional EPA office and WP circulated a request for a consultant who could build on the functional wetland assessment to draft a stream functional assessment for them. Though the assessment will go through a couple of years of development and field testing, EPA and WP plan for it to be a model for other states in the region.

Second, the HML-THPRD sale also exemplifies a move to *market* ecosystems as composed of various functions. Perhaps the most novel import of the sale is that it involved multiple kinds of ecosystem currencies – not only wetlands, but salmon habitat and water quality as well. The credit buyer, THPRD, did in fact only purchase salmon habitat credits. But in buying these, market administrators also removed an equivalent amount of temperature and wetland credits from the ledger of available credits. The WP's market regulations allow buyers like THPRD to access a number of different types of credits from a given "map unit" at a site. In purchasing credits of one type, however, the amount of other credits, of different types, that are left to sell is proportionally reduced. Because the ecological processes underlying the services at one site are to some extent shared (e.g. groundwater recharge is a function vital to water temperature and wetland habitat services), it would in theory be possible for a restoration entrepreneur to trade part of a function twice or more. Despite the risk of selling more nature than a site actually

provides, for many regulators (e.g. Fox 2011) and marketers (e.g. White and Penelope 2013), the accounting maneuver of "stacking" multiple services can expand conservation markets by compensating restorationists for each and every service they produce, not just one stream or wetland.

Finally, the siting of HML represents a gesture by agencies toward watershed and landscape-oriented governance. They are seeking to prevent developers from making impacts to highly functioning sites, while ensuring that restoration for the market happens in priority areas. These priority areas include sites that have the potential for restoration of different kinds of ecosystems, sites within mapped "conservation opportunity areas", or especially well-functioning sites; HML is all of these. There is both a wetland and stream on the site, the property lies within a priority area, and it was already somewhat preserved and not very degraded. Regulators see in the COTE protocols a way to encourage strategic site selection, in which restorationists seek out the best spots, as opposed to opportunistic site selection, in which restoration gets done wherever there are willing landowners. In sum, the HML-THPRD sale embodies three key moves for US environmental governance by regulators, conservationists, and restoration entrepreneurs. As signees to the final COTE document themselves noted, it was meant to:

> "provide standard, functions-based credit calculation methodologies to measure both impacts and benefits [functional accounting] in a way that provides new incentives for restoring the breadth of ecosystem functions [stacking multiple kinds of services] and moving impacts from the highest functioning sites [watershed planning]." (WP 2009)

What HML potentially signifies as a new model for ecosystem governance, however, only goes so far. The COTE process has not inspired entrepreneurial restorationists to establish any other HML-style banks offering multiple credit types. The new kind of functions-based wetland credit that agencies and conservationists are testing at HML has not sold because they are more expensive. Though the salmon habitat credit has sold several times now (the THPRD trade was the first time it did), there are still lingering questions amongst regulators about whether it is something they want to continue to deploy in the long-term. Finally, even for traditional wetlands-only restoration projects, the state and conservationists have not inspired more strategic site selection. HML may have been in a good position in the watershed, with opportunities for

both wetland and stream restoration, but the idea has not yet caught on with entrepreneurial bankers of ecosystem service credits.

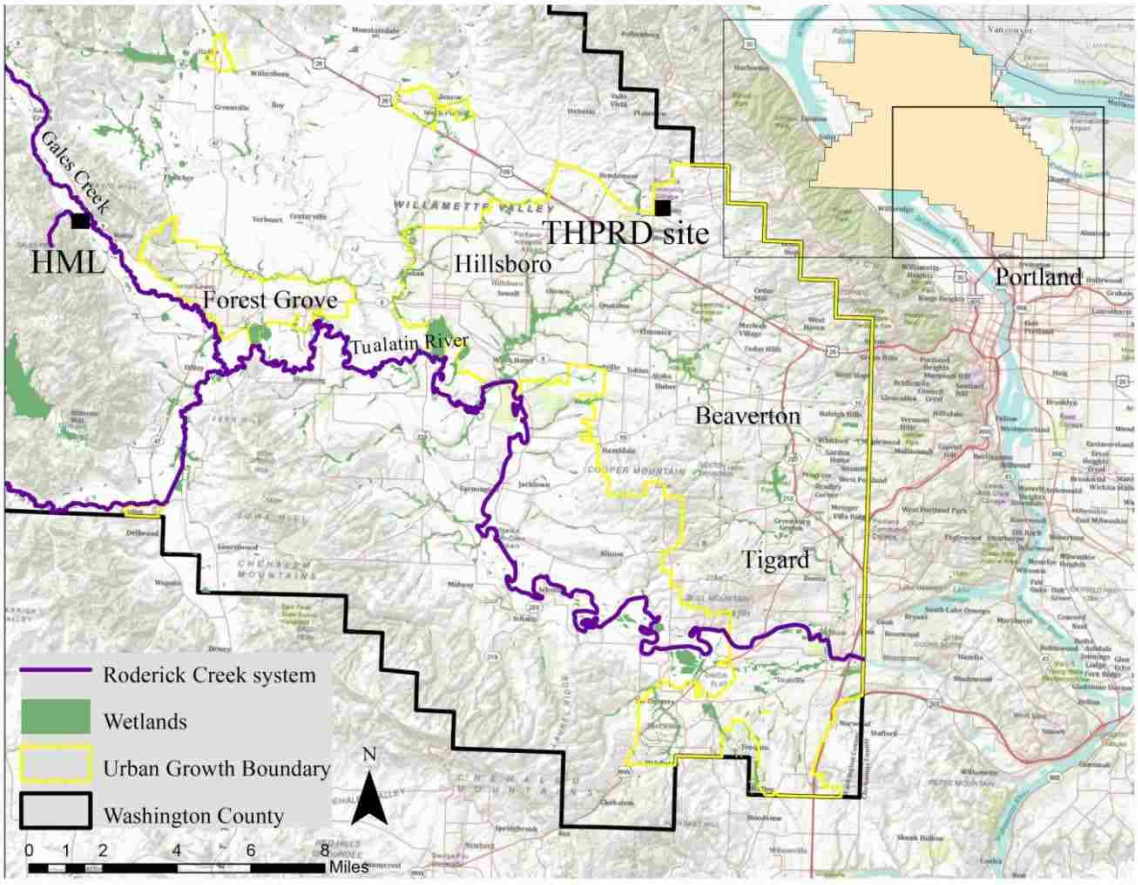


Figure 1.3. Map of Washington County. Source: Author.

1.4: Research Question

When we hear someone like Pavan Sukhdev say that what needs to be done to prevent environmental degradation is to "put a value on nature," the challenge of resource protection sounds so easy. But the task has not been so effortless in Oregon, as HML has remained just a prototype for how regulators, conservationists, and entrepreneurs might better valorize the environment. For some market actors - mainly regulators and non-profit conservationists - this limitation has been unfortunate, while for those mitigation bankers wanting to do restoration for the market as entrepreneurs, it has not been as much of a problem. In order to explain what has gone right and wrong in Oregon, and to what end, we need to understand the specific interests and hesitations of market actors.

The main question of this research is: what are different market actors' and institutions' guiding rationales, or logics, in proposing and enacting the new kind of market-oriented ecosystem service governance represented by COTE and HML?

At first glance, authors writing in what is an extensive scholarship on market-oriented environmental governance suggest that the logics driving those involved in COTE and HML may revolve around the use of state power to provide "regulatory relief" to developers and empower entrepreneurs to invest in restoration. In other words, the logics of Oregon actors may be about neoliberalization - the *privatization* of environmental degradation and restoration, the *commercialization of* ecosystem services through their sale as credits, and the *commodification of* services as ecologists are enrolled to measure them and restoration firms or, in the case of HML, DSL, assign them a price (Bakker 2005; McCarthy and Prudham 2004; Heynen et al. 2007). Scholars are quick to note that these ways of thinking about and acting on the environment regularly fail (Castree 2008). Successful or not, the literature also gives us reason to think these logics are not going to look the same everywhere in the first place (McAfee and Shapiro 2010; Dempsey and Robertson 2012; Roth and Dressler 2012; Shapiro-Garza 2013; in general, Gibson-Graham 2006). Both points warrant extending the research question to: what are the different logics within regulatory, conservationist, and entrepreneurial sector actors in Oregon? In what ways are logics disrupted or divergent to the extent that the success of HML has been limited at best?

We could answer the question of why HML has not sold new kinds of credits or motivated entrepreneurial restorationists to do similar kinds of banks in several different ways. We could say that regulators and conservationists have been unable to maintain trust, engagement, or vigor around the project of measuring and marketing ecosystem services (e.g. O'Grady 2011). We might also answer that the problem is that market actors did not get ecosystem services' measure right. After all, as Sukhdev says, "we cannot manage what we do not measure" and, for him, the right measure is a price that comes out of the kind of fully-fledged market that has not happened in Oregon (Sukhdev 2010; cf. Sullivan 2012). Similarly, and finally, we could turn our gaze toward nature and argue that market actors have encountered an "uncooperative," complex biophysical

environment in wetland and stream ecosystem services that proves to be something they cannot account for (Bakker 2005; 2009).

The answer I provide in this thesis differs and is three-fold. I argue that the rationales that come into conflict and cause market sticking points are regulatory ones - often allied with conservationist logics - that are different from entrepreneurial understandings of why there should be a market and how it should work. Regulators and entrepreneurs spar over two issues, which constitute my first two answers, and which I flesh out in chapters 3 and 4. The first problematic revolves around what kinds of ecological assessments are deployed to define the credit commodities at the heart of the market. I share regulators' and bankers' opinions on whether to allow the stacking of or selling of multiple kinds of credits from one site, whether the salmon habitat credit is an adequate credit, and the utility of functions-based accounting. I argue that their different expectations about what ecosystem services and their metrics can do are what become controversial in and limiting to the market. With functional assessment in particular, regulators are hoping for a different set of results than entrepreneurs. They gain some legitimacy in taking this position, however, because everyone agrees the old system is untenable.

In assessing restoration success, market actors also consider the ecological conditions and processes that occur across the landscape. This is the second market problematic: where entrepreneurs should do mitigation banking? The developers of the COTE protocol intended to drive restoration to the "right place" on the landscape and limit impacts to those areas. As such, new assessments and market rules embody *spatial logics*, but these are also diverse and contested. Adherents to a conservation logic of ecosystem services see the value of restoring nature as fundamentally spatial - some places are more worthwhile to restore than others. Entrepreneurs should be guided to do restoration in these priority areas, they argue. But this conservation logic can come at the expense of capital by forcing bankers into working off a smaller set of potential restoration sites, and on sites that are more costly. Still, regulators are willing to say to permittees, "don't develop this place," or to bankers, "do restoration here," in a way that has proved limiting to entrepreneurial restoration. This territorialization of nature reworks and forms the state at a stronger position vis-à-vis capital, so that what appears to be a

revamping of the market to facilitate accumulation is at least now in fact a constraint to marketization.

My final point in this thesis is that debates around what ecosystem assessments are most appropriate and where entrepreneurs should do restoration for the market illustrate deep contradictions in the commercializing and commodifying neoliberal logic of ecosystem markets. While the state in Oregon wants entrepreneurs to restore ecosystems and sell them as credit commodities, it also wants them to perform restoration in locations that may not be the most advantageous to bankers - in "strategic" rather than "opportunistic" places. Regulators are in a position where they oversee a market that is based on the twin ideas of welcoming private investment in ecosystem services restoration and permitting resource impacts, but yet they are uncomfortable with the idea of letting bankers invest or developers impact wherever they please. Likewise, the state's move to roll-out new function-based measures of restoration success flounders on the fact that entrepreneurs are tied to an older currency. Again, regulators have designed and implemented a market that at its core was about facilitating private restoration of ecosystem services, but at the same time they do not think that just any definition of the credit commodity traded in the market will work. They would like to see a better credit, but it is one that is, at least in the short-run, constraining entrepreneurial restoration.

The contradiction regulators confront illustrates that as the on-the-ground pilot for a revamped market in ecosystem services HML is not necessarily neoliberal, contra what many academic commentators might suggest (e.g. Büscher et al. 2012), though not all (Mansfield 2004; Robertson 2007; McAfee and Shapiro 2010; Roth and Dressler 2012; Shapiro-Garza 2013). Making a market in ecosystem services might seem like a clear-cut case of a roll-out of rules and regulations favorable to a capitalist accumulation of new kinds of resources. However, in Oregon, the state is at the same time constraining capital vis-a-vis its position before the COTE protocol, at least in the short term. Whether regulators will continue to hold their position, or whether entrepreneurs adjust to new market conditions, is unclear at this point. Either way, right now, regulators' and conservationists' pressing logic is what has made the market sticky so far.

1.5: Literature Review

1.5a: Neoliberal natures and conservation

Many researchers characterize the commodification of nature as part and parcel of a neoliberalization of government and economy (McCarthy and Prudham 2004; Bakker 2005; Heynen et al. 2007; Castree 2008, 2011; Büscher et al. 2012). Neoliberalization is a project of both "rolling back" state programs that impinge upon capitalist accumulation and "rolling out" new rules, regulations, and protocols to foster markets (Peck and Tickell 2002). Although these new programs and policies may still find their actual foundations in government action, they at least have ideological grounds in their claim to achieve social goals efficiently (Harvey 2005). For those interested in the relationship between state, economy, and environment, neoliberalization entails policy-makers, scientists, market actors, and others coalescing to de-regulate direct state management of ecosystem use and impacts and to re-regulate ecosystem products and outcomes as commodities (Robertson 2004). Some scholars distinguish between the neoliberalization of natural resources and neoliberal conservation (Arsel and Büscher 2012; Büscher et al. 2012). This is the difference between how, say, water provisioning is privatized, commercialized, and commodified (Bakker 2005, 2013) and how ecosystem protection or restoration becomes the purview of private interest and gain at the expense of the state or local communities (Büscher and Dressler 2012). In other words, "neoliberal conservation shifts the focus from how nature is used in and through the expansion of capitalism, to how nature is conserved in and through the expansion of capitalism" (Büscher et al. 2012, 4).

Research into nature commodified as a credit, however, is rather few and far between. Where it does exist, there are two gaps I hope to fill: 1) scholars focus on carbon offsets and other relatively settled metrics; 2) researchers work is largely confined to the developing world. First, offset credits, to a large extent now constitute how governments regulate and businesses account for carbon dioxide and indeed, most research perspectives at least tangential to the crediting of nature focus on carbon (e.g. Bumpus and Liverman 2008; Lansing 2011; Boyd et al. 2011). The measurement of carbon is, however, a relatively agreed upon task – at least to the point of adequacy for a global market and for various regional ones. Various protocols translate forest

restoration, gas destruction, and cover crop planting into a measure of the weight of greenhouse-forcing gases kept out of the atmosphere or sequestered in the soil. What the case of HML and the COTE process ask us to do instead is pay attention to how the physical, chemical, and biological complexities of wetland and streams *services* are yet to be boiled down into workable calculations that make a metric based on ecosystem process rather than weight or volume. I watch, in action, the process of how regulators, conservationists, and entrepreneurs come to agree on and put into practice these protocols.

Secondly, because most carbon offset projects occur in developing countries, most research is conducted there as well (cf. Robertson 2004; Hillman and Instone 2011). Insights from those studies are certainly valuable, but I am concerned with the specific dynamics that accompany crediting nature in an advanced capitalist country. McAfee and Shapiro (2010) and Corbera and Brown (2008) show how ecosystem crediting programs in Mexico are uniquely positioned in that country's specific political and economic context. Corbera et al. (2006), for instance, show how the introduction of markets reinforce existing power inequalities in a local community, while Shapiro-Garza (2013) details how rural social movements are able to capture and hybridize a market-based ecosystem services project. I am after that same sort of contextual analysis, but with an eye toward Oregon. Oregon is different because land tenure arrangements, the institutional coherence and position of the state, and the embeddedness of relations of capitalist production and exchange differ from Mexico, or elsewhere (see McCarthy 2002; Robbins 2002 on how political ecology has translated to the first world). Neoliberal governance is not identical in shape and form everywhere and is not a totalizing, self-actualizing discourse. The term “rolling” implies a sense of ease, consistency, and closure, but in the literature, neoliberalization is acknowledged variously as a hybrid (Larner 2003), variegated (Brenner et al. 2010), or overdetermined (Althusser 1980; Gibson-Graham 2006) project. My research reinforces the point that neoliberalization as a process is messy and plays out differently - sometimes successfully, sometimes failingly, sometimes in hybrid fashion - in different places.

In the end, the thrust of the neoliberal natures research is that capitalists aim to have the state to do its bidding, with negative results for the environment. As such, much

has been said in the literature about whether and why neoliberalization fails (Castree 2008a,b). Less has been said about what happens as a consequence of neoliberalization failing, but my research contributes here by drawing on three key points from the literature on state theory. First, because the state is a social relation situated in particular historical-geographical contexts, modern state regulation of capital involves civil societal actors - including conservationist NGOs - just as much as it does bureaucrats (Jessop 2002). Secondly, states as coherent, forceful, and legitimate entities form in relation to - not before - their projects of making sense of the environment (Mitchell 2006; Asher and Ojeda 2009). Third, state projects that fail can still have the effect of extending new kinds of social relations (Ferguson 2006). I show how attempts in Oregon to commodify ecosystem services fail, but that this is not the end of the story. They instead have the effect of forming state, civil society, and capital relations in favor of the state and allied conservationists, at least for now, as part of a continuous regulation and re-regulation of capitalist encounters with the environment.

1.5b: Political Ecology

I also draw on the work of political ecologists in order to understand how projects of environmental governance like ecosystem services market-making in Oregon can fail to come to fruition as planned and remake state, civil society, and capital relations. Political ecologists' thematic and topical interests are diverse and interdisciplinary, ranging from takes on the way individuals and social movements develop environmental identities to critiques of the use of habitat conservation as a means of social control. They are, to the most common degree and highest abstraction, concerned with showing how environmental phenomena that are regularly taken as natural, or given, are contested and contingent. Political ecologists are primed to share stories that demonstrate when and how environmental policy creates "winners and losers" (Robbins 2011, 87), the different kinds of claims people make about nature, and how resource access and use is politically and economically contextualized.

Political ecologists contextualize decisions about resource management within "chains of explanation" that center on locally, regionally, and globally extensive political and economic structural forces. They argue against the idea that the cause of

environmental degradation is simply profit-maximizing rational actors. Instead, they situate how people use land or develop knowledge about it within social norms (Nightingale 2006), survival strategies (Stonich 1992), the introduction of capitalist social relations, or devolution of state governance (Agrawal 2006).

Political ecologists contextualize environmental projects within these as they *change over time*, and in engaging with the historical background to their cases, make stronger, more convincing claims. Part of what makes Oregon's market unique is a new attempt by regulators and conservationists to measure the benefits of restoration and the impacts of development differently than they have in the past and a historical lens is necessary to understand why the state continues to press forward on this project to the point of disrupting the entire market. For McAfee and Shapiro (2010), it proved worthwhile to examine how a payments for ecosystem services program in Mexico evolved over time. In each phase, the Mexican government altered how it paid peasants for their restoration efforts and changes over the three phases reflected how over time peasant social movements were able to embed their own collective interests within the ostensibly neoliberal program. State regulators came to choose continuing the historical role of the Mexican state in subsidizing rural communities against the wishes of World Bank economists. For Bakker (2005), too, a historical lens was necessary in order to see the "retrenchment" of water neoliberalization in Britain. Between the Thatcher era and the late 1990s, regulating authorities and water agencies came to rethink the value of commodifying water. Water itself was difficult to move between supplying and demanding districts and use-based pricing was a burden on the poor. If Bakker had stepped into her research only at one particular time, she would have found it self-evident that municipal water systems in Britain had either been successfully neoliberalized, or at another time, never really neoliberal. The basis for her central thesis that neoliberal water governance is fractious and shaped by fluvial physics would have been nulled. By thinking historically, I attempt to make sure that by stepping into the Oregon scene in the midst of regulators' and conservationists' attempted roll-out of new functional ecosystem assessments, I do not write their market-making off as evidently neoliberal or not.

In their founding statement on political ecology, Blaikie and Brookfield (1987, 17) wrote not just about "chains of explanation," but of deploying these alongside the

"concerns of ecology." Political ecologists are critical of how scientists, bureaucrats, and land users produce knowledge about the environment, and in their critique they make two kinds of claims (Robbins 2011). First, they make claims about how nature works, in order to debunk "apolitical" rehearsals of, for instance, Malthusian explanations of land degradation and deforestation in West Africa (e.g. Bassett and Koli Bi 2000). This allows them to demonstrate what work environmental policy performs if it does not actually address the root of the issue policy-makers intend it to. Political ecologists also make claims about how policy-makers, businesses, scientists, and conservationists themselves narrate how environmental processes work (e.g. Peet and Watts 1996; Turner 1999). In my research, contextualizing the production, circulation, and application of knowledge (Goldman et al. 2011) about something like salmon habitat makes for more convincing arguments about how neoliberalizations triumph, hybridize, or falter because of what Ward (2013, 3) calls "sui generis socio-natural attributes."

In particular, the "social nature" concept shows us when and how ecology is and is not useful in explaining market outcomes (Castree and Braun 2001). For students of "social natures," the metaphors scientists and economists employ in describing something called "salmon habitat" are more accessible, meaningful, and powerful than the "truth" of nature itself. Nature either does not exist independently of social articulations of it (Harvey 1996; Latour 1999) or at the very least asking after the truth of nature is a tedious and irrelevant question (Demeritt 1998). Latour (1999) develops a brilliant image of what social nature looks like on the ground. Latour's lab is in the Amazon, where he examines the botanical and pedological practice of describing transitions between forest and savanna ecosystems. His point is that the field study's work describing those transitions - proved in journal articles and lab notebooks - always refer back to other pieces of paper where data was organized or to other plants or other concepts endlessly. He largely paves the way for a social natures approach to neoliberal natures in his elaboration of these "circulating references." For him, there is no hope of ever grounding a final truth about this particular case of forest-savanna transition.

Latour's claim that representations of ecological processes endlessly reference each other does not mean that nature is irrelevant to the privatization, commercialization, or commodification of the environment. It does suggest rethinking how and why nature

matters. Ecological assessment, functions-based or otherwise, for wetland and stream markets is one project of circulating references. Like Latour's colleagues in the Amazon, assessors go out to sites and generate ecological data from restoration sites that always refers back to some previous measure, claim, place, or idea. But because assessment is reference or representation, rather than "materiality," it does not mean that the circulation of knowledge cannot be stopped or disrupted, "intransigent" (Braun 2006) or "uncooperative" (Bakker 2005). Indeed, my goal is to see when the circulation of ecological references flounders. This is part of my larger project of paying attention to the precarity of the logics of assessment, in order to explain why HML and COTE have not moved much beyond the prototype stage.

1.5c: Science and Technology Studies (STS)

"We don't want scientists saying what the risk of a lawsuit is, and we don't want lawyers saying what the value of a wetland credit is."
-Doug MacNair, Cardno ENTRIX, "What's the Value of Valuation?" session at the Ecosystem Services Markets: Making Them Work conference, Madison, WI, June 2011.

Where Latour leads us with his discussion of circulating references is into a literature on the social construction of science. He gives us good reason to follow *experts* like pedologists and botanists "in action" - or in the Oregon case, the conservationists authoring, consultants performing, and regulators judging the market's ecological assessments. I see his approach as yet another way political ecologists can contextualize their explanations of successful and failed environmental management. My research contributes to the project of bridging PE and STS (Forsyth 2003; Lave 2012, 2013) by way of analyzing the expert production, circulation, and application of ecological knowledge.

