Chapter Two

FROM CONSUMER BOOM TO ECOLOGICAL BUST

Before the great crash of 2008, the world economy went on a spending spree unlike any in human history. The combination of sheer population (6.7 billion) and the emergence of a global middle class with money to spend resulted in a truly gargantuan scale of consumption. The United States was at the forefront of this trend, a surprising fact given the unprecedented levels of material comfort its population had already achieved.

The shift toward consumption had been occurring for decades. In 1969 the fraction of gross domestic product devoted to personal consumption stood at 61.5 percent. (The major alternatives are investment, government spending, and exports.) Twenty years later, the consumption share was 65.6 percent, and by 2007 it had topped 70 percent. Expenditures per person hit a peak that same year, at $32,144. It's an extraordinary figure, especially when compared with a global average income of only $8,500, or the fact that more than half the people in the world earn less than $1,000 annually.

From the perspective of fifty years earlier, when the nation was already very prosperous, the expansion of consumption is also striking. In 1960 the average person consumed just a third of what he or she did in late 2008. Since 1990, inflation-adjusted per-person expenditures have risen 300 percent for furniture and household goods, 80 percent for apparel, and 15–20 percent for vehicles, housing, and food. Overall, average real per-person spending increased 42 percent.

This doesn't mean well-being was proceeding apace. Average spending gives information about one spot (or "moment") in a distribution. As has been extensively documented, the distribution of purchasing power was getting vastly more unequal. Since 2000, nearly half, or 47 percent, of the nation's entire income has accrued to the top 20 percent of the population. Before the crash, income inequality was worse than at any time since the end of the 1920s boom, and by some measures had even exceeded that historic peak. Even though consumption was increasing, so too were poverty, indebtedness, and lack of health insurance. Broader measures showed erosion in well-being even as spending was accelerating. The United States, which in 1990 ranked number two in the world on the Human Development Index, had plunged to number fifteen by 2006. The nonstop upscaling of lifestyles was arguably contributing to, rather than offsetting, the deterioration in quality of life.

After the financial crisis hit, attention was focused on fiscal imbalances—a gaping trade deficit of $719 billion and, by 2008, nearly $14 trillion in household indebtedness. Those numbers are important. But the failure has not just been monetary. There's a material dimension that has been overlooked. What transpired in the late years of the bubble was an almost manic speedup in the flow of goods through households and the larger economy. It has been most obvious in apparel and consumer electronics, but it is a more general phenomenon. Notably, every one of those products used up or altered some part of the planet and its ecosystems. New data discussed below shows that material impact is increasing, and ominously so.

There's a curious aspect to the material impact of consumption, when considered from a cultural perspective. Among wealthy countries and wealthy consumers, products have become so abundant and lifestyles so comfortable that the use of goods to meet basic needs (food, clothing, shelter, transport) is often overshadowed by their role as symbolic communicators. Brands, styles, and exclusivity are used to convey social status, construct identity, and differentiate from or join with others. These symbolic aspects of consumption have become more valued.

But as the goods themselves become less important, and their social meanings more salient, their physical or material impact on the planet intensifies. That's because symbolic consumption relies heavily on fashion and novelty. People buy more products and turn them over quickly. I call this the materiality paradox. It describes what happened during the boom, and it's part of why consumption is taking an escalating toll on the planet. Transcending the materiality paradox is one of the urgent tasks we face, and plenitude can help us do that.

Elite discourse remains focused on returning us to the status quo. The operating assumption is the desire to stimulate household consumption. But that raises an obvious question. Is what ails the country a shortage of cars, square footage in housing, television sets, sofas, clothing, dishes, laptops, and cell phones? To see the folly in the "spend our way back to normal" route, we need to look at what was happening before the crash and how it has affected ecosystems and natural resources. Clothing is a good place to start, not because it's the most ecologically significant of the things we consume (it is not), but because it was the cutting edge of a set of unsustainable consumer practices.

21

Fast Fashion: The Case of Apparel

The most revealing fact about the contemporary apparel market is this: clothing can now be purchased by weight, rather than by the piece, and at a price as low as a dollar a pound. That means it's possible to buy gently used, even high-end apparel for less than rice, beans, or other basic foodstuffs. In historical perspective, this is almost unfathomable.

In the West, apparel has been expensive to produce and has therefore been a high-priced and valuable commodity for centuries. Once fashioned, garments had long and varied lives. A dress or jacket might be born as special occasion wear, then segue into an everyday outdoor piece, then become a garment for indoor sociability, and eventually be worn (and worn out) while doing domestic chores. Apparel also traversed social hierarchies, passed down from elites to their servants. In some households, garments were turned into quilting squares, thereby extending a textile's productivity for years. A piece of clothing might end its useful life as a rag, and literally turn to dust.

While economic growth has rendered all consumer goods far less valuable today than they were in the past, apparel is a special case. According to the historian Beverly Lemire, clothing has been worth so much that it served as an alternative currency in the secondhand economies that have existed for centuries alongside markets in new goods. From the seventeenth through the mid-nineteenth century, apparel was a primary medium of exchange, second only to metals and precious stones. Even in the twentieth century, some used clothing continued to have value in exchange.

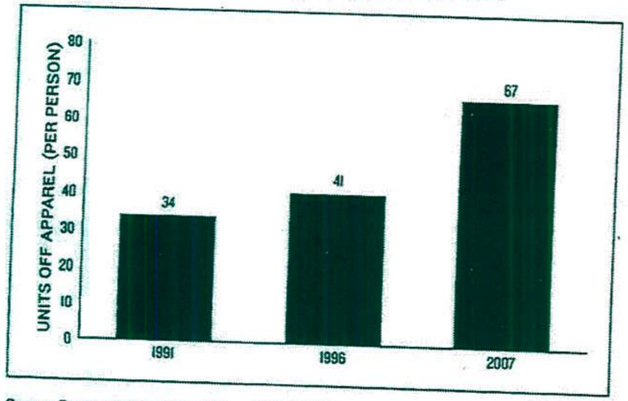
This history puts the nearly free gently worn garments of the early twenty-first century into sharp relief. The United States has been piling up mountains of clothing that have virtually no value. There's a profound ecological insight here. The production system drives businesses to use natural resources at hyperspeed, and the consumer system makes the resulting products redundant almost as fast. It's a recipe for disaster.

The accumulation of clothing has been made possible by plummeting prices. At the high end, there has been stratospheric escalation (three-thousand-dollar suits, handbags, and the like), but in the broader mass market, cheapening has been the norm. The outsourcing of production has driven prices down. Global surpluses of labor, including vast numbers of former rural peasants in China, combined with the market power of chains such as Wal-Mart, have led to relentless downward pressure on apparel workers' wages. Other contributors to low prices include artificially inexpensive global shipping, technological innovation in inventory control, and fierce competition among suppliers. In the late 1990s, the Asian financial crisis accelerated the downward price trend as exporting economies endured a severe contraction that further eroded wages. The cost of a dress, a pair of pants, or a coat declined sharply. The consumer price index for apparel, which stood at 127 in 1991, fell to a low of 117.9 in 2006.

For twenty years, consumers have ratcheted up their purchases of apparel. Consider the category of outer- and underwear (which excludes socks and hosiery, but includes all other apparel, such as pajamas, swimsuits, and so on). In 1991 Americans bought an average of thirty-four dresses, pairs of pants, sweaters, shirts, underwear, and other items. In 1996 that number had risen to forty-one. By 2007 per-person consumption had soared to sixty-seven items. American consumers were purchasing a new piece of clothing every 5.4 days.

Higher acquisition has been accompanied by more stylistic change. The industry has shortened the time between the design of a garment and its appearance in the store. The annual fashion cycle has been gradually reduced to a few months, and in some stores the

FIGURE 2.1 Purchases of New Apparel by U.S. Consumers



Source: Data on units of apparel from AAFA (2008) and U.S. Census Bureau (2005 and earlier years with missing data made available to author)

floor life of a garment is measured in weeks. As the economics of apparel production have changed, so too have consumers. They have come to expect low prices and frequent design change. Buying is more indiscriminate, and garments are worn fewer times. Shoppers can indulge their taste for novelty, worrying less about whether their wardrobes are versatile and durable. There has been a shift out of what the industry calls basics, which persist over years with relatively slow-moving design, to fashion, which by definition has fast-moving style. People now buy more fashion items, and basics themselves are also more fashionable. It's a fast or McFashion world, in which style is available at mass marketers, such as H&M or Old Navy, at rock-bottom prices.

