

The Capitalocene

Part I: On the Nature & Origins of Our Ecological Crisis

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This essay builds out an argument for understanding the past five centuries as the Capitalocene, the “age of capital.” The present essay – the first of two parts – engages the non-dominant Anthropocene reading of modern history and its accounting of ecological crisis. Situating the Anthropocene perspective within green thought since the 1970s, I show that the emphasis on the Industrial Revolution as the origin of modernity flows from a historical method that privileges environmental consequences and occludes relations of capital and power. Underscored by – but hardly limited to – Anthropocene arguments, this consequentialist bias is pervasive to green thought’s engagement with history: as a succession of social processes that cause environmental consequences. This bias underpins a series of important mis-recognitions. Above all, green thought’s love affair with the Industrial Revolution has undermined efforts to locate the origins of today’s crises in the epoch-making transformations of capital, power, and nature that began in the “long” sixteenth century. The alternative to the “Age of Man” (the Anthropocene) is the “Age of Capital” (the Capitalocene). In this, capitalism is understood as a world-ecology, joining the accumulation of capital, the pursuit of power, and the co-production of nature in dialectical unity. This alternative is developed in successive philosophical, historical, and theoretical registers. First, I highlight the problem of Cartesian dualism in global environmental change. The alternative implies a shift from humanity and nature to humanity-in-nature. Second, I reconstruct early capitalism’s extraordinary environmental transformations through its mutually reinforcing transitions in science, production, and power. Finally, I argue for a historical frame that takes capitalism and nature as double internalities: capitalism-in-nature/nature-in-capitalism. The generalization of the value-form (the commodity) is possible only through the expanded reproduction of value-relations that unify wage-labor with its conditions of expanded reproduction: the unpaid work of human and extra-human natures.

When and where did humanity’s modern relation with the rest of nature begin? The question has gained new prominence with growing public concern over accelerating climate change. For the past decade, one answer to this question has captivated scholarly and popular audiences alike: the Anthropocene.

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It is, in Paul Voosen's apt phrase, "an argument wrapped in a word" (2012).

Just what kind of argument is it? As with all fashionable concepts, the Anthropocene has been subject to a wide spectrum of interpretations.² But one is dominant. This one tells us that the origins of modern world are to be found in England, right around the dawn of the nineteenth century (Crutzen and Stoermer, 2000; Crutzen, 2002; Steffen, Crutzen, and McNeill, 2007; Steffen, et al., 2011a, 2011b; Chakrabarty, 2009; *The Economist*, 2011a, 2011b). The motive force behind this epochal shift? In two words: coal and steam. The driving force behind coal and steam? Not class. Not capital. Not imperialism. Not even culture. But... you guessed it, the *Anthropos*: humanity as an undifferentiated whole.

The Anthropocene makes for an easy story. Easy, because it does not challenge the naturalized inequalities, alienation, and violence inscribed in modernity's strategic relations of power and production. It is an easy story to tell because it does not ask us to think about these relations *at all*. The mosaic of human activity in the web of life is reduced to an abstract humanity as homogenous acting unit. Inequality, commodification, imperialism, patriarchy, and much more. At best, these relations are acknowledged, but as after-the-fact supplements to the framing of the problem. This framing unfolds from an eminently commonsensical, yet I think also profoundly misleading, narrative: one in which the "human enterprise" is set against the "great forces of nature" (Steffen, et al., 2011b, 2007). The taxonomy of "Anthromes" (Ellis, et al., 2010) – ecosystems dominated by humans, and therefore not "wild" – *precedes* the interpretation of historical change, substituting highly linear notions of time and space for historical-geographical change. At the same time, Anthropocene scholars cannot escape the conclusion that humans, too, are a "geophysical force" – the singular is important here – that operates *within* nature (Steffen, et al., 2011b, 741). This is the "One System/Two Systems" problem common to green thought in its mainstream and critical currents. Philosophically, humanity is recognized as a species within the web of life; but in terms of our methodological frames, analytical strategies, and narrative structures, human activity is treated as separate and independent. There are "human constructions" and "natural" constructions (Zalasiewicz, et al., 2011b: 837) – even as humans are recognized as a geophysical force. This dissonance creates rather more fog than light, for the recognition of humanity-in-nature becomes a kind of philosophical cover for reductionist narratives of humanity *and* nature.

Holism in philosophy, dualism in practice. This is the generalized condition of green thought today.

If regional environmental historians and political ecologists have challenged this general condition (White, 1995; Bakker, 2003), global environmental change scholars have clung to the nature-society binary ever more tenaciously over the past decade. The key question we may pose to this latter group is this: Is the reduction of humanity's patterns of variation and coherence acceptable as anything other than a first-order sketch of modern historical change? Is humanity as "geophysical

² The argument over the periodization of Anthropocene rages on. Some archaeologists now argue for converting most or all of the Holocene into the Anthropocene, either from the mega-fauna extinctions at the dawn of the Holocene, or the origins of agriculture, c. 11,000 B.P (summarized in Balter, 2013; see Smith, et al., 2010; Ruddiman, 2005, 2013; Gowdy and Krall, 2013). Still others argue for an Anthropocene c. 2,000 years B.P (e.g., Certini and Scalenghe, 2011). While other still argue, albeit weakly, for a post-1945/1960 periodization (Zalasiewicz, et al., 2008). Empiricist concepts like the Anthropocene are often a conceptual and historical mess, precisely because they propose to engage reality as bundles of quantitative aggregates prior to discerning the actually existing historical relations within which such numbers can be given historical meaning. The facts in the debate may be more-or-less correct, but adding up facts does not a *historical* interpretation make (see, e.g., Carr, 1962).

force” and unified “enterprise” a reasonable historical proposition? As a metaphor for communicating the significant – and growing – problem posed by greenhouse gas emissions and galloping climate change, the dominant Anthropocene argument is to be welcomed.³ But only to a point.

There are really two major dimensions of the Anthropocene argument today. One is a strict emphasis on atmospheric change and its proximate drivers. The other, and there is frequent slippage with the first, is an argument about history, and therefore about the global present as historical moment. In this latter, the dominant Anthropocene argument goes beyond the domain of earth-system science, reaching into the very heart of historical analysis: the dialectically-bound questions of historical agency and periodization.

The Anthropocene argument takes biogeological questions and facts – turning on the presence of variously significant stratigraphic signals (Zalasiewicz, et al., 2008, 2011) – as an adequate basis for historical periodization. Two subtle but powerful methodological decisions underpin this approach. In the first instance, empirical focus is narrowed to the consequences of human activity. In this, the Anthropocene argument embodies the *consequentialist bias* of green thought across the Two Cultures. The case for humanity’s domination of the earth is constructed almost entirely on the basis of a significant catalogue of biospheric changes. The drivers of such changes are typically reduced to very broad “black box” descriptive categories: industrialization, urbanization, population, and so forth (Steffen, et al., 2011a, 2011b). The second methodological choice turns on the construction of humanity as “collective” actor (e.g. Zalasiewicz, et al., 2011). Here the historical-geographical patterns of differentiation and coherence are erased in the interests of narrative simplicity. This erasure, and the elevation of the *Anthropos* as a collective actor, has encouraged several important misrecognitions: 1) a neo-Malthusian view of population typically lurks on, or just beneath, the surface of these analyses (see esp. Crutzen, 2002; Fischer-Kowalski, et al., *forthcoming*; Ellis, et al., 2013),⁴ ignoring the modern world-system’s actually existing patterns of family formation and population movement (e.g. Secombe, 1992, 1995; Massey, et al., 1999); 2) a view of historical change in which technology-resource complexes drive historical change; 3) removing the issues of scarcity from the actually existing relations of capital, class, and empire, and depositing the former into the container “nature,” ontologically independent of these relations; and 4) assigning responsibility for global change to humanity as a whole, rather than to the forces of capital and empire that have given modern world history its coherence.

The two principal framing devices – consequences determine periodization, the *Anthropos* as the driver of these consequences – stem from a philosophical position that we may call Cartesian dualism. As with Descartes, the separation of humans from the rest of nature – “Are humans overwhelming the great forces of nature?” (Steffen, et al., 2007) – appears as self-evident reality.⁵ In its

³ So too its analogues in the radical tradition (e.g. Foster, et al., 2010).

⁴ Strictly speaking, the view of Ellis and his colleagues follows a Boserupian model in which rising population leads to innovation and “intensification” (2013; Boserup, 1965). This model simply turns Malthus on his head, positing population growth as opportunity rather constraint. The problem is that the whole history of capitalism, certainly from 1450-1850, was one of *declining* person-to-land ratios on a systemic basis; indeed the whole thrust of capitalism’s geographical expansion produced recurrent downward revisions in the labor-to-land ratio. Moreover, capitalism’s commodity frontiers were frequently the sites of the *most* intensive and rapid changes in land use, from the sugar commodity frontiers of the long 17th century to the wheat and cotton frontiers of North America in the 19th century.

⁵ One major break within the emerging Anthropocene conversation is found in the argument of Pálsson and his colleagues (2013), who rightly challenge the neo-Malthusian conception of limits, the dualism immanent in the dominant Anthropocene argument, and the reluctance of earth-system scientists to take seriously questions posed by the “envi-

simplest form, this philosophy locates human activity in one box, the rest of nature, in another. To be sure, these two acting units interact and influence each other. But the differences between and within each acting unit are not mutually constitutive, such that changes in one imply changes in the other – although such dialectical relations are empirically acknowledged from time to time (Steffen, et al., 2011a: 845-846). This dualism leads Anthropocene advocates to construct the historical period since 1800 on an arithmetic basis: “human activity plus significant biospheric change = the Anthropocene.” In this, too, the Anthropocene perspective incorporates the common sense of green arithmetic: “society plus nature equals environmental studies.”

It all makes wonderful sense, again up to a point. The problem is that the parts do not add up to the whole. Human activity not only produces biospheric change, but relations *between* humans are themselves produced by nature. This nature is not nature-as-resource but rather nature-as matrix: a nature that operates not only outside and inside our bodies (from global climate to the micro-biome) but also *through* our bodies, including our embodied minds. Humans produce *intra*-species differentiations which are *ontologically* fundamental to our species-being: inequalities of class especially, inflected by all manner of gendered and racialized cosmologies. Human history as a whole, but modern world history in particular, is full of contingency and rapid change that has not only produced non-linear shifts, but has also been *produced by* non-linear relations of power and wealth, already bundled with, and within, nature as a whole.

From this vantage point, we might do well to pause, and to ask, Does the Anthropocene argument obscure more than it illuminates?

I think it probably does.

The dominant Anthropocene argument obscures the actually existing *relations* through which women and men make history with the rest of nature: the relations of power, (re)production, and wealth in the web of life. To be sure, some radicals have sought to recuperate the Anthropocene argument as crystallizing “capitalism WITH nature” (Swyngedouw, 2013: 16). But I find it difficult to square such recuperations with the Anthropocene’s fundamentally bourgeois character: above all, its erasure of capitalism’s historical specificity and the attendant implication that capitalism’s socio-ecological contradictions are the responsibility of all humans.

There is no denying the urgency that many scholars – and many citizens – feel in relation to climate change in the 21st century (e.g. Foster, Clark, and York, 2010; Hansen, 2009). There is little question about the pressing realities of climate change. But does the urgency to communicate the realities of climate change override the need for an adequate historical interpretation of the problem? Conceptualizations of a problem and efforts to resolve that problem are always tightly connected. So too are the ways we think the origins of a problem and how we think through possible solutions.

And it is here – in thinking through the origins of the problem of rapid and fundamental biospheric change – that we find the central *historical, and therefore political*, problem with the Anthropocene argument, whether posed in centrist or radical terms. If we shift our historical method from one that unduly prioritizes environmental consequences to one that prioritizes the relational/consequential nexus – viewing differentiated and geographically-specific “modes of humanity” as products and

ronmental humanities.” What is striking about this argument, however, is its unwillingness to question the *historical* periodization of the Anthropocene, and the problematic slippage between geological and historical periodizations of time.

producers in the web of life⁶ – a very different view of the Anthropocene problem comes into focus. From this standpoint, the origins of a new pattern of environment-making began in the Atlantic world during the “long” sixteenth century. Why is this not “merely” a historical problem, but also a political one? In sum, to locate the origins of the modern world with the steam engine and the coal pit is to prioritize shutting down the steam engines and the coal pits. (And their 21st century incarnations.) To locate the origins of the modern world with the rise of capitalist civilization after 1450, with its audacious strategies of global conquest, endless commodification, and relentless rationalization, is to prioritize the transcendence of the relations of power, knowledge, and capital that have made – and are now unmaking – the modern world as we have known it. Shut down a coal plant, and you can slow global warming for a day; shut down the relations that made the coal plant, and you can stop it for good.

The erasure of capitalism’s early modern origins, and its extraordinary reshaping of global natures long before the steam engine, is therefore of some significance in our efforts to develop effective political strategies to global warming... and far more than global warming alone! Ask any historian and she will tell you: how one periodizes history decisively shapes the interpretation of events, and one’s choice of decisive relations. Start the clock in 1784, with James Watt’s rotary steam engine (Crutzen, 2002), and we have a very different view of history – and a very different view of modernity – than we do if we begin with the English or Dutch agricultural revolutions, with Columbus and the conquest of the Americas, with the first signs of an epochal transition in landscape transformation after 1450. Are we really living in the *Anthropocene*, with its return to a curiously Eurocentric vista of humanity, and its reliance on well-worn notions of resource- and technological-determinism? Or are we living in the *Capitalocene*, the historical era shaped by relations privileging the endless accumulation of capital?

How one answers the historical question shapes one’s analysis of – and response to – the crises of present.

CAPITALISM AS A WAY OF ORGANIZING NATURE

To ask about humanity’s modern relation with the rest of nature is to shift our focus from the consequences of these relations to the relations that enfold and unfold these consequences. Consequences *are* crucial. Those issuing from climate change are especially salient, perhaps especially in its suppressive impact on labor and land productivity in world agriculture: signaling the end of capitalism’s *longue durée* cheap food regime (Kjell, et al., 2009; Zivin and Neidel, 2010; Peng, et al., 2004; Moore, 2012, 2013b). But to periodize historical change on the basis of consequences – or a highly-stylized interpretation of the Industrial Revolution fueled by fossils – is to cloud our vision from the outset. Of course we must begin with the decisive shifts in the dominant relations of power and production, of classes and commodities. To leave it at that, however, says nothing new. What the more sophisticated versions of the “coal and capitalism” argument appreciate is that the long 19th century transition in the relations of power and production was one that went beyond relations between humans; it also implied a transition in humanity’s relation with the rest of nature (e.g. Huber, 2008; Malm, 2013).

I would go further. The radical engagement with the Anthropocene has proceeded through an agreement on periodization – the Two Century Model – which is problematic enough. More fun-

⁶ Credit goes to Roelvink for the turn of phrase, “modes of humanity” (2013).

damentally, both centrist and radical approaches to the Anthropocene argument have converged on an ontological agreement: the “co-production of *society WITH nature*” (Swyngedouw, 2013: 16, emphasis added; also Davis, 2010; Gowdy and Krall, 2013), as if these were two independent entities (but see Sayre, 2012). While co-production *is* the right way to put it, its association with a Nature/Society vocabulary short-circuits the effort to move from modernity *WITH* nature towards modernity *in-nature*. Why? Because the philosophy of co-production depends on acting units that are themselves co-produced. To be sure, radicals such as Swyngedouw – a pioneer in the critique of Nature/Society dualisms (1996) – understand this. But the distance between philosophical critique and world-historical interpretation has been great. The Achilles’ Heel of the post-Cartesian critique has been historical analysis, resulting in a disjuncture between the “production of nature” as theoretical construct and world-historical process. Without a sufficient historical grounding, the critique of Nature/Society dualism tends to stumble on the terrain of world history, precisely the turf staked out by the Anthropocene position.