When Ward (2013, 2) claims that "specific sociopolitical actors produce, modify, and cope with the terms of market-oriented rule-making regimes" he is talking about the *subjectivity* of scientific, entrepreneurial, and regulatory experts. He refers to the way that they are subject to social roles and how they see that subjection. In different ways, political ecologists are starting to pay attention to how individuals - in roles as regulators, activists, conservationists, or entrepreneurs - think about, identify with, and enact environmental policy (Robbins and Krueger 2000; Robertson 2010; Brannstrom 2011;

Lave 2012; Doyle et al. 2013; Ward 2013). They do so to demonstrate how environmental knowledges, opinions, and performances associated with particular roles (e.g. conservationists know larger restoration areas provide better long-term ecosystem protection and so they work through government to advocate for more of these kinds of areas) are often shared by individuals across often conflicting roles (e.g. conservationists and entrepreneurs) and how this can make governance sometimes more complicated, sometimes more divisive, or sometimes more consensual. In the case of Oregon's ecosystem services markets, individual regulators, conservationists, and entrepreneurs comprise the market governance process, but these individuals are not just legal scholars, nature-lovers, and profit-seekers. As Doug MacNair would have it, the valuation of wetlands and streams demands scientists and lawyers perform their proper expertises, but to what extent - and when - do scientists and lawyers actually act just as knowledge-providers and legal counsels in those roles?

For example, it has been easy for some market-makers in Oregon to forget that HML serves as a bank of credits. In early August of 2012, I met one of DSL's mitigation program coordinators at HML. We ran through an assessment questionnaire in order to evaluate the site's ecological performance. The calculator does not require extensive ecological training from its user, but she was formally trained in ecology. Eventually, she got to talking about what a private sector banker of credits would have to do at HML to earn credits. She explained how she and her regulator colleagues at EPA and Corps - as members of an Interagency Review Team - would judge the banker's work. DSL, however, is the entrepreneur at HML: "well, I guess I'm the banker here," she corrected herself after having realized her slip. In that moment, she had to choose to be the banker instead of the regulator. Permitting and reviewing the site may have been a more accustomed task for her, but selling credits did not necessarily come so easily. After all, as another regulator told me, one of the drivers of the COTE process was to get agency staff to learn to "think like economists," as the move to credit stacking and functions-based accounting made market implementation more complex.

Focusing on the moments when the state, as comprised of individuals performing ordinary tasks of ecological assessment (Mitchell 2006), cannot fully grasp and enact its purported role as tester and guarantor of new market-based initiatives may do a lot to

explain why HML has not been immediately successful as a site for neoliberalizing nature. Throughout the thesis, I show that the experts at the heart of making the Oregon market do not fall neatly into one category or the other. As one person put it to me, he is a "hybrid" - wildlife ecologist and designer of software for the market, all in one. In short, it may not be appropriate to say that regulators are out to satisfy the letter of the law and nothing else, since this ignores the fact that many may have ecological motivations as well. Nevertheless, as the regulator at HML played the part of the assessor rather than the banker, people choose to perform one logic or another at certain times. As such there may be certain logics or positions that do come to ground and matter more than others, and I demonstrate how and why they do.

1.6: Methods

The methods I employed in this research square with and put flesh to the theoretical approach I outlined above. I conducted interviews with market actors, reviewed key documents, and participated in the site visits and office work that comprise the ecosystem assessments of restoration success. Interviews helped me develop an understanding of regulators', conservationists', and entrepreneurs' subjectivities and these conversations also told me a bit about the history of assessment development. Reviewing legal statutes, market protocols, and COTE workshop notes told me even more about the history of the market. Finally, participating in visits to restoration sites and performing the office work of assessment helped me to understand both regulators' sense of how they see themselves regulating the market, as well as the ways ecological representations matter to the market.

1.6a: Interviews

The goal of having conversations with policy, science, and market actors involved with HML is, in the broadest sense, to get people to work through and shed significance on a context to which I only have static, textual access (Kvale 1996; Valentine 1997). This involves asking people (often those who wrote or financed a particular document) about how something happened, or how something described in a document works. Interviews are important tools for picking apart representations of actors and ideas that

are either too glossy or wholly invalid (Schoenberger 1991). Interviews, as semi-structured conversations, foster an atmosphere that allows for informants to work through problems and for researchers to grasp how informants narrate those problems.

I asked people to tell me about their opinions on and knowledge of how HML was developed and is currently managed as a model mitigation bank. I conducted interviews during a visit to Oregon in the summer of 2012 with over 20 regulators, conservationists, and entrepreneurial actors. I talked with regulators from both state and federal agencies, conservationists from several different influential non-profits, and consultants who both advise bankers and run their own restoration banks, but are formally trained in fields ranging from soil science to botany to wildlife ecology. I chose who to interview, and what questions to ask them, based on a preliminary reading of notes from the COTE workshop (WP 2009). I tried to speak with as many participants from the workshop process as I could. In general, I evaluated my sampling plan on its appropriateness and adequacy (Kuzel 1999). It would be inappropriate to choose informants based on a random sample, in part because the number of people involved in making Oregon's ecosystem services markets is rather small. After talking to COTE participants, I "snowballed" several new contacts by asking informants who else it would make most sense to talk to (Valentine 1997). The goal was to interview enough people to reach some sort of information "saturation" point at which no new knowledge is gained from additional interviews (Kvale 1996). I transcribed interviews in Kentucky using a modified form of the guide Poland (1995) outlines. I followed Cope's (2003) suggestion for coding interviews – a two-step process of first making broad descriptive codes and then analytical ones. In general, I recursively drew out key themes and paying attention to the emic categories informants themselves use while I derive useful etic, or analytical, categories (Crang 1997).

1.6b: Documents

The various methods I utilized facilitated one another, but there were multiple specific goals in my document analysis. The first was to understand how people code and present complex issues – for instance, how they understand functional ecosystem assessment and its utility (or not) at HML. Related, the second was to read documents for

embodying compromises between different market logics (regulatory, conservationist, entrepreneurial). The third reason was perhaps more mundane – documents are where a lot of the action is – for example: letters between regulators and market administrators and printed spreadsheets which list the credits available from HML.

I began the research by reading: notes from the workshop to set up the rules of the market; training manuals for the credit calculators; permits issued to projects buying credits from HML; the HML "instrument" which lays out the plan for restoration at the site. I also produced some summary statistics on credit "banks" in Oregon, to get a sense of how HML was different from other sites in the state. I examined what I consider to be two different sets of documents, but which do overlap greatly: regulatory and technical. Regulatory documents include both documents such as Exhibit D from the EPA/WP's Request for Proposals to develop a stream assessment framework as well as files documenting, approving, and managing specific mitigation projects (WP 2012). Technical documents are both market and science-oriented. An example of a market technical document is the Crediting Protocol (2009), which spells out how trades from HML and other WP restoration sites can happen. An example of a science-sector technical document is a brochure from the firm Parametrix (2010) which details how its Ecometrix assessment tool can be used by field technicians to measure indicators that then wrap up into scores for various ecosystem functions. Parametrix took a chunk of this tool to make the calculator for salmon credits used at HML. In the main, document analysis was conducted during the summer before the site visit as a way of developing background in the issue.

1.6c: Assessment work

Reading the technical documentation for assessments help me understand how assessments work on the ground when I had the chance to visit restoration sites. Hearing what people have to say in interviews and what they write in documents are two moments that get at my research question. Yet another element is what people do - how they take those documents and put them into practice. This third method involved two moments: 1) participating in assessments in action at HML; 2) tagging along with regulators and entrepreneurs to visit other restoration sites. The idea with 1) was to gain a basic

understanding of what functional measurement methodologies mean in use on the ground (which also means in the office). The regulatory and market logic behind new stream and wetland assessments is that they should be relatively rapid and simple to perform: done by two people, with two days of training, in two days. My goal was to capture their explanation of what the HML site means for them – what a site restored with a "splice and dice" functional framework looks like and what parts of the assessment are straightforward and which potentially constitute problems for regulators and entrepreneurs. In sum, I had the opportunity to do four site visits, each of which gave me a sense for: 1) what regulators expect from restoration sites; 2) how consultants think about which sites are good and how to assess them; 3) how bankers think about site selection and investment; 4) how site assessment with the credit calculators works.

I draw the interview, document, and site-based research together within a case study frame. Looking at one particular market-making endeavor, rather than all efforts everywhere to commodify ecosystem services (e.g. Mariola 2012a; Sullivan 2013), allows me to trace out the causes and implications of failures, success, and hybridity. If I were to set out to understand how the legal, scientific, financial, and conservationist project to make the world “an immense collection of ecosystem services” (Robertson 2012b) operated writ large, I would be less likely see the subjectivities, changes over time, and production of ecological knowledge that I have suggested contribute to these outcomes. What Blaikie (1985), in his formulation of political ecology, long-ago called “the view of bureaucrat in the airplane,” obscures too much. My narrative instead seeks to extend from the bottom-up in order to rethink what we know about the project of market-oriented environmental governance (Burawoy 1991). To that end, I now turn to background Oregon’s ecosystem service markets, HML, and COTE. In the next chapter, I explain how in the HML and COTE projects regulators and conservationists have engaged in national and international conversations about ecosystem services, while remaining very much grounded in the Oregon context.

Chapter 2: Ecosystem Services - a Conversation on Conservation

Driving down Half Mile Lane in the middle of the Oregon dry season, one of the first sights that stands out is a large pool of water near where the road crosses Roderick Creek (see figure 1.1 in Chapter 1 and 2.2 below). It's there this time of year because a beaver has built a dam just downstream of the site that is backing up water. At the dam, the landowner has jokingly put a "Home for Sale" sign pointing towards the beaver's habitat (see figure 2.1 below). The dam does provide an ecosystem service to downstream communities by forcing nutrients and sediments to settle out, but it also limits other services, like fish habitat. The landowner would rather get rid of the beaver because it is preventing him as the consulting restorationist on the project from finishing up some of the planting work. Staff from DSL realize his concern, but are not planning to do anything about it. After all, some estimates put pre-settlement North American beaver populations at 400 million and conservationists have gone to considerable lengths - such as paradropping beavers into underpopulated areas (Ferry 2012) - to bring them back.

In this chapter, I explain how the Oregon ecosystem service market works. There are certainly plenty of interesting market trivia, like whether and how to manage beavers, but I start getting at the market's more systemic sticking points. In the first section, I introduce the entrepreneurial actors of the market. I also discuss the market's state and federal legal foundations and the regulators who write and implement its rules. In the second section, I narrate a history of environmental politics in Oregon that informs how regulators have designed the market with the help of non-profit conservationists. Stepping back, I point to the ways environmental economists and others outside of formal policy arenas have since the mid-1990s started talking about nature as a set of ecosystem services. Environmental economists and their allies' conversation on conservation sets another stage for ecosystem services market-making in Oregon. In the last section, I describe in detail how an entrepreneurial banking would go about site selection, ecological assessment, and marketing credits. My goal here is to walk through the Oregon market as a way of introducing those sticking points in Oregon's market that I showcase in the following two chapters. As such, throughout the chapter I highlight the

important parts played by functions-based ecological assessment and restoration site selection.

Figure 2a. “Home For Sale.” A beaver dam is backing up water onto the HML site. Source: Author.

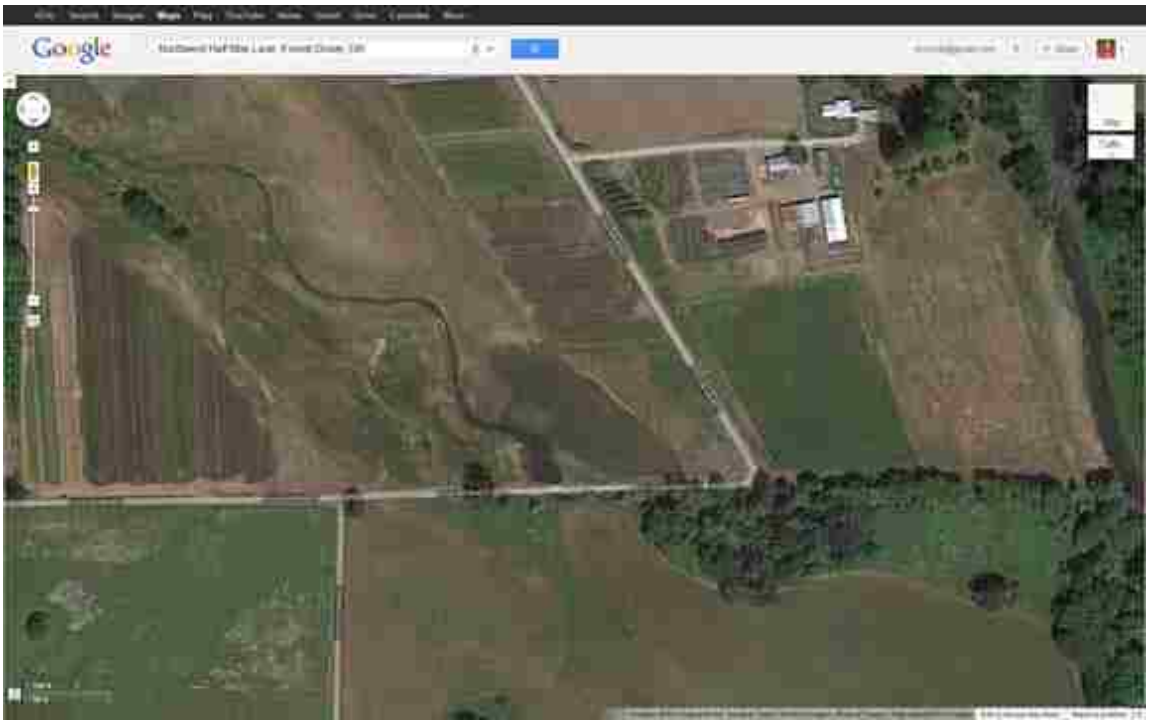


Figure 2b. The HML restoration site as seen from above. In the middle of the photo is the pool that was created after a beaver built a dam downstream. Source: Author; Google Maps.

2.1: Market Frameworks

2.1a: Permittees, landowners, entrepreneurs and consultants

In markets for wetlands and streams, environmental regulatory agencies allow public and private entities to compensate restorationists as a way of mitigating resource impacts that the agencies would otherwise prohibit or ignore. In Oregon's market, these permittees range from private housing developers to public parks and recreation departments like THPRD to the Oregon Department of Transportation. THPRD, as we saw in the last chapter, needed a permit for the impact it was going to create as it extended a recreation trail across a stream. It compensated for that impact by purchasing an amount of credits from HML equivalent to the scope of the impact. New construction of housing subdivisions comprises a sizable portion of the number of impacts to which HML in particular is supplying credits. The other large portion of impacts is for road extension projects that run into wetlands or streams.

Land managers establish "mitigation banks" in order to sell credits to permittees. Banks are both plans and places; they are financial and legal instruments land managers

draft and follow as they sell credits from a particular place or property where they have undertaken ecological restoration. The practice of banking credits in Oregon is mostly limited to mom and pop ryegrass seed farmers in the Willamette Valley looking for extra income on a piece of land. Sometimes farmers will take a project they want help financing and developing to an entrepreneur willing to invest in restoration, and sometimes an entrepreneur will come to them with something in mind. In either case, the land remains the landowner's, but it is typically under a long-term protection agreement or conservation easement. Banks must also be approved by the regulatory agencies, which in Oregon have signed off on around 30 since the practice started there in the late 1980s. There are a couple of exceptions to this general model of mitigation banking. At HML, the banker is not the site's landowner, nor a private entrepreneur contracting with the landowner, but DSL, a public agency. Also, a new, more speculative type of banking firm is entering the Oregon market. Unlike a farm, consultant, or government bureaucracy, these companies' sole purpose is in banking as a business venture. They often outright purchase the land they need to do restoration projects. Already, the California-based restoration firm Wildlands has purchased land and started an endangered species and wetland bank in southern Oregon.

Bankers - landowners, public agencies, or otherwise - hire private consultants with scientific training to run ecological assessment questionnaires on restoration sites. The purpose of assessment is to "measure and predict outcomes" of restoration, or degradation, in order to know the kind and degree of improvement and impairment (WP 2012, 1). A salmon habitat assessment, or calculator, for instance, requires the user to quantify the amount and size of downed trees or, "large woody debris," present and expected on the site. Consultants can then calculate the number of salable credits as the difference between site conditions pre- and post-restoration. In the same way, developers calculate debits as the difference in habitat pre- and post-road construction, trail extension, or other kind of impact.

A cottage industry of consultants has grown in Oregon in response to bankers' and developers' need to have trained individuals judge sites for crediting and debiting purposes. Consultants not only perform ecological assessments on sites, but also help their clients through the process of validating and registering credits as well as

monitoring site progress toward restoration goals. Their educational backgrounds are rather diverse, ranging from soil science to ecology and geology. Each academic background tends to produce a distinct view on the goals of mitigation, although they downplay the effect that has on restoration practice. Many consultants in Oregon are "single shingle" operations, meaning they function independently and not as part of a larger environmental consulting or engineering/design firm. They assist restoration projects done for non-regulatory reasons and they assess compensatory mitigation projects that are implemented by developers like THPRD themselves and not bankers. This form of compensatory mitigation is also known as permittee responsible mitigation (PRM). The majority of consultants I talked with do advise bankers, however, and there are even some consultants who operate their own mitigation banks. Consultants see themselves as providing independent ecological advice to bankers and permittees, but they are still more market players than anything else. They are responsive to market conditions in many ways. The 2007-2010 recession, for instance, wiped out many consulting operations as the demand for housing development projects imploded.

2.1b: Regulations and regulators

The housing market may be driven more by global credit flows than by regulations, but markets for aquatic ecosystem services would not exist without them. The legal basis for these markets is in the Clean Water Act (CWA) section 404 system of permits for impacts to waters of the United States.[1] This program of land use permitting is run on a day-to-day basis the US Army Corps of Engineers with oversight from the US EPA. An impact, as defined in section 404, is an addition to or removal of material from a wetland or stream, as when THPRD adds concrete pylons to a stream to build its trail extension.

Nowhere in the CWA does Congress actually mandate that the agencies must oversee markets in impact offsets. Instead, the regulatory framework for the market has grown over time as agencies have developed guidelines - sometimes as no more than what amounts to internal staff memos - for asking permittees to compensate for their aquatic resource impacts. As regulatory practice, compensation emerged in the late 70s

[1] 33 U.S.C. § 1344; CWA § 404

and early 80s as EPA staff setting the criteria by which the Corps judged permits realized that the Corps was likely to rubber stamp most of them. EPA felt the need to revamp how they conditioned permits, in order to stem wetland loss and the agencies ultimately agreed to design a sequential approach to permitting developers. To get a permit, developers must first *avoid* and *minimize* resource impacts, and only then are they required to *compensate* or trade for any remaining impacts.[2] (Hough and Robertson 2009; Gardner 2011). Corps and EPA lead this permitting process, which involves public comments and comments from related agencies. The final determination about whether to allow a project to proceed and on what terms rests with Corps and EPA.

Even with a sequential approach to permitting, the agencies found that they were not necessarily meeting the goals of the CWA to ensure the integrity of aquatic resources. Wetland loss continued at astounding rates. Towards the end of the 80s, Vice President George H.W. Bush, as presidential candidate, championed a policy calling for *no net loss* of wetlands. The idea was to direct Corps and EPA to emphasize the compensation part of the mitigation sequence as a way of ensuring that wetlands paved over would be replaced. The directive, put in motion by Bush months after he came into office, set the stage for the contemporary focus on market and entrepreneurial mitigation banking (Robertson 2000).

In Oregon, DSL has run a similar resource protection program under state law alongside the evolution of the federal program. Oregon has what is known as a Removal/Fill (R/F) law on the record which, squeaking in in 1971 before the 1972 Clean Water Act, establishes a permit review program for developers adding or removing material from wetlands and waters of the state.[3] Moreover, at around the same time that the federal agencies were beginning to think about no net loss and asking permittees to compensate for impacts, Oregon lawmakers established in 1989 a compensatory mitigation component to permit review and approval. DSL gets to sit at the table alongside Corps to review permits and works with Corps and EPA to set the criteria by which they judge permits and bank proposals.

[2] And *allowed* to compensate for their impact. Developers cannot just propose buying their way out of permit conditions

[3] Oregon Revised Statutes § 196.600

There are two emerging exceptions to the fact that most of Oregon's ecosystem service market activity is centered on CWA section 404 and Oregon's R/F law. Both are still conceptually very similar to section 404 and the R/F law. First, under another part of the CWA, section 402, EPA runs another permit program for pollutants that are added by pipe to aquatic resources, like when a power plant discharges hot or toxic wastewater into a river. EPA has the authority to impose a Total Maximum Daily Load (TMDL) of a pollutant in a given watershed, which is basically a cap on pollution kind of like the no net loss directive for wetlands and streams. Polluters falling under a TMDL can reduce pollution and trade any reduction below their individual target, as a credit, to other polluters needing to meet the cap (see Mariola 2012a). There are also new markets in endangered species. The Endangered Species Act (ESA) is implemented by the US Fish and Wildlife Service (USFWS) for land plants and animals and by the National Oceanic and Atmospheric Administration's National Marine Fisheries Services (NMFS) for marine species. They ask private developers as well as other government agencies to avoid "jeopardizing" the survival of threatened and endangered species. Typically, this has meant preventing development projects from going forward, or at least compelling developers to modify them so as to avoid "harming" species (Proctor and Pincetl 1999; Feldman and Jonas 2000). However, USFWS and NMFS have relatively recently started to authorize species banking in some parts of the country and for some species. The idea is much like wetland and stream banking: developers impacting species purchase credits from a conservation bank in order to offset their effect.

Staff-level interpretations of ESA, CWA sections 402 and 404, and Oregon's R/F law and juridical rulings have been pivtoal to making the market what it is today. This is especially true for CWA markets (Hough and Robertson 2009; Gardner 2011), which exist nationally but operate differently in different regions (Womble and Doyle 2012; Doyle et al. 2013). The decisions about what makes for avoidance, minimization, and adequate compensation are not necessarily Washington, D.C. decisions; the federal agencies have regional and district offices around the country and in Portland, Oregon specifically, with staff handling individual cases. Often times there are few, if any staff exclusively designated to overseeing mitigation at an office like this. For instance, it took several years after establishing the program in 1989 for the Oregon legislature to finally

fund a full-time mitigation specialist at DSL. Limited staff resources can make for disjointed and irregular policy-making, but so too can having to work in conjunction with staff from sister agencies like USFWS, to approve ecological assessments, permits and trades, develop criteria and standards, and monitor banking sites. In the case of DSL, staff also manage the sale of credits from the agency's own bank sites, like HML. Moreover, these regulators on the frontlines of ecosystem service markets are not often graduates of public policy or political science programs. Instead, they are typically trained at the master's level in some kind of ecological science such as fisheries biology or as civil engineers. The ecological/ engineering split typically describes the difference in staff background and approaches between the Corps and the environmental agencies. A variety of different actors make up the regulatory end of the market. Put another way, regulators are not just bureaucrats, they are ecologists and sometimes bankers too, as in the case of DSL staff who oversee the HML bank.

2.1c: The 2008 Mitigation Rule

It was not until a rule put out by the Corps and EPA in 2008 that the agencies first comprehensively addressed compensatory mitigation in administrative rule.[4] In the 2004 National Defense Authorization Act, the US Congress asked the Corps and EPA to formalize the way they went about authorizing mitigation, and in particular, to advance the use of banking for offsetting wetland and stream impacts. The rule's authors set the stage for an economically and ecologically revamped market in four ways.

