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it is very doubtful whether this is a satisfactory, long-time, logical solution of the problem.

There is little if any doubt in the mind of every thoughtful individual that we should take action to repair the damage done by those, who agitating for quick action and justifying their performances on the grounds of lofty motives, have devastated the area in the past or are contributing to its devastation at present. With periodic droughts and yearly dust storms, disaster and desolation are on their way. Crop benefits, feed loans and other thinly disguised subsidies are no solution of the problem; they are at best merely palliatives: immediate and necessary relief for human misery. They afford no permanent solution of the problem of either soil or human wastage, of which the second is probably more serious than the first. Attack on these problems should be based on *physical facts* rather than on political expediency as at present. Possibly this is too much to expect as a reality, but if such is the case, the future holds but slight promise for the Western Great Plains.

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THE FATE OF THE INDIGENOUS[1]

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The American people have in recent years been developing an appreciation of the importance of our native plants and animals, not merely in their appraisable value for sale, but in their indirect value as members of the communities of plants, animals and human beings. The scientific study of such matters as these, which is the field of ecology, may therefore be faced with a timely opportunity.

It is my purpose to call to your attention some of the possibilities of a long-time, coordinated study from the ecological point of view of the typical indigenous flora and fauna, to describe how such a study is being successfully conducted on a bit of coast land in England, and to point out that in Minnesota we have an exceptional opportunity for research of this sort which may be worthy of the active consideration of this Academy.

Several years ago my interest was attracted by a scheme for a *complete* biological study of an area on the South Haven Peninsula in Dorset, on the south coast of England. Under the encouragement of Captain C. Diver, a secretary of the British Genetical Association and a zoologist by training and by avocation, there is being brought into action "a body of workers who, while making separate studies of the groups in which they are specialists, will yet do so with a coordination in attack and a unity in aim towards the ulti-

[1] Paper No. 1511 of the Scientific Journal Series of the Minnesota Agricultural Experiment Station.

mate objective — the elucidation of the complex bonds that hold together a complete society of plants and animals." [2]

The area being studied has special advantages for this purpose. It is well suited for ecological work, it has suffered little interference by man, it is abundant in features interesting to naturalists, and furthermore by its bracing sea air and its detachment from human industry it provides a pleasant place of refuge for naturalists who may desire a change of scene and who therefore may enjoy participating in the absorbing study proposed.

This area is a rather low-lying peninsula about two miles long and two-thirds of a mile wide, bounded on three sides by tidal water and with an easily defined artificial boundary at its base. A principal ridge of Eocene origin runs in the shape of a crescent partly across the base and along the harbor side of the peninsula, roughly paralleled toward the sea by three relatively recent ridges of blown sand. Now enclosed from even the high tides are several lakes and pools. This inland water covers about eighty of the approximately 750 acres. It is particularly fortunate that, at least as far as its shore line is concerned, the area has been mapped through three and one-half centuries, beginning with the time of Henry VIII, so that it has been possible to establish the nature and approximate date of changes which have occurred in the physiological features.

Though the area had long been studied by biologists, no previous coordinated effort had apparently been made to survey it biologically in such a complete way. When, in 1931, the distribution of a species of grasshopper in a part of the area was mapped in detail, it became apparent to Captain Diver that a complete biological survey would be worth attempting. He thereupon undertook a study of the history of the area and its physiography.[3] With this article a map was published on a scale of six inches to one mile, with cross-lines marking hundred-yard squares, and with the various features and areas clearly named and designated. Ordnance maps drawn on a larger scale are also obtainable.

The plan is that as the area is surveyed for a given species, the data will be recorded in a field notebook. The distribution of the species will later be plotted on one of the six-inch scale maps, and additional information, including dates, will be entered in the wide margin provided for the purpose. Arrangements will be made to deposit the field notebooks, original maps and collections at a central institution.

The uniform method of mapping is one of the outstanding features of the scheme, for after the early surveys of individual species have been made, comparisons of two or more maps will be possible

[2] C. Diver and R. Good. The South Haven Peninsula Survey (Studland Heath, Dorset): General scheme of the survey. Jour. Ani. Ecol. 1934, Vol. 3, pp. 129–132.

[3] C. Diver. The physiography of South Haven Peninsula, Studland Heath, Dorset. Geographical Jour. May 1933, Vol. 81, pp. 404–427.

as a means of revealing correlations between different kinds of organisms, such as between a preying insect and the species preyed upon and between an insect or other animal and a species of plant. The comparison of maps made at different times for the same species will also serve as a means of studying causes of death associated with various stages in the life cycle, the occurrence of cyclical changes in populations and the extent and rate of movement, colonization and germinal interchange. Evidence should also be obtainable on the evolutionary value of genetic and cytogenetic changes.