My position is that the critique of Nature/Society dualisms is not only relevant to historical analysis, but that the history of capitalism cannot be explained in terms of a ping-pong of nature-society interactions. The bundle of transformations that gathered steam in the closing decades of the 18th century were *co-produced* by human and extra-human natures (in which the latter are also directly constitutive of so-called “society”) – not only at the level of consequences, but in terms of the strategic relations behind capitalism’s peculiar reordering of the biosphere over the *longue durée*. This perspective views capitalism as, at once, producer *and* product of the web of life. The patterns of co-production are contingent but cohered, and this coherence reveals itself in specific patterns of environment-making that reach well beyond conventional reckonings of landscape change. This coherence is realized and reproduced through definite rules of reproduction – of power, of capital, of production. For capitalist civilization, these rules embody a *value relation*, quite literally determining what counts as valuable and what does not.⁷ Different civilizations have different value relations, that prioritize different forms of wealth, power, and production. Feudal Europe, for instance, privileged land productivity while the world capitalist system increasingly privileged labor productivity after 1450. To this we will return later in the essay. For the moment, I simply wish to highlight that capitalism’s “law of value” – understood more expansively than for Marx, but in the spirit of Marx’s method (Marx, 1973; Hopkins, 1982; Sayer, 1987) – produced an exceedingly peculiar form of wealth. This is of course capital as value-in-motion, whose substance is abstract social labor. Importantly, abstract social labor may be accumulated only through a far-flung repertoire of imperialist enclosure and appropriation of nature’s “free gifts” in service to commodity production (Burkett, 1999; Moore, 2011a). Capital is value-in-motion is value-in-nature. Value is a bundled relation of human and extra-human natures (e.g. Marx, 1977: 283; Burkett, 1999). Hence Marx writes that the natural fertility of the soil may “act as an increase in fixed capital” (1973: 748): an observation pregnant with socio-ecological implications for the analysis of capital accumulation.

We may begin to unpack these implications through a suggestive proposition: Value operates through a dialectic of exploitation and appropriation that illuminates capitalism’s peculiar relation with, and within, nature. The relations of exploitation produce abstract social labor. The relations of appropriation, producing abstract social nature, enabled the expanded accumulation of abstract social labor. On the one hand, the system turns on a weird coding of what is valuable, installing human work within the commodity system (wage-labor) as the decisive metric of wealth. In this domain, the

⁷ The argument for global value relations has been articulated by Araghi in a distinct but complementary register (2009a, 2009b).

exploitation of labor-power is pivotal, upon which all else turns. On the other hand, the exploitation of wage-labor works only to the degree that its reproduction costs can be checked. The mistake is to see capitalism as defined by wage-labor, any more than it defined by the world market. Rather the crucial question turns on the historical connections between wage-work and its necessary conditions of expanded reproduction. These conditions depend on massive contributions of unpaid work, outside the commodity system but necessary to its generalization. Sometimes this is called the domain of social reproduction (e.g. Bakker and Gill, 2003), although it is here that the adjective “social” seems especially unsuitable – where does the “social” moment of raising children end, and the “biological” moment begin? Clearly, we are dealing with a zone of reproduction that transcends any neat and tidy separation of sociality and biology, which are better viewed as internal to each other. Neither is this zone of reproduction – the domain where unpaid work is produced for capital⁸ – a narrowly human affair. For unpaid work not only makes possible the production of potential – or the reproduction of actual – labor-power as “cheap” labor; it also involves the unpaid work of extra-human natures. In this domain of reproduction, the *appropriation* of unpaid work is central.

My use of appropriation therefore differs from Marx, who deployed the term more or less interchangeably with the exploitation of wage-labor. Appropriation, in what follows, names those extra-economic processes to identify, secure, and channel unpaid work outside the commodity system into the circuit of capital. Scientific, cartographic, and botanical revolutions, broadly conceived, are good examples, and themes to which we will return later in this essay. Movements of appropriation, in this sense, are distinct from movements of the exploitation of wage-labor, whose tendential generalization is premised on the generalization of appropriative practices.⁹ So important is the appropriation of unpaid work that the rising rate of exploitation depends upon the fruits of appropriation derived from cheap natures, understood primarily as the “Four Cheaps” of labor-power, food, energy, and raw materials (Moore, 2012).

This use of appropriation therefore implies a labor/work distinction, insofar as labor in the Marxist tradition has been used as a shorthand for abstract social labor (Marx, 1967 and especially 1967, I: ch. 18; e.g. Mandel, 1981). *Work*, in what follows, signifies the historically-grounded forms of geo- and bio-physical activity as they “bundle” with humanity’s distinctive forms of sociality and embodied thought (e.g. White, 1995). This allows us to see that only some energy becomes work, and only some work becomes value. These broadly-entropic transitions allow us to highlight the self-consuming character of the capital relation, which in any given historical configuration tends to burn through its necessary biophysical conditions (included workers) and in so doing jack up the organic composition of capital (Marx, 1977: 377-380; Luxemburg, 1913: 328-427). Thus, capitalism’s cheap nature strategy, and the recurrent cyclical movements in favor of ever-cheaper nature until 2003 (Grantham, 2011), may be understood in relation to the cyclical threat of the Four Cheaps turning dear (Mandel, 1975; Rostow, 1978). Costly nature turns cheap through appropriating unpaid work on the commodity frontiers inside and outside the heartlands of commodification (respectively,

⁸ I do not mean to suggest that life-activity in the zone of reproduction is work *as such*, only that *capital* views it as such. Indeed, as I will show, a significant part of capitalist history is the identification and development of symbolic-material practices that aim to activate new streams of unpaid work in service to capital.

⁹ The dialectic paid/unpaid work *does not*, therefore, displace the centrality of the value-relations with the circuit of capital. The terms paid/unpaid work serve to illuminate the constitutive relations through which socially-necessary unpaid work makes possible the successive determinations of systemic labor-time. In other words, the present argument agrees with the classical Marxist position on the centrality of the exploitation of labor-power. My point is that the historical-geographical reproduction of this central relation cannot be explained absent the relational movements that channeled unpaid work into the circuit of capital.

(Hochschild, 2002; Moore, 2000b). These cheap nature movements, at least until 2003, counteracted capitalism's tendency to voraciously consume both the geological accumulations and biological configurations of unpaid work as manifold capitals compete at the point of production. The competitive struggle in production – not merely the market, as environmental historians and sociologists would suggest (e.g. Cronon, 1991; Foster, 2001) – compels capitalists to pursue rising rates of labor productivity, often through mechanization. Rising labor productivity tends strongly towards the rising throughput of materials per quantum of necessary labor-time. The constant danger, given capitalism's industrial dynamism and commitment to expansion, is that the value of inputs will rise, and the rate of profit, fall. This tendency towards the overproduction of fixed capital and the underproduction of raw materials was so important for Marx that he called it a general law (Marx, 1967, III: 119-121; also Moore, 2011a; Bukharin, 1915).¹⁰

Such post-Cartesian readings of capitalism's "general laws" – or other propositions regarding the *longue durée* movements and moments of the capitalist world-ecology – opens up the possibility of moving from the "environmental" consequences of "social" processes to the socio-ecological constitution of Anthropogenic drivers themselves. Too often, the environment leads an unduly narrow existence, as a zone of consequences, impacts, and conditions. Green scholars study the metabolism of globalization, industrialization, and agrarian change, rather than studying globalization, industrialization and agrarian change *as* metabolisms, as ways of organizing nature. I think this transition from the political ecology or environmental history of social change towards social change *as* environment-making is now a possibility, with significant intellectual and therefore political implications. To move from a focus on the environmental consequences of so-called social processes to a view of social processes as co-produced by human and extra-human natures involves more than philosophical assertion, and entails more than registering political and theoretical protest. Such a move also demands historical reconstruction – a reconstruction made possible by generations of environmental scholars across the Two Cultures since the 1970s.

Such historical reconstruction calls into question any periodization premised on a dualistic "social driver plus environmental consequence" model. This remains the hegemonic model within global environmental studies, even as regional studies have long since transcended such dualisms (e.g. White, 1995; Kosek, 2006). From this standpoint, the Anthropocene argument is not only philosophically and theoretically problematic – viewing humans as separate from nature and erasing capitalism from the equation – it also offers an unduly narrow conceptualization of historical time. This plays out at two levels. One is an awkward conflation of geological notions of time with the periodization of historical change. The other is the Anthropocene's recuperation of an older historiographical vista which saw the "real" changes of "real" modernity beginning in the later 18th century.

In this respect, the Anthropocene argument feeds into Green Thought's longstanding love affair with the Two Century model of modernity: *industrial* society, *industrial* civilization, *industrial* capitalism. The notion that It all began with the Industrial Revolution has been with us for a very long time (e.g. Toynbee, 1894/1884/1881; Beard, 1901). After taking a pounding in the 1970s (Wallerstein, 1974; Frank, 1978), the Two Century Model came roaring back at the dawn of the 21st century. Not just Anthropocene advocates, but many critical historians and social scientists, came to embrace the

¹⁰ It is of course true that rising labor productivity – in value terms – may or may not involve rising throughput. This latter is the strongest tendency. Nevertheless, it would be possible to increase labor productivity without rising throughput by reducing the value composition of production; such a downward reduction would likely take the form of wage cuts. Even in these instances, such reductions would be temporary and partial, except in the case of an epochal crisis.

Industrial Revolution as the source of all things difficult and divergent (e.g. Pomeranz, 2000; Harvey, 2010). Within green thought, the embrace of the “industrialization thesis” on the origins of ecological crisis has been especially warm (Moore, 2003b; see, e.g. Daly and Farley, 2004; Huber, 2008; Heinberg, 2003; Jensen, 2006; Malm, 2013; O’Connor, 1998; Steffen, et al., 2007, 2011; Wrigley, 1990, 2010).

What this Two Century model obscured was the remarkable remaking of land and labor beginning in the “long” sixteenth century, *c.* 1450-1640 (Braudel, 1953). (About which, more presently.) Ignored – even by environmental historians (see Moore, 2003a, 2003b) – was the important historiography of economic change in early modern Europe and the Americas, written during the postwar era.¹¹ Only occasionally were these analyses framed in terms of capitalism; but for these historians there was no question that the early modern transformations of economies and landscapes were dialectically bound (see *inter alia*, Braudel, 1972; Galeano, 1973; Kellenbenz, 1974, 1976; Kriedte, 1983; Nef, 1964; Malowist, 2009; Prado, 1967; Wallerstein, 1974; Brenner, 1976; Sella, 1974; de Vries, 1974, 1976; Cipolla, 1976). Since the 1970s, for all their distinctive geographical emphases and interpretive differences, the view of *early* modernity as *real* modernity has persisted (e.g., de Vries and van der Woude, 1997; de Vries, 2001; Brenner, 2001; Crosby, 1997; DuPlessis, 1997; Jones, 1987; Komlos, 2000; Landes, 1998; Seccombe, 1992; Mokyr, 1990: 57-80; Moore, 2003a, 2003b, 2007, 2010a, 2010b; Nef, 1964; Prak, 2001; van Zanden, 1993). For some, this ongoing “revolt of the early modernists” (van Zanden, 2002) did not go nearly so far enough: the decisive period begins sometime just after the turn of the millennium (van Zanden, 2009; Levine, 2001; Arrighi, 1994; Mielants, 2007).¹² And yet, green thought has been slow – *very* slow – to engage this literature. This holds true even for students of early modern environmental history (e.g. Richards, 2003; Warde, 2006a, 2006b; Grove, 1995; Williams, 2003). Industrialization appears, in the metanarratives of green thought, as a *deus ex machina* dropped onto the world-historical stage by coal and steampower.

There are two questions here. First, is Industrialization the Big Bang of modernity, or is it instead a cyclical phenomena of capitalism from the long sixteenth century? Second, is Industrialization the most useful concept for explaining large-scale and long-run patterns of wealth, power, and nature in historical capitalism?

If the first question was tackled during the 1970s and ‘80s (e.g. Hopkins and Wallerstein, 1977; esp. Wallerstein, 1989), the second question has rarely been posed, much less answered. This is much more curious than one might initially supposed. For postwar economic history was arguably the one field in world social science that took seriously ecological questions. A modest dose of intellectual history may therefore explain some measure of the problem. Here the conjuncture of the 1970s is important. In this decade, the “new” environmental studies emerged (e.g. Worster, 1977; Merchant, 1980; Schnaiberg, 1980), and the “old” economic history, which had been strongly committed to the study of material life (e.g. Nef, 1964), passed from the scene. Economic history since the 1970s has rarely taken environmental matters seriously in the Industrial Revolution (e.g. Allen, 2011; but see Jonsson, 2012; Warde and Marra, 2007; Wrigley, 1990, 2010). Marx’s conception of industrialization – of the rise and development of “large-scale industry” – might have come to the rescue. This could have permitted a view of industrialization as a crystallization of technology, class, and nature – a synthesis whose outlines had been suggested by Marx (1967, 1977), and theoretically (*but not historical-*

¹¹ Indeed, the field of economic history – prior to the cliometric revolution of the 1970s – was the most consistently environmentally-aware field of world social science in the first three-quarters of the 20th century.

¹² Much of this literature is often extraordinarily Eurocentric – Landes, Jones, and van Zanden especially.

h) reconstructed at the end of the last century (Burkett, 1999). But the cutting edge of marxist thought in the 1970s was found in historical sociology and political economy, typically abstracted from their bio-geographical conditions (Anderson, 1974a, 1974b; Mandel, 1975; but see Wallerstein, 1974, 1980). Questions of nature, agro-ecology, and resources were explored only by a few Marxist (or *marxisante*) trailblazers (see, *inter alia*, Commoner, 1971: 249-291; Enzensberger, 1974; Harvey, 1974; Leiss, 1972; Marcuse, 1972; Schnaiberg, 1980; Schmidt, 1973; Walker, 1979; Williams, 1972; Young, 1973, 1979).¹³

This conjuncture of the 1970s decisively shaped the field of investigation for environmentally-oriented historians and social scientists. Amongst the key consequences for green thought was the acceptance of the Industrial Revolution in two major ways: 1) as an essentially technical and resource phenomenon abstracted from class relations (e.g. Wrigley, 1990); and 2) as the “explanatory nexus” of modern environmental problems, and indeed of modernity as a whole (Wallerstein, 1986: 67; e.g. Ponting, 1991). It need not have been this way. Prior to the 1970s, a significant historiography had long emphasized industrialization, not as a singular event, but as a succession of industrializations, commencing in Europe as far back as the thirteenth century (Carus-Wilson, 1941; Gimpel, 1976; Nef, 1964). This would appear favor a conceptualization of world history in which successive waves of industrialization took shape out of successive of eras of socio-ecological innovation and thence crisis. (It would also have corrected the one-sided emphasis on scarcity that was a defining feature of green thought in the 1970s [e.g. Meadows, et al., 1972]. But environmental historians have been slow to take advantage of this opportunity. Today, we still do not have a comprehensive environmental history of the Industrial Revolution, even in its most conventional historical and geographical setting: England, between the 1760s and the 1860s.¹⁴ Nor do we have comprehensive ecohistorical interpretations of the “second” industrial revolution of the later 19th century, or of the “third” industrialization of the Global South – China above all! – since the 1970s.

But is industrialization really the best way to frame the origins and subsequent development of modernity’s “ecological” crisis? At its best, industrialization is a shorthand for the tensions between technology and power, between the “forces” and “relations” of production; these are hardly novel historical problems. But these tensions have, almost universally, been framed in dualistic terms, contained within a “social” universe of human relations ontologically prior to the latter’s engagement with web of life. This is the problem of Cartesian dualism, one that bears bitter fruit in the hegemonic narrative of industrialization as acting upon, rather than developing through, nature.¹⁵ At a

¹³ The question to ask is not, Why didn’t Marxists pay attention to ecology?, but rather: Why did these pioneering analyses gain so little traction?

¹⁴ For an insightful survey of environmental historians’ relation to the Industrial Revolution narrative, see Barca, 2011; also Osborne, 2003; Steinberg, 1986. A perceptive marxist re-examination is offered by Malm, 2013.