As Congress had asked, regulators first prioritized mitigation banking of credits over developers undertaking their own restoration. Their goal was to ensure better ecological outcomes from compensatory mitigation. Corps and EPA were responding to a report from the National Research Council in 2001 which had proved scathing to the approach known as permittee-responsible mitigation (PRM) (NRC 2001). In PRM, permittees undertake the task of restoring degraded wetlands as a way of offsetting their impacts. Building off of similar reports on mitigation from around the country, including Oregon (Schaich and Franklin 1995), the NRC found that many PRM projects failed

[4] 33 C.F.R. §§ 325, 332 (2008); 40 C.F.R. § 230 (2008); Administrative rules have the weight of statutory laws like the Clean Water Act. On the difference between guidance and rules see: Salzman and Thompson 2003; Gardner 2011

because they were surrounded by negative land uses, constructed only after having been permitted, and faced little regulatory oversight. In the 2008 rule, regulators argued that one site with a bank of sellable credits established speculatively in advance of development impacts in the watershed would be easier for them to oversee and to compel long-term management actions from than many individual permittee-responsible sites.

Banking may or may not be more ecologically successful than other forms of compensatory mitigation. The NRC report highlighted the need to improve restoration siting in order to achieve restoration success, a task which regulators took up in the rule as a second priority. A mitigation bank that an entrepreneur places in the middle of a housing development is likely to be subject to ecological stress, but a bank that a banker puts in next to an already-conserved area might be especially valuable. Taking up the report's findings, many public commentators argue that entrepreneurs have to work in the right spot in the landscape for banks to be worthwhile. This is reflected in the 2008 rule, in which regulators called for a watershed approach to bank site selection. Agency staff are supposed to ask bankers to justify their proposal to make a bank in part by explaining how the site meets watershed-wide habitat, hydrological, or other ecological priorities. Bankers are supposed to point to some comprehensive watershed plan, but what counts as a watershed plan is left to each agency district to decide. Whether each plan will mean siting should be done to maximize positive ecological effects is not clear.

Third, the rule called for better assessment and crediting of compensation. Until this point, the way that bankers across the country have earned credits for their restoration work has been based on proxies like acres of wetland restored. Spatial extent alone makes for a lousy predictor of the viability and importance of a restored ecosystem, but it is a metric by which agencies can track their progress toward the "no net loss" of wetland acreage. In the 2008 rule, federal staff called on district staff to develop better standards that look to either the ecological functions of a site like floodplain surface water storage or to the condition of habitats and ecological communities. Regulators and conservationists believe that functional assessments provide a better measure of a restoration site's ecological processes.

Finally, to the chagrin of many public commentators, the rule also explicitly calls for establishing criteria and creating assessments for stream mitigation. Before the rule,

the program emphasized wetland - in fact, the EPA office overseeing it was called the Wetlands Division. Standards for how agency staff should assess impacts to streams and proposals to compensate for these impacts were largely lacking (Lave et al. 2008). Commentators worried that the inclusion of streams in the rule would only further streams' degradation, and that stream restoration was too complex and scientifically uncertain to make up for losses. Regulators responded by pointing out that stream impacts and compensation were already allowed, but that streams were regularly compensated "out of kind." That is, because of a lack of acceptable metrics, one kind of stream might be restored with a different kind (e.g. an intermittent stream for a perennial one). Regulators argued that better assessments and standards would allow them to require compensation of streams for streams, "in-kind."

The 2008 rule on mitigation was a milestone in the evolution of metrics and guidelines for how to trade wetlands and streams. In this section, I introduced the two main sets of characters at play in these markets in the US: entrepreneurial and regulatory actors. There are developers who, in building housing subdivisions, become permittees, bankers who perform ecological restoration in order to earn mitigation credits that they can sell to permittees, and regulators who craft and implement the rules for it all. These regulators and entrepreneurs are the main players nationally, but state by state, district by district, more actors and institutional environments take the stage.

2.2 Counting on the Environment

2.2a: Enlibra

In Oregon, regulators have allied with conservationists to implement the directives of the 2008 rule, and have done so in conversation with existing state initiatives, mandates, and institutional settings. Their work has required bringing different actors with sometimes different mandates and agendas to the table. In August 2008, a series of five workshops called Counting on the Environment (COTE) were hosted by the non-profit conservation group, the Willamette Partnership (WP). As a result of these workshops, a variety of regulatory agencies and conservationists agreed to test a new market protocol, also called COTE, in a joint public-private endeavor. In the protocol, COTE participants launched new functions-based methodologies for measuring wetland

and stream restoration efforts which emphasized watershed planning. HML was the on-the-ground pilot project that emerged from the conversations at COTE.

The story of how the COTE workshops came to be in many ways revolves around current Oregon governor John Kitzhaber. In multiple terms spanning more than a decade, Kitzhaber is a recurring character in conservation in the state. In the early to mid-1990s, state regulators and public officials were confronting the prospect of new endangered and threatened species listings. The northern spotted owl undoubtedly drew the most attention (Prudham 2004; W. Robbins 2004; Proctor and Pincetl 1999), but salmon were also on the feds' docket. State leaders realized that in order to revive declining salmon populations, there was a need for voluntary - as opposed to government mandated or regulation-driven - habitat restoration. In 1997, under the leadership of Kitzhaber, they produced what was known as the "Oregon Plan," a major component of which was the creation of dozens of watershed councils throughout the state. These councils are state-supported non-profit entities that engage in stream, wetland, and fish habitat restoration throughout the state. The Plan directed state staff to provide councils with technical and organizational capacity, but that goal proved untenable over the next couple of years as staff became overextended. In 1999, Oregonians then passed a state ballot measure to dedicate lottery revenue to a new government entity that would oversee restoration efforts. Since the late 90s, the Oregon Watershed Enhancement Board (OWEB) has directed over several hundred million dollars to watershed councils to conduct nearly 5500 miles of stream restoration alone (OWEB 2011).

OWEB and the Oregon Plan represent a set of principles of governance dubbed "Enlibra" that Kitzhaber has advocated for throughout the West since 1998 (Leavitt Center n.d.). The big idea behind Enlibra is to increase collaboration between the communities losing jobs from declining logging or other resource extraction operations and the government agencies that are increasingly more interested in achieving ecological goals. As federal agencies listed the spotted owl, a loose coalition of residents, think-tanks, and industry throughout the West had begun to protest what they saw as excessive constraints on rural livelihoods from federal land use policies. Seeing themselves as proper stewards, Wise Use movement participants wanted greater access to log, hunt on, and graze federally-owned lands (McCarthy 2002). Kitzhaber's Enlibra principles of: 1)

decentralized public-private partnerships; 2) science-informed, but values-based policy; 3) performance and outcomes-oriented funding - all in the name of sustaining rural livelihoods - were aimed at legitimizing state environmental management in the face of Wise Use activists' property access claims. But the Enlibra principles had a more general thrust as well. As I show below, they also structured the approach of the COTE workshops.

Citizen concerns over rights to use land - federal or private - have played prominent parts in wetland and stream mitigation markets (Gardner 2011). They have been a major reason why Oregon environmental agencies have moved to ecosystem functions-based accounting. A key property rights court case and related piece of legislation tell the story of what compelled DSL to actually meet its functions mandate.[5] In a series of court battles that he has waged for nearly 30 years now, Mel Stewart, has sued the City of Corvallis and DSL to prevent them from regulating a two acre piece of property he owns (Figure 2.3). His argument is that even though it looks and feels like a wetland site, it provides no actual wetland ecological functions like storing surface water and so does not count as a wetland. He has been only somewhat successful with the courts, but has convinced the legislature to join his cause. In 2001, in legislation dubbed the "Mel Stewart rule," legislators added a sentence to the Oregon Revised Statutes at 196.825 (4): "Compensatory mitigation shall be limited to replacement of the functions and values of the impacted water resources of this state." The legislature told regulators that they can only ask permittees to compensate for functions and values lost. If functions do not exist, as Stewart claims for his piece of ground, permittees cannot be on the hook for them.

[5] Though called for in the 2008 federal rule, functions-based approaches were not novel then. DSL's own 1989 compensatory mitigation mandate calls for the agency to ensure that permittees replace wetland functions. The agency has found itself relatively unable to follow through with the goal. see also *Dolan v. City of Tigard* 512 U.S. 374 (1994)

Figure 2.2a. Mel Stewart's wetland. He argued it provided no functions, and in a series of court cases, sued the state to shed any liability to compensate for it if he were to develop it. Source: Jacob Gjesdahl and Aniko Drilik-Muhleck. November 2012.

DSL was thus in need of developing a way to assess functions in its mitigation program. What regulators ended up with was the wetland functional accounting tool called ORWAP (Oregon Rapid Wetlands Assessment Protocol). It is an extension of author Paul Adamus's previous work on Oregon's ecosystem service calculators, which in turn are based on work he did in the early 1980s for the Federal Highways Administration to create some of the earliest wetland methodologies in the US. Adamus says he was commissioned to do ORWAP specifically after the Oregon legislature in the early to mid-2000s heard complaints about the way an older functional assessment method called HGM (Hydrogeomorphic) classified different kinds of wetlands. HGM was limited because each part of the state, with different kinds of wetlands, had to have

its own version of the calculator. Legislators set out to mandate their own categorizations, but Adamus and DSL were able to convince them that they could produce something that would work for all of Oregon.

Just as DSL is on the hook for wetland functions, the agency needs a way to assess stream functions. Adamus is also now working with EPA and WP to develop a stream functional assessment for Oregon. The only major stream-related assessment currently is the salmon habitat calculator, which generated the credits used in the HML-THPRD trade. The history of the calculator parallels ORWAP's basis in a transportation agency's demand for an assessment tool. A duo of consultants developed it in response to the Oregon Department of Transportation's (ODOT) need to assess impacts to salmon habitat as it began a statewide bridge repair program in the early-2000s. ODOT wanted a standardized calculator to be able to assess impacts quickly, holistically, and to get a sense of their mitigation responsibilities statewide. In a series of weekly meetings that lasted about a year, the consultants - now staff at the private engineering firm Parametrix - sat down with research scientists and environmental agency representatives to figure out how such a calculator would work. The Ecometrix calculator ended up as a comprehensive site calculator covering not just salmon habitat but most any ecosystem (Parametrix 2010). Only a few years later, in the COTE process, did participants pare Ecometrix down to become the salmon habitat calculator used in WP protocols and in the DSL-THPRD trade.

COTE was much like the stakeholder process of making Ecometrix. It was convened in August 2008, a few months after the federal rule dropped. In the workshops, participants agreed to move forward on several of the points the rule called for but which had also been fomenting in the state. The overarching goal of COTE was to make mitigation markets and other restoration opportunities work better for landowners, somewhat along the lines of the federal rule's directive to promote banking. The goal is perhaps more in the vein of Enlibra, in that participants see the COTE project as moving beyond the idea that resource stewardship is antithetical to development. Three specific agreements coming out of COTE also showcased the Enlibra principles. First, participants agreed to test out several functions-based ways of assessing restoration success, including ORWAP and a version of Ecometrix that focused on salmon habitat.

These new and improved assessments are supposed to make for better, science-informed decision-making. Second, some agencies, like OWEB, are also interested in using functional assessments as a way to decide whether funding particular restoration projects is a worthwhile investment of public monies. Finally, COTE participants also agreed in principle to a way of incentivizing bankers to do better restoration site selection. Site selection is not so much an "objective data gathering" task so much as it is a "values" approach to policy. The COTE incentive system establishes a "process for priorities" - a way regulators can determine where in the landscape restoration is most needed and to try to guide bankers there.

Nothing like COTE has taken place elsewhere in the country since the rule went into effect in April 2008. The task of implementing the 2008 rules for the wetland and stream market is very much a place-conditioned task (Doyle et al. 2013), and the right things came together in Oregon. State agencies in Oregon already had a need for functional assessment. Kitzhaber had championed a form of public-private governance coming out of the stewardship conflicts of the mid-90s. As a consequence, Oregon has grown to be a home for active and well-connected conservationist groups. These groups have been successful in meeting the Oregon regulators' need and desire for better market metrics and protocols.

2.2b: Ecosystem Services - a Conversation on Conservation

Future work to grow ecosystem service marketplaces in Oregon will be made possible and limited by contextual factors like the extent to which state institutional funding trajectories allow agency staff to participate. But marketplace-making has been and will be also shaped by the growing global discussion on marketizing ecosystem services. In this section, I describe this conversation and the way it has formed over the past 15 years or so. Leading advocates of ecosystem services management call for "making nature's values visible" as if they were just waiting "out there" as valuable services ready to be accounted for (TEEB 2010). My point here is that ecosystem services do not come out from nowhere, but are a specific kind of concept and practice.

The ecosystem services concept is a way of talking about nature that is distinctly different from talking about nature as something to be set aside and preserved. It is a

conversation about conservation that scripts nature as a sort of factory, one in danger of closing up shop because people benefit from its output without paying. For environmental economists (Costanza et al. 1997) and allied ecologists (Daily 1997), ecosystem services refer broadly to the benefits to society which "flow" from nature. We can look just slightly beyond HML for a good example: water temperature regulation. A precursor to the WP's work was a suburban Portland water utility, Clean Water Services (CWS). In the early to mid 2000s, EPA imposed a TMDL, or "pollution diet," on the Tualatin watershed. Under the TMDL, CWS had to achieve certain reductions in stream temperature, but a plant to chill their effluent would have been too costly. Instead, CWS got permission from EPA to pay farmers elsewhere in the watershed to plant trees in riparian zones that which would eventually shade and cool streams (Cochran and Logue 2011). The cooler water, then, provides a service to society by improving habitat for threatened and endangered salmon.

Services, the story goes, must be measured and valued - often as a price - in order to prevent their destruction and incentivize their stewardship. Three major waypoints mark this line of argument. First was Costanza et al.'s 1997 work to price the world's ecosystem services (see also Daily 1997). For them, "Earth [is] a very efficient, least-cost provider of ecosystem services" - to the tune of 33 trillion US dollars annually - much like riparian trees were a least-cost provider of cool water in the Tualatin for CWS. The UN's Millenium Ecosystem Assessment in 2005 then called for a services approach for assessing ecosystem change and implementing development projects. One of the most important legacies of the MEA was in conceptualizing different kinds of services: provisioning (e.g. genetic resources), regulating (e.g. water purification), and cultural (e.g. aesthetic) services. Most recently, in 2012, Pavan Sukhdev's The Economics of the Environment and Biodiversity (TEEB) project was pretty much the only success story at the global environmental sustainability conference Rio+20 (see also MacDonald and Corson 2012). TEEB is a coalition of para-governmental authorities that produces reports on and argues for measuring the value of nature as a way of convincing decision-makers to prevent further species and ecosystem loss. At Rio+20, the TEEB team wrangled world leaders into agreeing to an historic framework for national-level price accounting of "natural capital".

Environmental economists argue that the best way for governments to establish prices for natural capital are markets in which environmental goods and services are freely traded. For them, markets most effectively provide information that dissuades firms from resource impacts and prods others to invest in nature. “Markets send price signals to people, it’s powerful. It’s like getting info for free,” is how Bobby McCormick, professor of law at Clemson University put at one recent ecosystem services markets conference. Most ecosystem services are, however, not traded in any open market, which is why many environmental economists champion existing mitigation markets in wetlands and streams. But in these markets, how regulators conceptualize the ecological processes credits are supposed to represent is crucial since some kind of assessment of restoration success is required to develop the credit as a commodity. Otherwise, all the information about the wetland or stream commodity is actually for naught when the purchaser - the permittee - finds out it has bought more of, less of, or something completely different from what it bargained for (Boyd 2006; Boyd and Banzhaf 2006). Without the right information, environmental economists argue, rational market actors cannot work to preserve and allocate resources efficiently.

Much of the effort to construct a language of assessment for markets like Oregon’s centers on three different terms: functions, services, and values. *Functions* are ecological processes like surface water storage that are measurable by *attributes* like percent of seasonal water extent. Parametrix’s development of the salmon habitat calculator was largely a back and forth discussion over how to draw what are called scoring curves which gage the relation between attributes and process performance (see figure 2.4). Participants wondered whether, for instance, a habitat cover function ought to score, say, a 30% or 40% for a given attribute. Attributes perform differently at different levels. Attribute 2 in the figure below performs the best at just one specific level before dropping sharply, while the relation of attribute 3 to functional performance is linear.

Regardless of how they perform, ecological *functions* may or may not do anything useful for society. *Services*, however, are just that - the useful effect of some ecological function on society. Surface water storage functioning may be an important component of wetland health, but if the wetland does not also store and delay water and mitigate flooding, it does not provide a service. Moreover, though functions may mitigate flooding

for society as a service, that service may not be especially meaningful.

Attribute		Impact Site	CWM Site			Net Gain or Loss
		Predicted Loss	Existing	Predicted	Δ	
Attribute 1	Function score					
	Value score					
Attribute 2	Function score					
	Value score					
Attribute 3	Function score					
	Value score					
Attribute …	Function score					
	Value score					

Figure 2.2b. How ORWAP separates out function and value scores. Attributes, like extent of water storage and delay, receive both kinds of scores at three moments: the predicted loss at the impact site; the compensation site (CWM) as it currently exists; the predicted gain at the site from restoration. Source: DSL (2011).

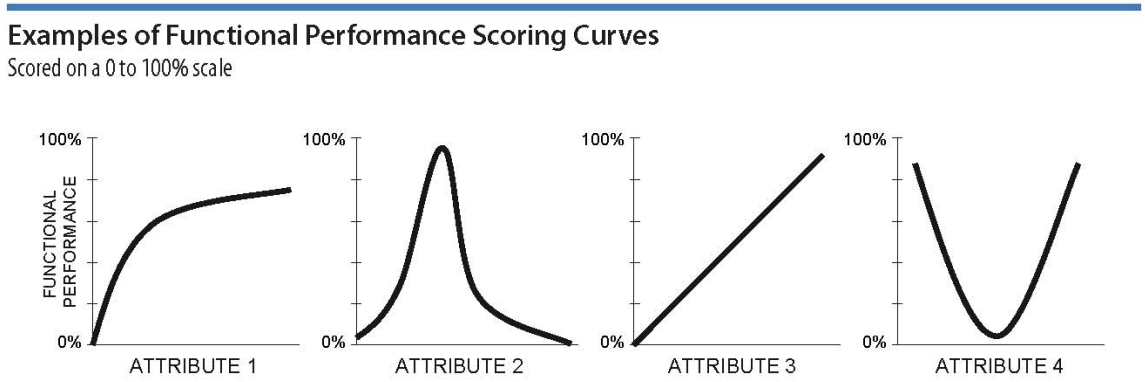


Figure 2.2c. Parametrix's scoring curves of functional performance. Some functions perform linearly, parabolically, or otherwise. Source: Parametrix (2010).

A service becomes valuable the more it becomes useful to society, as when a wetland stores water upstream of a housing subdivision situated in the 100 year floodplain. In his work for the Federal Highways Administration in the early 1980s, Paul Adamus first made what would become a lasting distinction between assessing ecological functions and values. He recollects that at the time other calculators would claim that a site was functioning well because, for instance, it was receiving a lot of nutrient inputs from a nearby cow pasture that it could cycle and settle out. For Adamus, that is actually a value - the site has a valuable *opportunity* to clean up nitrogen and phosphorous inputs from manure, but that does not mean it actually is functioning in that way. The point is

that these sorts of conceptualizations of the differences between functions, services, and values have become necessary to trade a credit commodity in the market.

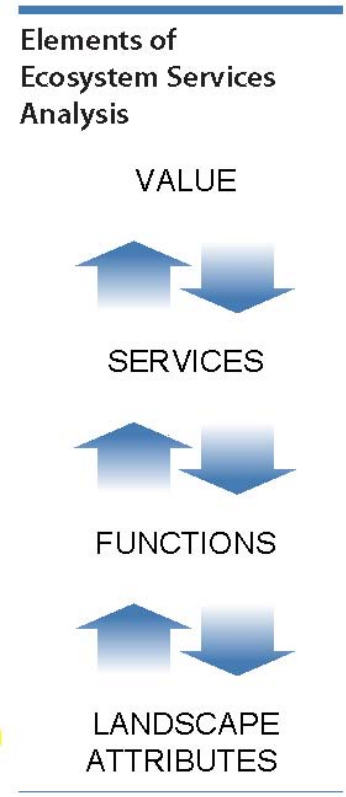


Figure 2.2d. Parametrix figure conceptualizing the relationships between attributes, functions, services, and value in ecosystem services analysis. Source: Parametrix (2010).

Although the distinctions between ecological functions, services, and values have been vital to how ecosystem markets operate, they are not set in stone. Rather, they are the product of how ecologists like Adamus, economists like Sukhdev, and agencies like DSL have felt the need to talk about ecosystem services. As such, functions, services, and values will look or operate differently from place to place, even as the general scheme stays the same. Projects utilizing the MEA approach, for instance, will likely put more elaboration on what a service is (i.e. provisioning, regulation, or cultural). Functions, services, and value constitute a language that allows regulators, policy-makers, economists, and others to explain - for the market and otherwise - what an ecosystem does. Importantly, this means services are not just out there waiting to be measured, because services are as much ideas about how nature works as anything else. To get to the point where Oregon regulators and conservationists were talking about functions,

services, and values at COTE took the success of folks like Costanza et al. (1997), the MEA, and TEEB, to elevate the conversation.

2.3: Making a Mitigation Bank

2.3a: Site Selection

In this section and the two that follow, I outline how a banker might develop a bank to sell credits in Oregon's ecosystem service markets, after the 2008 federal rule and after the participants who wrote the COTE protocol attempted to implement the rule's directives. Before bankers can get lost in the debates about what makes their mitigation credits representative of an ecosystem function, service, or value, they need to find a site to do restoration. All else equal, restorationists will want to work where it is cheapest to do so. In Oregon, they might look to lower-lying valleys with larger farms and properties where most currently operational banks are situated, or they may be a farmer already located there and looking to bank credits. Either way, this may not be where conservationists' and regulators' think a bank would best suit the needs of the watershed. HML, in contrast, is situated in the headwaters of the Tualatin River. The area happens to be what regulators, with the help of some conservationists, have mapped out as a priority location in the watershed.

One of the major goals of the COTE process was to develop a way of incentivizing permittee and banker behavior to be more strategic about site selection. The idea was to provide *additional* incentive to convince restorationists to do restoration where they would not have done so otherwise. "Additionality" is key to many market makers because to achieve an efficient outcome they want to pay only for the work that any payment actually causes (Gillenwater 2011). Participants at COTE spent considerable time mulling over how exactly to incentivize restoration siting. The discussion focused on the use of *trading ratios* to encourage and discourage entrepreneurs and developers. Trading ratios set the rate at which credits and debits are allocated; restoration in a priority area, for instance, could earn more bankers credits than elsewhere. Likewise, a developer making an impact in a priority area would have to buy more credits. In theory, ratios can be even more complicated than this. An early proposal for trading ratios at COTE would have incorporated information about the likelihood of

ecological success for different kinds of restoration designs as a way of incentivizing better design. Better designs would earn bankers more credits. The idea was nixed and simplified, as participants acknowledged that such complexity in determining what makes credits and debits could prove cumbersome to entrepreneurs and developers. Over the course of the workshop process, participants ultimately settled on a market protocol that aims for additionality only through location and timing of restoration and impact.

The site selection incentives that the COTE protocol put in play did not actually play a part in how COTE workshop participants chose a site to test the protocol. DSL and WP got lucky in finding a good site, rather than being motivated by the incentive of extra credits. What happened was that the current landowner - a consultant and restorationist himself - purchased the land in 2008 to start a native plant nursery with his wife. They were looking to make some extra money off the land and just so happened to be talking to someone from CWS about doing a riparian temperature project there. Their CWS contact forwarded them onto DSL, which was looking for somewhere in Washington County to invest funds it had collected from permittees who were able to buy credits from DSL in advance of any on the ground restoration. The WP in turn found the site from DSL. The landowner does not actually gain from any of the bank's proceeds, but DSL did purchase a conservation easement from them for their land.