The concept of fashion is worth considering for a moment. It implies constant movement, even ephemerality. This year's styles must be different from last year's. In *Empire of Fashion*, a history of its rise in the West, the French philosopher Gilles Lipovetsky argues that we embrace fashion because it shows that we can afford to be wasteful, abandoning goods merely because they are no longer stylish. Fashion is to some extent a love of the frivolous, or at least a flight from necessity. By all accounts, fashion is a social, rather than a functional, dynamic. In a fashion-driven world, a piece of apparel, furniture, or electronics can lose its appeal because it is no longer stylish or because it has become too widely available. That's a key distinction between fashion and nonfashion items. Consumers who buy new energy-efficient gas boilers will not be tempted to ditch them because their neighbors adopt them. But once "everyone" has a granite countertop, a pashmina scarf, a pair of UGGs, or a (fill in the blank), fashion-conscious consumers begin to abandon these items. Examples like gas boilers are getting harder to find as more and more of what we buy is sucked out of the realm of the purely functional into the orbit of design and fashion. The British sociologist Mike Featherstone called this trend "the aestheticization of everyday life." By the end of the boom, it was affecting everything from the pencil holder on the desk to the teapot on the stove, never mind the cell phone, its case, and its ringtone.

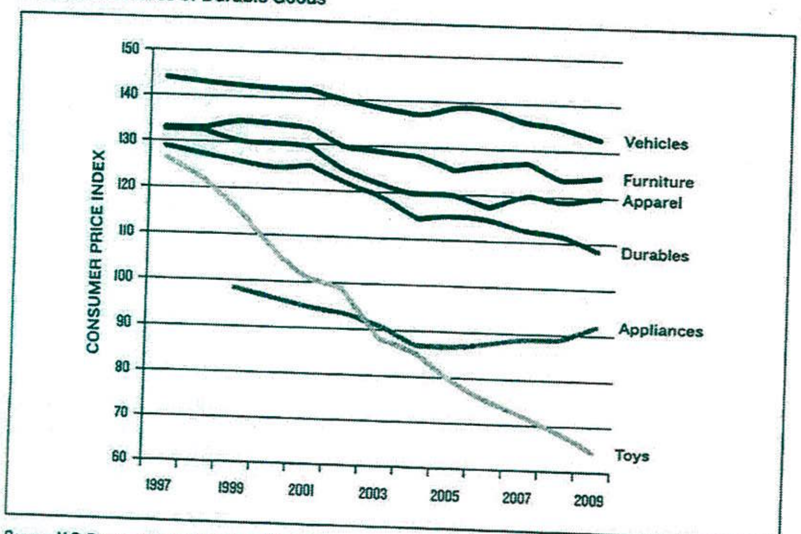
Fast Fashion Writ Large

Industry has a rather prosaic name for products that move quickly through the market. They're called FMCGs, or fast-moving consumer goods. Traditionally these have been products, such as toothpaste and detergent, that are used up in a flash. During the boom, apparel became an FMCG. So, too, have a number of other products that are considered consumer durables, but whose life cycle is now anything but. Electronics, furniture, and other household items started moving quickly. And as they did, the sheer volume of consumption in the U.S. economy ratcheted sharply up.

Thinking about the volume of consumption is a stark departure from the ordinary practice of economics, which focuses on prices and dollar flows. Dollar data is often very detailed, allowing analyses of buying patterns among groups of consumers or responsiveness to changes in prices. But the number of couches people buy or how much those couches weigh is typically outside the economist's field of vision. Yet those measures are central not only to the consumer experience, but also to the ecological impacts of spending.

The dollar metric can miss the boat in a period like the present, with rapid product innovation and falling prices. Spending data is adjusted for changes in prices, but there is no perfect method to do so, and parsing out changes in quality is complex. One hundred dollars of spending can represent one, two, three, even twenty shirts.

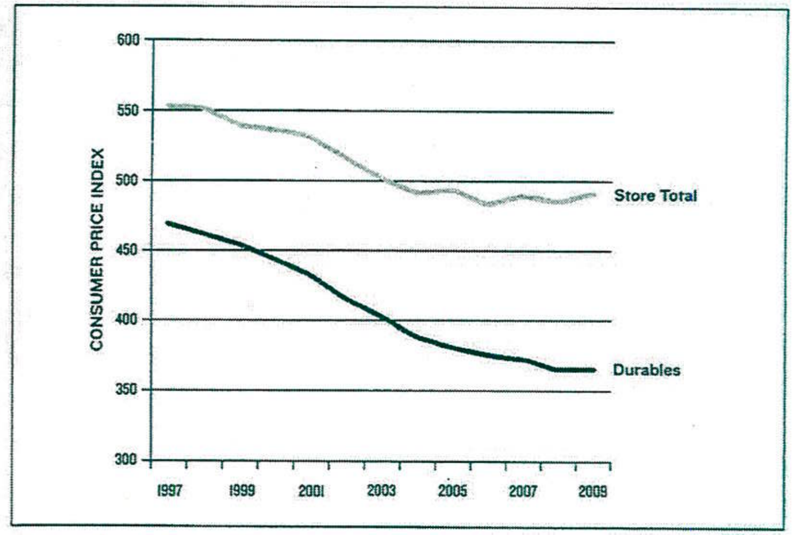
FIGURE 2.2 Prices of Durable Goods



Source: U.S. Bureau of Labor Statistics (2009a)

During the boom, there were bargains galore as goods prices dropped precipitously. In addition to reductions in the prices of apparel, the prices of toys fell by nearly half. For other goods, prices rose as the economy expanded in the beginning of the decade, but fell in the later stages of the boom. Furniture, appliance, and vehicle prices declined after 1999. Computer prices (not shown) fell dramatically, to a tenth of their 1991 value. The department store index for durable goods reached a peak of 470 in 1997, then fell a hundred points. Prices for all products at department stores went down as well. As products got cheap, people started buying more.

FIGURE 2.3 Department Store Prices



Source: U.S. Bureau of Labor Statistics (2009a)

By how much? To answer that question, we need measures such as the actual number of items or, even better for ecological analysis, the weight of goods. It is hard to find that information because data collection is skewed toward dollar values. The Census of Manufactures periodically publishes reports for some categories, but only a few. Industries do their own research, but it is typically proprietary. (Apparel is unusual, because of its history of international quotas.)

One bright spot in the data landscape is that when products arrive on our borders, their numbers and weights are recorded. Because so many manufactured goods are now imported, this is not a bad starting point. Products come into the country in four main ways—by sea, air, rail, or truck—and the government collects information on all four. I've compiled the data from 1998 until 2007 for selected commodities, as well as for the manufacturing sector as a whole. Unfortunately, the data does not allow identification of purchasers (or end users), and includes not only goods destined for households, but also those purchased by businesses and government.

Let's start with the living room couch. During this nine-year period (1998–2007), the total weight of all the furniture imported into the United States rose 155 percent, from 4,671 million kilograms to 11,894 million. Anecdotal evidence suggests an IKEA effect. IKEA, a low-cost Swedish producer specializing in up-to-date design at bargain prices, opened its first U.S. store in 1985 and subsequently increased its national presence. The large increase in furniture volumes is probably due to the downward price pressure exerted by IKEA and similar retailers, as well as to a growing sensibility of fashion in the furniture market.

FIGURE 2.4 Furniture Acquisition

	1998	2007	*Change*
Consumer Price Index	133.6	127.1	*6.5-point decrease*
Weight of imports (in millions of kgs)	4,671	11,894	*155% increase*
Units of imports (in millions)	327.6	651.3 (2005)	*99% increase*

Sources: U.S. Bureau of Labor Statistics, U.S. Bureau of Transportation Statistics, WISERTrade

A tally by item, rather than weight, reveals a similar story. Aggregating across fifty-one detailed categories of furniture (mattresses of cotton, mattresses of cellulose, etc.), I found that in 1998, 327.6 million pieces of furniture of all types were imported into the United States. By 2005 imports were twice as numerous, at 651.3 million. The unit data also suggests accelerated buying spurred by the expansion of cheap but fashionable imported furniture.

Do the expanded imports really represent a rise in consumption, or are they just replacing domestic furniture production? I haven't found data on domestic production by volume or in units. However, consumption of domestically produced furniture in dollar terms (defined as domestic production minus imports) rose 25 percent. At the same time, prices fell, so the rise in the number of pieces produced was even larger. Furniture is becoming a faster-moving consumer good.

