

Cultural Carrying Capacity

by Garrett Hardin, 1986

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A biological approach to human problems

Science, like all human institutions, evolves. Earlier in this century Einstein probably spoke for most of the scientists of his day when he identified the inner force that drew him to scientific work: "I believe with Schopenhauer that one of the strongest motives that lead men to art and science is [the desire to] escape from everyday life with its painful crudity and hopeless dreariness, from the fetters of one's own ever-shifting desires. A finely tempered nature longs to escape from personal life into the world of objective perception and thought" (Einstein 1935).

Then came the Second World War and the Manhattan Project, culminating on 6 August 1945 with the announcement of the bombing of Hiroshima. Almost overnight scientists realized they could no longer escape becoming involved with the "crudities" of the world. In December of the same year, with Einstein's blessing, the Bulletin of the Atomic Scientists was founded to explore the human implications of scientific discoveries. From the day of its founding, this bulletin has, in the best and truest sense, been a controversial journal. Never again would the escapism of a Schopenhauer be quite so attractive to scientists. Biologists preceded the physicists in discovering the social perils of pursuing science wherever it might lead. By mid-nineteenth century it was obvious that there were overlaps between the territories claimed by biologists and theologians. Peace-lovers tried to establish a demilitarized zone between two tribes, but it didn't work. In 1925 ideological warfare broke out in Dayton, Tennessee. The legal outcome of the Scopes trial was ambiguous, though one philosopher, as late as 1982, maintained that "the evolutionists won a great moral victory" (Ruse 1982). A different conclusion was reached by the biologist and evolutionist, H. J. Muller. Thirty-four years after the trial, this Nobel laureate noted that the subject of evolution was almost entirely missing from high school biology textbooks. He concluded that, practically speaking, biologists had lost the battle in Dayton. On the centenary of the Origin of Species Muller thundered, "One hundred years without Darwinism are enough!" (Muller 1959).

The next quarter of a century showed that Muller was no mere viewer-with-alarm (Nelkin 1977). During this period the "scientific creation" movement was born. Subsequent successes of the creationists were due in equal measure to their political skill and to the relative apathy of professional biologists. Finally biologists became sufficiently disturbed by what was happening to public education to fight creationists in the courts. Judge William R. Overton's detailed and thoughtful judgement against the creationists in Arkansas on 5 January 1982 foretold the end of the creationists' dominance of the public debate (Montagu 1984).

That is history; but history should never be regarded as mere "water under the bridge." As Santayana said: "Those who cannot remember the past are condemned to repeat it" (Santayana 1905). For more than a century, we biologists failed to do our civic duty by bringing home to the general public the human significance of evolution through natural selection. That which we sowed by a century's near total neglect of public education, we richly reaped in the form of widespread anti-intellectualism fostered by Bible-worshipping

fundamentalists. Biology abounds in insights that call for a massive restructuring of popular opinions. If the sad history of Darwinism in the agora is not to be repeated again and again, biologists must accept the responsibility of bringing their insights to the public.

Among the more important biological concepts crying out for public explication today is the idea of "carrying capacity." Resistance to exploring its implications arises in part from the same source as resistance to Darwinism, as illustrated by the following quotations, one of which predates the *Origin of Species* by more than two decades.

From the beginning of the nineteenth century, evolution (though not natural selection) was "in the air." In 1837 Cardinal Nicholas Wiseman, perhaps the most influential Roman Catholic in England, disposed of human evolution with these words: "It is revolting to think that our noble nature should be nothing more than the perfecting of the ape's maliciousness" (Wiener and Noland 1957). Obviously the ground was well prepared for the rejection of Darwin's ideas long before he wrote his great book. Darwin's acute awareness of the opposition awaiting his theory no doubt accounted for much of his long delay in publishing the *Origin*.