Personal connections and trust are clearly vital to how water quality markets operate (also see Mariola 2012b). Besides HML, I talked to three consultants doing bank work in the Portland metro area and most of them relied upon social networks for their business. In one case, the consultant had found a site through a personal contact; in another, the regulatory agencies made the connection by recommending a landowner interested in banking to the consultant. In the final case, the consultant only found a willing landowner partner after sending out dozens of letters to owners with potentially worthwhile sites. His work was well-planned, but lucky. It is the exception; most landowners come forward to propose banking. HML's owner was himself motivated and already involved in restoration activities, unlike most farmers. Conservationists face difficulties in enrolling landowners into operating private mitigation banks, in spite of the rhetoric that the market is about duly rewarding them. As regulators and conservationists

move to make banking more of a strategic decision, they will have to contend with its very opportunistic nature.

2.3b: Assessment

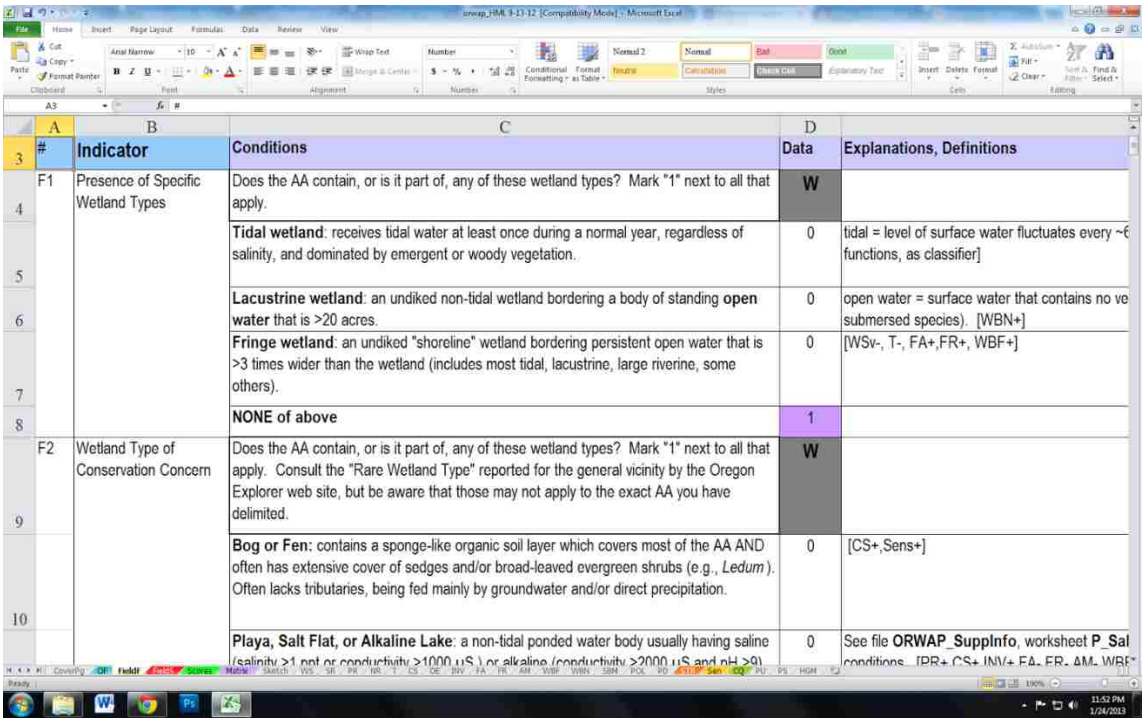
However bankers acquire sites, once they have one they have to assess it before they can earn credits. In early August 2012, I had the opportunity to visit HML with DSL and WP staff in order to run wetland and stream function-based assessment methods. On a typical Oregon summer morning - cloudy, opening to clearer skies - we ran through questions in the ORWAP field component. The calculator is a multiple choice questionnaire requiring the user to, among other things: estimate the amount of vegetative cover on the site or possible upgradient and off-site sources of sediment influx. We walked around a bit in order to get better or different perspectives on particular questions, taking a rather leisurely three hours to work through the 140 or so multiple choice questions. The goal ultimately with these assessment methods is to have two consultants, with two days of training, capable of running them at a site in under two hours. The approach promises to be positive for permittees and bankers, who do not want to spend more time and money on assessment than necessary.

HML is the Oregon testing grounds for the new kind of wetland and stream *function* assessment. For streams, functions "are the processes that create and support an ecosystem." (WP 2012, 1). Ecological function is a notoriously ill-defined term (e.g. Fischenich 2006), but the most important goal of functional assessment is to gage change over time. The idea is that functions in their natural capacity are "inherently stable and resilient to disturbance because the functions at play are generally interrelated, responsive, and unconstrained" (WP 2012). The goal then is to predict how restoration efforts will perform in order to create those functions. That does not necessarily mean coming back to the site year after to year to predict a trend, but rather taking focused measures that can explain what ought to happen over time on the site. A good example comes from the functional assessment for salmon habitat. That calculator asks the user to count and measure large woody debris present in the stream and along the banks. It asks the user to look at the banks as a way of getting at what pieces of wood could be recruited

into the stream over time to provide habitat cover for salmon. ORWAP author Paul Adamus describes something similar with wetland functions.

A site assessment of condition, on the other hand, is more focused on the characteristics and *structure* of an ecosystem at a given point in time. A quick detour to Ohio provides a good example. There, regulators have long been working to develop assessments of stream and wetland conditions. Their efforts have focused in no small part of the categorization and characterization of biological communities and their main measure is one of indexed biotic integrity (IBI). Whereas a functional assessment might just ask the user for an estimate of the percent ground cover of native species on a wetland site, an IBI measure might ask for a more detailed characterization of the different kinds of species that are actually there. As functional assessment guru Adamus put it, condition assessment is taxing because it requires identifying, or "keying" individual plants. It is potentially really involved for consultants on the ground.

Functional ecological assessment does have consultants doing work in both the field and the office, but it may be less taxing than condition assessment. The first field component of ORWAP, for instance, has users answering questions about seasonal water extent, percent herbaceous cover during the summer, and soil composition, for example. These methods are not necessarily as involved as sampling vegetation with the use of random plots. Questions are often multiple choice. The ORWAP question about seasonal extent of water has users choose between <5% or none, 5-25% of the assessment area, 25-50%, 50-75%, and 75+%. The second field form asks users to score the sensitivity of the wetland to both internal and external sources of degradation. A typical question here might concern the influence of upstream logging. The user would account for when logging last occurred and how much of the wetland they thought the activity would affect. The last portion of ORWAP, the office one, is similar in what it aims to capture. It asks the user to employ several web-based mapping utilities from Oregon State University and federal agencies, as well as other GIS to assess the landscape context of the wetland. Is the site downstream of a quarry moving massive amounts of sediment around, as HML is?



#	Indicator	Conditions	Data	Explanations, Definitions
F1	Presence of Specific Wetland Types	Does the AA contain, or is it part of, any of these wetland types? Mark "1" next to all that apply.	W	
		Tidal wetland: receives tidal water at least once during a normal year, regardless of salinity, and dominated by emergent or woody vegetation.	0	tidal = level of surface water fluctuates every ~6 functions, as classifier]
		Lacustrine wetland: an undiked non-tidal wetland bordering a body of standing **open water** that is >20 acres.	0	open water = surface water that contains no ve submersed species). [WBN+]
		Fringe wetland: an undiked "shoreline" wetland bordering persistent open water that is >3 times wider than the wetland (includes most tidal, lacustrine, large riverine, some others).	0	[WSv-, T-, FA+,FR+, WBF+]
		NONE of above	1	
F2	Wetland Type of Conservation Concern	Does the AA contain, or is it part of, any of these wetland types? Mark "1" next to all that apply. Consult the "Rare Wetland Type" reported for the general vicinity by the Oregon Explorer web site, but be aware that those may not apply to the exact AA you have delimited.	W	
		Bog or Fen: contains a sponge-like organic soil layer which covers most of the AA AND often has extensive cover of sedges and/or broad-leaved evergreen shrubs (e.g., *Ledum*). Often lacks tributaries, being fed mainly by groundwater and/or direct precipitation.	0	[CS+,Sens+]
		Playa, Salt Flat, or Alkaline Lake: a non-tidal ponded water body usually having saline	0	See file **ORWAP_SuppInfo**, worksheet **P_Sal**

Figure 2.3a. ORWAP spreadsheet. Source: Author

After answering all the questions, users look to the final scores. ORWAP generates scores of functional *effectiveness* that are relative to other high functioning wetlands in the state. Answering 95% on the question about extent of herbaceous cover in vegetated parts of the site, would, all else being equal, give scores of 1.00 (or fully effective) to aquatic invertebrate habitat and waterbird feeding and nesting habitat functions. ORWAP provides two kinds of scores in the end, then. The first are functional scores for 15 or so different functions, like water storage and delay and waterbird feeding habitat. Excel then wraps these 15 different scores up into six grouped services scores by taking the highest score from the set of functions that contributes to a particular grouped service. For instance, the water quality group is determined by the maximum of the four functional scores for sediment and nutrient retention processes.

Functional measurements do not in and of themselves make a credit or debit. In ecological functions-based accounting, assessors do two rounds of calculations at the bare minimum: a pre-impact or restoration assessment to establish a *baseline* and a second round to evaluate the predicted impact or restoration result. The difference between the predicted result and the baseline is the uplift or change in functional effectiveness and

constitutes the quantity of credit or debit. Functional assessment seems simple and straightforward, at least compared to condition assessment, but whether it will work for consultants and the bankers they work for is still unclear.

2.3c: Marketing

As the 2008 final rule on mitigation from EPA and the Corps did make clear, functional assessment methods are a preferable approach to overcoming the problem that *ratios* present as poor proxies of ecological processes in determining how many credits bankers get. In Oregon, crediting is currently based solely on a ratio of the acreage and kind of restoration done: *creation* of a new wetland, *restoration* where one does not currently exist but probably did, and *enhancement* of an already existing but degraded one. As a testing grounds for functional assessment, DSL provides both functional and ratio credits for sale from HML. The restoration design of HML is not any different between the two, rather, the accounting is two-sided. There is not a ratios area of HML and a separate functions area. Both kinds of credits are sold from the same part and accounted for together. At HML, 9.3 acres were restored, nearly 1.5 were created, less than .75 were enhanced, and about .9 acres qualified as buffer. That breaks down into 12.15 wetland credits for sale total off of the 24 acre site. A permittee does not have to do this calculation; 10 acres of impacts simply requires 10 credits.

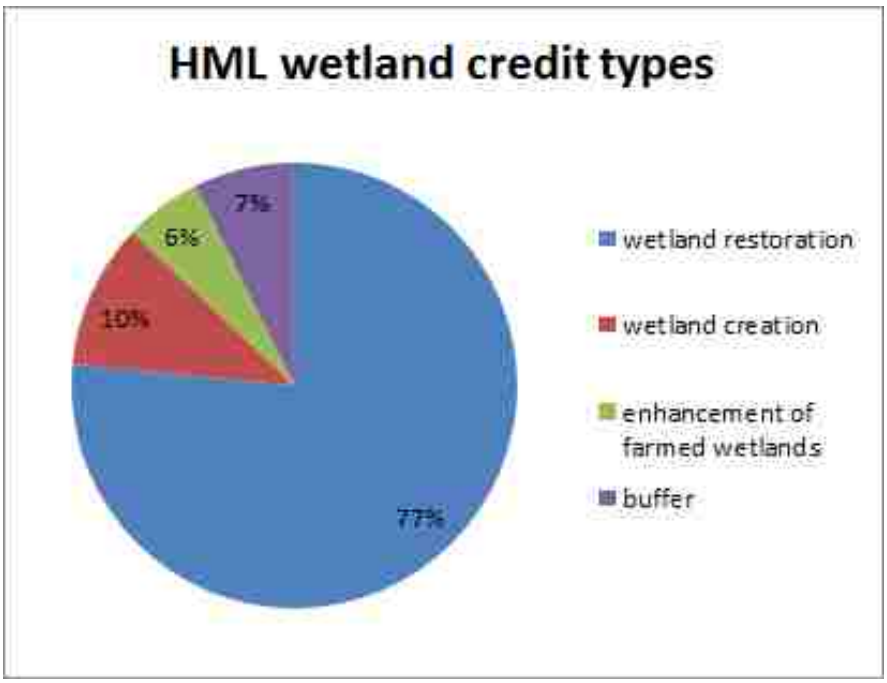


Figure 2.3b. Wetland credit types at HML. The majority came from restoration of areas that were likely once wetlands. Source: Author (http://geo.usace.army.mil/ribits/index.html).

Ratios are proxies for the ecological processes restoration sites actually perform. However, there is broad agreement among market actors that the ratio proxies are no longer adequate proxies. Ratios may ensure a no net loss of acreage (cf. NRC 2001), but cannot necessarily distinguish on the quality of the resource being lost. Moreover, as regulator Bill Abadie put it, under a ratio system a banker could do "C" work on the same number of acres as someone doing "A" work, but agencies would have to grade them similarly and they would receive the same number of credits to sell. Even consultants whose work revolves around bankers' use of ratio credits agree. To consultant George Kral, ratios are arbitrary: "What is three acres of enhancement, what is that? Why is creation an acre and a half?" The response from regulators is to find a way of having the actual hydrological, vegetative, or chemical improvements from banks and degradations from impact sites stand in as the credit/debit. Hence regulators have pushed for functions-based crediting.

Functional assessment allows regulators and bankers to generate more *kinds* of credits. Refuged from a sticky midsummer 2011 day in a Madison, WI hotel conference room, conservationists, regulators, and consultants from across the country took to

debating the finer points of what counts as an ecosystem service credit. In a special session on credit *stacking* at one of the premier ecosystem services conferences in the nation, Devon Judge-Lord from the WP explained the possibilities and pitfalls of an emerging practice where bankers sell multiple kinds of ecosystem service credits from one restoration site. Currently, most mitigation banks in the US sell only one kind of credit, like wetlands, streams, or species habitat. He explained that by stacking multiple credit types at HML - not just wetlands, but water temperature and salmon habitat - they are trying to drive investment to the "whole suite of functions" a site provides.

The idea with stacking is that bankers should be able to market as many credits as there are actual environmental services. A site may have wetland, salmon, and temperature functions that all share the same space. Most any segment of Roderick Creek at HML is going to have salmon habitat, temperature functions, and riparian wetlands. The difficulty comes in quantifying the ecological relationship between different functions, like surface water storage, and their relative contributions to different services, like salmon habitat or wetlands. Some functions are rather isolatable. Coarse in-stream gravel, for instance, indicates potential salmon habitat, but probably has nothing to do with wetlands. In an approach that did not allow multiple credits to be sold, or that allows only one kind to be sold at a time, the cobble function could not be called out and credited if the wetland already had. Bankers would have little incentive to restore the stream on a site.

The practice of stacking becomes a problem when we look at functions that contribute to multiple services. One of the functions underlying both wetlands and salmon credits is surface water storage. Wetland vegetation and salmon both depend on regular inundations of floodplains and the storage of water on these floodplains (Shreffler et al. 1990). This kind of functional overlap becomes tricky in crediting because it may cause a net loss of the resource. Suppose a developer wants to impact a wetland in Hillsboro and comes to DSL to buy a credit from HML. If the Hillsboro developer buys a wetland credit from HML, it has bought some claim on the ability of Roderick Creek at HML to inundate floodplain wetlands, but it has also bought some claim on surface water storage for salmon. If HML then sold a salmon credit to say ODOT, without changing the available amount of salmon credits in its ledger, it would have sold some portion of the

surface water storage functionality of the site twice. The result is a net loss, centered at the mitigation site. It has not provided enough surface water storage to account for the two impacts.

Some assessment tool authors, like Parametrix (2010) claim that the relationship between two functions is perfectly expressible within the algorithms embedded in their function-based assessment tool's Excel spreadsheets. They are comfortable making a claim about the exact amount a given ecosystem function, like surface water storage, contributes to both salmon and wetlands. Under a Parametrix system, when the Hillsboro developer buys a wetland credit from HML, DSL would only remove from sale the number of salmon habitat credits that actually also contributed to the purchased dwetland credit. If the surface water storage function contribute 75% to wetlands and 25% to salmon habitat, DSL would remove a quarter of a salmon credit. This method allows more credits to be sold, but is a strong claim about how salmon use floodplains in relation to wetland vegetation.

COTE participants took a conservative route on stacking, assuming the relationship between salmon and wetlands function is 1:1. If the Hillsboro developer buys a wetland credit from HML, DSL would remove an equivalent number of salmon habitat and temperature credits. But even claiming that shared functions contribute equally to different services is still some assumption about an ecological relation. Stacking problematizes environmental economists' need to know where in nature ecosystem *goods* or stocks end and ecosystem *services* or flows begin (Boyd 2006; Boyd and Banzhaf 2006). The degree to which an ecosystem is accounted for as more than the sum of its parts when it is marketed in Oregon's ecosystem services marketplace continues to be a hot topic just as it is an unsettled issue for economists and other practitioners in other markets (Dempsey and Robertson 2012).

2.4: Conclusion

As a USFWS staffer once summed it up for me, ecosystem service metrics "are not developed in a vacuum." To make a metric, representatives of agencies or consulting firms or research institutes, all with specific institutional histories and interests, must sit down together and haggle over the state of the science, statutory goals, and so on. They

take part in a conversation on conservation, using the language of functions, services, value, stacking, bundling. The seemingly straightforward market transaction in which DSL traded THPRD four function-based salmon habitat credits from HML would not exist without a plethora of regulatory apparatuses either: state and federal legal statutes, administrative rules, court judgments on those rules, and staff interpretations. The trade also demanded consultants who could perform the assessment work of judging restoration success. In Oregon, ecosystem services metrics have been conceived of and implemented through public-private partnerships, be it between watershed councils and OWEB, engineering firms and public agencies, or conservationist groups and environmental regulators. The nature of this work becomes problematic for the market, which I demonstrate in the next two chapters.

Chapter 3: State and Market Expectations of Ecosystem Services

As an attempt to price nature's benefits, Oregon's revamped market in ecosystem services has achieved relatively little. My claim in this thesis is that right now new measures and market protocols are not projects the state has successfully rolled-out as novel or improved means for commodifying and accumulating services. Instead, this move has had the effect of constraining the market. In this chapter, I revisit and expand upon three moments in the HML-THPRD salmon credits swap to point to some key tensions in the project of measuring and managing ecosystem services in Oregon. I argue that different expectations actors hold for the market's metrics and design are its downfall.

When DSL traded away four salmon credits from HML to THPRD in late January 2012, agency staff also struck away a similar amount of wetland credits from the ledger. This practice of *stacking* multiple kinds of credits from the same site has been of concern to ecosystem service market makers across the country (e.g. White and Penelope 2013). Some ecologists and agency staff suggest that if DSL were to trade a salmon credit to THPRD and a wetland credit to a different developer, DSL might be selling twice what's in the middle - the functions, like surface water storage, that contribute to both salmon and wetland credits. Because of this uncertainty, WP and DSL took a conservative route, assuming the relationship between salmon and wetlands function is 1:1. But even the claim that a shared function like surface water storage contributes equally to both salmon and wetland services is some assumption about an ecological relation.

THPRD is not even impacting any salmon habitat. Its project is located in an overgrown, unnamed tributary that is not known by authorities to be salmon-bearing (Figure 1.1). What the salmon calculator really does is measure a set of stream functions, like large woody debris recruitment, that are proxy measures for salmon habitat. No one is actually counting salmon. The use of salmon credits in the trade was a way for regulators to account for *stream* biological, physical, and chemical degradation rather than habitat loss specifically. It was, as one regulator put it, "like swapping a Cadillac for a Pinto" - that is, trading a high quality habitat restoration credit for a minor stream impact.

A month after the HML-THPRD swap was approved, a neighbor to THPRD's suburban trail extension sent off a polite yet insistent email to DSL's director requesting a hearing to dispute the agency's permit allowing THPRD to impact the stream and some wetlands with its trail bridge (DSL 2012b). She argued that THPRD's functions-based assessment of the impacts of the trail to the site was incomplete and inaccurate. In part, it was incomplete because it did not capture her on the ground experience of flooding on the site. To back her case, she had talked to natural resource consultants, who run ecological assessments day in and day out. Consultants and the mitigation bankers they work for are not adopting functional accounting methods like ORWAP even though theoretically measuring and marketing functions - and not acres - would give them more kinds of things to sell. If ordinary citizens are disputing the adequacy of functional assessment, alongside the entrepreneurial actors it is supposed to benefit - why do state regulators even bother ask consultants to measure functions and to what end?

What we see when we dig into the HML-Tualatin Parks trade are three moments where regulators and consultants must come to terms on what extent and in what character to account for ecosystem services in their assessment and trade. Leading ecosystem services market advocate Pavan Sukhdev (2010), for one, realizes this when he claims that "we cannot manage what we do not measure." But the specifics of the task are often ignored, as when Sukhdev plainly calls for "putting a value on nature." Ecological assessment is an art and science fraught with complexity and uncertainty. Alongside geographers writing about the politics of "knowing nature" (Goldman et al. 2011), I argue that Oregon's limited trade in new kinds of credits is a result of new metrics and protocols not working for the right people. I show when and how regulators, conservationists, and entrepreneurs agree upon approaches to crediting services. My point is that their *expectations* of what nature can do in a market are themselves generative of market outcomes (see Borup et al. 2006; Lave 2013; Randalls and Petrokofsky 2013). Measures of salmon habitat that serve as proxies for stream functions prove adequate for most regulators currently, though they won't in the long term. At the same time, most market actors are comfortable with WP's conservative approach to selling multiple kinds of credits. The big sticking point, however, is that consultants insist that functional assessment is set to make them lose out, while state agencies expect to achieve better

ecological accounting from it. Because everyone still agrees that the old accounting method is unsound, the state may win some legitimacy in its effort.

That environmental policy is about "winning and losing" (Robbins 2011 [2004], pg. 87) is no surprise given the research of political ecologists over the past 30 years showing how third world peasants (e.g. Peluso 1992; Stonich 1993), inner city residents (e.g. Heynen, Perkins, and Roy 2007; Truelove 2011), and the rural poor (e.g. Black 1990; McCarthy 2002) all can be marginalized from access to resources as a result of policy. A large part of winning and losing out on nature's benefits in these cases stems from different "claims about nature," or ways of producing, applying, and circulating ecological knowledge (Goldman et al. 2011). Describing nature with indirect measures or as a "stacked" set of functions is a project of creating environmental knowledge, but it is not knowledge that is always created, circulated, and applied very easily. Rebecca Lave (2012b), for one, calls for understanding the political economic forces motivating and limiting the production of knowledge about ecosystems, rather than just the circulation or application of such knowledge. Regulators', conservationists', and entrepreneurs' high hopes, indifference, and skepticism about what can be known about and done with ecosystem services are shaped by the legal atmosphere they operate within, their view on the state of the science, and fiscal constraints. Here, I ask, what are the political economic imperatives which inform how Oregon regulators deploy assessment protocols and ecosystem metrics? What keeps ecosystem functions-based environmental knowledge from circulating? I focus on the contests over what comes to count as acceptable environmental knowledge in Oregon and the disruptions in that process.

3.1: Stacking Ecosystem Services

Credit stacking and its opposite, credit bundling, are different ways regulators and entrepreneurs conceptualize the relationship between the credit commodity and on the ground ecosystem processes. Functions on a restoration site can be bundled together into one "ecosystem credit" type or they can be parsed out into different kinds - wetlands, water temperature, salmon habitat - and "stacked" as credits originating from a single area. By assessing specific ecological functions, bankers can sell as many credits as there

are measured processes, and regulators can know about the performance of each process on the site.