Consumer electronics are also exhibiting a fashion cycle. The weight of imported electronics, such as computers, cell phones, televisions, fax machines, and MP3 players, increased by 75 percent over the period 1998–2007. This is especially notable when we consider that a number of these products, such as laptops, MP3 players, and cellular phones, have been shrinking in size and weight, and laptops

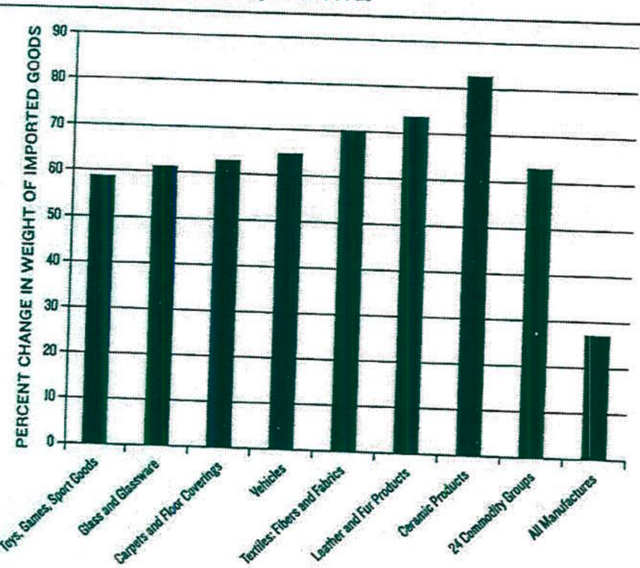
FIGURE 2.5 Consumer Electronics

	1998	2005	*Change*
Consumer price index for information technology	44.3	14.0	*30.3-point decrease*
Units of imported goods, in millions			
Cell phones	14	177	*1,150% increase*
Laptops	3	24	*620% increase*
Vacuum cleaners	67	188	*180% increase*
Ovens, toasters, coffeemakers	76	227	*200% increase*
Other small electronics	715	1,400	*96% increase*

Sources: U.S. Bureau of Labor Statistics, U.S. Bureau of Transportation Statistics, WISERTrade have grown in popularity. There has been a shift to thinner flat-panel and plasma televisions. My calculations on imported unit volumes show that these have increased substantially. The number of imported cell phones rose twelvefold, from 14.2 million in 1998 to 177.2 million in 2005. Laptops rose from 3.3 million to 23.8 million, a sevenfold expansion. Furthermore, the increase is not just occurring in newer technologies. Imports of vacuum cleaners more than doubled (67 million to 188 million). Ovens, toasters, and coffeemakers rose from 76 million to 227 million. A subset of ten small electronics categories increased from 715 million units in 1998 to 1.4 billion in 2005, a nearly 100 percent increase. Industry data shows that total purchases of computers rose from 38.9 million in 1998 to an estimated 64.2 million in 2007.

A similar story can be told across manufacturing. The weight of imported ceramics rose by 83 percent, glass and glassware by 61 percent, leather and fur products by 74 percent, toys and games by 59 percent, textiles by 70 percent, carpets by 63 percent. In a few of these cases, declines in domestic production offset some of the increase, but in others domestic production was an addition to total consumption. The vehicles category is environmentally very significant, because of both emissions and the heavy volume of materials used for manufacture. The material volume of imported vehicles rose 64 percent. Domestically produced consumption in dollar terms increased by 14 percent over the period, and prices of new vehicles fell slightly, indicating that the weight of imports plus domestic production has increased in the range of 80 percent. Other commodity groups with large increases include plastics and rubber, and pearls, stones, metals, and jewelry. Food and pharmaceuticals also increased.

FIGURE 2.6 The Growing Weight of Imported Goods



Source: U.S. Bureau of Transportation Statistics, WISERTrade (2009)

Figure 2.6 also shows the growth in volume of twenty-four commodity groups that constitute most of the consumer economy, as well as data on all commodity imports. Taken together, the twenty-four commodities increased in total weight by 63 percent, or 7 percent a year. For the entire goods sector, which includes more of what business purchases, the total increase over the period was 28 percent, or approximately 3.1 percent annually. The growth in domestic production was in addition to these increases.

Discard Nation

Had the acceleration of consumer purchasing been a one-time spurt or yielded items that would be used and appreciated over many years, its impact could have been manageable. But acquisition has been paired with product abandonment. It's a grand consumer churn, and its speed is unprecedented. Fashions change within months. People grow tired of their purchases more quickly. Products become technologically obsolete or break. Either we're not getting much benefit from what we buy, or we're struggling to keep up with changing styles, or both.

The government doesn't keep comprehensive statistics on used goods, either in the household or as they reenter the market or the waste stream. But there's partial and anecdotal evidence that points to rising household inventories of unused products and discard to various outlets.

When consumers acquire additional goods, they have to find places to put them. The census survey of new housing does not include information on closets or storage space, but new homes have gotten much larger, and anecdotal evidence suggests significant increases in closet and other storage space. In fact, closets have become a mini-industry, with a retail presence (e.g., California Closets and the Container Store). There are numerous books on how to reduce clutter. There is even a profession, represented by the National Association of Professional Organizers, devoted to helping people with their material overload. Another trend is the rise in commercial self-storage. One in ten households now rents storage space, a 65 percent increase since 1995. The industry collects more than $20 billion in annual sales, and has installed 20.8 square feet of capacity per household in the United States.

Consumer electronics are piling up at a rapid rate. The Environmental Protection Agency has estimated that in 2007 alone, 140 million cell phones reached a stage called end of life (EOL). They're ready to be disposed of, having already been stored at home for some time. (The EPA is counting electronics because they contain toxic metals, and there are efforts under way to recycle them, including a few state laws that prevent landfill disposal.) This compares with only 19 million in 1999. Two hundred and five million computers and peripherals transitioned into EOL in 2007 (compared with 124 million in 1999). Since 1980, about 1.2 billion computers and televisions alone have been collected, with another 235 million still sitting in storage in households and offices. For cell phones, computer products, and televisions together, 373 million, or about 1.2 per American, arrived at EOL in 2007. And these are just a few categories—storage and discard are also rising for fax machines and DVD and MP3 players, among others.

Apparel discard has also risen dramatically. The secondhand clothing industry has been estimated to exceed one billion dollars. Much of the supply is exported to low-income countries. In 1991, 316 million pounds of worn clothing were exported from the United States to the rest of the world. By 2004 exports stood at 1.1 billion, an almost fourfold rise. Unpublished regression analyses I have done find that imports of new garments track and predict these exports of used clothes. The more new pieces consumers purchase, the more used ones they give away. Households have also been putting a larger quantity of apparel into the waste stream. In 2007, textiles made up approximately 4.7 percent of the annual municipal waste stream of 254 million tons, which amounted to seventy-eight pounds of textile discards per person.

Another piece of evidence of the exploding supply of used items is the growth of eBay, Craigslist, and other online sites that transfer goods between and among people. The government isn't keeping track of these sites, but they have expanded rapidly. I did manage to find data on exports of used or secondhand merchandise, a grab-bag category that includes items ranging from paintings and drawings to worn clothing, used tires, and postage stamps. Many of the items are industrial, such as backhoes, excavators, and tractors, so it's not a great measure, but it does show that by weight, these exports increased 66 percent from 1998 to 2005.

The Materiality Paradox

The logic of the fashion model is that social and cultural considerations, rather than functionality, drive purchases. Whether for reasons of style, fit, color, design, or even just novelty, in a fashion-driven consumer world, items that still work in the everyday sense of the term are abandoned because they are seen as out-of-date, ugly, ratty, old, or just plain boring. Their social meaning, or what the literature calls symbolic value, is what counts. For decades, theorists of consumer society, most prominently Jean Baudrillard, have written about this symbolic economy.

These postmodern accounts of consumer culture argue that what we now care about as we consume is not products themselves, but the signs and symbols they connect to. Image is paramount. The classic example is the branded athletic shoe, which costs only a few dollars to make, and is not physically distinct from many other shoes. Nevertheless, consumers shell out large sums, which can range from fifty to two hundred dollars, to get these status symbols. Advertising and media have succeeded in cultivating desire for the Apple logo, the Prada triangle, or the Nike swoosh, even more than for the phone, the bag, or the shoe.

Some consumer theorists argue that the emergence of a symbolically driven economy implies that when people crave images and social meaning, the materiality of goods becomes unimportant, which in turn can produce dematerialization. The idea is that we consume images, rather than material products. Virtual possessions in the computer environment Second Life can substitute for offline "stuff." Others predict the material impact of spending will be reduced through technological change. These are comforting thoughts, because material impact is what drives ecological degradation.