How vigorously that opposition expressed itself is well shown by the oft-told story of the Huxley-Wilberforce debate (see, *inter alia*, Hardin 1959 and Brent 1981). Less spectacular, but no doubt more typical, was the reaction of the Victorian lady who, on hearing about Darwin's theory, expostulated: "Descended from the apes! My dear, we will hope that is not true. But if it is, let us pray that it may not become generally known!" (Dobzhansky 1955). It is natural that people committed less to truth than to the stability of society should prefer taboo to confrontation (Hardin 1978).

In what follows, I shall use the term man in the generic sense, to apply to any and all members of the human species regardless of sex. When so used, man is equivalent to the Latin homo rather than vir. This usage is old-fashioned but, I think, aesthetically preferable to expository hybrids of person -- (as in personholes, an unhappy substitution for manholes). Even the most casual reading of the Bible shows that man occupies a very special place in the Judeo-Christian view of the world. Simply put, Darwin's great contribution to public thought was the idea that man is an animal. Not one in a thousand of those who reject Darwinism today do so because they have made a close study of the theory (as laid out, for instance, in any of the standard university textbooks on Darwinian evolution). On the contrary, their rejection has its roots in a highly emotional reaction to the thought that human beings are truly animals, answering to principles that govern all animals. Yet this assumption is the foundation of all biological research into the nature of *Homo sapiens*. The contrary assumption, as expressed by Cardinal Wiseman and the anonymous Victorian lady, can be called the hypothesis of human exemptionism, or exemptionism for short (Catton and Dunlap, 1978). The exemptionist assumes, without proof, that men (and women) are exempt from important laws that govern the behavior of other animals. Darwinians do not deny that there are some aspects in which human beings are unique among animals -- for instance, in being able to argue about evolution! But Darwinians put the burden of proof on those who make any particular claim of the uniqueness of man.

At various times in the past man was said to be the only animal that could use tools, make tools, communicate with others of his kind, or conceptualize. Soon after each uniqueness was postulated some nonhuman exception was found. Desperately seeking something unique about their own species, apologists even looked for less laudable differentia. On various occasions it was claimed that man was the only animal that made war against his own kind, or that lied, or that committed murder or rape. But again, as fast as negative qualities were put forward, animal exemplars were found.

In the end a few unique human abilities were found. (No other animal conjugates verbs or declines nouns.) But the kinship of man and the animals (meaning "other animals") remains a fruitful working hypothesis for biologists. This hypothesis is recommended to scholars of all persuasions as a sovereign remedy against deceptions engendered by exemptionist thinking. In the end we find that man is indeed a remarkable animal. There is no need to hamstring research at the outset by a commitment to exemptionism.

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Carrying capacity in a nonhuman setting

The management of herds, both wild and domesticated, rests on the concept of carrying capacity. A brief account of David R. Klein's classic study of the reindeer on an Alaskan island will serve to illustrate what carrying capacity means (Klein 1968).

In 1944 some two dozen reindeer were released on St. Matthew Island where previously there had been none. Lichens were plentiful and the animals increased at an average rate of 32% per year for the next 19 years, reaching a peak of about 6,000 in the year 1963. During the heavy snows of 1963-64 almost all of the animals died, leaving a wretched herd of 41 females and 1 male, all probably sterile. It was not so much the inclement weather that devastated the herd as it was a deficiency in food resources, a deficiency that had been brought about by overgrazing.

The carrying capacity of a territory is defined as the maximum number of animals that can be supported year after year without damage to the environment. After careful study Klein concluded that 5 reindeer per km² was the carrying capacity of an unspoiled St. Matthew Island. An animal census taken in 1957 gave 4 animals per km². A further 32% increase during the ensuing year would have brought the population to 5.3 per km², a transgression of the carrying capacity. Had the herd been managed (which it was not), the number would have been kept somewhere near the 1957 size, below 5 per km².

In developing a policy for dealing with carrying capacity transgressions we must answer two questions: (1) How precise a figure is the stated carrying capacity? and (2) What are the consequences of transgressing the carrying capacity?

