DISCUSSION

THE CENSUS BUREAU AND THE GREAT LAKES AREA SITUATION

THIS is a brief reply to the defense of the Census Bureau, by Geographers Batschelet and Proudfoot, in a recent issue of SCIENCE, regarding current inaccuracies in the total area figures for the United States and the Great Lakes States.

We tried unsuccessfully for four years (not quite ten!) to track down the responsibility for these errors, with one federal bureau after another squirming out of it. For fourteen months of this period, we had the assurance of Director Austin that the Census Bureau would clearly show the correct total area figures for the Great Lakes States and the United States in the Census of 1940. News of the reversal of this promise was not conveyed to us until the bureau's official release of April 11, 1941, arrived. The bureau then said it was too late and too expensive to change, and retired to a last-line defense by disclaiming legal status for their area figures. At this point we pursued the librarian of the Congress of the United States to the extent of one letter; and it was that official who laid the responsibility for official area figures squarely at the door of the Census authorities.

The omission of 61,000 square miles from the total area of the United States can not be lightly dismissed as meaning nothing to any one other than Michigan and Great Lakes chauvinists. This is an American domain comparable in area to England, Scotland, Portugal, Austria, Belgium, Bulgaria, Denmark, Greece, Guatemala or Holland—a greater portion of American-owned earth's surface than occupied by any one of twenty-seven states of the Union.

Michigan's Great Lakes water area, say the Census Bureau defenders, has never been denied her. They then proceed to give columns of reasons for excluding Great Lakes area from the total area of Michigan and the other Great Lakes States. This Great Lakes water area is denied in total area figures in all current reference books, which take their facts from the Census Report.

Of course the Census Bureau knows about the Great Lakes areas of the Great Lakes States. All figures in the tabulation that accompanied our original article were gleaned, here and there, from footnotes and subsidiary tables in the 1940 Census Report. The bureau's fault is that its way of hiding the figures (so that, they state, even we missed them), is misleading and the cause of widespread inaccuracies.

The clause in the proposed new Michigan constitution will specify merely that the Great Lakes area of Michigan shall be included in the official total area figure of the state. That will permit the use of more accurate measurements from time to time as these become available.

Difficulty in apportioning Great Lakes water among counties and townships of Great Lakes States is given as a reason for lopping off more than one third of the total area of Michigan and more than a seventh of that of Wisconsin; for short-measuring six other states; and amputating from the United States the area of a good-sized kingdom. This is Procrustean performance, not scientific procedure. Surely the mosaic of statistical interpretations should be fitted to the actual fact, rather than the fact mutilated to facilitate statistics.

The Census Bureau defenders cite practise in regard to various large bodies of water in the world, as arguments to support their method. These seas—most strikingly the Mediterranean and the Baltic—are not at all comparable with the Great Lakes. Significantly they omit Lake Victoria in Africa, Lake Baikal in Siberia and Great Slave, Great Bear and Winnipeg Lakes in Canada, all inland fresh-water bodies as large or larger than Lake Ontario. In these approximately parallel instances, the current practise is to include the water areas in the geographical divisions which possess them or a part of them.

We agree whole-heartedly that it is not the function of the Census Bureau to decide state claims to land or water areas and that it does right to avoid trouble in the matter of coastal water areas to which various states "feel they have a legal claim." But when boundaries are legally established, by treaty, Acts of Congress and decisions of the Supreme Court of the United States, the Census Bureau is bound to respect them, and cease to classify them—for statistical convenience—among boundaries that are nebulous.

It seems necessary to re-emphasize that the international line through the Great Lakes region exists independent of the presence of water. If an earthquake tomorrow should swallow or shift any or all of the Great Lakes, the boundary would still remain exactly where it is to-day.

The Census Bureau's obsessional fear of the political hornet's nest involved in ocean-coastal claims is apparent in the space they devote to that tangled world-situation—which is totally unrelated to the clear division of the Great Lakes waters.

Canada and Ontario view the matter as a simple arithmetical problem—the square measurement of regions within established legal boundaries. Ontario includes its share of the Great Lakes in its total area

because this is legally a part of that province. Canada includes this water area in its total area, because Ontario is a legal part of the Dominion. They rest their case convincingly on the Quebec Act of 1774; the Treaty of Paris of 1783; the Constitutional Act and an Order in Council in 1791; the Union Act of 1840; and the British North America Act in 1867.