The consumer theorists are certainly right about one thing. Symbolic value has become far more important. Expanded expenditures on advertising and marketing, the growth of brand value as a corporate asset, and the emergence of fast fashion are all evidence for that view. But, in opposition to theorists of dematerialization, the materiality paradox suggests that the rising importance of symbolic value increases, rather than reduces, pressure on the planet. That's because sign economies are vulnerable to the dynamics of rapidly changing symbolic value, through the fashion cycle. If what is symbolically valued remains so for only a brief period of time, then replacement goods become necessary. The materiality paradox says that when consumers are most hotly in pursuit of nonmaterial meanings, their use of material resources is greatest. This point brings to mind Raymond Williams's famous quip that our problem isn't that we're too materialistic; it's that we're not materialistic enough. We devalue the material world by excessive acquisition and discard of products. The plenitude principle of true materialism reverses this attitude.

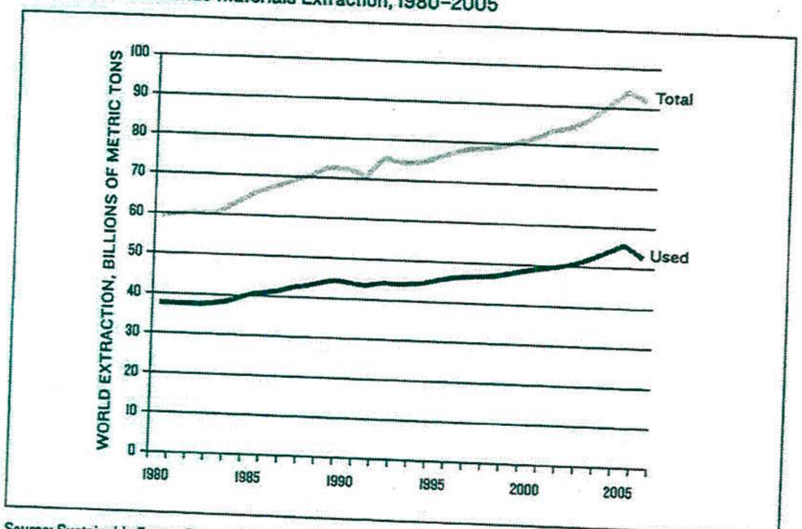
Of course, it's not only the planet that suffers in this stage of consumer culture. The fast-fashion dynamic puts enormous pressure on consumers to keep up with what can at times feel like a dizzying acceleration in norms. It's financially exhausting, and requires time to shop, compare prices, and learn to operate new technologies. Fast fashion fosters an unhealthy dissatisfaction with what one has and anxiety about falling behind. Among the comfortable, it can engender a lack of contentment and gratitude.

The materiality paradox hasn't been recognized, and especially not by scholars of consumption in the wealthy countries. Perhaps the globalization of production partly explains this. It's easier to believe we've left the manufacturing era if sooty factories and mining operations no longer dot the landscape. But examining the data on material flows through the economy and across the globe reveals a far less comforting picture than one gets from the talk about a postmaterial future.

Material Economics

In contrast to predictions of dematerialization, the volume of materials used globally, as well as in each individual region of the world, is rising. The extraction and transformation of resources like fuels, wood, sand, gravel, minerals, and biomass create the pulse of an economy. Until recently, scholars paid relatively little attention to how these materials move through and across economies. But that is changing. One of the most interesting metrics is called material flow analysis. MFA tracks the extraction of resources through production and consumption. The field is still in its infancy, and not well known in the United States, but it is growing, especially in Europe.

FIGURE 2.7 Worldwide Materials Extraction, 1980–2005



Source: Sustainable Europe Research Institute (2009)

We now have the first comprehensive global estimates of material flows over time. In 1980 humans extracted and used 40 billion metric tons of metals, fossil fuels, biomass, and minerals. (One metric ton equals 2,204.6 pounds.) Twenty-five years later, the annual use of materials had increased 45 percent, to 58 billion. All regions are heavier users, including North America. While 58 billion tons is a very large number, it represents only that portion of extracted resources that actually enter the economy. Another 39 billion or so tons are displaced in the process of production. This unused or wasted extraction is sometimes called overburden. It's the soil that's removed in coal mining, the discarded shells of plants, and so forth. For some commodities, the overburden is enormous. To yield one ounce of gold, a mining company can excavate a hundred or more tons of earth.

On a per-person basis, materials use has been nearly constant over these twenty-five years, as more efficient use of materials has been counterbalanced by expanded production. In 2005, the global average was about 8.8 metric tons, or just under fifty pounds of materials used per day. The U.S. consumer, however, consumed two and a half times the global average, or 23 metric tons. But even this is an understatement, because it doesn't include the flows of imported materials, which are large and have grown rapidly. Unfortunately, the data to track imports and exports by country is not yet complete, but

FIGURE 2.8 Total U.S. Consumption, 2000, in thousands of metric tons

Agricultural, grazing, fish, fiber crops	4,122,766
Forestry	657,702
Coal and oil	7,466,204
Natural gas	581,329
Iron ores	372,805
Other metal ores	1,539,492
Industrial minerals	1,767,137
Construction minerals	1,413,704
Total	17,921,137

Sources: Provided to author by Sustainable Europe Research Institute (SERI) the researchers who are putting it together were able to give me the numbers for 2000. That year, total U.S. material consumption, including imports and overburden, was 17.9 billion metric tons. That works out to 59.8 metric tons, or 132,000 pounds of oil, sand, grain, iron ore, coal, and wood for every person, to produce the United States' GNP. Divide that by 365 and it yields an eye-popping 362 pounds a day. It's not a sustainable number.

The largest category is for coal and oil, and natural gas use is also significant. It is well known that Americans are wasteful consumers of fossil fuels. The housing stock isn't properly insulated, building codes are lax, and easy conservation measures still haven't been put into place. In comparison to citizens of other comparably wealthy nations, Americans have more cars per person, drive more miles, take more airplane flights, and live in larger homes. Most important, the country hasn't moved off coal yet, despite its very high emissions. As a result, in 2006 the average American emitted 19.7 metric tons of CO_2 per year, while the Germans, Japanese, and British were at about 10 tons, the Italians were at 8.3, and the French at 6.7. Given all the discussion about the emissions of China and India, it's worth noting that their per capita rates are low, at 4.6 and 1.3 respectively. But it's also true that in the United States households are responsible for less than half of all emissions—a huge fraction is attributable to industry, whose practices households do not control.

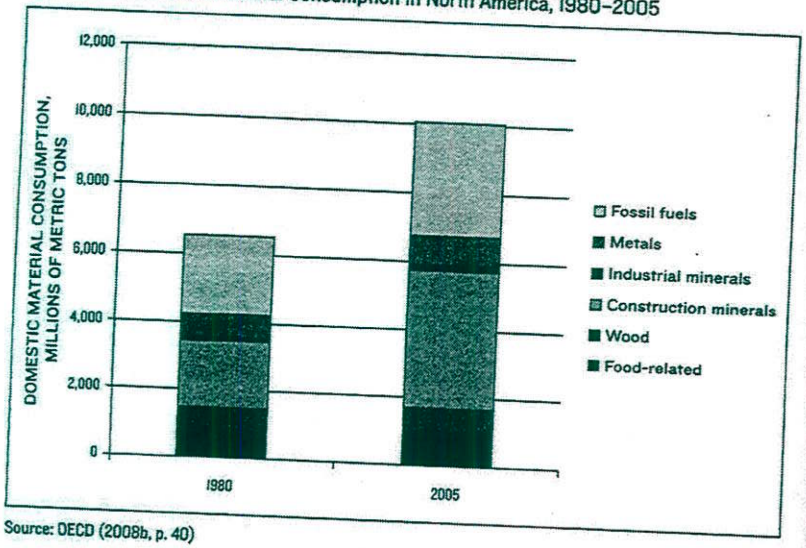
The second-largest category is agriculture. In recent years, there has been a good deal written about how food is produced and consumed in the United States, and the adverse effects of this system on consumers and the earth. Factory farming is chemical-intensive and produces large greenhouse gas emissions. The number of calories produced per person is high, and American patterns of food production are resource-intensive and polluting, especially beef production, which yields excessive carbon dioxide and methane. The average U.S. beef diet emits the equivalent in greenhouse gases of 1,800 miles of driving, and Americans eat more beef (ninety-four pounds in 2005) than people anywhere except Argentina. Research on beef versus vegetable production found that in comparison to asparagus, for example, beef is thirty-six times more greenhouse gas–intensive. And perhaps the most distressing fact of all is that an estimated 40–50 percent of U.S. food is wasted along the chain from farm to table. We're destroying the environment with industrialized food production, a good portion of which just gets driven to landfills, where it rots and releases even more methane.

