

Sustainable Growth: An Impossibility Theorem

Herman E. Daly

Herman E. Daly challenges the "economic oxymoron" of sustainable growth by arguing that present growth is impossible if we are to eradicate poverty. He proposes the way to achieve an optimal scale of development which balances renewable with non renewable resources.

Impossibility statements are the very foundation of science. It is impossible to: travel faster than the speed of light; create or destroy matter-energy; build a perpetual motion machine, etc. By respecting impossibility theorems we avoid wasting resources on projects that are bound to fail. Therefore economists should be very interested in impossibility theorems, especially the one to be demonstrated here, namely that it is impossible for the world economy to grow its way out of poverty and environmental degradation. In other words, sustainable growth is impossible.

In its physical dimensions the economy is an open subsystem of the Earth ecosystem which is finite, nongrowing and materially closed. As the economic subsystem grows it incorporates an even greater proportion of the total ecosystem into itself and must reach a limit at 100 percent, if not before. Therefore its growth is not sustainable. The term "sustainable growth when applied to the economy is a bad oxymoron — self-contradictory as prose, and unevocative as poetry.

Challenging the economic oxymoron

Economists will complain that growth in GNP is a mixture of quantitative and qualitative increase and therefore not strictly subject to physical laws. They have a point. Precisely because quantitative and qualitative change are very different it is best to keep them separate and call them by the different names already provided in the dictionary. *To grow* means "to increase naturally in size by the addition of material through assimilation or accretion". *To develop* means "to expand or realize the

potentialities of; to bring gradually to a fuller, greater, or better state". When something grows it gets bigger. When something develops it gets different. The Earth ecosystem develops (evolves), but does not grow. Its subsystem, the economy, must eventually stop growing, but can continue to develop. The term "sustainable development" therefore makes sense for the economy, but only if it is understood as "development without growth" — i.e. qualitative improvement of a physical economic base that is maintained in a steady state by a throughput of matter-energy that is within the regenerative and assimilative capacities of the ecosystem. Currently the term "sustainable development" is used as a synonym for the oxymoronic "sustainable growth". It must be saved from this perdition.

Politically it is very difficult to admit that growth, with its almost religious connotations of ultimate goodness, must be limited. But it is precisely the nonsustainability of growth that gives urgency to the concept of sustainable development. The Earth will not tolerate the doubling of even one grain of wheat 64 times, yet in the past two centuries we have developed a culture dependent on exponential growth for its economic stability (Hubbert, 1976). Sustainable development is a cultural adaptation made by society as it becomes aware of the emerging necessity of nongrowth. Even "green growth" is not sustainable. There is a limit to the population of trees the earth can support, just as there is a limit to the populations of humans and of automobiles. To delude ourselves into believing that growth is still possible and desirable if only we label it "sustainable" or color it "green" will just delay the inevitable transition and make it more painful.

Limits to growth?

If the economy cannot grow forever then by now how much can it grow? Can it grow by enough to give everyone in the

world today a standard of per capita resource use equal to that of the average American? That would turn out to be a factor of seven,¹ a figure that is neatly bracketed by the Brundtland Commission's call for the expansion of the world economy by a factor of five to ten. The problem is that even expansion by a factor of four is impossible if Vitousek *et al* (1986, pp. 368-373) are correct in their calculation that the human economy currently preempts one-fourth of the global net primary product of photosynthesis (NPP). We cannot go beyond 100 percent and it is unlikely that we will increase NPP since the historical tendency up to now is for economic growth to reduce global photosynthesis. Since land-based ecosystems are the more relevant, and we preempt 40 percent of land-based NPP, even the factor of four is an overestimate. Also reaching 100 percent is unrealistic since we are incapable of bringing under direct human management all the species that make up the ecosystems upon which we depend. Furthermore it is ridiculous to urge the preservation of biodiversity without being willing to halt the economic growth that requires human takeover of places in the sun occupied by other species.

If growth up to the factor of five to ten recommended by the Brundtland Commission is impossible, then what about just sustaining the present-scale — i.e. zero net growth? Everyday we read about stressed-induced feedbacks from the ecosystem to the economy, such as greenhouse buildup, ozone layer depletion, acid rain, etc. which constitute evidence that even the present scale is unsustainable. How then can people keep on talking about "sustainable growth" when: (a) the present scale of the economy shows clear signs of unsustainability, (b) multiplying that scale by a factor of five to ten as recommended by the Brundtland Commission would move us from unsustainability to imminent collapse, and (c) the concept itself is logically self-contradictory in a finite, nongrowing ecosystem? Yet sustainable growth is the buzz word of our time. Occasionally it becomes truly ludicrous as when writers gravely speak of "sustainable growth in the rate of increase of economic activity". Not only must we grow forever, we must accelerate forever! This is hollow political verbiage, totally disconnected from logical and physical first principles.