The first paper, on the physiography of the area, was published in the spring of 1933. By the autumn of 1934, the cooperation of 12 biologists had been obtained to undertake the study of certain groups of plants and of animals, and of one geologist to study the origin of the dune sand, and three additional papers had been published.

A perusal of the list of workers reveals the fact that they are not all necessarily ecologists. This impressed me as being one of the important features of the schemes: it makes possible the cooperation in a coordinated ecological study of persons who may not be trained ecologists, but who may, nevertheless, by their familiarity with a single or with a few species, make worthy, individual contributions, and in so doing develop a better understanding of the interrelationships of organisms and their environment and among the various organisms in their communities, and a greater appreciation of the important implications of ecology to human welfare. In other words, three purposes are realized: (1) a long-time, coordinated ecological study is carried out, (2) this study is made more inclusive through the cooperation of people who are not ecologists, and (3) these cooperators become ecologically minded.

In contemplating the attractive features of this scheme, I found myself lifting it up bodily from its native heath, transporting it to Minnesota, and setting it down upon our native soil to regard the effect. Although this was only a mental exercise in which the scheme had to be returned before its temporary loss might be detected by some naturalist making an early visit to the peninsula, nevertheless it set in motion certain lines of thought.

The imaginary application of such a scheme for ecological research in Minnesota naturally leads to a consideration of the flora and fauna indigenous to our state. Inasmuch as certain types of fauna are usually associated with certain types of vegetation, it is permissible to consider the flora primarily.

In 1620, the vast area which later became the United States was almost half covered with forests, the extent and magnificence of which was unknown until many years later. On the American continent as a whole, probably the most extensive types of vegetation were the northern coniferous forest, covering much of Canada and dipping down extensively into the lake states of Minnesota, Wis-

consin and Michigan, the temperate deciduous forest, covering most of the remaining area east of the Mississippi river, and the steppe or prairie, covering most of the area between the Rocky Mountains on the west and the forests on the east. Minnesota has the advantage for the naturalist of including part of each of these three great biotic areas, as well as some of the less extensive oak poplar savannah.[4]

The boundaries of these areas were remarkably well defined by Warren Upham in 1883.[5] The coniferous forest, covering approximately the northeastern third of the state, was characterized principally by the Norway, white and jack pines, the white spruce, balsam fir and white birch on the higher land, with black spruce, tamarack and white cedar in the swamps. With these dominant species were associated numerous other species of trees, shrubs and herbaceous plants. Here were found the typically northern animals; the woodland caribou, moose, northern deer, Canada lynx, wolverine, marten, fisher and snow-shoe hare. Here, too, the Canada spruce partridge, the Arctic woodpecker and the Canada jay lived the year round and many migratory species came for the summer. These are merely representatives of the rich fauna and flora of the region.

The coniferous forest was bordered on the west and south by the deciduous forest. On the west this took the form of a relatively narrow but variable strip averaging perhaps 20 miles wide, but on the south it spread out much wider to include a noteworthy area called the "Big Woods." The boundaries of the Big Woods, defined by N. H. Winchell[6] in 1875, may be outlined briefly. Beginning a few miles west of Minneapolis, the eastern edge crossed the Minnesota in a line toward Lakeville in Dakota county. Continuing south it passed about a mile east of Cannon City, and of Owatonna, then turning to the west and northwest, passed about four miles north of Waseca. About six miles south of South Bend, it turned north and crossed the Minnesota. Beginning to bear off toward the northeast at St. Peter, the boundary passed near Arlington, New Auburn, Glencoe and Darwin, beyond which its exact location had not been traced. The term was strictly, and originally, only applicable to the spur that included the Lower Minnesota valley, extending nearly to the Iowa line.

Winchell listed 55 species of trees and woody plants which he found in this area. The dominant trees were the hard maple, white and red elm, basswood and red oak. In the southern part from Shakopee southward, the Kentucky coffee tree, black walnut, and red mulberry were commonly found. A number of southern species

[4] For a more complete description of the characteristics of these areas see: C. O. Rosendahl, Minnesota. Naturalist's Guide to the Americas. Baltimore, 1926.

[5] Warren Upham, Catalogue of the Flora of Minnesota. Geol. and Nat. Hist. Surv. of Minn., Ann. Rpt. of Progress for 1883, Part VI, 193 pp.