¹⁵ Naming is always fraught with new challenges. In speaking of Cartesian dualism, it is of course true that all blame should not be heaped upon poor Rene. He personified a much broader scientific and especially philosophical movement:

The effect [of Descartes’ argument] is to enforce a strict and total division not only between mental and bodily activity, but between mind and nature and between human and animal. As mind becomes pure thought—pure *res cogitans* or thinking substance, mental, incorporeal, without location, bodiless—body as its dualised other becomes pure matter, pure *res extensa*, materiality as lack. As mind and nature become substances utterly different in kind and mutually exclusive, the dualist division of realms is accomplished and the possibility of continuity is destroyed from both ends. The intentional, psychological level of description is thus stripped from the body and strictly isolated in a separate mechanism of the mind. The body, deprived of such a level of description and hence of any capacity for agency, becomes an empty mechanism which has no agency or intentionality within

time when Cartesian dualism, as philosophical construct, finds itself widely questioned across the spectrum of green thought (e.g. Harvey, 1996; Latour, 1993; Plumwood, 1993; Braun and Castree, 1998; Castree and Braun, 2001), such dualism retains its hegemony over the methods, theory, and narrative frames of world-historical change (see Moore, 2011a). Left ecology still tends to think of capitalism *and* nature rather than capitalism-in-nature (e.g. Foster, Clark, and York, 2010; Heynen, et al., 2007). This is the largely-unacknowledged dissonance at the core of green thought today, between the philosophical recognition that humans are a part of nature (humanity-in-nature) and the construction of histories, recent and remote, that proceed as if human relations are ontologically prior to the web of life (humanity *and* nature).

Whereas the Anthropocene argument begins with biospheric consequences and moves towards social history, an unconventional ordering of crises would begin with the dialectic between (and amongst) humans and the rest of nature, and thence move towards geological and biophysical change. These consequences, in turn, constitute new conditions for successive eras of capitalist restructuring across the *longue durée*. Relations of power and production, themselves co-produced within nature, enfold and unfold consequences. The modern world-system becomes, in this approach, a *capitalist world-ecology*: a civilization that joins the accumulation of capital, the pursuit of power, and the production of nature as an organic whole (Moore, 2003, 2011a, 2011b, 2011c, 2013a, 2013b; also Deckard, 2012, 2013; Leonardi, 2012; Niblett, 2012, 2013; Mahnkopf, 2012; Marley, 2013; Marley and Fox, *forthcoming*; Oloff, 2012; Ortiz, *forthcoming*; Parenti, 2014; Weis, 2013). This means that capital and power – and countless other strategic relations – do not act *upon* nature, but develop *through* the web of life. Crises are turning points of world-historical processes – accumulation, imperialism, industrialization, and so forth – that are neither social nor environmental in the usual sense, but rather bundles of human and extra-human natures, materially practiced and symbolically enabled. In world-ecological perspective, nature stands as the relation of the whole. Humans live as one specifically-endowed (*but not special*) environment-making species within the web of life.

The challenges involved in translating the philosophical premise of humanity-in-nature into historical methods and narrative strategies are considerable. Certainly, a core problem has been the difficulty in forging a conceptual vocabulary that grasps “society” and “nature” as a singular ontological domain, such that all human activity is simultaneously producer and product of the web of life. The problem has been recognized for a long time, and especially since the 1970s (Birch and Cobb, 1981; Harvey, 1993). Elsewhere, I have tackled the problem with the concept of the *oikeios*, signifying the creative, generative, and multi-layered relation of species and environment (2011a). The *oikeios* provides a way to move beyond the narrative trope of “the” environment (as object) in favor of *environment-making* (as process), at all turns a co-production of specifically bundled human and extra-human natures (Moore, 2013a). “Nature” and “society,” in world-ecological perspective, are viewed as violent abstractions that – by positing discrete ontological domains of humans without nature and nature without humans – dissolve the messy, bundled, and creative co-productions of historical change. The idea of nature as external to human relations is not, however, a magician’s trick of

itself, but is driven from outside by the mind. The body and nature become the dualised other of the mind (Plumwood, 1993: 115).

It is certainly true that a humans had long recognized a difference between “first” and “second” natures, and between body and spirit. *However*, capitalism was the first civilization to organize on this basis. For early modern materialism, the point was not only to interpret the world but to control it: “to make ourselves as it were the masters and possessors of nature” (Descartes, 1637/2006: 51). This sensibility was a key organizing principle upon which capitalist civilization organized.

smoke-and-mirrors; it is a real historical force. Capitalism, *as project*, emerges through a world-praxis that creates external natures as objects to be mapped, quantified, and regulated so that they may service capital's insatiable demands for cheap nature. At the same time, *as process*, capitalism emerges and develops through the web of life; nature is at once internal and external. In this way of seeing, the *oikeios* is a general abstraction that gains historical traction only insofar as it provides the conditions for recasting the great drivers of world-historical change – foremost among them the perennial darlings of industrialization, imperialism, capitalism, modernity – as co-produced by humans and the rest of nature.

If capitalism as a “way of organizing nature” gets us moving in the right direction, this is a statement more of the “what” of modernity-in-nature than of the “how.” To recast the “how” of capitalism as world-ecology – how power, capital, and nature form an organic whole – we might turn to Mumford's notion of *technics* (1934). Mumford grasped that a new technics emerged in the early modern era – crystallizing tools and knowledge, nature and power, in a new *world-praxis*, one that reduced both “man” and “nature” to abstractions. For Mumford, power and production in capitalism embodied and reproduced a vast cultural-symbolic repertoire that was cause, condition, and consequence of modernity's *specific form* of technical advance. This was not, Mumford made plain, a story to be celebrated. It was, rather, one to be recognized, and critiqued, for its peculiarity: “The Chinese, the Arabs, the Greeks, long before the Northern European, had taken most of the first steps toward the machine... [T]hese peoples plainly had an abundance of technical skill at their command. *They had machines; but they did not develop 'the machine'*” (1934: 4, emphasis added). Here Mumford might have stopped, as have so many green thinkers. But he did not. At the heart of Mumford's argument was the idea that machines, *technics*, and the alienated violence of capitalist civilization move through the web of life. It was the

discovery of nature as a whole [that] was the most important part of that era of discovery which began for the Western World with the Crusades and the travels of Marco Polo and the southward ventures of the Portuguese. Nature existed to be explored, to be invaded, to be conquered, and finally, to be understood... [A]s soon as the procedure of exploration was definitely outlined in the philosophy and mechanics of the seventeenth century, man himself was excluded from the picture. Technics perhaps temporarily profited by this exclusion; but in the long run the result was to prove unfortunate. In attempting to seize power, man tended to reduce himself to an abstraction, or, what comes to almost the same thing, to dominate every part of himself except that which was bent on seizing power (Mumford, 1934: 31, emphasis added)

In the absence of a world-ecological concept of *technics*, much of green thought conflates the Industrial Revolution with modernity (Steffen, et al., 2011a, 2011b; Malm, 2013). The question of origins is elided – not resolved – through recourse to a meta-narrative premised on the self-evidently periodizing implications of rising CO² emissions and other eco-consequential phenomena. The question of the origins of world-ecological crisis is axiomatically reduced to a surficial representation of the drivers and consequences of 19th century industrialization. Of course it all began with coal, says the Anthropocene argument, because the consequences are measurable, and this is, after all, what counts. The consequences of this approach – green thought's consequentialist bias – are more significant than commonly recognized. Kingsnorth puts this well:

My feeling is that the green movement has torpedoed itself with numbers. Its single-minded obsession with climate change, and its insistence on seeing this as an engineering challenge

which must be overcome with technological solutions guided by the neutral gaze of Science, has forced it into a ghetto from which it may never escape. Most greens in the mainstream now spend their time arguing about whether they prefer windfarms to wave machines or nuclear power to carbon sequestration. They offer up remarkably confident predictions of what will happen if we do or don't do this or that, all based on mind-numbing numbers cherry-picked from this or that 'study' as if the world were a giant spreadsheet which only needs to be balanced correctly (2011).¹⁶

I would go still further. The fetish of industrialization quickly leads to others. A stylized love affair with machinery leads quickly to a stylized love affair with resources. This is not surprising given the faint influence of political economy and class analysis in most green interpretations of industrialization. But even for those on the left who favor a class-relational approach, a certain fossil fuel-fetishism appears, as when Malm suggests (2013) that we insert fossil fuels as the spark that ignites the engine of capital (also Altvater, 2006; Huber, 2008). "Capital," in these accounts, forms independently of the web of life, and intervenes in "nature" as an exogenous force, variously intruding in, and interrupting, a pre-given "traditional balance between humanity and nature" (Foster, 1994: 40). This view of capitalism as an exogenous rather than endogenous actor in relation to the web of life has the paradoxical effect of reducing nature to a substance that can be variously protected or destroyed (e.g. Martinez-Alier, 2002). No matter how dialectical the conception of capital, so long as this conception unfolds within a Cartesian frame – humans without nature, nature without humans – the analyst is compelled to engage capital's relation with nature as "tap" and "sink" *first*, and only later as the field within which modernity unfolds. When push comes to shove, the philosophy of humanity-in-nature gets pushed aside in favor of analytical practicality (compare Harvey, 1993 with Harvey, 2003, 2005).¹⁷

It is always tempting to "think in terms of realities that can be 'touched with the finger'" (Bourdieu and Wacquant, 1992: 228). In this way of thinking – Bourdieu calls it substantialist (*ibid.*) – substances form prior to, and independently of, events and fields of relations, rather than developing *through* environments cohered by definite patterns of events (Birch and Cobb, 1981: 79-96 and *passim*; Moore, 2011a, 2011b). Substantialism, in this sense, is at the heart "human exemptionalist" social theory (Catton and Dunlap, 1979), which isolates humanity from its extra-human conditions of reproduction. The result is a way of thinking humanity as ontologically independent – a kind of human substance apart from the 'substance' of Earth/Life. Even when the professed goal is holism, substantialist dualism fetters the move towards synthesis (e.g. Foster, 2013b). Why? Largely because human exemptionalist social theory – and this is still most social theory (e.g. Ritzer, 2005) – presumes humanity's specificity in the absence of a historical specification of the whole: the natures within which human activity unfolds, and to which human activity actively contributes.¹⁸ The very

¹⁶ Lohmann advances a similar argument in relation to Bill McKibben and 350.org, which have succumbed to a "CO₂ fetish": "As apolitical objects seemingly susceptible to manipulation, management and mastery by experts,... [these molecules] are easily treated, fetishistically, as 'the' cause of global warming" (2012: 100, 106).

¹⁷ Human exemptionalism embraces humanity as "an 'exceptional' species... [in which] the exceptional characteristics of our species (culture, technology, language, elaborate social organization) somehow exempt humans from ecological principles and from environmental influences and constraints" (Dunlap & Catton, 1979: 250).

¹⁸ And yet, it would be silly to deny the signal accomplishment of a broadly "green" social theory, which is now significant. Indeed, the present argument is possible precisely because green social theory has, in its critique of nature-blind theorizations, made possible an argument for transcending the dualism of the "social theory and the environment" tradition (e.g. Barry, 2007; Sonnenfeld and Mol, 2011; Benton and Redclift, 1994). Nor do I intend to take lightly the groundbreaking contributions of a (very broadly defined) "production of nature" tradition formulated by critical geogra-

procedure that might establish humanity's "dialectical historicity" is in the process denied (Meszaros, 1970: 40). What Marx and Engels called "historical nature" (1970: 41) is too often missing from critical and mainstream green perspectives.

It turns out that, as with pregnancy, one cannot be a little bit Cartesian. For nature is either abstract and external or historical *and* immanent to everything that humans do, including those large-scale and long-run patterns of power and production that we call civilizations, world-systems, modes of production, and so forth.

The conceptualization of historical natures matters quite a bit to our periodizations of capitalism. For if nature is neither pre-given nor external, we are confronted with the thesis that historical change is a bundled movement of human and extra-human natures. In capitalism, these bundles assume multiple forms, foremost among those of capital, state and imperial territoriality, and class relations. But we may also look the family of "regimes" of food (Friedmann and McMichael, 1989), energy (Podobnik, 2006), and raw materials (Bunker and Ciccantell, 2005). Capitalism as a whole, I wish to emphasize does not *have* an ecological regime, but is in its most fundamental historical a sense a way of organizing nature. But this merely established a new set of questions around how these specific regimes mark specific crystallizations of nature and wealth, tools and power.

On the terrain staked out by the Anthropocene argument, we might consider how the definite relations of early capitalism – co-produced in the web of life – transformed coal from a rock in the ground to a fossil fuel. Let us be clear that the call for the relationality of humanity-in-nature does not deny the materiality of resources. (Moore, 2011a, 2011b). Far from it! The world-ecology alternative argues that resources are relational and therefore historical. Geology is a "basic fact"; it becomes a "historical fact" through the historically co-produced character of resource production, which unfolds through human/extra-human nexus: the *oikeios* (quotation from Carr, 1962; Moore, 2013a; Harvey, 1974). Geology, in other words, co-produces power and production as it bundles with (equally co-producing) human patterns of power and production – hence the re-bundling of capitalist relations across the later 18th century North Atlantic as the energy regime shifted from charcoal and peat to coal. Specific geological formations, under definite historical circumstances, can become once object of human activity and *subject* of historical change. This allows us to see civilizations moving *through*, not around, the rest of nature.

Geology becomes *geo-history* through definite relations of power and production; these definite relations are geographical, which is to say they are not relations between humans alone. (Any geographical point of view unfolds from the premise that human activity is never ontologically prior to its geographical conditions and consequences.) At the risk of putting too fine a point on the matter, geology does not "directly determine" the organization of production (Bunker and Ciccantell, 2005: 25), precisely because the organization of production is not directly determined at all, but rather co-

phers (e.g. Harvey, 1974, 1996; Smith, 1984; Braun and Castree, 1998; Swyngedouw, 1996). Here too we find arguments that enable the post-Cartesian formulation of a *theory of historical change*, the heart of social theory: whose contribution is to facilitate the interpretation of historical change in the modern world. What is striking, for all the pioneering labors of green theorists, is the weakness of this tradition in destabilizing the Cartesian premise that social relations are ontologically prior to the web of life. This is of course far more than a theoretical problem. It is problem, at its core, of narrative *language*, of methodological bias (within humanity or simultaneously within and between modes of humanity-in-nature), of theory as the designator of decisive strategic relations and the ontology of those relations.

produced. Articulations of production and reproduction are mediated through the *oikeios*, especially its dialectic of organic life and inorganic environments (Birch and Cobb, 1981; Moore, 2013a).¹⁹

In the case of coal, we might note the revolution in English coal production began not in the eighteenth century but in the first half of the *sixteenth* century. If the Anthropocene begins not in 1800 but in the long sixteenth century, we begin to ask much different questions about the drivers of world-ecological crisis in the 21st century. The onset of the English coal revolution, c. 1530 (Nef, 1932: 19-20, 36, 208), directs our attention to the relations of primitive accumulation and agrarian class structure, to the formation of the modern world market, to new forms of commodity-centered landscape change, to new machineries of state power. This line of argument only appears to return to “social relations” because the legacy of Cartesian thought continues to tell us that state formation, class structure, commodification, and world markets are about relations between humans... *which they are not*. These too – states, classes, commodity production and exchange – are bundles of human and extra-human nature. They are processes and projects that reconfigure the relations of humanity-in-nature, within large and small geographies alike.

From this standpoint, to stick with coal, we can say that geology co-produces energy regimes as historically-specific bundles of relations; geology in this view, is at once subject and object. The view that geo-material specificities determines social organization does not highlight geology’s role in historical change; it obscures it. This is so for two reasons, tightly-linked. First, to say that geology determines historical change is to confuse geological facts for historical facts. Second, to conflate geological facts for historical facts is to engage in environmental determinism of a specific kind: the “arithmetic” of Nature plus Society.

But Nature plus Society does not add up. Perhaps most significantly, environmental determinisms, however partial or sophisticated they may be, leave intact the Cartesian order of things, in which society (humans without nature) and nature (environments without humans) interact rather than interpenetrate. The alternative, to see geology co-producing historical change through the *oikeios*, allows us to see energy regimes – even whole civilizations – moving *through*, not around, the rest of nature. The definite relations of early capitalism – co-produced in the web of life – transformed coal from a rock in the ground to a fossil fuel. Material flows and their particularities *do* matter. But their historical significance is best understood through a relational rather than substantialist view of materiality, one in which the flows of resources, circuits of capital, and the struggles of classes and states form a dialectical whole.

