AIRPLANE PHOTOGRAPHY AND ECOLOGICAL MAPPING.

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A comprehension of the problems involved in a study of plant succession of the zonation of plants is greatly facilitated by adequate maps. It is also quite true that possible solutions of some problems as well as some less apparent relationships are suggested by the preparation of maps or the pondering of available ones.

Frequently, helpful maps are not available for ecological studies. Road and land surveys mean little. Contour maps, which would be valuable, and cover-type maps are prepared for few places the ecologist chances upon in his studies. Not many ecologists are surveyors; nor do they have the necessary surveying equipment with which to work. As a result mapping naturally becomes a process of tying-in, off-setting, and scrap-paper trigonometry transferred to the out-doors, and is both tedious and inaccurate; or, as is frequently the case, the worker does without a map. Inaccessible places present a more acute problem; yet it is in just such places that airplane photographs facilitate the preparation of maps; indeed, only by such pictures is it practical to prepare them at all.

In so far as I know the only use of airplane photography in the study and mapping of vegetation was that reported by William S. Cooper of the University of Minnesota, at the 1925-26 annual meeting of the American Association for the Advancement of Science, at Kansas City[1].

The present work is in connection with "Some Ecological Studies of Bacon's Swamp" to be published later. Being a somewhat distinct problem it is presented in this separate form. Bacon's Swamp, with an approximate area of 30 acres, lies in the E ½, SE ¼ of Section 6, Washington Township, Marion County, Indiana. Its proximity to Indianapolis has long made it a favorite field of study and rendezvous of nature students, especially those of the city high schools and Butler University, and a tramping-ground for the Nature Study Club.

The interior of the swamp is occupied by a wet meadow composed predominantly of grasses, sedges, ferns, etc., with scattered patches of cat-tails and open water with such hydrophytes as *Saururus cernuus* (Plum.) L. and species of Polygonum. The wet-meadow is surrounded

[1] Cooper, W. S. Experiments in the Study and Mapping of Vegetation by Airplane Photography.

In correspondence Doctor Cooper has informed me that the material on which he reported at the Kansas City meeting "has not been published and probably will not be in separate form." He continued, "It was merely an incidental matter concerned in my study of the sand dunes of the Pacific Coast and their vegetation. Whatever results I have will be incorporated in my final report on that work and this will not be ready for at least two years."

"Proc. Ind. Acad. Sci., vol. 36, 1926 (1927)."

by a moat in which the water stands at a depth of two to four feet. The moat is filled with *Cephalanthus occidentalis* L. and is bordered with *Salix nigra* Marsh. The depth of the water and the dense tangle of the buttonbush in the moat makes the greater portion of the swamp inaccessible and accounts for the abundance of birds despite the nearness of the city. From the point of view of the ecologist, when confronted with mapping the plant zonation, these topographical and vegetational features present practically insurmountable obstacles. And as mentioned previously, it is in just such a situation that the airplane makes the whole process easy.

The accompanying maps were prepared from pictures taken at an altitude of 5,000 feet. Five shots were necessary to cover the area of the swamp. Prints from the plates were fitted together so that the entire swamp was shown in one picture in its actual proportions. The camera was equipped with a 10-inch focal length lens. According to optical laws, and reciprocal triangles involved, each linear inch on the prints equals in feet one-tenth of the altitude at which the pictures were taken. For this particular work one-inch on the photograph equals 500 feet. The maps were enlarged to double dimensions so that the scale on the maps is one inch to 250 feet.

The enlargement of the map from the assembled photographs was a matter of manipulating a pantograph, a simple enlarging contrivance consisting of two sets of parallel bars so connected that any movement of the tracer, fastened at one end, is augmented at the other end where the pencil is attached. This instrument is adjustable so that different degrees of enlargement or reduction can be made.

The present work presents, perhaps, as severe a test as could be put to the process of mapping. The pictures were taken from a fairly high altitude, late in the fall, with only fair sunlight, and rather smoky atmosphere. Moreover, the vegetation of the swamp offered less contrast than most any other subject. Yet the essential proportions of the major associations are delineated. This is exactly what could not be accurately established from the ground except by an unreasonable expenditure of time and energy, to say nothing of the requisite skill. Whereas, a pantograph can be manipulated with ease and a copy or an enlargement of a picture produced quickly. The preliminary map thus prepared was taken into the field and the details, not apparent in the photographs, were sketched into the map by hand. The production of the final map was a matter of draftsmanship. Figure 1 shows the preliminary outlines as obtained directly from the photographs. Figure 2 is the final product derived from figure 1 by working in, from the field, the details not shown in the photographs.

In conclusion it may be said that airplane photography offers an accurate, quick, and cheap method of mapping and studying vegetation of inaccessible regions. This method will no doubt be utilized more and more for all sorts of mapping as planes become more numerous. Ecologists may do well to adopt the methods which our government and private enterprises have found indispensable.

