creased by 70 percent during this period. Fifth and subsequent births have also increased somewhat in recent years and are likely to continue upward for the balance of the decade, although there is little likelihood that the rates for these birth orders will return to the levels of the 1920's.

Second births increased almost without interruption from a low point in 1933 to a peak in 1952. Although the rate has fallen off somewhat, it still is at an unusually high level—one-third above the rate in 1940, and about one-eighth higher than in 1920. In 1945–55 the number of families that had a second child exceeded those that had a first child—a situation which is probably without precedent in our history.

At the other end of the scale, the Metropolitan Life Insurance Company statisticians report that the proportion of older people has been increasing for more than a century, slowly at first and more rapidly in recent decades. The proportion of population at age 65 or older is 8.6 percent, or about one in 12. In 1900 only 4.1 percent of all Americans were in this age group.

According to the Population Reference Bureau, Inc., for the third consecutive year the number of births in the US has totaled more than 4 million. This rising tide of births will soon add further to the mounting school enrollment figures. For the three years from October 1953 through October 1956, kindergartens and elementary schools had to expand enough to take in an extra million children each year. The Census Bureau finds that the total increase for those three years was 3,119,000. The big increase in school children is still to come. Kindergarten enrollment went up 82 percent from 1950 to 1955. Between 1950 and 1955, the number of children who are 5 years of age or under jumped from 14,184,504 in 1950 to 18,305,000 in 1956, an increase of 4,120,496. The number of children in elementary schools increased by 24 percent, and high-school enrollment rose only 19 percent.

Uranium Production

The Atomic Energy Commission has disclosed for the first time statistics concerning uranium ore reserves and uranium mining and milling operations. The information, which was limited to production since 1 July 1955, was authorized by the commission's revised declassification guide.

The uranium ore reserves still in the ground on 1 Nov. 1956 were estimated in millions of tons as follows: New Mexico, 41; Utah, 7.5; Colorado, 4.1; Arizona, 2.6; Wyoming, 2.3; Washington, 1.5; and others, 1. The total is 60 million tons.

The uranium ore mined during the period from July to December 1955 was 840,000 dry tons; from January to June 1956, 1.34 million dry tons; and from July to December 1956, 1.66 million dry tons.

The amount of uranium concentrate milled from the raw ore doubled this last year, the yield of concentrate from the crude ore averaging about ¼ of 1 percent. At the beginning of 1956, uranium concentrate was produced at a rate of about 4000 tons per year; at the close of the year the rate was more than 8000 tons per year. Specifically, uranium concentrate milled during the period from July to December 1955 was 1600 tons; from January to June 1956, 2600 tons; and from July to December 1956, 3400 tons.

At present, 12 uranium mills are in operation in the United States. All are privately owned with the exception of one AEC-owned plant. The total private investment is established at $50 million, with a total daily capacity of 8960 tons. Eight more mills, representing an investment of about $35 million and a rated daily capacity of 4025 tons, are scheduled for completion in 1957 or early 1958.

Randomized Cloud-Seeding Experiment

A recent decision of the Board of Supervisors of Santa Barbara County, Santa Barbara, Calif., to finance a randomized cloud-seeding experiment provides an unusual opportunity for studying the effects of silver iodide smoke, produced by ground generators, on storms passing over mountainous areas. It appears that this will be the first randomized experiment conducted in the United States using ground generators of silver iodide. Also, because of possible complications with lawsuits for damages and the consequent reluctance of public agencies to conduct cloud-seeding experiments on their own, it may be quite some time before another experiment of this kind is organized. In the past there appear to have been only two randomized cloud-seeding trials, those conducted by the U.S. Weather Bureau and by the University of Chicago meteorologists and statisticians. However, these trials involved seeding from aircraft.

During the decade that has elapsed since the discovery of techniques for artificially nucleating supercooled clouds there has been a large amount of effort expended to secure an answer to the question, "Does cloud seeding produce significant increases in precipitation?"