¹⁹ Bunker’s great insight was that the history of capitalism is centrally about space and nature. This was foundational proposition (Bunker, 1984; Bunker and Ciccantell, 1997). However, for Bunker, Nature remains condition and consequence, but not directly constitutive in the co-production of capital and empire. The result has been an oscillation between social and environmental determinisms; the consequence of saying that extra-human natures are “theoretically independent” of social relations is that social relations are conceptualized as theoretically independent of nature (Ciccantell and Bunker, 2002: 70). Material specificity – of wood, of coal, of oil – is taken as a closure rather than as a point of departure for the co-production of historical change. The Innis-Bunker position, taken as empirical assertion rather than methodological opening, therefore blunts the argument for nature’s agency before it can reach its greatest potential. This potential is not found in a retro-fitted environmental determinism, but rather in the coevolution of world commodity production and exchange as ways of organizing nature, product and producer of epoch-making transformations in life, land, and labor.

Bunker's insight that material particularities shaped industrialization as much as industrialization shaped the rest of nature is an important corrective to the prevailing wisdom (Bunker and Ciccantell, 2005). For much of the green left – one finds little fundamental difference with the Anthropocene argument – industrialization is a matter of society acting upon the earth, drawing upon fossilized carbon and spewing forth all manner of nasty effluents. This substantialist view of industrialization, and its conflation with capitalism, has encouraged a powerful metabolic fetish, one reproduced even by radical scholars in the critique of “fossil capitalism” (e.g. Altvater, 2006). In this scheme of things, “material flows” are given ontological priority over the relations that create, enfold, and develop through these flows. The ontological relationality of material flows and class relations (*inter alia*) is denied as a matter of research practicality. Cartesian practicality, as in the logic of metabolic fetishization, pushes the movements of classes and capitals from the analysis altogether (e.g. Fischer-Kowalski and Haberl, 1997, 1998; Haberl, et al., 2007, 2011)! For radical and mainstream scholars alike, there is a tendency to invoke an exogenous nature that creates an “ahistorical and apolitical bottom line.” This is the view of “nature [as] external, [in which] the laws of thermodynamics are immutable... [O]ver time, [the argument holds] human actions will ‘wind down’ the earth’s energy and resources” (Braun, 2006: 198).

The metabolic fetish, and its manifold resource- and energy-determinisms, is easy to justify quantitatively. More energy used, more minerals extracted and metals produced, more urban-industrial workers and fewer agrarian producers, and so much more. For this reason, perhaps, most environmentally-oriented historians of the Industrial Revolution have preferred to analyze energy (rather than, say, parliamentary enclosures) with its allure of easy mathematization (e.g. Wrigley, 2010; Siefert, 2001; Malanima, 2006). But numbers are tricky things. They easily entrain a powerful empiricist logic that can blind its handlers to plausible alternatives that might enfold quantitative data within world-relational processes.²⁰ Gould elegantly reminds us that “numbers suggest, constrain, and refute; they do not, by themselves, specify the content of scientific theories” (1981: 106). More poignant still, the confusion of numbers for explanation tends to ensnare “interpreters... [in the logic of] their own rhetoric. They [tend to] believe in their own objectivity, and fail to discern the prejudice that leads them to one interpretation among many [others] consistent with their numbers” (*ibid.*; also Elden, 2006: ch. 3).²¹ Thus do we have an Anthropocene line of thought that has given rise to many possible periodizations, with the exception of the one interpretation most consistent with its assessment.

This interpretation is the turning point of the long sixteenth century.

THE ORIGINS OF CAPITALISM: FROM ECOLOGY TO WORLD-ECOLOGY

Capitalism in 1800 was no Athena, bursting forth, fully grown and armed, from the head of a carboniferous Zeus. Civilizations do not form through Big Bang events. They emerge through cascading transformations and bifurcations of human activity in the web of life. This cascade finds its origin in the chaos that followed the epochal crisis of feudal civilization after the Black Death (1347-53), followed by the emergence of a “vast but weak” capitalism in the long sixteenth century (Moore, 2003a, 2007; Wallerstein, 1974; Malowist, 2009; quotation from Braudel, 1961). If we are to

²⁰ A paradigm instance is such enfolding is on offer in Silver (2003).

²¹ Let me be clear that quantification is not only useful but necessary to any broadly world-ecological, or post-Cartesian, method. But quantification, as such, cannot be regarded as a superior form of data in any *a priori* fashion – distinct analytical tasks demand distinct forms of data collection and analysis.

put our finger on a new era human relations with the rest of nature it was in these centuries, centered geographically in the expansive commodity-centered relations of the early modern Atlantic. At the risk of putting too fine a point on the matter: the rise of capitalism after 1450 marked a turning point in the history of humanity's relation with the rest of nature, greater than any watershed since the rise of agriculture and the first cities – *and in relational terms, greater than the rise of the steam engine*. That dramatic consequences and quantitative expansions *eventually* follow in the wake of new, epoch-making relations will not surprise any historian. But even the *immediate* consequences were dramatic.

The rise of capitalism after 1450 was accompanied, and made possible, by an epochal shift in the scale, speed, and scope of landscape transformation across the geographical expanse of early capitalism. The long 17th century forest clearances of the Vistula Basin and Brazil's Atlantic Rainforest occurred on a scale, and at a speed, between five and ten times greater than anything seen in medieval Europe (Moore, 2007, 2010b; Darby, 1956; Williams, 2003). Feudal Europe had taken centuries to deforest large expanses of western and central Europe; after 1450, comparable deforestation occurred in decades, not centuries. To take but one example, in medieval Picardy (northeastern France), it took 200 years to clear 12,000 hectares of forest, beginning in the 12th century (Fossier, 1968: 315). Four centuries later, in northeastern Brazil at the height of the sugar boom in the 1650s, 12,000 hectares of forest would be cleared in a single year (Moore, 2007: ch. 6). These are precious clues to an epochal transition in the relations of power, wealth, and nature that occurred over the course of the long medieval crisis and the expansion that commenced after 1450.

A modest catalogue of the early capitalism's transformations of land and labor, from the 1450s to the eve of the Industrial Revolution, would include the following commodity-centered and – influence changes: 1) the agricultural revolution of the Low Countries (c. 1400-1600) – motivated by the crisis of sinking peat bogs resulting from medieval reclamation – which allowed three-quarters of Holland's labor force to work outside of agriculture (van Bavel, 2001, 2010; Brenner, 2001; van Dam, 2001; van Zanden, 2003); 2) the mining and metallurgical revolution of Central Europe, thoroughly transforming the political ecology of forests across the region (Nef, 1964; Vlachovic, 1963; Moore, 2007: ch. 2); 3) the first signs of the modern sugar-slave nexus in Madeira, whose rapid rise and decline (1452-1520s) was necessitated by rapid deforestation (Moore, 2009, 2010d); 4) Madeira's crisis was followed quickly by the sugar frontier's movement to São Tomé (1540s-1590s) and the first modern, large-scale plantation system, which allowed one-third of the island to be deforested by 1600 and encouraged large-scale slave revolts (Vansina, 1996; Solow, 1987); 5) northeastern Brazil displaced São Tomé at the commanding heights of the world sugar economy after 1570, from which issued the first great wave of clearing Brazil's Atlantic rainforest, unfolding at an unprecedented pace (Schwartz, 1985; Dean, 1995); 6) meanwhile, the African "slaving frontier" shifted from the Gulf of Guinea to Angola and the Congo in the later sixteenth century, marking the first of several major expansions in the slave trade (Miller, 1988); 7) Potosí emerged as world's leading silver producer after 1545, and then again with its epochal restructuring after 1571, on the heels of the exhaustion of Saxon and Bohemian silver mining, itself conditioned by deforestation, declining ore quality, and labor unrest (Bakewell, 1984; Moore 2010e); 8) the exhaustion of central European mining and metallurgy also afflicted iron and copper production by 1550, which favored English iron output (to 1620), and above all, the rise of Swedish iron and copper (Sundberg, 1991; Hildebrand, 1992; King, 2005); 9) American silver depended on European timber, and so Potosí's efflorescence was accompanied by the shift in the forest products frontier from Poland-Lithuania towards southern Norway in the 1570s followed by renewed movements into the hinterlands of Danzig (again) by the 1620s, and thence towards Königsberg, Riga and Viborg in successive turns (Moore, 2010b); meanwhile 10) the rise of the Vistula breadbasket in the 1550s, exporting cheap grain to the maritime Low Coun-

tries, was followed by the agro-ecological exhaustion of Polish market-oriented agriculture in the 1630s (Szygielski, 1967; Moore, 2010b); 11) any shortfalls from the Polish agro-ecological downturn were quickly made good by the English agricultural revolution, which made England the breadbasket of Europe by 1700, albeit on agro-ecological basis that showed signs of exhaustion after the 1760s as productivity stagnated (Overton, 1996; Jackson, 1985); 12) English forests were rapidly appropriated during the 17th century expansion, such that pig iron output in 1620 would not be exceeded until 1740 even with rising demand, met by imports, especially from Sweden, where iron devoured the forests with such speed that even Sweden's sylvan abundance yielded before the onslaught of the iron commodity frontier (King, 2005; Brinley, 1993; Fouquet, 2008: 59-60; Mathias, 1969: 450; Hildebrand, 1992); 13) the stagnation of English iron output after 1620 also stimulated an iron commodity frontier movement into Ireland, which, along with the manufacture of staves for export, quickly reduced the Emerald Isle's forest cover from 12.5 percent to just two percent, such that little iron would be produced by the mid-17th century (Kane, 1844: 3; Kinahan, 1886-87; McCracken 1971: 15, 51, and *passim*); 14) the Dutch energy regime, centered on the extraction of domestic peat as "cheap fuel," reached its highpoint in the 17th century, but the easily-tapped zones were quickly exhausted, and peat output declined sharply after 1750 (de Zeeuw, 1978: 23 and *passim*); 15) in southeast Asia, the Dutch imposed a new colonial regime between the 1650s and 1670s, securing a monopoly over the clove trade during the 1650s through the large-scale removal of "unauthorized" clove trees, the large-scale relocation of indigenous populations from the interior into new colonial administrative units suitable for labor drafts, and the establishment of new shipyards outside the Batavian core (Boxer, 1965: 111-112; Zerner, 1994; Boomgaard, 1992a; Peluso, 1992: 36-43); 16) from the early 17th century, wetlands across the Atlantic world were reclaimed, often by Dutch engineers, from England to Pernambuco and Suriname, Rome to Göteborg (Wilson, 1968: 78-81; Rogers, 2005: 51; Richards, 2003: 193-241; Boomgaard, 1992b); 17) the great burst of Iberian and Italian expansion during the "first" sixteenth century (c. 1450-1557) produced a relative, but widespread, exhaustion of Mediterranean forests – beginning earlier for the Italians and Portuguese, somewhat later for Spain – and especially their capacity to supply quality shipbuilding timber, by the early the 17th century (Braudel, 1972; Cipolla, 1976; Moore, 2010a; Wing, 2012; Lane, 1933); resulting in 18) the relocation of Spanish shipbuilding to Cuba, where one-third of the fleet was built by 1700, and the more modest yet significant expansion of Portuguese shipbuilding in Salvador da Bahia and Goa (Parry 1966; Funes Monzote, 2008; Morton, 1978; Boxer, 1969: 56-57); this was followed in the 18th century by 19) the emergence of major shipbuilding centers and significant frontiers for timber and naval stores in North America during the 18th century (Perlin, 1989; Williams, 2003); 20) the relentless geographical expansion of forest product and shipbuilding frontiers were bound up, in no small measure, with the increasingly vast fleets of herring, cod, and whaling vessels that searched and devoured the North Atlantic's sources of maritime protein (Richards, 2003: 547-616; Poulsen, 2008); 21) the search for fish was complemented by the search for furs, which had only a modest economic weight in world accumulation, but whose steady advance (and serialized exhaustion of fur-bearing animals) across North America (Siberia too), stretching by the 18th century into the expansive Great Lakes region, encouraged significant infrastructure of colonial power (Leitner, 2005; Wolf, 1982: 158-194; Richards, 2003); 22) the steady expansion of sugar demand and the exhaustion of Bahia's sugar complex by the mid-17th century favored successive sugar revolutions of the West Indies, from Barbados in the 1640s to Jamaica and St. Domingue in the 18th century, leaving a trail of African graves and denuded landscapes in its wake (Watts, 1987); 23) human ecologies too were transformed in many ways, not least through the sharply uneven "cerealization" of peasant diets – and the "meatification" of aristocratic and bourgeois diets – within Europe after 1550 (Braudel, 1981: 190-199; Komlos, 1990, 1998); 24) the resurgence of Mexican silver production in the 18th century and the attendant deforestation of already-thin Mexican forests (Bakewell, 1971; Studnicki-Gizbert and

Schechter, 2010); 25) the revolution in English coal production from 1530 (Weissenbacher, 2009; Nef, 1932); and, perhaps most significantly, 26) the epoch-making “Columbian exchange,” as Old World diseases, animals, and crops flowed into the New World, and New World crops, such as potatoes and maize, flowed into the Old World (Crosby, 1972, 1986).

Perhaps, one might object, these landscape transformations were nevertheless the output of an essentially preindustrial civilization? This is the common sense point of departure for the Anthropocene argument. Let us take industrialization as consisting of two decisive moments of capitalist *technics*. One is industrialization as a shorthand for the rising mass of machinery and inputs relative to labor time – Marx’s rising technical composition of capital (1981: chapter eight, esp. 244-45). It might be more fruitful to call these processes *mechanization*. The other is industrialization as a shorthand for standardization and rationalization, prefiguring, in embryonic form, the assembly line and Taylorism of the twentieth century.²² If this rough-and-ready definition holds, we are hardly short of examples in the three centuries before Watt’s rotary steam engine: the printing press, perhaps the earliest “great leap forward” in labor productivity with a 200-fold increase after 1450, such that 20 million printed books were produced by 1500 (Febvre and Martin, 1976: 186; Maddison, 2005: 18); the sugar mill in the colonies, successively boosting labor productivity, and the sugar refinery in the metropolises (Daniels and Daniels, 1988; van der Woude, 2003; Moore, 2007); very large blast furnaces in iron-making (Braudel, 1981: 378-379); new ships, such as the Dutch *fluyt*, leading to a fourfold increase in labor productivity in shipping and likely a comparable advance in shipbuilding (Unger, 1975; Luccassen and Unger, 2011); a new shipbuilding regime, led by the Dutch, which combined Smithian specialization (simplified tasks), the standardization of parts²³, organizational innovation (integrated supply systems), and technical change (sawmills to displace costly skilled labor) combined to triple labor productivity (Wilson, 1973; van Bochove, 2008: 196; de Vries, 1993; Noordegraaf, 1993)²⁴; the rapid expansion of iron implements in agriculture (Bairoch, 1973); the mercury-amalgamation process in New World silver production (Bakewell, 1987); the elaboration and diffusion of screw-presses (Kellenbenz, 1974); the *saigerprozess* in the Central European copper-silver metals complex, and after 1540, the rod-engine for effective drainage, which reached Sweden by 1590 (Blanchard, 1995; Hollister-Short, 1994); the quick diffusion of the “Saxony Wheel” in textile manufacturing, trebling labor productivity, accompanied by the diffusion of fulling and napping mills, advancing productivity still further (Munro, 2002: 264); the doubling of the number of water mills, already widely deployed in the medieval era, doubled in the three centuries after 1450, and tripling of

²² This shorthand applies not only to machineries but also the rationalization of human and extra-human relations necessary to work these machines – Taylor’s time-and-motion studies in the early 20th century (1914; also Braverman, 1974) are one indication of the symbolic coding, mapping, and “rational” reorganizations of human/extra-human relations attendant upon capitalism’s successive industrial revolutions, but hardly new to the 20th century. Consider, for example, meatpacking’s “dis-assembly lines” in the antebellum United States (Cronon, 1991), or the rationalization of labor processes and landscapes necessary for the early modern sugar plantation (Mintz, 1985; Moore, 2007). Moving beyond the immediate process of production, one can see a long line of such rationalizations in play across the time and space of early capitalism – suggested in various if partial ways by Weber’s formal rationality (1947), Foucault’s biopolitics (2003), and Sombart’s thesis on the “art of calculation” double-entry bookkeeping (1915), a far from exhaustive list! As I will argue later in this essay, these moments are constitutive of the law of value as a historical process constituted through the dialectics of abstract social labor and abstract social nature.

²³ “In constructing the vessels [in the Dutch Republic by 1600] there was some standardization of design, parts, and building methods. The *busses* were all very much alike, while the *fluitschip* [*fluyt*]... was designed on simple lines... Such ships were put together *by methods which faintly foreshadowed the modern assembly line*” (Heaton, 1948: 275, emphasis added).