If they are stacked on the same site, credits may share ecological processes and this poses an economic and ecological problem. Ecologists are dubious that functions shared by streams and wetlands can be written off as inconsequential, suggesting that "you don't mess with one part and nothing else is affected." Economists as well worry that in stacking credits the extent of overlap makes it impossible to properly account for services. For them, markets require a well-defined commodity, but "nature does not come prepackaged in units like cars, houses, and bread" (Boyd 2006, 716). Household or regulation-based, car or credit, commodities can prove worthless if their purchaser finds out they have bought more of, less of, or something completely different from what they bargained for (Boyd 2006; Boyd and Banzhaf 2006). In a cap and trade system like the one in which markets participants aspire toward a "no net loss" of wetlands and streams, stacking multiple credit types to sell to different entities each requiring a credit to meet the cap could "oversell" site-specific ecological processes (Cooley and Olander 2011; Robertson et al. forthcoming).

My objective here is not to evaluate whether credit stacking at HML has been ecologically detrimental. Instead, I talked to regulators, conservationists, and consultants about their *opinions* on stacking in order to understand why they would do it and whether and when it becomes problematic. National discussions about the theoretical pitfalls of stacking have informed Oregon market-makers (and they in turn have led the discussion). The risk of overselling resources is what drove the WP's conservative approach to stacking. DSL staff explained to me how WP stacking calls for a proportional, or 1:1 reduction of related credits when one kind is sold. At HML, when any kind of credit from riparian "Zone One" (see figure x) is sold, DSL deducts every other credit available from the zone proportionally because they are linked. Even if the WP protocols did allow for a ratio that wasn't 1:1, assessment tool maker Paul Adamus discusses the trouble with gaging the interactions of stacked ecological indicators:

> Adamus: Existing models can't tell us how much increase in sediment retention function in a wetland is going to cause a decrease in salmon habitat. We know there's a relationship there, but models can't quantify it that exactly because the supporting science itself is not that precise.

Nost: Are you able to dig into the model and know that it counts for 80% of the streams and 20% of the wetlands?
Adamus: Not yet. We are currently doing asensitivity analysis of ORWAP's models that calculate ecosystem services, but as you can imagine, it's a computing challenge because in order to capture the complexity present in nature and the variation present across an entire region, some of ORWAP's function models have up to 40 contributing variables.

For Adamus, the interactions between all the model variables are difficult to compute. However, the authors of the salmon calculator, Ecometrix, are more willing to say they can measure these interrelationships. Theirs is a choice about what ecological knowledge they can generate and what it can do for the market that, differing from the close collaboration between DSL, EPA, and Adamus, has not worked for regulators.

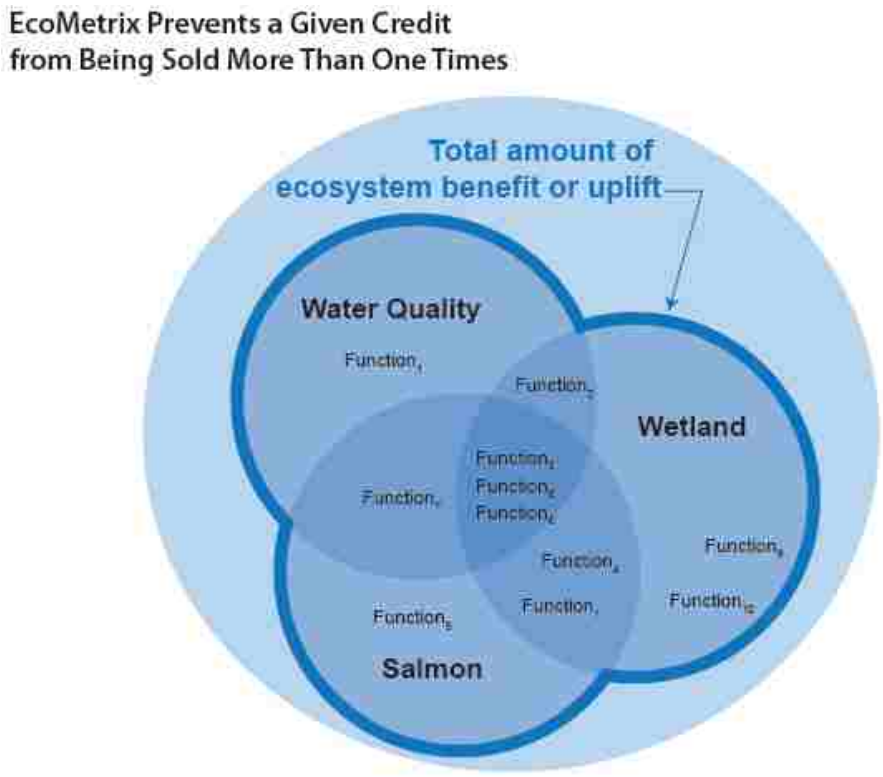


Figure 3.1. Parametrix's conceptualization of functional ecological interrelationships. They claim that with their EcoMetrix calculator they can account for the precise relationship between salmon, water quality, and wetlands, and therefore prevent overselling resources. Source: Parametrix (2010).

If stacking was potentially controversial, why did market-makers propose multi-crediting in the first place? Derek Billings[6] at USFS is not a regulator, but he thinks a lot about regulatory efficiency as well as landowner livelihoods. Playing a large part in the discussion on stacking services in Oregon and nationally, he notes that stacking - however conceptually difficult it might be - makes it easier for a landowner to get involved in the market. It eases the number of regulatory "hoops" they have to go through in order to sell more kinds of credits and so it encourages restoration of multiple resources. He asks, "if you could get one set of protocols that would work for let's say in this case four different markets, why wouldn't you?" This was a commonly heard refrain, and the overture to the COTE process.

For one staffer from USFWS, regulations *themselves* are the problem yet to be overcome in credit stacking. In her mind, the science on the interrelatedness of ecological functions may in fact be settled, but stacking is about "more than just the science." Even though stacking credits can be beneficial, there are political and statutory limits to how stacking can be implemented. She claims that these barriers may be particular to the USFWS, however. Ranei Nomura, from the state DEQ, concurs. For her, DEQ is quite willing to entertain stacking. She has to, in fact, because of the relative *lack* of regulations. Nomura says she has no regulatory guidance or law to point to if, for instance, a landowner wants to sell carbon credits in addition to temperature credits from a riparian planting project. In this way, the regulatory "landscape" on stacking is uneven; some agencies can do it while others cannot. Regulators' general goal of establishing a more encompassing set of metrics for restoration markets runs up against legal constraints.

For several conservationists and regulators, the ideal credit is bundled, but again, regulations prove to be obstacles. The ESA in particular is a tough mandate with which to credit restoration because it emphasizes counting species rather than protecting habitats. Sally Duncan, for instance, would like to see an "Endangered Habitat Act" that focuses on ecosystem processes rather than restoring species populations per se. Likewise, for

[6] Pseudonym. I have used pseudonyms for research participants who either did not respond in timely fashion to my request to quote them or who requested anonymity.

one USFWS staffer, who noted regulatory barriers to stacking, there are regulatory barriers to bundling as well.

> USFWS staffer: Yea ideally an ecosystem credit or a biodiversity credit would be better. But if you think about this though - so let's say there's a sagebrush ecosystem credit, you'd have to have a lot of people agree (laughs) on it - including us, I mean everybody has needs for that metric....I mean the thing with something like sage grouse and listing is time is short. We only have 2, 3 years to figure something out or we're probably going to list it. So and I think metrics are a big part of that, I mean that's where people are struggling. And it's not just sage grouse, it's the whole sagebrush ecosystem, which is one of the most threatened in North America, right? So ideally yea I'd love to see an ecosystem or biodiversity credit or metric but I don't know, it's just, it's somewhat out of my scope and my agency's scope. Which is a shame because it's not. We're supposed to conserve ecosystems.

Limits on the scope of regulatory action - limits like the time and effort it takes to figure out whether to list a species - are barriers to bundling a "biodiversity credit." So too is the fact that The staffer's legal mandate is to protect specific threatened and endangered species even if the agency's overall mission is to conserve ecosystems. She pointed out that:

> USFWS staffer: When the rubber meets the road when you're negotiating mitigation or something, it's about the species. Unless you've taken the habitat, whether it is occupied, not, whatever - we have to tie it back to the species.

When asked about balancing between a metric for the species and a metric for the habitat. Regulations as they exist can pose a barrier to what regulators themselves see as better definitions of the credit commodity, be it bundled or stacked.

Some consultants also support credit bundling. Sean Pickles[7], for example, is interested in instituting more comprehensive crediting requirements that would better incorporate fish habitat and water quality metrics. He also has in mind a more expansive temporal horizon for mitigation when he says he wants to see it done for the "the needs of the future" at each site. Another consultant, Mike Allsworth[8], however, notes the difficulty in such a sweeping vision. He supports the idea behind making a more comprehensive credit and for restoring multiple resources, but argues that the bottom line is bankers have to separate functions in order to get a sellable credit.

[7] Pseudonym
[8] Pseudonym

> Allsworth: Well that's too ideal, I think it - to be able to do these integrated type credits where you've got a forest credit that had everything, that had wet prairie that transitioned to an upland savanna to an oak savanna to to forested. It wouldn't sell. It would just be too hard to market and there's no driver. I think that that could be taken into account when you're planning that you actually you know you take in those things into consideration but the only way you're going to measure things and provide credit is to have em be separated.

In other words, there are economic imperatives to what bankers want out of mitigation metrics. Though perhaps ideal, an ecosystem credit would prove too costly.

Market actors' perspectives on the problems and possibilities of stacking vary greatly. They differ because stacking is in the end just as much one way of conceptualizing ecological relationships as much as it is a technical protocol outlining what credits can be traded in the market. Different market actors have different agendas when it comes to deciding what ecosystem services credits any plot of ground can provide - and with good reason. Entrepreneurs need to be able to do business, while regulators find themselves needing to follow statutory mandates. But because of these divisions, stacking is not going to provide a universal account of any restoration site. It will not meet the goals of a regulator or consultant favoring the bundling of credits and at the same time it might not be the perfect fit for the consultant or banker's ecological concerns. That said, there is a provisional consensus that the way the WP protocol governs stacking and has been implemented at HML is a suitable way of bringing more of nature into the purview of government, conservation, and business. It is exactly because agency staff can push regulations only so far and bankers can do only so much business with a bundled credit that they agree that stacking, for now, will work for the market.

3.2: Crediting Salmon Habitat

"Every drop of water that hits the ground eventually becomes coho salmon habitat (laughs), it just does."
-Oregon environmental consultant, 7-18-12

Is good salmon habitat a function of the number of pieces of large wood debris in a restored stream? Is it kcal/day of stream temperature reduced by riparian plantings? Or, as one environmental consultant unwittingly suggested, should the object of concern

actually be every drop of water? Regulating each drop of water could of course prove politically and economically daunting, if not scientifically challenging. What are the political, economic, and scientific limitations and opportunities to these definitions of salmon habitat? Why did the COTE metric in particular come to work for the market?

Consensus among regulators, conservationists, and consultants that the COTE metric can in fact continue to serve as the market's salmon habitat credit commodity is less likely to coalesce than the consensus on stacking. The few sales of salmon habitat credits from HML have actually compensated stream function losses rather than losses of habitats specifically. DSL and other regulators have been comfortable using the metric as a way of accounting for biological, physical, and chemical stream functions - not just salmon habitat. But in the long run, regulators are not keen on using what often gets described as the overly-complicated habitat calculator for either habitat impacts *or* as a stream measure. The agencies consider the salmon credit only a relatively decent proxy for several of the things that make for a good stream, such as the presence of large woody debris for in-stream fish habitat. It is too narrowly focused on things like diversity in channel gravels that may not be important to good stream functioning outside of providing salmon redds. Going forward with plans to develop a functional stream assessment and crediting method, the agencies are reluctant to rely on the salmon habitat credit commodity and are instead starting from scratch.

In the first place, the COTE salmon habitat credit has not even proven itself adequate to the regulatory body charged with protecting threatened and endangered anadromous fish – NOAA NMFS – because of the agency's institutional position and stance. Staff from NMFS actively participated in the COTE process where regulators and conservationists approved the salmon habitat methodology. Exceptionally, the agency did not sign on. As much as their sister agencies would have liked to have them at the table, they have been reluctant to get into overseeing salmon habitat trading because of limited staff time and resources to deploy to the issue. At least to the staff from NMFS that participated, the COTE-approved methodology is a decent measure of salmon habitat. It could be less of a black box and could emphasize the ways offsite and future conditions affect restoration sites. But besides individual staff, NMFS as an institution did not want

to unload another project. This was a major barrier to getting the salmon habitat metric to work for a market in endangered anadromous fish.

Only recently has NMFS come around to condone trade in salmon habitat (NMFS 2013). The design of this market is currently ongoing, but NMFS has chosen the metric that will define the credit commodity at the heart of the market. They did not go with the COTE-approved metric, choosing instead one that they have developed in-house. It remains to be seen if this metric will work for other agencies - if it even has to - or any entrepreneurs that will decide to bank in salmon habitat restoration.

Before NMFS's recent decision to support a salmon market, temperature credits were supposed to do the work of recovering salmon habitat. In Oregon, the reason water temperature is a listed TMDL pollutant that entities like CWS have had to deal with is because of the negative effect warm water has on salmon. But in its mitigation work to comply with the Tualatin Basin temperature TMDL, CWS focuses on lowering water temperature by paying farmers to plant riparian trees rather than directly improving salmon habitat. While many of CWS projects do include direct habitat improvements, these improvements are not creditable under the TMDL because there is no reliable metric to determine how much temperature is reduced. Much like staff at USFWS have to bring ESA mitigation back to the species, Ranei Nomura has to implement a kcal/day of water temperature reduced approach to comply with the temperature TMDLs. She has been advised by legal counsel to focus on kcal targets and unable to ask directly for biologically-based criteria for salmon habitat restoration.

> Nomura: Unfortunately the way most of our state water quality criteria are set up, it's a pollutant by pollutant approach. Our temperature criteria to protect salmon are for the most part numerical temperature standards rather than, for example, the amount of quality spawning habitat we need to support the species. And, while numerical temperature standards are important, they aren't the whole story; habitat improvements are also needed. Unfortunately, because of legal history and focus on numerical criteria, we have to keep our focus on the number. A city discharging treated wastewater with a thermal load has no direct impact to salmonids and contributes a very small percentage of the overall thermal load to a watershed, can come to me and say they want to offset their load by developing two acres of great habitat for salmonids, which is what the fisheries agencies want and DEQ also thinks is great idea, but I still have to ask them how they are going to quantify the temperature benefits or kcals reduced from the habitat improvements because of the way the temperature wasteload allocations are done in the TMDL to line up with our temperature criteria.

Agencies and their staff are often under statutory obligation to devise, implement, and enforce proxy measures. The regulations stemming from the Clean Water Act make it difficult if not impossible to directly restore salmon habitat, but temperature credits have proven at least somewhat useful.

DSL, Corps, and EPA are not keen on using the salmon calculator for either habitat impacts *or* as a measure of stream performance. Despite approving the HML-THPRD trade, DSL is dissatisfied with the salmon habitat credit. The salmon habitat calculator assesses Coho salmon habitat specifically, but many impact sites, like the tributary at THPRD, are never frequented by such fish. DSL staffer Dana Hicks says that in the three years since the COTE workshops, "the other thing I think we realized is we need a stream functional assessment....you can't really run the salmon metric run on something that fish don't even use." For her it would be like trading a "Cadillac for a Pinto," or, in other words, high quality credit for a low quality debit.

Regulators consider the salmon habitat credit only a relatively decent proxy for several of the things that make for a good stream, such as the presence of large woody debris for in-stream habitat. It is too narrowly focused on things like diversity in channel substrate composition that may or may not be important to a good stream functioning outside of providing salmon habitat. The idea behind using salmon habitat for streams came out of COTE, after NMFS did not commit to its use for ESA conservation banking. EPA explains the tradeoff between adopting a general calculator that assessed a number of kinds of stream functions and a specific, salmon habitat-oriented proxy. They are "not quite happy with it," but it is only in retrospect that regulators realize they may have done themselves a "disservice" by focusing on salmon as opposed to a more general stream metric. At one point, the salmon habitat metric was what they thought a stream credit should be, but it turns out it will not be in the long-run.

The kind of credit agencies ought to employ is another question and open to wider debate. Was THPRD's stream impact best captured by a salmon habitat credit, or a more general stream credit, or even a wetland credit? One banker thinks a wetland credit would have been a better match, given the current kinds of credit types available on the market and the nature of the impact:

> Banker: Well one thing that kind of frustrated me, because they [DSL] made a salmon credit sale for a wetland, like the edge of a creek and then the creek wasn't salmon-bearing, so I was sitting there going, a better fit would've been them to buy a credit from me rather than putting a salmon credit, or buying a salmon credit for a non-salmon bearing creek.

What counts as nature's benefits in these mitigation markets is up for question and open to capture by different interests: banking, regulatory, conservationist. For now, for most agencies, the salmon habitat credits will work for impacts to streams, and regulators are in a better position to make that decision than one banker who has instead offered up a wetland credit.

There have been several more trades of salmon credits to cover stream impacts since DSL sent four to THPRD in early 2012. The swaps might be better than nothing, even if they are not ideal. Going forward with plans to develop a functional stream assessment and crediting method, the agencies are reluctant to rely on the salmon habitat commodity credit and are instead starting from square one with the help of the WP. Regulators would like to see a better fit credit, but may be in constrained in achieving that. For now, they will deploy it.

3.4: Fighting over Functions

What regulators' and consultants' thoughts on whether to stack credits or to use salmon habitat credits as indirect measures of stream quality point to is a bigger fight over the implementation of ecological functions-based accounting. There is broad agreement among market actors that crediting that is based on ratios of the amount and type of restoration performed is scientifically unsound and in need of change. For regulators, functions are the answer, and theoretically, entrepreneurial actors might support functional accounting because it gives them more kinds of credits to sell. But I show how and why consultants contest functional accounting. Their argument is that ORWAP, as a functions accounting tool, is too subjective and does not give them the results they would expect. In the previous chapter, I illustrated how in Oregon's ecosystem services marketplace scheme, market actors work to render nature useful for the mitigation market with the help of digital tools like Excel and ArcGIS. But spreadsheets and GIS layers do not necessarily make this work more accurate. The gaps

and contradictions stemming from regulators' and conservationists' particular choices about what to measure and how still exist and become problems for the market.

Consultants launch several critiques against functions-based crediting. In short, they see ORWAP as not being able to account for their restoration work. Many find that it is not sensitive or accurate enough to capture improvement in ecological functions. In his office located just blocks from the A-Boy hardware store of *Dolan v. City of Tigard* fame, I talked to consultant George Kral about the possibilities and pitfalls of using functional assessment to get at a better equation of impact and restoration uplift. He says ORWAP is not reliable. He tells me the story of how he had a consultant run ORWAP at a mitigation bank in Washington County. While he expected to be able to earn 42 credits from the 95 acre site under the ratios regime, the initial ORWAP result gave him only 3.2 credits. After investigating the spreadsheet, he realized that his consultant had made a different assumption about the hydrological condition on the state. When the consultant ran it again with the corrected assumptions, he ended up with about 33 credits - better than 3.2, but still less than the expected 42. The lesson he took away was that, "I don't think that you would have two different practitioners take ORWAP to the same site and come up with the same answer, running ORWAP. It's just not going to happen."

The problem consultants have with ORWAP is not simply that it is an error-prone way of assessing functions, but that functions may not be the best measure to begin with.[9] Only a little farther up the road from George Kral in Tigard, I talked to independent consultant Sean Pickles about ORWAP. He says it is not sensitive enough to capture the features of a site he thinks are important. Pickles questions whether ORWAP can capture the functional uplift from sites that do not already have many wetland features, like a variety of water regimes or vertical vegetative structure. He thinks it should be able to show lift in turning non-native vegetation into native grass and forb vegetation. Likewise, standing on the edges of the wetland at his new bank, consultant cum entrepreneur Jonas Moiel tells me that some questions may be designed in such a way that inherently prevents consultants from showing ecological change over time.

[9] Even if it were, the fact that ORWAP is the standard for functional assessment in OR and that consultants don't buy into it means that - for all intents and purposes - there is a problem with functions in general

> Moiel: There are questions in ORWAP such as: In the future how many trees will you have that are a size class of 150 years old or older? These questions do not pertain well to mitigation sites and are more suited for classifying existing wetland areas. When performing the ORWAP analysis on the Tualatin Valley Bank site we omitted questions like this from our analysis. The State and Federal agencies questioned our approach and wanted all functions to be evaluated per the protocol; however, we made the point that if the site was to be protected indefinitely that in theory we would have trees that mature to 150 years old. The point being that functional assessment methodologies have been developed to evaluate existing wetland areas but not to compare the baseline conditions of a mitigation site to the future predicted conditions. This is a major problem as the wetland banking industry is at a point of flux between having banks create functional credits rather than wetland acre credits. Currently, there are no approved or scientifically backed methods for calculating functional credits in the state of Oregon.

Moiel's new bank is never going to be able to show lift in the question that asks about 150 year old trees. He suggests ORWAP's temporal lens may not be sensitive enough to capture short-term changes and calls for relying more on individual judgment of the consultant or banker.

Regulators walk a fine line between the need to incentivize restoration while asking for good mitigation practice from bankers. A quick detour away from ORWAP illustrates this well. At a training session for an oak savanna functional calculator, fellow attendees and I wondered why landscape features like the connectivity of the site to other natural areas were weighted so heavily in the final score. The metric developer explained that the scientific committee that had developed the calculator wanted to weigh it even more because landscape context is so crucial to the success of habitat, but the WP vetoed this idea because it would make it more difficult for bankers to make uplift if their score was so influenced by surrounding properties. I discuss this landscape context issue at length in the next chapter, but Moiel suggests that like the oak calculator's far-reaching spatial optic, ORWAP may be too far-sighted.

Sensitivity in measurement can be an influential factor in credit prices as well. Returning briefly to the oak savanna training shows how. At the workshop, the trainer's mantra was that the oak calculator is a quick assessment and that we should not focus too much on whether to score, say, vegetative cover as 25% versus 30%. Ultimately, the overall score would not change that much. Eventually, the WP executive director had to step in and caution that in a mitigation context, even a 1% change in the overall score

from one question about vegetative cover can be meaningful. If the site is 100 acres, that potentially makes for one credit lost. While the price for an oak savanna credit may not approach the current average price for a wetland credit $70,000, the point struck folks home.

The fact that functional assessment in general is sensitive and potentially costly is explained by consultants when they talk about ORWAP's difficulty in characterizing their enhancement of wetlands. Unlike HML, where only less than an acre out of 24 was enhanced, much of the current mitigation work bankers do is based on the enhancement ratio. Because ORWAP is concerned with functions, it assumes that a site bankers will only enhance by definition already has some hydrological functionality. This baseline calculation makes it difficult to get an "uplift" or "delta" - the credit definition in a functional crediting system. For consultant Brent Haddaway, the first thing that came to mind about changing mitigation was the enhancement problem.

> Nost: Last question: if you were president of ecosystem restoration and mitigation here in OR, what would you change?
> Haddaway: That's a title? (laughs) (EN: It is now!) Um that's a very good question, I'm not a big fan of the - I guess it's a pretty boring answer, but the functions assessment method that they're using to evaluate mitigation. I just cannot accept the valuing all uplands as zero. It just, there may be legal reasons for it - it's just too - I think it skews your mitigation too wildly and too away from enhancement.

Consultant Mike Allsowrth goes one step further to explain that the trouble with ORWAP and enhancement is that it disincentivizes restoration of farmed floodplains, a favorite of mitigation entrepreneurs in the area. Allsworth claims that ORWAP does not pencil out for these projects and may cause many consultants and bankers to stop doing restoration work.

> Nost: In a situation where ORWAP is required, do you think that you know, with an emphasis on function -
> Allsworth: It won't work, it won't work. It doesn't work. I guarantee you it doesn't work because I've done it on a number of sites where we've applied ORWAP and on a farmed wetland, pick any one you want - on a farmed wetland, we can't enough lift to get our - and we come back to this: we have to have - most of the sites that I've looked at, we've had to have 6-10:1. It doesn't pencil out. You can't cover your costs - if you have to go out and buy 7 acres of farmland and you can generate 1 credit, at 50-60000 dollars, it doesn't pencil out financially, it won't' work. and it doesn't work and it's not working.