Housing and construction are also materials-intensive. On the residential side, there has been a trend toward much larger homes. The average single-family dwelling built in 1980 was 1,740 square feet. Twenty years later, it had expanded 45 percent, to 2,521. Ninety-five percent of these homes have two or more bathrooms, 90 percent have air-conditioning, and 19 percent have three-car or larger garages.

The conventional wisdom says that we can continue to grow indefinitely because technological change will allow us to dematerialize. The idea is that GDP can be decoupled from materials use, pollution, and eco-impact, allowing it to rise to the heavens, while its materiality shrinks. While it's true that each dollar of GDP is now responsible for less material flow, over the last twenty-five years, the growth of GDP has canceled out this reduction almost everywhere.

Between 1980 and 2005, the United States and Canada increased their materials use by 54 percent, or about 2 percent a year, even before accounting for imports. Over this period, total materials consumption rose from 6.6 billion to 10.1 billion metric tons. Population rose by 35 percent, less than the materials increase. So not only did total materials use rise, but per-person use also went up. Material flow per dollar of GDP did decline, about 25 percent, but the total growth was more than twice that. Paper is a good example of the failure of technology to reduce material impact. Computers were supposed to yield the paperless society, but in the United States, per-person con-

FIGURE 2.9 Domestic Material Consumption in North America, 1980–2005



Source: DECD (2008b, p. 40)

sumption of paper has risen since 1980 and stood at 650 pounds a year in 2005, the highest in the world. With 4.5 percent of the world's population, America accounts for a third of paper consumption, almost all of which comes from trees.

Western Europe has done much better than North America, in part because fossil fuel use has fallen, compared with a 43 percent rise in North America. As a whole, Europe increased its materials use only 9 percent, far less than the 54 percent in the United States and Canada. The differences between the two regions' energy consumption also raises the point that not all materials are equally damaging. Fossil fuels, because of their role in climate change, are most problematic. One of the troubling trends of recent years is that wealthy countries have been off-loading a good portion of the burden of their fossil fuel consumption to poorer nations where production is taking place. Chinese factories, for example, are fired by coal, an extremely dirty fuel with an outsize impact on climate. Considering just global warming gases, in 2004 the United States is estimated to have outsourced 20 percent of its total emissions.

In the 1980s, the bulk of expert opinion settled on lower impact per dollar of GDP, or what is called relative decoupling, as the cure to ecological ills. However, the experience of the last twenty-five years suggests that the market alone will not produce results fast enough to counteract ongoing environmental damage. One reason is the materiality paradox, something neither economists nor other social scientists counted on. Improvements in efficiency and technology have been unable to outstrip the rising material volume of accelerated acquisition. And while weight-reducing innovation is occurring in some products—electronics and camping equipment are obvious cases—not everything is getting lighter. Vehicles, refrigerators, and homes got bigger and heavier. The promise of dematerialization also didn't take into account the enormous expansion of demand for materials from what has come to be known as the Global South, the countries outside the wealthy Western nations that lack the funds to purchase the latest and most resource-efficient technologies.

More generally, dematerialization has been stymied by the failure to incorporate ecological costs, especially for fossil fuels. Western Europe's relative success in containing material flows is due to smart energy policies that raised taxes and reduced consumption. North America, with its subsidies for coal, oil, and gas, has been far more voracious. We shall see in the next chapter that improvements in energy efficiency that are not offset by taxes are effectively price reductions, which spur consumption.

In thinking about solutions, it is important to recognize that consumers have been cut off from the material realities of production. Producers and retailers prefer that consumers not think about the damage their purchases are having on the earth, so information is not typically available, especially at the point of purchase. Does the factory that assembled the cell phone rely on dirty, coal-fired electricity? Are the dyes in the shirt toxic, as is typical in much of the world's apparel? Was that beautiful piece of jewelry made of gold excavated from a mine whose chemical processing is poisoning water supplies and causing cancer in local residents? It's hard and sometimes impossible to even know the answers to these questions, much less be able to stop the destructive practices. This means that fashion cycles can accelerate in products that have extreme impacts, with consumers none the wiser, as the rage for flat-screen televisions reveals. A spate of recent research revealed that some manufacturers had begun using a synthetic gas called nitrogen trifluoride (NF_3), whose climate impacts are thousands of times that of CO_2. So far the quantity of the gas released is tiny, but the example shows that the model of unregulated producers plus uninformed consumers can be disastrous.

The emphasis on dematerialization is one component of a broader approach that says technological improvements, or technology plus ecologically sound pricing, will be sufficient to repair and protect ecosystems. This remains the stubbornly dominant thinking among experts and politicians, even though the numbers don't add up for the short to medium term. Why is there so much resistance to addressing other remedies, such as how fast we grow and patterns of consumer choice? Part of the answer lies in a spirited conversation on the future of the planet that took place decades ago, after which the mainstream discourse declared infinite growth an ecologically viable path.

Are There Limits to Growth?

The 1950s and early 1960s were a heady time at the Massachusetts Institute of Technology. While eventually the institute would be embroiled in controversies over its involvement in the Vietnam War, at this point there was great enthusiasm among the researchers whose inventions lay the groundwork for the computerization and information technology that would reshape the world in the 1990s. Jay Forrester was one such engineer, a young man from Nebraska who arrived at MIT for graduate study in 1939. Forrester started his career working on systems feedback control in military equipment, including submarines. During the Second World War, he was sent to the Pacific theater to repair a radar system aboard the aircraft carrier *Lexington*, and survived a torpedo attack. Forrester returned to MIT in 1947. Under his direction, the institute's first digital computer was created, and Forrester patented the first random-access magnetic computer memory.

In the 1950s, Forrester got involved with business problems and developed a comprehensive theory of management known as systems dynamics. It was a natural outgrowth of computers because it involved taking large quantities of information and analyzing how it moved together as an integrated system. Forrester applied the technique to business organizations, cities, and schools. In 1970 his urban modeling led him to the Club of Rome, a group that had just been founded by Aurelio Peccei, an Italian businessman, to look at "the human predicament" over the long run. In contrast to prevailing enthusiasm about economic growth and future possibilities, the Club saw storm clouds on the horizon. One was population, which was already above 3.5 billion, and at that moment was growing hyperbolically; that is, its growth rate was increasing as population grew. The Stanford ecologist Paul Ehrlich had warned that population was a bomb ready to go off. Would food supplies be adequate to feed the 6 billion expected for 2000? Would there be enough oil, gas, aluminum, and other fuels and metals? Forrester offered to create a systems dynamics model for the entire world and analyze how five key factors—population, food, industrial production, nonrenewable resources (especially fossil fuels), and pollution—might develop over the next 150 years. Within weeks, a delegation from the Club came over to MIT and agreed to finance the project. Forrester turned to the young researcher Donella (Dana) Meadows, a Harvard Ph.D. in biophysics, her husband Dennis Meadows, who was on the MIT management faculty, and others. They helped develop a model that would become the basis of their book sensation, *The Limits to Growth.* When it was published in 1972, it sent shock waves around the globe.

The Limits to Growth was about whether the earth could support continued expansion in people, production, and pollution. The simple story was that all three were expanding exponentially, and at faster rates than counteracting forces, such as cleaner technologies, higher-yielding food grains, or the earth's natural absorptive capacity. If human activity was small relative to the earth, this wouldn't pose a problem, but as humans began to use more and more of the planet's resources, the question of the earth's carrying capacity would inevitably be broached. The sources of degradation (population, production, pollution) would overwhelm the sinks (absorptive and productive capacities). At a 4 percent growth rate (a common range for the global economy), output doubles every eighteen years. As we neared the end of the twentieth century, levels of industrial production dwarfed those of the past. Would this kind of growth continue to be possible?

Systems dynamics research is often structured around scenarios—by setting variables at different rates or changing the core relationships of the model, different outcomes will be generated over various time spans. *The Limits to Growth* asked what would happen over the long run if then-current trends continued, as well as how various kinds of interventions would affect the trajectory. The main finding was that with what we now call a BAU scenario (dubbed the "standard run"), pressures would begin to appear in the early twenty-first century. The most pessimistic of the scenarios foresaw a decline in income starting in 2015. Food production would become inadequate and pollution would begin to overwhelm the capacity of the planet to absorb it. Nonrenewable resources would become more expensive to extract. As the century progressed, environmental imbalances would intensify, eventually leading to collapse.

The book attracted enormous publicity, and eventually sold more than 30 million copies in thirty languages. The 1973 oil embargo and stagflation created a sense that things were going awry. Many in the scientific community signed on to the view that the earth has limited carrying capacity and that humanity needs to be careful not to overrun its resources.