²⁴ The new sawmill technology spread rapidly and “could be found in Brittany by 1621, Sweden in 1635, Manhattan in 1623, and soon after Cochin, Batavia, and Mauritius” (Warde, 2009: 7; also Davids, 2003; Moore, 2010b; Boomgaard, 1992a).

aggregate horsepower (Debeir, et al., 1991: 90-91, 76); the extraordinary multiplication of spring-driven clocks (Landes, 1983)... Nor does this exhaust the list.

What do these transformation suggest? A general observation would point towards an qualitative shift in relation between land and labor, production, and power. If some of the foregoing catalogue of early capitalist industrializations look more like a quantitative amplification of medieval developments, as a totality they embodied a qualitative shift. And if many of these transformations fit nicely into Marx's distinction between manufacturing and machinofacture, some (the sugar plantation, shipbuilding, large-scale metallurgy) bore more than a passing resemblance to the latter. In my view, any adequate explanation of this qualitative shift must recognize that there was a transition from control of land as a direct relation of surplus appropriation to control of land as a condition for rising labor productivity within commodity production. This transition was of tremendously uneven and messy. (Aren't they always?) Hence, where peasant cultivation persisted across early modern Europe, there was no dramatic rupture with the medieval rhythm of landscape transformation (e.g. Plack, 2005) – *except where, as in seventeenth century Poland, peasants were directly pushed towards sylvan zones by cash-crop cultivation* (Blum, 1957; Moore, 2010b).²⁵ Wherever primary commodity production penetrated, however, the tempo of landscape transformation accelerated. Why should this be? Although the pace of technical change did indeed quicken – and the diffusion of techniques even more so – in the “first” sixteenth century (1450-1557), I do not think this was enough to compel such an epochal shift in landscape transformation. In my view, this shift has a lot to do with the inversion of the labor-land relation and the ascendance of labor productivity as metric of wealth, unfolding on the basis of appropriating cheap natures. It is here that we glimpse the tenuous and tentative formation of capitalism as a regime of abstract social labor, and the disciplines of socially necessary labor-time.

TOWARDS PROVISIONAL SYNTHESIS: THE ORIGINS OF THE CAPITALOCENE

I have said these transformations are clues to an epochal transition. But clues to what kind of transition, and to what sort of capitalism? Let me offer two working propositions, one explanatory, the other interpretive. First, these transformations represented an early modern revolution in labor productivity within commodity production and exchange that was dialectically bound to a revolution in strategies of global appropriation.²⁶ Crucially, this labor productivity revolution in the zone of

²⁵ Cash-crop agriculture is, of course, a different story with a spectrum of market-dependent farmers transforming landscapes at a rapid pace, from the fifteenth and sixteenth centuries, in locales as diverse as the maritime Low Countries and Madeira (Brenner, 2001; Moore, 2009, 2010d).

²⁶ Our conceptual language on this point is still imprecise. “Labor productivity” is here understood in Marx's terms of value composition and the rate of exploitation. Hence, rising labor productivity may involve workers producing more average commodities for the same wages (or even, for a few, rising wages, as during the Fordist “productivity-wages” pact). Alternatively, it may involve workers producing the same number of average commodities for lower wages, a movement expressed in the language of unit labor costs. To some degree, this is captured in Marx's distinction between absolute and relative surplus value. But this distinction is too often hardened into categorical difference. At a minimum, I would suggest that early capitalism mobilized not technical innovation in production and coercive and symbolic innovation in lengthening the working day, but also pursued ingenious strategies of appropriating cheap natures, at little or no cost, in such a way as to reduce *de facto* unit labor costs (value composition). In such situations – here I think of Norwegian forests or Polish grain or even African slaves at the end of the sixteenth century – the appropriation of “natural fertility” (Marx) may act like an increase in relative surplus value.

Finally, the problem of labor productivity – especially in early modern capitalism – is thorny. One problem is empirical: much of our best evidence is for physical labor productivity, which only indirectly corresponds to the production of surplus value. Another is the sectoral- and nationalist-bias to labor productivity studies, which do not add up to a systemwide labor productivity estimate. Thus, if one includes the Americas, the direct and indirect implications for labor productivity growth are gigantic. A third difficult is the study of labor productivity absent the conceptualization of the

commodification was rendered possible by a revolution in the technics of global appropriation – *including* appropriation within Europe.²⁷ This was manifested not only in the immediate practices and structures of European imperialism. More fundamentally, the “new” imperialism of early modernity was impossible without a new way of seeing and ordering reality. One could conquer the globe only if one could see it (Ingold, 1993; Pratt, 1992). Here the early forms of external nature, abstract space, and abstract time enabled capitalists and empires to construct global webs of exploitation and appropriation, calculation and credit, property and profit, on an unprecedented scale (Merchant, 1980; Lefebvre, 1991; Postone, 1993; Crosby, 1997; Pickles, 2004; Sombart, 1915; Chaunu, 1979). The early modern labor productivity revolution turned, in short, on the Great Frontier (Webb, 1964), understood simultaneously in land/labor and symbolic registers. The fact that early capitalism relied on global expansion as the principal means of advancing labor productivity and facilitating world accumulation reveals the remarkable precocity of early capitalism, not its premodern character. This precocity allowed early capitalism to defy the premodern pattern of boom and bust (Brenner, 1985; Goldstone, 2002): there would be no systemwide reversal of commodification after 1450, not even during the “crisis” of the 17th century.²⁸ Why? In sum, because early capitalism’s *technics* – its crystallization of tools and power, knowledge and production – were *specifically organized* to treat the appropriation of global space as the basis for the accumulation of wealth in its specifically modern form: capital, the substance of which is abstract social labor.

This takes us to a second proposition, which turns on our interpretive frame. The three revolutions we have identified – of landscape transformation, of labor productivity, of the *technics* of global appropriation – suggest a revision of thinking the law of value in ways both orthodox and revolutionary. Crudely put, I think Marxists have *understated* the significance of value relations in the modern world-system. First, a vast but weak law of value crystallized during the long 16th century. I would begin with a certain mis-recognition of the law of value. In this, value-relations have been defined as a phenomenon reducible to the “economic” form of abstract social labor. But such an interpretation significantly understates the epoch-making influence of value relations. The law of value – understood as a gravitational field exerting durable influence over the long-run and large-scale patterns of the capitalist world-ecology – is not an *economic* phenomenon alone, but a *systemic* process with a pivotal and decisive economic moment (abstract social labor). Second, the moment of value accumulation (as abstract labor) is historically materialized through the development of scientific and symbolic regimes necessary to identify, quantify, survey, and otherwise enable not only the advance of commodity production but also the ever-more expansive appropriation of cheap natures.

“Cheap nature” in the modern sense encompasses the diversity of human and extra-human activity necessary to capitalist development but not directly valorized (“paid”) through the money economy.

reproduction of labor-power – largely uncommodified in this period – and the appropriation of uncommodified extra-human natures.

²⁷ But “Europe” is easily reified (Wallerstein, 1974: 51); its geography in the “first” sixteenth century comprised western and central Europe as far north as the Danish Sound, scarcely reaching much beyond the Elbe except for scattered German colonies in the old Hanseatic zone (e.g. Danzig, Königsberg, Reval).

²⁸ One of the great fetishes of economic history is the primacy of the category of “economic growth,” which may not be the most useful approach for comprehending the nexus capital accumulation/systemwide commodification in the early modern era. This is the trap into which Pomeranz (2000) falls in charting the “Great Divergence,” which may be read as a very broad accounting of a very broad notion of “productive forces” between East and West around 1800. In my view, this misses the point entirely. Europe may well have fared poorly relative to China in this accounting, but the new configuration of wealth, power, and production around a globalizing technics in the Atlantic world entailed a qualitative shift, such that capital accumulation, and the production of surplus value (labor productivity), proceeded much more vigorously than the twentieth century models of economic growth would have it.

The decisive historical expression of Cheap Nature in the modern era is the Four Cheaps of labor-power, food, energy, and raw materials. These Four Cheaps are the major way that capital prevents the mass of capital from rising too fast in relation to the mass of appropriated cheap nature – when the delivery of such cheap natures approaches the average value composition of world commodity production, the *world-ecological surplus* falls and the pace of accumulation slackens. The centrality of cheap nature in the endless of capital can, then, be adequately interpreted only through a post-Cartesian frame that understands value as a way of organizing nature. In this, the law of value is co-produced through the web of life. We cannot make sense of value through a Cartesian sorting of “labor and nature” – commonplace in left green thought (e.g. Clark and York, 2005). Rather, because value relations encompass a contradictory unity of exploitation and appropriation heedless of a Cartesian divide, only an analysis that proceeds from essential unity of humanity-in-nature can move us forward. The present argument, then, is a brief for such a post-Cartesian – I would call it world-ecological – reading of value. The goal is to focus our attention on the relations of the *oikeios* that form and re-form capitalism’s successive contradictory unities of the exploitation of labor-power (paid work) and the appropriation of a global zone of reproduction (unpaid work) from the family to the biosphere.

This line of thinking and investigation led me to an unexpected argument. I cannot help but see a new law of value in formation in these centuries, expressed by two epoch-making movements.²⁹ One was the proliferation of knowledges and symbolic regimes that constructed nature as external, space as flat and geometrical, and time as linear (the field of abstract social nature). The other was a new configuration of exploitation (within commodification) and appropriation (outside commodification but in servitude to it). In this latter (the production and accumulation of value), we have the paradox; in the former (abstract social nature) we have clues to how this paradox has been resolved historically. On the one hand, capitalism is a civilization that turns on the zone of commodification and the exploitation of labor-power within it. On the other hand, strategies of commodification and exploitation can work only to the extent that uncommodified natures are somehow put to work, for free or very low cost. In sum, capitalism must commodify life/work but depends upon the “free ride” of uncommodified life/work to do so. Hence, the centrality of the frontier. Historically, this paradox has been resolved partly through brute force, gunboat diplomacy, shock doctrines, and all the rest. But force is an expensive proposition. However necessary, brute force has been insufficient on its own to unlock and to mobilize the wealth of nature for the *long-run* accumulation of capital. Beginning with the Iberians clear through to the long 20th century, one of the first things great empires and states do is establish new ways of mapping, categorizing, and surveying the world

²⁹ Of course every civilization is cohered by one of another way of configuring human and extra-human relations. We may debate the best language for the relational core that coheres this or that civilization, which I take to be relatively durable pattern of power and production over long-time and large space. My understanding of “law” aligns with Marx’s Hegelian reading: law as a general historical tendency that exerts a long-run influence over the historical development of modes of production and reproduction in a given civilization. As with Marx’s other “laws,” these are broad historical tendencies that operate not *in spite* of countervailing tendencies, but *because of these*. (This is what distinguishes a historical-relational method from an ideo-typical one.) For this reason, I have likened capitalism’s law of value to a *gravitational field*, drawing in all manner of external phenomena in contingent fashion. Thus historical capitalism is indeed “structurally variant” (Arrighi, 2004) but relationally invariant, insofar as the logic of capital encourages the remaking of the world into interchangeable units – not only economic but also political and otherwise (e.g. Scott, 1998; Foucault, 2003) – amenable to facilitating the endless accumulation of capital. The exhaustion of that logic of capital as historical strategy is of course not only a matter of biophysical breakdown, or accumulation crisis, but also of class struggles that challenge the praxis of endless commodification.

(Cañizares-Esguerra, 2004; Barnes and Farish, 2006).³⁰ These are strategic expressions of the production of abstract social nature – to which we turn in the latter half of this essay – and they have been crucial because they allow for the frontier-led appropriations of cheap nature that make possible an otherwise self-consuming strategy: commodification. Coercively-enforced, to be sure, the world-praxis of appropriating cheap natures (humans included) so that some other natures (only some humans included) could be exploited has provided the decisive condition for advancing labor productivity within the commodity system (the field of abstract social labor). I do not think these two movements of abstract social labor and abstract social nature exhaust the possibilities; but I cannot escape the conclusion that they provide at once a minimal and indispensable basis for unpacking the history of capitalism as a way of organizing nature.

It is to the question of abstract social nature and the limits of capitalism that we turn in Part II.

REFERENCES

- Aiton, Douglas James (2007). *'Shame on him who allows them to live': The Jacquerie of 1358*. PhD dissertation. Department of History, University of Glasgow..
- Allen, Robert C. (2011). *Global economic history: A very short introduction*. Oxford: Oxford University Press.
- Altvater, Elmar (2006). "The Social and Natural Environment of Fossil Capitalism," in Leo Panitch and Colin Leys, eds., *Coming to Terms with Nature: Socialist Register 2007*. London: Merlin Press.
- Anderson, Perry (1974a). *Passages from Antiquity to Feudalism*. London: New Left Books.
- Anderson, Perry (1974b). *Lineages of the Absolutist State*. London: New Left Books.
- Araghi, Farshad (2009a). "Accumulation by Displacement: Global Enclosures, Food Crises, and the Ecological Contradictions of Capitalism," *Review* 32(1), 113-146.
- Araghi, Farshad (2009b). "Labor in Nature: Food, Ecology, and the Crisis of Global Value Relations," paper presented to the conference, Food, Energy, Environment: Crisis of the Modern World-System, Binghamton University, October.
- Arrighi, Giovanni (1994). *The Long Twentieth Century*. London: Verso.
- Arrighi, Giovanni (2004). "Spatial and Other 'Fixes' of Historical Capitalism." *Journal of World-Systems Research* 10(2), 527-539.
- Bakewell, Peter J. (1971). *Silver mining and society in colonial Mexico: Zacatecas, 1546-1700*. Cambridge: Cambridge University Press.
- Bakewell, Peter J. (1984). *Miners of the Red Mountain: Indian Labor in Potosí, 1545-1650*. Albuquerque: University of New Mexico Press.
- Bakewell, P.J. (1987). "Mining," in Leslie Bethell, ed., *Colonial Spanish America*. Cambridge: Cambridge University Press, 203-249.
- Bakker, Isabella, and Stephen Gill, eds. (2003). *Power, production, and social reproduction: human in/security in the global political economy*. New York: Palgrave Macmillan.

³⁰ During the Second World War and the early Cold War, the entire Earth became a "generalized space of American military strategy" (Barnes and Farish, 2006: 808) – and, I might add, a generalized space of American-led world accumulation (Arrighi, 1994).

- Bairoch, Paul (1973). "Agriculture and the Industrial Revolution, 1700-1914," in Carlo M. Cipolla, ed. *The Fontana Economic History of Europe, III: The Industrial Revolution*. London: Fontana/Collins, 452-506.
- Bakker, Karen J. (2003). "A political ecology of water privatization," *Studies in Political Economy*, 70, 35-58.
- Balter, Michael (2013). "Archaeologists Say the 'Anthropocene' Is Here — But It Began Long Ago," *Science*, 340 (19 April), 261-62.
- Bank for International Settlements (2006). *76th Annual Report*. Basel: Switzerland. www.bis.org/publ/arpdf/ar2006c.htm
- Barca, Stefania (2010). "Energy, property, and the industrial revolution narrative," *Ecological Economics*, 70(7), 1309-1315.
- Barnes, Trevor J., and Matthew Farish (2006). "Between Regions: Science, militarism, and American geography from World War to Cold War," *Annals of the Association of American Geographers*, 96(4), 807-826.
- Barry, John (2007). *Environment and Social Theory*. 2nd ed. New York: Routledge.
- van Bavel, Bas (2001). "Land, Lease and Agriculture: The Transition of the Rural Economy in the Dutch River Area from the Fourteenth to the Sixteenth Century," *Past & Present*, 172, 3-43.
- van Bavel, Bas (2010). "The medieval origins of capitalism in the Netherlands," *BMGN-Low Countries Historical Review* 125(2-3): 45-79.
- Beard, Charles (1901). *The Industrial Revolution*. London: George Allen & Unwin.
- Beinart, William, and Lotte Hughes (2007). *Environment and Empire*. Oxford: Oxford University Press.
- Birch, Charles, and John B. Cobb (1981). *The Liberation of Life*. Cambridge: Cambridge University Press.
- Blanchard, Ian (1995). *International Lead Production and Trade in the 'Age of the Saigerprozess': 1460-1560*. Wiesbaden: Franz Steiner Verlag.
- Blum, Jerome (1957). "Rise of Serfdom in Eastern Europe," *American Historical Review*, 62(4), 807-36.
- van Bochove, Christiaan Jan (2008). *The economic consequences of the Dutch: Economic integration around the North Sea, 1500-1800*. Amsterdam: Amsterdam University Press.
- Boomgaard, Peter (1992a). "Forest management and exploitation in colonial Java, 1677-1897," *Forest & Conservation History* 36(1), 4-14.
- Boomgaard, Peter (1992b). "The Tropical Rain Forests of Suriname: Exploitation And Management 1600-1975," *NWIG: New West Indian Guide / Nieuwe West-Indische Gids*, 66(3/4), 207-235.
- Boserup E. (1965) *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure*. London: Allen & Unwin.
- Boxer, Charles R. (1965). *The Dutch seaborne empire, 1600-1800*. London: Hutchinson.
- Boxer, Charles R. (1969). *The Portuguese Seaborne Empire 1415-1825*. New York: Alfred A. Knopf.
- Bourdieu, Pierre and Loic J.D. Wacquant (1992). *An Invitation to Reflexive Sociology*. Chicago: University of Chicago Press.
- Braudel, Fernand (1953). "Qu'est-ce que le XVI^e siècle?" *Annales E.S.C.*, 8 (1): 69-73.