Carrying capacity estimates: imprecise but important

There is no hope of ever making carrying capacity figures as precise as, say, the figures for chemical valence or the value of the gravitational constant. On St. Matthew Island the growth of reindeer moss is no doubt greater some summers than others. Certainly the availability of lichens is much less in winter when they must be dug out from under the snow. Then too there are secular variations in climate: the exceptionally severe winter of 1963-64 might have been part of a long-term cycle. To these variations must be added unavoidable variations in expert opinion. As a result, any particular figure for carrying capacity has a substantial element of the arbitrary in it. Should we refuse to build policy upon arguable estimates? What would happen if we ignored all estimates of carrying capacity?

The short answer is disaster. Whenever a population grows beyond the carrying capacity, the environment is rapidly degraded; as a result, carrying capacity is reduced in subsequent years. Uncontrolled, the population continues to grow larger (for awhile) as the carrying capacity grows smaller.

The details of transgression-disasters vary from one situation to another, but some of the consequences are extremely common. Overexploited edible plants are replaced by weeds

previously rejected by the exploiting herbivores. Soil that has been laid bare is eroded away; this reduces local productivity in subsequent years. Soil turned into silt fills reservoirs and clogs irrigation systems. Loss of the rain-absorbent capability of soils produces faster runoff after rain, and more devastating floods in lower areas. These effects are especially severe when forests on steep slopes are destroyed.

The consequences of systematically exceeding the carrying capacity are serious and, more often than not, irreversible even when the territory is freed of excess animals. Reversibility may be possible on a geological time scale of tens of thousands of years, but on the time scale of human history such long-term reversibility is no cause for complacency. The Tigris-Euphrates valley, ruined by mismanagement two thousand years ago, is still ruined. If ecologists were ever asked to write a new Decalogue, their First Commandment would be: Thou shalt not transgress the carrying capacity (Hardin 1976).

Because transgression is so serious a matter, the conservative approach is to stay well below the best estimate of carrying capacity. Such a policy may well be viewed by profit-motivated people as a waste of resources, but this complaint has no more legitimacy than complaints against an engineer's conservative estimate of the carrying capacity of a bridge. Even if our concern is mere profit, in the long run the greatest economic gain comes from taking safety factors and carrying capacities seriously. Is it not time to change the meaning of the word conservative to take account of a new variety, the ecological conservative (Hardin 1985a)?

The ecoconservative knows that time has no stop. Profit seekers who focus too sharply on the bottom line of today's ledger book underestimate the consequences of time's arrow. To the ecologist, bottom line conservatives are not true conservatives. (Unfortunately bottom line conservatives now fill most of the positions on the White House staff.)

The ultimate goal of game management is to minimize the aggregate suffering of animals.

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Capacity strategy versus sanctity strategy

When the numbers of an exploiting herd of animals shoot past the carrying capacity of their environment, what should concerned human beings do? The answer is simple: get rid of the excess fast. This is the correct answer regardless of whether we are primarily concerned with the well being of the animals themselves, or with human profits to be derived from exploiting them.

Quite often the simplest and least cruel way to diminish animal numbers is to shoot the excess. This rational solution has been vigorously opposed since its espousal by Aldo Leopold in the 1930s (Flader 1974). In state after state, the public has had to be educated to see the harm that deer do to themselves when their numbers become too great. Game managers have been opposed by amateur but publicity-wise "animal lovers" (who will henceforth be referred to without quotation marks). With the best of intentions, animal lovers force state agencies to adopt remedies that inevitably lead to more animal suffering. The ill-advised measures include the following.

WINTER FEEDING. The carrying capacity of the land is usually lower in winter than in summer. When a population is no longer kept under control by predators, the numbers rise until there are too many animals to survive a normal winter. The shipping of food to the herd following winter storms prevents Nature's harsh but efficacious remedy for overpopulation. When continued for several seasons, winter feeding produces too many animals even for the summer season, and the environment is subjected to year-round degradation.

TRANSPLANTING. Animal lovers, like some economists (Simon 1981), cannot accept the fact that the world has limits. Whenever the media carry accounts of starving deer, someone is sure to propose that the animals be forcibly moved to other areas that, curiously, are assumed to be both suitable and underpopulated. When such experiments are carried out, the results are invariably expensive and unsatisfactory.