The Great Lakes region between the international line and the southern shore of the Great Lakes is a part of the United States and should be included in its total area, by virtue of the Treaty of Paris of 1783.

The Great Lakes region between the international line and the Michigan shoreline of the Great Lakes is within the boundaries of and constitutes a part of the State of Michigan, by virtue of the Ordinance of 1787; Act of Congress for the division of Indiana Territory, 1805; Act of Congress, June 15, 1836, admitting Michigan to statehood; and three Supreme Court decisions (270 U. S. Rep., p. 295; 272, p. 398; 297, p. 550–552).

The proposition that title, jurisdiction and proprietorship of the land under the waters of the Great Lakes is in the adjoining states is recognized and established by the following authorities: *Illinois Central Railroad Co.* v. *People of the State of Illinois,* 146 U. S. Rep. 387; *Murphy* v. *Dunham,* 38 Fed. Rep. 503, Eastern District of Michigan, Brown J.; *Bigelow* v. *Nickerson,* 70 Fed. Rep. 113, 7th Circuit Court of Appeals; Attorney General's Opinions, Volume 6, page 172.

The foregoing citations were given us by the Honorable Edward Gearing Kemp, former Assistant U. S. Attorney General, now chief counsel of the Budget Bureau at Washington. This eminent jurist, after reading the entire correspondence with the Federal bureaus, commented that the "old method of reporting water areas is obviously misleading, and in my opinion, inaccurate."

We have no quarrel with the Census Bureau. Their task is vast and tedious and its difficulties too little appreciated. They have gone forward, in many ways, since the time of Gannett, as they say. Nevertheless, their attitude toward this Great Lakes question gives grave room for suspicion that they need a speedier adjustment to this fast-moving world. Why should they, at a time when this continent is leading the earth in countless ways, hark back for precedents to the chaos of old-world geography, where boundaries are about as permanent as the wake that a ship leaves in the water? Above all, why do this in relation to the great transcontinental boundary of North America, the fixity of which marks a new epoch in history, is the envy of the world and a model for the future?

If the Bureau of the Census persists in being concerned exclusively with statistical involvements, and the General Land Office to be interested in nothing but land areas, and the Geological Survey is motivated chiefly by a desire to cooperate with the foregoing agencies, where is the world and its reference books to look for the answer to the simple arithmetical question: What is the total area of the United States and the Great Lakes States? At present, the prevailing inaccuracies are a shadow on the record of the Census Bureau.

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SCALE CURVES IN CARTOGRAPHY

IT is well known that a sphere can not be mapped upon a plane with a uniform scale. Various types of maps are faithful with respect to angles or areas or geodesics, but not to all of them. In the Mercator projection, the scale varies from latitude to latitude. In a general conformal map, the scale varies from point to point (and therefore is a function of the latitude and longitude).

However, if the mapping is not conformal (angles not preserved), then the scale necessarily depends not only upon the point but also upon the direction. Hence the situation is essentially non-isotropic.

We define a *scale curve* as a locus along which the scale does not vary. In the conformal (or isotropic) case, we have merely ∞^1 scale curves; whereas in the non-conformal mappings, we have ∞^2 scale curves. In all conformal maps, the scale curves form a simple family; but in all non-conformal maps, the scale curves form a doubly-infinite family.

Among the famous non-conformal maps are azimuth equidistant projection, azimuth equi-area projection and the various gnomic and orthographic projections. For each of these, the scale varies in a complicated way not usually described geometrically but only analytically. A faithful graphical representation would involve the construction of the double infinity of scale curves. We study these curves (all of which are complicated) in detail. We prove that no mapping of the sphere exists with ∞^2 straight scale curves. *A new class of surfaces is discovered with straight scales.*

The two most famous conformal maps of the sphere are the Mercator projection (1560) and the stereographic projection, essentially known to Ptolemy (150 A.D.). In the former case, the ∞^1 scale curves are parallel straight lines, and in the latter case, they are concentric circles. We prove that these are the only maps where the single infinity of scale curves forms an isothermal family (connected with the Laplace equation). They are also the only maps where the scale curves are parallel. If we demand that the scale curves (in a conformal map) be straight lines,