As a tool for assessing functions, ORWAP's misses can be costly.

The HML pilot has also demonstrated that functional assessments will result in fewer credits for bankers to sell, and thus higher prices for permittees in need of credits. Kirk Jarvie from DSL notes that the move to functions will be costly in part because unlike ratios they do not provide certainty to bankers like Kral "from the get-go" that a given acreage can be developed into a number of credits. Regulators recognize that devaluing the ratios-based currency will be difficult. Yvonne Vallette at EPA puts it well:

> Vallette: Problem is that we had developed a fairly elaborate wetland methodology but now we had a full marketplace that had been established on a very different currency (laughs). So now we're hoping that by having something like COTE established, we'll be able to speak in this money terminology that people can understand. We were hoping to be able to make this transition from an old accounting method to a new one and it'll just be a matter of figuring out some kind of conversion factor for the old to the new...people don't want to feel as though the value of the currency that they have now is gonna be deflated because all of a sudden we're going to Euros (laughs).

Vallette realizes bankers' uncertainty about how their current projects will be able sell if their currency is deflated. But for her, a functional credit is a better credit, even if it costs several hundred dollars more than a ratio credit, as it does at HML.

Still, because no one is compelling permittees to buy functional credits yet, the only wetland credits that have sold from HML have been ratio ones. While DSL's rules require entrepreneurs to conduct a functions-based assessment for some parts of the mitigation process, they are not yet requiring functional *crediting*, as much as they would like to. Kirk Jarvie from DSL elaborated that:

> Jarvie: The saving grace is that uh it is, [functional accounting] is very consistent with what our statutory obligation is right now and the current method is not. So the great news is we can always point to statute and say, you know, we're doing this to fulfill what we probably should've been doing a long time ago and this is what statute envisioned, at least in theory.

Moving forward, the justification in the language of the law is important because it gives regulators something to reference if consultants complain.

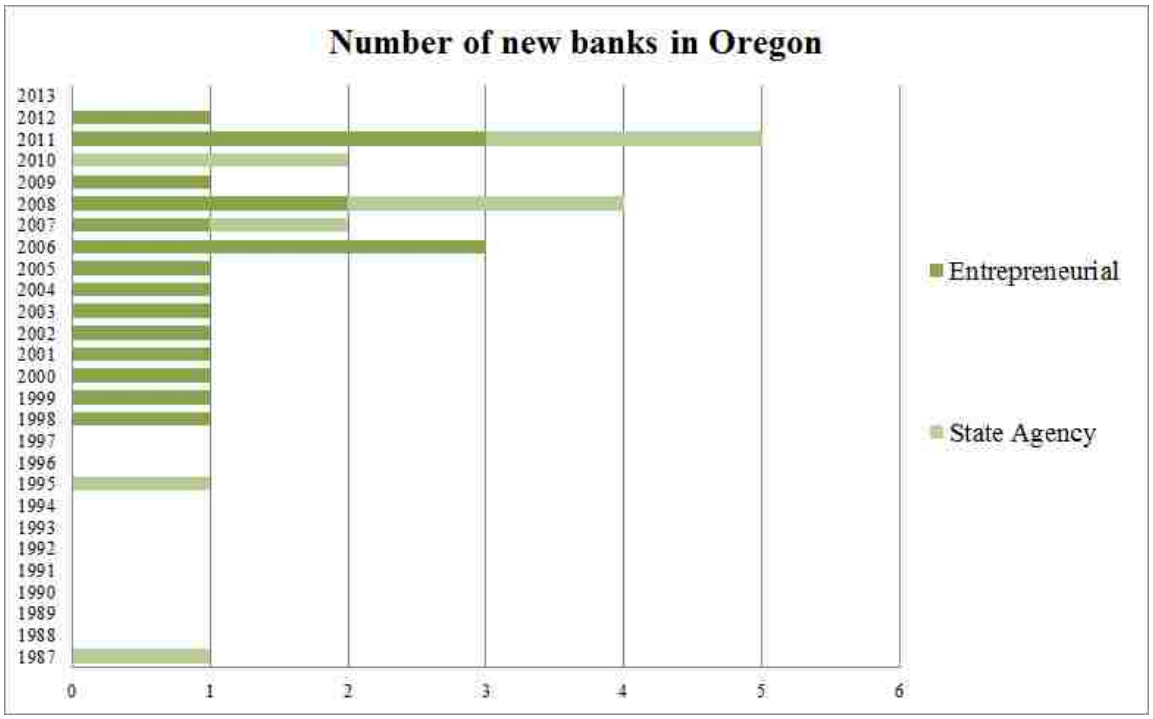


Figure 3.4. The number and type of mitigation banks opened each year in Oregon. Source: RIBITS (http://geo.usace.army.mil/ribits/index.html)

Developing a new currency is a project for another grant, regulators say. Yet the functions fight may be coming to a head, with talk of a lawsuit against any attempt by the state to mandate functional crediting. Bankers may stop investing in new restoration work and indeed market growth in recent years has slowed somewhat (see figure x). In Oregon, banks typically take about two years to go through planning, approval, and implementation and so the explosion of new entrepreneurial banks in 2011 were already in the works before COTE and functional assessment were finalized. What the functions fight shows is that the project of measuring nature's benefits for the market is not an exercise in revealing nature's "true values," and not apart from business imperatives nor regulators' and consultants' ideas about what accounting techniques are most ecologically appropriate. Consultants do not think ORWAP captures functional uplift - and are skeptical of uplift as the target - while agencies think ORWAP and functions provide a "higher and better" approach.

3.5: Expectations

It may be easy for someone like Pavan Sukhdev to advocate for ecosystem services accounting on an international stage and see ecosystem services as out there, just waiting for policy-makers, scientists, and corporations to reveal their "true values." After all, the goal is to "make nature's values visible" (TEEB 2010). But ecosystem services markets on the ground require the production and circulation of knowledge about services - a task riddled with uncertainty (Dempsey 2013; Johnson 2013), informed by policy directives (Lave 2012a,b), confronted by unwilling scientists (Robertson 2006) or regulators (Robertson 2010; 2012b), and so on - and more often than not, not everyone at the table demands the perfect measure. To understand why some credits or protocols do end up working for the market, I draw on an STS literature (Brown and Michael 2003; Borup et al. 2006; Lave 2013; Randalls and Petrokofsky 2013) to develop a way of talking about what regulators, conservationists, and consultants come to *expect* out of credits. This is a question of the adequacy of ecological metrics, for whom, and in what context. Some measures, in some situations will allow the market to run smoothly because they meet everyone at the table's expectations of what nature can do, what the credit can do, and what stakeholders themselves can do. Likewise, other measures, in other situations, do not meet expectations.

My turn to expectations is a call is to clarify and re-articulate what political ecologists and economic geographers mean when we talk about ecological crisis and their fixes (Bakker 2009; Castree 2009) or the role "materiality" plays in shaping market outcomes (Boyd, Prudham, Schurman 2000; Bakker 2005; Sneddon 2007; Bakker 2009). Bumpus (2011, 630), for instance, concludes his study of the production of carbon dioxide offsets by claiming that: "the material nature of carbon reductions and the social relations in which these [offsets] are governed, argued, negotiated and enacted are dialectically related to the broader requirements of the new and evolving carbon economy." He draws on the work of Bakker (2005) to emphasize several of the "inherent difficulties" (628) carbon market actors face in using existing technologies to measure different kinds of greenhouse gas emissions for crediting purposes. In Bakker's groundbreaking take on Britain's privatized and commercialized system of water distribution, she argues that water made for an "uncooperative" commodity because

water districts were unable to effectively trade it with one another. For her, water's bulky volume and natural inclination to flow downhill explains why its commodification was unsuccessful and productive of a crisis. Yet, I would add that, as Robertson (2012a) puts it, this "'uncooperativeness' only appears within the context of specific social projects which require cooperation." In this sense, what makes Bakker's claim resound is that it is contextual; water was uncooperative in this case because it did not meet the expectations of Britain's privatized municipal water companies to travel between watersheds. One could imagine that they could have trucked water across watersheds and between cities, but this would likely have been costly beyond what they imagined reasonable. As Robertson (2012a) concludes, "'materiality' may be the answer, but perhaps not for material reasons." What regulators, conservationists, consultants, or other market actors make out of nature's materiality is what matters and we need to be able to articulate those expectations and when and how they are met or failed. Otherwise, we miss out on who wins, who loses, who is responsible for those outcomes, and why.

Throughout all three moments of the HML-THPRD trade, regulators', conservationists', and consultants' expectations of what they and nature can do are sometimes achieved, sometimes missed, and sometimes somewhere in the middle. There is good reason to think that stacking multiple kinds of credits on one mitigation site might lead to an overselling of ecological processes. After all, ecology is supposed to be a science of the holism of parts. At any rate, it is certainly a complex and uncertain task to parse out those ecological relationships. But this has not prevented market actors in Oregon from stacking wetland and stream credits. For many regulators, bundling may be a better way to account for ecological interrelationships, but it does not meet political (statutory) or economic expectations (sellable credits) for actors. Bundlers are willing to concede on the issue and so there is a working agreement among regulators, conservationists, and consultants, that nature can be parsed into functions. The consensus is that the WP protocol on stacking is an adequate approach to crediting ecosystem services Oregon.

Salmon habitat is in a sense "uncooperative" as it has proven resistant to regulators' and conservationists' attempts to metricize it. But it is resistant in Oregon only because, first, decision-makers at NMFS themselves have been resistant to the idea

that salmon habitat is something that can or should be traded, if only because that would mean more work for the agency. Second, water is uncooperative because the way the authors of the salmon habitat calculator conceived of streams cannot work for the CWA agencies (Corps, DSL, and EPA) that are now trying to develop a more comprehensive stream metric. Their expectations of what materialities a stream water quality should reference are different than what the salmon habitat commodity credit currently references. There is nothing per se about water in this case that would otherwise prevent the creation of salmon habitat or streams as things to be sold. HML may lay claim to the first salmon habitat bank in the nation, but streams are regularly traded elsewhere in the country (Lave et al. 2008). Indeed, DSL is trading salmon habitats for streams because, although their long-term expectations are not yet met, the metric is adequate for now.

Functional accounting of ecosystems is not without controversy. Regulators think that restored wetlands and streams provide a set of functions that can be measured and circulated as credits. Consultants may or may not agree, but the bottom line is that functions, as gaged by ORWAP, simply do not meet bankers' expectations about the amount of ecological uplift they achieve in their restoration work. Functions, at least for now, do not give bankers what they need. Bankers make the question of whether functional calculators better capture restoration efforts out to be: what aspects of the site are and are not captured and for whom? They argue: only parts, and not for them. Functional accounting does not tell them about what they would want and expect to know about vegetation and hydrology, and it does not give them the number of credits they would expect either. This is a costly unexpected consequence for them. And this is why it pays for political ecologists and economic geographers to pay attention to expectations. Because regulators have high hopes for functions to replace what everyone agrees is a broken ratios system that no longer meets most expectations, their claim gains more legitimacy.

3.6: Conclusion

Political ecologists, resource geographers, and scholars of neoliberal natures can draw upon work in STS on expectations to understand the design and implementation of new and expanded environmental markets. There are a couple insights my own case

provides into how they might do so. Many STS scholars have focused their attention on the promises made by promoters of new *technologies* like xenotransplantation (Brown and Michael 2003), biopharming (Milne 2012), underwater logging (Randalls and Petrokofsky 2013) or even stream restoration (Lave 2013), and the "performative" work of such promises. Heeding actors' expectations can more broadly explain why (conservation) *market* projects, plans, and designs succeed and fail. Related, expectations are "generative" not just of consensus and legitimacy, but conflict, because they are politically and economically situated within particular market subjects (cf. Starr and Griesemer 1989).

What matters for the Oregon ecosystem services market when actors stack, deploy proxy credits, and generate functions-based credits are regulators' and consultants' expectations of what can be done with knowledge about nature within the market context. There is a consensus between regulators and consultants on stacking in spite of potential economic and ecological consequences, because statutory barriers prevent better options and because stacking may prove to be a more holistic approach to restoration accounting. The salmon calculator has not met the expectations of the salmon regulator, NOAA NMFS, for a market in habitat conservation, nor has it met the long-term expectation of CWA section 404 regulators to serve as a stream functions proxy. In the meantime, it will do for trades like the one which credited THPRD's trail impact. Functional accounting, however, is not proving adequate. Regulators have great expectations that it will provide a better credit, but consultants do not see it as economically advantageous. This puts regulators and consultants at cross-purposes, but regulators may win out because their expectations about the ability to measure ecological functions are legitimated as a claim to get beyond the broken ratios system.

One of the world's foremost advocates for ecosystem services, Pavan Sukhdev (2010), has called for getting the price of nature's benefits right lest they be mismanaged. My point has been that underlying this price measure are ecological assessments that are not technical problems as much as they are social ones. I have explained how regulators', conservationists', and consultants' interests, motivations, and expectations of what nature can do influence the success of a market in environmental services. The limited success of the Oregon market is not a product of missing nature's "true values" but of not getting

that measure right for bankers (functions) or regulators (salmon habitat). In the next chapter, I hone in on how these measures also generate *spaces* for restoration that serve the purposes of the state more so than consultants.

Chapter 4: Putting a Value on Nature

In this chapter, I argue that how regulators, conservationists, and bankers in Oregon plan for, choose, and evaluate locations that enter the market as mitigation banking restoration sites proves to be market-constraining, but perhaps only in the short-term. As we saw in the previous chapter, one of the neighbors to THPRD's trail extension has disputed the permit approval allowing THPRD to impact a stream with its trail bridge (DSL 2012b). The neighbor's cause for concern was partly that the functions-based assessment of the site was inadequate, but also that DSL had not properly asked THPRD to avoid or minimize its impacts before allowing the entity to compensate for them. One reason citizens and non-profit groups like The Nature Conservancy (Wilkinson et al. 2009) pressure regulators to get developers to first avoid and minimize impacts is that the use of mitigation banks to offset wetland and stream impacts has the effect of transferring localized ecological processes to distant restoration sites (BenDor and Brezovic 2007; BenDor, Sholtes, and Doyle 2009). In mitigation banking, streams and wetlands that developers pave over in suburban Portland are restored and credited in other parts of the broader Tualatin River watershed. The distance between HML and THPRD's unnamed stream tributary may only be 16 miles as the crow flies, but more importantly, the two sites occupy very different points within the watershed network (see maps in Chapter 1 and below). Ultimately, they are equally part of the Tualatin watershed, but the tributary and the creek it flows into before reaching the Tualatin both provide important services for Beaverton, a Portland suburb. At HML, the stream credits may represent a higher quality resource than that destroyed at THPRD, but they are specific to Roderick Creek just before it enters Gales Creek.

Here I show how Oregon's regulators, conservationists, and entrepreneurs design and implement assessments and rules that provide some means of accounting for the spatial embeddedness of ecosystem service provision. These measures of what in regulators' and conservationists' logic are location-dependent ecological *values*, however, prove problematic for entrepreneurial banking practice. The work of "putting a value on nature" (Sukhdev 2010) in Oregon's ecosystem service marketplace is not as uncontroversial as simply pointing to places on the map might seem. Disagreements between regulators and bankers' consultants take center stage, as where to do restoration

becomes another facet of bankers' hesitations about the deployment of functions-based assessment. I argue that the spatial logics of these assessments and other market protocols have proven obstacles to a robust market. Two of the primary motivations for the COTE process and the 2008 final rule were to facilitate watershed planning and promote mitigation banking, both of which appear to be a revamping of the market to better commodify and commercialize wetland and stream ecosystems, and ultimately foster capital accumulation. My claim is that these are in fact constraints to the market. They may prove to be short-term only, however, as in the long-run bankers might adjust to regulators' expectations about where they want them to do restoration.

That market actors in Oregon are eager to articulate the "value of nature" comes as no surprise given the work of political ecologists to depict the triumphs and travails of surplus value-seeking capitalists as they confront the environment (Robertson 2000; Lansing 2011; Ernstson 2012; Robertson 2012b). In suggesting that the planning, choosing, and judging of restoration sites across the landscape for the market is what constitutes this pursuit for value in Oregon, my argument contributes to a literature on the ways states, at particular historical-geographical moments, come to hold power and legitimate what are often non-market goals through spatially-explicit strategies to organize nature (Whitehead et al. 2006; Asher and Ojeda 2009. I argue that the ways Oregon regulators - with the help of conservationists - plan for where restoration occurs can be means to state power and legitimacy vis-à-vis entrepreneurial market actors. This is a response to the call from Corson, MacDonald, and Neimark (2013) to detail the social relations and metrics that constitute new markets in conservation. I have found there is good reason to pay attention to the *spatial* logics and social relations that matter *over time* in such markets. To show why, I first illustrate different ways market advocates and actors in Oregon think about the spatial nature of ecosystem service provision. These logics revolve around a service's opportunity or constraint to perform some valuable benefit for society.

4.1: Spatial Logics of Ecosystem Services

4.1a: Opportunity and constraint as ecosystem service value

Back in Tigard, consultant Sean Pickles tells me about what he sees as the goal of wetland and stream restoration and he emphasizes the importance of the placement of projects. Tucked into an easy-to-miss corner of a grocery store parking lot sits a small stream-side wetland (see figure 4.1 below). At first glance, it seems out of place. When the shopping mall was built in the early 2000s, environmental regulators had allowed the owners to compensate for paving over other wetlands on the property by restoring existing wetlands on the site, rather than purchasing a credit from a bank. The wetland provides benefits to Tigard and the metro area in the form of storing and delaying floodwaters and allowing nutrient assimilation processes to occur naturally instead of in expensive water treatment plants. In general, for ecosystem practitioners and researchers alike, wetlands and streams present "capacities," or opportunities, in providing services that society values. These opportunities - and constraints - to provision are to a large degree a matter of proximity (see e.g. NCP 2013). Restoration work that meanders a small headwater stream in the middle of nowhere offers relatively little opportunity to mitigate flood damages, while the stream might provide excellent opportunity to restore salmon habitat. Likewise, a wetland in Forest Grove does not provide the same recreational opportunities to Tigard residents, though perhaps migratory bird habitat or carbon sequestration functions do not need to be specifically located in Tigard.

Figure 4.1a. A wetland mitigation site in Tigard, OR. Source: Author.

Regulators, conservationists, and consultants in Oregon talk about the opportunity and constraint for an ecosystem process or function to deliver some kind of benefit as a *value*. It is unclear where this specific way of conceptualizing ecosystem process originates, but internationally it has become a sort of lingua franca. Contributors to one of the keystone texts of the ecosystem services approach, Gretchen Daily's 1997 edited volume, *Nature's Services*, did not dwell on the relationship between the context of ecosystem service provision and its value (Daily et al. 1997), but by 2013, the scene was different. By then, Daily could declare that "We need to be able to pinpoint places on the landscape … and say these places are really the most important for supplying these benefits" (Hoff and Daily 2012). Likewise, the authors of a recent TEEB report on the value of wetlands named "Geospatial mapping [as] a powerful instrument to demonstrate where the source of value comes from (i.e. the location and the extent of water and wetlands resources)" (Russi et al. 2013). Ecological economists are also increasingly interested in how the spatial arrangement or character (Newell and Swallow 2012) and

the landscape location (Ruhl et al. 2009; Womble and Doyle 2012) of ecosystem services contribute to how valuable society finds them.

In Oregon, service-as-value thinking cuts across different kinds of market actors. Yvonne Vallette, a regulator, notes how restoration sites that can deliver multiple resource types present an opportunity.

> Vallette: So again, if you can find a site that can accommodate both needs, like it's got some great opportunities for stream rehabilitation and some riparian establishment that helps not only on-site functions but off-site as well. Even a wetland can help for some additional water quality plus storage. And you can add a value to all of that. That's huge.

Wetland, stream, and riparian restoration work on a single site makes for a "value-added" mitigation site because it improves multiple ecological components like water quality and storage on and off site. Mike Allsworth, a consultant, also describes opportunity as ecological. His concern centers on what can constrain, "influence," or "stress" a site, such as the nearby presence of invasive species like reed canary grass. He notes that the bank development and regulatory decision processes need to account for site stressors. Ecological or otherwise, value itself is a term that is not defined in law, but in regulatory memos DSL refers to wetland value in particular as, "the importance or worth of a wetland function to societal needs. This includes public attitudes and the [wetland's] opportunity to provide a given function based on its location" (DSL 2011).

4.1b: Three spatial logics of ecosystem services

I propose that there are three spatial ways of thinking about the restoration of ecosystem services which all play off the opportunity and constraint definition of ecological value and which inform site selection in Oregon's market. They are not wholly separate logics, but more like interwoven strands of thought. First, there is what might be called an eco-regulatory logic. Regulators at the state and federal levels argue restoration sites should be located in such a way that enhances their ecological success and also achieves the programmatic goal of "no net loss." For them, the banking of credits at one site, to be sold to many development projects, is a reaction to "postage stamp mitigation" in which restorationists built smaller mitigation projects across the landscape that were ineffective because they were easily influenced by surrounding land use. In a way, their

view draws off of Island Biogeography Theory (see Laurance 2008), whose adherents theorized that larger islands of conservation proved more resilient to species-endangering habitat fragmentation.

The second spatial logic of ecosystem services is a way of reasoning about nature and space that is focused on economic efficiency. For environmental economists, *equimarginality* describes a spatially efficient scenario where, across all relevant firms, every extra dollar spent on pollution abatement or conservation fails to return more than dollar's worth of pollution reduction or habitat protection. If "command and control" mandates requiring each firm use the "best available pollution abatement technology" fail, it is because - the story goes - these policies do not acknowledge the fact that each factory or wastewater treatment plant or housing developer has unique cost schedules for managing their external costs to society (Field 2010; see also Polasky et al. 2008). Some firms can mitigate emissions, effluents, or habitat impacts more easily than others. The implication is that where polluters do mitigate or compensate entrepreneuring restorationists for impacts will be where it is least costly for them to do so. This logic partly underlies the regulatory one as well. The very idea of building a bank instead of mitigating on-site reflects the idea that developers deserve spatial flexibility. The question is, where does the bank go? All else equal, if given the flexibility a suburban Portland housing developer needing to abate a subdivision's impacts on salmon habitat will do so where it is easiest to. This is probably outside of the urban growth boundary where land is less expensive anyway and where the demand for housing is not as pressing. The choice may or may not have anything to do with the quality of habitat there.

In a third logic, conservationists instead argue for planning restoration in *specific* sites where it can be most efficient (Kiesecker et al. 2009; Kiesecker et al. 2010). This is much like the previous logic, but does not assume an equal playing field among sites. Many conservationist non-profits also want the most bang for their buck, while realizing the economics might not always work out. They want to focus the limited supply of restoration dollars in "opportunity areas" and other places they deem critical habitat. They wish to improve already existing ecosystems, while limiting development of those areas as well. And while those drawing on the eco-regulatory logic see value in a larger

site, conservationists also see value in larger projects, but on particular sites. To achieve this goal they map priorities and work to incorporate conservation planning into regulatory decision-making. Besides promoting banking, the 2008 final mitigation rule also called for a "watershed approach" to mitigation. The approach has Corps and EPA consider watershed plans - including those drafted by conservationist groups - when evaluating entrepreneurs' proposals to bank. As the rule noted, what counts as a watershed plan and how to deploy them is still up to each Corps district's chief engineer, and by extension, regulatory staff. In the next section, I dive into whether and how they do in Oregon.

