# Are We Consuming Too Much—for What?

HERMAN E. DALY,* BRIAN CZECH,† DAVID L. TRAUGER,‡ WILLIAM E. REES,§ MANSI GROVER,‡ TRACY DOBSON,†† AND STEPHEN C. TROMBULAK‡‡

*School of Public Affairs, Van Munching Hall, University of Maryland, College Park, MD 20742-1821, U.S.A., email hdaly@umd.edu
†Department of Wildlife and Fisheries Sciences, Virginia Polytechnic Institute and State University, National Capital Region, Alexandria Center, 1021 Prince Street, Alexandria, VA 22314, U.S.A.
‡Natural Resources Program, Virginia Polytechnic Institute and State University, National Capital Region, Alexandria Center, 1021 Prince Street, Room 312, Alexandria, VA 22314, U.S.A.
§University of British Columbia, School of Community and Regional Planning, Vancouver, BC V6T 1Z2, Canada
††Department of Fisheries and Wildlife, Michigan State University, 10C Natural Resources Building, East Lansing, MI 48824-1222, U.S.A.
‡‡Biology and Environmental Studies, Department of Biology, Middlebury College, Middlebury, VT 05753, U.S.A.

## Introduction

In a provocative paper published in the *Journal of Economic Perspectives*, 11 coauthors, all distinguished economists and ecologists (Arrow et al. 2004), asked in their title, "Are We Consuming Too Much?" The paper's relevance to conservation biology was soon highlighted in a summary in *Conservation in Practice* (Christensen 2005), which in turn engendered a response by several readers (*Conservation in Practice*, vol. 6, no. 3). No doubt the original article would have elicited comments too, but it is the policy of the *Journal of Economic Perspectives* not to publish comments. No matter, when 11 leading scholars jointly pronounce on such an important question it acquires the air of a manifesto and demands that the larger scientific community take a close look at their argument—they deserve no less.

## The Question: Scale versus Allocation

We do so here, by focusing the question a bit. We begin by asking, Are we consuming too much for the rest of the planet? In other words, is the scale of the human economy so large relative to the containing biosphere that it displaces biospheric functions that are at the margin more important than the extra production and consumption? One index of the extent to which this might be the case is a decline in biodiversity. We do not argue that there must never be a reduction in biodiversity—only that marginal costs of increasing the human scale of population and per capita resource consumption are rising, whereas the marginal benefits of extra production and population are falling. If the costs are not already growing faster than the benefits of scale increase, we believe that they soon will be.

Neoclassical economics does not recognize any problem of optimal scale of the macroeconomy relative to the biosphere and neither do Arrow et al. To ask if we are consuming too much within their analytical framework means only "is consumption too large relative to investment"—is the total product, whatever it may be, allocated properly among alternative uses—especially between consumption and investment? A more relevant question goes begging; namely, "Is the physical scale of total production too large relative to the biosphere, even if it is efficiently allocated between the final uses of consumption and investment?" The question could then be restated as "Are we consuming and investing too much, that is, are we producing too much?" Or, because in a physical sense we neither produce nor consume, but only transform, the question becomes, "Are we transforming too much of the natural world into ourselves, our furniture, and ultimately our wastes?" Whether the scale of the human economy is optimal, or even sustainable, is one question. Whether the allocation of the amount of transformed stuff between current consumption and investment is optimal, is a second, entirely different, question.

A third question is "Who is *we*?" How much of the transformed stuff goes to each class or each part of the world, and is the per capita amount going to the wealthy

*Paper submitted June 21, 2006; revised manuscript accepted January 25, 2007.*



Conservation Biology Volume 21, No. 5, 1359–1362

DOI: 10.1111/j.1523-1739.2007.00770.x

excessive in the sense that it could not possibly be generalized to all without provoking ecological breakdown? Although we believe the consumption levels of the wealthy are excessive in this sense, as demonstrated by the ecological footprint analysis (Wackernagel & Rees 1996), this is not the meaning of "too much" that Arrow et al. are concerned with. In their neoclassical focus on allocation, Arrow et al. leave out distributive and scale criteria. Here we focus on their omission of scale.