[6] N. H. Winchell. Notes on the big woods. Ann. Rept. Minn. State Hort. Soc., 1875. pp. 47–50.

of animals here reached their northwestern limits. Others ranged into this region from the coniferous forest to the north. The following comments by Winchell are pertinent to the present discussion:

"The existence of this great spur of timber shooting so far south from the boundary line separating the southern prairies from the northern forests, and its successful resistance against the fires that formerly must have raged annually on both sides, is a phenomenon in the natural history of the state that challenges the scrutiny of all observers. While it holds mines of wealth, open to the practical economist, it affords to the scientist a rich field for observation and study. With timber, comes the fauna that is peculiar, in our latitude, to timbered regions. This fauna is strikingly different from that of the prairies. The bear, the wolf, deer, a great number of forest warblers, and numberless winged insects, that would otherwise be restricted to the northern half of Minnesota, are by this spur of timber brought into a much more southern latitude. The deer at present roams over the whole of the tract from north to south. It furnished shelter for thousands of birds that winter among us, but which otherwise would become exterminated, or driven from the state. . . . It is eminently a region of small lakes. What may be the cause underlying, that has wrought this wonderful diversity in the heart of our great state is a subject for legitimate investigation. . . . That this tract is destined to be of untold benefit to the state can not be questioned. It is as yet but sparsely inhabited, and the details of its natural history are unknown."

Another part of the deciduous forest, separated from the Big Woods by a tongue of prairie, was found in the southeastern corner of the state, along the bottom lands and the bluffs of the Mississippi river and extending back to the west on the uplands about 30 miles. This forest was very similar to the Big Woods, but more varied, and with more frequent examples of the flora which here reached their northwestern limits. Indeed, there were within this area several unique localities which have survived until the present without serious change. Notable among these is Gwinn's Bluff, below Winona, where the witch hazel reaches its northwestern limits and is met by the white cedar, found here in an outpost fully 150 miles farther south than elsewhere, and a species of *Claytonia* which occurs typically in the Rocky Mountains and in Alaska.

The southwestern part of Minnesota and a strip along the western side of the state consisted of grassy prairie, often separated from the forest region, however, by areas of oak or poplar savannah. In the southwestern corner of the state, particularly in the region known as the Coteau des Prairies, the vegetation became more characteristic of the broad western prairies. The wheat grasses, beard grasses, rye grass, Indian grass and other species of grasses were the dominant vegetation, accompanied by the multitude of flowers which are characteristic of the prairie. Here were seen vast herds of bison, the swift pronghorn antelope, the prairie

fox, coyote, pocket gopher, and jackrabbit. Among the birds which were common in this area but are now extinct or rare, were the whooping crane, three species of plover, long-billed curlew, marbled godwit, western willet, prairie chicken, and prairie sharp-tailed grouse. The specimens of Sprague's pipit in the foreground of the prairie habitat group in the Natural History Museum of the University were found only after the search was extended to primitive, unbroken prairie.

In establishing national parks and monuments, consideration has been given to many striking features: mountains, canyons, caverns, and bad lands, yet the prairie, which has a magnificent, spacious beauty of its own and has played its great part in the history of America, has been neglected, perhaps because of its former monotonous vastness, until the original, natural prairie has almost disappeared.

In addition to the presence of these great biotic types, the state has certain other advantages for biological studies. It contains more inland lakes than any other state and by its participation in three great drainage systems, flowing into the Gulf of Mexico, the Gulf of St. Lawrence, and Hudson's Bay, it affords a diversity of fresh-water marine types.

The location of natural areas and their reservation for scientific studies is not any easy task. The principal requirements are that they possess features of biological interest, such as tracts containing primitive, indigenous flora and fauna, and that they be preserved in the natural condition and reserved for observation and study by scientists. It is not necessary that such areas consist exclusively of a stable climax type of vegetation, but at least a nucleus of such types would be highly desirable, and it is also important that tracts of the climax types be preserved. To realize their greatest scientific value, these areas should be preserved alike from trampling and other damage by picnickers and campers, from so-called improvement by CCC camps or other agencies, from alteration and experimentation by well-meaning scientists, and from unwise or unrestrained collecting. The joint use of such areas for public recreation would inevitably diminish their value for the scientific observation of the natural, native associations and successions.

The need of natural areas has been recognized by the ecologist for some time, and efforts have been made, both successfully and unsuccessfully, to have them established in Minnesota. Their importance to forestry was officially recognized when in 1930 the Acting Secretary of Agriculture issued a regulation containing the following provisions: [7]

"The forester shall determine, define and permanently record a series of areas of national forest land to be known as . . . natural

[7] L. F. Kniepp. A national system of experimental forests and ranges. Science, 1930, Vol. 72, pp. 560–561.

areas sufficient in number and extent adequately to illustrate or typify virgin conditions of forest or range growth in each forest or range region, to be retained in a virgin or unmodified condition for purposes of science, research, and education . . . Within any areas so designated, except for permanent improvements needed in experimental forests and ranges, no occupancy under special use permit shall be allowed, or the construction of permanent improvements by any public agency be permitted, except as authorized by the forester or the secretary."

