RATIONAL ENCHANTMENT: INSTITUTING ECUADORIAN BIODIVERSITY

by

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Abstract

An increasing concern for biodiversity loss transformed politics and society in Ecuador beginning in the late 1980s. Amidst a proliferation of expert work to gain new knowledge of *what* biodiversity existed *where* in order to curb species extinctions, both the state of biological science and the way that Ecuador was governed were remade. To examine the institution of biodiversity and its contemporary consequences in Ecuador, this dissertation draws on ethnography with and archival research on a community of botanists connected with Ecuador's National Herbarium. It begins by examining the specialized work that formed the foundation for NGO-led biodiversity conservation. It then looks at the rise of environmental impact assessment used to anticipate and mitigate the impacts of development projects. Finally, the dissertation examines the contemporary dilemmas of Ecuadorian field biologists in the context of the recent dismantling of much of this institutional infrastructure from the last 30 years.

The dissertation's central argument is that biodiversity is an intrinsically modern (and relatively recent) relationship to biological resources, and that it comes with many of the dilemmas and problems that characterize modern institutions. Its emergence as a recognizable domain, either of expert management or more general social commitment, is inextricably bound up with the production of certain forms of specialized knowledge, and the use of that knowledge in authorizing certain kinds of institutional interventions. A mis-recognition of this aspect of biodiversity (for example, by conflating 'biodiversity' with 'biological things themselves') risks misunderstanding what kind of an object it is, to the detriment of anthropological critiques of environmental politics.

Introduction

But when the time came for my return to Panuré (for I had to give up the boat and Indians by a certain day) the weather cleared up, and as we shot down among the rocks which there obstruct the course of the river, on a sunny morning, I well recollect how the banks of the river had become clad with flowers, as it were by some sudden magic, and how I said to myself, as I scanned the lofty trees with wistful and disappointed eyes, “There goes a new Dipteryx - there goes a new Qualea - there goes a new ‘the Lord knows what’!" until I could no longer bear the sight, and covering up my face with my hands, I resigned myself to the sorrowful reflection that I must leave all these fine things “to waste their sweetness on the desert air”.

Richard Spruce, 1908[1858]: 208-209

In summary, we do not know how many endemic species have already gone extinct on Centinela; all are in dire peril. Although all or most of the trees that were endemic to Centinela may already be extinct… many of the herbs and epiphytes have thus far survived… The only solid conclusion may be that we still know so extremely little about the plants of western Ecuador and their distributions that we cannot hope to make educated conservational decisions without a far more extensive floristic data base.

Calaway Dodson and Alwyn Gentry, 1991: 292

Biodiversity as a Problem

This dissertation is concerned with the historical emergence and present dynamics of biodiversity as a problem in Ecuador. Since biodiversity is commonly understood as a resource, describing it as a 'problem' may seem counterintuitive. Obviously, the problem is biodiversity *loss* (or the destruction of whole types of living forms faster than new types are produced). But a concern for species extinctions is typically coupled with various uncertainties: about what living forms are actually 'out there'; what forms have already gone extinct; how they function together in an ecosystem; what potential utilities they pose for humans; what might be 'driving' extinctions; and what kinds of relationships we ought to cultivate with biodiversity to avoid destroying it in the first place. By describing biodiversity as a 'problem', I reference this larger complex of interrelated unknowns, anxieties and dilemmas.

The problem of biodiversity did not appear overnight in Ecuador. It built on longstanding Western relationships to biological resources. South America has historically been an important region for European and American travelers to encounter cultural otherness and environmental abundance across colonial and post-colonial contexts (Pratt 1992; Stepan 2001; Raffles 2003). The first quote in the frontispiece, from a letter by the English botanist Richard Spruce, demonstrates this clearly. Spruce entered Ecuador via the watershed of the Pastaza River in eastern Ecuador after making sidetrips in the western Brazilian Amazon such as the one he describes in this passage. By his own account, he was overcome with wonder at the diversity of flora he found in that region.

Dodson and Gentry's quote from their 1991 paper 'Biological extinction in western Ecuador' expressed a different kind of amazement, at the rapidity with which the

highly diverse flora they studied was being destroyed as a consequence of informal settlement. Spruce had been haunted by the sense that he was leaving behind a natural bounty to languish unappreciated and unstudied by science. Dodson and Gentry, on the other hand, seem haunted by the sense of racing against time, and the feeling that much had already been permanently lost without being able to specify *what*.[1] Both the quotes from Spruce, and Dodson and Gentry show the tremendous value placed by foreigners on the South American flora they came into contact with in the midst of their fieldwork. They also hint at an evolution in the role of botanists and their science, from ad hoc biological collecting in localities that were perceived as incredibly rich, to a struggle to find mechanisms for the rational management of living things, en masse and in situ, as these localities appeared increasingly endangered by human activity.

As field collectors for St. Louis-based Missouri Botanical Garden, Dodson and Gentry were keenly aware of their institution's attempts to construct a database for Andean South America like the one they called for, to support conservation decisions. A database would need to both consolidate existing scientific knowledge, and incorporate new basic botanical field research to find undescribed species and range extensions. Furthermore, whatever numbers such work produced would only be meaningful in relation to other estimates, for example at the national or global levels.

Historically, all such numbers have varied wildly. Spruce had thought the area he traversed entering eastern Ecuador contained 70-80,000 plant species, though he lacked much basis for thinking about global totals. In 1990, Balslev and Renner estimated that Ecuador had a minimum of 16,500 vascular plants residing in it, though they were

[1] This was a common tone in conservationist discourse. See for example E. O. Wilson's *The Diversity of Life* (1992), which cites the example of Dodson and Gentry's work at Centinela.

working with a checklist limited to the Amazon and containing only 3300 records. Others estimated a minimum of 20,000 for Ecuador (Gentry 1978, Harling 1986). Yet, when botanists from Missouri Botanical Garden, Denmark's Aarhus University, and Quito's Pontifical Catholic University began collaborating to produce a flora for the country in the 1980s, it at first seemed like they might not top 10,000 known species (David Neill, pers. comm.). A *Catalog of Vascular Plants of Ecuador* was eventually published through their collaboration in 1999 (Jorgensen et al. 1999), more than a decade after its planning had commenced. Its tally reached 15,901 scientifically known, systematically reviewed plant species. In the time it had taken to produce that volume, intense interest in tropical rainforest conservation and a plant collecting bonanza precipitated by oil development had produced many hundreds of new species that needed to be added to the country's flora later in the 2000s (Ulloa and Neill 2005; Neill and Ulloa 2011).

Prior to the widespread availability of digital academic databases and the internet, producing the *Catalog* was a monstrous logistical problem. It required networking via mail with over 230 specialists in plant families distributed around the globe; collecting their literature and reviews of their own herbaria collections; collating these; and checking for errors and redundancies. This work was combined with plant collecting on the ground in Ecuador to fill gaps that collectors believed (though they could not know) to exist in extant floristic knowledge. The digital database that eventually emerged at Missouri Botanical Garden from this work contains well over 400,000 specimens from Ecuador, and thousands more were shipped elsewhere in order to obtain identifications. It turned out to be extraordinarily difficult to learn what science already 'knew' about plant diversity in Ecuador. And amidst the work involved in gaining new knowledge of *what*

biodiversity existed *where*, both the state of the science and the way that Ecuador was governed were transformed. By the time the *Catalog* was published in 1999, Ecuador had already been designated as a 'megadiverse' country (Mittermeier et al. 1997). It had a highly active field of NGOs that were guided by subnational spatial designations like 'biodiversity hot spots' (Myers 1990; Reid 1998), and which relied on its National Herbarium for botanical data. It had new norms that governed petroleum, its most lucrative economic sector, through 'environmental impact assessments', in which biodiversity inventory was a key component. And it had a Ministry of the Environment, formed in 1996 with a World Bank grant. A key condition of that grant was the creation of a national vegetation map – for which the requisite scientific infrastructure was conveniently already available.

Thirty years of some of the most intense biological inventory in the world have hardly produced a sense of Weberian disenchantment about the extent of biodiversity in Ecuador, 'the knowledge or belief that if one but wished, one could learn it at any time' (Weber 1917: 139). On the contrary, the country's biological resources are not considered exhaustively scientifically known. Current estimates place the total number of vascular plant species in the country at around 25,000, of which 18,000 are known. Estimates for the global total hover around 250,000 (Neill 2012). According to these (rough and continuously evolving) numbers, perhaps 7,000 species remain undescribed in Ecuador; and about 10% of the world's vascular plant diversity is thought to reside in a country the size of the U.S. state of Colorado. Much of this diversity remains 'threatened' in one way or another. And while plants are viewed as a valuable national patrimony by biologists, agronomists and others, economic uses for them that are

sustainable, equitable and (crucially) scalable are elusive. Simultaneously, Ecuador's biodiversity and its status as a megadiverse country have become a touchstone of national identity for many Ecuadorians, and conserving biodiversity is an ethical commitment they share with many foreign visitors. Where one would not have encountered the word 'biodiversity' in Ecuador for most of the 1980s, it is now a prominent problem there, in the broad sense described at the outset of this introduction.

To think about these processes – the institution of biodiversity – this dissertation draws on ethnography with, and archival research on a community of botanists connected in diverse ways with Ecuador's National Herbarium. Its central argument is that biodiversity is an intrinsically modern (and relatively recent) relationship to biological resources, and that it comes with many of the dilemmas and problems that characterize modern institutions. Its emergence as a recognizable domain, either of expert management or more general social commitment, is inextricably bound up with the production of certain forms of specialized knowledge, and the use of that knowledge in authorizing certain kinds of institutional interventions. A failure to appreciate this aspect of biodiversity (for example, by conflating 'biodiversity' with the 'biological things themselves') risks misunderstanding what kind of an object it is, to the detriment of anthropological critiques of environmental politics.

In the remainder of this introduction, I briefly highlight some of the theoretical conversations that form a starting point for the empirical work undertaken here. I then consider the history of Ecuador since the end of its military dictatorship in 1980, with special attention to the intersection of the country's petroleum economy, macroeconomic crises, and environmental and natural resource governance. Because the ethnographic

approach taken here is distinct, I then turn to a discussion of the 'community of practice' as an ethnographic starting point for understanding environmental expertise. I follow this with a description of the participant observation, interviews and archival work that constituted my core methods. The introduction closes with a brief outline and discussion of the analysis contained in the body of the thesis.

Theorizing Environmental Expertise: Governmentality, Infrastructure and Expert Subjects

This dissertation focuses on the work of characteristically modern specialists – scientists, technicians, administrators – in the study and management of biodiversity in Ecuador. The body of the dissertation deals with a number of issues in different literatures. Nonetheless, the overall orientation of the research can be understood by examining literature on governmentality inspired by Michel Foucault; science and technology studies scholarship on knowledge infrastructure; and the emerging anthropology of expertise. Since these literatures are not closely associated, and because they are rarely used as a starting point for research on environmental politics, it is worthwhile to carefully draw out the connections between them that are useful to this dissertation. The style of analysis that Foucault developed under the name 'governmentality' forms an especially important point of reference.

In arguing for a need to study 'governmentality', Foucault drew attention to what he characterized as an 'overvaluation of the problem of the state' (2007: 108-9) in political theory. By this he meant that analyses of European development tended to treat political power as the sole purview of a 'state' that could be unproblematically

individuated from ‘society’; and that in such analyses the state typically had a pre-ordained role. In the course of analysis, ‘the state’ tended to be reified as a unitary, volitional agent with motives that were clearly specified in advance. This made it difficult to identify historical changes in how the problems confronting political power were perceived, or how solutions to them were designed.

Foucault’s response to the overvaluation of the state was to radically expand the focus of analysis, from formal operations of the state to the general planning of human organization, what Burchell et al. (1991) later paraphrased as the ‘conduct of conduct’. He emphasized that ‘government’ had a range of connotations that were not limited to the workings of the state. For example, early political economists had reasoned about the proper role of the state vis a vis society on the analogy of the ‘government of the household’, or the right dispensation of the household’s members and resources according to a presumed natural order; the sense of ‘government’ as a state function was partially a product of the word’s transference from other contexts. For Foucault, studying ‘governmentality’ meant understanding permutations in reasoning about the conduct of human conduct, more broadly (Rose et al 2006). This formed the starting point for analyzing series of historically specific problems and the solutions devised to deal with them, some of which achieved sufficient inertia to remain enduring parts of Western liberal political institutions (Foucault 2007, 2008).

As an analytical approach, ‘governmentality’ was not principally concerned with analyzing neoliberalism, so much as constructing a more general genealogy of liberalism (cf. Rose et al 2006). Nonetheless, a flexible, open-ended analysis of political reasoning has proven particularly useful for some scholars as austerity and privatization have

altered the role of the state in environmental governance in much of the world (Goldman 2005; Liverman and Vilas 2006); and networks of bilateral aid agencies, multilateral lenders, NGOs and private firms have taken prominent roles in managing social relationships with the environment (Fisher 1997; Leach and Fairhead 2003; Brosius 1999; Li 2007).

Scholarship on Latin American neoliberalism and the environment has primarily drawn on Marxian or institutional economic theory. This literature has analyzed the changes brought by neoliberalism at different scales, and has not shared a single definition of neoliberalism (Castree 2010). Whereas the consequences of reducing social spending and subsidies in Latin American countries have been widely regarded as catastrophic, assessments of the effects of market-oriented policies on natural resource management seem to have been more mixed (Liverman and Vilas 2006; Perrault and Martin 2005). For example, decentralization may have created opportunities for greater public participation in resource governance (e.g. Wilder 2010). Nonetheless, in contexts with well-established institutions for managing natural resources, their forced reorganization in accordance with generic free-market norms (especially the norm that markets can only function when property is held individually) seems often to have contributed to the economic vulnerability of local people and encouraged over-exploitation of their resource base (Greenberg 2006; Klooster 2003), without necessarily improving democratic participation (Vásquez-León 2010).

The rise of biodiversity conservation as a ubiquitous concern has been correlated with the rise of neoliberalism; yet, since it is understood to be a response to the excesses of (typically capitalist) resource extraction, or 'economic externalities', reviews of the

literature have not tended to analyze it alongside neoliberalism's impact on natural resource domains like forest or aquaculture (e.g. Liverman and Vilas 2006). Biodiversity and neoliberalism have been explicitly considered in tandem primarily in the context of programs explicitly oriented toward the commodification of local resources, like payments for ecosystem services, as these have gained traction in the 2000s (Igoe and Brockington 2007).

A gap arguably exists in this literature, which has focused either on a) local responses to land and natural resource enclosure or b) the increasing imbrication of conservation with commodification. In these different academic conversations, *what biodiversity is* often remains unproblematized. Thus, reviewing the literature on neoliberalism and the environment in Latin America, Liverman and Vilas (2006) recognize the recency of biodiversity as a form of 'value' (330). Because they focused on literature that can paint a 'before' and 'after' portrait of neoliberalism's effects, and on resources already unambiguously commodified, it would have been difficult for them to incorporate literature on biodiversity in their review. This is precisely the utility of a 'governmental' approach, as it allows identifying the origins of political problems, and tracing their development while remaining agnostic about whether or not they will follow clearly defined institutional trajectories. In lieu of historicizing biodiversity in this way, it is difficult to understand a) on what basis programs of conservation became possible in the first place; and b) whether the more recent 'neoliberal' variant is best understood as a corruption or displacement of intrinsically preferable relationships to resources that preceded it (as routinely implied by the literature above). With an analytical perspective informed by studies of governmentality, chapters two and three argue at length that

understanding *how* biodiversity became a problem in particular contexts (protected area planning and environmental consulting) denaturalizes it, and helps us to better grasp what kind of a thing it is.

Governmentality forms a flexible and (for Foucault, at least) non-normative starting point for understanding the emergence of a broad domain like biodiversity as a problem. But because the governmentality scholarship has been primarily focused on expert plans, studying the actualization of those plans requires additional theoretical resources. Scholarship in science and technology studies is useful in this regard. A basic insight of STS is that experts are not 'brains in vats' (Latour 1999); they are always embedded in sociotechnical contexts. Their products (e.g. inventions or scientific breakthroughs) can often be understood as an outcome of the interaction of the 'agency' of contingent arrays of human and non-human actors, often amidst contests for scientific prestige or domination of a particular market niche (Latour and Woolgar 1979). This orientation has been taken up by critical scholarship on the environment from a number of different angles; emphasizing the role of the materiality of the environment; the intrinsically political nature of science; the maintenance of boundaries between different kinds of experts; and shifting understandings of what 'the environment' itself is (Braun and Whatmore 2010; Jørgensen et al. 2013; Goldman et al 2011; Olson 2013).

STS literature on 'knowledge infrastructures' takes up an interest in networks of human and non-human 'actants', but focuses on the dynamics of larger systems of knowledge production (Star 1989; Star and Ruhleder 1995; Bowker 1996; Star and Bowker 2010). As these systems are defined in part by the way they endure over long periods of time, temporality is a prominent concern in this literature (Bowker 2015;

Karasti et al 2010). One example is the long-term cycles of feedback knowledge infrastructures may produce. For example, the presumption that a place exhibits high biodiversity often results in that place being the focus of disproportionate effort to study and manage biodiversity, with the consequence that a positive feedback loop is formed (Bowker 2001). The recognition of these forms of feedback suggests that understanding the effects of knowledge infrastructures requires studying them with longitudinal depth, although studies that take this step are relatively rare (but see Karasti et al. 2016).

Rabinow (2003) proposes a distinction between 'assemblage' and 'apparatus' that is useful in thinking about the temporal dynamics of knowledge infrastructures, and the broader contexts in which they are embedded. Under his definition, an assemblage is a heterogeneous configuration with emergent dynamics: it produces something novel, the advent of which fundamentally changes the context in which it was produced. On the other hand, an apparatus is a more stable configuration, characteristically concerned with the management of problems that are retrospectively taken to be self-evident. Schematically, the formation of environmental institutions in Ecuador over the last thirty years can partially be understood in terms of a movement from periods of dynamism and fluidity in which some 'assemblage' was active, to a more stable 'apparatus' in both biodiversity conservation (chapter two) and environmental consulting (chapter three).

Over the historical timeframe examined here, and amidst these dramatic institutional changes, it would be reasonable to suspect that cultural relationships to the environment have changed as well. This is particularly the case for environmental specialists, who work in recently created institutions, and whose work is focused on historically novel forms of managerial intervention. How specialists perceive and reason

about the environment, relate to 'nature', or conceive of their environmental responsibilities is obviously an important component of environmental politics. Yet, on the basis of the approaches discussed so far, it remains difficult to ask basic anthropological questions about environmental experts: who are they, and how do they make sense of the world?

Linguistic anthropology has been a source of innovation with regard to the ethnographic study of experts (Carr 2010). Focusing on 'communities of practice', linguistic anthropologists have examined the training of experts, particularly in legal and medical settings (e.g. Mertz 2007; Brada 2013; Carr 2013). This literature approaches expertise as something done rather than as a latent property of the expert in question, with expert practices forming the empirical point of departure for understanding how expert professional identities are learned and mobilized.

The focus on practices as a means for crafting expert selves is a crucial complement to the literature on governmentality (focused on the discourses and practices that experts design to cope with social problems); and knowledge infrastructure (focused on the deployment of expert practices to provision knowledge, often to other experts). Methodologically, the use of practices to define expert communities is also an important component of my work, discussed below. Unfortunately, much of the recent linguistic anthropology of expertise has viewed the production of experts with a high degree of skepticism, seeing claims to expert knowledge as both misleading and potentially oppressive, and in need of debunking. While the world of international development and petroleum politics inhabited by American and Ecuadorian biologists over the last thirty years is certainly full of cynical interests, it is also a domain of earnest reflection about

social and environmental problems, and the role that legitimate specialized knowledge will have to play in addressing them. Thus, in chapter four I draw on recent anthropological literature on ethics (Faubion 2011; Lambek 2010) and technopolitics (Ong and Collier 2005; Fortun and Fortun 2005; Marcus 2003) to think about the imbrication of 'governmental' reasoning (focused on the management of others) and ethical reflection (focused on trying to be the right kind self) in Ecuadorian field biology. As I show in that chapter, a focus on the production of expert subjects from the perspective proposed here exposes the complexities of Ecuador's politics after the heyday of neoliberalism, and instantly complicates any simple dichotomization of dominant and subaltern, or governor and governed in environmental politics.

Guided by the theoretical orientations outlined above, this dissertation chronicles how environmental expertise has iteratively resituated itself amidst political technologies of its own design in Ecuador since the mid-1980s. To borrow another term from Foucault, biologists in Ecuador have progressively 'problematized' the environment (Foucault 1984; Rabinow 2003): in the ruptures produced by drastic economic problems and rapidly changing political institutions, they have progressively studied the environment, exposed it to a variety of forms of expert thought and action, uncovered unanticipated complexities, and responded to the planned and incidental effects of their own interventions. In the process they have played roles in producing biodiversity as a pervasive focus of management, and a point of reference for widely held social values and ethical self-understanding. In order to understand the broader context in which this expert work occurred, I briefly examine some salient features of Ecuador's history since the 1980s.

Historical Context: Petroleum, Economic Crisis and the Environment in Ecuador

The 1980s saw major changes in Ecuador, as democratic rule was reinstituted; fluctuations in the oil market created an unpredictable economic climate; and austerity and privatization became watchwords of governance in the region. In order to historically situate the unprecedented domestic and international interest in the country's biotic environment that emerged in the 1990s, I examine the history of the country's petroleum economy beginning and the reinstatement of civilian rule in 1980. I then turn to the pressures experienced by Ecuador to maintain a 'market-oriented' and 'investment friendly' climate amidst ongoing economic difficulties in the 1980s and 1990s, and the resultant social backlash. Finally I briefly consider the emergence of environmental governance as a major concern in the country, and the push for greater economic independence under Rafael Correa beginning in 2006.

Petroleum reserves were discovered in Ecuador in the early 20th century, although the major Amazonian commercial reserves that have formed the bulk of the country's oil wealth were not developed until the 1960s. Martz (1987) argues that competition over control of the oil field and its products was a fundamental driver of regime change in the country from the early 1970s through the mid-1980s. The dictatorship that took over Ecuador in 1972 was legitimated by popular resentment toward previous administrations for having given away too much, too easily to foreign oil companies. High oil prices and the significant leverage held by OPEC in the 1970s made it feasible to gradually ratchet up Ecuador's control over the oil field during that time (Hey 1995). Oil revenue also made Ecuador appear a good credit risk for international development loans.

Yet, with about half of state revenue derived from oil, the country was at the mercy of the international petroleum market, and found itself with a massive debt burden that it struggled to pay back as prices fell after the turn of the decade (Martz 1987). These economic struggles played a part in ending the country's military dictatorship at the close of the 1970s. After protectionist policies under the dictatorship that drove away some foreign oil firms, Ecuador made a notable turn toward encouraging foreign investment in petroleum under Oswaldo Hurtado, who was elected in 1980 (Hey 1995). Hurtado also passed highly unpopular austerity measures to deal with the economic problems resulting from declining oil prices and mounting foreign debt (ibid.). These policies have subsequently been identified as initiating a more general, sustained turn to 'market-oriented', neoliberal policies in Ecuador (Hey and Klak 1999). In the 1980s and 1990s Ecuadorian leaders initiated these policies to deal with the country's economic problems in a manner that would not cause friction with IFIs in the course of renegotiating its significant foreign debt (ibid.; USAID 2000).

Liberal economic policies in the context of a serious downturn in standards of living for many Ecuadorians invigorated popular protest (Weiss 1997; Zamosc 1994; Postero 2005). Historically, popular movements in Ecuador have been split between those that are class-based, and those predicated on ethnic criteria, typically indigenous rights. Within indigenous movements there has been a further major split between advocacy by highland and lowland groups. Protest against austerity measures had the effect of fueling and consolidating indigenous rights movements in Ecuador, with many groups having significantly strengthened political organizations as a result (Jackson and Warren 2005, Lucero 2008). Simultaneously, lowland indigenous peoples gained new

visibility in protesting oil extraction in the middle of the 1990s (Sawyer 2004). The confrontation between the 'Goliath' of multinational oil and the 'David' of grassroots opposition resonated powerfully for Ecuadorian observers (Narváez 2009), legal activists (Kimerling 1990) and the donor base of international environmental NGOs (e.g. RAN 1991). The convergence between local protest and domestic and international environmental advocacy rapidly developed a schism between more politically radical, and more mainstream organizations that found it advantageous to compromise with oil companies (Rival 2011; the latter group included the National Herbarium). Subsequent interactions between indigenous peoples and environmental interests have been highly complex (Erazo 2013; Stocks et al. 2012).

