CONSERVATION. THE BIOSPHERE AND THE TECHNOSPHERE

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While the urgent practical tasks of conservation are visibly changing, both in their nature and in their scale, our fundamental conceptions of conservation of the natural environment are being modified no less quickly. In this transitional situation it is very difficult to keep abreast, particularly of the changes in perspective and attitudes which form the background for conservation policies and programs. The following reflection are offered as a contribution towards meeting a part of this need.

Not so long ago, it was widely thought that a main part of the function of conservation was to acquire and set aside natural areas of special value which would then only need to be defended against human interference in order to retain for ever the features which confer on them their distinctive quality and character. It was vaguely appreciated that some dynamic elements were involved in maintaining a “balance of nature” but it seems to have been assumed that such a balance would be maintained virtually intact so long as “natural conditions” could be maintained in face of threats from mankind.

In the knowledge that the encroachments of human activities on “nature” had in the past been extending only gradually and without any very drastic changes in their character, it was assumed that such trends would continue and very foresaw the dramatic acceleration of both technological change and on the scale of demand in terms of land use. It was also too readily assumed that changes outside natural areas would not be of a kind to cause serious repercussions within them, and that the ecological patterns of particular areas were somehow naturally insulated, except in rare situations, from whatever might be going on in other distant or even neighboring areas.

Looking back in the light of our still sketchy knowledge of ecology, this approach already looks old-fashioned and naive. The great extent of changes due both no natural and human causes during the past few thousand years is now much better appreciated. We are becoming accustomed to think in terms of a North American continent which was fairly recently joined by a land bridge to Eurasia but was long cut off from South America by the sea from the present Isthmus region. Greater knowledge of such early cultures as the Mayan bring home to us the extent to which apparently virgin forest must have been interfered with by human intrusions which are already very difficult to trace. In England excavations at Silbury Hill in Wiltshire have led to discoveries of plant and insect remains enabling the building of this immense megalithic mound structure to be dated somewhere around 4150 years ago, at which period the surrounding chalk grass lands were evidently already subject to heavy grazing, presumably by cattle. Picturesque and apparently natural pools of ware like the Norfolk Broads, also in England, have again recently been proved to be entirely man-made, in that case through the extraction of peat during the Middle Ages. The boundary between what is natural and what is humanly modified or artificial has thus become more difficult to draw and we have become increasingly uncertain how to define what is strictly natural and to distinguish it from various kinds of at least partly man-made landscape.

Emphasis has shifted from consideration of a wood, a bog or an Arctic Alpine heath to the idea of an ecosystem, subject through flow processes to a cycle of nutrition and decay which may either maintain or unrecognizably alter the profile of the plant formations on the ground as we identify them in our visual generalizations. We are becoming increasingly aware of the inherent instability or susceptibility to catastrophic change of many types of scenery or habitat. It is also borne on us that however efficient a ring fence may be erected around a National Park or Nature Reserve, many humanly initiated factors such as air pollution, air borne infections by such blights as that which practically exterminated the American chestnut, and the dissemination of toxic chemicals in biological food chains can do much to undermine the efforts of the most dedicated and competent management.

We are coming increasingly to think in terms of a global Biosphere composed of living beings together with their environment which can be arbitrarily divided into biomes and smaller units simply for convenience of study. It is as yet less widely recognized that a similar approach can equally be applied to the systematic scientific study of the activities and impacts of man through the workings of the great counterpart to the Biosphere which he has created, and which may be described as the "Technosphere" consisting of the mainly inanimate elements artificially organized to meet the economic and social needs of mankind through the application of a technology which is

increasingly acquiring a momentum and direction partly independent of immediate human control.

It seems worthwhile to attempt to discuss in slightly more detail the nature and workings of this "Technosphere" and the nature of its repercussions on the Biosphere.

Starting with the simplest type of situation, I was recently, on the coast of Cornwall, supplied with mackerel and other fish which had been caught that same day by local fishermen in quite small numbers which (although I did not actually buy them on the beach) might be said to represent a type of cropping of the natural resources more or less identical with that performed by such predators as cormorants (*Phalacrocorax*) and gannets (*Sula*). The Technosphere was involved only through providing the engine and regular weather reports for the fishermen and the motor-van to bring the fishes from them to me.

Farther along the coast fishing has long since become organized on a larger scale with the result, among others, that cleaning of the catch at the harbour produces a plentiful supply of waste products which sustain a large and noisy population of gulls (*Larus* spp.). If these are watched, it is soon evident that the adults and semimature birds, being stronger and more aggressive, eat their full share before the immatures and juveniles can take their turn. If the supply were not so plentiful, undoubtedly a great many of the gulls would perish at that stage, but as they are thus spoon-fed by man, their survival rate is enormously improved, and their pressure of population has led to their colonizing not only new breeding sites but many fresh feeding areas, for example on farmland and rubbish dumps inland, where they compete successfully with more specialized species and lead to the development of a larger and more generalized avian biomass with a markedly greater component of highly social forms.