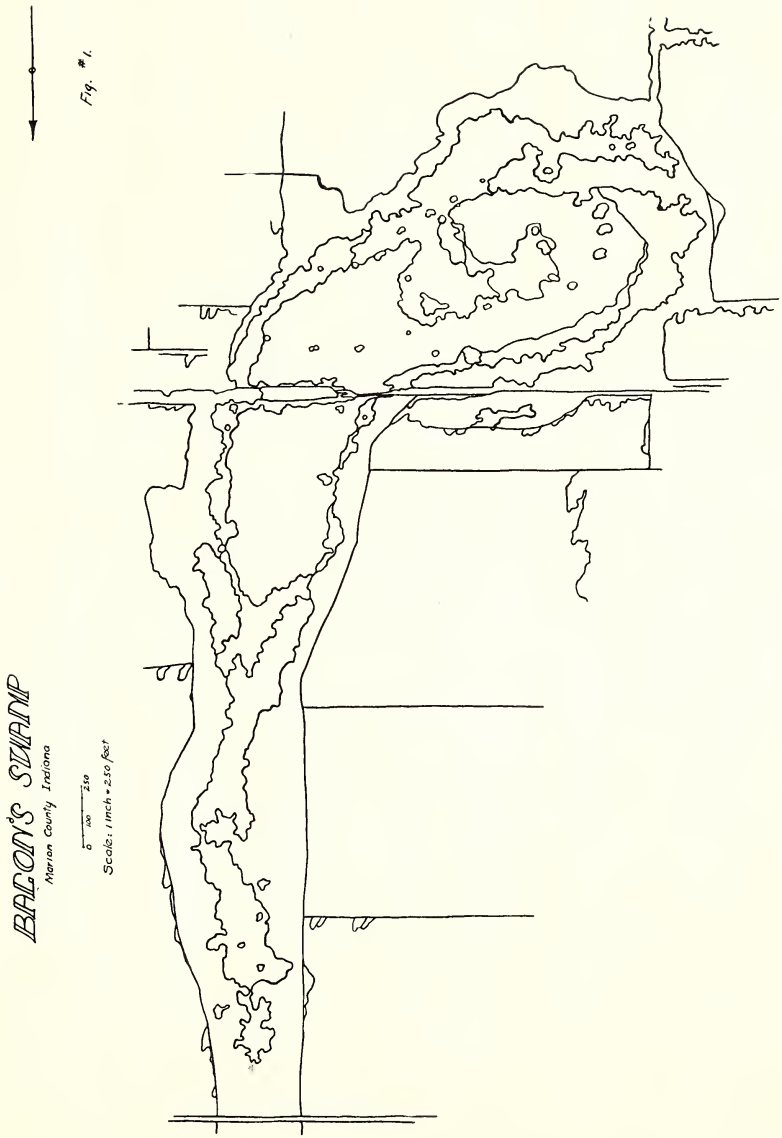

Fig. 1. Preliminary outlines as obtained directly from aerial photographs.

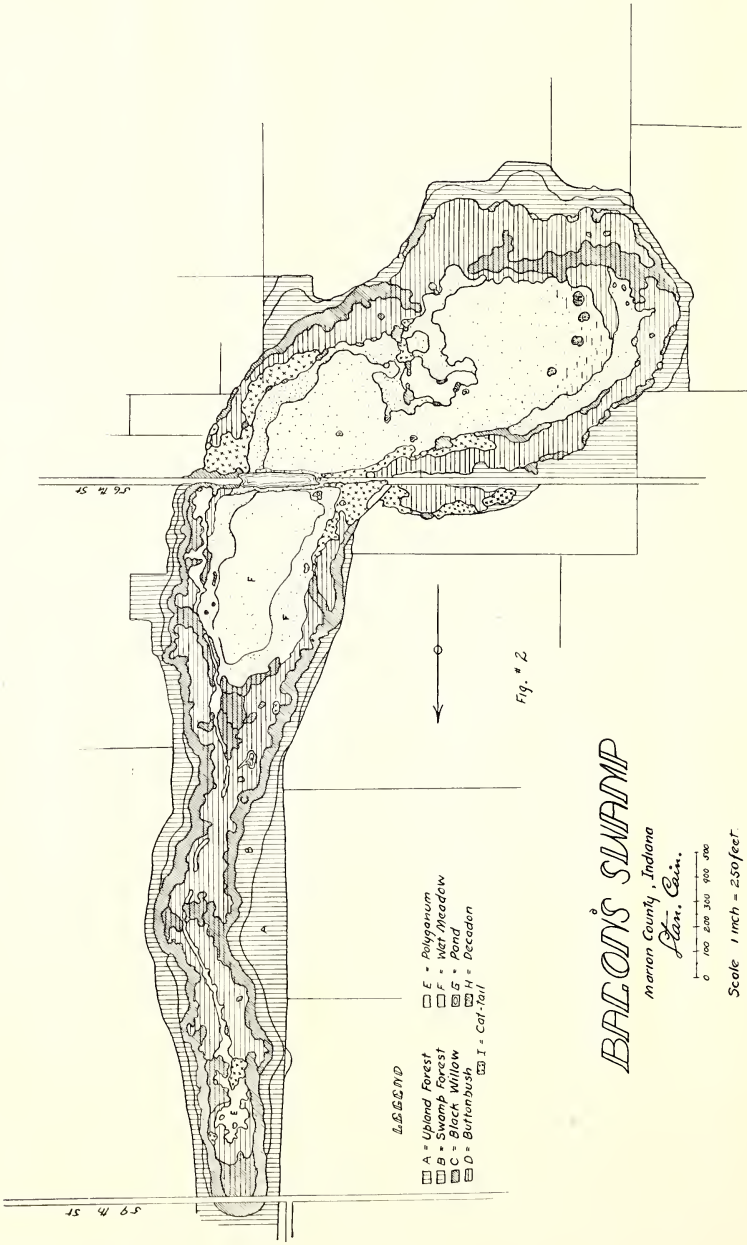

Fig. 2. Completed map derived from figure 1 and the addition of details from a field study.