As was the case elsewhere in Latin America, popular protest confronted a state significantly weakened by austerity measures, and macroeconomic problems (Hale 2006). The causes of Ecuador's banking crisis at the turn of the millennium are the subject of a literature unto themselves, although a credit boom in the mid-1990s is seen as having significantly contributed to inflation (Jácome 2004; de la Torre et al. 2001), which went unabated thanks to financial deregulation (SAPRI 2001). Annual inflation reached almost 100% in 1999 (USAID 2000), and nearly twice that in last months of the year as the banking system completely shut down (Jácome 2004). Ecuador's President Mahuad switched the currency to the U.S. dollar and froze the country's banks in an attempt to short-circuit inflation, although he was deposed in 2000. International assistance was required to get Ecuador's banking system functioning again. These negotiations brought a Structural Adjustment Program, worked out with the World Bank and implemented in

2001 (World Bank 2003). The interaction of austerity and inflation in creating institutional room for new environmental actors is discussed in chapter two.

What are now understood as the country's 'environmental' problems are closely linked to its wealth disparities, historically regarded as the most polarized in the Andean region (Hey and Klack 1999; Martz 1987). The period of oil wealth was associated with an exacerbation in monetary income disparities in Ecuador (ibid.). Moreover, the hacienda system left Ecuador with radically polarized land tenure that the country found difficult to remediate, despite four different agrarian reform laws in the latter half of the 20th century (Barsky 1984). Ecuador had 'tierras baldias' laws characteristic of former Spanish colonies, that framed land with forest as uninhabited and not being productively used (Guy and Sheridan 1998). With significant pressure on agricultural portions of the Sierra and southern coast, many Ecuadorians informally settled and cleared the land to receive a formal title from the country's colonization department. Particularly on the northern coast, informal settlement fed into regional timber industry (Sierra and Stallings 1998), leading to widespread deforestation such as that observed by Dodson and Gentry (1991). As the botanists' article indicates, deforestation from informal settlement was understood to be the primary focus of conservation efforts at the beginning of the 1990s. However, the gradual emergence of serious controversy about the damage done by Texaco in the 1970s as a new round of oil contracts were signed in the 1990s redirected the attention of environmental NGOs and activism more generally. The interaction of activism, governance and the oil extraction is discussed in greater depth in chapter three.

Ecuador's economy stabilized in the mid-2000s, although the series of economic crises and liberal policy fixes had provoked serious popular resentment. Rafael Correa

was elected in 2006 amidst the region's turn to more pronounced leftist politics, promising a novel commitment to social welfare in the country (Radcliffe 2012). His ability to cancel significant portion of the country's foreign debt, and attempts at achieving greater control of oil through higher taxes marked a new period in the country's politics (Arsel and Angel 2012). As I discuss in chapters three and four, his presidency saw complex confrontations between the country's environmental actors and resource extraction, with significant portions of the apparatus of environmental governance that had developed under previous administrations dismantled. This dissertation's ethnography was conducted in the context of deterioration of the environmental impact assessment process and the dismantling and defunding of environmental NGOs. At the same time, there was extensive controversy about whether or not to conduct further oil development in Yasuní National Park, Ecuador's largest protected area, among other environmental issues.

Conceptualizing the Object of Study: Ethnography of an Expert Community of Practice

This project brings ethnographic depth to the study of environmental expertise, through long-term participant observation of professional scientists, administrators and technicians. In order to understand how that expertise was constituted among the people I studied most closely, and to have some comparative context for understanding them, I necessarily followed or sought out experts across a range of institutions and physical settings in Ecuador. These twin features of the work – striving for ethnographic depth with a specific kind of 'expertise' and tracking or seeking out experts across contexts –

meant that the project demanded as much clarity as possible about who its principle ethnographic subjects were. To conceptualize who my ethnography was about, I drew on the concept of 'community of practice'.

Linguistic anthropologists have been the most prominent advocates for the community of practice as an analytical lens within anthropology. The term was taken up by linguistic anthropology and sociolinguistics to deal with problems with the longer-standing concept of 'speech community' (Gumperz 2009). In brief, research focused on the 'speech community' underwent multiple rounds of criticism for treating senses of collective belonging, territorial occupancy, culture and language as unproblematically correlated with one another (Eckert 2006). Linguistic anthropologists have increasingly turned to the community of practice as a framework for understanding 'local' social differentiation with respect to empirically recognizable practices (Mendoza-Denton 2008; Bucholtz 1999). This is not a linguistic anthropological dissertation, but the community of practice is a useful way of understanding community for this ethnography because it a) begins with observable, intersubjectively meaningful practices as a definition of group membership, and b) allows that group to include members with diverse formal institutional affiliations.

The research presented in this dissertation is focused primarily on a community of practice defined in terms of its reliance on taxonomic methods in plant science, and its historical association with Ecuador's National Herbarium. For purposes of this research, "taxonomic methods" refers to collecting specimens, and visually or tactilely comparing them with other already-known specimens for purposes of taxonomic identification (whether for training, scientific publication or environmental impact

assessment). Ultimately, Eckert (2006) notes that "the value of this approach relies on the ability of the analyst to seek out communities of practice that are particularly salient to the… question being addressed" (684). The community of practice studied here has historically had a highly influential role in shaping Ecuador's environmental governance, and remains embedded in the thick of the country's rapidly changing environmental institutions, as I show in the remainder of this dissertation. And while the definition of the community of practice used here necessarily references an institution (the National Herbarium), a focus on the practices, rather than institutional affiliation allows my analysis to trace the study and management of biodiversity across institutional contexts.

It is worth noting that not all professional botanists are first and foremost taxonomists, since many (especially non-Ecuadorians, and Ecuadorians associated with prestigious programs at private universities) are primarily trained in molecular or statistical methods. Nor are all professionals who are trained in plant taxonomy technically plant scientists, since many are funneled directly into positions that do not allow them to engage in basic scientific research and academic publishing. There is no one-to-one correspondence between the practice of plant taxonomy and the profession that an individual works in (or any other categorical identity). The analytical goal was not to divide people between those wholly inside or outside of the practice, but to use the practice as an empirical point of departure to understand how both experts and the knowledge they claim are produced. For example, do they use the practice for academic research or primarily in an applied setting? Do they value it or see it as backwards in relation to other methods in plant science? What role do they envision these practices to play in environmental management? Alternatively, do they rely on the products of others

who are experts in plant taxonomy to inform their own specialized work which might, for example, be focused on petroleum engineering?

Using the practices of plant taxonomy to orient data collection and analysis begs the question of what 'practice' means in this context. The approach to practices taken here is influenced by theorists whose focus is on learned activities, which are subject to social evaluation, and which can be done well or poorly (Cetina et al. 2001; MacIntyre 1981; Silverstein 2008). As MacIntyre (1981) points out, to engage in a practice is to subject oneself to its canons of evaluation. Moreover, to engage in a practice *well* or effectively implies mustering, channeling or embodying certain forms of collectively or institutionally sanctioned authority; as Barnes (2001) puts it, 'To engage in a practice is to exercise a power' (28). Thus practices are a concrete point of reference for understanding an abstraction like 'institutional change' (i.e. how biodiversity became an institutionalized concern in Ecuador; chapters two and three). They also facilitate understanding the contemporary nuances of hierarchies in the environmental professions, and the ramifications of these hierarchies for plant taxonomists' professional aspirations, senses of self and cultural relationships with the environment (chapter four).

The members of this community of practice received mentorship in plant science, or served as teachers and mentors under the auspices of the National Herbarium, or the Missouri Botanical Garden field program that preceded it. Over time, the community expanded (particularly in the late 1990s, when many remember the Herbarium as a 'factory of botany') and then contracted somewhat in the late 2000s amidst financial difficulties and a change in management at the Herbarium. The community has also become more clearly delineated along national lines over time: for example, whereas

American and Ecuadorian scientists both formed part of the Herbarium's rapidly evolving staff in the 1990s, the Herbarium is now entirely Ecuadorian-run, with American (and other foreign) scientists needing to formally request affiliation with it to use its collection or otherwise collaborate. The community of practice has also become more Ecuadorian over time, as the projects that drew many American scientists to work in Ecuador have shut down; their institutional homes have shifted focus away from Ecuador; and multiple generations of Ecuadorian students have received training in plant science, so that they greatly outnumber the occasional foreign scientists that come through. Like other kinds of 'communities' studied by anthropologists, this one was highly heterogeneous, with drastic differences in power between its members, particularly between Ecuadorian and American scientists. Americans that worked with the National Herbarium, by definition, had funding for fieldwork outside the U.S., typically due to grants they received to support their ongoing trajectories of research. Ecuadorians tended to not have significant institutional support for their research; their institutional homes tended to be more unstable; and they depended on foreign collaborations to participate in major international programs or initiatives. I discuss the heterogeneity of the community further in reference to interviewing in the following section.

Methods: Participant Observation, Interviews and Archival Research

I conducted fourteen months of ethnographic fieldwork in Ecuador in 2013 and 2014. This work built on two months of scoping research in the summer of 2013, for a total of more than two and a half years spent physically present in Ecuador during my

graduate education. This ethnography was necessarily carried out at dispersed geographic locations in order to participate in, and observe the work of biologists and other professionals both at their institutional homes, and in the field. As discussed above, despite being physically 'multi-sited', this is best conceived as an ethnography of a community of practice, defined less by a focus on places than on a particular group of individuals engaged in plant taxonomy.

I used a workshop held at the National Herbarium during the first month of my fieldwork to administer a social network questionnaire to botanists. The questionnaire was used to quickly ascertain how the National Herbarium and its staff were connected to other state institutions and private organizations, and which of those were most important to its present functioning, in order to target the remainder of my data collection.
The bulk of my data collection used participant observation, interviews and the collection of archival documents. I describe these below, followed by a consideration of the limitations of the approach I took.

1. Participant observation: I primarily conducted participant observation in four contexts: i) the National Herbarium in Quito; ii) the State Amazonian University in Puyo; iii) the Central University in Quito; and iv) various botanical field trips.

i. The National Herbarium (Quito): The bulk of my institutional ethnography was conducted within the National Herbarium. When I was physically present in Quito, I spent some portion of my time nearly every day of the work week there. The Herbarium was a particularly valuable site because it gave me access to

Ecuadorian botanists; to students; to foreign botanists and ecologists who required its comparative collection when they were working in the country; and to a steady stream of private consultants that used its collections in environmental impact assessments.

My participant observation was oriented both toward the institutional activities of the Herbarium proper, and toward those of consultants and other visitors who came there to use its collection. With regard to the Herbarium's institutional activities, my participant observation included helping with specimen processing, managing collections, reorganizing documents, reorganizing the library and assisting with general maintenance of the facility. The Herbarium also has an active internship program that formed a useful starting point for getting know university students, as I discuss below. Much as it did for me, the Herbarium connects students with consultants, allowing them to find their way into that field. Finally, I was also generously granted office space in the building, which allowed me a place to write notes, conduct interviews and digitize archival data when not actively engaging with the staff or visitors. This space also gave me a more general base of operations outside of my apartment.

Much of my time at the Herbarium was spent in the collection room, where I often introduced myself to consultants and students by offering to help identify their specimens. Several people that I met this way became lasting friends. One individual, whom I refer to as 'Edi' in the third dissertation chapter, effectively became a mentor to me in plant taxonomy, and I spent a large amount of time learning from him both in the collection room and the field. As I note in that chapter, Edi worked extensively as a consultant in EIA. It was largely through biologists like Edi, whom I met in the collection room, that I was eventually able to network to the environmental firms themselves, using

botanists as references to eventually get permission to observe EIA fieldwork, to interview their staff and collect documents from them. Based on prior experiences, I did not think it was worthwhile (and could potentially be counterproductive) to contact environmental consultancies without well-established personal references. Building my relationships with botanists to network to the environmental consultancies took roughly eight months of engagement in the Herbarium.

ii. The State Amazonian University (Puyo): The second most important institutional context in which I conducted participant observation was the State Amazonian University on the edge of the small upper Amazonian city of Puyo. A significant portion of my time was spent observing the establishment of the Centro de Investigacion Posgrado y Conservación Amazónica (CIPCA), a large research station situated roughly an hour outside of Puyo. Two of the main forces behind the creation of CIPCA were David Neill, the former director of the National Herbarium, and Mercedes Asanza, a former National Herbarium botanist, who are both now professors at the State Amazonian University. This research station includes the country's first dedicated Amazonian herbarium, which is integrated into the University's program for biological resource development and 'biocommerce'. In this setting, I observed classes, field exercises and botanical training in the CIPCA herbarium. I also contributed labor to the establishment of the herbarium itself by helping with the transport of specimens and furniture, and the organization of the physical space prior to its use by the University's students. Participating in the founding of a new herbarium was very useful in understanding the oral historical and documentary materials pertaining to the National

Herbarium's early history. With scholarships that support students from outlying (characteristically indigenous) communities in the province, the State Amazonian University serves a very different population than the Central University in Quito discussed below, and thus formed a useful point of comparison.

iii. The Central University (Quito): Over the course of one semester I observed two biology-track classes at this public university after getting permission from a university professor (who I also met in the Herbarium's collection room). I also made periodic, opportunistic visits to the Central University at other times. In this context I was able to observe some of the students I had already met at the Herbarium, as well as meet others who provided useful insights into the attitudes that are brought to biology training, and what students value about the biology track. It also gave me access to the content of biology education, which forms an important context in which a specific vision of Ecuador as an environmental nation, and biologists as environmental professionals, are both produced. Historically, the Central University has had close ties to the National Herbarium, including professors that have worked at both institutions, internships at the National Herbarium that have often gone to Central University students, and contributions of labor and specimens from Central University professors to the National Herbarium's collection.

iv. Botanical fieldwork: Traditional plant collecting by naturalists and taxonomically-trained botanists is opportunistic, so a walk through town or the drive home from a vacation can easily turn into an impromptu 'field expedition'. That said, I

was able to participate in, and observe a range of formally-designated botanical fieldwork, including: Ecuadorian academic research in the northern sierra; U.S. academic research in the southern sierra and upper Amazon; biological consulting for the provincial government of Pastaza in the lower Amazon; personal collecting expeditions around Quito by U.S. and Ecuadorian botanists; the establishment and inventory of a permanent forest parcel near CIPCA; educational field collecting outside of Quito; and environmental impact assessment in the petroleum sector in Orellana province around the ITT. These trips ranged from one to ten days in duration, and differed considerably depending on the nature of the project and specific specialists involved.

2. *Interviews:* I digitally recorded 77 formal, semi-structured interviews and conducted five others in which permission was not granted to use a recorder. The interviews were designed to collect data on four topics:

i. Contemporary biological training and research in Ecuador
ii. The development of scientific institutions related to biology and the environment in the 1990s and early 2000s
iii. Contemporary environmental consulting
iv. The development of the environmental consulting industry in the 1990s and early 2000s

Most interviewees could address more than one of these domains. For example, many U.S. biologists who worked in Ecuador in the 1990s also participated in early

environmental consulting. Thus, topics and prompts related to each of these themes were drawn on selectively depending on the biographical experiences of the person being interviewed. I deemed the historical perspective provided by domains ii) and iv) especially valuable, and individuals that could address them were fewer and often harder to find. I conducted more intensive oral history interviews with individuals that could speak to those topics whenever possible.

Additionally, in order to understand the community of practice centered on the National Herbarium, I needed other points of comparison. I thus made a special effort to conduct interviews in other networks. These included biologists and ecologists (who were not plant specialists) in Quito, botanists based in the coastal city of Guayaquil, and botanists based in southern Ecuador. Finally, I interviewed scientists associated with the Pontifical Catholic University in Quito, where a collaboration between Ecuadorian and Danish scientists forms a second important botanical community of practice. In all of the above cases, I added a component to interviews to elicit their outsider perspectives on the work of the National Herbarium, which is well known in the country.

3. *Archival document collection:* There were three archival document sources that were central for my work. Participant observation in the institutions mentioned above, as well as oral historical interviews, were crucial for interpreting the documentary evidence that I collected.

i. The personal archive of David Neill: The most important archival source was the collection of personal papers held by David Neill, the U.S. expatriate

botanist who effectively headed the National Herbarium from the 1990s until 2010. These documents informed both my historical analysis of the Herbarium, and of the development of environmental consulting.

ii. The archive of the National Herbarium: I collected documents pertaining to the current administration of the Herbarium, as well as some records from the 1990s about staff and scientific protocols. The National Herbarium also houses a collection of writings by the botanist Misael Acosta-Solís that are necessary for understanding the development of field biology in Ecuador.

iii. The archive of a U.S.-based environmental consultancy: I was granted access to the archive of the Ecuadorian office of a U.S.-based environmental firm. I used this source to understand how environmental consulting reports have changed since the early 1990s, and how the practices of environmental firms have evolved over that same period. Some documentation was also collected from an Ecuadorian consultancy. I attempted to corroborate what I found at each of these sources with documentation collected from the Ministry of the Environment in Quito.

Results and Analysis

The body of the dissertation consists of three parts. The first two chapters are primarily historical, dealing with two important institutional changes related to the environment in Ecuador emerging from the 1990s: the founding of the scientific infrastructure that supported NGO-led protected area creation and management, and the

emergence of the environmental consulting field, focused on environmental impact assessments. These two historical chapters provide a foundation from which to understand the contemporary situation of environmental professionals in Ecuador. The third chapter pursues this ethnographic project by looking at the ethical dilemmas of biologists in the midst of institutional changes under President Correa as oil development in Yasuní National Park went from being a likelihood to a certainty in 2013 and 2014.

In the first chapter, "Taxonomic government: Ecuador's National Herbarium and the institution of biodiversity, 1986-1996", I analyze the role of a U.S.-Ecuadorian collaborative botanical project that founded the country's National Herbarium. This institution formed a scientific infrastructure that supported a highly active field of international and domestic NGOs and environmental consultants beginning in the early 1990s. Far from a natural or inevitable framework for governance, instituting biodiversity as a relationship to biological resources required an enormous amount of technical work, remolding existing institutions to eventually create a new apparatus for assessing the distribution of living organisms across national space.

Historicizing how biodiversity was produced as an enduring problem in Ecuador in the late 1980s and 1990s allows us to attend to what kind of a thing it is with greater care. Concerned with incredibly rapid species loss on massive geographic scales, biologists faced problems having to do with the size of their undertaking, and thus with the allocation of scarce specialized labor and financing that are the core problems of bureaucracy. As chapter two demonstrates, producing the floristics for a country even as small as Ecuador is an incredibly laborious and logistically complex task. Biodiversity, as

a way of valuing life en masse, was also a form of commensuration in terms of which institutional interventions could be organized by prioritizing the areas of greatest value.

In Ecuador, biologists thus faced some of the central problems of modern bureaucracies; but they did so in a fast-moving institutional environment in which many of the most capable environmental organizations had loose, complex relationships to 'the state', traditionally conceived as the bureaucratic core of the polity. The individuals involved in instituting biodiversity were far from anti-capitalist, but had commonplace (liberal) ideas about the role of the state in regulating the use of natural resources. In the absence of a state able to play that role, they did their best to create an institutional architecture that could conserve biodiversity on the basis of shared ways of reasoning about the environment, and shared specialized practices for studying it.

Many commonsense ways of conceptualizing political power are inadequate to the complexity of the situation described in chapter two. 'Taxonomic government' was neither wholly 'inside' nor 'outside' the formal Ecuadorian state; it is not best characterized as a confrontation between 'public' and 'private' organizations, or between organizations of specific national origins. Taxonomic government was comprised of a field of organizations that straddled these various distinctions, and which were concerned with biological resources. This field was also in dialog with existing state departments so that some of these (like its forestry authority) were gradually impacted by a growing concern for species loss. Consequently, these departments increasingly availed themselves of taxonomic methods for characterizing Ecuadorian territory. The field of organizations that emerged was not a Leviathan or a monolith, but it was certainly more

tightly coordinated than an analytical preoccupation with 'decentralization' in environmental governance would lead one to believe.

Given the problems of scale faced by biologists simply in figuring out what life was where, it should be unsurprising that, from its earliest days, biodiversity conservation was bound up with capitalism in various ways. It relied extensively on the capitalist milieu in which it existed in order to operate, for example through the logistical and financial support of extractive industry; the creation of new financial instruments in debt-for-nature swaps; and by taking advantage of the space that was cleared for new institutions by austerity in the 1990s. The National Herbarium's highly productive partnerships with oil companies are one dramatic response to the problem of scale: they successfully converted the Ecuadorian Amazon into a space of floristic evaluation on the basis of sufficiently 'synoptic' plant collecting. But, given the logistical difficulties of dendrological survey in the Amazon, they could only do so through the efficiencies generated by massive, industrial intervention into the Amazonian landscape.

Analyses of contemporary paradigms in conservation can benefit from keeping in mind the larger capitalist context in which biodiversity conservation inevitably operates, and on which its most fundamental programs (like the scientific work underpinning protected area planning) have relied. If corporate sponsorship or the use of complex financial instruments are taken to be hallmarks of 'neoliberal conservation', for example, then the word 'neoliberal' would be redundant in Ecuador: at no time has biodiversity conservation existed without those things, and given its character as a complex, large-scale form of economic intervention, it is unlikely to operate without them in the future. On the other hand, attempts to conserve biodiversity by deliberately commodifying it

(like payments for ecosystem services; PES) can be distinguished by their uptake of rationales informed by the profit-motive and theoretical frameworks borrowed from microeconomics. In analyzing something like PES, it would be worthwhile to bear in mind that biologists in Ecuador had relatively little to say about how community-level economies actually worked for much of the 1990s. Paradigms like PES did not replace unambiguously anticapitalist models or styles of intervention in Ecuadorian conservation as they grew in popularity in the 2000s; rather, they have formed a fundamentally different (and much more complex and detailed) kind of work, in which the substantive dimensions of local human economic relationships with biological resources became the focus of intervention. Microeconomics was present in conversations about biodiversity from the coining of the term (Wilson 1988: 193-99), but it arguably required a certain formalized relationship to biodiverse spaces (protected areas or other formal designations), as well as firsthand familiarity with those spaces on the part of conservationists, to make the re-engineering of local economies feasible (whether via market-oriented paradigms or otherwise). Given the historical correlation of biodiversity conservation's rise with neoliberal conditions in much of the world, as well as the diversity of relationships that it can have with capitalism, the phrase 'neoliberal conservation' is potentially misleading. A more precise and useful analysis could focus on the diversity of relationships that conservation can have with capitalism and their effects, rather than sorting conservation paradigms into those that are neoliberal and those that are not.

The second chapter is titled "Petroleum governance as experimental system: Uncertainty and entrepreneurship in the Ecuadorian oil field, 1988-2014". There, I

analyze the emergence of environmental consulting in the country's oil sector as domestic and international pressure to reform oil development encouraged foreign developers to find ways to demonstrate environmental due diligence. I observe that the country's first environmental governance in the oil field occurred at the height of neoliberal policy pressures, and was largely an attempt by oil companies to legitimate their activities in the face of hostile environmental and social activism. The article argues that the tensions between oil companies, activists and the state created a situation that entrepreneurs exploited to experiment with new ways of conducting petroleum development. This field co-evolved with the larger sphere of biodiversity conservation, as it relied on NGOs and individual biologists to conduct the 'baseline' assessments. With the increase of national control over oil extraction and refining processes, environmental regulation has become less answerable and the consulting industry has lost the leverage it once had to produce new techniques in development.

At the core of this chapter's argument is the claim that innovation actually took place in a neoliberal policy context in Ecuador in the 1990s. Innovation has not generally figured prominently as a focus in the cultural anthropological scholarship on neoliberalism.[2] This is odd, given that most of this scholarship understands neoliberalism as a context in which capitalism expands into new domains – something which presumably entails 'innovation' in one way or another. In the context of environmental politics, scholarship on neoliberalism has tended to focus on commodification (as discussed in this introduction's literature review). Elsewhere, scholars have examined the creep of calculative rationality into new domains of life. Neither of these approaches

[2] The sociology of economics has taken innovation more seriously, though this subdiscipline has not generally been concerned with analyzing neoliberalism (e.g. Mackenzie et al. 2007).

exhausts the various processes that constitute neoliberalism or the effects that those processes can have. As I show in chapter three, consulting and its associated innovations were not characterized by particularly complex new forms of calculative rationality. Neither did environmental consulting commodify a pre-existing domain. Environmental consulting represented a fundamentally new institutional structure in Ecuador, which arguably subjected the petroleum sector to its most 'hands-on' reform up to that point in the country. As I note, the future regulatory context and the kinds of changes in petroleum work that were possible were huge unknowns from the perspective of all involved. This uncertainty was actually central to the early emergence of the market for environmental services: as long as regulation was a vague threat on the horizon, oil firms had an incentive to continue investing in new innovations that consultants could provide. In many ways the emergence of this new capitalist domain had to do with the existence and manipulation of uncertainty, essentially the opposite of the expansion of technologies of calculative rationality, which rely on the ability to anticipate and carefully track costs and benefits. Keeping in mind the historical and sociotechnical situatedness of the actors involved – their lack of foreknowledge about the future – helps us to understand how the market developed the way it did.