- Braudel, Fernand (1961). "European Expansion and Capitalism, 1450-1650," in Contemporary Civilization Staff of Columbia College, Columbia University, eds., *Chapters in Western Civilization*. New York: Columbia University Press, 245-288.
- Braudel, Fernand (1972). *The Mediterranean and the Mediterranean World in the Age of Philip II*. Vol. I. Siân Reynolds, trans. New York: Harper & Row.
- Braudel, Fernand (1977). *Afterthoughts on Material Civilization and Capitalism*. Baltimore: Johns Hopkins University Press.
- Braudel, Fernand (1981). *The Structures of Everyday Life: The Limits of the Possible*. New York: Harper & Row.
- Braudel, Fernand (2009/1958 orig.). "History and the Social Sciences: The *Longue Durée*," *Review*, 32(3), 171-203.
- Braudel, Fernand (1982). *The Wheels of Commerce*. Siân Reynolds, trans. New York: Harper & Row.
- Braun, Bruce, and Noel Castree, eds. (1998). *Remaking reality: nature at the millenium*. New York: Routledge.
- Braun, Bruce (2006). "Towards a New Earth and a New Humanity: Nature, Ontology, Politics," in Noel Castree and Derek Gregory, eds., *David Harvey: A Critical Reader*. Oxford: Blackwell, 191-222.
- Braverman, Harry (1974). *Labor and Monopoly Capital*. New York: Monthly Review Press.
- Brenner, Robert (1976). "Agrarian Class Structure and Economic Development in Pre-Industrial Europe," *Past & Present*, 70, 30-75.
- Brenner, Robert (1985) "The Agrarian Roots of European Capitalism," in T.H. Aston and C.H.E Philpin, eds., *The Brenner Debate: Agrarian Class Structure and Economic Development in Pre-Industrial Europe*. Cambridge: Cambridge University Press, 213-327.
- Brenner, Robert (2001). "The Low Countries in the Transition to Capitalism," *Journal of Agrarian Change* 1(2), 169-241.
- Brinley, Thomas (1993). *The Industrial Revolution and the Atlantic Economy*. New York: Routledge.
- Bukharin, Nikolai (1929/1917 original). *Imperialism and World Economy*. New York: International Publishers.
- Bunker, Stephen G. (1984). "Modes of extraction, unequal exchange, and the progressive underdevelopment of an extreme periphery," *American Journal of Sociology* 89(5), 1017-1064.
- Bunker, S.G., and P.S. Ciccantell (1999). "Economic Ascent and the Global Environment," in Walter L. Goldfrank, D. Goodman, and A. Szasz, eds., *Ecology and the World-System*. Westport, CT: Greenwood Press, 107-123.
- Bunker, S.G., and P.S. Ciccantell (2005). *Globalization and the Race for Resources*. Baltimore: Johns Hopkins University Press.
- Burkett, Paul (1999). *Marx and Nature*. New York: St. Martin's Press.
- Cañizares-Esguerra, Jorge (2004). "Iberian science in the renaissance: Ignored how much longer?" *Perspectives on Science*, 12(1), 86-124.
- Carus-Wilson, E.M. (1941). "An industrial revolution of the thirteenth century," *Economic History Review*, (1st series) 11(1), 39-60.
- Carr, E.H. (1962). *What is History?* New York: Penguin.
- Castree, Noel, and Bruce Braun, eds. (2001). *Social nature: Theory, practice, and politics*. Oxford: Blackwell Publishers.
- Certini, Giacomo, and Riccardo Scalenghe (2011). "Anthropogenic soils are the golden spikes for the Anthropocene," *The Holocene*, 21(8) 1269-1274.

- Chakrabarty, Dipesh (2009). "The Climate of History: Four Theses," *Critical Inquiry*, 35, 197-222.
- Chaunu, Pierre (1979). *European Expansion in the Later Middle Ages*. Amsterdam: North Holland Publishing Company.
- Ciccantell, Paul S., and Stephen G. Bunker (2002). "International Inequality in the Age of Globalization: Japanese Economic Ascent and the Restructuring of the Capitalist World-Economy," *Journal of World-Systems Research* 8(1), 62-98.
- Cipolla, Carlo M. (1976). *Before the Industrial Revolution: European Society 1000-1700*. New York: W.W. Norton.
- Clark, Brett, and J.B. Foster (2009). "Ecological Imperialism and the Global Metabolic Rift," *International Journal of Comparative Sociology*, 50(3-4), 311-334.
- Clark, Brett, and Richard York (2005). "Carbon Metabolism," *Theory and Society*, 34(4), 391-428.
- Clark, Gregory (2009). *Farewell to Alms*. Princeton: Princeton University Press.
- Clayton, Neil (2003). "Weeds, people and contested places," *Environment and History*, 9(3), 301-331.
- Commoner, Barry (1971). *The Closing Circle*. New York: Bantam Books.
- Costanza, Robert, et al. (1997). "The value of the world's ecosystem services and natural capital," *Nature*, 387(6630), 253-260.
- Cronon, William (1991). *Nature's Metropolis*. New York: W.W. Norton.
- Crosby, Alfred W., jr. (1972). *The Columbian exchange: Biological and cultural consequences of 1492*. Westport, CT: Greenwood Press.
- Crosby, Alfred W., jr. (1986). *Ecological Imperialism*. Cambridge: Cambridge Univ. Press.
- Crosby, Alfred W., jr. (1997). *The Measure of Reality*. Cambridge: Cambridge Univ. Press.
- Crutzen, Paul J. (2002). "Geology of Mankind: The Anthropocene," *Nature*, 415, 23.
- Crutzen, Paul J., and Eugene F. Stoermer (2000). "The Anthropocene," *IGBP [International Geosphere-Biosphere Programme] Newsletter*, 41, 17-18.
- Daly, Herman E., and Joshua Farley (2004). *Ecological Economics*. Washington, D.C.: Island Press.
- van Dam, Petra (2001). "Sinking Peat Bogs. Environmental Change in Holland, 1350-1550," *Environmental History*, 6(1), 32-45.
- Daniels, John, and Christian Daniels (1988). "The Origin of the Sugarcane Roller Mill," *Technology and Culture*, 29(3): 493-535.
- Darby, H.C. (1956). "The Clearing of Woodland in Europe," in William L. Thomas, Jr., ed. *Man's Role in Changing the Face of the Earth*. Chicago: University of Illinois Press, 183-216.
- Davids, Karel (2003). "Innovations in Windmill Technology in Europe, c. 1500-1800: The State of Research and Future Directions of Inquiry," *NEHA-Jaarboek voor Economische, Bedrijfs-en Techniekgeschiedenis*, 66, 43-57.
- Davis, John A. (2006). "The European economies in the eighteenth century," in Antonio Di Vittorio, ed., *An Economic History of Europe: From expansion to development*. New York: Routledge, 92-134.
- Davis, Mike (2006). *Planet of Slums*. London: Verso.

- Davis, Mike (2010). "Who will build the ark?" *New Left Review*, II/61, 29-46.
- Davis, Ralph (1973). *The Rise of the Atlantic Economies*. Ithaca, NY: Cornell University Press.
- Dean, Warren (1995). *With Broad Ax and Firebrand: The Destruction of the Brazilian Atlantic Forest*. Berkeley: Univ. of California Press.
- Deane, Phyllis (1973). "The role of capital in the industrial revolution," *Explorations in Economic History*, 10(4), 349-364.
- Debeir, Jean-Claude, Jean-Paul Deléage, and Daniel Hémerly (1991/1986 orig.) *In the servitude of power: Energy and civilisation through the ages*. John Barzman, trans. London: Zed.
- Deckard, Sharae. 2012. "Mapping the World-Ecology," unpublished paper, School of English, Drama, and Film, University College Dublin.
- Dehing, Pit, and Marjolein 't Hart (1997). "Linking the fortunes: currency and banking 1550–1800," in Marjolein 't Hart, Joost Jonker, and Jan Luiten van Zanden, eds., *A financial history of the Netherlands*. Cambridge: Cambridge University Press, 37-63.
- Descartes, René (2006/1637 original). *A Discourse on the Method of Correctly Conducting One's Reason and Seeking Truth in the Sciences*. Ian Maclean, ed. Oxford: Oxford University Press.
- Dunlap, Riley E., and William R. Catton, Jr. (1979). "Environmental Sociology," *Annual Reviews in Sociology*, 5, 243-273.
- DuPlessis, Robert S. (1997). *Transitions to Capitalism in Early Modern Europe*. Cambridge: Cambridge University Press.
- The Economist* (2011a). "A man-made world," *The Economist* 399, 81–83.
- The Economist* (2011b). "Welcome to the Anthropocene," *The Economist*, 399, 13.
- Elden, Stuart (2006) *Speaking against number: Heidegger, language and the politics of calculation*. Edinburgh: Edinburgh University Press
- Ellis, Erle C., Kees Klein Goldewijk, Stefan Siebert, Deborah Lightman, and Navin Ramankutty (2010). "Anthropogenic transformation of the biomes, 1700 to 2000," *Global Ecology and Biogeography*, 19(5), 589-606.
- Ellis, Erle C., Jed O. Kaplan, Dorian Q. Fuller, Steve Vavrus, Kees Klein Goldewijk, and Peter H. Verburg (2010). "Used planet: A global history," *Proceedings of the National Academy of Sciences* 110(20), 7978-7985.
- Emmer, Pieter C. (1972). "The History of the Dutch Slave Trade: A Bibliographical Survey," *Journal of Economic History*, 32(3), 728-747.
- Enzensberger, H.M. (1974). "A critique of political ecology," *New Left Review*, I/84, 3–31.
- Febvre, Lucien, and Henri Martin (1976 [1958]). *The Coming of the Book: The Impact of Printing, 1450-1800*. David Gerard, trans. London: Verso.
- Fischer-Kowalski, Marina, and Helmut Haberl (1997). "Tons, joules, and money: Modes of production and their sustainability problems," *Society & Natural Resources*, 10, 1, 61-85
- Fischer-Kowalski, Marina, and Helmut Haberl (1998). "Sustainable Development: Socio-economic metabolism and the colonization of nature," *International Social Science Journal*, 158, 573-587.
- Fischer-Kowalski, Marina, Fridolin Krausmann, and Irene Pallua (forthcoming, 2014). "A sociometabolic reading of the Anthropocene: Modes of subsistence, population size and human impact on Earth," *The Anthropocene Review*.

- Fossier, Robert (1968). *La Terre et les Hommes en Picardie jusqu'à la Fin du XIIIe Siècle*. 2 vols. Louvain and Paris: B. Nauwelaerts.
- Foster, John Bellamy (1992). "The Absolute General Law of Environmental Degradation Under Capitalism," *Capitalism Nature Socialism* 3(2), 77-86.
- Foster, John Bellamy (1994). *The Vulnerable Planet: A Short Economic History of the Environment*. New York: Monthly Review Press.
- Foster, John Bellamy (2000). *Marx's Ecology: Materialism and Nature*. New York: Monthly Review Press.
- Foster, John Bellamy (2001). "Capitalism's Environmental Crisis: Is Technology the Answer?" *Hitotsubashi journal of social studies*, 33(1), 143-150.
- Foster, John Bellamy (2012). "A Missing Chapter of Monopoly Capital: Some Theoretical Implications," *Monthly Review* 64(3), <http://monthlyreview.org/2012/07/01/a-missing-chapter-of-monopoly-capital>,
- Foster, John Bellamy (2013). "Marx and the Rift in the Universal Metabolism of Nature," *Monthly Review*, 65(7), 1-19.
- Foster, John Bellamy, Brett Clark, and Richard York (2010). *The Ecological Rift: Capitalism's War on the Earth*. New York: Monthly Review Press.
- Foucault, Michel (2003). *Society must be defended*. New York: Picador.
- Foucault, Michel (2007). *Security, Territory, Population*. New York: Picador.
- Fouquet, Roger (2008). *Heat, Power and Light: Revolutions in Energy Services*. Northampton, MA: Edward Elgar.
- Frank, Andre Gunder (1978). *World Accumulation, 1492-1798*. New York: Monthly Review Press.
- Friedmann, Harriet, and Philip McMichael (1989). "Agriculture and the state system: The rise and decline of national agricultures, 1870 to the present," *Sociologia Ruralis*, 29(2), 93-117.
- Funes Monzote, Reinaldo (2008). *From Rainforest to Cane Fields in Cuba: An Environmental History since 1492*. Alex Martin, trans. Chapel Hill: University of North Carolina Press.
- Galeano, Eduardo (1973). *The Open Veins of Latin America*. New York: Monthly Review Press.
- Gimpel, Jean (1976). *The Medieval Machine: The Industrial Revolution of the Middle Ages*. New York: Penguin.
- Goldstone, J.A. (2002). "Efflorescences and Economic Growth in World History:," *Journal of World History*, 13(2), 323-389.
- Gould, Stephen Jay (1981). *The Mismeasure of Man*. New York: W.W. Norton.
- Gowdy, John, and Lisi Krall (2013). "The ultrasocial origin of the Anthropocene.," *Ecological Economics*, 95, 137-147.
- Grove, Richard H. (1995). *Green Imperialism*. Cambridge: Cambridge University Press.
- Haberl, Helmut, et al. (2007). "Quantifying and mapping the human appropriation of net primary production in earth's terrestrial ecosystems," *Proceedings of the National Academy of Sciences* 104(31), 12942-12947.
- Haberl, Helmut, Marina Fischer-Kowalski, Fridolin Krausmann, Joan Martinez-Alier, and Verena Winiwarter (2011). "A socio-metabolic transition towards sustainability? Challenges for another Great Transformation," *Sustainable Development*, 19(1), 1-14.