ADOPTION. Wild horses (really feral horses) in the western United States tug strongly at the heartstrings of animal lovers. Years of political pressure, orchestrated by "Wild Horse Annie" Johnston, finally compelled Congress to pass the Wild Free-Roaming Horses and Burros Act of 1971. This act forbids private citizens or commercial enterprises to kill, capture, or harass wild equines on federal lands.

Wild horses increase by about ten percent per year, which means a doubling of the population every seven years. Unfortunately, the rate of increase of the grazing lands is a negative number. Something has to give. So the Bureau of Land Management (BLM 1980) set up an "Adopt A-Horse Program" to reduce the herds in an acceptable manner. A US resident, after filling out an application form and paying \$200 for a horse or \$75 for a burro, can pick up and transport (at his own expense) an animal to take to his home property. If the adopter takes care of it in an approved manner for one year he can then obtain title to it.

The animals are rounded up by combined ground and helicopter crews. The psychic trauma of

such a roundup is presumed, without evidence or inquiry, to be less than the trauma of being shot. The cost to the government of each animal adopted, after subtracting the adoption fee collected was \$400 in fiscal year 1981, and \$474 in fiscal year 1982 (BLM 1982). Thus is the expense of unwanted cruelty commonized (Hardin 1985b) .

How many Americans have a suitable horse lot, and the money and the inclination to adopt a wild horse? The number is unknown. How fast is the number of potential adopters increasing? With continued urbanization the population of potential adopters is undoubtedly shrinking. Meanwhile the wild horse population grows at plus ten percent per year.

The working of the mind of the committed animal lover is one of the wonders of nature. Light is thrown on this wonder by a statement made in Florida in 1982, when a portion of the Everglades became seriously overpopulated with deer. The state Game and Fresh Water Commission recommended that the deer population of 5,500 be reduced by killing 2,250 animals (41%). Reacting to this proposal a Florida attorney sought a court injunction to protect the lives of innocent, helpless, harmless, and otherwise happy creatures that have been placed on earth by God to be free from the torment of man." He claimed that killing any of the animals would amount to a "deprivation of the rights of the deer to live freely and peacefully on earth, according to nature's order" (Florida 1983).

In other words, this attorney was extending into the animal realm the idea of the "sanctity of life" that many ethicists accept in the human realm. Ironically, this amounts to a denial of the exemptionism that is usually supported by those who reject the conclusions of biology.

Curiously, the manner of the rejection is the exact opposite of that practiced by biologists: animals lovers would endow animals with the gifts usually reserved for human beings.

Animal lovers and professional biologists should be able to agree on the ultimate goal of game management: to minimize the aggregate suffering of animals. They differ in their time horizons and in the focus of their immediate attention. Biologists insist that time has no stop and that we should seek to maximize the wellbeing of the herd over an indefinite period of time. To do that we must "read the landscape," looking for signs of overexploitation of the environment by a population that has grown beyond the carrying capacity.

By contrast, the typical animal lover ignores the landscape while focusing on individual animals. To assert preemptive animal rights amounts to asserting the sanctity of animal life, meaning each and every individual life.

Were an ecologist to use a similar rhetoric he would speak of the "sanctity of carrying capacity." By this he would mean that we must consider the needs not only of the animals in front of us today but also of unborn descendants reaching into the indefinite future.

Time has no stop, the world is finite, biological reproduction is necessarily exponential: for these combined reasons the sanctity strategy as pursued by animal lovers in the long run saves fewer lives, and these at a more miserable level of existence, than does the capacity strategy pursued by ecologically knowledgeable biologists.

Thus do we have the paradox that the interests of an animal species are best served by focusing attention on the environment rather than the individual animals. The environment is taken as a "given," and the animal population is made to match the capacity of the environment.

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The human context: culture and carrying capacity

So far as it is within our power we surely would like to manage human populations under the ideal used for animals, namely, to minimize suffering and maximize happiness over many generations. This means that, for human populations as for others, the prime commandment must be Thou shalt not transgress the carrying capacity.