Prior work on environmental politics in Ecuador has made only passing reference to consulting (e.g. Sawyer 2004). Because of the frequent antagonism between the consulting field and the popular movements most often studied by anthropologists in Ecuador (ibid.), little attention has been paid to how the field functioned or why it existed in the first place. The field of environmental impact assessment that eventually evolved in the late 1990s had 'antipolitical' dynamics, as mitigating the effects of development has

often been treated as a substitute for prior consent or democratic participation in development in the last three decades. Yet, despite its opacity and the degree of influence exerted by oil companies, the field seems to have had some of the effects that it claimed for itself in the 1990s and 2000s. The environmental consulting field worked as an antipolitical technology *because* it actually made petroleum development less destructive than it had been during the 1970s and 1980s. Attending to the practical dimensions of the governance of a specific resource domain like petroleum shows that neoliberalism and its aftermath may exhibit highly unintuitive dynamics. And it casts light on the still underexplored role of consultants. Simply denouncing their work as part of a larger neoliberal milieu is, I argue, less useful than examining the historical development of the markets in which they operate in order to grasp how 'decentralized' environmental governance actually works.

The spatial dimensions of economic development and conservation work studied here deserve one further note. The consistent involvement of biologists in petroleum consulting can be understood, partially, as one way in which the production of space (in particular the spatial distribution of different kinds of resources, and the evolution of the infrastructures involved in managing or extracting them) impacted their community of practice. The fact that Amazonian biodiversity lies atop Ecuador's most important oil deposits has meant that the practical dimensions of conservation work have always been interwoven with the capitalist production of space in the region (also clearly evidenced in chapter two). The imbrication of conservation and extractive industry has effects beyond the immediate ability to access the field or transport specimens; it also impacts the social networks that multiple generations of Ecuadorian biologists became part of (as these

included the apparatus of petroleum regulation), and the geographic regions they have developed firsthand familiarity with. While expert work is not immediately dependent on 'local' relationships to resources in the way that community economies tend to be, experts are nonetheless impacted by the production of space in complex ways.

The dissertation's third chapter is titled "Ethical subjectivity in Ecuadorian field biology: Science, race and nation in an extractivist economy'. Against the backdrop of controversial oil development in the country's largest Amazonian protected area, I ethnographically examine the subject position of Ecuadorian field biologists in the country's current 'post-neoliberal' moment. To understand the ethical subjectivity of Ecuadorian field biologists, I first consider how students' sensibilities about race and the environment are adapted to the context of biology in higher education. I then consider the perspective of professional biologists, fully committed to their science, on the relationship between knowledge and ethics, noting that to be an ethical subject is to have adequate environmental knowledge. Problems of accessing and owning biological knowledge are also problems for the possibility of environmental ethical subjecthood. The history of the extraction of scientific products from the country is viewed as inhibiting both scientific research and ethical responses to contemporary problems, like alternatives to oil development. The position of Ecuadorian scientists within the larger political economy of scientists makes it difficult both to produce scientific products, or to take even partial ownership of the things they help foreign scientists produce.

Finally, I consider how environmental consulting forms a common but highly problematic context for the enactment of biologists' values. With the gradual dismantling of the NGO-centric apparatus of environmental governance that emerged

from the 1990s, environmental consulting in development projects is a source of employment for nearly all biologists. Environmental consulting in Amazonian oil development is a livelihood that threatens biologists' connections to science, and thus ethical subjecthood, at the level of its technical details. The general problems posed by consulting for biologists' involvement in science means that Ecuadorian field biology, more generally, struggles to remain in contact with international science.

With an awareness of the historical development of the institutions in which these professionals work, we can see that the emergence of a new social and political concern – biodiversity – corresponded with the emergence of new subject positions in Ecuador. Literature in environmental anthropology has not often attended to the subjective dimensions of expertise in environmental governance. When it has, the notion has sometimes retained the resonance of a relatively rigid form imposed 'from above' by powerful institutions. In general, it remains difficult for anthropology to take seriously 'expert', professional, or otherwise formal institutional domains as a focus of analysis without occupying one normative extreme or another (denouncing or celebrating them, for various reasons). Thus, one of the interventions this chapter attempts to make is to rethink the normative stance that anthropologists take toward these domains: what kinds of critique are meaningful and constructive in relation to environmental professionals? Ecuadorian field biologists are clearly aware of the many compromises they are forced to make in their professional lives, and of the disadvantaged position they generally occupy in the political economy of science. At the same time, they have certain forms of authority that come with their discipline, and a unique vantage point onto the complexities of environmental politics at the national level, as well as in the places where

development is being implemented. Ultimately, this chapter argues that ethical subjectification is subtle but important cultural work that occurs at the formal, institutional level of environmental governance.

At this point the multiple ways in which biodiversity is a characteristically modern problem should be clear: assessing biodiversity is a commensurating activity that both assigns value to space, and coordinates complex institutional activities with finite resources. Intervention on biodiversity's behalf has relied on 'capitalism' in a variety of ways. Biodiversity is characteristically 'governmental', in that Ecuadorian institutions must now justify themselves, particularly in the context of economic development, in relation to their impacts on, and stewardship for biodiversity. And the management of biodiversity, especially in the context of EIA, is now a context in which the dilemmas posed by contemporary resource-extractive capitalism are being confronted by biologists. A concern for biodiversity forms a part of emerging subject positions as a consequence of the last thirty years of institutional development.

Two observations that this dissertation makes are that a) biodiversity conservation emerged as a new governmental concern, and then flourished in the midst of neoliberal conditions in the 1990s; and b) that biodiversity conservation has subsequently struggled in the period under Rafael Correa, in which the state has had greater effective sovereignty. This is counter-intuitive if we conceptualize biodiversity as intrinsically anticapitalist, and capitalism as a coherent totality. However, as I have attempted to detail, there are countless features of the Ecuadorian context that could be defined as 'capitalist', which are quite distinct from one another. If instead, we understand biodiversity conservation as an 'externality' in a broad sense – as something lying outside

of the concerns of powerful institutions – it makes more sense that it would have taken shape as a new way of reasoning about and acting on the world during a time of massive institutional disruption. Conservation took advantage of certain affordances of a neoliberal policy context and of capitalist development (especially in the oil sector) while simultaneously attempting to curtail the excesses of capitalism in other areas. The general weakness of Ecuadorian institutions in the 1990s clearly facilitated its emergence as a pervasive concern. With some consolidation of political power in the late 2000s, the balance of interests has shifted considerably and environmental concerns face a very difficult context, in which resource extraction remains an important engine for the Ecuadorian economy but there is little capacity to reform or regulate it.

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Appendix A: Taxonomic Government: Ecuador's National Herbarium and the Institution of Biodiversity, 1986-1996

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Abstract

This article argues that Ecuador's National Herbarium was a central catalyst in instituting biodiversity as a historically novel relationship to biological resources in the country. Developed through an agreement between St. Louis-based Missouri Botanical Garden and the Ecuadorian state, the Herbarium served as infrastructure for the field of biodiversity conservation in the country during the 1990s by helping to prioritize geographic regions for intervention. The National Herbarium's infrastructure work simultaneously modified existing regimes for managing plant resources during a time of economic crisis. The practices of biologists were woven across protected area planning, environmental assessment and development projects. Through archival documentation and oral histories, I analyze biodiversity's emergence as a governable object out of an institutional arrangement I term "taxonomic government", organized around taxonomically-based biological systematics.

Keywords**:** infrastructure, economization of biodiversity, governmentality

Introduction

Beginning in 1988, a field program administered by St. Louis-based Missouri Botanical Garden (MOBOT), under the auspices of the Ecuadorian state, conducted a number of formally contracted botanical inventories for foreign oil companies. The majority of the work took place in or around Yasuní National Park, the country's largest Amazonian protected area. Field technicians for the program that would become Ecuador's National Herbarium worked as fast as they could "behind the chainsaws and ahead of the bulldozers", as reports from the time put it. Technicians salvaged plant specimens from what had previously been the canopy level of felled trees before the sites were cleared for construction. Concluding a report to the Calgary-based oil company

Petro-Canada on fieldwork along the company's newly constructed road, the MOBOT-affiliated botanist David Neill wrote:

> *Besides petroleum itself, the forest resource is the most important economically in the region; and in the long term the forest is much more valuable even than petroleum. How will this development take place, and how can the forest be managed on a sustainable basis? For rational development to take place, it will be important to know, for example, where stands of high-quality timber occur… and how to predict where these occur.*[3]

Three decades later, Yasuní National Park is once again in the midst of large-scale petroleum development (Acosta, 2010; Rival, 2010). Critics who are unequivocally opposed to it, as well as those who aspire to balance petroleum production with environmental concerns now focus their advocacy on the number and uniqueness of species to be found in the park. Thus, evaluating the "global conservation significance of Ecuador's Yasuní National Park", Bass et al (2010) write that "Distribution maps of amphibian, bird, mammal and vascular plant species across South America show that Yasuní occupies a unique biogeogaphic position where species richness of all four taxonomic groups reach diversity maxima" (3).

Neill and his colleagues in the late 1980s framed their work as a first step toward rational forestry, which could commercialize particular tree species in a coordinated, sustainable way. In contrast, the concerns of experts and the public presently center on the impending loss of species in an area now conceived as one of the most biodiverse in the world (ibid., Finer et al, 2009). The syntheses of biological studies prompted by the

[3] David Neill, Botanical Inventory of the Petro-Canada Road, Rio Tigüino, and the Cachiyacu and Golondrina Well Sites, Pastaza Province, Ecuador. Project report to Petro-Canada, 1990.

controversy unequivocally demonstrate the biological importance of Yasuní. They also show the enormous effort made to catalog species and quantify diversity within the park; to propose these as intrinsically valuable in lieu of any direct utility to broader Ecuadorian society; and, more recently, to link them to other environmental problems like climate change. In the intervening decades, then, a novel object – biodiversity – has become a compelling focus of political action.

This article uses the history of Ecuador's National Herbarium to examine how the social, technical and political concern for biodiversity was instituted in the country. The National Herbarium played a catalyzing role in this process by generating a technological apparatus that straddled public and private institutions and assisted with targeting conservation areas by provisioning species-level botanical data. Its work formed the basis for new relationships to Ecuador's biological resources as its methods and scientific products became widely available managerial tools.

The core of my analysis focuses on the period between 1986 and 1996. In 1986, a field program was proposed by MOBOT that would allow international NGOs to design conservation programs in Andean South America on the basis of specimen-level biological data. In 1996 Ecuador's Ministry of the Environment was created with a mandate framed in terms of the governance of protected areas for biodiversity conservation, replacing pre-existing Ecuadorian institutions. In these eleven years, the practices of systematic biology, and botany in particular, formed the foundation for a pervasive new way of linking institutions to the environment. The period coincides with the coining of the term "biodiversity" (Wilson et al., 1988; Takacs, 1996) and its ascendance as a theme of specialized literature, multilateral agreements, bilateral funding

and widespread public interest. The present case thus helps us to think about how, and with what consequences, biodiversity emerged as a political problem in Ecuador.

To understand these issues, this article draws together science and technology studies scholarship on "economization" and infrastructure with the "governmentality" approach to the study of modern institutional power associated with Michel Foucault (Burchell et al., 1991). As scholars of economization have argued with regard to calculative rational action generally, the capacity to evaluate biological resources is, in part, a function of the specific technological setting in which actors operate (Callon and Muniesa 2007). In 1990s Ecuador, biologists focused their efforts on creating knowledge infrastructure to assist with identifying biodiversity conservation priorities. Their frequently ad hoc "infrastructure work" (Star and Bowker 2010) resulted in enduring mechanisms for the management of biological resources. Drawing on oral history, historical archives and secondary literature, I show how the uptake of this work produced biodiversity as a "knowable and administrable domain" (Rose et al., 2006: 86), on the foundation of taxonomically-based biological systematics.[4]

In order to better distinguish what kind of program biodiversity conservation was upon its entrance in the 1980s, I begin my examination of empirical materials by distinguishing two distinct paradigms by which plants were configured as resources in 20th century Ecuador. I then turn to the creation of the National Herbarium, examining

[4] Eighty percent of the historical documentation examined during this article's writing, and all archival documents cited, come from the personal archive of David Neill. Approximately 15% of the documents examined come from the libraries of two environmental consultancies and the remaining 5% from the archives of the National Herbarium. These resources were augmented by interviews with 31 individuals dealing with the history of the National Herbarium, environmental consulting and botany in the country. This included individuals presently or previously affiliated with the National Herbarium, Missouri Botanical Garden, the Pontifical Catholic University in Quito, Aarhus University in Denmark, the Ministry of the Environment, and private consultancies.

the infrastructural arrangements that made it possible to presumptively attribute value to territory in terms of biological resources, en masse. Following this, I examine how the National Herbarium applied the logic of biodiversity to petroleum work sites as a novel spatial scale of floristic evaluation, and molded the industry of environmental consulting. Finally, I show how foreign debt and austerity created the conditions for the Ecuadorian state's uptake of this technology, which spanned the fields of conservation and environmental consulting. Biodiversity became an institutionalized relationship to biotic resources as biologists' practices and infrastructures linked a wide range of public and private organizations. I conclude by briefly considering some contemporary implications of what I term "taxonomic government". First, I consider in greater detail how literature on economization, infrastructure and governmentality can inform our understanding of biodiversity.

Instituting Biodiversity: Economization, Infrastructure, Government

Ecuador's National Herbarium, and the organizations that it worked with, sought to reframe the diversity of life as a resource, a project of what Çalişkan and Callon (2009, 2010) refer to as "economization". Biologists conducted basic exploration and research in biological systematics, and used the resulting data for territorial planning. Their work revolved around the construction of new scientific infrastructures to coordinate between different organizations and communities of experts (Star and Bowker 2010; Star 2010), with the eventual goal of reworking the existing Ecuadorian institutions involved in managing biological resources. In its goal of reformatting social relationships to these resources, biodiversity conservation was a project of what Michel Foucault (2007)

referred to as "government" or the "conduct of conduct" (Burchell et al., 1991: 2), focused on defining and grappling with the problem of biodiversity loss.

Biologists working in Ecuador in the latter half of the 20th century were alarmed by the rapid conversion of forest to agricultural purposes that they observed. MOBOT field botanists Calaway Dodson and Alwyn Gentry (1991) documented a severe example of this over three decades of fieldwork in the western, coastal region of the country. At that time, they estimated that only 4% of the forest remained that had existed at the beginning of the 20th century. Their experience suggested that numerous species extinctions had already occurred in the region. They estimated that the total conversion of forest on the coast would result in the loss of over 1200 more endemic vascular plant species. The authors argued that the region was being damaged by state policies encouraging irrational land use, and that conservation programs needed to be enacted on the basis of more thorough biological inventory.[5]

Dodson and Gentry's approach was consistent with how biologists and others increasingly posed the fragility and finitude of life's diversity as a problem in need of intervention under the heading "biodiversity" in the late 1980s (Wilson et al., 1988). Biological explorers and their precursors had always identified local resources and circulated them through entrepreneurial and administrative networks (Müeller-Wille and Scharf, 2009; Raffles, 2002; Sevilla and Sevilla, 2013). What biologists called for with

[5] Rapid informal settlement of Ecuador's "internal frontiers" was a result of radical inequality in land tenure (Hey and Klak 1999). The practice was bolstered by the legal doctrine, shared by former Spanish colonies, of tierras baldías. This doctrine framed uncultivated, and especially forested land as economically unproductive (Guy and Sheridan 1998). In Ecuador, legal title to land could be acquired by clearing it of forest to demonstrate the intention to use land productively. National policies encouraging settlement were seen as politically expedient alternatives to the sensitive task of redistributing the land holdings of the country's agricultural elites.

greater frequency in the 1980s was a different function that could presumptively treat the diversity of life en masse as a resource around which social relationships could be reorganized to avoid environmental devastation. Recent literature on economization thus provides a useful vocabulary with which to analyze how conservation "[enacted] particular versions of what it is to be 'economic'" (Callon et al., 2007: 4).

As suggested by Dodson and Gentry, the central focus of conservation planning was on what, following Callon et al. (2002), we could call the "qualification" of plant resources through biological inventory. Callon et al. use the term "qualification" to characterize how new commercial goods are configured by interactions among various entities and processes such as advertising, testing, focus groups, and patterns of consumption. The salient properties of a product, the aspects that demand refinement by producers and form a value for consumers, emerge out of this distributed activity. "Qualified" objects may be framed as "singular" and incommensurable with other objects; ordinally ranked amidst other goods; or treated as stores of quantifiable value (ibid.). International and domestic Ecuadorian actors qualified geographic areas of interest for biodiversity conservation in a variety of ways throughout the 1990s. These ranged from assertions about the scientific importance of sites due to the fact that they had never been biologically explored; to simple species lists; to the identification of endangered and endemic species; and eventually to diversity metrics generated through rigorous inventory. Conservation planning involved producing large quantities of "first-order" data (typically, lists of species found in a locale) that could then be summarized into new "second-order" products (such as estimates of local endemism or floristic maps).

Biologists' practices treated the volume of living forms as a "value" distributed across geographic space (Bowker, 2005). While this is an intuitive simplifying formal move, the technical work required to produce descriptions of biodiversity in these terms is still massive (Bowker, 2000a). For example, botanists had long relied on spatially coarse records of plant collecting localities and the circulation of anecdotal information through networks of colleagues. Coordinating efforts to save biodiversity in Andean South America required MOBOT to format and pool large volumes of spatially-referenced botanical data with information from other disciplines. These needed to be available to the various actors working on conservation, which then needed standardized ways to assess the information at hand. Economizing Ecuador's biodiversity was thus, among other things, a problem of knowledge-infrastructural design.

The National Herbarium comprised part of what I term a "technology of spatial prioritization" that grew up around biologists and other experts, spanned public and private organizations, and assisted with the identification of conservation targets. This technology enrolled the traditional tools of plant systematics into new projects of the management of biological resources. As Li (2007) puts it, conserving biodiversity was a matter of "rendering technical", or formulating the problem of conserving life's diversity in terms amenable to botanists' expertise (cf. Rose, 1999; Mitchell, 2003). Biological inventory and the production of knowledge infrastructures embedded experts in a technological setting that allowed them to apply formal decision criteria to biodiversity conservation interventions on the basis of their own disciplinary techniques (Miller and Rose, 1997; Callon and Muniesa, 2005).

As the National Herbarium was forming, Ecuador was undergoing sweeping political and economic changes, due largely to its foreign debt. From the 1980s to the 1990s Ecuador slid from economic stability to currency collapse. Those two decades saw massive inflation, reductions in public spending, the removal of subsidies for domestic industries, and the stripping away of controls on foreign investment (Hey and Klak, 1999; Jácome, 2004). Thus, the emerging technology of spatial prioritization was guided by the needs of international actors, who provided the only funding available during this period of austerity. Moreover, neoliberal reforms had important impacts on how botanical fieldwork interacted with petroleum development, the country's most important economic sector. Botanical collecting not only used petroleum development to conduct fieldwork, but transposed the logic of biodiversity to the oil field to study the impacts of development. Biologists' practices and infrastructures eventually reoriented the Ecuadorian state's governance of biological resources, not by direct coercion, but by provisioning it with a new technology for reckoning with space and resources that cut across the burgeoning fields of conservation and environmental consulting.

Ultimately, I suggest that biodiversity was produced through "taxonomic government", a retrospectively discernable apparatus that crystallized over the time period in question with the National Herbarium at its center. The starting point for Foucault's analysis of "governmentality" was that the conduct of conduct is not the sole purview of a monolithic state, but occurs in countless ways throughout society (Silverstein, 2015; Erazo, 2013; Asdal, 2008a; Rose et al., 2006).[6] The analytical

[6] Taxonomic government, as defined here, is not best conceived as a form of what Foucault termed "biopower". Rabinow and Rose (2006) argue that biopower describes political rationalities and interventions centered upon the "vitality" of individuals and collectivities. For the thinkers and disciplines that Foucault studied, and those analyzed more generally in the

question of interest to studies of governmentality is how particular mechanisms and rationales for the "conduct of conduct" become widespread, conventionalized and institutionalized – sometimes to the extent that they become constitutive features of "the state", though this is not necessary (e.g. Donzelot, 1979; Power, 1999). This analytical move refuses to posit transhistorical functions of the state so that the question can be posed more pointedly of how particular rationales and mechanisms coalesce into intelligible, enduring paradigms of political power.

From this perspective, the botanical norms by which new plant species are described are just as potentially "governmental" as more familiar functions of the modern state: they order social action. The practices on which taxonomic government was based were those of biological systematics, as MOBOT director Peter Raven and the biologist-philosopher E. O. Wilson put it, "hitherto regarded as 'little science'" but "badly in need of growing large" (1992: 1099). In examining "taxonomic government" I focus on the practices of biologists as these cut across numerous different organizations and projects. The term "taxonomic government" distinguishes the political technology that emerged in Ecuador in this period from environmental politics in which ecology or other disciplines played more prominent roles in Ecuador and elsewhere (e.g. Lowe, 2006). It also

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literature he has inspired, "vitality" has been understood to be a function of self-maintaining, reproducing, or teleological system with different inflections across such disciplines as economics (Collier 2011), ecology (Nading 2012) or medicine (Klawiter 2008). On the other hand, systematic biology is not primarily concerned with self-regulating systems; rather, it names objects and situates them in terms of evolutionary relatedness to other known and named objects – a very different notion of "system". Ecology and population biology were integrated into the programs of NGOs working in the country in the late 1990s and 2000s, and played roles in regional community-level interventions focused on the reform of human-environment relationships. Importantly, taxonomic government as analyzed here was primarily focused on intervening upon formal organizations, rather than specific interventions at the level of communities, in order to configure biodiversity as an actionable political problem. Its central features, biological inventory and taxonomic systematics, continue to be central in environmental consulting and state-level planning.

distinguishes this technology from that which might develop where statistical or molecular methods form the basis for large-scale biological inventory, rather than the physical inspection and description of specimens. I thus intend to highlight a form of governmentality based on a very specific set of practices. Taxonomic government emerged as one way of *doing* biodiversity on the basis of taxonomic biological techniques as these became increasingly available: biologists' infrastructure work defined both what the problem was, and how that problem would be passed along to other communities of experts (Karasti et al., 2010; Bowker and Star, 2000). The approach taken here thus examines the reflexivity or "performativity" of social institutions through the infrastructure work involved in constituting them (Rabinow, 2003; Bowker, 2000b; Mackenzie et al., 2007; Jasanoff, 2013).

Before turning to the details of the technology of spatial prioritization that was founded by the National Herbarium, it is useful to briefly distinguish prior forms of resource management from the spatially-oriented rationality that came to characterize biodiversity conservation.

Substantive and Spatial Logics of Plant Resource-Making

While biodiversity is commonly referred to as a "resource", the program enacted by the National Herbarium deserves to be distinguished from other relationships to plant resources. In this section I contrast two different tendencies in the economization of plants, which I term "substantive" and "spatial" logics of resource-making.[7] The substantive logic focused on particular plant species that posed identifiable utilities to people, especially through economic improvement and commercialization. The treatment

[7] A distinction intended to parallel Weber's (1978) between substantive and formal rationality.

of plants as "substantive" resources most closely resembles what someone is likely to have in mind when they think of a resource: a good that meets specific human needs or wants. On the other hand, the spatial logic began with the geographic space to which plants were assigned as a resource category. This is a more abstract and formal way of reckoning with resources, and a precursor to how plant resources were increasingly framed in biodiversity conservation in the 1990s. To exemplify the substantive logic, I turn to the work done by MOBOT's program in the mid-1980s in Ecuador. For the spatial logic, I examine the planning conducted in the mid-1970s, forming the basis for Ecuador's system of protected areas and the National Herbarium's later work. Contrasting these two logics shows how the work of the National Herbarium segued from a more conventional program of exploration and plant resource development, to one that emphasized the spatial distribution of flora as a basis for institutional planning.