Alleviating poverty not angelizing GNP

The important question is the one that the Brundtland Commission leads up to, but does not really face: How far can we alleviate poverty by development without growth? I suspect that the answer will be a significant amount, but less than half. One reason for this belief is that if the five to ten fold expansion is really going to be for the sake of the poor, then it will have to consist of things needed by the poor — food, clothing, shelter — not information services. Basic goods have an irreducible physical dimension and their expansion will require growth rather than development, although development via improved efficiency will help. In other words, the reduction in resource content per dollar of GNP observed in some rich countries in

recent years cannot be heralded as severing the link between economic expansion and the environment, as some have claimed. Angelized GNP will not feed the poor. Sustainable development must be development without growth — but with population control and wealth redistribution — if it is to be a serious attack on poverty.

In the minds of many people growth has become synonymous with increase in wealth. They say that we must have growth to be rich enough to afford the cost of cleaning up and curing poverty. That all problems are easier to solve if we are richer is not in dispute. What is at issue is whether growth at present margin really makes us richer. There is evidence that in the US it now makes us poorer by increasing costs faster than it increases benefits (Daly and Cobb, 1989, see Appendix). In other words we appear to have grown beyond the optimal scale.

Defining the optimal scale

The concept of an optimal scale of the aggregate economy relative to the ecosystem is totally absent from current macroeconomic theory. The aggregate economy is assumed to grow forever. Microeconomics, which is almost entirely devoted to establishing the optimal scale of each micro level activity by equating costs and benefits at the margin, has neglected to inquire if there is not also an optimal scale for the aggregate of all micro activities. A given scale (the product of population times per capita resource use) constitutes a given throughput of resources and thus a given load on the environment, and can consist of many people each consuming little, or fewer people each consuming correspondingly more.

An economy in sustainable development adapts and improves in knowledge, organization, technical efficiency, and wisdom; and it does this without assimilating or accreting, beyond some point, an ever greater percentage of the matter-energy of the ecosystem into itself, but rather stops at a scale at which the remaining ecosystem (the environment) can continue to function and renew itself year after year. The nongrowing economy is not static — it is being continually maintained and renewed as a steady-state subsystem of the environment.

What policies are implied by the goal of sustainable development, as here defined? Both optimists and pessimists should be able to agree on the following policy for the US (sustainable development should begin with the industrialized countries). Strive to hold throughput constant at present levels (or reduced truly sustainable levels) by taxing resource extraction, especially energy, very heavily. Seek to raise most public revenue from such resource severance taxes, and compensate (achieve revenue neutrality) by reducing the income tax, especially on the lower end of the income distribution, perhaps even financing a negative income tax at the very low end. Optimists who believe that resource efficiency can increase by a factor of ten should welcome this policy which raises resource prices considerably and would give powerful incentive to just those technological advances in which they have so much faith.

Pessimists who lack that technological faith will nevertheless be happy to see restrictions placed on the size of the already unsustainable throughput. The pessimists are protected against their worst fears; the optimists are encouraged to pursue their fondest dreams. If the pessimists are proven wrong and the enormous increase in efficiency actually happens, then they cannot complain. They got what they most wanted, plus an unexpected bonus. The optimists, for their part, can hardly object to a policy that not only allows but strongly incentivates to the very technical progress on which their optimism is based. If they are proved wrong at least they should be glad that the throughput-induced rate of environmental destruction has been slowed. Also severance taxes are harder to avoid than income taxes and do not reduce incentives to work.

At the project level there are some additional policy guidelines for sustainable development. Renewable resources should be exploited in a manner such that:

- (i) harvesting rates do not exceed regeneration rates; and
- (ii) waste emissions do not exceed the renewable assimilative capacity of the local environment.