Most of the principles worked out for populations of nonhuman animals apply with little change to human populations. Carrying capacity must take account of seasonal variations -- hence Aesop's story "The Ant and the Grasshopper." Long cycle secular variations may also be important (though man, the inveterate optimist, seldom takes really adequate account of future threats). And variations in expert opinion are even greater when we deal with the human situation.

For nonhuman animals it seems reasonable to measure carrying capacity in terms of resources available for survival. In evaluating the human situation, however, we are not satisfied with so simple a metric. We hold that "Man does not live by bread alone." We go beyond the spiritual meaning of the Biblical quotation in distinguishing between mere existence and the good life. This distinction, like so many population-related ideas, was well understood by Malthus, who held that the density of population should be such that people could enjoy meat and a glass of wine with their dinners. Implicitly, Malthus's concept of carrying capacity included cultural factors.

The good life, then, must include a reasonable (though undefined) amount of luxury food (fresh vegetables, quality meats, delicious drinks), clothing beyond that needed for mere conservation of body heat, comfortable housing, adequate transportation, space heating and cooling, electronic entertainment, vacations, etc., etc.

There is no agreed upon metric to which we can reduce the various goods so that we can compare the level of living of one people with another. There is, however, a useful partial measure. and that is the units of energy used per capita year in the various countries. Periodically the United Nations publishes a measure of energy use, stated in terms of kilograms of coal equivalent per capita per annum. Consider the following figures for the year 1982: Ethiopia, 31; World, 1,823; United States, 9,431 (UN 1984). On a relative basis, setting Ethiopia equal to unity, these become: Ethiopia, 1; World, 59; United States, 304. Admittedly, many real components of the quality of life are left out of this energy measure, e.g., many aesthetic goods, interpersonal goods, and perhaps even spiritual goods. Material energy sources are, to a large extent, interconvertible as sources of material goods and facilitators of immaterial goods. Wood can be burned to cook food, burned to heat a house, or used to construct a house. Oil can cook food, heat a house, or be used to create raw materials for an artistic painting. Crude as it is, the measure of people's energy consumption at least yields a first approximation to the material quality of their life.

The enjoyment of nonmaterial goods requires at least a minimum of material well-being. On

this crude measure, the average inhabitant of the world is about 60 times as well off as an average Ethiopian, while Americans are more than 300 times as well off. Anyone who goes to Ethiopia and tries to live the life of an average Ethiopian will conclude that these figures cannot be far wrong.

Carrying capacity is inversely related to the quality of life. When dealing with human beings there is no unique figure for carrying capacity. So when a pronatalist asserts (Revelle 1974) that the world can easily support 40 to 50 billion people -- some ten times the present population -- he need not be contradicted. If everyone lived on the energy budget of the Ethiopians, the earth might support 60 times the present population, or about 300 billion people.

The figure just given is only a crude estimate. In less hospitable regions, e.g., in Lapland, energy must be used to produce more clothing or space heating. In the Imperial Valley of California, energy must be used for the importation and pumping of water. But such facts are no more than the details that would be needed to refine the estimate of the maximum possible population supportable by the earth -- if such an estimate is worth refining, which is doubtful.

In the physical sciences the most basic terms stand for entities that are "conserved under transformations," that is for entities that remain quantitatively the same when qualitatively changed. Mass and energy are such conservative concepts. Without conservative concepts intellectual anarchy takes over and analysis becomes impossible.

In bioeconomics carrying capacity plays a conservative role. In the nonhuman world its application presents few problems. Carrying capacity does not vary without cause; it does not increase in response to need; it cannot be transgressed with impunity; and its definition in particular circumstances presents no serious problem to the well-informed. Such is the situation so long as we deal only with nonhuman populations.

When we move to human populations, however, the situation changes. The naive question, "What is the human carrying capacity of the earth?" evokes a reply that is of no human use. No thoughtful person is willing to assume that mere animal survival is acceptable when the animal is *Homo sapiens*. We want to know what the environment will carry in the way of cultural amenities, where the word culture is taken in the anthropological sense to include all of the artifacts of human existence: institutions, buildings, customs, inventions, knowledge. Energy consumption is a crude measure of the involvement of culture. It may not be the best measure possible, but it will do for a first approach.