The substantive and spatial logics examined here are best conceived as tendencies intrinsic to natural resource governance throughout colonial and postcolonial history (on forestry see Grove, 1996; Tucker, 2011; Mathews, 2011). In Ecuador, a substantive logic of plant resource-making formed the basis for the industrial use of plants for much of the 20th century, either in the context of programs for national economic development with assistance from the U.S. Department of Agriculture (Acosta-Solís, 1944) or in transnational business dominated by firms like United Fruit (Striffler, 2001). After World War II, Latin American countries frequently relied on U.S. capital and technical expertise to develop natural resources, including plants (McCook, 2002; on Ecuador see Cuvi, 2011). As late as the mid-1980s, the pattern of plant science in the service of U.S.-

assisted resource development still held sway, in programs like the one that inaugurated MOBOT's field program in Ecuador.

MOBOT's field collectors, such as Dodson and Gentry, had worked sporadically in Ecuador since the 1950s (Dodson and Gentry, 1978). The permanent field program that eventually became the National Herbarium was initiated by a USAID-funded project conducted with the Ministry of Agriculture and Livestock beginning in 1984. The project's stated goal was "to strengthen the capacity of professional foresters and botanists in Ecuador to study and manage the Ecuadorian humid tropical forests by means of a dendrological and economic botany study of selected sites in the forest of the Amazon region of Ecuador".[8] Its primary deliverable to USAID and its Ecuadorian partner institutions was to be an illustrated dendrological guide, "Plant Resources of Amazonian Ecuador". MOBOT's work was part of a larger project designed to help the Ministry of Agriculture and Livestock identify and begin researching commercially viable trees in the Amazon, a region that had not received extensive dendrological study previously.[9]

Provisioning useful information on commercializable tree species required the ability to perform plant taxonomy in the country, and thus demanded access to an herbarium. An herbarium can be conceptualized as a reference library of plants, built up through the gradual accumulation of specimens identified by experts in taxonomic families. The fieldwork conducted by MOBOT personnel was intended to produce specimens from Amazonian trees, and generate the scientific infrastructure required for future commercial research. MOBOT personnel began in 1985 by establishing a regular

[8] USAID memorandum to MOBOT regarding Flora of Ecuador grant extension, 12.3.1985.
[9] David Neill, Plant Resources of Amazonian Ecuador ("Flora del Ecuador"), Third Project Report (August-December 1985).

collecting site in the upper Amazon. Specimens were brought back to an herbarium dedicated to forestry outside of Quito, and duplicates of these were circulated internationally to be identified. As taxonomic identifications were sent back to Ecuador, a "local" collection of expertly identified specimens accumulated. The resulting information was fed into the larger USAID-supported research on useful plant species to characterize the properties of their woods, optimal growing conditions, yields and other factors. The substantive logic of economizing plants thus involved the intensive technical development of woody plant species on the basis of biological exploration and research in plant systematics through globally distributed scientific networks. MOBOT's forestry program resembled others in a longer history of collaboration in Ecuadorian forestry reliant on U.S. sources for technical expertise and capital (Cuvi, 2009).[10]

A project conducted jointly by the U.N.'s Development Programme and Food and Agriculture Organization in 1976 provides an informative look at a contrastive, spatially-oriented logic of resource-making in Ecuador.[11] Occurring just a few years prior to MOBOT's collaboration with USAID described above, projects such as this set the stage for a major burst in protected area planning during the late 1980s. The project's goal was to support the creation of national parks in order "to maintain outstanding wild areas of the country for the sustained production of a flow of products and services that will contribute to the benefit of the population and national development, without diminishing the natural capital of these areas". Rubrics for designing the system were borrowed from

[10] Because of the historical reliance on foreign technical assistance in forestry and agronomy, many of their technical products (including specimens) ended up exclusively in foreign hands. This was one of the reasons that MOBOT needed to create an herbarium in Ecuador at the outset of its work.

[11] UNDP-FAO Final Report: Preliminary Strategy for the Conservation of Outstanding Wild Areas of Ecuador (Informe final: Estrategia preliminar para la conservación de áreas silvestres sobresalientes del Ecuador), 2.1976.

the Food and Agriculture Organization and U.S. National Park Service.[12] The report's criteria were intended to be comparable within and across national contexts, and match up with the categories of U.N. funding mechanisms (such as its recently minted Man and the Biosphere Programme) in a manner that presaged the conservation boom of the 1990s (Fairhead and Leach, 2003). The project's final report presents geographic regions ranked according to coarse descriptions of resources, amenities or judgments of their uniqueness.

Biologists consulting for the World Wildlife Federation (WWF) produced a follow-up report in 1978 focused specifically on the Yasuní River watershed, which ranked fifth on the original report's overall list and first among its recommended protected areas in the Amazon.[13] The WWF report did not present information on the economic uses of plants in the watershed, but argued for its value on the basis of the density of plants found there and the distinctiveness of the flora. The authors identified 405 species, suggesting the area might have 12 times that in reality.[14] The 1978 report advocated "complete protection", and suggested boundaries for a reserve.

The 1976 U.N. report framed Ecuador's prospective national parks as repositories of "natural capital" in need of rationalization: they required protection in order to maintain viable stocks of resources. The authors presumed that plants in these regions constituted some form of resource requiring further qualification. As opposed to the U.N. study, the 1978 WWF report says nothing about the economic value of the Yasuní watershed to the region or Ecuador more broadly, but insists on its value in terms of the

[12] E.g. U.S. National Park Service, National Park System Plan (Natural History) for Greece, Consultant's Report to the OECD, 1974; UNFAO, Management and Integrated Development of Wild Areas (Manejo y Desarrollo Integral de Areas Silvestres), Documento Técnico de Trabajo No. 4, 1974.
[13] WWF, Final Report on the Biological Study of the Yasuní River (Reporte final sobre el estudio biológico del Rio Yasuní), 5.20.1978.
[14] Ibid. p. 15.

abundance of plants there and the consequent need to study it further (in essence, its value adhered in its scientific interest). The spatial logic of economizing plants in the 1970s was thus a matter of framing territories in terms of resources presumed to exist within them, and later elaborating this value through biological fieldwork.

Scholarship in political ecology has theorized territorialization, the formation of new geographic units, emphasizing either the extension of state control over space (Vandergeest and Peluso, 1995), or the formation of new regimes of capitalist extraction of natural resources (Brogden and Greenberg, 2003; Sheridan, 2007). The U.N. and WWF studies of the 1970s loosely combined both of these aspects. The studies extended state planning to previously outlying regions of the territorial nation-state (Sevilla Pérez, 2013), using tools provided by international actors to attribute economic value that later needed to be confirmed and elaborated. The initial assumption of the 1976 U.N. study was that the resources would be of use to a developing capitalist economy. The prioritization of areas for protection had a "performative" dimension (Mackenzie et al., 2008; Bowker, 2000b), inasmuch as presumptively designating them as valuable provoked further study and attributions of value with the assistance of multilateral financing. This two-step process was accelerated and refined in the conservation boom that the National Herbarium helped to initiate, as I discuss below.

As biologists drew attention to species loss in Ecuador in the 1980s, rendering biodiversity technical was clearly not a matter of imposing expertise onto a domain that had previously lacked expert intervention. It rather involved pivoting an existing apparatus, oriented at the time to the substantive economization of plants, toward the goals of the emerging field of biodiversity conservation, and the distribution of plants

across national space. MOBOT's forestry work with the Ministry of Agriculture and Livestock participated in an older paradigm of resource-making, linked during the 20th century to the U.S. Forest Service and state-managed commercial forestry.[15] However, one of MOBOT's goals of participating in the USAID program was to initiate a field program in the country that could lay the foundation for what would later be biodiversity conservation. In the process, the role of biological research was increasingly reconfigured to feed into projects predicated on a spatial logic of economization.

A Technology of Spatial Prioritization

In the late 1980s, as public support for forestry began to disappear, MOBOT botanists ended their project with USAID and the forestry department and began conducting fieldwork as the country's National Herbarium.[16] Here I examine two projects in particular that had the logic of spatial prioritization prominently built into them. In the first, the National Herbarium's work was aggregated with other data to form a central repository of spatially-referenced biological information for Ecuador. This project involved pooling what Power (2004) terms "first-order" data products from various biological sciences. In the second project, sites with high plant diversity throughout the

[15] Ecuador's existing forestry research had links to the U.S. tradition of conservation through the sustainable management of resources associated with the USDA and U.S. Forest Service (Miller 2001). On the other hand, protected area planning borrowed directly from the U.S. National Park System (Spence 2001). Each of these traditions was picked up and modified in the Ecuadorian context (e.g. Cuvi 2005).

[16] Ecuador's National Herbarium was formally created as a subsection of the Museum of Natural Sciences by the Danish botanist Lauritz Holm-Nielsen when he registered its acronym (QCNE) with the New York Botanical Garden's Index Herbariorum in 1977. However, the Herbarium existed only on paper until the period discussed here, when an agreement was reached to allow MOBOT field collectors to grow and manage its collection, again under the supervision of the Museum. The collaboration between Danish botanists based at the University of Aarhus, and botanists and the Pontifical Catholic University in Quito was the other major botanical program in the country at this time. Botanists from this collaboration also worked with the National Herbarium on some of its consulting work in the 1990s, as well as other projects.

country were characterized on the basis of the National Herbarium's floristics as well as firsthand observations to provide summaries of regional conservation issues. This was an example of "second-order" aggregations of species-level data (ibid.). In both cases, the Herbarium and the techniques of botanists bridged the roles historically played by biological exploration and territorial management, and produced a new technology for prioritizing spaces for conservation through infrastructure design (Star and Bowker, 2010).

The National Herbarium's establishment in Ecuador was motivated by a joint project with The Nature Conservancy (TNC), a Washington D.C.-based environmental NGO. In the early 1980s, TNC was in contact with MOBOT botanist Alwyn Gentry, and communicated its desire for a computerized database that would allow identification of conservation priorities. As Gentry noted in a memorandum to Peter Raven, this database would optimally be scalable and linkable to others in order to assist broader conservation efforts in Andean South America. Gentry wrote: "[TNC personnel] very clearly want (and obviously need and <u>should</u> want) a specimen-based approach. What they need to know is where individual species are, not what species occur in a given country".[17] Conservation work would thus be informed by floristics derived from species-level data, irrespective of political boundaries. This required collecting and taxonomically identifying physical specimens, an obvious role for MOBOT.

TNC's work in Latin America at the time was focused on building national Conservation Data Centers, storehouses of spatially-referenced biological data. Where the work was successful it provided an unprecedented level of biological detail over large

[17] Letter from Alwyn Gentry to Peter Raven concerning TNC program, 8.5.1986. Underlining in original.

geographic areas. In the case of floristics, botanical rubrics were developed to distinguish species compositions in upper canopy, lower canopy and understory, allowing mapping at the national level of these distinct forest components.[18] Botanical data were fed to the Conservation Data Center from MOBOT's own in-house database, and later integrated into a digital geographic information system. Aggregated data could then serve a large number of purposes, from coordinating TNC's own regional efforts, to designing biologically meaningful national maps, a process that one planning document refers to as "ecoregionalization".[19]

An example of the National Herbarium's second-order products is its contribution of "datasheets" for a casebook on *Centres of Plant Diversity* by the International Union for Conservation of Nature (IUCN) beginning in the late 1980s.[20] The first goal of the IUCN program was to "identify which areas around the world, if conserved, would safeguard the greatest number of plant species". Inclusion criteria for sites were based on numbers of species (or estimates thereof) and levels of endemism. Datasheets for each region contained brief floristic characterizations, descriptions of known useful plants, an "economic assessment" outlining local relationships to natural resources, threats to biodiversity, conservation recommendations and a bibliography.

The National Herbarium's contributions to the IUCN project encapsulate the overall tendency in this period to synthesize scientific research with botanists' informal observations from the field into informationally rich instruments. For example, National Herbarium botanists made two expeditions in the early and mid-1990s to the Cordillera

[18] Work strategy for botany (Estrategia de trabajo del area de botánica), no date.
[19] General Report of the Conservation Data Center (Informe general del CDC), 12.1990. "Ecoregion" was a scale of planning used elsewhere in conservation during this period (e.g. Dinerstein et al 1995).
[20] A small subset of these remains available online at http://botany.si.edu/projects/cpd/samap.htm.

del Cóndor, a low-lying mountain range on the Amazon side of the Andes. The region had not been identified by the 1976 UN study as a conservation priority. The National Herbarium's work there identified the cordillera as a limestone outcrop similar to the Guyana shield, a geological formation occurring at the intersection of Venezuela, Brazil, and Guyana far to the north. This discovery offered a promising window onto the region's evolutionary history (Ulloa and Neill, 2006). Similarly, the National Herbarium produced a datasheet for Yasuní National Park drawing on its observations of unanticipated floristic heterogeneity in the lower Ecuadorian Amazon. In these cases, the National Herbarium's botanists emphasized their importance on the basis of scientific debates in a planning tool for an international audience.

Thus, the production of first-order data like species lists generated new second-order aggregations of botanical data in terms of which planning and scientific research could be coordinated. These were combined, in turn, with expert judgments about the value of particular locales in light of scientific debates and local environmental threats (Cochoy, 2008). With this combination of contextually-informed judgment and formal knowledge, the National Herbarium bridged the functions of biological exploration and territorial management. The larger technology of spatial prioritization relied on the ability to rapidly incorporate these findings into planning.

The National Herbarium and the Conservation Data Center created the sociotechnical conditions for formal decision-making by embedding experts within an apparatus that mapped geography on the basis of taxonomically identified specimens. The broader technology of spatial prioritization in which these organizations participated was thus a "qualifying distributed device" (after Callon and Muniesa, 2005) in which

both conservation priorities, and the terms in which these would be conceived, were negotiated between experts and organizations. The two distinct steps of the 1976 U.N. study and the 1978 report by the WWF were collapsed into a productive cycle of feedback between the basic goal of aggregating biological data and the conceptualization of new scales of environmental governance. The work of visiting sites, collecting specimens, circulating findings among colleagues and synthesizing them produced zones of intensive environmental interest prior to the consolidation of evidence or deliberative procedures (e.g. Neill et al., 1999; Schulenberg and Awbrey, 1998). Biodiversity, a new way of describing and valuing Ecuadorian space, was enacted in the way taxonomically-based biological systematics formatted and linked conservation organizations.

Qualifying the Biotic, Framing the "Site"

Botanical fieldwork (first for the forestry project, and later as the National Herbarium) brought botanists into direct contact with petroleum field operations in the Ecuador's Amazon. The difficulties of plant collecting and the politics of petroleum development incentivized collaboration between botanists and petroleum field operations. As plant collectors encountered and made use of petroleum development, practices of spatial prioritization used by international and national conservation organizations were transposed to the oil field. One result of this convergence was that the petroleum development "site" was framed as a scale of floristic evaluation and comparison in the emerging field of environmental consulting. Examining the National Herbarium's specimen collecting in the country's Amazon shows how the practices of spatial qualification required by conservationists were recontextualized as governmental tools

beyond protected area planning.

The orientation of the initial MOBOT-USAID program in the mid-1980s toward Amazonian forestry posed problems not normally encountered in ad hoc botanical plant collecting. First, physical access to far-flung collecting sites was difficult due to limited infrastructure in the region. Second, the Amazonian canopy from which specimens were collected was anywhere from 25 to 50 meters overhead, requiring a slow and physically laborious process of climbing the trees to retrieve them. The petroleum industry assisted with both of these problems. Botanists approached a team of drilling subcontractors to informally arrange specimen collecting at their work sites once trees had been felled. David Neill recalls the National Herbarium's first encounter with them in 1986 or 1987 thus:

> *"We were driving along the road to Coca and stopped where they were drilling a well, and I sort of explained to them that we were interested… in where they were cutting down trees, because then we don't have to climb them, we can get specimens from the trees, botanical specimens, much easier - including the epiphytes, and the trees if they're in flower or fruit, etcetera. So we became sort of camp followers of the petroleum industry… That had been sort of my modus operandi in Nicaragua and elsewhere and… that's generally the way botanists in the tropics have worked." 3.14.14.*[21]

Leading this wave of foreign oil development was Conoco, then a subsidiary of chemical company DuPont. The development proposals in the late 1980s were controversial due in part to their plans to operate within Yasuní National Park. Conoco

[21] This initial contact was with a U.S. contractor working for the Corporación Estatal Petrolera Ecuatoriana, the state oil company that became Petroecuador in 1989, shortly thereafter..

eventually sought to collaborate with environmentally-minded scientists, encouraged by the highly public legacy of environmental degradation by Texaco.[22] Conoco courted a wide range of environmental and social advocacy organizations, both international and domestic, with a long list of criticisms of the project. The company's agreement to hire environmental consultants was seemingly based on a desire to insulate itself from future litigation.[23] In addition to dividing environmental NGOs in the country (Rival, 2011), the Conoco drilling controversy inaugurated the field of biological petroleum consulting. The National Herbarium's work was central to this, as its opportunistic collecting evolved into a formal arrangement with Conoco in 1988, followed by a string of contracts for other oil companies in the mid-1990s.

Petroleum consulting precipitated a significant spike in productivity for botanists. Renner (1993) estimated that the history of botanical collecting in Ecuador's Amazon had produced about 60,000 collections in 250 years.[24] On a single project, the National

[22] Petroleum was the country's largest contributor to GDP and provided roughly half of all state revenue (CIA 1998). Much like forestry, oil operations relied extensively on the technical support of foreign companies. The primary form of regulation for petroleum for much of the 20th century was risk-sharing agreements between the Ecuadorian state and foreign oil developers that were widely considered to be unfavorable to the country (Kimmerling 1990, 1995). This unregulated development resulted in a well-publicized international lawsuit, brought in 1993 against Texaco (later bought by Chevron) for its socially and environmentally destructive operating practices during the 1970s and 1980s (ibid.). The legacy of Texaco's work provided a highly public example of what "the worst of the worst" foreign petroleum operators were capable of, in the words of some consultants interviewed for this research.

[23] While summarizing the National Herbarium's negotiations with Conoco in a memorandum to Peter Raven, David Neill wrote "[An environmental advisor at USAID] said that he tried to emphasize to the Conoco people that they could do something here that would be very beneficial and be of great propaganda value for the company, for a relatively low cost (much less than paying lawyers in a lawsuit 5-10 years from now), and evidently he convinced them" (memo concerning contract negotiations with Conoco, 3.22.1988). Raven was also in contact with Conoco's environmental office in Houston, which he described as enthusiastically supportive of the consulting arrangement with the National Herbarium (memo from Peter Raven to David Neill concerning Conoco contract negotiations, 8.30.1988).

[24] A "collection" is a group of specimens that come from the same individual plant and are identified by a single collection number. When an expert identifies a duplicate from a collection,

Herbarium collected 5,000 specimens from 1991-93 and was averaging about 500 collections per month at the time of a contract renewal in 1994.[25] Other petroleum projects also generated large numbers of specimens, and rapidly built up the Herbarium's floristic knowledge of Ecuador's lower Amazon.

With new firsthand experience of the lower Amazon and the aid of a specimen collection that was accruing with quasi-industrial efficiency, National Herbarium scientists were able to treat the oil field as a space of both biological exploration and evaluation. Biological inventory offered a preliminary means of what Callon (1998) refers to as "framing" economic externalities: inventory delineated a type of development "impact", and subjected it to the formal rationality of biodiversity conservation. The treatment of biological resources as a value unevenly distributed across space was consequently implemented at a finer spatial scale than that typical of conservation planning, through the massive infrastructural support of the petroleum industry. The spatial qualification of plant resources examined and differentiated between sites scattered throughout what had previously been treated by conservationists as a single biotic region (the lower Ecuadorian Amazon), describing space at the level of the petroleum development "site".

Natural history and biological field science have historically relied on infrastructural development to gain access to field sites (e.g. Kohler, 2006; Hayden, 2003). The history traced here is distinguished by the move from such opportunistic

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the other specimens from that collection are effectively identified, as well. Individual specimens from the same collection can be shared between institutions, allowing different herbaria to have taxonomically identified specimens from the same plant.

[25] David Neill, Botanical Inventory and Revegetation of the Maxus Pipeline Road, Petroleum Block 16, Amazonian Ecuador. Maxus service contract, 5.1.1994. Renner mentioned and explicitly omitted the National Herbarium's ongoing oilfield collecting from her calculations in 1993.

fieldwork to the careful coordination of botanists with oil companies to place them on the ground as forest was being cleared; and eventually to the insertion of biologists at proposed work sites prior to construction in order to describe a site's "baseline" condition.[26] On the basis of the site, for the first time in Ecuador floristic comparisons were regularly being made with reference to something "outside" of biological field science. The result was that botanical knowledge was used in the petroleum development process to anticipate, describe or mitigate the impacts of oil work in the emerging field of environmental consulting. Coupling together the qualifying capacities of biological systematics and petroleum development, the field of environmental consulting effectively took the formal logic of biodiversity to an extreme that was impossible in biodiversity conservation at the national level. The infrastructure of biological inventory in the oil field was thus in place when U.S.-based environmental consultancies arrived in the mid-1990s to work in the oil field. Inventory was immediately integrated into these companies' environmental assessment procedures, and became a standard feature of Ecuadorian environmental impact assessment as regulation was formalized by the state in the late 1990s and early 2000s.

The National Herbarium's work in the Amazon is an important example of how the practices of field biology and biological systematics extended outwards from the technology of biodiversity conservation planning to form more broadly applicable governmental tools. Similar practices were used in development projects supported by bilateral agencies, contributing to a burgeoning field of environmental consulting. This episode of plant collecting shows the feedback relationship that existed between the

[26] These changes roughly parallel the shifting roles of biology and ecology in the U.S. with the implementation of the National Environmental Protection Act in 1969, and the consequent rise of the environmental consulting industry there (Jay et al 2007).

acquisition of biological knowledge through exploration and the consolidation of biodiversity as a domain that could be subjected to governmental techniques.

Taxonomic Government in Search of a State

By the mid-1990s, as a consequence of the projects described above, the National Herbarium formed the core of a technology of spatial prioritization used for targeting international conservation efforts, assisting with national-level protected area planning, and employed in environmental consulting. A qualifying distributed device for attributing value to space in terms of biological resources was strung together with taxonomically-based biological systematics at its core. These practices were interwoven with bilateral aid agencies, domestic and international NGOs, scientific institutions, private environmental consultancies, and transnational and domestic petroleum companies. Here I examine a parallel trajectory whereby this political technology was incorporated into public institutions beyond the National Herbarium. As a consequence of the country's economic problems, the rationales and practices of biodiversity conservation were integrated into the state, culminating in the creation of the Ministry of the Environment in 1996.

As discussed above, Ecuador had longstanding programs of plant research and forestry, but these relied on foreign technical and financial support, such as that provided by MOBOT and USAID in the mid-1980s (Cuvi, 2011). In the 1990s, the limited public funding for research on plant resources at Ecuador's forestry institute was further eroded by austerity measures. David Neill recalls:

During the kick that everybody had for privatizing everything in the early

nineties… [Ecuador's forestry institute] decided they didn't want to have research anymore. So they basically fired everybody and turned the whole place [the forestry research station outside of Quito] over to, part of it went to the police for an academy and part of it was this indigenous university… that would have been about ninety-two, three… (Later in the same interview)… [S]o all those specimens were incorporated into the National Herbarium… so, yeah, we inherited, the library was sort of like dumped out on the street, out in the open one day. So we got a truck, scooped up all the books we could and brought them into [the National Herbarium]. 3.14.14

Neill's anecdote dramatically illustrates the way that Ecuadorian state institutions were being redirected and repurposed throughout this period (in this case, literally salvaged by being hauled away in a rented pickup). MOBOT's botanists were forced to move to the National Herbarium in 1991, an institution that existed in name only at that point, under the authority of the country's Museum of Natural Sciences.

In the climate of austerity, MOBOT's move away from the forestry program needed the aid of private organizations with foreign financing. This was made possible in 1989 when the WWF and TNC engineered a "debt-for-nature" swap, allowing institutions to purchase chunks of the country's foreign debt at an 84% discount. Debt-for-nature swaps involved purchasing foreign debt to build institutions for environmental protection within the debtor country (Sadler, 1990). MOBOT contributed to the agreement and, beginning in 1991, botanists operating as the National Herbarium were funded through this mechanism. Ecuadorian sucres were purchased on request by the Ecuadorian environmental NGO Fundación Natura and disbursed to the National

Herbarium.[27]

The debt crisis and resultant austerity thus had two interacting effects. First, they cut back more traditional domestic programs of research and product development such as USAID had initially proposed to MOBOT in the mid-1980s. Second, inflation made it economically feasible to generate the technology of spatial prioritization needed by biodiversity conservation. The longstanding, but highly malleable practices of taxonomic systematics and biological fieldwork were reoriented away from programs of resource development and into conservation. While the Ecuadorian state attempted to keep environmental regulation to a minimum to position itself for debt renegotiations (Hey and Klak, 1999), petroleum companies took up biological techniques preemptively and a new way of governing Ecuadorian development emerged, initially outside of the state.

