about 1 gm. of phosphorus, equivalent to about 7 gm. of calcium phosphate. Thus each square kilometre of sea has an annual turnover of about seven tons. To put any appreciable fraction of this quantity into the English Channel would involve a vast expenditure. Moreover, such addition would soon be dissipated into the ocean.

H. G. Wells is right in laying emphasis on the importance of phosphorus in limiting the fertility of the ocean, but his recent statement[3], that though "fisheries intercept a fraction of this phosphorus, the greater part of it forms insoluble compounds with other substances, bones, shells and so forth, and sinks slowly into the abyss beyond recovery", is incorrect. Actually the phosphate taken up is largely regenerated by excretion and decay; also the vertical circulation of the water column, which begins as the surface cools in autumn and continues until spring, brings phosphate and other nutrient salts to the well-illuminated regions again. A certain amount does sink to the abysses of the ocean. But much of this is brought up again when the oceanic currents impinge on banks and continental shelves. In this circulation, drainage from the land plays a very small part and cannot possibly account for differences observed between one year and another in such a body of water as the North Sea.

Phosphate is, of course, only one of the plant nutrients that would require to be added.

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[1] Ritchie, J., *Nature*, **154**, 275 (1944).
[2] Atkins, W. R. G., *Science Progress*, No. 106 (Oct. 1932).
[3] Wells, H. G., "Man's Heritage" (London, 1944).

Temporary Ponds, a Neglected Natural Resource*

NATURAL pools which contain water for a few months in spring, and are dry for the remainder of each year, are found in many parts of the world. I have examined them in Great Britain, Denmark, Sweden, Siberia[1], Canada[2], Australia and Africa. In the past little attention has been paid to ponds of this kind, except by specialists. Since they are potentially useful to man a short account of them may be of interest.

The annual history of a temporary pond in the north temperate and sub-arctic zones is as follows: With the coming of spring, and the melting of the snow which has accumulated during the winter, water collects in shallow grassy depressions and remains there for two months or more. A large number of invertebrate animals emerge from the resting condition in the soil on the bottom of the pond site, and become active within a few hours of the filling of the pool. Some animals, such as the Entomostraca, over-winter as eggs, while others, including the snails, spend the winter in the adult condition. Within one month of the formation of the pond each spring, a very great abundance of life of many kinds is found in the water, and it is in this that the usefulness of these habitats lies. When the pond dries in early summer the aquatic fauna and flora resume a resting condition, and the pond site becomes a land habitat. Because of the presence of the excrement of the water animals, the pond sites are well fertilized, and therefore support a luxuriant growth of land plants during the terrestrial phase. The leaves and stems of these land plants serve, in turn, the following spring, as food for the aquatic animals, and in that manner fertilize the aquatic phase of the pool.

In at least one respect the immediate utilization of temporary ponds is possible. In the year 1928 I was engaged in scientific work at a fish hatchery on Lake Winnipegosis, in central Canada. At this place there was need for the feeding of the fry of whitefish (*Coregonus clupeformis*) before they were planted in the lake, in order that they should have a surer start in life; in other words, in order to reduce the wastage among the fry planted in spring when there is little food in the lake waters. A suitable food supply for the fry was found in temporary ponds on shore near the hatchery. It might be assumed that once the warmer weather had come, there would be a development of fish food in the waters of the lake at an equal rate as in the temporary ponds on the shore. In practice things do not happen in that way. In the lake there is a time-lag, due in the first instance to the fact that before the biological food-producing processes can really get under way two to three feet of ice must be melted by the sun. In contrast to this, there is a very rapid development of many organisms in the temporary ponds, because those sites have been dry during the winter and so have no covering of ice; in practice it was found that the collection of plankton and organic detritus in the temporary ponds, and the feeding of it to whitefish fry, is feasible, and results in the rapid growth of the fry.

Taking a long view, it is possible to think of the efficient utilization of the plant and animal proteins and carbohydrates which are available in temporary ponds in a rationalized agriculture. Under those conditions an aquatic crop, such as plankton or fishes, could be reaped from a given piece of ground, and be followed by a field crop, such as oats. A rotation of that sort is said to be followed in carp ponds in Central Europe. Another possibility is that the site, after the drying of the pond, could be used for intensive protein-rich grazing.

In many parts of the world temporary ponds are undesirable as being a wasteful hindrance to the agriculturalist, or they may be dangerous, as breeding places of disease-carrying mosquitoes and snails. The purpose of the present note is to point out their useful possibilities. In other words, temporary ponds, so often regarded as a nuisance, are in reality a neglected natural resource.

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[1] Mozley, Alan, *Trans. Roy. Soc. Edin.*, **58**, 605 (1935).
[2] Mozley, Alan, *Amer. Nat.*, **66**, 235 (1932).

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Surface Area of Small Objects

THE determination of the surface area of objects such as small particles or stones is of importance in many fields of research. These particles are usually convex in shape, but it seems that the mathematical theory of convex bodies is not widely known among experimental workers in this subject.