Deciding the allocation between investment and consumption does determine the rate of growth, so one might think that takes care of scale. But it does not. Consumption can still be too big even if investment and growth are zero. In the neoclassical world the economy can never be too big, even though it might sometimes grow too fast. Arrow et al., along with other neoclassical economists, focus on the allocation question and neglect the macroscale question. We suggest that reversing the emphasis and focusing on the question of the optimal scale of the economy relative to the biosphere is more productive, given that the allocation question has been analyzed exhaustively, and everyone agrees that efficient allocation is desirable.

Although recognizing the importance of the allocation question, we take a page from the neoclassical economist's book, and for present purposes adopt a laissez-faire attitude regarding it. How the capacity of the human economy is allocated among different goods and services we leave to the market; how the life-support capacity of the rest of the biosphere is allocated among different species we leave to evolution. But the scale of the economy relative to the biosphere, currently left to the market, should, we believe, be a matter of public policy. Declining biodiversity is an important evidence for judging whether the human scale is excessive, even though we would not argue that a reduction in biodiversity is never justifiable.

## Subjective Experience of Yet-to-Exist People, Aggregated over Persons and Discounted over Time—a Reasonable Criterion?

In their first sentence Arrow et al. (p. 147) revise the question "Are we consuming too much?" to the more explicitly anthropocentric "Is humanity's use of Earth's resources endangering the economic possibilities open to our descendents?" This formulation at first seems general enough to embrace the scale question. Nevertheless, Arrow et al. (p. 148) proceed to narrow their focus to what happens to "intertemporal social welfare." Specifically, is the discounted value of utility, from the present to infinity, and aggregated over persons, maximized, or is it at least sustainable in the sense that it does not decline over generations?

The authors do not develop an ecologically sound production function. Instead, they base their analysis on a utility function, stating that utility in the aggregate is a function of consumption at any given time. We concur that economics is about utility, or the satisfaction of human wants. Nevertheless, utility is not determined only by consumption of goods and services. Many factors other than consumption contribute to utility, including community, companionship, and even healthy ecosystems. Nor is there recognition in this utility function of any complementarity between the enjoyment of produced goods and natural goods; for example, what happens to the utility of scuba diving gear without coral reefs or of hiking boots without trails and wilderness in which to hike? More basically, utility is an experience, not a material thing. It does not have a natural growth rate like trees in a forest, deer in a population, or even money in the bank, which would justify discounting future quantities back to equivalent present quantities. Discounting is operationally the inverse of the exponential growth function. In the absence of growth, it is an empty paper-and-pencil calculation. Nor can utility, a psychic phenomenon, directly impinge on the environment or even be bequeathed from one generation to the next.

## The Biophysical World

Natural resources, on the other hand, are things, not experiences. Some of them do have natural growth rates, they all can be bequeathed, and their use depletes environmental sources and pollutes environmental sinks. Defining excessive consumption in terms of resource throughput relative to environmental capacities and defining intergenerational equity in terms of bequeathing an intact resource-generating base of natural capital are more operational than hermetic formulas for calculating discounted aggregate utility, as if it were measurable and grew like money in the bank.

The biological and physical aspects of the world we live in are constraints on the satisfaction of human wants. Although the authors know this, they, in the tradition of neoclassical economics, leave these biophysical constraints far in the background as economic "externalities" to be reckoned with by "shadow pricing." Of course, no theory is perfectly complete, and there will always be externalities. When so many vital realities, including the capacity of the Earth to support life, must be classified as "externalities" in order to apply neoclassical theory, then we think it is time to restructure the theory in a way that includes the vital issues. As with the ancient Ptolemaic cosmologists, these 11 authors are positing too many epicycles to save too many phenomena that are too anomalous. We wonder why the ecologists among them did not provide more insight into the biophysical constraints on intertemporal social welfare.

## Misplaced Concreteness

Precisely how did they decide whether consumption was excessive or deficient? They used two criteria: the "maximum present value criterion" and the "sustainability criterion" (Arrow et al. 2004:149–150). The maximum present value criterion is the standard in neoclassical economics and is met if the stream of future values, discounted and summed to the equivalent present value, is maximized. Their sustainability criterion is slightly more progressive in ecological terms and is met if the level of consumption results in a stream of utility that is not declining. Nevertheless, to them excessive consumption does not mean reduction in biodiversity or overuse of resources resulting in observable consequences such as the loss of ecological services or increased pollution or even the widespread purchasing of meretricious junk. They mean only that current consumption is too large *relative to investment* if one wants to allocate resources so as to maximize or at least maintain, the unobservable, subjective utility of mostly yet-to-exist individuals theoretically aggregated into society from now to infinity.