After leaving the forestry program, MOBOT's botanists no longer answered to the Ministry of Agriculture. For most of the 1990s, the National Herbarium was headed by a U.S. ex-patriot botanist, staffed primarily with Ecuadorian scientists, formally operated under the auspices of Ecuador's Museum of Natural Sciences, corresponded with MOBOT for steering its scientific efforts, and answered to the private Ecuadorian NGO Fundación Natura for budgetary purposes.[28] The most consistent oversight the Herbarium faced was the permitting process required for exporting specimens, leaving it largely free to serve as infrastructural support for biodiversity conservation in whatever

[27] With the plummeting value of the sucre against the dollar in the 1990s, MOBOT enjoyed a roughly 6:1 return on an initial purchase of $50,000 worth of debt, financing much of the National Herbarium's herbarium activity from 1989 through roughly 1997 with an eventual equivalent of about $350,000 at 1989 exchange rates. These approximations are based on David Neill's recollections and an examination of partial records of the National Herbarium's budgets in the early 1990s. This was a small component of a larger USD3.5 million deal for developing the country's system of protected areas.

[28] The Conservation Data Center was operated with a similarly complex arrangement, once again answering to Fundación Natura for financial accountability.

manner was most expedient. The messiness of this arrangement should indicate both the weakness of the Ecuadorian state under austerity in the 1990s, and the severe analytical limitations of focusing on the national affiliation of institutions, rather than on the rationales and practices they deployed in such a context.

When Ecuador applied for World Bank funding for protected area management in the mid-1990s, one of the first requirements of the program was that a repository of geographically referenced biological information be constructed. The National Herbarium and the forestry institute served as the basis for this work, which provided the botanical data and technical support for a national vegetation map.[29] The outcome of the World Bank's program was the creation of the Ministry of the Environment in 1996, which then had authority over the country's protected areas. The forestry institute, which had previously held these responsibilities, was moved from its longstanding home in the Ministry of Agriculture and Livestock. Whereas protected area management had been a sub-department of Ecuador's forestry authority in the 1970s, the reverse became true in the mid-1990s. Moreover, by the time the Ministry of the Environment was formed, a highly active field of environmental organizations already existed with which it would interface, which provided financing for the country's protected areas, and which could describe and track the environmental impacts of the country's most important economic sector. While the creation of Ecuador's Ministry of the Environment in 1996 usefully marks a degree of public interest in biodiversity loss, it was enabled by the already-existing field of taxonomic government.[30]

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[29] INEFAN Interinstitutional Agreement for the Transfer of Taxonomic Information (INEFAN Convenio Interinstitucional para Traspaso de Información Taxonómica), 4.23.1996.

[30] Another indication of the broad international interest in biodiversity was the Convention on Biological Diversity, of which Ecuador was a signatory in 1992.

Counter-intuitively, neoliberal reforms inadvertently contributed to the production of biodiversity in Ecuador. Scholars studying neoliberal reforms' impacts on natural resource management have emphasized the removal of state regulation and processes of commodification (Liverman and Vilas, 2006; Yates and Bakker, 2006). This scholarship has observed that neoliberal reforms have frequently privatized resources by "rolling back" existing state regulatory authority and "rolling out" state institutions designed to be dependent on the private sector (Peck and Tickell, 2002). These are obviously crucial aspects of neoliberalism. Yet, in Ecuador's case a narrow focus on commodification as these scholars conceive it, rather than reflexive processes of economization, would miss the emergence of a historically distinct relationship to resources at precisely the time when the state was most susceptible to reorientation (Ong and Collier, 2005). The "rolling out" of a Ministry of the Environment reliant on consultants, NGOs and bilateral aid had less to do with privatizing formerly publicly held resources than a reorientation of the state that resulted from linking it to a novel calculative apparatus.

Callon and Muniesa (2002) suggest that one way of thinking about political power is in terms of the asymmetry in calculative capacities between devices. A drastic asymmetry existed between the Ecuadorian state and the distributed qualifying apparatus predicated on biological practices described here. The latter was able to map the space of the territorial nation-state in biological terms, and even calculate the impacts of foreign oil companies. Setting aside preconceptions about the "decentralized" character of institutional arrangements that emerged from neoliberal reforms, the technology of spatial prioritization founded by the National Herbarium in fact appears highly centralized: it was premised on close coordination of agencies and their mandates through

shared protocols, methods and personnel under a single fiscal authority. The centralized character of this apparatus was a function of the kind of political program it sought to enact, in which fine-grained biological information would eventually inform natural resource governance. An analysis of governmentality – a focus on the uptake of specific rationales (in particular, the spatial logic of resource-making) and practices (in particular, biological inventory and taxonomically-based systematics) – helps to clarify these political arrangements in a way that a focus on alliances and confrontations between institutions of different national origins, between state and civil society, or between different arms of the state, would not. The National Herbarium and its sibling institutions did not confront the Ecuadorian state as external entities, and neither were they situated neatly within it. They transected the state, provisioning it at different locations with biological data for which it had little regulatory use until 1996. The spatial distribution of biological resources became a conventionalized basis for environmental management as this apparatus became an increasingly relied-upon infrastructure of state regulation. Biodiversity was thus instituted.

Conclusion: Performing the "Little Science" of Biological Systematics

In describing the role of the accounting technique of double-entry bookkeeping in the rise of capitalism, Callon and Muniesa (2005) note that it did not simply solve a problem that was clearly outlined in advance. Rather, double-entry bookkeeping reconfigured how profits were conceived and calculated as it became institutionalized: "We could even say that [double-entry bookkeeping], simply by being there, available, proposes this calculation to the entrepreneur who accepts the invitation" (17). A similar

phenomenon occurred with the availability of the techniques and infrastructures that assembled taxonomic government from the mid-1980s to the mid-1990s. Botany was a particularly important discipline for this work because of its use in characterizing territory. The National Herbarium and its sibling institutions formed a distributed qualifying device able to link space and plant resources through biological systematics. Botanical practices were taken up and transformed in the oil field to produce petroleum sites as objects for floristic inventory, helping to define the terms in which state regulation would be enacted. Calculative capacities were repeatedly proposed, and the invitation to configure territory and plant resources through them was repeatedly accepted. Taxonomic government evolved as biologists' practices assumed a central role in territorial management and development planning in public institutions, NGOs, environmental consultancies and oil companies.

Studies of knowledge infrastructure routinely emphasize its coordinating function: knowledge infrastructure has, built into it, particular modes of interaction between communities of experts (Bowker, 1994; Star and Bowker, 2010). An analytic of governmentality, as deployed here, can shed light on the political ramifications of such infrastructure work by tracing the rationales and practices of experts across institutional boundaries as these cohere into enduring and powerful paradigms for the conduct of conduct (Foucault, 2007). Examined in this light, knowledge infrastructure work exhibits many of the problems of large-scale social coordination and the deployment of expert knowledge associated with modern political institutions. Biodiversity conservation arrived in Ecuador as a form of planned economic change predicated on the qualification of territory. Attending to the infrastructure work involved in instituting biodiversity

shows how future biodiversity conservation was anticipated and staged (Star and Bowker, 2010) – not just the "conduct of conduct", but the "planning of planning". To the extent that biodiversity came to exist as a formally recognizable value in Ecuador, it did so because of the way that biologists' practices formed the foundation for a field of environmental work.

While the primary focus of this article has not been on the contemporary implications of taxonomic government, Yasuní National Park is once again informative in this regard. The National Herbarium's work on Amazonian floristics in the 1990s has allowed plant ecologists to link Yasuní to international ecological research (Losos and Leigh, 2004). Its embeddedness in these networks has resulted in greater international outcry from experts about the threats posed by development in previously unexploited portions of the park (Bass et al., 2010; Finer et al., 2009). The outcry, in turn, has prompted an increased level of scrutiny at the national level, making Yasuní the target of a huge number of environmental studies in anticipation of the infrastructure required to produce oil and move it to refineries. Thus we can see the performativity of biodiversity infrastructure work (Bowker, 2000b): positing a region as biodiverse results in a spiral of increasing biological information about it. This cycle of knowledge production has been enabled and amplified by petroleum development. Yasuní has emerged as both a thoroughly exploited oil field, and a well-documented tropical rainforest valued for its biodiversity.

The contemporary environmental consulting industry in Ecuador manifests a less intuitive performative aspect of this history. Advocates for biodiversity, such as E. O. Wilson and Peter Raven, treated biological systematics as the base on which biodiversity

conservation needed to be built in the 1990s. The "little science" was subsequently "infrastructured" for this purpose into a field of environmental actors, including the Ecuadorian state. The relatively prestigious work of international botanical exploration has moved on to areas of Andean South America that are less "well collected", as the National Herbarium's research resulted in the Ecuadorian Amazon being one of the best-studied parts of the watershed. Biological systematics has been reworked into a "gray science" (Rose et al., 2006) or "little tool" (Asdal, 2008b) most often used in environmental impact studies. The resulting apparatus makes it possible to qualify Yasuní's petroleum sites in terms of individuated biotic constituents. At the same time, while ecologists have played a highly visible role in environmental advocacy around Yasuní, a common complaint of environmental consultants is that ecological knowledge is not well-integrated into the environmental impact studies that govern oil development. The overwhelming historical focus on biological inventory in the country has made it difficult to trace connections between society and environment in the fashion typical of "biopolitics", or government of the systems that ensure the vitality of populations and individuals (Foucault, 2008; Olson, 2010). Hampered in their ability to draw these connections, contemporary environmental consulting studies of Yasuní could be considered "pre-biopolitical".

The present oil development in Yasuní has garnered attention partially because it highlights controversial changes in Ecuador's own environmental regulatory apparatus. In the last decade, the administration of President Rafael Correa has enacted restrictions on the foreign financing that previously supported environmental NGOs; scaled back public consultation in the development process; and maintained a hostile posture toward

the field of environmental activism. In effect, these policies have dismantled portions of the apparatus described in this article. Scholars have asked what the "post-neoliberal" era (Yates and Bakker, 2013) means for rights and resources in Ecuador and Latin America, generally. The case of Yasuní shows that biodiversity cannot be blithely disregarded, but the conditions in which it will be governed continue to evolve. Whether these emergent arrangements are later deemed neoliberal, "post-neoliberal" or something else, understanding them will require carefully tracing the mutations of institutions and techniques that generate and respond to the problems of government.

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Appendix B: Petroleum Governance as Experimental System: Uncertainty and Entrepreneurship in the Ecuadorian Oil Field, 1988-2014

Abstract

Environmental governance in Ecuador's oil field was inaugurated in the late 1980s, as oil development provoked domestic and international outcry. Uncertainty about when, if and how environmental regulation might be imposed on foreign developers led them to look for ways to legitimize development. Entrepreneurs used the opportunity to experiment with environmental mitigation in the oil field to reduce damage and deflect criticism. Under pressure from recurring environmental controversies, this 'experimental system' continuously produced innovations within the framework of environmental impact assessment for much of the 1990s and 2000s. Oil nationalization under President Rafael Correa has increasingly rendered such experiments in the oil field unprofitable and infeasible. Studying the entrepreneurial management of regulatory uncertainty helps us to understand Ecuadorian petroleum governance across neoliberal and post-neoliberal periods.

Keywords: oil; uncertainty; entrepreneurship; experimental system; neoliberalism/post-neoliberalism; Latin America

Introduction

In 2013, a road was photographed by a National Geographic Society photographer in Ecuador's lower Amazon. The road fell inside the boundaries of Petroleum Block 31, as well as Yasuní National Park, the country's largest Amazonian protected area and one of the most biodiverse places in the world (Bass et al. 2009). To minimize deforestation within the well-known park, Block 31's operating license specified that there should only have been a narrow 'ecological path' to allow a small crew to lay fiber optic cable for remote control of wells and platforms. Instead, the photograph seemed to show that the state oil company Petroamazonas had constructed a wide access road. The ensuing controversy illustrates how innovations in the oil field like the 'ecological path', used in the past by foreign oil companies to minimize environmental damage and deflect criticism, are complicating development in the current context of nationalized oil.

Ecuador's Ministry of the Environment denied the existence of the Block 31 road when photos first became public in 2013. A follow-up study was conducted in 2014 by foreign specialists who used satellite imagery to assess the location and width of the road, and compare it to the specifications of the environmental license (Finer et al. 2014). They found that the average width of the road was more than twice that permitted, publishing their report amidst growing unease in the country over the development process. The Ministry of the Environment then admitted the road's existence, but asserted that it had been properly constructed, and that the remote sensing study had been incompetently executed (MAE ndi). The road became the subject of heated public debate (e.g. Hoy 2014).

The Block 31 road controversy was a small episode in a larger debate about contemporary oil development in Yasuní. With the election of President Rafael Correa in 2006, a portion of the park known as the Ishpingo-Tambococha-Tiputini reserve (ITT) was slated for development (Acosta et al. 2009), for which Block 31 serves as a gateway. The ITT is a particularly politically sensitive reserve, both because it represents the point of highest biodiversity within Yasuní, and because it is the home of indigenous people living in voluntary isolation from wider Ecuadorian society. Correa's push to develop the ITT has accompanied increasing national control over an oil field historically operated by foreign companies, fostering new dynamics in the oil development controversies that have surrounded Yasuní for three decades (Narváez 2009).

The 'ecological path' was a stipulation in the original management plan for Block 31, designed by Houston-based environmental consulting firm Cardno-ENTRIX in 2006. The block was leased to the Brazilian company Petrobras at that time. Cardno-ENTRIX

served as a broker that helped Petrobras navigate the state's formal criteria and the practical realities of oil work, including costly environmental measures to appease regulators and activists. In the face of intense scrutiny and rising export taxes, Petrobras abandoned Block 31 in 2008, leaving it to be operated by the state company Petroamazonas (Alvaro 2010). Many of the conditions on Petrobras' work were carried over into Petroamazonas' management plan, including the 'ecological path'. In effect, the Block 31 controversy ensnared a state oil company, and the regulatory authority that purported to oversee it, in stringent environmental measures intended for a foreign developer.

Oil nationalization is thus reorienting an apparatus historically predicated on the tension between foreign companies, the state and environmental interests during the 1990s and 2000s, when foreign companies dominated the oil field and the state had little leeway to regulate them (Arsel and Angel 2012). The 'ecological path' was a product designed by petroleum consultants to demonstrate reasonable environmental foresight under pressure from activists. It typifies the kinds of innovations designed by petroleum consultants over the last two decades: prosaic (though costly and labor intensive) changes in the way that work is done in the oil field to minimize environmental damage and shield developers from environmental controversy. As this anecdote shows, the 'ecological path' and other forms of environmental mitigation pioneered prior to oil nationalization continue to condition petroleum governance today in unpredictable ways. The Block 31 example suggests that understanding the dynamics of petroleum governance in the post-neoliberal present requires that we attend to its historical development. It also alerts us to

the role of the petroleum consulting industry in generating the innovations that have informed oil work through recurring controversies.

To understand Ecuadorian petroleum governance, this article draws together interviews and oral histories conducted with forty-five individuals who presently work, or have in the past worked in the country's environmental consulting field, along with archival research and secondary literature. I begin by analyzing how foreign developers in the late 1980s and 1990s faced uncertainty concerning whether the Ecuadorian state would implement environmental regulation, and what form this regulation would take. This uncertainty created the opportunity for entrepreneurs to offer environmental services to insulate foreign developers from environmental criticism. Under these conditions, the oil field functioned as an 'experimental system' that bundled together advocacy, scientific research and technical intervention to continually innovate new oil field practices that promised to reduce environmental damage and shield developers from criticism. The ascendance of environmental impact assessment as a standard consulting service compartmentalized existing networks of specialists, and further encouraged high-cost experiments in environmental engineering. Innovations in development practices by the petroleum consulting field preemptively defined oil's liabilities, and were taken up as norms by the state. Since 2006, increasing state ownership of oil development has meant that the ability to leverage investment in new development practices is greatly reduced in post-neoliberal Ecuador. By the accounts of consultants themselves, oil nationalization has made environmental consulting increasingly ineffectual at actually mitigating the damage done by development.

Ultimately, I argue that the petroleum consulting industry and the regulatory apparatus with which it interacts are products of entrepreneurship in the context of political uncertainty created by neoliberalism, itself. The central dynamic I describe is a cycle of feedback in which new objects are innovated, and serve as forms of technical support for further experimentation and innovation. Informal norms, and later national laws and regulations were established to govern the oil field that drew on the precedents set by private consulting firms, thus verifying their legitimacy and enabling further experimentation. Environmental governance in the oil field exhibited 'performativity' (Callon 2007), as the redesign of oil work at the level of highly specific practices succeeded in gradually defining normative ideas of environmentally responsible development. The example of profit-driven environmental governance in Ecuador shows the unintuitive dynamics that neoliberalism can exhibit (Ferguson 2010; Welker 2012; Shamir 2010), and highlights the need for analyses that attend to its productivity. Taking seriously neoliberalism's ability to produce the new, I argue, will be crucial for understanding its long-term effects.

Oil's Uncertain Situation and the Logic of Petroleum Consulting

In the late 1980s and early 1990s, international and domestic protest against oil development in Ecuador created significant pressure for foreign oil companies to make oil production less socially and environmentally harmful. Simultaneously, the Ecuadorian state repeatedly renegotiated its foreign debt with multilateral institutions for which minimizing regulation was a condition for bargaining (Hey and Klak 1999). Moreover, oil accounted for about half of all state revenue. Strident state intervention in

the oil field was thus unlikely, despite widespread protest. These countervailing forces created a space for enterprising consultants to help foreign oil companies demonstrate goodwill by reforming existing development practices. Entrepreneurs had few precedents in Ecuador, either for the practical precautions they might recommend that foreign oil companies take, or for the formal criteria the state might eventually use to measure foreign developers' effectiveness in safeguarding the environment. Consultants transformed this uncertainty into an opportunity for innovation.

The opportunity to innovate in environmental governance stood in stark contrast to the preceding decades of oil development. In the 1960s and 1970s, the state lacked the technical capacity to find and develop Ecuadorian oil reserves. It also faced recurring problems related to foreign debt that it hoped to remedy with oil revenue. Foreign operators thus had leverage to conduct development on their own terms over this period (Martz 1987). The primary formal instruments of oil work were 'risk-sharing' agreements between foreign developers and the Ecuadorian state oil company that focused on apportioning costs and profits with no reference to the damage done by development (Narváez 2012; Terán 1991).

Texaco became the most infamous of the foreign companies to work in the country in this period. In contract renegotiations in the 1970s and 1980s, social and environmental problems resulting from Texaco's work became the subject of public controversy and an international lawsuit was eventually launched in 1993 (Narváez 2009). With Texaco's work serving as a searing reminder of the dangers involved, the controversy surrounding oil development became particularly heated in the late-1980s as the U.S.-based DuPont subsidiary Conoco considered developing a number of sites that

fell within Yasuní National Park (Rival 2011). The externalities of oil work – particularly the damage to ecosystems and indigenous communities in the areas around work sites – were being forcefully highlighted in ways that impacted the ability of foreign companies to work in the oil field (Sawyer 2004; Kimerling 1995). A large number of organizations, such as social and environmental NGOs, state agencies, local political organizations and scientific research institutions, became involved in the controversy.

Contrasting the concerns of activists with Conoco's response in the late 1980s helps us to understand oil's uncertain situation. One of the most prominent advocates against development was Ecuador's largest environmental NGO, Fundación Natura. The NGO's position paper on 'the current problematic of the Ecuadorian Amazon region' spelled out a number of issues including in-migration and informal settlement; land speculation; labor recruitment in petroleum development; the prostitution and alcoholism that followed oil camps; a lack of enforcement for protected areas; lack of local input in conservation planning; and a lack of consideration for ancestral lands in the design of the indigenous Waorani territory.[31] Conoco's Environmental Management Plan for Block 16, which it presented to Fundación Natura and other critics, highlighted accommodations like the close grouping of well sites to reduce the footprint of drilling operations; re-injection of the contaminated water used to maintain pressure in the well back underground; air emission control; and assurances about avoiding disturbing indigenous Waorani and Kichwa peoples in the area.[32]

[31] "Posición de la Fundación Natura sobre la problematica actual de la Región Amazonica Ecuatoriana (RAE)", Fundación Natura, Sept 1988.
[32] "Flotel Orellana Meeting Itinerary and Environmental Management Plan", Conoco, 14-17 May 1990.

Whereas Fundación Natura traced an expansive biopolitical web of social and environmental concerns, Conoco's response was antipolitical, emphasizing a series of locale-specific technical fixes. The discordance between the two shows the enormous space that existed to define what the problems of the oil field were, whose problems they were, and how they would be dealt with. The situation was ripe for entrepreneurs to leverage uncertainty about the future regulatory context of oil production into present demand for environmental services.

Scholars examining the intersection of expert knowledge and politics increasingly recognize uncertainty as a problem distinct from risk (O'Malley 2004; Callon et al 2008; Samimian-Darash and Rabinow 2015; Esposito 2012). Risk is an approach to a problem predicated on a known universe of possible future outcomes and their associated distributions of probabilities, costs and benefits. Government through risk is based on meticulous political technologies that render individuals or society calculable in relation to future conditions that are considered in the aggregate, or over the long run (ibid.). In contrast, O'Malley (2004) describes uncertainty as an orientation toward futures 'imagined as singular, infrequently recurring or unique'. Government of oneself or others in relation to uncertainty relies on 'experienced judgment, shrewd guesswork, [or] rules of thumb' (13). This scholarship approaches uncertainty, not as a property of situations or things in the world, but as a way of conducting oneself and others in the present on the basis of specific ways of reasoning about the future (ibid.). From the perspective of oil companies and their consultants in the late 1980s and early 1990s, future regulation or litigation constituted a singular, unpredictable event in terms of which the oil field needed to be conducted in the present.

Uncertainty is central to the interlocking Western notions of legal liability, reasonable foresight and innovation. In Western law, legally responsible action is based on evidence of 'reasonable foresight', or signs that common sense precautions have been taken in commerce. O'Malley (2000) suggests that conventional ideas about reasonable foresight are particularly conditioned by the problem posed by capitalist innovation. If an innovation precipitates some form of harm, the law lacks clear precedents for dealing with the outcome, due precisely to the fact that the harm is caused by something new. Reasoning about liability and reasonable foresight in such cases involves imagining the situated, practical work of entrepreneurship; how precedents that existed prior to the innovation had some partial or tangential bearing on the case at hand; and how 'common sense' did or did not inform the conduct of the firm (ibid.). In 1990s Ecuador, oil companies needed to establish that they were exercising some form of 'reasonable foresight' vis-à-vis activists and the state in the present, and imagined litigants in the future. But what counts as reasonable foresight in lieu of established exemplars or precedents? This was the area requiring innovation in Ecuadorian oil work.

Uncertainty has also been seen as a definitional aspect of business innovation. Frank Knight (1921), the standard reference in economics, argued that if an entrepreneur's product is an actual innovation – if the entrepreneur produces something legitimately new – its shape cannot be fully known in advance of its actual emergence. For Knight, the entrepreneur is the figure uniquely endowed with the judgment and confidence to navigate this uncertainty, as well as the volatility of supply and demand to which their innovation must be fitted. Similarly, Beckert (2003) notes that innovation violates the assumptions of 'teleological' accounts of capitalist research and

development, in which a utility-maximizing actor chooses an optimal path to a preconceived end. This is because the 'ends' of innovation are by definition unknowable in advance. In contrast, Beckert (2003) sketches an iterative, experimental model of design in which both 'vaguely understood problems and solutions become clearer until a solution has been reached' (780). Thus, liability, reasonable foresight and innovation are correlates of one another, but they emerge in a temporally complex and flexible dance. Entrepreneurship in petroleum governance took advantage of this flexibility to invert the conventional relationship between reasonable foresight (as a way of reasoning about capitalist intuition confronting unpredictable situations in the past) and innovation (as definitionally precipitating unprecedented change in the future). With consultants' guidance, the production of clear and historically novel examples of reasonable foresight in Ecuador's oil field became the explicit focus of entrepreneurship. Regulatory uncertainty – the anticipation of retrospective evaluations of reasonable foresight – was transmuted into the ever-forward-looking uncertainty of innovation in development practices.