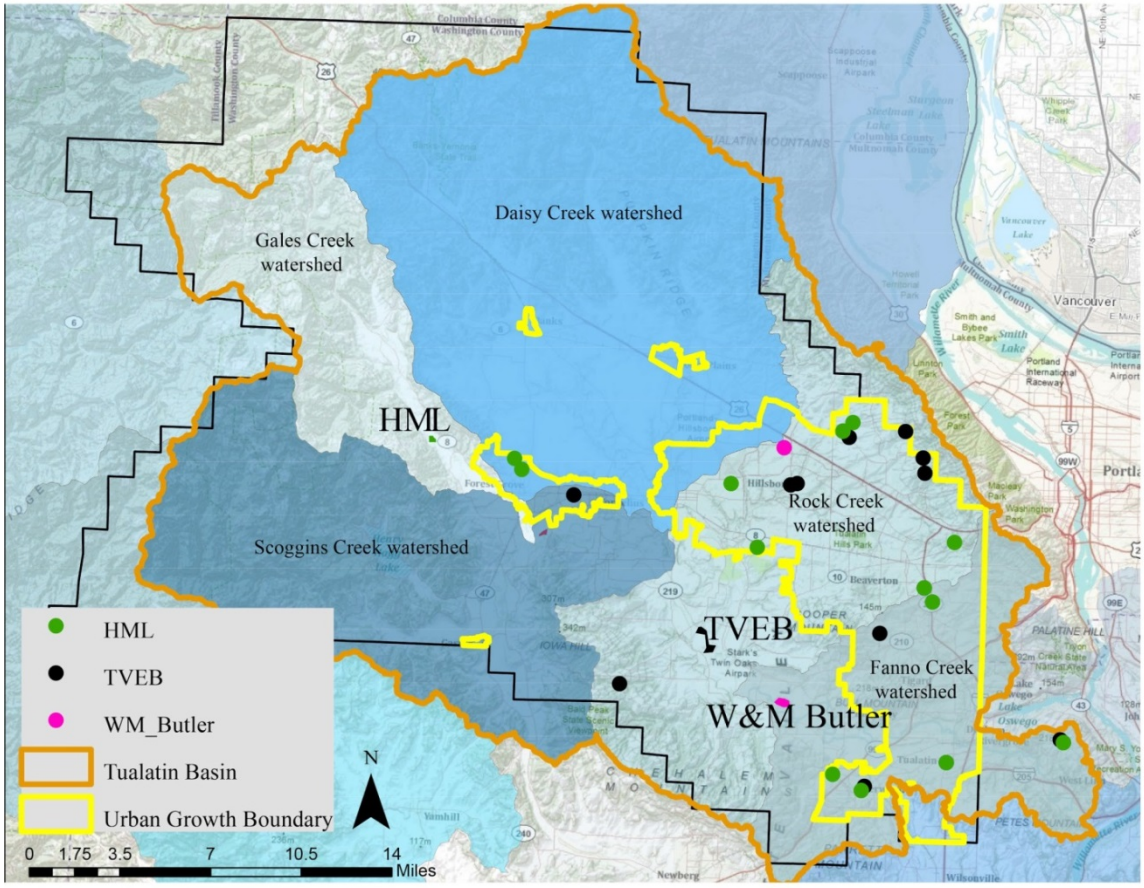


Figure 4.1b: Mitigation banking in Washington County. Dots represent locations of impacts and are color-coded with the banks they have purchased credits from. The Tualatin River basin defines the extent to which the three banks can sell credits, but pictured are smaller sub-basins and the urban growth boundary. Source: Author.

4.2: Three Moments in the Measure of Value

In Oregon, the three strands of logic which suggest where and how restoration projects should be sited inform three different moments where regulators, conservationists, and bankers plan for, choose, evaluate restoration for the ecosystem service marketplace. These moments are where landscape ecological data are produced, become economically and legally meaningful, and the state, conservationists, and entrepreneurs negotiate where restoration gets done (or not). Here, I set up some of what the tensions between regulators and entrepreneurs are - at least theoretically - and flesh them out in the following section.

4.2a: Assess

The first moment of value's measure comes when consultants run credit calculators on a restoration site. These calculators contain both field and office-based components but questions in both parts ask assessors to gage the ecological context of the site. On the ground, this means scanning the horizon to think about potential future impacts to the site. In August 2012, when I had the opportunity to run ORWAP at HML with DSL, we spent a good chunk of time looking beyond the site boundaries to speculate on how much the giant scar in the side of nearby hills - a rock quarry - has and would *stress* the site and *risk* its ability to perform functions. Back in the office, one of the key mapping utilities consultants employ for the ORWAP assessment is the Oregon Explorer (OE)(Figure 4.3). OE gathers a lot of data from outside the site together and displays it to the user in one frame. Consultants have to answer questions about landscape context by using OE to, for instance, draw a two mile radius circle around the site to see how many other similar habitats the site is connected to in the area, or what sources of ecological stress are nearby, like the quarry at HML. The key point here is that the value score of a banker's site is relational to the site's surroundings, yet these are often habitats and properties which the entrepreneur has no or little control over. This calculation of values "comes in at the 11th hour" after ORWAP scores ecological functions, as the program's author notes. They are scores on a 1-10 scale which portray the relative opportunity for each function to occur.

Figure 4.2a. Oregon Explorer. Consultants use the online mapping tool to assess the landscape context of a restoration site. Source: http://oregonexplorer.info/

4.2b: Regulate

Do regulators consider offsite constraints and value scores when they assess consultants' monitoring reports or bank prospectuses? The short answer is yes, and that is exactly why those questions are there. The longer answer is that regulators' approaches are more fractured. Bankers have to develop and get agency approval on performance standards, or criteria of success, that determine when and if they actually receive their credits to sell. Regulators have an opportunity to account for the value of a site in defining performance standards, and this constitutes one of three parts to the regulatory moment of value's measure. At HML, for instance, the quarry upstream is one potential stressor to the site's performance, but regulators decided that they were comfortable with its presence. In general, then, there is a risk that offsite conditions will change over time and affect the site. Regulators have a legal basis for influencing where bankers decide to site their projects, one that is based on the value of different functions' performance in relation to this offsite future. But agencies may or may not decide to take any action on a case by case basis.

How regulators classify and categorize different ecosystems across the landscape is the second part of the regulatory moment of assessing the value of sites. Agencies categorize different kinds of wetlands in particular in order to assess their value relative to other wetlands (Robertson 2012b; stream categorization is in the works alongside a stream functional assessment). In Oregon, there are different types of wetlands and some are more common or rare than others. In parts of Oregon as elsewhere, forested wetlands have been partially replaced by farmed wetland. There is no direct relationship between abundance and value, however. The point of categorization is to be able to compare across all class types of wetlands - to know that a forested wetland is in fact different than a farmed one. A key purpose of ORWAP is to allow comparisons among different kinds of wetlands. Before ORWAP, there were a variety of assessment methods and most were specific to only a few wetland types or regions of the state. That was unacceptable to the Oregon legislature, which attempted to intervene, with the result being the formation of a technical committee that recommended development of a rapid, statewide, all-wetland-types method. ORWAP's author, Paul Adamus, tells the story:

> Adamus: And what happened was some members of the legislature got impatient and insisted on developing their own simplified ranking of wetland types without input from scientists. Fortunately cooler heads prevailed and multiple stakeholders were recruited to advise the development of an appropriately detailed, science-based method that could support wetland categorization.

Instead of letting the legislature mandate wetland classes, agencies supported the development of ORWAP which could assess any kind of wetland. Categorization is important for where bankers do restoration work, as I show below. The state has marked out farmed wetlands, which for the most part require enhancement work, as less worthy of restorationists' attention.

The third part of the regulatory moment of value's assessment is regulators' deployment of watershed and landscape approaches to recommend and approve bank sites. The idea behind these approaches inspired by the 2008 final rule is to facilitate banking in sites that meet watershed needs like pollution reduction or flood prevention. For DSL regulator Dana Hicks, one of the big successes of the COTE process - launched just months after the final rule came down - was, "to try to encourage mitigation where it made the best ecological sense and discourage impacts in areas that we really wanted to

to keep because of their value for various functions provided." For her, the COTE approach meets the need both for better bank siting and to identify areas to keep impacts away from. Mapping these sites gives agencies and allied conservationists something to point to when they get funding for restoration; it gives them a plan. Oregon's Department of Forestry and Wildlife has written wildlife plans but it has also aggregated and mapped these into a number of areal units that it calls Conservation Opportunity Areas. TNC has drawn up a "Willamette Valley Synthesis Map" that brings together a set of habitat, hydrologic, and geomorphic GIS "layers", including the COAs, to identify restoration priorities. Though it was developed by TNC, a non-profit, the map has become something regulators and conservationists alike regularly point to.

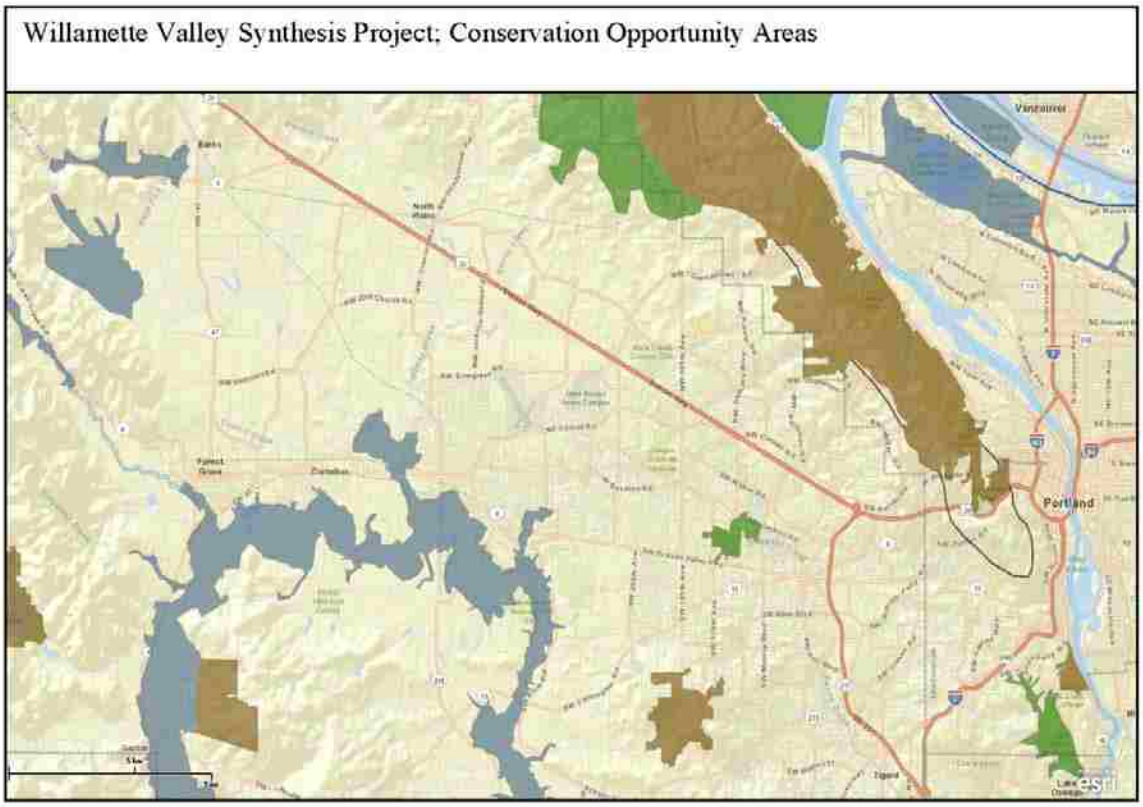


Figure 4.2b. The TNC Synthesis Map of "conservation opportunity areas" in the Washington County area. Areas shaded blue indicate aquatic priorities. Source: The Nature Conservancy 2011.

4.2c: Market

The Synthesis Map is the crux of the final moment in value's measure - the market moment. In the protocols that the WP has established for its ecosystem service marketplace, trading ratios deliver more credits to bankers doing work in priority areas and require developers in sensitive areas to buy more. The ratios establish what WP calls a "Reserve Pool" of credits that the group administers as means to cover compensation requirements if a bank fails. The way it works is that if a bank were to set up shop in an area demarcated in the Synthesis Map they earn the full amount of credits - none have to go to the Reserve Pool. If they bank elsewhere they have to pay into the pool a certain percentage of their credits, the idea being that banking outside of the priorities constitutes a future risk from the landscape from invasive species or other factors that make the site not a priority. COTE participants designed the trading ratios to deal with location (and timing) of restoration as well as impacts (developers filling in a priority salmon habitat area will need to buy more credits). At present, WP uses the ratios only if a banker chooses to (and none have), but DSL has considered adopting them as part of its own regulatory program (DSL 2011).

With the limitation that regulators can only ask for equivalent compensation of resources - a precedent established down the street from PS's grocery store wetland in the *Dolan v. City of Tigard* US Supreme Court case - it is unclear whether the state can actually require these ratios. As a DSL regulator explains it:

> Kirk Jarvie: Again we're constrained by a statutory obligation that says mitigation will be limited to the the lost functional attributes of the impact site itself. Depending on how you interpret that, it might be difficult to require somebody to do more than they would otherwise be applied.

Jarvie adds that there was a lot of "behind the scenes" work at COTE playing with the numbers to balance incentivizing better site selection while not discouraging bankers. Though they may not be able to require them yet, as regulators and conservationists work together on facilitating better site selection, trading ratios may constrain bankers.

Across all moments, planning for and evaluating restoration sites for Oregon's ecosystem service market solicits a particular kind of spatial optic - a lens for measuring value and seeing how each individual bank squares with that vision of landscape and context ecological effects. The key point is that some spatial optics may work for the

state's and conservationists' goals for restoration, but not consultants'. In the next section, I show how they in fact do not work for consultants.

4.3: Three Problematics in the Measure of Value

Value is not given in space. It is defined, contested, and contingent and in Oregon this revolves around three problematics in how restoration sites are planned for, chosen, and evaluated: 1) the extent to which offsite factors are included in bank criteria; 2) defining the sites that are especially valuable; 3) categorizing particular kinds of wetlands in the landscape as valuable or not.

4.3a: Site Context

The first sticking point between consultants and regulators centers on the measure of the landscape context of restoration sites. The more regulators - or the ecosystem service calculators they require - capture and weight landscape factors, the more bankers are constrained because they rarely can do anything about ecological conditions and processes in surrounding parcels. The extent to which regulators in Oregon take heed of banker concerns about landscape assessment is questionable. Several examples illustrate that regulators only go so far in asking bankers to manage for the landscape and not just the restoration site. When Jonas Moiel was trying to get his bank approved, the IRT hassled him about the typical offsite culprit, reed canary grass. They ultimately backed down: "Eventually what I said, well what do you want me to do, convert everybody around me into a wetland bank?" According to consultant Mike Allsworth, regulators could say no to a site proposal if they did not think it was sustainable, but ultimately the banker can still move forward by developing ways of dealing with invasives and other offsite risks. Putting in shrubs, buffers, or bonds may be somewhat of a cost, but it is not a rejection.

Allsworth claims that bankers unquestionably consider offsite factors in choosing a site, but *how* they have to assess landscape context is still ecologically questionable, according to one of their leading advocates, Sean Pickles.

> Pickles: But the bigger issue that a lot of us tend to think is inherent to ORWAP is it looks at not your site alone, but it looks at a much larger area....So I think the real big question a lot of us have is: we understand the scientific principle of

> acknowledging all of these offsite kind of resources but how are they influencing the outcome? And we don't know that. ....The more I use something like ORWAP you know the more questions I have like why is it appropriate to compare this site, how big it is, to something that might be within a 2 mile radius. I need a strong real world connection. If the issue was that that there was you know uh connectivity to something that was contiguous, I can sort of see the corridor effect as being significant. Something that's a mile away on the other side of the freeway, you know I'm feeling like we're adding in an element that is insignificant.

Accounting for landscape context may be scientifically sound, but doing so impinges on the final site score. For Pickles, the problem is not so much about the effect on the score, but the ecological reasoning it embeds. He needs ORWAP to show him a "real world connection" and it needs to be a significant one, too. In short, at this point regulators will press bankers on how they plan to deal with landscape factors, but will only go so far in claiming that the offsite future makes the bank a bad idea. However, as Pickles notes, the calculators themselves still embed a landscape assessment that constrains site scores, behind bankers' backs, outside of the IRT setting.

4.3b: Priority areas

Bankers may also benefit from offsite conditions and processes. DSL can do nothing about the rock quarry upstream from HML, but it benefits from being upstream of populated 100-year floodplains; HML provides a water storage and delay value. Demarcating the good sites for banking is the second problematic in valuing ecosystem services in Oregon. What are the conditions from which bankers can benefit from space, and do they? Why value a site like HML in particular?

The ecological reasoning that defines what counts as a good restoration site is a stage set largely by regulators and conservationists in Oregon. At times, consultants may agree with the reasoning and on other accounts they do not. As Yvonne Vallette, EPA, noted earlier, the possibility of developing multiple kinds of credits adds value to a site. Sites mapped within priority areas are also more valuable. There is no one definition for what makes for a priority and although the Synthesis Map serves to set the table, WP retains the right to call any bank a priority even if it does not strictly fall within the already mapped priority boundaries. An alternative criterion WP uses is an ORWAP score above 50% functioning, the idea being that already functioning wetlands are

important to protect and to improve. Related, headwaters make for good restoration sites. Upper portions of watersheds are thought by regulators and conservationists to be generally less disturbed than low-lying, farmed floodplain wetlands and less polluted from upstream areas. HML, for instance, makes for a good site according to regulators and conservationists. It incorporates both a stream and wetland and is in the headwaters, at least compared to the other Washington County banks. It is also located in a Synthesis Map area.

Bankers tend to employ a different ecological reasoning about what makes a good site. Jonas Moiel is sometimes frustrated by how regulators and conservationists identify sites as priorities.

> Moiel: The thing that's been frustrating to me is that high priority areas are being identified through a variety of data sources such as GIS overlays for salmon habitat or endangered species, but that many areas may be overlooked when taking this approach. For example, endangered plant locations are added to the state database only when found and recorded, but that doesn't mean that endangered plants don't exist outside of the database and/or other high priority areas. The Tualatin Valley Bank is adjacent to a salmon bearing stream and provides rearing habitat for juvenile salmon; however the agencies do not classify this is a high priority because it is located off the main stem of the Tualatin River which does not provide spawning habitat. In this case, the system is flawed because the site has high quality fish habitat which is beneficial to salmonids; rearing habitat is known to play a large role in juvenile salmon health and survival.

While supportive of priority areas in general, Moiel questions the use of GIS layers to objectively identify priority sites because layers miss important nearby offsite factors when each one only focuses on a single criterion. He goes on to note that prioritization might actually help bankers identify good opportunities for banking, but again he questions what counts as a good opportunity in the first place.

> Moiel: Yea, I don't know if prioritization would make banking more or less difficult, its just one step in the research process. I think that prioritizing areas can be helpful when looking for new restoration sites, however this approach can be flawed in that it may keep people from investigating the facts on their own. It seems that many times priorities are set by identifying areas with known existing ecological value such as fish habitat which may overlook valuable habitat such as corridors. Fragmented pieces of habitat that provide a corridor of transport for fish as wildlife are very valuable but may not be prioritized if located in an area that doesn't have known endangered species nearby.

Moiel asks why corridors do not count as valuable in mitigation banking. His ecological reasoning extends beyond the thinking that a big island, or bank, is best for conservation, to think about what birds and other land animals (and maybe plant species) need to make it from wetland to wetland.[10] Ultimately, Moiel claims, the state should not and will likely not necessarily compel bankers on the question of whether they are banking in a priority area.

Many conservationists and regulators themselves are more hopeful about the state's role in valuing potential sites for bankers. For a conservationist from TNC, agencies should in fact be more forceful in getting bankers to work on good sites. Cathy Macdonald's a proponent of a program the state had come up with previously to incentivize priority area work. She summarizes it by noting that as with any market, some places are more productive or trafficked than others.

> Macdonald: And it will mean not everybody will get to play, just like everybody doesn't get to play in any other commodity. There are places that are better for corn than others. There should be places that are better to do conservation.

Macdonald envisions the state playing an active role in setting the stage for site selection by making clear that some are more valuable than others. A former regulator and COTE participant, Bill Abadie, agrees that ideally the agencies would first identify the site best suited to banking and *then* offer it to a banker. That kind of site selection has so far been the exception.

> Abadie: Ideally, an ecologically high value parcel that is important to the stream that needs restoration would be identified. It would be beneficial to have a regional wetland restoration plan that identifies areas for restoration. A parcel of land with restoration potential would be identified, and then we would encourage somebody to convert it into a bank or an individual/single party mitigation site. However, most of the banking here, is opportunistic. In other words, the landowner and/or the banker already own the land or was able to obtain the property for a good price.

Abadie is pragmatic rather than ideal about the ability of agencies to overcome "opportunistic" banking, or banking in which the entrepreneur develops a particular site because it was more convenient than finding the "high value parcel." At another state agency, DEQ, Ranei Namura reflects Abadie's pragmatism about site selection. For her, priority areas are broadly set by the TMDLs and many of the TMDLs are focused on

[10] Distance to other islands is the other half of IBT.

mainstem water bodies lower in the watershed and farther away from prime salmon habitat in need of restoration. As a result, until TMDLs are updated with more work on tributaries in a watershed, Nomura will take what restoration she can get in areas covered by the TMDL with the hope that these actions with further encourage action throughout the basin.

> Nomura: The way we did the Rogue Basin TMDL [temperature reduction plan], it's perfectly legitimate for Medford [an Oregon city] to conduct restoration actions on the Rogue River even though fisheries agencies would prefer work on the tributaries to the Rogue. Work on the mainstem of the Rogue would get the city more kcals for their money - as trees grow, they provide a larger portion of shade over a wider river than they would a smaller tributary. A 20 foot tree is going to shade and block more solar radiation on a 50 foot wide river than a 10 foot wide stream. So even though the 10 foot stream might be a higher priority, the wider river may be more cost-effective for ratepayers, which is fine with DEQ because the mainstem still needs riparian restoration to improve the health of the watershed. It's a tradeoff that we try to balance.

She goes on to note that strategizing about site selection is difficult anyway because "the landowners need to volunteer" and different groups have different ideas about priority areas.[11]

But the institutional and subjective positions of DEQ and of Abadie are somewhat idiosyncratic. DEQ is running its own compensation program apart from Corps, EPA, and DSL oversight. Abadie is with the Corps, but does not work in compensatory mitigation anymore. Yvonne Vallette, at EPA, is more insistent on the potential of ratios and other means of convincing restorationists to go to the right places.

> Vallette: Well we recognize that site selection is key, we've always known that in the wetland arena, but we couldn't tell bankers go here versus here. I mean their choices are strictly based on economics, you know, meaning the cheapest piece of land that you know. So what we had to do is figure out how to, you know how to play into those economics, meaning if you look for a better spot, you can make more. But the current ratio or scheme of crediting wouldn't, just really didn't account for that....And we now have because of GIS tools and various you know resource censusing tools that we have, we can look at all these overlays and

[11] Nomura added, "To assist with the implementation of its temperature trading program, Medford contracted with The Freshwater Trust, "…an action-oriented 501(c)(3) not-for-profit that restores rivers and streams throughout Oregon." While there may have been some initial concern about restoration only being performed on the mainstem of the Rogue, Medford's restoration projects to date are in important salmon-bearing tributaries to the Rogue River."

> determine where all these you know priorities not only for what the immediate needs are for you know like with regards to water quality and things like that, but also targeting to what we know historically should or could occur there.

At least some agencies - the ones with more developed mitigation programs, like EPA - are going forward with devising means of getting bankers to conserve priorities. The idea is to use GIS to find sites that can meet immediate watershed needs and historical patterns and then to incentivize restoration in those spaces. But as Moiel noted, GIS does not see all - it embeds its own ecological reasoning - and agencies may be hard pressed to justify its use. Although at the moment the state may not be requiring sites to the extent some conservationists wish, it is playing a heavier hand on site selection than it has previously. The state is doing this even if the bankers think agencies cannot do anything about their site selection.