When dealing with human problems, I propose that we abandon the term carrying capacity in favor of cultural carrying capacity or, more briefly cultural capacity. As defined, the cultural capacity of a territory will always be less than its carrying capacity (in the simple animal sense). Cultural capacity is inversely related to the (material) quality of life presumed. Arguments about the proper cultural capacity revolve around our expectations for the quality of life. Given fixed resources and well-defined values, cultural capacity, like its parent carrying capacity, is a conservative concept.

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Economists and ecologists in conflict

Suppose resources are not fixed? If by resources we mean natural resources that are available for human use at a particular time, at a particular stage in technological development, then resources have not been firmly fixed during all of human history. The past two centuries have seen the most spectacular increase in the resources actually available for human use. Malthus, because he was not acutely aware of the increase in carrying capacity going on in his time, was so unlucky as to put forth a theory of population that was too static to suit the economists of subsequent times, who are keenly aware of the effect of technology on the resources effectively available to the human species.

A careful reading of Malthus's work shows that he described what we would now call a cybernetic system in which negative (or corrective) feedbacks keep the population fluctuating about a relatively fixed set point (Hardin and Bajema 1978). The set point is, of course, the carrying capacity of the environment. Unfortunately for Malthus's reputation, the spectacular development of technology in the years after 1798 moved the set point steadily upward.

Biologists find no difficulty in fitting this new fact into the Malthusian cybernetic scheme, but many economists and other social scientists see the continued increase in available resources as incompatible with Malthusian theory. The difference in opinion is closely connected with a difference in the perception of time (Hardin 1985b). Economics, the handmaiden of business, is daily concerned with "discounting the future," a mathematical operation that, under high rates of interest, has the effect of making the future beyond a very few years essentially disappear from rational calculation. Told that petroleum resources will, for all practical purposes, be exhausted in 20 years, the biologist starts to worry, while the economist merely yawns. For most economic planning, the ultimate horizon of time is only five years away.

The economist can give two rather telling arguments for continuing to refuse to take seriously any predictions of the state of the world more than five years from now. First, for more than two centuries science has come up with one miracle after another, steadily increasing the functional carrying capacity of the world.

Why should science not continue to do so?

Scientists see less of the miraculous in the development of technology. I am afraid that many economists see "Science-and-Technology" as a magician with a bottomless hat out of which an endless series of rabbits can be pulled. Economists have difficulty taking energy shortages seriously. They say: "First we had wood for fuel. As that became exhausted, we found we could use coal. Before that became exhausted, we discovered oil. As we began to worry about the supply of that, we discovered atomic energy. It looks like atomic energy is

inexhaustible; but if it isn't, why worry? Scientists will discover something else; and just in time, as they always have in the past." Such faith may be heartwarming, but it is also dangerous.

Economists have advanced another excuse for never worrying (Simon 1981), which is rather subtle and more difficult to deal with. Quoting Aesop, they maintain that "Necessity is the mother of invention." This is certainly at least a half-truth. But some economists go on to imply that the greater the necessity, the greater the inventiveness. This may be seriously doubted. In our time, necessity is greatest in wretchedly poor countries like Bangladesh and Ethiopia; but is inventiveness at its maximum in such poor countries? Certainly not.

The stimulus of necessity is most effective when the standard of living includes a considerable surplus of resources (luxury) available for investment in the chancey activities of investigation, invention, and testing.

Put another way, when the scale of living falls so far below the cultural carrying capacity as to preclude effective inventiveness -- when the cultural capacity is seriously transgressed -- then living conditions spiral downward as the good life degenerates into mere existence sans inventiveness. Translated into human terms, the ecological first commandment becomes: Thou shalt not transgress the cultural capacity.

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One world or many?