Scholarship on neoliberalism typically treats entrepreneurship, either as a force that reorganizes social forms around the profit motive, competition and calculative rationality (Rankin 2001; Foucault 2008); or as a central metaphor in the ethos of self-improvement that accompanies Western-style business culture (Yurchak 2003). Critical scholarship has paid less attention to innovation, despite its centrality to entrepreneurship. The combination of development led by unpopular foreign companies, environmental pressure and lack of regulation in Ecuador in the 1990s created an intensely productive climate for entrepreneurs to generate environmental practices and norms where there had

been none – to repeatedly innovate, a la Knight or Beckert. Beckert's model of innovation parallels that given by Rheinberger (2015) of 'experimental systems' like scientific laboratories. Rheinberger goes one step further by highlighting how, in the context of scientific research, the 'new' is incorporated within the system that produces it and serves as a basis for further experimentation. As I show below, in the context of enduring environmental pressure on foreign developers and the Ecuadorian state, this temporal structure – the production and subsumption of the new – emerged in the oil field to minimize environmental damage and deflect criticism.

The Oil Field as Experimental System

Oil companies working in Ecuador in the late 1980s and early 1990s faced uncertainty regarding if and how environmental regulation would be imposed on the oil field. The relevant question for these companies was: from the perspective of a future reflecting on present oil development, what will have constituted reasonable foresight? Consultants approached the oil field on their behalf as a space of unknown social and environmental value; of unexamined development practices; and of unknown potential for mitigation. The oil field took its character in the late 1980s and early 1990s from the trial-and-error nature of consultants' work.

To understand what took shape amidst oil's uncertain situation in the late 1980s I look to Rheinberger's (2015) model of the 'experimental system'. As noted above, for Rheinberger, an experimental system is defined by its continued ability to produce the new, and to incorporate the new as a technical aspect of further work. Oil work was not amenable to synoptic control to the degree of a laboratory – on the contrary, it was a

decentralized, competitive field. But it shared with such scientific systems what Rheinberger (2015) describes as 'ignorance at one remove': the sense that managing oil work's socio-environmental context required innovation, and that steps in that direction would set precedents and fold back on the oil field in unpredictable ways. Drawing on Rabinow (2003), Rheinberger describes the experimental system as an 'assemblage', or a complex ensemble of people, things and practices with emergent and unpredictable capacities – an apt way of conceiving of the volatile oil field in the late 1980s and early 1990s. I organize my analysis of the oil field during this period in terms of social advocacy, environmental research, and environmental mitigation.

First, one vast set of problems involved the relationship between oil development and people who lived in the region. These included attempts to recruit local labor, to negotiate political agreements, and to advocate various forms of stewardship over communities or organized indigenous groups on the part of social scientists or NGOs. One report by an anthropologist to Conoco from 1989 provides an example of the latter. The report contains recommendations based on nearly 20 years of experience in the region working with Waorani people. While arguing that the best-case scenario would be to leave the region undeveloped, the author addressed a range of issues that posed potential risks for the Waorani. A particularly pressing one was road construction, which enabled outsiders to informally settle land that belonged to, and was actively used by the Waorani. The author provided recommendations for minimizing road construction, and advised that Conoco permanently guard the roads against informal settlers.[33]

[33] "Assessment of the Impact of Road Construction and Oil Extraction Upon the Waorani Living on the Yasuní", James A. Yost, Apr 1989.

The most active domain of academic or applied research in the experimental assemblage was in biological science and environmental restoration, as tensions over oil exploration dovetailed with increasing concern for tropical forests and biodiversity (author, date). One particularly ambitious example was proposed by St. Louis-based Missouri Botanical Garden in a report to Conoco, from 1988 or 1989:

> *The seismic testing lines and the helipads offer 2 very interesting possibilities for scientific study in a virgin tropical forest environment. First, some of the seismic lines are still open enough to be walked along without major additional clearing. They are already set out on a grid pattern of which a detailed map exists. The lines offer a wonderful opportunity for [vegetation] transect studies in the area… Second, the helipad clearings represent approximately 10 years of tropical forest succession. Information from a study of the species of plants that return most quickly would add scientific data on regeneration…*[34]

The primary problem of interest for these botanists was forest succession, which would inform contemporary debates about the maintenance of biodiversity in tropical forests. In their work, environmental scientists proposed to make use of regularities that were already built into the oil field as a form of 'infrastructure' for their own research.

The third domain of experimentation was environmental mitigation, typically through direct oversight by contractors as petroleum infrastructure was being constructed. One former contractor described an intervention he designed in the early 1990s for well construction characteristic of this kind of work:

[34] "Conoco – Biological Research Cooperation", report and proposal to Conoco, David Neill, no date (1988 or 1989).

> *…You have to basically floor a pretty big area [with] big thick timbers where the well equipment's going to sit on the ground and the traditional way of doing things [was] they go out, they find a big tree, they cut it down, they cut up the boards, they take a bulldozer, run it through the forest and put a sled on the back, load up the boards and pull it back. Well, the impact of the bulldozer going through everywhere there's a tree around was humungous… so I got one of the companies to try heli-transporting the boards and it worked so successfully that that became the norm… The company's well aware of the environmental impact, well aware of their image, and to be able to say "Yeah, we're cutting the tree down but the 300 meters between the well and the tree", or "the 500 meters is still pristine…" So as I said, I established the norm but it took experimentation, we were the first ones to do that…*[35]

An existing work plan could be observed by the consultant, and then rearranged in relation to a new object of concern, like deforestation. Since work plans were largely fixed by the time consultants arrived in the field with construction crews, this required iteratively observing established methods for different aspects of petroleum development and suggesting small adjustments that could ameliorate specific kinds of damage.

To understand their internal dynamics, Rheinberger (2011) distinguishes between experimental systems' 'technical' and 'epistemic' objects. Technical objects are those that allow experimental uncertainty to function productively by holding particular parameters of a context constant. In modern biology (Rheinberger's focus), laboratory equipment, databases or experimental organisms constitute technical objects, embodying accepted knowledge. Epistemic objects are the focus of ongoing scientific questioning,

[35] Interview with expatriate North American consultant, 5.5.13.

taking on a definite shape only retrospectively, like the rate of metabolization of a new drug by an organism. Once knowledge about an epistemic object has been established, this new knowledge can be treated as a 'technical' aspect of ongoing work on new scientific problems. Thus, once an organism's rate of metabolic uptake of a drug is established, scientific inquiry might move on to the drug's interaction with the organism's nervous system. An experimental system that endures as such is consistently able to produce interesting new phenomena, and to absorb these as unproblematic technical aspects of ongoing work on emerging epistemic objects.

In the cases of environmental research and mitigation, we can easily see how the oil field itself presented 'technical objects' that could be manipulated to achieve new ends. In the case of botany, the seismic transects and other features that had been built into the Amazonian landscape by oil work could be harnessed to the methodological needs of environmental science. In the case of mitigation, existing work practices, themselves, formed a starting point for interventions that rearranged those practices to reduce environmental damage. In the place of 'epistemic objects' we can also see some of the 'entrepreneurial objects', or innovations arrived at by consultants that helped them generate and capture the demand of oil companies: controls on oil roads, re-vegetation, and the minimization of well footprints were all suggestions made by early consultants that garnered the interest of oil companies because they promised to reduce their exposure to activist criticism. These three innovations each became recurring prescriptions in the coming decade of oil development, increasingly forming an assumed, normative component of oil work as entrepreneurs turned to other innovations under continued pressure by environmental activists. In scientific experimental systems, the

formation of new technical objects imparts stability to the overall system, allowing experimentation to remain productively focused on new, carefully defined problems. In the oil field, innovations like the ones described above were quickly converted into technical objects in the form of informal norms, and then laws and regulations that brought stability to relationships between the state, oil companies and consultants.

Before turning to this stabilization, I examine how the nature of the petroleum consulting field conditioned and encouraged experimentation. Understanding how the organization of the consulting field encouraged experimentation requires looking at the internal reorganization of the field incurred by the entrance of large foreign firms in the mid-1990s, and the uptake of environmental impact assessment as consultants' paradigmatic commercial service.

Dynamics of Environmental Impact Assessment in Ecuador

By the mid-1990s, large, foreign firms began entering the Ecuadorian market for environmental services in the oil sector. U.S.-based firms brought environmental impact assessments (EIAs), which rapidly became synonymous with environmental consulting. First institutionalized in the U.S. under the National Environmental Policy Act in 1969, EIA spread with its uptake by multilateral lending institutions, and subsequently by states seeking loans or debt renegotiation (Goldman 2005). Here I examine how EIA reorganized the consulting industry. EIA initially allowed large firms to capture the market in petroleum consulting by posing as a more thorough alternative to the ad hoc consulting available in Ecuador in the late 1980s and early 1990s. As it became mandatory, the structure of EIA formed a useful technical framework for experiments in

environmental engineering for large consultancies, while allowing less profitable aspects of the process to be outsourced to other actors. EIA itself thus exhibited the movement from innovation, to 'technical object' in its career in Ecuador. The dynamic of the experimental system was not confined to direct interventions in oil work, but included the organizational frameworks in which that work was done.

A quote from one former consultant who went out of business in the early 1990s provides a starting point for thinking about the pressure exerted by these large firms on smaller, local ones when they began working in Ecuador:

> *…[T]he international oil companies were so gun-shy that they basically didn't want to work with me. They wanted to work with big-name environmental companies from the U.S., who came in with all of their doctorados [PhDs], who didn't know shit about the region, and who would all call me and try to take me out to lunch and try to get as much information as they could… The reports [in the late 1980s and early 1990s] were basically very simple, and that was another thing that the companies wanted a lot more, just, a lot, like professional Spanish, the bullshit that goes into these things. What I prepared was short, to the point: "Here's what needs to be done, here's what's here". And that's not what all the companies wanted, that's why I got out of the business…*[36]

Small consultancies faced competition as oil companies sought the security of more experienced and better-known firms through recurring controversies.[37] Part of large firms' commercial appeal came from their ability to 'concentrate trade' (Dannhaeuser

[36] Interview with expatriate North American consultant, 6.5.13.
[37] Prominent controversial projects after Conoco included work by the Spanish company Maxus in the mid-1990s; construction of the heavy crude oleoduct in the early 2000s (discussed below); and plans to develop Block 31 and the ITT announced in 2006 (also discussed below).

1996), or to offer a number of services that petroleum companies desired in one location: describing oil's context, mitigating its impacts and defining its contractual obligations in the framework of EIA. Bundling together these services resulted in a complex textual product. In trade concentration, Applbaum (2009) notes that older firms 'are typically drawn into competition with the newer venues, and are thereby incorporated within the market ecology of the newer forms' (259). As the quoted consultant indicates, in order to stay competitive within the emerging 'market ecology' of the mid-1990s, smaller firms were pressured to emulate formal aspects of large firms' work, like their reports. Where early reports could be as short as two or three pages, those that take the format of EIA are several hundred. The consulting field exhibited what Shamir (2010) has called a 'market of authorities', as the comprehensiveness and formality of consulting services formed the basis of competition. EIA thus served as an 'entrepreneurial object' in the early- and mid-1990s: the complexity of the process and the size of the documentation it generated were taken as signs of rigor in environmental due diligence, and large firms used this value to gain control of the petroleum consulting field.

The EIA process is oriented toward the production of 'reports' and the acquisition of an operating license. These reports take the form of two formally distinct documents that emerge in tandem: the baseline study and the management plan. The baseline describes the context in which the project will take place. This data allows consultants to help their oil company client describe liabilities related to the proposed work. Practices for dealing with these issues are described in the management plan. The two reports are submitted to the Ministry of the Environment, which issues a permit once they are

approved. The report then serves as evidence of due diligence, and spells out the obligations of the developer, the violation of which can trigger an environmental audit.

The trade concentration incurred by EIA encouraged high-cost innovation in environmental engineering. The profits of consulting firms were directly related to oil companies' expenditures to make their projects environmentally friendly. Consulting firms thus focused their efforts on developing complex engineering plans – by far the most costly component of projects – while leaving the comparatively cheap baseline component to be conducted by other entities. The organization of contractors within EIA encouraged this, as specialists that could contribute to baseline studies (who had previously contracted directly with oil companies) became subcontractors vertically integrated beneath environmental consultancies. With their involvement throughout the planning process, specialists in environmental engineering were positioned to build expensive environmental innovations into petroleum development project from the start, rather than attempting to leverage changes after projects had already been designed. And they could outsource the less profitable baseline component to their subcontractors in Ecuador's burgeoning field of environmental governance.

NGOs and other organizations with programs of social advocacy and environmental research in the Ecuadorian Amazon had significant freedom to use the baseline components of EIA to complement research or institution-building they were already pursuing (author, date). On the other hand, from the perspective of large environmental consulting firms, the socio-environmental context of oil work could reliably be 'known', because specialists – botanists, ichthyologists, herpetologists,

hydrologists, geologists, anthropologists, rural sociologists and others – could readily be called upon to describe it.

Arguably the apex of high-cost Ecuadorian EIA was the heavy crude oleoduct (oleoducto crudo pesado; OCP), a 300-mile pipeline running from Ecuador's eastern-most oil fields, across the Andes and down to a refinery on the northern coast. The OCP was constructed between 2001 and 2003 by an international consortium at a cost of over USD1 billion (Gelder 2003). The OCP faced significant opposition throughout the construction process, including protests that closed the construction right of way. OCP construction through highly biodiverse cloud forest around the Andean resort town of Mindo offers a glimpse of how capital-intensive and complicated such projects could be. With assistance from U.S.-based Cardno-ENTRIX, an elaborate environmental engineering project was undertaken using expensive technologies (e.g. helicopter transport for pipeline section; the manipulation of pipe segments with cables to minimize the use of ground-based vehicles). Whereas mitigation in the experimental assemblage had involved one or two individuals observing work at a site and suggesting small trial-and-error adjustments, Cardno-ENTRIX's work on the OCP involved cascading teams of specialists and integrating mitigation with the planning of the entire pipeline. Early mitigation contracts seem to have typically been for a few thousand dollars in the 1980s, while the OCP operation around Mindo ran into the millions (Alemán et al. 2008).

Ecuador's National Herbarium and the National Polytechnic University in Quito, institutions with direct links to the consulting field from its inception, were contracted by Cardno-ENTRIX for biological assessment. The National Herbarium was involved in floristic survey of the pipeline right-of-way, salvaging epiphytes from the cloud forest

canopy, and re-vegetation using nursery plants from its own research program (ibid.). In contrast with the large expenditures on environmental engineering, the National Herbarium's contract covered expenses related to the work, and wages for a small crew of part-time technicians.[38] The example of Mindo helps us to see the difference in investment that baseline and mitigation work experienced as a consequence of the way that EIA organized consulting work, and the ability of petroleum consultants to use the EIA format to concentrate their efforts on experimentation with profitable, new mitigation practices.

EIA began its trajectory in Ecuador as an 'entrepreneurial object' that allowed large, foreign firms to generate and capture demand for their services. But it quickly became a normative background condition – a technical object – that allowed them to profitably focus their energies on innovations in environmental engineering. Its career in Ecuador illustrates what Esposito (2012) refers to as 'changing the rules of the game during the game' in order to turn a profit. Propelled by recurring environmental controversies, the imposition of EIA onto the Ecuadorian context encouraged the formation of distinct and differently capitalized experimental systems, corresponding to mitigation and baseline studies. With consultants closely involved with projects from start to finish, EIA remained an experimental field even as it produced an ever-growing number of norms and best practices. Taken on its own terms, petroleum consulting 'worked'. EIA leveraged (sometimes astronomical) expenditures for petroleum projects in the name of minimizing environmental damage, while there was still political pressure to do so.

[38] Based on an examination of partial budgets from the National Herbarium for the OCP project.

Enterprising Environmental Government

The entrepreneurial logic of the early consulting field in the late 1980s and early 1990s transformed uncertainty about if and how environmental regulation would be implemented in Ecuador into an opportunity to innovate new oil field practices. In the mid-1990s, the field was quickly overtaken by large, foreign consultancies that brought EIA with them, incentivizing expensive innovations in the narrowly circumscribed, but capital-intensive domain of environmental engineering. Throughout this period the oil field functioned as an experimental system in which entrepreneurs continually produced new practices that served to insulate oil companies from environmental criticism. Here I examine the parallel uptake of the oil field's work by the state over the course of the 1990s, culminating in petroleum regulation enacted in 2001. Ecuador's growing body of norms for petroleum development amounted to a welter of new technical objects that stabilized the oil field as an experimental system as they were formalized into law and regulations.

Two laws passed in 1994 and 1999 mandated EIA, but neither detailed how it was to be conducted, leaving this to be worked out on a case-by-case basis.[39] Departments within rapidly evolving state agencies like the Ministry of the Environment (formed in 1996), and the National Hydrocarbon Agency (formed in 1986) independently established complex 'terms of reference' for different kinds of oil work (e.g. seismic testing, test drilling, pipeline construction) drawing on experiences of contractors. At the national level, consultants' direct input was eventually sought for legislation like the 'Substitute Regulation of Environmental Regulation for Hydrocarbon Operations' in

[39] Polìticas Básicas Ambientales del Ecuador, Decree No. 1802, 7 Jun 1994 and Ley de Gestión Ambiental, Law No. 37, 30 Jul 1999. The former law was meant to signal commitment to the principles of the 1992 Rio Declaration.

2001.[40] The 84-page law took up a large number of innovations from the consulting field, such as the use of forest 'canopy bridges' to allow for faunal movement above linear features like roads or pipelines (Thurber and Ayarza 2005). Regulations also dictated which firms were eligible to bid on petroleum contracts based on their technical capacity. Access to the petroleum consulting field was thus regulated on the basis of the ability to comply with complex norms and work protocols that were created by large firms. These new norms constituted stabilizing technical objects for the experimental system: they relieved some of the regulatory uncertainty by ensuring that existing petroleum projects and consulting practices were compliant with the law, because they formalized norms that had been designed by consultants themselves. They also exercised a gatekeeping function on the petroleum consulting sector, allowing sufficiently established firms to control the market, and thus to command greater expenditures on environmental engineering in EIA. Much as EIA formed a technical object within the industry that allowed large firms to leverage investment in new development practices, its uptake by the state served to reinforce the dynamics of the experimental system by legitimizing the work that had already been done, and further shielding these firms from competition that might have reduced their ability to innovate.

Ecuador's petroleum sector provides an example of what Peck and Tickell (2002) refer to as 'roll-out' neoliberalism, in which environmental governance was designed to be dependent on the private sector, with some distinct features. First, the 'reregulation' of petroleum (Castree 2008) primarily involved formulating environmental norms where there had been none previously, and linking them to longer-standing mechanisms

[40] Reglamento Sustitutivo del Reglamento Ambiental para las Operaciones Hidrocarburìferas, Decree 1215, 13 Feb 2001.

whereby the state exercised control over the oil sector (Martz 1987). Ecuador's period of most intense neoliberal reform coincides with the reorganization of the oil field in the name of the environment for the first time, driven by entrepreneurs' profits. Second, petroleum consulting generally, and EIA specifically, were commercially available services for which there was demand before they were mandated by law or regulation, a commodity before they were policy, in response to pressure by environmental activists and petroleum companies' unease with the possibility of future environmental regulation. Third, when policies did take shape, they were not stipulated by multilateral institutions (as was the case for countries subject to structural adjustment in the 1990s; Liverman and Vilas 2006). They emerged out of an interplay and gradual alignment between state and private sector in which technical details of oil governance were designed in a piecemeal fashion in the 'assemblage' of the early oil field, becoming accepted, practical solutions for requirements that were only formalized much later. The liabilities of oil development were thus preemptively defined by the distributed work of consultants, blurring the lines between public and private actors, or public norms and commercial products (Shamir 2010). Finally, the reorganization of oil work during Ecuador's neoliberal period was not an accident of timing. Pressure exerted by multinational institutions like the IMF ensured that controls on extractive industry would be minimal in this period, and inhibited the growth of institutions that might have encroached on the governmental work performed by consultants. This same pressure allowed the growth of environmental governance beyond the state in the 1990s, in the form of environmental NGOS that formed a resource that EIA relied on for baseline studies. Austerity and the international pressure to maintain a liberal regulatory climate created the space for petroleum consulting to emerge

and a context in which it could efficiently innovate. Environmental governance in Ecuador's oil field is thus a direct, if inadvertent, consequence of neoliberalism.

In contrast with the more fluid 'assemblage', Rabinow (2003) distinguishes the 'apparatus' (after Foucault 2007). An apparatus is also composed of heterogeneous components, but takes a more enduring form, is addressed to historically specific problems on the basis of certain political rationales, and through the use of specific techniques. Characteristically, its emergence retrospectively outlines a domain that subsequently seems self-evidently to require study and management. By 2001, what had previously been a dynamic and unpredictable assemblage, as described above, had become an 'environmental apparatus': a petro-state with new environmental regulations and agencies that co-evolved with an increasingly active consulting industry; and an oil field entangled with a host of normative 'best practices' that allowed oil work to intervene on itself in the name of the environment. Environmental regulation was no longer a vague shape on the horizon, but an actually-existing component of Ecuador's environmental apparatus that the consulting field had done considerable work to construct.

The uptake of petroleum norms by the state exhibited a variant of 'performativity' (Callon 2007; after Austin 1962), inasmuch as the preemptive enactment of environmental precautions in the oil field successfully defined what would later count as legitimate environmental governance. Esposito (2012) attributes the performativity of financial markets to their intensely circular character, in which the value of financial products is premised on actors observing each other observing. Credit ratings diffuse this circularity by offering a point of reference outside of these endlessly reflexive processes.

In the late 1980s Ecuadorian oil field, actors embroiled in environmental controversy also lacked actually-existing examples of what environmental due diligence might consist of outside of their claims and counter-claims. As the case of Conoco's work in the shadow of Texaco's disastrous legacy shows, generic, a priori concerns like 'deforestation' or 'informal settlement' were defined negatively and retrospectively – as that which had not been properly managed in past development. By realizing positive (in the sense of existing, as opposed to planned, imagined, hypothetical) ways of dealing with oil's externalities, consultants provided easily available points of reference that guided the thinking of regulators and others as more encompassing, formal norms for development were sought. Beyond the transformation of concrete interventions into exemplars of due diligence and then into national norms, a broader culture of experimentation in Ecuador's environmental apparatus became normative. Experimentation and the forward-looking orientation of innovation in petroleum project design came to index environmental due diligence.

For over a decade and half, petroleum consulting was an intensively productive and profitable field that radically changed how oil work was conducted on the ground, and how it was framed as a governable object by the state. Entrepreneurs used uncertainty about future environmental regulation to leverage investment in experiments that redefined how oil work was done. Their ability to do so was premised on continuous pressure exerted by activists on unpopular foreign oil developers, and the state that purported to oversee their operations. The election of Rafael Correa coincided with a period of relative economic stability that enabled a push for greater state control in oil development. The nationalization of oil has made it more difficult to enforce the

technical innovations designed by consultants, and encouraged a general unraveling of the culture of experimentation that emerged in Ecuador beginning in the late 1980s.

Faltering Experiments

President Rafael Correa was elected in 2006 with an agenda that included both rejecting the country's foreign debt as illegitimate, and increasing national control over petroleum. With success in renegotiating or canceling portions of Ecuador's debt again in 2008 (Salmon 2009), the state was emboldened to directly alter its relations with foreign developers in 2010 (Grugel and Riggirozzi 2012). Some foreign operators consequently exited the field, with Petroecuador and its subsidiary Petroamazonas taking over where they left off. Dwindling productivity drove the expansion of development toward the ITT, a politically sensitive reserve, in the 2000s (Acosta 2010). Despite controversy, the general popularity of Correa's administration and national control over oil have combined to make state-led development indifferent to the environmentalist pressures that led earlier, foreign developers to invest in the experimental system of petroleum consulting. In this section, I examine the current inability of specialists in both mitigation and baseline studies to use uncertainty in the way that formed the basis for the industry over the last decade and a half, as a consequence of oil nationalization.

Rheinberger (2011) observes that when experimental systems operate in conjunction with another, they can cohere into larger 'experimental cultures', in which distinct trajectories of research reinforce or undercut one another, each impacting if and how the others are able to produce meaningful and useful novelty for themselves in a sustained fashion. In forming separate but mutually supportive systems, baseline and

mitigation specialists constituted such an experimental culture during the 1990s and early 2000s. Here I examine the difficulties experienced by these distinct experimental systems in present-day, post-neoliberal Ecuador. The first example I turn to is consultancies and the reports that are iconic of their work. The second is botany and floristic assessment, long a standard component of baseline studies. These examples show the unraveling of the experimental system as a consequence of nationalized oil.