Balancing non renewable and renewable resources

Nonrenewable resources should be depleted at a rate equal to the rate of creation of renewable substitutes. Projects based on exploitation of nonrenewable resources should be paired with projects that develop renewable substitutes. The net rents from the nonrenewable extraction should be separated into an income component and a capital liquidation component. The capital component would be invested each year in building up

a renewable substitute. The separation is made such that by the time the nonrenewable is exhausted, the substitute renewable asset will have been built up by investment and natural growth to the point where its sustainable yield is equal to the income component. The income component will have thereby become perpetual, thus justifying the name "income", which is by definition the maximum available for consumption while maintaining capital intact. It has been shown (El Serafy, 1989, pp. 10-18) how this division of rents into capital and income depends upon: (1) the discount rate (rate of growth of the renewable substitute); and (2) the life expectancy of the nonrenewable resource (reserves divided by annual depletion). The faster the biological growth of the renewable substitute and the longer the life expectancy of the nonrenewable, the greater will be the income component and the less the capital set-aside. "Substitute" here should be interpreted broadly to include any systemic adaptation that allows the economy to adjust the depletion of the nonrenewable resource in a way that maintains future income at a given level (e.g. recycling in the case of minerals). Rates of return for the paired projects should be calculated on the basis of their income component only.

However, before these operational steps toward sustainable development can get a fair hearing, we must first take the conceptual and political step of abandoning the thought-stopping slogan of "sustainable growth".

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Notes

¹ Consider the following back-of-the-envelope calculation, based on the crude estimate that the US currently uses 1/3 of annual world resource flows (derived from *Material Needs and the Environment Today and Tomorrow*, 1973). Let R be current world resource consumption. Then R/3 is current US resource consumption, and R/3 divided by 250 million is present per capita US resource consumption. Current world per capita resource consumption would be R divided by 5.3 billion. For future world per capita resource consumption would be R divided by 5 billion. For future world per capita resource consumption to equal present US per capita consumption, assuming constant population, requires that R increase by some multiple, call it M. Then M times R divided by 5.3 billion must equal R/3 divided by 250 million. Solving for M gives 7. World resource flows must increase seven-fold if all people are to consume resources at the present US average.

But even the seven-fold increase is a gross underestimate of the increase in environmental impact, for two reasons. First, because the calculation is in terms of current flows only with no allowance for the increase in accumulated stocks of capital goods necessary to process and transform the greater flow of resources into final products. Some notion of the magnitude of the extra stocks needed comes from Harrison Brown's estimate that the "standing crop" of industrial metals already embodied in the existing stock of artifacts in the ten richest nations would require more than 60 years' production of these metals at 1970 rates. Second, because the seven-fold increase of net, usable minerals and energy will require a much greater increase in gross resource flows, since we must mine ever less accessible deposits and lower grade ores. It is the gross flow that provokes environmental impact.

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221

P. 8-A

EDITORIAL/OPINION

How to Turn Fish Into Pork

By MAURIE J. COHEN

Massachusetts Governor William Weld recently asked for federal disaster aid for his state's coastal communities. Rest assured, Nantucket and Cape Cod were not struck by a spring hurricane. Rather, Mr. Weld's request was for funds to ameliorate the economic devastation caused by closure of the Georges-Bank fisheries off the New England coast.

While these fisheries have long been regarded as some of the world's richest, capable of producing millions of tons of yellowtail flounder, cod and haddock, harvests have declined sharply. Biologists are virtually unanimous in attributing the collapse to an overcapitalized fishing fleet and technological advances that increase efficiency to ravaging proportions.

However, to substantiate a claim for disaster relief, Mr. Weld imperiously ordered the state's fishery specialists to prepare documentation on increased water temperature and predators as the cause of the fisheries' decline.

Recognizing the severe depletion of the Georges Bank fisheries, the Department of Commerce imposed the closure order late last year on more than 6,000 square miles of fishing grounds. This moratorium, designed to give the fish population an opportunity to recover, is expected to remain in place for several years. Meanwhile, 20,000 fishermen and employees of shoreside industries — many of them self-employed without unemployment insurance or benefits — are reeling from the income loss.

Ironically, New England fishermen have long fought even the most rudimentary forms of regulation to preserve their livelihood resource. The industry that regularly mobilized to defeat recommendations for stiff licensing requirements and limitations on fishing gear now finds itself in the discomfiting position of appealing for a federal bailout.

One prescient economic tenet is that a common-property resource exposed to unlimited exploitation will eventually be exhausted. And, as can be seen here, rational self-interest prevents any single fisherman from curbing appropriation from the shared pool. In fact, each fisherman is helplessly driven to increase his rate of exploitation because any portion of the resource left unharvested will be taken by competitors.