To whom is the first commandment of ecology addressed: to the whole world acting as a unit, or to subdivisions of the world? Is it wise to hope and plan for One World, a world without borders? Or must our plans assume the continuation of subdivisions something like the nations we now know? This is perhaps the most fundamental political question of our time. The insights of biology are needed to solve it.

The dream of One World has ancient roots. Buddha, born more than half a millennium before Christ, took a universalist position. He seems to have had little direct influence on the development of Western thought. Diogenes, in the fourth century BC, rejected mere patriotism, calling himself kosmopolites, a citizen of the world. Zeno of Citium, in the next century, committed Stoicism to the same ideal. Christianity apparently derived this universal ideal from the Stoics. Though parishes developed as a valuable administrative unit of the church, the guiding ideal of Christianity has departed more and more from parochialism (L. parochia, diocese or parish).

During the past century the production of literature extolling One World has been a "growth industry." For this there are two reasons, one good and one bad (or at any rate, insufficient). The good reason has its roots in the consequences of the growth of population and technology. Population growth shrinks the regions between competing sovereignties and brings us every day closer to "living in each other's pockets." Technology, ever more puissant in both war and peace, exacerbates the consequences of propinquity. The mounting dangers of such commonized disasters as acid rain, the greenhouse effect, and the nuclear winter make anybody's business everybody's business. A purely localized solution to such problems is no solution at all. When it comes to the commons of water and air, we truly live in One World, whether or not we are clever enough to make the appropriate political adjustments. The insufficient reason for the decline of parochialism in our time arises from a philosophical error. Wealth comes in only three forms: matter, energy, and information. The first two forms obey conservation laws: their exchanges are of the zero-sum sort. What Peter gains, Paul loses. When it comes to material wealth, selective forces operate against generosity and in favor of self-interest.

By contrast, exchanges of information are not bound by conservation principles: positive-sum outcomes are possible. The information that Peter gives to Paul does not make Peter the poorer. Moreover, Paul may operate on that information, later handing it back to Peter in improved form. That's a plus-sum relationship. Within limits, selection favors cautious generosity and disfavors extreme selfishness when it comes to the wealth of information. Other things equal, when it comes to the distribution of information, a world without borders should be a richer world than one divided into tight-lipped parishes.

Nowhere has the rejection of parochialism been stronger than in the world of science and scholarship generally. Those who deal primarily with ideas may quite unconsciously generalize

the plus-sum property of information exchanges into the domains of matter and energy, where it does not apply. It is not uncommon for dealers in information to naively suppose that Karl Marx's "From each according to his ability, to each according to his needs" (Marx 1972) is a wise rule to follow in exchanges involving matter and energy (as well as information).

I believe I have shown in "The Tragedy of the Commons" (Hardin 1968) that the promiscuous sharing of matter and energy leads to universal ruin. The argument may be restated in new and more biological terms. If discrete entities (nations, for example) are in reality competing for scarce resources, those entities that follow Marx's ideal will be at a competitive disadvantage competing with more self-seeking entities. The selective value of Marx's ideal is negative, so long as the number of administrative entities is greater than one.

But what if there is only one administrative unit? What if we succeed in creating the One World yearned for by Christians, Marxists, and countless other groups? Never mind that many keen minds have regarded this possibility as being highly improbable. What if...?

Bertrand Russell has given the answer. To survive as a cohesive unit, an entity must be held together by some sort of cohesive force. Says Russell: "Always when we pass beyond the limits of the family it is the external enemy which supplies the cohesive force....A world state, if it were firmly established, would have no enemies to fear, and would therefore be in danger of breaking down through lack of cohesive force" (Russell 1949). The writers of science fiction have long been aware of this, repeatedly creating a scenario that brings the nations of the world into a genuine union through the threat of enemies from outer space. Unfortunately, all experience with space, to date, has given us no hope of discovering such enemies. So the problem One World or Many? remains with us.

I have argued elsewhere (Hardin 1982) that no single way will suffice to administer the affairs of what some people call "Spaceship Earth." There must be some sort of fragmentation of administrative tasks, though a universal approach is needed for the protection of the commons of air and water. But most material wealth is, after all, fragmented around the world; parochial distribution calls for parochial controls. This logical necessity meshes well with the territorial instincts that have been selected for during millions of years of biological evolution. How the necessary "mixed economy" of administration is to be created and sustained is an enormous problem.