Consultants with environmental firms routinely contrast a past of innovation in environmental engineering with a present of malfunctioning institutions and corrupted practices. The late 1990s and early 2000s was a period of 'best practices' and 'million dollar conversations', as one put it in which they could convince high-level oil managers working for foreign companies to invest in expensive and novel mitigation; to conduct development in the most benign way possible; and to reflexively fold innovations back into future projects and formally recognized norms. In contrast, many note pressure to work as cheaply as possible in a more competitive consulting field, eliminating their ability to experiment in environmental engineering. Moreover, the Ministry of the Environment is seen as unwilling to carefully review reports, follow up with recommendations or enforce its own regulations against Petroecuador. These changes are often discussed in reference to the role and quality of EIA reports. One long-time consultant and former environmental law professor provided this anecdote as an illustration of the contemporary situation of EIA:

> *I had fourth year students who were interns with companies that do [EIA], and I said to them, don't tell me who you work for, it doesn't interest me to know. Tell me [instead] how you do them. So [they responded] "First, we're contracted for*

almost nothing… each project has a manager… The manager is dedicated to things 'up here', macro, big scope. For us, we students do the copy-paste and change all the names of the rivers"… [Good environmental firms] also copy and paste, but they do a good copy-paste, which is to say they copy things they need to copy in order not to repeat [work], with good quality control… so now in Ecuador we have a market not in quality, but in price.[41]

This quote drives home the general skepticism with which EIA is now regarded by its own practitioners, especially with regard to the integrity of the documents that it generates. Many consultants referenced what they feel to be a 'plague of copy-paste' in the industry. This typically means copying portions of baseline reports (especially toponyms and lists of species from biological assessments). When done conscientiously, (i.e. when copying relevant information from an old report for a new project) copying easily produces errors in lieu of 'quality control'. But consultants also reference the deliberate production of misinformation, copying data from any report on hand as a 'relleno', or filling, for a report in progress. The general sense conveyed by these consultants is that the reports will not be read, so what they contain is unimportant. Copying and pasting from old reports relies on the assumption that the Ministry of the Environment will not scrutinize the maps, text, or taxonomic lists in the baseline study.

The contrast between 'good copy-paste' and 'bad copy-paste' highlights tensions between the role of EIA reports as an infrastructure for public decision-making and a commodity. The report is intended to embody reliable environmental data putatively in the public domain, and which should be available for future projects in a given area to avoid unnecessary expense. But baseline studies represent a significant investment for

[41] Interview with Ecuadorian consultant, 3.10.14.

consultants and their clients. Reports with a known provenance are a form of capital for the firms that hold them. Where they were once circulated socially among consultants, now 'friendship only carries you so far', as this consultant put it. In the context of competition and regulators that seem indifferent to the quality of reports or their public availability, minimizing expenditures on baseline studies is a logical business strategy.

In the biological sciences, the ability to use baseline studies to produce new knowledge of the lower Amazon is also unraveling as a consequence of nationalization. Among botanists working in environmental consulting, for example, the oil field continues to offer promise for botanical exploration, even if they recognize this potential is reduced from what it was in the 1990s. One long-time consultant reflected on the ITT that 'Tambococha [a watershed in the ITT] is maybe one of the best areas that I've visited in the time I've performed consulting jobs, because we've been able to identify different [species], things that one doesn't find in other sectors'. As they did in the 1990s, botanists are attempting to use oil development in previously undeveloped portions of Yasuní to identify new species or species range extensions (author, date). Yet, EIA's vertical integration means that biologists are no longer in a position to negotiate support for basic science directly with oil companies on their own behalf. For example, the consultant above must pay out of pocket to generate scientifically useful specimens out of his field collections, despite the fact that oil companies are technically required to pay for this work. When studies actually employ them, botanists are able to conduct floristic inventory and identify known species in the planned spaces of oil development. But without institutional support for the production and circulation of scientific specimens, their ability to produce the 'new' is short-circuited. Difficulties in producing meaningful

novelty in this portion of the larger environmental apparatus arise not so much from the diminishing returns intrinsic to biological exploration, but from shifts in the incentives that oil companies and regulators have to support biological science.

In both of the above cases, the ability to use the oil field's uncertainty in a productive fashion is diminished. Mitigation can no longer leverage expenditures on large-scale, expensive environmental engineering projects. Pressure to reduce expenditures on consulting, regardless of controversy, has reduced the space for experimentation and resulted in deteriorating business practices. When they are still employed in baseline studies, botanists struggle to produce basic science through the work that they find in EIA. Moreover, the sense that EIA provides meaningful information as a basis for democratic deliberation, or even that it is a useful tool in development, has been significantly eroded among the specialists that conduct it. Whereas EIA previously formed a context for the production of new practices, the problem under nationalization is more likely to be whether many long-established norms are still being observed, and how to verify this. Activism like that which prompted the controversy around Block 31's 'ecological path', spearheaded by relatively powerful foreign actors, is one of the few avenues for confronting development that has prompted a serious response from regulators and state oil companies.

From Assemblage to Apparatus and Back Again

Incensed by the Ministry of the Environment's response to the Block 31 road controversy, activists attempted to visit the road to assess it firsthand in 2014 but were repelled by corporate security. The Ministry of the Environment maintains that the road

was properly constructed, and has been forced to spell out the technical specifications of an 'ecological path' (MAE ndii), formalizing a new object in terms of which the oil field will now be governed. The overall incident put a fine point on the challenge posed by nationalization, not just for managing the environmental harm of oil development at a technical level, but for Ecuadorian democracy generally. The country will continue to grapple with these newly-heightened tensions as it balances a commitment to popular social welfare programs (Radcliffe 2012) with the destructive resource extraction required to support them (Veltmeyer 2012).

The Block 31 controversy is a public manifestation of the unraveling of the experimental system that has constituted Ecuadorian petroleum governance since the late 1980s. In the context of ongoing environmental controversy, unpopular foreign-led development and a weak state, the oil field behaved like the two types of institutions characteristically driven by uncertainty: the entrepreneurial firm and the laboratory. Early entrepreneurs in the oil field leveraged regulatory uncertainty to conduct experiments in mitigation. EIA compartmentalized and vertically integrated petroleum consulting. This reformatting of the petroleum field exhibited the same dynamic as the larger experimental system. A complex process ensued of the consolidation of the consulting industry, and the formalization of environmental norms reflecting the practices the industry had produced. The experimental system 'performed' environmental due diligence as the practices that it designed were written into law, and the experimental ethos that pervaded it became a normative, expected part of oil work. Significant portions of Ecuador's environmental apparatus, both the techniques it relies on and the

norms that guide it, are thus products of entrepreneurship under foreign debt, austerity and the general climate of neoliberalism.

To acknowledge that consultants innovated is not to celebrate them, and saying that petroleum governance has deteriorated is not to suggest that it was ever adequate. Yet, the complexity of oil development means that environmental politics in Ecuador has been, is presently, and will continue indefinitely to be technopolitical. As such, it will always be conditioned by the forms of expertise that appear as necessary means for the ends of actors confronting one another amidst environmental controversy. The challenge is not to point out that technopolitics definitionally relies on expertise and thus exhibits antipolitical dynamics (something well-known long before these terms were invented; e.g. Dewey 1927). Rather, what is needed is an understanding of how historically specific forms of expertise pose themselves as tools to actors in this environmental field, and thereby more or less successfully reconfigure widespread understandings of what the problems they face are. Neoliberalism produced something new in the form of petroleum consulting and its experimental system. Whether this apparatus holds together or is deliberately dismantled in the context of nationalized oil, understanding how it conditions Ecuador's environmental politics will require an awareness of the dynamics of expertise in the oil field that generated it and that allowed it, at one time, to function.

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Appendix C: Ethical Subjectivity in Ecuadorian Field Biology: Science, Race and Environment in an Extractivist Economy

Abstract

Ecuador enjoys unprecedented independence in directing its petroleum-driven economy, even as the environment figures more prominently than ever in Ecuadorians' understandings of their country's values. Against the backdrop of controversial oil development in the country's largest Amazonian protected area, I ethnographically examine the subject position of Ecuadorian field biologists in the country's current 'post-neoliberal' moment. To understand the ethical subjectivity of Ecuadorian field biologists, I first consider how students' sensibilities about race and the environment are adapted to the context of biology in higher education. I then consider the perspective of professional biologists, fully committed to their science, on the relationship between knowledge and ethics, noting that to be an ethical subject is to have adequate environmental knowledge. Problems of accessing and owning biological knowledge are also problems for the possibility of environmental ethical subjecthood. The history of the extraction of scientific products from the country is viewed as inhibiting both scientific research and ethical responses to contemporary problems, like alternatives to oil development. Finally, I consider how the widely reviled industry of environmental consulting forms a common but highly problematic context for the enactment of biologists' values. With the gradual dismantling of the NGO-centric apparatus of environmental governance that emerged from the 1990s, environmental consulting in development projects is a source of employment for nearly all biologists. Environmental consulting in Amazonian oil development is a livelihood that threatens biologists' connections to science, and thus ethical subjecthood, at the level of its technical details. Ultimately, this article argues that ethical subjectification is subtle but important cultural work that occurs at the formal institutional level of environmental governance. Understanding what it means to be a good environmental subject in an extractive state significantly enhances our anthropological understandings of contemporary environmental politics.

Keywords*: ethics, subjectivity, environment, postneoliberalism*

Introduction

After graduating from the biology track at a public university, Edi was fortunate to find work at an academic institution. His job as a professor and administrator enabled him to eventually earn a graduate degree in botany. Yet, a minimal salary and family hardships meant that he was constantly forced to augment his income by working odd consulting jobs in environmental impact assessment (EIA), a technical process that attempts to assess and mitigate the threats posed by economic development. When I met

him in 2013, Edi was considering quitting his academic job to do project-by-project consulting full time. As a well-regarded botanist with personal connections at consultancies doing EIA in the oil sector – and with a major round of controversial petroleum development on the table – it seemed to him there would be no shortage of work.

At the same time, he considered himself an environmentalist. He had developed an intellectual fascination and respect for nature during his childhood wandering cloud forest and páramo, a distinctive high Andean grassland, in the countryside north of Quito. He considered himself at odds with the petroleum industry that has formed Ecuador's economic engine for half a century. Edi also understood acutely how environmental consultants are widely despised as shills or proxies for capitalist interests, and taken to be incompetent by their peers working in more esteemed scientific settings. In an interview after I had accompanied him on a petroleum consulting gig in the country's northern Amazon, he discussed his ethical commitments with reference to two watersheds we had worked in:

> *As you can attest, Tiputini is an area already totally altered, [whereas] Tambococha is one of the best areas I have visited, myself, in the time that I have done consulting jobs, because we have been able to identify different [species], things that one does not find in other sectors. And me, from my point of view, given that I have been formed in the question of conservation – or rather, I'm against these activities – or rather, I don't do this work to not lose work, but rather because another person will do it. And when I finalize the report, to put all*

the aspects [related to oil exploitation, so that] they don't do it in an irrational manner as they've done in other [oil] fields.

Responsible development requires knowing what is actually 'out there', biotically, and this entails the specialized scientific skills that Edi brings to the table. Edi problematically assumes that the ecological 'value' of a locale is necessarily degraded by indigenous horticulture, a consequence of his interest in finding new vascular plant species. But his discourse clarifies that acquiring floristic knowledge of a locality is an ethically loaded activity. For Edi, the suspect character of the consulting industry itself is a reason for him to engage with it in the high-stakes context of oil extraction in undeveloped areas of the Ecuadorian Amazon. In a field notoriously crowded with inexperienced and unscrupulous technicians, he takes the place of someone else who would likely be less competent and less able to make well-informed recommendations in the development process. In the context of Ecuador's 'decentralized' environmental governance, which remains heavily reliant on private consultants, biologists like Edi form an important interface between centers of planning and geographical areas where development or environmental interventions are implemented. They feed both 'hard data' and 'softer' impressions (like the contrast Edi draws between the Tiputini and Tambococha watersheds in the above quote) into institutional negotiations.

While field biologists play an important role in environmental governance, they are hardly alone in treating 'the environment' as a nexus of pressing ethical problems in Ecuador (e.g. Acosta et al 2009; Rival 2011; Erazo 2016; Kohn 2013). Over the last thirty years, environmental concerns have become central to the country's definition of itself to the extent that it ratified 'rights for nature' in its 2008 constitution. Despite its formal

environmental commitments, Ecuador remains economically reliant on petroleum. Historically, the problems resulting from natural resource extraction have driven managerial intervention in the name of the environment (Sawyer 2004; author, date). Beginning in 2006, the presidency of Rafael Correa brought Ecuador greater independence in directing its extractivist economy, even as the centrality of the environment has grown in cosmopolitan and popular understandings of the country's values. Field biology condenses these tensions. As Edi's take on oil consulting indicates, the ethical dilemmas of field biology center on the demands of scientific and environmental responsibility in Ecuador's 'post-neoliberal' extractive economy.

What does it mean to be a good environmental subject in a petroleum state? Anthropology has not generally attended to the emergence of middle-class or professional environmental ethical subjectivities outside of North America and Europe (but for steps in this direction see Choy 2011; West 2006; Satterfield 2007; Agarwal 2007; Lowe 2005). Moreover, the discipline has only recently begun to examine the formal, institutional dimensions of environmental politics in sufficient detail to understand them as domains of active cultural production in their own right (ibid.; Welker 2014; Erazo 2013). As I show below, such institutions form a setting for earnest ethical deliberation and experience by field biologists, where ethics is understood as the questioning of how humans should live collectively (Ong and Collier 2005; Fortun and Fortun 2005; Marcus 2000; Faubion 2011; Weber 2009[1917]). Under Ecuador's President Rafael Correa, the NGO-centric institutional architecture that emerged from the 1990s, focused on protected area planning and biological resources, has been reconfigured and partially dismantled. While anthropologists have commented

extensively on decentralized regimes of environmental governance similar to that which Correa's administration inherited (e.g. Li 2007; Tsing 2004), the shape that environmental politics will take in emerging post-neoliberal contexts remains an open question. It is clear, however, that subjects like Edi, 'formed in the question of conservation' over the last two decades of environmental governance, will continue to condition environmental politics.

Drawing on fourteen months of ethnography amongst Ecuadorian field biologists, I argue that a subtle but highly productive dimension of environmental governance consists in how the ethical sensibilities of experts are shaped and negotiated amidst the technical details of their professions. The community of practice in question centers on a public university in Quito; the National Herbarium, the country's most important center for plant science since the 1990s; and one Ecuadorian and one foreign-owned private consulting agency, each with longstanding connections to these public institutions. The individuals involved range from college freshman with no formal field or laboratory experience to seasoned professionals who have witnessed enormous developments in Ecuadorian floristics and petroleum politics over the last thirty years. They share lower-middle class family backgrounds, typically being the first in their families to venture into a profession demanding university training. Much like Edi, they tend to have biographical connections to rural places. Finally, their socioeconomic background means they are required to derive some of their income from consulting in EIA. Petroleum consulting figures especially prominently in their understandings of their professional prospects and ideas about what field biology is.

My analysis begins by examining how widely available ideas about race, environmental knowledge and ethics enable middle-class students to envision themselves as environmental authorities. Following this, I analyze the relationship between scientific and environmental ethics among fully trained professional biologists. I highlight how the possibility of environmental responsibility is predicated on adequate scientific knowledge, which Ecuador's position in the political economy of science renders problematic. Finally, I consider how environmental consulting forms a context in which many field biologists must negotiate their scientific and environmental values. Before turning to my analysis of field biologists' ethical subjectivity, I situate Ecuadorian environmentalism in relation to the country's recent round of oil extraction.

Extractivism and contemporary environmental tensions

Coinciding roughly with the election of President Rafael Correa in 2006, major changes were set in motion that have reconfigured the relationship between environmental interests, popular (and especially indigenous) movements, and the resource extraction that remains central to the country's economy. The present historical moment is distinguished by the increased control Ecuador exercises over its own extractivist economy (Gallegos 2015; Arsel and Angel 2012); by the populist state's commitments to social and environmental justice (Radcliffe 2012); and by a general social milieu in which concern for the environment forms a point of national pride. Debates about oil development in Ecuador's most famous Amazonian protected area have foregrounded these environmental tensions. In this section I consider these changes, and their reception by Ecuador's urban-based middle class. I conclude by examining the

more specific position of field biologists within the country's shift from a liberal economic climate in the 1990s and early 2000s, to one in which the state has greater control over both resource extraction, and the environmental actors working within its borders.

Correa ascended as president amidst a backlash against market-oriented reforms and foreign influence over the country's economy that characterized the 1980s through the early 2000s. A cornerstone of his populist platform was the promise to take greater control over the oil sector, the largest contributor to state revenue for decades. In that time, Ecuadorian oil fields have historically been developed and operated by foreign companies and their contractors. As older oil fields have depleted, the most attractive prospects for development in the 2000s have fallen within a section of Yasuní National Park, Ecuador's largest Amazonian protected area. Known as the Ishpingo-Tambococha-Tiputini (ITT) block (referenced by Edi in the introduction), the ITT is home to some of the world's highest biodiversity as well as indigenous people formerly living in voluntary isolation from wider Ecuadorian society. In 2007, the Yasuní-ITT Initiative was introduced to offset the opportunity cost of not drilling in the ITT through voluntary international donations to a U.N-managed trust fund (Acosta et al 2009; Rival 2010; Davidov 2012). The Initiative became emblematic of the difficult balance Ecuador has sought between greater national control over its most lucrative economic sector, respect for indigenous rights, and innovation in environmental governance.

Beyond an oil field dominated by foreign firms and the popular resentment this fostered, another legacy of the neoliberal 1990s is Ecuador's field of environmental governance. Ecuador's rich biodiversity, combined with one of the highest rates of

deforestation in South America (Sierra and Stallings 1998), encouraged it to be the focus of protected area planning and the reform of biological resource use over the last three decades, spearheaded by a mix of international and domestic NGOs. In the same time frame, the environmental consulting industry exploded as foreign oil companies responded to public outrage over environmental damage in the oil field (author date). In the last half decade, Correa's administration has increasingly targeted environmental NGOs by dismantling them (Reyes 2013), and by severely restricting the bilateral aid on which they have historically relied (ICNL 2016; Valencia 2013). These moves have contributed to the disintegration of a decentralized environmental apparatus that had, for many, begun to appear as a 'traditional' governmental technology after three decades.

By 2013, the Yasuní-ITT Initiative had failed to garner the desired donations. Correa lost patience with the process and brought it to a close, declaring to the Ecuadorian public that 'the world has failed us' in August of 2013 (El Ciudadano 2013). The decision sparked immediate protest by people living in the petroleum blocks slated for development (El Universo 2013, El Comercio 2015). Indigenous mobilization in the ITT controversy highlighted the more general difficulty of pressuring the postneoliberal, extractivist state to honor local rights in the development process (Davidov 2013; Novo 2014). The demise of the ITT Initiative also clarified the general importance of the environment to Ecuador's cosmopolitan, educated and largely mestizo-identifying middle-class. The reaction in urban centers included an unprecedented push for a national referendum on development in the ITT (Vidal 2014).

Much of the attempted referendum's momentum came from universities, in which 'biological tracks' have grown through synergy with the country's burgeoning

environmental sector over the last two decades. In the public university where I observed classes, the biology track is viewed as a discipline that can 'encompass all living things' as one student put it, a logical focus for students who cite rural connections as having endowed them with a fascination for the biotic world. A nostalgic relationship to rural places forms a source of moral authority and personal commitment in environmental matters (compare to Williams 1979). It is also a complex starting point for constructing a sense of environmentalist solidarity with lowland indigenous protests in the ITT controversy and elsewhere, as I discuss below.

Given the decline in NGO-led initiatives, the most common point of insertion into Ecuador's apparatus of environmental governance, for both young and experienced biologists, is environmental consulting in economic development projects. The movement of large numbers of Ecuadorian biologists between Quito and the lower Ecuadorian Amazon – a region historically conceived as 'marginal' to the nation-state (Sevilla 2014) – in environmental consulting makes the present round of oil development unique. Yet, while Ecuador's consulting industry is large, many consultants feel that its ability to alter development is also being eroded, as the state has sought to expedite high profile resource extraction projects like the ITT.

Field biologists thus fit awkwardly into the contemporary political landscape. Those who have a firsthand view of the destruction wrought by the last two decades of Amazonian development tend to desire the sovereignty in resource extraction that Correa has promised. Biologists tend to view the current round of development as a potential opportunity to fix the damage done at specific sites by foreign companies, and to set a precedent for 'balanced' (equilibrado) development. At the same time, they find

themselves increasingly alienated from the Correa administration by its actions (like dismantling NGOs and restricting bilateral aid). They also confront the Correa administration's overt hostility to environmentalism, famously evidenced in the President's reference in a public address to 'infantile environmentalists' (ecologistas infántiles), a phrase later taken up ironically by activists (e.g. El Comercio 2010). Biologists' position in Ecuador is neither one of utter subjugation, nor one of unfettered power. They provide an example of what Marcus (2000) refers to in passing as the 'petty empowered', the 'dominated segment of the dominant' (3). They are professionals with some sway in environmental governance, even as they operate in the margins of international science and struggle to impact how resource extraction is implemented. In the course of their work, mainstream Ecuadorian attitudes about the environment are translated and remolded, mapped onto the intricacies of their scientific and technical work. I turn now to an examination of the ethical subjectivity of field biologists, beginning with their relationship to indigeneity.

Indigenous exemplarity

Much of the discourse of professionals with biology training centers on the imaginary of 'the field', and particularly of the people living there with whom biologists interact in the course of fieldwork. The most emblematic case is of interactions with lowland indigenous peoples in the Ecuadorian Amazon, whose ecologically-attuned livelihoods make them the object of environmental ethical esteem. The trope of indigenous exemplarity also serves as a prompt to ethical reflection about the privileges and responsibilities of a middle class lifestyle, tacitly tied to a mestizo identity. In

educational settings, this trope is commonly used as a teachable example for students. As I show below, it embeds important class- and race-based lessons about the ethical subject position toward which biologists should aspire.

Like many settler colonial societies, Ecuador has a history of scientific discourse that has pushed back against the disciplining or eradication of indigenous culture by valorizing indigenous environmental, medical and other forms of knowledge (e.g. Tilley 2011; Pribilsky 2009). The country's foremost 20th century naturalist, Misael Acosta-Solís, wrote routinely about such knowledge as a national patrimony that could aid in developing the country's natural resource base, in public editorials and technical publications. In reference to the highland county of Otavalo, for example, he argued in the late 1930s that the indigenous Kichwa language was valuable because it embedded knowledge about economically valuable botanical resources (Acosta-Solís 1938). Reproducing Kichwa was therefore a responsibility of the rural educated class that could contribute to the betterment of the nation. Rural professors and students in Otavalo (assumed by the author not to be speakers of Kichwa by birth) were doing an exemplary job of preserving Kichwa botanical knowledge, partially by learning the language through their interactions with the 'nearby inhabitants', as the author put it.

Latin American scholarship has argued that mestizaje (like other racial forms) is irreducible to the phenotypic expression of a biological substrate, but depends on contingent enactments of race that are highly changeable across cultural and historical contexts (Cadena 2000; Arias and Restrepo 2011; Eiss 2016). Technical discourses and practices like those of field biologists are one cultural site in which ethical problems and racial distinctions are worked out in tandem (Poole 2016; Delgado and Rodríguez-Giralt

2014; Roberts 2012). From Acosta-Solis' perspective, Otavaleños performed an ethical act by reproducing indigenous botanical knowledge in rural schools. Yet, the line the author presumed between indigenous and mestizo in the countryside was, itself, likely murky. For the rural speaker of Kichwa, botanical knowledge would have formed both a resource (a source of moral authority based on participation in the project of national economic development) and a liability (a potential signifier of a subordinate racial status). Valorizing indigenous knowledge was (and is) not merely a matter of extending respect across a clear, unmoving demarcation between dominant and subaltern peoples, but an act of self-positioning in which aspiring 'dominant' subjects had stakes.

With radically expanded educational opportunities as a consequence of the state's increased commitment to public welfare (Hoof et al. 2013; Radcliffe 2012), more young people than ever move between country and city, and more avail themselves of higher education. In doing so, they must grapple with the class and race connotations of a rural background (Prieto 2004), and learn how to be cosmopolitan, middle class, and professional. As I show below, the trope of indigenous exemplarity is a powerful idiom for talking about the kind of ethical self expected of the mestizo environmental professional.