The publication also engendered a vigorous counterattack. Economists led the charge, which is not surprising, given the orientation of the field to a self-correcting market and optimism about technological change. The model didn't incorporate price signals and in its BAU version didn't incorporate pollution reduction. The Oxford economist Wilfred Beckerman lambasted it as "brazen . . . impudent nonsense." The economists' case was most prominently taken up by William (Bill) Nordhaus of Yale, who argued that the *Limits* model failed to incorporate enough technological change, especially of the resource-saving variety. If we are facing limits, he argued, there will be profitable opportunities for avoiding them through innovation. For example, the phenomenal growth in agricultural productivity over the previous century was seen as an indication of future ability to feed even the rapidly growing population of the late twentieth century. Another argument was that known reserves of nonrenewable resources were not good predictors of future supplies, because if scarcities did develop it would pay to devote more effort to exploration and drilling, and reserves would expand. Alternatives for scarce fuels or minerals would be invented. Economists were sanguine about the possibility of surpassing physical realities with human ingenuity.

Another key question was whether unabated exponential growth in population was a reasonable assumption. Europe and North America had already experienced their demographic transitions, with declining birth rates. China and India would not be far behind.

Population fears had surfaced at the moment of maximal growth, without enough credit given to counteracting forces. This is a point that was relevant to the model more generally. The no-adaptation, or standard run, scenario that yielded the worst outcome was unlikely, because its negative effects would call forth responses, a point the systems dynamics researchers understood well.

The debate didn't progress in the way one might have hoped. The two sides published in different journals, and there wasn't much direct conversation. The tone got nasty. It also assumed an unfortunate political hue, with conservatives more likely to dismiss the concerns, and supporters on the other side of the spectrum.

The conventional wisdom was that the economists won the day. One reason is that the shortages the model focused on were food and nonrenewables, such as stocks of oil and bauxite and other minerals. This was partly because of concern about peak oil and a long history of energy modeling. When energy, food, and other commodity prices declined in the 1980s, it was seen as prima facie evidence against the scarcity view and closed the case for some. On this point, there was a well-publicized bet between Ehrlich and an economist named Julian Simon about what would happen to the prices of key minerals, which Ehrlich lost decisively. The economists also correctly foresaw future increases in agricultural productivity, although they missed rising numbers of hungry and malnourished people and the destructive effects of the chemical- and water-intensive farming on which higher yields have been based. They were right that reserves of most materials are limited more by cost than by pure availability, and they made a number of valid criticisms about the structure of the model.

But did the economists win the battle over the model and lose the war about whether we are actually facing limits? It's looking more and more that way.

Evidence on global warming surfaced just as the *Limits* debate was occurring, and the Meadowses and their team wisely warned about this new threat. By contrast, Beckerman dismissed it as a scare story. Nordhaus estimated that warming might be economically beneficial, yielding up to a 5 percent improvement in world output, partly on account of subsequently discredited assumptions about more favorable agricultural conditions in cold countries. We know now that the conventional economic intuition was not only wrong, but spectacularly so.

Soon enough an outpouring of scientific data was reframing the discussion away from the fixed resources highlighted in *Limits* to the renewable systems on which life depends—atmosphere, forests, oceans, wetlands, and soils. By the mid-1980s, ecosystem indicators such as biodiversity were showing sharp declines. Ironically, the new sources of oil and gas that economists correctly anticipated arising were not a solution, as heralded, but contributors to destructive planetary warming. In 1993 a majority of the world's scientific Nobel laureates signed a warning that "human beings and the natural world are on a collision course . . . and that current practices put at serious risk the future that we wish for human society and the plant and animal kingdoms, and may so alter the living world that it will be unable to sustain life in the manner that we know." As the twenty-first century dawned, growth had already triggered dangerous climate change. If current trends continue, middle-range scenarios predict that half the world's population will be facing serious food shortage by century's end, and some analysts find that prediction overly optimistic. Early warnings about BAU growth now look ominously prescient.

Having failed to adapt when the alarm bells were first rung in the 1970s, we are already bumping up against the carrying capacity of the earth. An international collaboration among ecological economists and scientists that attempted to define safe operating zones, or what they term "planetary boundaries," reported in 2009 that of the nine they identified, we'd already exceeded three (climate, biodiversity, the nitrogen cycle), and were approaching limits on four more (freshwater use, land use, ocean acidification, and the phosphorus cycle).

Planetary Ecocide

The debate over limits raised questions of underlying philosophy about how natural and social systems operate. Conventional economic models are more likely to use linear relations, incorporate self-correcting mechanisms that work through market behaviors, and build in a tendency for the system to equilibrate to a fixed point. When scarcities develop, prices rise. The higher price reduces demand and encourages supply, which in turn eases the price pressure.

By contrast, the systems dynamics, climate, and newer combined climate-and-economic models understand that the world is often chaotic and nonlinear, with thresholds, tipping points, and other features that are far less reassuring than the simple market equilibrium story. One factor that leads to instability is feedback loops. These are relationships that intensify effects, either positively (enhancing an effect) or negatively (reducing it). Feedback loops are like superchargers that accelerate a trend in motion. Perhaps the best-known feedbacks are from the climate system. Rising CO_2 concentrations in the atmosphere warm the surface of the earth, causing the melting of permafrost, which in turn releases methane, a powerful greenhouse gas, which causes more warming. Once a system starts to go awry, feedback loops can be especially problematic, because they intensify the bad dynamics that are occurring. But there are also good feedbacks, such as an innovation in clean energy that induces other pollution-reducing technical change.

The biggest news of the last few years is the pace of climate destabilization. Rather than the safer, more predictable straight-line processes that were prominent in earlier thinking and research, scientists are now working through the far more worrisome mechanics of feedback loops. The official word from two thousand scientists who gathered in Copenhagen in March 2009 was that "the climate system is already moving beyond the patterns of natural variability within which our society and economy have developed and thrived. These parameters include global mean surface temperature, sea-level rise, ocean and ice sheet dynamics, ocean acidification, and extreme climatic events. There is a significant risk that many of the trends will accelerate, leading to an increasing risk of abrupt or irreversible climatic shifts." Translation: feedback loops have started, opening the door to the possibility of nonlinear, catastrophic climate change.

The growth of emissions has been rising, with the current annual level of CO_2e, or carbon dioxide equivalent, gases at more than fifty gigatons, or about 7.5 metric tons per capita. In ordinary times, the planet can absorb just under half the carbon that is emitted. But the presence of feedback effects may be reducing this capacity, and what were sinks become sources. Oceans are less absorptive now. On land, heat waves have already begun to reduce photosynthesis. Forest fires are releasing CO_2 and permafrost has begun to thaw. A longer growing season could operate in the opposite direction, but there is increasing fear that the bad feedback mechanisms will predominate. Polar ice caps are shrinking and the Greenland ice sheet is melting twice as fast as anticipated. Sea levels are rising, with some predictions of at least two meters by century's end. Higher sea levels will wipe out small island nations, turn coastal dwellers into migrants, and contaminate the water supplies of many of the world's largest cities.

Many scientists are worried that these apocalyptic scenarios may occur if we don't act promptly, although the power of feedback loops is still being debated. There is growing recognition that the goal the global conversation had been looking toward—a two-degree Celsius (3.6-degree Fahrenheit) rise—will yield disaster, because the planet is warming faster and the feedback loops are happening far more quickly than anticipated.

Forecasts of a BAU growth path predict dramatic increases in CO_2 concentrations. The Stern Review, an influential 2006 report by Nicholas Stern of the U.K. Treasury, suggested that BAU could yield 550 parts per million by 2035 and more than 650 ppm by 2100. Others are predicting as much as 1,000 ppm by 2100, but that pessimistic scenario assumes no policy response, which now seems unlikely. How much warming does the current path create? The latest major business-as-usual scenario, from MIT, predicts a catastrophic rise of five degrees Celsius by century's end. Disaster scenarios are being spun in which few species survive and large swaths of the planet are uninhabitable. Alternatively, nature may take revenge earlier, with climate destabilization causing famines, droughts, and storms that disrupt economic activity and make ordinary growth impossible. At a minimum, a one-degree Celsius warming in the system is inevitable, with more likely. We need to abandon BAU as soon as possible and begin to pull carbon out of the atmosphere. There is a growing international movement to make 350 ppm the target, but to achieve it, we need to start now.