4.3c: Categorization

If bankers are not going to want to work in the more valuable spaces because it is more expensive and regulators do not force them to go there, where else would they go? Whether bankers' current restoration practice is still worthwhile is the third problematic of value in Oregon's ecosystem service market.

Currently, entrepreneurs would typically bank on cropped floodplain wetlands. These are agricultural areas that do not necessarily have wetland vegetation, but do retain some wetland hydrology. Bankers therefore undertake wetland enhancement work on these kinds of wetlands (see chapter 3). However, agencies and conservationists are skeptical of the value of this work after a series of reports have shown that enhancement of wetlands in Washington County and others in the Portland metro region has resulted in a net loss of acreage and functions (Shaich and Franklin 1995). Enhancement work does not start from scratch; it repairs an already existing wetland. Developers might destroy a whole wetland site, but enhancement improves wetland hydrology especially only a little bit. Functional assessment also constrains bankers in that certain kinds of sites are harder to uplift functionally. Farmed floodplain wetlands, for instance, by definition already have some hydrological function and so are harder to produce an uplift out of. By measuring restoration success in terms of functions, the "functions fight" between regulators and bankers takes on a spatial form.

The way bankers and their consultants pick sites is somewhat opportunistic. That is, it is responsive to availability and convenience. The ideal restoration site is a previously farmed one, but not necessarily a cropped wetland. The *restoration* ratio provides the best ratio of credits per acre worked on (creation provides the 2nd best ratio, but is typically more difficult/risky):

> Moiel: Well, for wetlands an ideal site is one that can achieve a high percentage of restoration credit. Ideally, one would know the locations of drainage features such as drain tiling and they would be easy to reverse to restore historic hydrology. If the site is in agriculture, hopefully the farmer kept it clean of non-native plants, which would make the conversion easier and less costly…..When looking for a new mitigation site I review a variety of data sources such as soils mapping and aerial photography. If it appears to historically have been wetland but currently has upland plant species growing on it, it may have a high potential for wetland restoration. It's difficult to find a site that produces all restoration credit as many sites have existing wetlands which receive less credit per acre (enhancement ratio of 3:1). The Tualatin Valley Bank site has enhancement, creation and restoration. Ideally it would have had more restoration credit potential but its a great piece of habitat and will still be a profitable endeavor, I hope.

JM adds that a competitor in Washington County, Kral, found the right site, one where he predicts that can do a lot of restoration and earn more credits. He found it through personal contacts, much like CWS, DSL, and WP were lucky to find him, as he was already in the restoration loop and wanted restoration work done at HML. Though most of the HML work is in restoration, the site was not planned out as *the* site to bank on, nor did any incentives sway the banker to go there; finding it was fortuitous. Moiel says "good luck" finding the perfect site and then making a deal on it. Entrepreneurs have to be quite pragmatic about site selection.

Most banks have instead consisted of wetland enhancement. Does functional assessment give bankers the sites they need for their enhancement projects to pencil out? Maybe not, they think (see chapter 3). Yet consultant Brent Haddaway notes that bankers want to do enhancement precisely *because* bankers want to work in multiple credit type areas, i.e. in "the right position" - areas with wetlands and streams. By emphasizing hydrological uplift, however, ORWAP constrains bankers' enhancement work and may push it toward more risky wetland creation activity, Haddaway remarks. The assessment tool limits what bankers want to do. As a WP document puts it (2012, 4, available from

author), there will be “winners and losers” for using ORWAP to credit sites instead of ratios.

Regulators do not seem to be so concerned about the fallout from how ORWAP measures hydrological uplift. Not only does ORWAP impinge on enhancement work, but so do DSL regulations. DSL sets guidance on what types of land qualify as degraded and are hence appropriate for enhancement (DSL 2011). Essentially, the guidance makes it hard for cropped wetlands to count as degraded. For instance, compaction and tilling from farm activities do not count as enhanceable degradations. The agency’s goal here is to account for enhancement’s poor performance record and for the majority of impact types in the Portland metro area (Shaich and Franklin 1995). One of the most important functions lost in the urban landscape where most of the impacts occur is water storage and delay. But with enhancement there is very little improvement on that function. Water storage and delay may not actually be ecologically replaceable elsewhere (as Sean Pickles told us above) but not restoring it can nevertheless constitute a loss. Regulators and conservationists alike cite a report from EPA on mitigation in the Portland metro that looked at some of the earliest mitigation projects and found that most were enhancement or creation but failed to achieve the no net loss of functions and acreages goal (Shaich and Franklin 1995).

Consultant Mike Allsworth disagrees with the reasoning behind how DSL has determined hydrological degradation. He claims that of course the use of tiling and other farm activities change site hydrology.

> Allsworth: What’s hydrologic degradation? Well, tiling. Now there’s a lot of research out there, there’s some science out there that shows that these sites that are farmed on a regular basis where they come in and they till em and the put in a plow pan and they put in these little shallow ditches, those have limited effect but farming a site on an annual basis has a significant impact on the amount of water that flushes off the site initially. ... That’s hydrologic degradation, but that’s not enough [for DSL]. Now, ok, what’s enough? What’s - there’s the question, that’s the science that I wonder, how much hydrologic degradation is necessary to qualify?

Allsworth critiques DSL’s characterization of degradation as too subjective because it does not provide a standard, numerical basis for determining degradation. Theoretically, the use of ORWAP would resolve this problem since the assessment tool does provide a measure of actual hydrologic degradation and lift. However, as I illustrated in the last

chapter, consultants claim that ORWAP is actually not sensitive enough to pick up on changes in hydrological functioning. The result is that entrepreneurs are stuck in a double bind. The assessment tool that DSL is set to require them to use does not provide them the number of credits they would expect from their tried and trued cropped wetland enhancement sites. Even if ORWAP did give them the right numbers, DSL has already more or less taken a whole class of ecosystems off the map for restoration work. DSL says "restore functions," but does not provide the means or the spaces for entrepreneurs to do so.

When accounting for the spatial dependence of ecosystem service provision, the state is somewhat conciliatory to entrepreneurs on several points, like the effect of offsite reed canary grass, quarries, or beavers on a bank, or bank placement in watershed priority sites. The state is however now pushing consultants to restore the spaces it believes can provide some kind of functional gain. These are not cropped wetlands or sites with enhancement potential. Functional assessment has been difficult to deploy, because the spaces ORWAP and agency rules make visible as strategic for banking are not the ones entrepreneurs see. Some consultants suggest bankers will quit working; others talk of lawsuits. The question is: How far the state will push on functions and values going forward and to what effect?

4.4: Crisis?

To understand the extent to which the state will keep working towards better site assessment and selection for the market and to what effect, I argue that it is helpful to see the problematics of value's measure as reaching a crisis point. This means attending to the specifics of the current political moment and how they might differ over time. Without a crisis moment perspective, we might see bankers refraining from restoration or suing the state as flukes that can be solved with better rules, maps, or assessment tools, rather than seeing them as part of a more systemic problem. That problem is what most market actors would agree is an ecological crisis, in that the Willamette Valley continues to lose wetland and stream functions and habitat. This is knotted into a crisis of capitalism, where restoration entrepreneurs are unable to profitably improve ecosystems at the same time developers need to buy their credits to cover impacts. In turn, this is

wrapped up into an institutional crisis over implementing mandates to advance watershed approaches and functional assessment. The crisis revolves around the ability of regulators, conservationists, and bankers to account for what they see as nature's values.

As a regulation-based market, the agencies that comprise the state play a pivotal role in fashioning and resolving the crisis. Whitehead et al. (2006, 87) aid us in understanding state spatial strategies in demonstrating how land use maps allow states "to make sense of nature and order it spatially" by imagining different uses to which states could subject land. When regulators from DSL or EPA point out a particular habitat on the Synthesis Map, they imagine that land as worthwhile to restore. What Whitehead et al. (2006) are not so helpful for in the Oregon case is explaining why states become interested specifically in "putting a value" on nature/land. In their theory, the state is selfish - out to centralize and territorialize for its own ends. But the capitalist state is also wrapped up in regulating the excesses of capital even as it facilitates accumulation (Polanyi 1944). The state plays a vital role in constituting, or "articulating," the (spatially-explicit) value of the ecosystem services entrepreneurs wish to restore (Robertson 2012b; Ernstson 2012).

The state does not, however, necessarily make value out of thin air at the behest of capital (Jessop 2002). David Harvey (1982) shows us why the value of nature is constituted spatially and the effects of how states come to assess it. In his grand re-reading of Marx's critique of capitalism, Harvey argues that landowners play a "coordinating role" in facilitating and constraining accumulation as capitalists engage with the land. Land has no value per se, just a payment price, or ground rent. As rent does not reflect value proper, so capital is prone to over investment in (speculation) and underutilization of land. What matters here is that, for Harvey, the state can play a similar role to landowners in using signals like interest rates to coordinate how capitalists invest in land. Through land use planning and zoning, mapping COAs and other priority areas, and raising the bar for different types of restoration work, the state shapes how capital employs land to improve nature's benefits.[12] We have seen how mapping the good sites from the bad, the valuable from the not, can be detrimental to accumulation. In its

[12] The extent to which the state can do this is in part reliant on regulators securing digital tools and objects that allow the state and its allies to point to a map or spreadsheet and say, "this is valuable" (Meehan et al. 2013).

coordinating role, the state may not serve merely as "the executive committee of the bourgeoisie":

> While the state can undoubtedly put its stamp on geographical structures, it does not necessarily do so in ways that effectively bind the use of land to competition or the process of geographical re-structuring to the accumulation of capital. (Harvey 1982, 271)

The state does not always serve as the political apparatus of capitalists even as it organizes investment in the land. Harvey suggests that the state can go too far. Through its own investments, strong regulations, and outright ownership of land, the state can question the very ideal of private property. To be clear, Oregon regulators have not abolished private ownership, but they are constraining restoration capital by devaluing enhancement of cropped wetlands and prioritizing site selection.[13] Harvey illustrates how value can - and ultimately, must - work for capital at the same time the state can ask entrepreneurs to go to more costly but more valuable places.

Understanding the state as both facilitator and constrainer of capital suggests that the effect of the state's current spatial planning in Oregon's ecosystem services market is in the long-run ambivalent. That bankers are in fact not content with how the state has constituted value in the market means that the state currently operates in a market-constraining mode. But, as the Oregon banker and consultant JM highlighted earlier, priority area maps may facilitate banking by identifying and exposing potentially profitable sites. As such, bankers could eventually adjust to regulators' expectations about where it is best to do restoration. The result would constitute an "uneven development"(Smith 1984), or, "variegation" (Brenner, Peck, and Theodore 2010; Bakker 2013; Matulis 2013) of investment in restoration, where entrepreneurs come to site banks in those areas that have been named as the most ecologically and financially rewarding. This may not be problematic ecologically, except that it would likely enforce the split in which functions lost at in urban places like THPRD are replaced in rural areas like HML.

[13] Other kinds of land use restrictions coming from other parts of the state in Oregon have certainly triggered claims that private property is no more; see Walker and Hurley 2011)

4.5: Conclusion

The neighbor's complaint against permitting the THPRD trail was ultimately unsuccessful. However, the DSL-THPRD trade has been only one of a few in the salmon habitat currency so far. Another trade involving salmon habitat is in the works, again with agencies using the credits as proxies for stream quality (DSL 2012c). The application for the development permit and approval to purchase credits is being extended, in part because a commenting agency is requesting an alternative design. The Oregon Department Fish and Wildlife (ODFW) wants the developer of a new housing subdivision to implement a better culvert design so as to increase non-salmon fish passage and this would reduce the need for the developer to purchase stream credits. The ODFW commentator is perhaps worried about keeping fish in the city because only there does it have the same kind of value.

In Oregon's ecosystem services markets, the ways regulators, conservationists, and entrepreneurs plan for, choose, and evaluate restoration sites revolve around measures of "value." For them, value describes the opportunity and constraint for an ecosystem service to do something for society. Consultants, however, contest how the market currently articulates and circulates value. COTE participants want to move to a functions-based approach to mitigation, while consultants question: 1) why agencies see certain ecologies as valuable; 2) agencies' authority to ask them to do banking in priority areas; 3) whether functions-oriented assessments and rules will work for them. It is getting to the point where some consultants challenge the state's authority to ask them to use functional assessment. In this way, new strategies for governing resources not just at individual sites but across watersheds and landscapes are contested, contingent, and variegated (cf. Cohen 2012). The state in Oregon is using digital tools like ORWAP, GIS, and other mapping utilities to ask questions about what kinds of ecological functions are most valuable where. The greater the extent to which the state makes it difficult for developers to make impacts in valuable areas and incentivizes restoration in these areas, the more capital is constrained.

I have argued that the state's hand *becomes* strong in setting the precise terms of market-based conservation, and not necessarily in the sense of market roll-out. But whether it will continue to do so is questionable. Regulators find themselves in the

position of facing the contradictions of neoliberalization. Agencies have built a market to get private money into conservation, but want to compel where restoration is done. Ultimately, what looking at how states - with conservationist allies - and entrepreneurs plan for, choose, and evaluate restoration sites does is this: It focuses our attention on the spatial logics and political contexts of new markets in conservation (Roth and Dressler 2012). When Corson, MacDonald, and Neimark (2013) call for paying attention to the social relations and metrics of these markets, we should heed changes over time, within specific historical-geographical contexts, in order to see the moments where neoliberal conservation confronts its own contradictions. I flesh this idea out below in the conclusion.

Chapter 5: Conclusions

5.1: Ecosystem Service Logics

Pundits like Pavan Sukhdev are hopeful that ecosystem service markets are means to "putting a value," or price, on nature's benefits, while left-leaning scholars worry that this is exactly what will happen. Here, I have suggested that the design and implementation of markets for ecosystem services may not actually have the effect of commodifying and pricing the environment. According to environmental economists, the wetland, salmon habitat, water temperature commodities that define these markets require some kind of ecological measure, but the ones regulators and non-profit conservationist groups have introduced in Oregon have proven to be obstacles to fully-fledged trading and price discovery. At first glance, they did seem to work. In early 2012, DSL sold four salmon habitat restoration credits to a suburban Portland parks department. The sale was a key moment vindicating the COTE metric-making process and its test on the ground at HML. Salmon habitat functions like surface water storage were assessed, stacked with other credit types, and HML was well-positioned in the watershed context. It turned out, however, that the salmon habitat credit wasn't traded for an actual habitat impact. A neighbor to the park project disputed the functional assessment of the site. Though HML was a good place to do restoration, it was more of an opportunistic find than a strategic placement. HML was a state agency project which so far has not done its job of inspiring private restoration entrepreneurs to participate in a revitalized market.

Why haven't mitigation bankers adopted the HML model? Simply put, regulators' and conservationists' rationales for why there should be a market and how it should work differ from entrepreneurs'. More specifically, I've provided three answers in this thesis, all of which can contribute to the existing literature on market-oriented conservation governance. First, it helps political ecologists and those studying neoliberal natures explain how the production, application, and circulation of knowledge about nature is successful or is contested and what the effect on market outcomes is (chapter 3). I discussed how regulators, conservationists, and entrepreneurs have tried come to terms ecological assessments to use to define the credit commodities at the heart of the market. My argument was that different kinds of *expectations* about what measures can do are what prove controversial in and limiting to the market. For the most part, regulators and

entrepreneurs agree that the "stacking" of or selling of multiple kinds of credits from one site is sound practice, even if not ideal. Regulators themselves are divided on whether the salmon habitat credit is adequate for market purposes. It may be useful for now, but won't be in the long run. Entrepreneurs are skeptical of using functions-based assessment and crediting even though regulators have hoped bankers would adopt it. Everyone agrees the old system is broken, and the state gains some legitimacy as it points to statutory requirements to roll-out functional accounting. But at this point entrepreneurs are not likely follow through and implement functions-based banks.

The Oregon case also gives political ecologists and ecosystem services researchers alike reason to pay attention to the spatial logics of efficiency and prioritization which constitute the planning for, choosing, and evaluation of restoration sites for markets (chapter 4). My claim was that in Oregon these have limited market activity. Coming on the heels of the 2008 federal rule which prioritized watershed planning, COTE participants developed protocols that would drive restoration to the "right places" on the landscape and limit impacts to those areas. Regulators and non-profit conservationists adhering to this logic see the value in restoring nature as fundamentally spatial - some places are more worthwhile to restore than others. In a market restoration scheme, they argue, entrepreneurs should be guided to do restoration in these priority areas. Prioritization appears to be a revamping of the market to better commodify and commercialize wetland and stream ecosystems, and ultimately foster capital accumulation. But being driven to work in priority areas gives bankers a narrower range of landowners to work with. And all else equal, they'll want to work on sites where they can get the most credit bang for their restoration buck. Prioritization entails bankers having to work on sites with higher costs of restoration and potentially higher land prices, both of which would cut into their profits. This has led them to be hesitant to adopt the HML model of watershed planning and prioritization.

5.2: Not necessarily neoliberalization

Finally, what do the previous two explanations of why attempts to define an ecosystem service commodity have been contentious do for us? They illustrate that the maxim that "capital encounters barriers in its own nature" (Marx 1857, 410; also see

Smith 1984, 85) really does describe moments when capital confronts the environment just as well as it describes capitalist expansion in general. Revamping a market in ecosystem services might seem like a clear-cut case of a neoliberal roll-out of rules and regulations favorable to a capitalist accumulation of new kinds of resources. But I have argued that it is more ambiguous than that, and this ambiguity opens a political moment for intervention.

Oregon regulators' and conservationists' desire to revamp the market illustrates contradictions in the neoliberal logic of ecosystem markets. While the state wants entrepreneurs to restore ecosystems, it wants them to do so in what are not necessarily the most profitable locations - in "strategic" rather than "opportunistic" places. Regulators are in a position where they oversee a market that is based on the idea of welcoming private investment in ecosystem services restoration, yet they are uncomfortable with the idea of letting such investors invest just anywhere. Likewise, the state's move to roll-out new function-based measures of restoration success flounders on the fact that entrepreneurs are tied to the old currency. Again, regulators have designed and implemented a market that at its core was about facilitating private restoration of ecosystem services, but at the same time they do not think that just any definition of the credit commodity traded in the market will work. They would like to see a better credit, but it is one that constrains entrepreneurial restoration.

The state is forced to confront previous rounds of neoliberalization: previous mitigation banking ratio currencies, established in a first "wave" of neoliberalization, prove to be *the* barrier to implementing a better credit commodity. And it's hard now for the state to ask private bankers to do restoration in places the state values because the original goal of these "no net loss" markets was to privatize, commercialize, and commodify restoration. Regulators may or may not be able continue to hold their position vis-à-vis bankers. In large part, where the state will go will in large part depend on how regulators see themselves performing this project, but also whether entrepreneurs adjust to new market conditions.

The takeaway is that the long-term and short-term effects of market-oriented conservation projects are potentially two very different things. There is a difference between regulators', consultants', and conservationists' long-term and short-term

expectations about what knowledges can work for the market, and what nature can do. In the short-term, salmon habitat might work for regulators as a way to account for stream functions, but in the long-term it won't. The same goes for stacking - there is a consensus now, but credit bundlers might come around to advocate more strongly for their position. Regulators have long-term hopes for functions, but in the short-term this has meant entrepreneurs may not do restoration. Likewise, when it comes to where to do restoration, regulators and conservationists have implemented rules and measures that in the short-term constrain bankers. In the long-term, bankers might get used to what regulators expect from them when it comes to where to do restoration. The work that regulators and conservationists have done to map out priority sites could become useful visual aids for bankers - especially new ones - that describe where they could do work. As regulators and conservationists have them mapped out right now, restoration investments made in priority areas would exacerbate the split where urban ecosystem functions are lost in order to be compensated for in suburban, exurban, and rural areas. This intensification of investment in particularly worthwhile places at the expense of others is what several researchers are seeing now in a post-economic crisis, "post-neoliberal" world and calling "variegated" neoliberalization (Brenner, Peck, Theodore 2010; Bakker 2013; Matulis 2013; In general, this is uneven development. See Smith 1984). Ultimately, these moments where we can differentiate between short-term and long-run positions, powers, and consequences are precisely the sort of moments we should pay attention to in order to see how new markets can collapse under the weight of their own contradictions.

5.3: Future research

That there is an important difference between the short-term and the long-run suggests that ongoing research may prove worthwhile. Such work should explore how the state in Oregon continues to push restoration capital on the logic of ecosystem services. How regulators respond to the effects of climate change on restoration projects - or use the mitigation framework to confront it - will be a vital moment in this. Climate change promises to make crop production, urban living, and species and habitat conservation more challenging around the world, and in some places more than others. Oregon may not be the world's worst off, but policy-makers, scientists, and conservationists there are

nevertheless worried. As the authors of the government-commissioned Oregon Climate Change Adaptation Plan predicted in 2010, "natural hazards, water supply problems, drought, habitat changes and loss of ecosystem services will all affect Oregon's citizens, communities, and economy." They have not lost all hope, though, as they continued, "fortunately, many of the potential costs and consequences of climate change may be anticipated and planned for" (i). State and local-level governments in Oregon have for nearly 40 years now implemented what are likely the country's most comprehensive strategies and regulations for limiting and directing how businesses develop land and modify ecosystems (Walker and Hurley 2011). It comes as little surprise that government agencies there are to at least some extent attempting to plan for the effects of climate change.

One way agencies might strategize climate change adaptation is through ecological restoration, as a way of making ecosystem functions and services more "resilient" to climate variability and weather intensification. As we have seen, planning for and assessing restoration success is a task which brings regulators, scientists, conservationists, and entrepreneurs to the same table. Two years after the climate adaptation report was released, authors of an Integrated Water Resources Strategy (2012) requested by the state legislature boasted that, "Oregon has taken the unusual step of crafting a plan without waiting for statewide drought, flooding, litigation, or other crisis, unlike many other states" as part of "assist[ing] with climate change adaptation and resiliency strategies." The question that needs to be asked is, by which metrics does Oregon assess the success of its adaptation? This assumes that success as a finally achieved goal is even possible. It may not be if Oregon ecosystems and institutions are supposed to become dynamic and "resilient."

Already, two developments point to early answers to how regulators will ask restoration entrepreneurs to do about climate change. Right before Thanksgiving 2012, state and federal agencies released preliminary guidance on the kinds of things they want entrepreneurs and developers that impact streams to be assessing. In the guidance document, they do focus on the need to assess stream resiliency over time. Meanwhile, municipal entities in Medford and Eugene are paying landowners to plant riparian trees to shade streams. Their goal ultimately is to protect salmon habitat, which is likely to be

affected by higher temperatures and variability in snowmelt timing and amount. Understanding how these cities account for climate impacts in their programs will at the very least mean asking questions about site selection and ecological assessment - in short, everything I've talked about here. But the payoff will be insight into the dynamics of increasingly locally or regionally-based responses to the global problem of climate change.

APPENDIX A

Frequently Used Acronyms

Corps – Army Corps of Engineers

CWA – Clean Water Act

CWS – Clean Water Services

DEQ – Oregon Department of Environmental Quality

DSL – Oregon Department of State Lands

EPA – Environmental Protection Agency

ESA – Endangered Species Act

MEA – Millennium Ecosystem Assessment

NCP – The Natural Capital Project

NOAA NMFS – National Oceanic and Atmospheric Administration's National Marine Fisheries Services

NRC – National Research Council

ORWAP – Oregon Rapid Wetlands Assessment Protocol

TEEB – The Economics of the Environment and Biodiversity

TMDL – Total Maximum Daily Load

TNC – The Nature Conservancy

USFWS – United State Fish and Wildlife Service

WP – Willamette Partnership

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