At Ecuador's National Herbarium in northern Quito, Thursday afternoons are reserved during the school year for visits from student groups. Today, a boisterous group of boys from a nearby vocationally-oriented high school has been led into the collection room by the assistant curator Emilio, who begins delivering a familiar lesson. Containing

perhaps ten percent of the world's vascular plant diversity within its borders, Ecuador is a 'mega-diverse' country. This is why Ecuadorians need a herbarium. It is an archive of botanical knowledge, like a library of plants. Emilio retrieves an olive-brown leaf mounted on a sheet of thick acid-free paper from the workbench behind him and asks if anyone can identify the species.

Student chatter is the only reply.

It is a *ceibo*, he says, an Amazonian tree that can reach heights of 60 meters, towering above the already-tall upper Amazonian canopy. When he first began working in environmental consulting two decades ago you could see the tree everywhere in the lower Amazon. Now, he says, you don't find them – but the students are still talking.

"Who wants to be a biologist?" Emilio snaps.

A few hands go up, and other boys murmur their interest.

"And why do you want to be biologists, who wants it, why?"

"To take care of the environment," says a boy in front.

"'To take care of the environment'," Emilio repeats flatly. "You want to protect the environment? Look […] you are in the field someplace, some consulting job, some community, and you want [them to] not cut the trees. Some Indian with a ceibo in his garden [*chakra*; rotating Amazonian horticultural plot]. So, what are you going to tell them?"

"You're damaging the forest. You need to take care of nature," the same student responds, with vocal support and nods of agreement from his peers.

Emilio smirks, then looks upward and gestures toward the invisible ceibo:

Imagine the poor Indian ['indio'] in the field: this tree, this ceibo, is his only bank account, the only manner he has to get money, to buy medicine or gasoline [...] You're going to tell him simply 'don't cut this tree, you're damaging nature'? It's not that easy. Meanwhile, you're here in Quito, you have a comfortable life, you have a job working in consulting; you can buy your things [...] You're here using so, so much water in the shower during the drought [while] the páramo is burning, leaving the tap open when you brush your teeth [...] And you go to this little old man [viejito], this poor little guy [pobrecito] and tell him just 'please, sir, don't cut this tree – you're damaging the forest?' Why is he going to listen? He already knows how to manage in his own garden. Perhaps learn something from him. No. You need to make yourself responsible [hay que responsibilizarse tu mismo].

The students seem chastened as Emilio curtly directs them to follow him around the corner to the collection room workbench.

I saw Emilio deliver this lesson several times during tours of the Herbarium, although this instance was more pointed than usual due to his frustration with the students' inattentiveness. In the context of these thought exercises, the high school students' response was gauche: no one was supposed to simply come down hard on the indigenous person. The relationship Emilio suggests between personal virtue and the capacity to govern parallels the classical ethical reasoning examined by Foucault (1988; cf. Faubion 2011): to be worthy of exercising a managerial role over the socio-

environment, these students need to properly recognize their own 'environmental footprint' and privileged lifestyle; to step into the precarious economic circumstances of those they are trying to influence; and to learn something from these environmentally responsible others.

At the same time, the details of Emilio's discourse help to construct this lesson as one implicitly targeted at mestizo subjects. 'The chakra' is an easily recognizable signifier of Amazonian indigeneity, and helps to place the imagined scene in a space radically distinct from the highlands. 'Indio' is a cognate of 'Indian', often considered racist in Ecuador, as it would be in the United States, especially in the context of a presentation by a public servant. The diminutives 'viejito' (lit. 'little old man') and 'pobrecito' ('poor little guy' or 'poor little man') would be construed as condescending when used in reference to an adult man. Emilio assumes that the high school students will not take offense, and that they will be able to identify with the subject position of the mestizo consultant into which he is interpellating them.

There is no reason to assume that this entire group of middle or lower-middle class students identifies unambiguously as mestizo; it is entirely possible that some of them have immediate family in the countryside, some of whom may be Kichwa speakers. The possibility for offense is lessened, as Emilio treats lowland indigeneity as the ethical exemplar. This distances the locus of indigeneity (socially and geographically) from the likely background of the high school students, and allows Emilio to construct the interactional space as a mestizo one vis a vis his hypothetical example. His lesson thus exhibits two simultaneous layers of responsibilization (Rose 1999): first, the modeling of a hypothetical environmental professional who is (or ought to be) prompted to ethical

reflection about their privileged, urban middle-class lifestyle by their interactions in the field with an indigenous ethical other; and second, the real interactional inculcation of a tacitly mestizo sense of environmental responsibility in the visiting high school students through this imagined example of ethical reflexivity.

In this context, indigenous exemplarity is thus best understood as a trope involved in the production of environmental professionals. Anthropology has seen acrimonious debates about the 'ecological noble savage' (Hames 2007), focused on whether indigenous peoples are intrinsically 'conservationists'. In general, this literature has not observed that ideas about indigenous environmental ethics are a cultural problematic in terms of which environmental professionals also make sense of themselves and their own work, and which conditions the classed and raced dimensions of their subjectivities. Positioning oneself within Ecuador's racial hierarchy by extending respect is symptomatic of Ecuador's cultural politics (Novo 2014). For highland students and professionals, identifying lowland peoples as the epitome of indigeneity defrays some of the risk of stigma associated with a lower-middle class, rural background. Simultaneously, the extension of a special ethical regard allows the subject to participate in the imaginary of Ecuador's post-neoliberal plurinational state, by adopting a position from which they can reflexively absorb environmental lessons from indigenous others they encounter in their specialized work.

Technical discourses and practices, as well as more widely available cultural resources like imagery of Amazonian indigeneity are taken up by field biologists to craft an urban, mestizo professional sense of self. Like many such examples in the university biology classes I observed, Emilio's lesson is deliberately constructed so that students

can put themselves in the place of an environmental expert while having only minimum biological knowledge, through the use of easily intelligible social types and scenarios. Biological education is a context for learning about the character of the Ecuadorian polity and of the professional self, mobilizing widely held attitudes about race and environment as a starting point. For individuals who have taken up field biology as a vocation, the ownership and circulation of specialized biological knowledge, and the possibility of environmental responsibility in the extractive economy tend to be carefully considered problems. I now turn to the relationship between knowledge and environmental ethics from the viewpoint of professional biologists.

Economies of knowledge and virtue

Ecuadorian field biologists are on the margins of international plant science, typically having little institutional support and struggling to participate in cutting-edge scientific initiatives. Moreover, the taxonomic methods that they use most frequently, focused on the physical examination and description of specimens, are out of favor in a larger field driven by molecular and statistical methods. On the other hand, as urban-based middle-class professionals, they enjoy privileges that many Ecuadorians do not. As discussed above, they routinely interact with people in the course of fieldwork whose racial and class status are widely understood to be subordinate to them, yet who they rely on to various extents for access to field sites and environmental knowledge. This mid-tier status forms a complex position from which to reckon with what it means to be an environmentally responsible (collective or individual) subject against the problematic availability and ownership of biological knowledge. Most biologists see knowledge as

their best potential contribution to an environmentally ethical society, even as their ability to produce and access it is hampered by a lack of institutional support.

Scholarship on field biology and natural history has noted the consistent reliance of scientists and naturalists on 'local' knowledge in colonial and post-colonial settings (and the production of the 'local' as a consequence of this contact; Mueggler 2011; Raffles 2002). On the other hand, post-colonial studies of science have examined the power relations adhering in international science from the perspective of scientists in the 'global South' (Cañizares-Esguerra 2006; Medina et al. 2013; Sevilla and Sevilla 2013; Cuvi 2005; Budoski 1974). Both of these literatures have focused on the ownership of knowledge, and the extraction of scientific products. Here my focus is on how knowledge ownership is an intrinsically ethical problem for Ecuadorian biologists who want their country to have stronger scientific institutions. The availability of knowledge impacts the possibility of managing the country in an environmentally ethical way. I draw on an interview with an experienced botany professor to examine how indigenous environmental exemplarity forms a starting point for thinking about knowledge and environmental functioning. I then turn to how this ethical problematic is mapped onto the controversy surrounding oil development in the ITT, which involves problems created by the larger political economy of science.

When asked what motivated his professional work, Alberto said that he was inspired by the depth of knowledge held by his interlocutors in his academic biological fieldwork:

> *The jobs I've done with [three different lowland Amazonian indigenous peoples] for me have been important […] I think that my best professors have been*

indigenous informants. You learn a lot from them, because living in the forest they know how to manage the forest, you see this ethic in the way they maintain [it]. It's something conservationist, they have an ethic, they are good examples […] A people that have lived in the forest, in order to live in the forest, know how the forest functions and this is an ecological knowledge learned through time that isn't in books, isn't in the university…

Alberto sees the communities with shifting horticulture that he's interacted with as doing an exemplary job of maintaining the forest; their environmental knowledge is, in effect, an active component of local ecology that participates in the ongoing production of the forest, evincing an indigenous environmental ethic. He emphasizes that the maintenance of indigenous knowledge is a prerequisite to the maintenance of this ethic. Finally, sharing authorship with his ethnobotanical informants is an important part of his practice, a way of transferring indigenous ownership over knowledge to the realm of published science. In his highly abstract description, Alberto establishes a three-way equivalence between knowledge, ethics and environmental function: adequate environmental knowledge allows human activities to be conducive to environmental functioning; environmental functioning is evidence of environmental ethics; to have and operationalize environmental knowledge is the substance of environmental ethics. Access to knowledge is thus a precondition for ethical subjecthood.

This relationship between environmental knowledge and environmental ethics is mirrored in Alberto's understanding of his own role as a scientist and the possibilities of responsible development. In this, Alberto is not alone: the relationship between environmental knowledge and sustainability in indigenous communities often forms a

starting point for reflecting on scientific ethics, and the difficulties of making and accessing scientific knowledge in the country. Many biologists framed Ecuadorian institutions and scientific knowledge of the country as struggling to take shape historically against an outward flow of field specimens and literature, first to Spain and later to the U.S. This history of extraction of physical scientific products encourages a sense of national ownership corresponding both to biological resources, and to the knowledge that is seen as a prerequisite to managing or using them (cf. Lowe 2008). As one botanist put it to me, 'Your country, your flora'. The phrase takes its double meaning from the way 'flora' refers both to the ensemble of plants living in a geographic space, and to the scientific publication that describes those organisms.

Alberto followed his remarks about his professional motivation by considering other options that Ecuador might piece together beyond the Yasuní-ITT Initiative, which Correa had abandoned by the time of our interview. He connected the difficulties with constructing an alternative in Yasuní to the example of his own alienation from the products of his scientific work:

> *One possibility is ecotourism… You can't discount products of the forest, medicinal products that could be useful… The [lowland indigenous groups] also have a lot of information, there is botanical information but one never hears of this – you never hear talk about uses for non-woody forest products […] Some people tell you, 'the "infantile ecologists" complain just because some little bird appears' […] It's difficult to work with these people. If you don't know ecology and the interrelations, if you don't know a minimum of biology, you can't – how can you speak with these people? […] Of the [biological field] collections that*

I've made, many times I didn't know that they were new because I was learning, and because almost all [Ecuador's specimens] have gone to the United States. So in the United States, the specialists reviewed them, and you remain on the margin of that. You ought to see, because more than forty species from my collections have been published by other authors…

Alberto sketches a network, from lowland indigenous peoples to Ecuadorian and U.S. scientists, which ought to be harnessing environmental knowledge to frame Yasuní in terms of values that would provide an alternative to oil development. The role of indigenous knowledge as an inventory of resources recalls the writings of Acosta-Solís. Alternatives to oil extraction would need to combine some economic compensation with a respect for the environmental functions played by the Amazon, since no known Amazonian resource can compete with oil, dollar for dollar. Alberto suggests that the ability to frame the Amazon responsibly is in large part a function of ecological and biological knowledge. By embedding the recognizable phrase 'infantile ecologists' within the hypothetical direct reported speech 'the "infantile ecologists" complain…' Alberto constructs a wider field of technocrats who take their cues from President Correa, and who cannot be reasoned with in environmental matters as a consequence of their ignorance. In the midst of his discourse Alberto pivots abruptly to the question of his own scientific contribution, tying his work to the question of environmental responsibility. He notes not having known what he had come across in the field previously in his career, and that figuring out if something is a new species typically requires access to reference collections and literature. The implication is both that he has not been given due credit in

the course of his work, and that lack of access to the fruits of scientific labor like his impacts the country's ability to formulate compelling alternatives to oil exploitation.

The right economic formatting of Yasuní is an intrinsically ethically loaded question, and one that the country cannot respond adequately to in lieu of sufficient biological knowledge. Alberto, like Edi in this article's introduction, is prone to characterize development that is unguided by environmental knowledge as irresponsible. He also suggests that it is impossible to reason with people who lack environmental knowledge. Knowing 'a minimum of biology' is a prerequisite not just for minimally destructive development, but also for the ability to reason ethically about the environment at all; knowledge is an enabling condition, allowing the environment to be an object of ethical reflection and action. Difficulties in Alberto's own ability to verify what he has found in the field inhibit him as an ethical actor.

Field biologists tend to see themselves as key agents of environmental responsibility whose effectiveness is hampered by the impoverished institutional context in which they work. A desire for institution-building and ownership over knowledge is intertwined with a concern for constructing an environmentally ethical society, as well as ethical professional selves. From this perspective, environmental consulting presents a difficult (often intractable) context in which to enact their values. I turn now to consider environmental consulting, the most consistent form of employment available to Ecuadorian field biologists, as a domain of environmental ethical subjectification.

'Neither environmentalism, nor science'

Hailing from a small community outside of the small highland city of Otavalo, with a dark complexion and a thick braid that hangs to his waist, Sebastian could easily be a descendant of the rural Kichwa-speaking students or 'nearby inhabitants' that Misael Acosta-Solís saw as ethical exemplars. I typically encountered him hunched over the collection room workbench in the National Herbarium, dressed in a flannel or alpaca sweater over a black band t-shirt, with cargo shorts, canvas high-top sneakers and chain wallet. The Andes-inflected symbols of urban youth rebellion that he wore contrasted markedly, both with the dry institutional ambience, and with the quiet diligence with which he approached his work in the Herbarium collection room.

When I first approached Sebastian to chat, he was recently graduated from public university. At the time, he was working as a field technician for an Ecuadorian NGO revegetating páramo grasses in experimental plots about two hours outside of Quito. This was a coveted position that made him nearly unique among the public university students and alumni that I knew. He was clearly proud of the work he was doing, and willing to talk about it despite his reserved demeanor, as I did my best to help him identify his field specimens. He favored fieldwork in the páramo over other landscapes, and was on track to be a taxonomic specialist in highland grasses. When the conversation turned to the consulting industry in which many of his peers worked, he made his disapproval clear. It was 'neither environmentalism, nor science', he told me with a forcefulness that startled me. As he later explained, development was inevitably harmful, and to participate in EIA always involved giving tacit approval to environmental damage.

Roughly eight months into my fieldwork and seven into my friendship with Sebastian, the controls on foreign financing put in place by President Correa hit the NGO

that he worked for, which was shuttered overnight. After two months of unemployment, in February I accompanied Sebastian on his first petroleum consulting job in the lower Ecuadorian Amazon. The project was a timber valuation, intended to identify trees and estimate their board footage so that compensation could be paid out to the relevant community when an oil pipeline was constructed through their land. Our local hosts and the company's field coordinator were brutally matter of fact about the unlikelihood that payout from Petroecuador would ever make it past the provincial office of the Ministry of the Environment, to the community that was owed compensation.

Despite the grim context, our hosts and the fieldwork were both pleasant and the week went by quickly. On the return trip we stopped in the city of Coca, the province capital, where our group was required to register the 'biological materials' we had collected with the local Ministry of the Environment. Sebastian and I checked into a hotel, while the company's field coordinator carried off our large plastic sacks of specimens, pressed in newspaper, tied in twine and reeking of bootleg cane liquor that we'd used as a preservative to kill insects and mold. We laughed about what the officials at the Ministry of the Environment would make of the smell.

Fifteen minutes later, as we were relaxing in the hotel room, car horns and shouting erupted in the street. When we went outside to figure out what had happened, we were told that President Correa had made a surprise trip to Coca. His motorcade was making its way to the Ministry of the Environment. The official purpose of the trip was to congratulate the Ministry on its work preparing for the coming development in Yasuní, at the very office where our field coordinator was registering our liquor-soaked specimens. The subtext of the visit was hard to miss: the Ministry would not be standing

in the way of development. It would need to hurry up, expediting processes like the timber valuation we were in the middle of, or face the wrath of the President.

When we returned to the hotel room there was no need for conversation. We had spent much of our fieldwork casually conversing about national politics, Sebastian's views about the corrosive effects that Correa's policies were having on the country's environmental governance, and the corrupt character of the EIA process. His first job consulting in the petroleum sector had shown that he was justified in his skepticism and resentment of the field that forms his best professional prospect for the foreseeable future.

Ethical acts in 'an area totally altered'

Biologists bring to their university training and work a host of widely-available attitudes about knowledge, race and environment, such as those exhibited by the high school students addressed by Emilio. At the university level, their training encourages them to understand environmental ethics and biological knowledge as two facets of the same socio-environmental problem. Those who aspire to a career in science often see themselves as striving to rectify a history of scientific exploitation, which also hampers the possibilities for constructing an environmentally responsible society. Multiple factors, such as their social networks and institutional connections, the paucity of academic positions in Ecuador, and a lack of what they take to be more legitimate (state- or NGO-led) work in environmental governance – all conspire to funnel them into environmental consulting. As it was for Sebastian, entry into consulting is often a moment of reckoning with their environmental ideals and professional prospects. Their responses can range

from a sense of self-betrayal and resentment in a situation they feel to be impossible, to the more hopeful acceptance of consulting as 'a service we provide for the country', as one young woman who had just begun working in the field put it to me. In all cases, consulting is a context in which environmental commitments are enacted. In this section, I consider Edi's consulting work in the Tiputini watershed, what he later described to me as 'an area totally altered', to show how prosaic technical practices in fieldwork are laden with the problems of race, knowledge and economy discussed above.

It took three days to gradually arrive at the right-of-way of the pipeline that would eventually carry oil out of the ITT: first from Quito to Coca by plane; then from Coca down the Napo river toward Petroleum Block 31, which forms a gateway to the ITT; and finally via company-contracted launch to a local household that agreed to host us for the first leg of our fieldwork. The morning after we arrived, we were taken by two brothers, Victor and Luis, down a path leading past local houses, agricultural plots and forest. Within about forty-five minutes of walking, Edi began looking for a place to situate the impromptu quarter-hectare parcel we needed to construct. The decision involves a mix of Edi's botanical knowledge of local flora, with a more impressionistic, aesthetic evaluation of the landscape to decide where a parcel is most likely to yield a desired sample. The easiest plants to assess are the species characteristically associated with shifting horticultural plots – dangling cacao leaves in the lower canopy or spikes of yucca jutting from the understory are easily discerned cues that we are next to a fallow garden. Along with these cultivated species come others, like the plant family Melastomataceae, characteristic of regrowth in the forest after intervention. There is no need for Edi to

elicit any information form Victor or Luis about plants along this forest road, given his familiarity with the plants around us.

Scholars have highlighted how travel renders both people and landscapes amenable to evaluation by bracketing the experience of the traveler (Pratt 1992; Hayden 2000; Kohler 2006). Travel into the 'field' in EIA allows a narrowly defined site to be embedded within a larger regional sense of human intervention in the landscape. In the context of a biological inventory, this assessment translates into a judgment of ecological value, leading to formal measurements and a report.

Edi eventually settles on one such fallow garden for constructing the parcel. The next step is to construct a quarter-hectare parcel. The parcel formally translates a rough assessment of the local landscape into a taxonomic list and metrics of taxonomic diversity and abundance. Flagging tape is used to demarcate a physical space in which a sample will be taken. From there, trees above a ten centimeter diameter threshold are marked with bright yellow paint. The rest of the work in the parcel involves scaling trees to cut down specimens from the canopy that can be used for species-level identifications, collecting them in plastic bags and tracking them in a field notebook.

For field biologists seeking to maintain contact with basic scientific research, specimens collected in EIA are a crucial but problematic resource. Specimen collecting in EIA differs from the opportunistic plant collecting typically used in taxonomic botany. Specimen collection in EIA is motivated by the need to construct a defensible taxonomic portrait of the area of a specific development project, rather than by the goal of producing new species and range extensions in coarsely defined regions. Specimens collected in EIA need to be identifiable by a competent taxonomist, a relatively low bar that may be

achieved even with a partial leaf damaged by fungus or insects. But in order to be usable as a basis for scientific publications, multiple specimens must be cut from the same physical plant. These must be whole and accompanied by flowers and fruits, as they will be incorporated into the comparative collections of multiple herbaria. Even when collectors are conscientious about the quality of the specimens they are collecting, only a small percentage of trees in an Amazonian parcel will be in flower with fruits during any given inventory. The vast volume of scientifically useless specimens produced by EIA is a frequent target of critique by biologists. The increasing reliance of biologists on EIA for employment should be seen partially as a recontextualization of taxonomic practices from more esteemed basic science, to what scholars of governmentality have referred to as a 'gray science' of environmental impact assessment – an expert practice more focused on managing socio-environmental relations in the present than producing knowledge for the long-term (Rose et al 2006). Professional frustration with the ability of EIA to leverage change in the development process should be understood as a critique of the transformation of field biologists from producers of ecological knowledge, to custodians of the oil field.

The forest is densely shaded from the ground level, but opens up in unexpected ways as one ascends toward the canopy. Belted to a tree-trunk fifteen meters above the ground as he cuts down specimens on a long pole, Edi is able to see outside the fallow garden in which I and another botanist are collecting falling specimens and assigning them ID numbers. He pauses his work for a moment, then calls down to us to let us know that there is an interesting tree in flower just beyond the opposite edge of the

parcel. He will stop and collect a specimen from it on our way out of the parcel at the end of the day, he says. It could be something new.

The use of EIA fieldwork for ad hoc specimen collecting is an example of a common and prosaic practice that is nonetheless ethically freighted (Lambek 2010). It is an attempt to make the best case possible for the ecological value of what Edi perceives to be an adulterated landscape. In order to transform the field collection into scientifically usable specimens, Edi will have to pay out of pocket for the National Herbarium to process them, despite the fact that developers are legally required to pay for the processing of specimens in EIA. Circulating these abroad shores up his scientific prestige by perhaps producing something new, pending identification by a specialist. The act strives toward scientific and environmental responsibility by producing ecological value through scientific knowledge that may have longer-term impacts on how people understand the utilities posed by Amazonian biological resources, beyond the present construction of a pipeline.

Conclusion

This article has considered what it means to be a good environmental subject in an extractive economy, by examining the negotiation of environmental ethics by field biologists in the midst of Ecuador's most recent petroleum development in the ITT petroleum block. At the university level, mainstream attitudes about race, environment and knowledge are adapted to the context of biology, among the typically lower-middle class students with rural backgrounds that I studied. For professionals fully committed to biology as a scientific vocation, the problem of the adequacy of biological knowledge for

economic development is equivalent to the problem of the construction of an environmentally responsible society. They face challenges inherited from a legacy of the extraction of physical scientific products that also pose a challenge to the construction of ethical selves and an environmental polity. Fieldwork in EIA condenses the problems of racial belonging and respect, the possibility of contributing meaningfully to science, and of environmentally benign development. It is the context in which biologists are most likely to be able to

Clearly, environmental subjectivities are not only forged at the 'community' or 'local' levels; environmental politics also configures the subjectivities of environmental professionals and 'experts', those involved in planning and implementing environmental interventions, in subtle ways. Ideas about how to be a virtuous subject – how to take up field biology in a way that honors scientific and environmental ethics – are implicated in visions of the right way to mold social relationships with the environment, and vice versa. Field biologists often have a clear understanding of their situation, though their commitments may imply conflicts about how they should act. In the aftermath of decades of coerced liberalization and privatization, Ecuador's extractivist turn and increased disciplining of environmental interests intersect to create highly specific problems that are at once managerial (governmental, focused on the conduct of others' conduct) and ethical (focused on the conduct of oneself). Understanding the situation of environmental professionals vis a vis the extractive state will likely be important for understanding the country's political economy as a new, 'post-neoliberal' period of environmental politics develops. The ethical subjectivities of professionals in

environmental governance will strongly condition how the liabilities of a petroleum-based economy are understood, and the ability to envision and enact alternatives.

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