Intergenerational equity is one of the cornerstones of sustainability, and discounting the future, although it may be a natural human tendency and has some operational basis when there are natural growth rates, is a dubious practice for facilitating intergenerational equity. Furthermore, it is doubtful that people should or do relate present to future (especially the distant future) by an exponential function. Why not a logistic function characteristic of real growing populations? How, in any case, can we ascertain the value of biodiversity to future generations, especially when we are only beginning to recognize the ecological services provided by biodiversity? We cannot know with precision, but Edward O. Wilson (1984:121) thinks biodiversity loss will be "the folly our descendants are least likely to forgive us." Maybe "minimizing regrets" is a better criterion than "maximizing utility"—as some economists in the past have suggested. As long as we abstract from the problem of optimal scale of the economy relative to the biosphere and continue to treat economic growth as the *summum bonum*, then continuing biodiversity loss is inevitable.

According to Arrow et al., the solution to current overconsumption is to increase investment. Yet investment increases present resource throughput (just like consumption) in all cases except that of fallowing-type investment in natural capital. Present resource throughput is unlikely to be changed by substituting investment for consumption, and future throughput is likely to increase given its complementarity with the capital fund that is being increased by investment. The authors give us no clue as to what the "intertemporal social welfare" criterion implies for the larger question of optimal scale relative to the biosphere. Their assessment takes place in the ethereal world of discounted psychic experience of yet-to-exist people, not in the concrete world of matter and energy throughput, entropy, biodiversity, and regenerative capacities of ecosystems. Such abstraction from physical dimensions is a standing invitation to ignore the second law of thermodynamics. It also qualifies their assessment as a shining example of Alfred North Whitehead's (1925:51) "fallacy of misplaced concreteness," which economist Nicholas Georgescu-Roegen (1971:320) aptly calls "the cardinal sin of economics."

## Implicit Production Function

Fortunately, based on the concrete realities of conservation biology, we have more than a clue about the relationship of production and consumption to biodiversity conservation. The causes of species endangerment in the United States, for example, are like a who's who of the American economy, in both the investment and consumption behavior of that economy. That is why a different group of ecologists and economists recently proposed using gross domestic product (GDP) as a negative indicator for biodiversity conservation, noting the powerful and causally linked correlation of GDP with the number of federally listed threatened and endangered species (Czech et al. 2005).

As mentioned earlier, the Arrow et al. paper is based on a utility function, with no explicit production function. Goods and services are assumed to come from some implicit production process and enter into the consumption function as $c$. Does this implicit production function also yield a flow of physical wastes as well as useful output? Maybe whether we are consuming too much has something to do with how much waste we generate in transforming resources into products and then products into utility? If so it is inconvenient (from the viewpoint of allocation and scale) to leave waste out of the analytic framework.

Does the implicit production function require flow inputs of energy and materials as well as funds of labor and capital? Usually neoclassical production functions neglect resource flows altogether, including only the fund factors of labor and capital. But assume, as likely, that the authors had in mind a production function that includes natural resource flows. Are the funds and flows substitutes or complements? It would seem that the authors assume a very high degree of substitutability between resource flows and capital funds. But if one considers a realistic analytic description of production, as given in Georgescu-Roegen's (1971) fund-flow model, one sees that factors are of two kinds: resource flows that are physically transformed into flows of product and waste and capital and labor funds, the agents or instruments of transformation that are not themselves physically embodied in the product. There are varying degrees of substitution between

different resource flows and between the funds of labor and capital. But the basic relation between resource flow on the one hand and capital (or labor) fund on the other is complementarity. Efficient cause (capital) does not substitute for material cause (resources).

The World Bank's concept of "genuine investment" (Arrow et al.:159) counts all forms of capital (natural and manmade) as perfectly fungible dollar-for-dollar substitutes. In other words, it does not matter if one catches all the fish, cuts down all the forests, or unsequesters all the carbon because as long as one invests an "equal amount" in education, one's capacity to generate discounted aggregate future utility remains intact. For the World Bank this justifies their continuing policy of growth, to the relative neglect of environmental protection. Nevertheless, let us remember the obvious: production is the transformation of resources (material cause) into product by the agents of transformation, labor, and capital (efficient cause). Material cause and efficient cause are related as complements, not substitutes; the one in short supply is limiting. Complementarity greatly increases the force of scarcity, whereas substitutability greatly reduces it. Whether we are consuming too much is highly sensitive to the relative importance of these two relationships.