Larger fish vessels operating at much longer distances with much improved and larger storage capacity are able both economically and by direct competition to undermine the markets and competitive survival capacity of many localized inshore fishermen who are gradually forced to give up, with considerable indirect biological effects on the coastal areas which they have long exploited. In the extreme case of the Atlantic Salmon intensive fishing off Greenland is apparently seriously reducing stocks which swim up to reproduce in British rivers, where they provide the basis both for rod sport fisheries and for commercial estuarine fisheries. On an even larger scale the intensive commercial fishing off the Peruvian guano islands is evidently cutting into the food resources which sustain the vast populations of guano-producing cormorants, and is thus having repercussions not only on the Biosphere, but on other parts of the Technosphere as well.

Despite all its advances and triumphs of invention, the Technosphere is still very largely dependent for its raw materials on crudely lifting living or inanimate matter from the natural environment. The methods and scale of this removal often have serious effects, quite apart from the loss of nutrients or other elements. For example, crude exploitation of forest lands often exposes topsoil to being eroded by wind or water and carried down streams, with the result that channels are blocked and water quality deteriorates, apart from the effects on the amount of run-off and on the conservation of moisture in the atmosphere and the soil. Mineral extraction is often accompanied by creation of heaps of toxic spoil which in extreme cases carry no vegetation for many decades and which also lead to poisoning; both of surface and underground water flows. In other cases the sheer removal of nutrients can lead to wide spread degradation of habitat, although in highly cultivated areas this can be and usually is made good by application or artificial fertilizers, there are many grazing lands and marginal farmlands where the damage is never compensated.

The destruction of natural environment inherent in often crude and injurious methods of taking elements for the use of the Technosphere and the sheer quantitative losses of such elements from the Biosphere to the Technosphere are, however, far from being the entire story. The Technosphere lacks mechanisms as delicate and well adapted for processing its intake as are formed, e.g. by leaf cover synthesizing carbohydrate from solar radiation in the Biosphere. Many of the processing plants not only cause damage by their sitting and design, e.g. on coastlines or river frontages, but carelessly inject into the Biosphere large quantities of liquid effluents or toxic air pollutants which are then disseminated over very wide areas and even internationally. (There is currently much complaint in Sweden and Denmark concerning the damage inflicted by polluting substances blown by the prevailing wind from factories and power stations in England.)

Apart from these unintentional or careless leakages which are not intended to have any particular effects on the Biosphere, there are many other products of the Technosphere which are deliberately injected into the Biosphere for particular purposes. Among the best known of these are agricultural pesticides and artificial fertilizers, which tend to be used in amounts and by methods only to be described as recklessly irresponsible in relation to their inevitable biological consequences.

We may therefore picture the Technosphere as a vast worldwide mechanism, largely parasitically dependent on

the Biosphere for its inputs of energy and raw materials, which are then handled and processed in the most untidy and wasteful manner by methods taking little or no account of either the losses initially inflicted upon the Biosphere or of the damaging repercussions of wastes and other products which are injected, often indiscriminately, into it at the end of the Technosphere's conversion processes.

Regarded in this light the time seems to have arrived when we should cease thinking merely in terms of "pollution" or "erosion" or other isolated aspects. We should instead begin to take a cool and critical look at the entire Technosphere as a rival world to the Biosphere, which has grown to a scale requiring systematic and worldwide monitoring, and where necessary redesign and control, in order greatly to mitigate the quite inacceptable quantities and qualities of damage which its careless and uncontrolled operation manifestly involves. The only alternative is to face irreversible and far-reaching modifications in the Biosphere, the price of which will be paid not only by "nature" and "naturalists", but by all who have the misfortune to inhabit the consequences of present-day human irresponsibility.

This essay is therefore a plea for conservationists and ecologists not merely to continue their direct studies and efforts in terms of the Biosphere but also to assist in applying ecological principles and models to the systematic study of the Technosphere so that governments, economists and technologists may be enable to take an entirely fresh look at what is being done in the name of progress, and to substitute for current patterns something more worthy of description as truly progressive.

We must look forward to a situation in which economists will not think so exclusively in terms of money values and technologists so exclusively in terms of chemistry, physics and engineering. Not only should both become much more keenly and deeply aware of the biological implications and responsibilities inherent in their advice and decisions, but above all they should recognize that the principles and mechanisms of nature revealed by ecological study of the Biosphere can provide a model for managing the Technosphere on much more socially and ecologically acceptable lines with, at the same time, a great improvement in operational efficiency due to the scientific elimination of contradictions, confusions and interruptions in the necessary flow processes. In this way conservationists and ecologists will be better rewarded for their own efforts and will contribute towards taming and civilizing the monster which is currently inflicting so much damage on the earth's biological capital and on the values which conservationists are concerned to conserve.