These natural areas, which were to be included wherever possible in each experimental forest, were for the purpose of preserving in an unmodified condition examples of the virgin growth or other vegetative type to the end that the characteristic plant and animal life should continue to be available for scientific and educational purposes. The areas were expected to include from 1500 to 5000 acres, with an average of about 3500 acres. While they were to be established primarily to meet the needs of the Forest Service, their availability for use by other research or educational agencies for purposes which would not conflict with Forest Service projects, and under appropriate cooperative agreements approved by the forester, was assured.

It was supposed at first that such areas would have to be acquired by gift. In 1935, however, the National Forest Conservation Commission approved the purchase of 400 acres of primeval hemlock and hardwood forest in northwestern Pennsylvania, part of the original forest which gave name to the Province of Pennsylvania when it was granted to William Penn in 1681. It was stated [8] that within this tract camping was to be prohibited, trails were to be laid out only where possible without cutting, and that only observation, not experimentation, was to be carried on, to determine how this forest maintains itself and its wild life century after century totally undisturbed by man.

One natural area has been established by the Forest Service in Minnesota. The Pine Point area in the Chippewa National Forest covers 1176 acres on a peninsula in Leech Lake, where its stand of old growth Norway pine is reasonably safe from molestation and fire. The Sunken Lake area, which has also been proposed for reservation as a natural area, is particularly interesting to ecologists because there a formerly stable vegetation along a chain of lakes has had to adapt itself to the changes accompanying a lowering of water levels resulting from the breaking of a morainic dike.

If an early start were desired on the type of ecological study which I have described, probably the most promising location would be in Itasca State Park. Here there are several thousand acres, in the less accessible parts of the park, of practically undisturbed vegetation, including noteworthy stands of Norway pine. One drawback to this area is the lack of succession by young trees,

[8] Pennsylvania's primeval forest. Science 1935. Vol. 81, pp. 146–147.

due to feeding by too numerous deer. Maps are available on a scale of four inches to the mile and with contours at five foot intervals. The recent establishment there of the Forestry and Biological Station of the University of Minnesota makes available during a period of six weeks in the latter part of the summer all necessary facilities for living and for field and laboratory research, and provides pleasant contacts with capable biologists and numerous advanced students. The advantages of this location for the study of terrestrial and fresh water biology affords unusual opportunities for the student or guest investigator of botany or zoology.

The reservation of an area of the deciduous forest would facilitate the study of a very different type of vegetation with its characteristic accompaniment of animals, birds, insects, and lower forms of life. If such an area were established in the region of the Big Woods it would have the additional advantage of greater accessibility during a longer part of the year, making it possible for investigators to accomplish work on week-end or occasional trips. Sizable areas of primeval timber are still to be found in this region, some of them bordering upon attractive lakes. These areas consist principally of farm woodlots, in most of which there has been some grazing. Probably the best remnant of unpastured woodland is the Nerstrand Woods, of 1200 acres, which is now being subjected to cutting.

Of the three great biotic types, the prairie would probably offer the greatest difficulty in the location of a suitable natural area. The richness of the prairie land and its freedom from trees brought about its early cultivation, so that the unplowed prairie is now rare in Minnesota except along railroad rights of way. Nevertheless I have been led by reports to believe that a suitable area containing unbroken, but grazed, prairie could still be found in this state and some of the features of this formerly extensive but now rapidly vanishing biotic type could thereby be saved. The Section of Biology and Agriculture of the National Research Council has appointed a committee on the ecology of the prairie, which may be considering the preservation of such natural areas.

Some of the possibilities of cooperative, coordinated ecological research were outlined in the description of the study of South Haven Peninsula. The accomplishment of such research in the rich forest and prairie biotas of Minnesota would be a creditable achievement for this Academy of Science. But both for the Academy and for its members, the gains en route should be as important as the achievement. The cooperation not only of ecologists, but of the various kinds of biologists, botanists, zoologists, entomologists, mycologists and even biometrists, geneticists, chemists, geologists, and geographers would be utilized. Everyone from the high school teacher of biology to the narrow specialist could make his separate, published contribution. The closer association of our members from

the several institutions and our cooperation in the common cause of the study of indigenous problems should be of great benefit.

In this age of specialization, the true naturalist is threatened with extinction. Might not this scheme help to restore his species, as well as those of certain plants and animals on which he works? There are advantages in affording the specialist exercise in the broad field of nature and in exposing him to less familiar biotic conditions. Who knows but that as Linnaeus was stimulated by his journey in Lapland, Darwin by his observations on the voyage of the Beagle, and Bateson by his study of the steppes, there might not some day be one student in Minnesota so stimulated by his study of our biotic types that his thought would carry a little farther to mark another milestone in the progress of natural science?

I have endeavored to suggest some of the possibilities in comprehensive research on the fate of the indigenous, and to emphasize the need of preserving, from the fate of further disturbance or extinction, of relatively undisturbed natural areas for scientific observation. The active encouragement of projects such as these might well be one of the functions of this Academy.

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