In the meantime, whether or not we discover how to administer the commons of air and water, we must clarify our thoughts about the impact of competitive living on cultural carrying capacities. As before, let us allow per capita energy use to deputize for the total standard of living. This is an oversimplification of the real world, but the consequences deduced are general and would hold up under a more thorough analysis.

In making comparisons of one group of people with another it is difficult to attain objectivity, because we are one of the world's groups and we have varying relations with all the others. It will help, I think, if we use the intellectual device of the "man from Mars," the observer who can be perfectly objective about earthly affairs because he has no terrestrial ties. The man from Mars makes a tour of the earth and notes the widely varying standards of living and the widely varying densities of population. He also notes that resources vary widely in their distribution. Having evolved by natural selection on Mars -- is there any other way to evolve? -- our martian (like earthlings) has strong territorial feelings. He points out that a parochial distribution of resources should be matched by parochial consumption. This general principle does not preclude international trade when a particular resource is in very short supply in a particular nation; by trading parts of their relative surpluses, trading nations can mutually gain.

The per capita consumption of energy in Bangladesh is one thirty-eighth as great as the world average. Spokesmen for the country complain about this low energy income. (The material quality of life, however measured, seems correspondingly low.) How should others react to this discrepancy?

The standard earthly response is to say, "Bangladesh suffers from shortages." Thus do

earthlings demonstrate their fellow-feeling for the Bangladeshi, even though this may be the only way they do so. But what would the man from Mars say? Being under no felt necessity to demonstrate fellow-feeling, he might well respond thus: "Shortage, you say? Shortage of resources? If parochial resources are being fully used, how can there be a shortage? Parochial demand should match parochial supply. Why not say there is a longage in demand? Though it may not be possible to increase supply, it is always possible to decrease demand. You do this either by reducing people's expectations, or by reducing the number of people who have expectations -- which can always be done by reducing the birth rate. (There is no necessity to increase the death rate.)"

Continuing, the man from Mars says: "If each Bangladeshi enjoys only one thirty-eighth as much energy as the average earthling, maybe there are 38 times too many people living in Bangladesh? Should we not speak of a 'longage' of people, rather than a shortage of resources? In principle, a longage is always soluble; a shortage may not be."

If Bangladesh reduced its present population of 104 million people by a factor of 38 it would have only 2.7 million people. It is of interest to note that the state of Iowa has exactly the same area as Bangladesh, but with only 2.9 million people. There are many significant differences between the two areas, so not too much should be made of the contrast in population. But the equivalence does show that the suggested population for Bangladesh is not terribly unreasonable.

Adopting the martian principle that parochial demands should match parochial supplies would eliminate one important excuse for aggressive international actions. Implicitly thinking in One World terms easily leads to the concept of poor or "have-not" nations. An excessive passion for justice can then easily lead to the assertion that being poor justifies corrective military action. In our thermonuclear world, is there any justice that would justify embarking on an uncontrollable war?

By contrast, the carrying capacity approach results in replacing the concept of a "have-not" nation with that of an "overpopulation" nation. It's a rare piece of property that cannot support a suitably small population in comfort. This does not mean that every territory will have a helping of all the amenities of life: people who live in Spitzbergen should not assert their right to tropical beaches, nor people in Bali their right to skiing. The exceptional property that cannot meet a minimum standard for human existence should have a zero population. It makes no sense to say that every territory has a right to be occupied by a human population. Some wretched territories now inhabited should be abandoned.

Overpopulation can be corrected by means short of homicide and war. The means is attrition, which means seeing to it that the birth rate falls below the death rate (Hardin 1985b). This may be painful, but it is not war. For members of the Western world, part of the pain of adjustment of population to reality arises from the necessity of reexamining and substantially modifying our concept of human rights. In this reexamination, the deep concept of cultural carrying capacity must play a central role.