## Modern Agriculture, Capital Funds, and Resource Flows

The absence of the fund-flow distinction and of complementarity from the analysis leads Arrow et al. to offer agriculture as a case of successful substitution of capital for natural resources. "It is correct that we do consider knowledge and capital as substitutable for natural resources; they are, as witnessed by the extraordinary growth in agricultural productivity which made hash of Malthus's predictions." (K. Arrow, personal communication). We, on the contrary, consider modern agriculture a case of substituting one resource base (nonrenewable fossil fuels and fertilizers) for another (renewable sunlight and soil)—not a case of substituting "capital funds" for resource flows. Although we understand the impasse that led to the industrialization of agriculture, we do not offer it as evidence of sustainability, and we do not have confidence in the "empirical" finding (a direct consequence of their substitutability assumption) of Arrow et al. that China is the world's most sustainable economy.

Arrow et al. at least proffer the caveat that their analysis failed to deduct the depreciation of knowledge due to death and obsolescence. Nevertheless, they fail to note that a significant part of expenditure on education is consumption, not investment. Nor do they acknowledge that human knowledge accrues as a function of reallocating natural capital to education and research facilities that displace nonhuman species and the ecological services they provide (Czech 2001). They also fail to note that new knowledge is sometimes restrictive, rather than permissive, of further consumption (e.g., climate change, ozone depletion). In addition, because existing knowledge is a nonrival good with a price that is artificially determined by temporary patent monopolies, it follows that the valuation of knowledge as capital is arbitrary.

## Concluding Thoughts

At its core the article by Arrow et al. is abstract neoclassical economics, albeit with some value added by the collaborating ecologists. It suffers from the same limitations that render neoclassical economics ill equipped to address the question "Are we consuming too much?" in a way that really matters to conservation. Very much understated in our view is the "fundamental conflict between economic growth and wildlife conservation" (Trauger et al. 2003:1). That helps explain why, with the global economy at its all-time largest and still growing, we are faced with the "sixth extinction." It seems increasingly clear that we are indeed consuming beyond the optimal scale of the macroeconomy and that declining biodiversity is a salient indicator of this error. Genuine consensus between economists and ecologists is much to be desired, and we admire the authors for making an effort. But we think their consensus is rather one-sided and that it demonstrates the weaknesses of the neoclassical economists' framework, even when employed by our most distinguished economists and ecologists.

### Literature Cited

Arrow, K., P. Dasgupta, L. Goulder, G. Daily, P. Ehrlich, G. Heal, S. Levin, K.-G. Mahler, S. Schneider, D. Starrett, and B. Walker. 2004. Are we consuming too much? Journal of Economic Perspectives **18:**147–172.

Christensen, J. 2005. Are we consuming too much?: it turns out we may be worrying too much about how much we consume and far too little about how to invest. Conservation Biology in Practice **6:**14–19.

Czech, B. 2001. Incorporating nonhuman knowledge into the philosophy of science. Wildlife Society Bulletin **29:**665–674.

Czech, B., D. L. Trauger, J. Farley, R. Costanza, H. E. Daly, C. A. S. Hall, R. F. Noss, L. Krall, and P. R. Krausman. 2005. Establishing indicators for biodiversity. Science **308:**791–792.

Georgescu-Roegen, N. 1971. The entropy law and the economic process. Harvard University Press, Cambridge, Massachusetts.

Trauger, D. L., B. Czech, J. D. Erickson, P. R. Garrettson, B. J. Kernohan, and C. A. Miller. 2003. The relationship of economic growth to wildlife conservation. Technical review 03-1. The Wildlife Society, Bethesda, Maryland.

Wackernagel, M, and W. E. Rees. 1996. Our ecological footprint: reducing human impact on the earth. New Society Publishers, Gabriola Island, British Columbia.

Whitehead, A. N. 1925. Science and the modern world. Free Press, New York.

Wilson, E. O. 1984. Biophilia. Harvard University Press, Cambridge, Massachusetts.