The only way to protect the sustainability of a fishery from the greed of fishermen and their ravenous technology is with licensing and equipment limitations. In the absence of such action,

more and more fishermen end up chasing fewer and fewer fish.

Should the federal government acquiesce to Mr. Weld's request, not only will it be an incorrect diagnosis of the problem, but also a prescription for the wrong medicine. While a portion of the proposed emergency funds are for employment training and gear-buyout programs, one component of the aid package calls for a subsidized loan program to finance refitting fishing vessels. Without a commitment to reform, handing out funds to target alternative fish a few dozen miles away only sows the seeds of the next fishery collapse.

Despite the apparent creativity of this approach for pulling down supplemental revenue for the state, Gov. Weld does not receive credit for finding this new route to the federal pork barrel. Using disaster relief to offset fishery collapses started early last year when Congress hid \$30 million for New England fishermen in a omnibus disaster assistance bill.

That was followed by President Clinton declaring several coastal fishing communities in Washington, Oregon and California federal disaster areas, mobilizing \$20 million to mitigate the demise of the region's salmon fisheries.

Guidelines for disaster aid say that communities must show harm from uncontrollable natural forces to qualify for funds. Officials in the Pacific

Northwest had the temerity to argue that virtual destruction of the region's salmon stocks was attributable to El Nino, not the unrestrained profusion of hydroelectric facilities and industrial installations along the Columbia River.

Regardless of scientific veracity, El Nino (a mysterious South Pacific phenomenon that sends warm water to northern latitudes) was all that federal officials needed to hear before strapping on the feed bag.

These cases speak to a dangerous trend. The tendency to throw money at fishing communities unable to foresee the folly of their rapaciousness represents yet another policy intervention that discourages prudent risk evaluation.

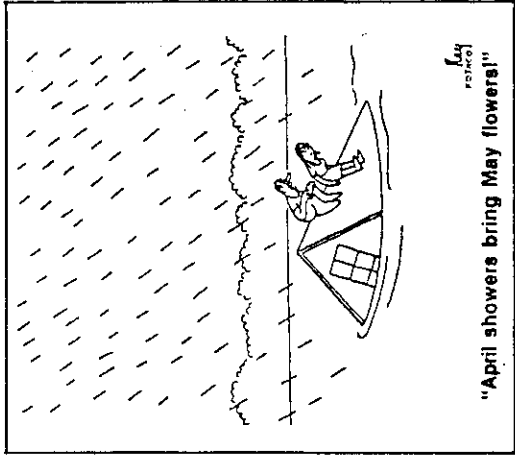
By making low-interest loans and reconstruction grants widely available following catastrophic events for the past 50 years, the government has implicitly encouraged development in flood plains, earthquake-prone areas and hurricane corridors. The bill sent to taxpayers spirals upward with each disaster because human settlement keeps sprawling into increasingly hazardous terrain.

The futility of the taxpayer bailout is demonstrated by our willingness to compensate the same victims for unprotected losses in successive disasters. In an age when the frequency of catastrophes reaches the proportions in Revelations, there is no shortage of opportunities to hitch the disaster-assistance wagon to the horse of political aspirations.

It is likely, for example, that the generosity extended to the victims of Hurricane Andrew in 1992 was motivated by Florida's prominence in the race to George Bush's re-election bid. California, however, has truly mastered that art of finding the government's altruistic underbelly. President Clinton's willingness to empty the pockets of the federal treasury over the skies of California every couple of months owes much to the attractiveness of the state's 52 electoral votes.

Fishermen, once certain of the availability of public compensation, will be emboldened like the residents of hazardous environments to disregard calls for self-discipline. Governor Weld is trying to create another group of irresponsible risk-takers who can roll the dice, comfortable with the knowledge that should they lose, the rest of us will be left holding the bag.

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By cartoonist
"April showers bring May flowers!"

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1827 by Samuel F.B. Morse

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The Boneyard

SPS owned by Lykes Bros. Steamship yard for scrap yards in the Far East this not be especially newsworthy except we helping to finance their final voyage to the tune of an estimated \$1 million. Lines for ocean shipping are, of course, ship lines have received subsidies over to help meet foreign competition and ships available for military emergency the Department of Transportation's ation, which controls the purse strings, it, if not the letter, of the government's ment is awarding bonus subsidies to that don't always compete with foreign to the military and in fact are about

222