- Hansen, James (2009). *Storms of my grandchildren: The truth about the coming climate catastrophe and our last chance to save humanity*. New York: Bloomsbury.
- Harvey, David (1974). "Population, Resources, and the Ideology of Science," *Economic Geography* 50(3), 256-277.
- Harvey, David (1996). *Justice, Nature, and the Geography of Difference*. Oxford: Basil Blackwell.
- Harvey, David (2003). *The New Imperialism*. Oxford: Oxford Univ. Press.
- Harvey, David (2005). *A Brief History of Neoliberalism*. Oxford: Oxford Univ. Press.
- Harvey, David (2010). *The Enigma of Capital and the Crises of Capitalism*. London: Profile Books
- Harvey, P.D.A. (1993). *Maps in Tudor England*. Cambridge: Cambridge University Press.
- Heaton, Herbert (1948). *Economic History of Europe*. 2nd ed. New York: Harper.
- Headrick, Daniel R. (1988). *The tentacles of progress: technology transfer in the age of imperialism, 1850-1940*. Oxford: Oxford University Press.
- Heinberg, Richard (2003). *The Party's Over*. Gabriola Island, BC: New Society.
- Heynen, Nick, James McCarthy, Scott Prudham, and Paul Robbins, eds. (2007). *Neoliberal Environments*. New York: Routledge.
- Hildebrand, Karl-Gustaf (1992). *Swedish Iron in the Seventeenth and Eighteenth Centuries: Export Industry before Industrialization*. Paul Britten Austin, trans. Stockholm: Jernkontorets bergshistoriska skriftserie.
- Hochschild, Arlie (2002). "The Commodity Frontier," Working Paper No. 1, Center for Working Families, University of California, Berkeley.
- Hollister-Short, Graham (1994). "The First Half-Century of the Rod-Engine (c. 1540-1600)," *Bulletin of the Peak District Mines Historical Society*, 12(3), 83-90.
- Hopkins, Terence K. (1982). "World-systems analysis: Methodological issues," in T.K. Hopkins, et al., *World-Systems Analysis: Theory and Methodology*. Beverly Hills: Sage, 145-158.
- Hopkins, Terence K., and Immanuel Wallerstein (1977). "Patterns of Development of the Modern World-System," *Review*, 1(2), 111-145.
- Huber, Matthew T. (2008). "Energizing historical materialism: Fossil fuels, space and the capitalist mode of production," *Geoforum*, 40, 105-115.
- Ingold, Tim (1993). "Globes and spheres: The topology of environmentalism," in Kay Milton, ed., *Environmentalism: The view from anthropology*. New York, Routledge, 31-42.
- Jackson, R.V. (1985). "Growth and deceleration in English agriculture, 1660-1790," *Economic History Review*, 38, 333-51.
- Jensen, Derrick (2006). *Endgame, Volume 1: The Problem of Civilization*. New York: Seven Stories Press.
- Jones, Eric L. (1987). *The European Miracle*. Cambridge: Cambridge University Press.
- Jonsson, Fredrik Albritton (2012). "The Industrial Revolution in the Anthropocene," *The Journal of Modern History*, 84(3), 679-696.
- Kane, Robert (1845). *The industrial resources of Ireland*. 2d ed. Dublin: Hodges and Smith.

- Kellenbenz, Hermann (1974). "Technology in the Age of the Scientific Revolution 1500-1700," in Carlo M. Cipolla, ed., *The Fontana Economic History of Europe, II*. London: Fontana/Collins, 177-272.
- Kellenbenz, Hermann (1976). *The Rise of the European Economy*. London: Weidenfeld and Nicolson.
- Kinahan, G.H. (1886-87). "Irish Metal Mining," *The Scientific Proceedings of the Royal Dublin Society*, n.s., 5, 200-317.
- King, Peter (2005). "The Production and Consumption of Bar Iron in Early Modern England and Wales," *Economic History Review*, n.s., 58(1), 1-33.
- Kingsnorth, Paul (2011). "The Quants and the Poets," *Dark-Mountain.net*, available at <http://dark-mountain.net/blog/the-quants-and-the-poets>, accessed 24 June, 2013.
- Kjellstrom, T., Kovats, R. S., Lloyd, S. J., Holt, T., & Tol, R. S. (2009). "The direct impact of climate change on regional labor productivity," *Archives of Environmental & Occupational Health*, 64(4), 217-227.
- Komlos, John (1990). "Height and Social Status in Eighteenth-Century Germany," *Journal of Interdisciplinary History*, 20(4), 607-621.
- Komlos, John (1998). "Shrinking in a Growing Economy? The Mystery of Physical Stature during the Industrial Revolution," *Journal of Economic History*, 58(3), 779-802.
- Komlos, John (2000) "The Industrial Revolution as the Escape from the Malthusian Trap," *Journal of European Economic History*, 29, 307-331.
- Kosek, Jake (2006). *Understories: The political life of forests in northern New Mexico*. Durham: Duke University Press.
- Kreidte, Peter, Hans Medick , and Jürgen Schlumbohm (1981). *Industrialization before industrialization: Rural industry in the genesis of capitalism*. Cambridge: Cambridge University Press.
- Kriedte, Peter (1983). *Peasants, Landlords, and Merchant Capitalists*. Cambridge: Cambridge University Press.
- Landes, David (1983). *Revolution in time: clocks and the making of the modern world*. Cambridge, MA: Harvard University Press.
- Landes, David S. (1998). *The Wealth and Poverty of Nations*. New York: W.W. Norton.
- Lane, Frederic Chapin (1933). "Venetian Shipping During the Commercial Revolution," *American Historical Review*, 38(2), 219-239
- Latour, Bruno (1993). *We Have Never Been Modern*. Cambridge: Harvard University Press.
- Lefebvre, Henri (1991). *The Production of Space*. Donald Nicholson-Smith, trans. Oxford: Blackwell.
- Leitner, Jonathan (2005). "Commodity Frontier as Contested Periphery: The Fur Trade in Iroquoia, New York and Canada, 1664–1754," in Paul S. Cicantell, David A. Smith, Gay Seidman, eds., *Nature, Raw Materials, and Political Economy*, Emerald Group Publishing Limited, 231-252.
- Leiss, William (1972). *The Domination of Nature*. Boston: Beacon Press.
- Levine, David (2001). *At the dawn of modernity: Biology, culture, and material life in Europe after the year 1000*. Berkeley: University of California Press, 2001.
- Levins, Richard, and Richard Lewontin (1985). *The Dialectical Biologist*. Cambridge, MA: Harvard University Press.
- Lohmann, Larry (2012). "Financialization, Commodification and Carbon: The Contradictions of Neoliberal Climate Policy," in Leo Panitch, G. Albo, and V. Chibber, eds., *Socialist Register 2012: The Crisis and the Left*. London: Merlin, 85-107.

- Luxemburg, Rosa (1913/2003 ed.). *The Accumulation of Capital*. New York: Routledge.
- Maddison, Angus (2005). *Growth and Interaction in the World Economy: The Roots of Modernity*. Washington, D.C.: AEI Press.
- Malanima, Paolo (2006). “Energy crisis and growth 1650–1850: The European deviation in a comparative perspective,” *Journal of Global History*, 1(1), 101–121
- Malm, Andreas (2013). “The Origins of Fossil Capital: From Water to Steam in the British Cotton Industry,” *Historical Materialism*, 21(1), 15–68.
- Malowist, Marian (2009). *Western Europe, Eastern Europe and World Development, 13th-18th Centuries*. Leiden: Brill.
- Mandel, Ernest (1975). *Late Capitalism*. London: New Left Books.
- Marcuse, Herbert (1972). “Ecology and revolution,” *Liberation*, 16, 10-12.
- Marley, Benjamin (2013). *Battle for the Mountains: Restructuring Extractive Production and the Socio-ecological Crisis in West Virginia's Coalfields*. M.A. thesis, Department of Geography, Syracuse University, 2013.
- Marley, Benjamin, and Samantha Fox (*forthcoming*). “Exhausting Socio-Ecological Relations: Conditions of Economic Viability in the Era of Mountaintop Removal in West Virginia,” *Journal of World-Systems Research*.
- Martinez-Alier, Joan (2002). *The environmentalism of the poor*. Cheltenham, UK: Edward Elgar.
- Marx, Karl (1967). *Capital*. 3 vols. Frederick Engels, ed. New York: International Publishers.
- Marx, Karl (1973). *Grundrisse: Introduction to the Critique of Political Economy*. Martin Nicolaus, trans. New York: Vintage.
- Marx, Karl (1977). *Capital*, Vol. I. Ben Fowkes, trans. New York: Vintage.
- Marx, Karl (1978). *Capital*, Vol. II. David Fernbach, trans. New York: Pelican.
- Marx, Karl (1981). *Capital*, Vol. III. David Fernbach, trans. New York: Pelican.
- Marx, Karl, and Frederick Engels (1970). *The German Ideology*. New York: International Publishers.
- Massey, Douglas S., Joaquin Arango, Graeme Hugo, Ali Kouaouci, and Adela Pellegrino (1999). *Worlds in Motion: Understanding International Migration at the End of the Millennium*. Oxford: Oxford University Press.
- Mathias, Peter (1969). *The First Industrial Nation: The Economic History of Britain, 1700-1914*. London: Methuen & Co.
- McAfee, Kathleen. 1999. “Selling nature to save it?” *Society and Space*, 17(2): 133-54.
- McAfee, Kathleen. 2003. “Neoliberalism on the Molecular Scale.” *Geoforum*, 34(2): 203-219.
- McCracken, Eileen. 1971. *The Irish Woods Since Tudor Times*. Newton Abbot, Ireland: David & Charles.
- McMichael, Philip (1991). “Slavery in Capitalism,” *Theory and Society*, 20(3), 321-349.
- McMichael, Philip (2012). *Development and Social Change*. Fifth ed. Beverly Hills: Sage.
- McNeill, J.R. (2008). “Global Environmental History in the Age of Fossil Fuels (1800-2007),” in K. Mizoguchi, ed., *The Environmental Histories of Europe and Japan*. Kobe: Nagoya University Press, 1-11.
- Meadows, Donella H., Dennis L. Meadows, Jorgen Randers, and William W. Behrens III (1972). *The Limits to Growth*. New York: Signet/Mentor.

- Merchant, Carolyn (1980). *The Death of Nature: Women, Ecology, and the Scientific Revolution*. New York: Harper & Row.
- Merchant, Carolyn (1989). *Ecological Revolutions*. Chapel Hill: University of North Carolina Press.
- Meszaros, Istvan (1970). *Marx's Theory of Alienation*. London: Merlin Press.
- Mielants, Eric H. (2007). *The Origins of Capitalism and the 'Rise of the West'*. Philadelphia: Temple University Press.
- Mies, Maria (1986). *Patriarchy and Accumulation on a World Scale: Women in the International Division of Labour*. London: Zed.
- Miller, J.C., 1988. *Way of Death: Merchant: Capitalism and the Angolan Slave Trade 1730–1830*. Madison: University of Wisconsin Press.
- Mintz, Sidney W. (1985). *Sweetness and Power: The Place of Sugar in Modern History*. New York: Penguin.
- Mokyr, Joel (1990). *The Lever of Riches: Technological Creativity and Economic Progress*. Oxford: Oxford University Press.
- Moore, Jason W. (2000). "Sugar and the Expansion of the Early Modern World-Economy," *Review* 23(3), 409-433.
- Moore, Jason W. (2003a). "Nature and the Transition from Feudalism to Capitalism," *Review* 26, 2, 97-172.
- Moore, Jason W. (2003b). "The Modern World-System as Environmental History? Ecology and the Rise of Capitalism," *Theory & Society* 32, 3, 307-377.
- Moore, Jason W. (2003c). "Capitalism as World-Ecology: Braudel and Marx on Environmental History." *Organization & Environment* 16(4), 431-458.
- Moore, J.W. (2009). "Madeira, Sugar, & the Conquest of Nature in the 'First' Sixteenth Century, Part I," *Review* 32,4, 345-90.
- Moore, Jason W. (2010a). "'Amsterdam is Standing on Norway' Part I: The Alchemy of Capital, Empire, and Nature in the Diaspora of Silver, 1545–1648," *Journal of Agrarian Change*, 10, 1, 35–71.
- Moore, Jason W. (2010b). "'Amsterdam is Standing on Norway' Part II: The Global North Atlantic in the Ecological Revolution of the Long Seventeenth Century," *Journal of Agrarian Change*, 10, 2, 188–227.
- Moore, Jason W. (2010c). "The End of the Road? Agricultural Revolutions in the Capitalist World-Ecology, 1450–2010," *Journal of Agrarian Change*, 10, 3, 389–413.
- Moore, J.W. (2010d). "Madeira, Sugar, & the Conquest of Nature in the 'First' Sixteenth Century, Part II," *Review* 33(1), 1-24.
- Moore, Jason W. (2010e). "'This Lofty Mountain of Silver Could Conquer the Whole World': Potosí and the Political Ecology of Underdevelopment, 1545–1800," *Journal of Philosophical Economics* 4, 1, 58–103.
- Moore, Jason W. (2011a). "Transcending the Metabolic Rift," *The Journal of Peasant Studies*, 38, 1, 1-46.
- Moore, J.W. (2011b). "Ecology, Capital, and the Nature of Our Times," *Journal of World-Systems Analysis* 17(1), 108-47.
- Moore, Jason W. (2011c). "Wall Street is a Way of Organizing Nature: Interview," *Upping the Anti* 12, 47-61.
- Moore, Jason W. (2012). "Cheap Food & Bad Money: Food, Frontiers, and Financialization in the Rise and Demise of Neoliberalism," *Review*, 33(2-3), 125-161.
- Moore, Jason W. (2013a). "From Object to *Oikeios*: Environment-Making in the Capitalist World-Ecology," unpublished paper. Department of Sociology, Binghamton University.

- Moore, Jason W. (2013b). "Crisis: Ecological or World-Ecological?" in Carolin Wiedemann and Soenke Zehle, eds., *Depletion Design: A Glossary of Network Ecologies*. Amsterdam: Institute of Network Cultures.
- Moore, Jason W. (2013c). "El Auge de la Ecología-Mundo Capitalista, I." *Laberinto*, 38, 9-26.
- Moore, Jason W. (2013d). "El Auge de la Ecología-Mundo Capitalista, II." *Laberinto*, 39, 6-14.
- Moore, Jason W. (2014). "The End of Cheap Nature, or, How I learned to Stop Worrying about 'the' Environment and Love the Crisis of Capitalism," in Structures of the World Political Economy and the Future of Global Conflict and Cooperation, edited by C. Suter and C. Chase-Dunn (Berlin: LIT, 2014), 1-31.
- Morton, F.W.O. (1978). "The royal timber in late colonial Bahia," *Hispanic American Historical Review* 58(1), 41-61.
- Mumford, Lewis (1934). *Technics and Civilization*. London: Routledge and Kegan Paul.
- Munro, John (2002). "Industrial energy from water-mills in the European economy, fifth to eighteenth centuries," in Simonetta Cavaciocchi, ed., *Economia e Energia Sec. XIII-XVIII*. Paris: Le Monnier, 223-269.
- Nef, John U. (1966/1932 original). *The Rise of the British Coal Industry*. London: Routledge.
- Nef, John U. (1964). *The Conquest of the Material World*. New York: Meridian.
- Niblett, Michael (2013). "The 'impossible quest for wholeness'." *Journal of Postcolonial Writing*, 49(2), 148-160.
- Noordegraaf, Leo (1993). "Dutch industry in the Golden Age," in Karel Davids and Leo Noordegraaf, eds., *The Dutch economy in the Golden Age*. Amsterdam: Nederlandsch Economisch-Historisch Archief, 131-157.
- O'Connor, James (1998). *Natural Causes: Essays in Ecological Socialism*. New York: Guilford.
- Oloff, Kerstin (2012). "'Greening' the Zombie," *Green Letters*, 16(1), 31-45.
- Ortiz, Roberto José (2013). "Latin American Agro-Industrialization, Petrodollar Recycling, and the Transformation of World Capitalism in the Long 1970s," Unpublished paper, Fernand Braudel Center, Binghamton University.
- Osborn, Matthew (2003). "'The Weirdest of All Undertakings': The Land and the Early Industrial Revolution in Oldham, England," *Environmental History*, 8(2), 246-269.
- Overton, Mark (1996). *Agricultural Revolution in England. The Transformation of the Agrarian Economy, 1500-1850*. Cambridge: Cambridge University Press.
- Parenti, Christian (2014). "The Inherently Environmental State: Nature, Territory, and Value," Unpublished paper, School for International Training.
- Parry, J.H. (1966). *The Spanish Seaborne Empire*. Berkeley: University of California Press.
- Patel, Raj (2009). *The Value of Nothing*. New York: Picador.
- Peluso, Nancy L. (1992). *Rich Forests, Poor People-Resource Control and Resistance in Java*. Berkeley: University of California Press.
- Peng, Shaobing, et al. (2004). "Rice yields decline with higher night temperature from global warming," *Proceedings of the National Academic of Science*, 101(27): 9971-9975.
- Perlin, John (1989). *A Forest Journey*. Cambridge, MA: Harvard University Press.