The difficulty is that, as with material flows, the emissions trajectory has been relentlessly upward. Most ominously, between 2000 and 2007 anthropogenic emissions rose four times faster than in the 1990s, more than even the most extreme scenario considered by the IPCC in 2000. The rate of increase in atmospheric CO_2 was 2.2 percent in 2007, far higher than the 1.5 percent of the 1990s, and above even the 2.0 percent prevailing since 2000. In the United States, the latest data shows the necessary turnaround hasn't yet occurred. Although emissions per dollar of GDP have fallen by 30 percent since 1990, and per capita emissions have stabilized, total emissions are expanding, albeit slowly. Early reports are that the economic crash has reduced global emissions, but the numbers are not yet available. It's essential that recovery not restart the fossil fuel juggernaut.

Scientists are gathering evidence about how climate disruption is affecting ecosystems, species, and planetary balance around the world. Changes are greatest at the poles, but they are happening all over. NASA's James Hansen reports that arid subtropical climate zones are expanding poleward and that an average expansion of 250 miles has already occurred. Enterprising biologists at Harvard and Boston University compared present-day New England flora and fauna with what Henry David Thoreau and others documented, and found that more than 60 percent of the species that were around in the 1850s are either gone or will be soon, including some of the most "charismatic," such as orchids and lilies. Mountain glaciers, on which hundreds of millions depend for water, are disappearing. Coral reefs are dying. Drought is intensifying, not only in sub-Saharan Africa, but in Australia, the southeastern United States, and other areas. The southwestern United States is at risk of becoming a permanent dust bowl, as are other parts of the planet. Climate change is already putting ecosystems at risk, and as they decline, they exacerbate climate instability. But planetary distress is also evident outside the realm of climate.

We are in the midst of what biologists refer to as the sixth mass extinction. The last one happened 65 million years ago, with the loss of the dinosaurs. Among birds and mammals, extinction is occurring at a hundred to a thousand times natural rates. A major study by the International Union for the Conservation of Nature found that 38 percent of the 45,000 species they studied are currently threatened with extinction. A quarter of all wild mammals are at risk of disappearing. A U.S. report on birdlife released in 2009 found that a third of all bird species were already endangered, threatened, or in serious decline. In addition to climate change, the main drivers of species

57

decline are habitat loss, overexploitation (as in fishing), pollution, and invasive alien species. The Living Planet Index of the World Wildlife Fund, which follows 1,686 vertebrate species, has declined by 30 percent since 1970. Terrestrial species have declined by 33 percent, freshwater species by 35 percent, and marine species by 14 percent. These are unprecedented developments in human history and represent losses of incalculable value. Anthropocentric valuations stress the role of species in ecosystem functioning, the loss of potential drugs and technological advances, and the benefits humans get from being able to see and interact with plants and animals. Worldviews that do not measure nature solely in terms of its value to humans recognize the collapse of biodiversity as a profound loss on its own terms. Zebras, hippos, polar bears, elephants, lynxes, and many other wondrous creatures are in jeopardy.

A comprehensive assessment of the state of the world's ecosystems was carried out by the United Nations in 2005. It found that 60 percent, or fifteen of the twenty-four major ecosystem services it studied, are being degraded or used unsustainably. It concluded that over the last fifty years humans have changed ecosystems more "rapidly and extensively" than in any comparable period in human history. Most ominously, the study found "established, although incomplete evidence" that this degradation was increasing the likelihood of nonlinear changes and collapses in the ecosystems (analogous to the abrupt climatic responses discussed above). Air quality, erosion regulation, water quality, wood fuel, natural buffers for weather hazards, and pest regulation all declined.

The oceans are a particular source of concern. The combination of overfishing, destructive trawling methods, toxins, and acidification caused in part by climate change are resulting in a collapse of ocean ecosystems. Stocks of large open-ocean fish have plummeted, with estimates of decline ranging from 65 to 90 percent. Coral reefs may be completely gone within a few decades. Surface warming has already begun to inhibit vertical mixing of ocean waters. Together with chemical runoff, this creates a condition of oxygen depletion called hypoxia that kills off multicellular life. In 2008 scientists found 405 oceanic dead zones, in comparison with 49 in the 1960s. Ecologists and oceanographers are watching in horror as once diverse and spectacular ocean habitats turn into the equivalent of algal deserts, great reservoirs of slime.

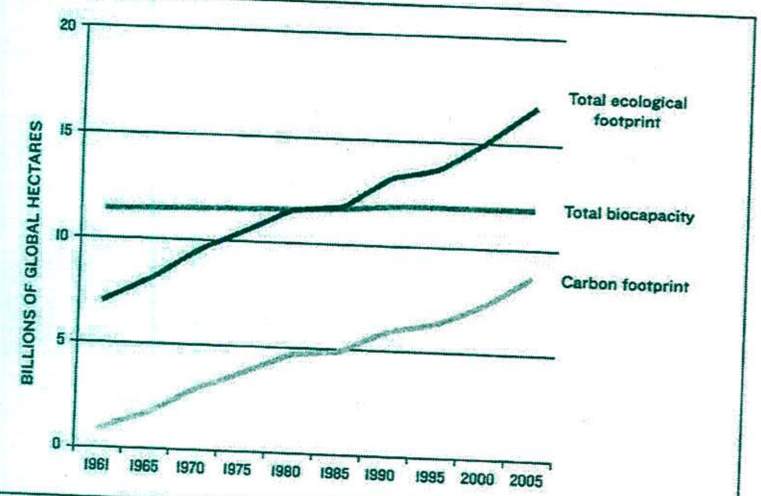
The Human Footprint

While learning about ecocide can be demoralizing or overwhelming, simplified measures are proving useful for mobilizing a public response. That's the theory behind the ecological footprint, an evocative metric developed in the 1980s by University of British Columbia ecologist William Rees and his then–graduate student Mathis Wackernagel. The footprint measures the amount of land and shallow sea area used to produce the food, fuel, plastics, metals, wood, fibers, and other resources consumed by a household, business, city, area, or nation. For the household, it takes into account how far food travels to reach its table. It looks at the number of trips taken in cars and trains, the size of the house, how warm it is kept in winter, and how much air-conditioning is used in the summer. It includes a measure of how much ecosystem capacity is needed to absorb the carbon the household burns. It is expressed as a land area, which highlights the fact that what people consume ultimately depends on cropland, forests, and fisheries. Eco-footprint analysis is the basis of the widely reported statistic that if everyone on the globe lived as Americans do, we'd need five planets to support the human population.

The five-planets calculation is of course an overly simplified one, and the footprint is a highly aggregated concept that leaves out many things, such as toxic substances. It's not a measure of impacts, on either ecosystems or human health, although it does have strong connections to them, especially through its treatment of carbon. It's undergoing a continual process of refinement and improvement, and is being adopted by governments, companies, and communities around the world.

Footprint research also analyzes the existing biological capacity of the earth in comparison with what humans are using. Biocapacity is not a fixed number because land is brought in and out of cultivation; new technologies improve the productivity of land, enabling more production on less acreage; degradation turns arable land into desert; and fisheries rise and fall. Between 1961 and 1995, measured global biocapacity increased slightly, but it has fallen since then as ecosystems have degraded. When the human footprint is below the world's biocapacity, we're in a viable situation. When it exceeds it, we've begun to eat into natural capital and are undermining the reproduction of future generations.

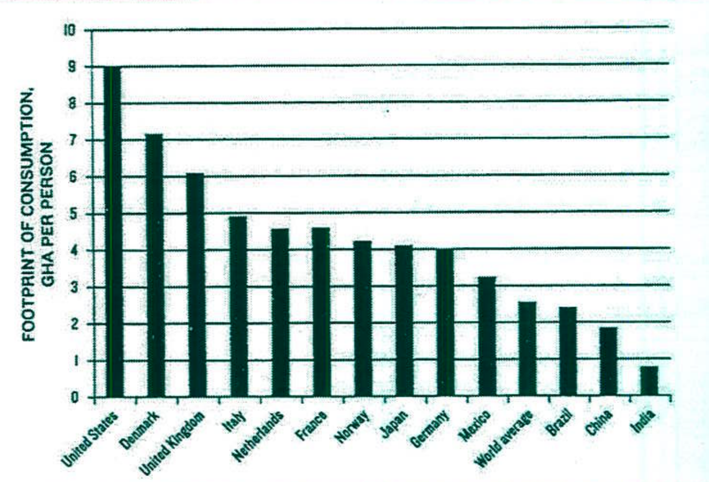
FIGURE 2.10 Ecological Footprint, Carbon Footprint, and Biocapacity



Source: Global Footprint Network (2009)

By these calculations, the world first reached its limits in 1986. Since then resource use has increasingly outstripped biocapacity. According to the latest data available (2006), there are about 1.8 available hectares (or 4.5 acres) for every person globally, but we're using 2.6, for a per capita deficit of 0.8. We've entered the zone of what the Meadowses and others called overshoot, and are living beyond our planetary means. By this measure, we are operating 40 percent above biocapacity.