- Perrings, Charles (2010). "Exotic effects of capital accumulation," *Proceedings of the National Academy of Sciences*, 107(27), 12063-12064.
- Petram, L.O. (2011). *The world's first stock exchange: How the Amsterdam market for Dutch East India Company shares became a modern securities market, 1602-1700*. PhD dissertation, University of Amsterdam.
- Pickles, John (2004). *A History of Spaces: Cartographic reason, mapping and the geo-coded world*. New York: Routledge.
- Pimentel, David, et al. (1973). "Food production and the energy crisis," *Science*, 182, 443-49.
- Plack, Noelle (2005). "Agrarian Reform and Ecological Change During the Ancien Régime: Land Clearance, Peasants and Viticulture in the Province of Languedoc," *French History*, 19(2), 189-210.
- Plumwood, Val (1993). *Feminism and the Mastery of Nature*. New York: Routledge.
- Podobnik, Bruce. *Global energy shifts*. Philadelphia: Temple University Press.
- Pomeranz, Kenneth. 2000. *The Great Divergence: China, Europe, and the Making of the Modern World Economy*. Princeton: Princeton University Press
- Ponting, Clive (1991). *A Green History of the World*. New York: St. Martin's Press
- Pomeranz, Kenneth. 2000. *The Great Divergence*. Princeton: Princeton University Press
- Postone, Moishe (1993). *Time, Labor, and Social Domination*. Cambridge: Cambridge University Press.
- Poulsen, Bo (2008). "Talking Fish: Cooperation and Communication in the Dutch North Sea Herring Fisheries, c. 1600–1850," in *Beyond the Catch: Fisheries of the North Atlantic, the North Sea and the Baltic, 900–1850*, eds L. Sicking and D. Abreu-Ferreira, 387-412. Leiden: E.J. Brill.
- Prado, Caio Junior (1967). *The Colonial Background of Modern Brazil*. Berkeley: University of California Press.
- Prak, Marteen, ed. (2001). *Early Modern Capitalism: Economic and Social Change in Europe 1400-1800*. New York: Routledge.
- Pratt, Mary Louise (1992). *Imperial eyes: Travel writing and transculturation*. New York: Routledge.
- Pálsson, Gísli, et al. (2013). "Reconceptualizing the 'Anthropos' in the Anthropocene: Integrating the social sciences and humanities in global environmental change research," *Environmental Science & Policy*, 28, 3-13.
- Richards, J.F. (2003). *The Unending Frontier*. Berkeley: Univ. of California Press.
- Ritzer, George, ed. (2005). *Encyclopedia of Social Theory*. 2 vols. Thousand Oaks, CA: Sage.
- Rockström, Johan, et al. (2009). "Planetary boundaries: Exploring the safe operating space for humanity," *Ecology and Society*, 14(2).
- Roelvink, Gerda (2013). "Rethinking Species-Being in the Anthropocene," *Rethinking Marxism*, 25(1), 52-69.
- Rogers, T.D. (2005). *The Deepest Wounds. Labouring Landscapes of Sugar in Northeastern Brazil*. PhD dissertation, Department of History, Duke University, Durham, NC.
- Rostow, Walt Whitman (1978). *The world economy: history & prospect*. Austin: University of Texas Press.
- Ruddiman, William F. (2005). *Plows, Plagues Petroleum: How Humans Took Control of the Climate*. Princeton: Princeton University Press.

- Ruddiman, William F. (2013). "The Anthropocene," *Annual Reviews in Earth and Planetary Science*, 41, 4.1-4.24 [Review in Advance].
- Saad-Filho, Alfredo (2002). *Value of Marx*. New York: Routledge.
- Sayer, Derek (1987). *The Violence of Abstraction*. Oxford: Blackwell.
- Sayre, Nathan F. (2012). "The Politics of the Anthropogenic," *Annual Review of Anthropology*, 41, 57-70.
- Schiebinger, Londa L. (2004). *Plants and empire: Colonial bioprospecting in the Atlantic world*. Cambridge, MA: Harvard University Press.
- Schiebinger, Londa L. and Claudia Swan (2005). "Introduction," in Londa L. Schiebinger and Claudia Swan, eds., *Colonial botany: science, commerce, and politics in the early modern world*. Philadelphia: University of Pennsylvania Press.
- Schmidt, Alfred (1973). *The Concept of Nature in Marx*. London: New Left Books.
- Schnaiberg, Allan (1980). *The Environment: From Surplus to Scarcity*. Oxford: Oxford University Press.
- Schwartz, Stuart B. (1985). *Sugar Plantations in the Formation of Brazilian Society*. Cambridge: Cambridge University Press.
- Secombe, Wally (1992). *A Millennium of Family Change: Feudalism to Capitalism in Western Europe*. London: Verso.
- Secombe, Wally (1995). *Weathering the Storm*. London: Verso.
- Sella, Domenico. 1974. "European Industries 1500-1700," in Carlo M. Cipolla, ed. *The Fontana Economic History of Europe II: The Sixteenth and Seventeenth Centuries*. New York: Collins/Fontana Books, 354-426
- Shand, Hope (2003). "New enclosures: why civil society and governments need to look beyond life patenting," *CR: The New Centennial Review* 3(2),187-204.
- Sieferle, Rolf Peter (2001). *The Subterranean Forest: Energy Systems and the Industrial Revolution*. Michael P. Osman, trans. Cambridge: The White Horse Press.
- Silver, Beverly J. (2003). *Forces of Labor*. Cambridge: Cambridge University Press.
- Silver, Beverly J., and Eric Slater (1999). "The Social Origins of World Hegemonies," in G. Arrighi, B.J. Silver, et al., *Chaos and Governance in the Modern World-System*. Minneapolis: University of Minnesota Press, 151-216.
- Slicher van Bath, B.H. (1963). *The Agrarian History of Western Europe, 500-1850 A.D.* Olive Ordish, trans. New York: St. Martin's Press.
- Smith, Felisa A., Scott M. Elliott, and S. Kathleen Lyons (2010). "Methane emissions from extinct megafauna," *Nature Geoscience* 3(6), 374-375.
- Smith, Neil (1984). *Uneven Development*. Oxford: Basil Blackwell.
- Smith, Neil (2006). "Nature as accumulation strategy," in Leo Panitch and Colin Leys, eds. *Socialist Register 2007: Coming to terms with nature*. London: Merlin Press, 16-36.
- Smith, Pamela H., and Paula Findlen, eds. (2002). *Merchants & Marvels: Commerce, science, and art in early Modern Europe*. New York: Routledge.
- Solow, Barbara L. (1987). "Capitalism and Slavery in the Exceedingly Long Run," in Barbara L. Solow & Stanley L. Engerman, eds. *British Capitalism and Caribbean Slavery: The Legacy of Eric Williams*. Cambridge: Cambridge University Press, 51-77.

- Sombart, Werner (1915). *The Quintessence of Capitalism*. M. Epstein, trans. and ed. New York: E.P. Dutton & Co.
- Sonnenfeld, David, and Arthur P.J. Mol, eds. (2011). *Social Theory and the Environment in the New World (dis)Order*. Special issue of *Global Environmental Change*, 21(3), 771-1152.
- Steffen, Will, Paul J. Crutzen and John R. McNeill (2007). "The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature?" *Ambio*, 36(8), 614-621.
- Steffen, Will, Jacques Grinevald, Paul Crutzen and John McNeill (2011a). "The Anthropocene: Conceptual and historical perspectives," *Philosophical Transactions of the Royal Society A*, 369, 842-867.
- Steffen, Will, et al., (2011b). "The Anthropocene: From global change to planetary stewardship," *Ambio*, 40(7), 739-761.
- Steinberg, Theodore L. (1986). "An Ecological Perspective on the Origins of Industrialization," *Environmental Review: ER*, 10(4), 261-276.
- Studnicki-Gizbert, Daviken, & D. Schecter (2010). "The environmental dynamics of a colonial fuel-rush: Silver mining and deforestation in New Spain, 1522 to 1810," *Environmental History*, 15(1), 94-119.
- Sundberg, Ulf (1991). "An Energy Analysis of the Production at the Great Copper Mountain of Falun During the Mid-seventeenth Century," *International Journal of Forest Engineering* 1(3), 4-16.
- Super, J.C. (1988). *Food, Conquest, and Colonization in Sixteenth-Century Spanish America*. Albuquerque: University of New Mexico Press.
- Swyngedouw, Erik (1996). "The city as a hybrid: on nature, society and cyborg urbanization," *Capitalism Nature Socialism*, 7(2), 65-80.
- Swyngedouw, Erik (2013). "Apocalypse Now! Fear and Doomsday Pleasures," *Capitalism Nature Socialism*, 24(1), 9-18.
- Szcygielski, W. (1967). "Die Okonomische Aktivitat des Polnischen Adels im 16–18. Jahrhundert," *Studia Historiae Oeconomicae*, 2, 83–101.
- TeBrake, W. H. (1993). *A plague of insurrection: popular politics and peasant revolt in Flanders, 1323-1328*. Philadelphia: University of Pennsylvania Press.
- Toynbee, Arnold (1894/1884 original/1881 lectures). *Lectures on the Industrial Revolution of the Eighteenth Century in England*. London: Longmans, Green, and Co.
- von Tunzelman, G.N. (1981). "Technological Progress during the Industrial Revolution," in R. Floud and D. McCloskey, eds., *The Economic History of Britain since 1700*, vol. I. Cambridge: Cambridge University Press, 143-63.
- Unger, Richard W. (1975). "Technology and Industrial Organization: Dutch Shipbuilding to 1800," *Business History*, 17(1), 56-72.
- Unger, Richard W. (2011). "Dutch Nautical Sciences in the Golden Age: the Portuguese Influence," *E-Journal of Portuguese History*, 9(2), 68-83.
- Vansina, Jan (1996). "Quilombos on São Tomé, or in Search of Original Sources," *History in Africa*, 23, 453-459.
- Vernadsky, Vladimir I. (1997/1926 original). *The Biosphere*. New York: Copernicus.
- Vlachovic, J., (1963). "Slovak Copper Boom in World Markets of the Sixteenth and in the First Quarter of the Seventeenth Centuries," *Studia Historica Slovaca*, 1: 63–95.
- Voosen, Paul (2012). "Geologists drive golden spike toward Anthropocene's base," *Greenwire*, Sept. 17, http://eenews.net/public/Greenwire/2012/09/17/1?page_type=print, accessed 5 May, 2013.

- de Vries, Jan (1974). *The Dutch rural economy in the Golden Age, 1500-1700*. New Haven, CT: Yale University Press.
- de Vries, Jan (1976). *The Economy of Europe in an Age of Crisis*. Cambridge: Cambridge University Press.
- de Vries, Jan (1993). "The labour market," in Karel Davids and Leo Noordegraaf, eds., *The Dutch economy in the Golden Age*. Amsterdam: Nederlandsch Economisch-Historisch Archief, 55-78
- de Vries, Jan, and Ad van der Woude (1997). *The First Modern Economy: Success, Failure, and Perseverance of the Dutch Economy, 1500-1815*. Cambridge: Cambridge University Press.
- de Vries, Jan (2001). "Economic Growth before and after the Industrial Revolution," in Maarten Prak, ed., *Early Modern Capitalism: Economic and Social Change in Europe, 1400-1800*. New York: Routledge, 175-191.
- de Vries, Jan (2008). *The industrious revolution*. Cambridge: Cambridge University Press.
- Walker, Richard A. (1979). "Human-Environment Relations: Editor's Introduction," *Antipode*, 11(2), 1-16.
- Wallerstein, Immanuel (1974). *The Modern World-System I: Capitalist Agriculture and the Origins of the European World-Economy in the Sixteenth Century*. New York: Academic Press.
- Wallerstein, Immanuel (1980). *The Modern World-System II*. New York: Academic Press.
- Wallerstein, Immanuel (1982). "Revolutionary Movements in the Era of US Hegemony and After," *Contemporary Marxism*, 5, 120-128.
- Warde, Paul (2006a). *Ecology, Economy and State Formation in Early Modern Germany*. Cambridge: Cambridge University Press.
- Warde, Paul (2006b). "Fear of wood shortage and the reality of the woodland in Europe, c. 1450–1850," *History Workshop Journal*, 62(1), 28-57.
- Warde, Paul (2009). "Energy and Natural Resource Dependency in Europe, 1600-1900," BWPI Working Paper 77, University of Manchester.
- Warde, Paul, and Antonio Marra (2007). *Energy Consumption in England & Wales, 1560-2000*. Naples: Consiglio nazionale delle ricerche, Istituto di studi sulle società del Mediterraneo.
- Watts, David (1987). *The West Indies: Patterns of Development, Culture, and Environmental Change since 1492*. Cambridge: Cambridge University Press.
- Weber, Max (1947). *The Theory of Social and Economic Organization*. New York: Free Press.
- Weber, Max (1992/1930 original). *The Protestant Ethic and the Spirit of Capitalism*. New York: Routledge, 1992
- Webb, Walter Prescott (1964). *The Great Frontier*. Austin: University of Texas Press.
- Weis, Tony (2013). *The Ecological Hoofprint*. London: Zed.
- Weissenbacher, Manfred (2009). *Sources of power: How energy forges human history*. New York: Praeger.
- White, Richard (1995). *The Organic Machine: The Remaking of the Columbia River*. New York: Hill & Wang.
- Williams, Michael (2003). *Deforesting the Earth*. Chicago: University of Chicago Press.
- Williams, Raymond (1972). "Ideas of Nature," in J. Benthall, ed., *Ecology*. London: Longman, 146-164.

- Wilson, Charles H. (1968). *The Dutch Republic and the Civilisation of the Seventeenth Century*. New York: McGraw Hill.
- Wilson, Charles H. (1973). "Transport as a Factor in the History of European Economic Development," *Journal of European Economic History*, 2(2), 320–37.
- Wing, John T. (2012). "Keeping Spain Afloat: State Forestry and Imperial Defense in the Sixteenth Century," *Environmental History*, 17, 116–145.
- Wisner, Ben (1978). "Does radical geography lack an approach to environmental relations?" *Antipode*, 10(1), 84-95.
- Wolf, Eric R. (1982). *Europe and the People without History*. Berkeley: Univ. of California Press.
- Worster, Donald (1990). "Transformations of the Earth," *Journal of American History* 76(4), 1087-1106.
- Wrigley, Edward Anthony (1990). *Continuity, Chance and Change: The character of the industrial revolution in England*. Cambridge: Cambridge University Press.
- Wrigley, E. A. (2010). *Energy and the English Industrial Revolution*. Cambridge: Cambridge University Press.
- Young, Robert M. (1973). "The Human Limits of Nature," in Jonathan Bethell, ed., *The Limits of Human Nature*. London: Allen Lane.
- Young, Robert M. (1979). "Science is a Labor Process," *Science for the People*, 43-44, 31-37.
- Young, Robert M. (1985). "Is Nature a Labor Process?" In: L. Levidow and R.M. Young, eds. *Science, technology, and the labor process*, Volume 2. London: Free Association Books, 206–32.
- Zalasiewicz, Jan, et al., (2008). "Are we now living in the Anthropocene?" *GSA Today*, 18(2), 4-8.
- Zalasiewicz, Jan, et al. (2011a). "Stratigraphy of the Anthropocene," *Philosophical Transactions of the Royal Society A*, 369, 1036-1055.
- Zalasiewicz, Jan, et al. (2011b). "The Anthropocene: a new epoch of geological time?" *Philosophical Transactions of the Royal Society A*, 369, 835-841.
- van Zanden, Jan Luiten (1993). *The Rise and Decline of Holland's Economy*. Manchester: Manchester University Press.
- van Zanden, Jan Luiten (2002). "The 'revolt of the early modernists' and the 'first modern economy'," *The economic history review*, 55(4): 619-641.
- van Zanden, Jan Luiten (2003). "The ecological constraints of an early modern economy: The case of Holland 1350-1800," *NEHA-Jaarboek*, 66, 85-102.
- van Zanden, Jan Luiten (2009). *The long road to the Industrial Revolution: The European economy in a global perspective, 1000-1800*. Leiden: Brill.
- de Zeeuw, J.W., (1978). "Peat and the Dutch Golden Age: The Historical Meaning of Energy Attainability," *A.A.G. Bijdragen*, 21, 3–31.
- Zerner, Charles (1994). "Through a Green Lens: The Construction of Customary Environmental Law and Community in Indonesia's Maluku Islands," *Law & Society Review*, 28(5), 1079-1122.
- Zivin Joshua, and Matthew Neidell (2010). "Temperature and the Allocation of Time." Working Paper 15717, Washington, D.C.: National Bureau Of Economic Research.