FIGURE 2.11 Ecological Footprint per Capita, Selected Nations, 2006



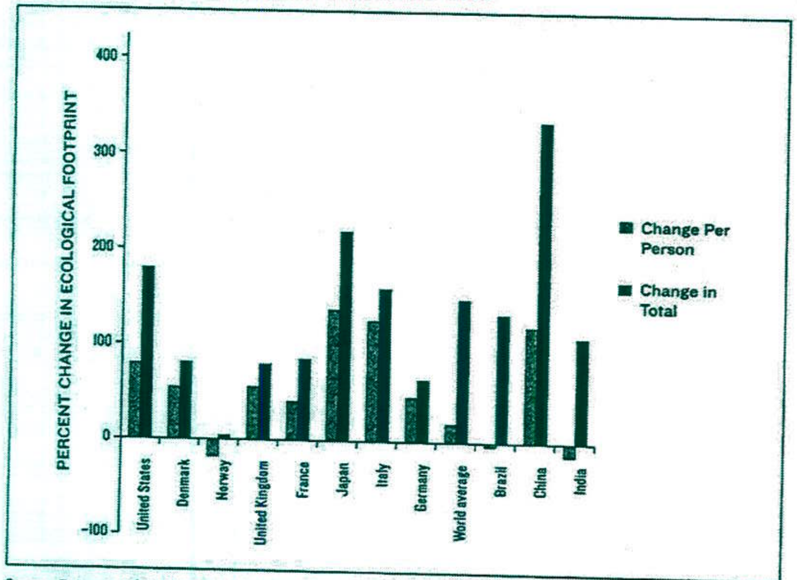
Sources: Global Footprint Network (2009) and Ewing et al (2008), "Table I: Per-Person Ecological Footprint of Production, Imports, Exports, and Consumption, by Country," Appendix F, pp. 41–45

Global calculations are useful for some things, such as measuring planetary trends. National numbers allow us to see which countries are consuming beyond their means, or beyond fair global allotments. The United States once had the world's largest per capita footprint, but the United Arab Emirates currently exceeds it by a hectare. Americans each consume 9.0 hectares, or five times the global biocapacity of 1.8 hectares. The biggest component of the U.S. footprint is carbon emissions, which account for about 70 percent of the total

(6.4 hectares). The large, wealthy countries of Europe (Germany, France, Italy, Spain) and Japan have per capita footprints that are about half that of the United States (although colder Denmark is higher, at 7.2), and the United Kingdom is at 6.1. Perhaps the most important lesson North Americans can take from the footprinting exercise is that it is possible to have materially rich lives with far less impact on the earth. It's also useful to recognize that in the Global South, including China and India, per capita impact remains low. The Chinese footprint is 1.8 hectares; India's is only 0.8. Brazilians and Mexicans are a bit higher, at 2.4 and 3.2 respectively.

Despite the nation's enormous wealth, the tread mark of the United States is getting heavier rather than lighter. Between 1961 and 2005, the U.S. footprint has risen 181 percent, even more than the world average of 150 percent. On a per-person basis, the rise is 78

FIGURE 2.12 Changes in Ecological Footprint, 1961–2005



Source: Ewing et al (2008), "Table 7: Percent Change in Population, Ecological Footprint, and Biocapacity, 1961 to 2005", Appendix F, pp. 67–71

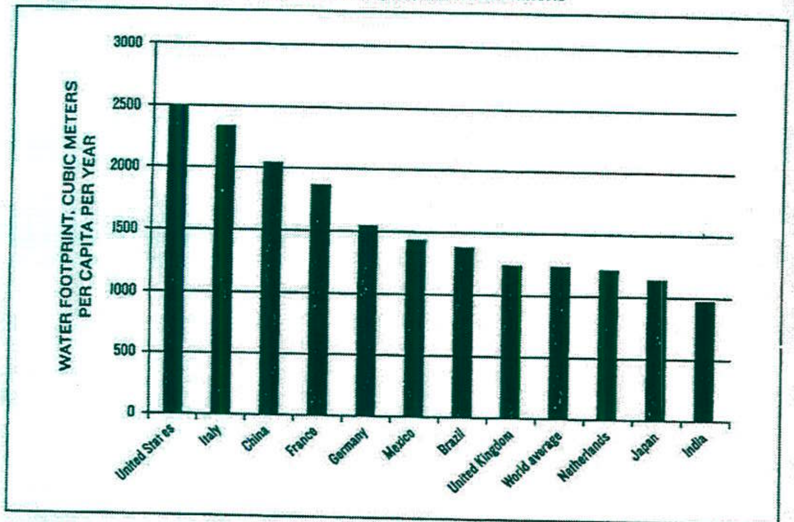
percent. Unfortunately, the United States is not unique, although it is extreme. As a group, the rich countries have expanded their footprints considerably more than the middle- and low-income ones, and not just on a per capita basis (where the gap is largest), but even in terms of total impact. In contrast, the average Indian has a lower footprint now than in 1961, despite a dramatic increase in income. So does the average Brazilian. China's growth is substantial in both per capita and aggregate terms (122 and 336 percent respectively), but has started from a very low base.

This data also shows that even very wealthy countries can remain rich and reduce their footprints. The average Norwegian has a 19 percent lower footprint today than he or she did almost half a century ago, even with a per capita income that is about eight thousand dollars higher than the U.S. level. The Finns and Swedes barely raised their footprints over this period. Their incomes are not quite at U.S. levels (they're about nine thousand dollars lower), yet these rank among the richest societies in the world.

The footprint concept has also been used to look at water use (although the word *footprint* is something of a misnomer in this case). Many predict that water will be to the twenty-first century what oil was to the twentieth: an increasingly contested resource. While measuring what is termed water stress is complex, a common estimate is that about a third of the world's population now lives in areas with moderate to heavy stress on water supplies. Water-intensive farming and warming-induced drought and desertification will intensify these pressures. Privatization, which has proceeded far in some countries, threatens equitable solutions. Analyses from the IPCC's Fourth Assessment Report suggest that by 2050 the number of people living in water-stressed areas may increase dramatically, with worst-case estimates reaching 6.9 billion.

The water footprint shows how much water a nation relies on,

FIGURE 2.13 Annual Water Footprint Per Capita, Selected Nations



Source: Hoekstra Chapaggin (2007), "Table 3: Composition of the Water-Footprint for Some Selected Countries. Period: 1997–2001," p. 42

including both domestic uses and use of imported products. As with other ecological resources, the United States has outsize habits. Its water footprint is the world's highest, at 2,483 cubic meters per capita. That's twice the global average of 1,243, and twice the level of comparably rich countries. The U.S. figure is so large because of the nation's water-intensive agriculture, meat-heavy diet, suburban lawns, and high consumption of consumer electronics, apparel, and other commodities. It requires 2,000 liters of water to produce one T-shirt, 2,400 for a hamburger, and 8,000 for a pair of leather shoes.

The ecological and water footprints together cover land, atmosphere, shallow sea, and fresh water. What they make clear is that BAU growth in global resource use is not viable. For the United States, they reveal a level of consumption that is ethically indefensible and strategically unwise. But perhaps most important, these metrics also indicate that such profligacy is unnecessary. Comparisons with comparable countries show the United States could halve its ecological and water footprints and retain, by almost any accounting, lifestyles of affluence and abundance. Even more telling is the fact that others are managing to reduce impact without putting on a hair shirt. And, if Americans were willing to make even more far-reaching changes, their footprints could be reduced considerably below half what they are today, even to globally fair, indeed imperative, levels, without undue sacrifice.

Taking Stock

We are living in extraordinary times. The consumer boom of the 1990s and 2000s was a historical anomaly. Goods moved at hyperspeed through the retail and household economies. Material flows, predicted to decline, accelerated. Never have so many bought so much for so little. But like all binges, the consumer extravaganza had to end. Now we've got twin crises—financial and ecological—and today's best thinking understands we'll have to solve them together.

Economists, however, have worked to protect business-as-usual. Bullish on markets, this thinking also extends to their views about the environment. The standard logic says that incorporating full ecological costs will avert planetary disaster. The experience of the last few years should give us pause about this sanguine conclusion. From the financial, commodities, housing, and other volatile markets, there has been enough evidence of herd behavior, irrationality, corruption, and short-termism to question the view that markets will necessarily yield predictable and sustainable outcomes. Entrusting the fate of the planet purely to the rationality of markets is a dangerous leap of faith. To see how and why economists came to their position, let's take a closer look at how they think and at the practice of environmental economics.

65