Several years ago the Division of Water Resources of the Department of Public Works of the state of California conducted an investigation of this subject, particularly in relation to the widespread commercial cloud-seeding operations in California. With the help of the Statistical Laboratory of the University of California, it was established that no clear-cut answer to the question of the efficacy of the cloud-seeding operation is available and that none can be expected until a special, so-called "randomized," experiment is performed.

In order to understand this pessimistic conclusion one must take into account that, according to the opinion of professional meteorologists, not all storms are suitable for seeding and only a part of them are actually seeded. Also, in order to judge whether or not the seeding is effective, one must have some sort of standard of comparison, such as, for example, the amount of rain fallen from the same storm in a comparison area, presumably not affected by seeding. In these conditions, even if the comparison between the rain in the target and in the comparison areas appears favorable to the conclusion that seeding is beneficial, there is always the question of whether or not the observed excess of rain in the target is the effect of seeding or a mark of success of forecasting.

In fact, the meteorologist engaged in cloud seeding may be expected to be able to identify among the approaching storms those that will deposit in the target relatively more rain than the others. Then, if only those more promising storms are seeded, the comparison with any preassigned standard would tend to indicate a positive effect of seeding, even though the actual effect of this operation is minute or nil.

This difficulty of distinguishing between the success of forecasting and the success of seeding can be avoided by performing a randomized trial. The meteorologist engaged in weather modification is allowed to select at will the opportunities for seeding. Once such an opportunity is identified, a random experiment is performed: for example, a coin is tossed. If the coin falls heads then the actual cloud seeding begins, but not otherwise. However, the observations of the rainfall are conducted on all seeding opportunities, both those seeded and those not seeded. Then, with a sufficiently long series of observations, the comparison between the seeded and not seeded storms allows a definite conclusion regarding the effectiveness of seeding as such, free from the possible effects of forecasting.

For quite some time appeals for a randomized experiment went unheeded. On the one hand, the communities that paid for cloud seeding (and they were those that believed in the effectiveness of these operations) were reluctant to let about one-half of the seeding opportuni-

ties go unseeded. On the other hand, the companies engaged in commercial cloud seeding did not show any enthusiasm for a randomized trial.

This impasse was broken last May at a conference at the Statistical Laboratory of the University of California at which the problem of artificial weather modification was publicly discussed. After several papers were presented to the audience, all emphasizing the advantages of a randomized experiment, Robert D. Elliott, president of the North American Weather Consultants, took the floor and announced that, provided that financial arrangements could be made, his company would be prepared to submit to a randomized cloud-seeding experiment.

For some years past Elliott's company has been engaged in cloud-seeding operations in Santa Barbara County under contract with the county. Last summer this contract was considered for renewal, and Elliott was successful in persuading the Board of Supervisors of the county to agree that the operations over the forthcoming 3 years 1957–59 be conducted on a randomized basis. At its September meeting the Board of Supervisors approved the contract, and the randomized experiment is to begin on 1 Jan. 1957.

As conceived now, the Santa Barbara experiment will be a cooperative enterprise. With financial support of Santa Barbara County, the actual cloud seeding will be performed by the North American Weather Consultants. The California State Department of Water Resources has undertaken the responsibility of collecting the data on the rainfall. This activity, with Robin R. Reynolds in charge, involves installing and servicing a considerable number of rain gages over the target and over the three selected comparison areas. These rain gages, 38 of which are automatic, are being lent by the U.S. Weather Bureau. The local Forest Service is interested in the experiment and is expected to be very helpful in the observational part of the program. Finally, the Statistical Laboratory of the University of California, Berkeley, has designed the experiment and will evaluate the results.

It is hoped that the expenditures connected with these activities will be covered by a grant from the National Science Foundation. In the meantime, the Office of Naval Research has authorized the Statistical Laboratory to meet the initial expenses connected with the trial from its grant to the Statistical Laboratory intended for other purposes.

While the purely practical question of effectiveness of commercial cloud seeding, with the use of ground generators, is likely to be settled after the 3 years of the proposed study, the framework of the experiment just described would leave unanswered a host of important theoretical questions. The outcome of the experiment may be favorable or unfavorable. In either case there will be questions on why the results were as they were, what was the mechanism of success or failure, did the seeding affect equally all the storms passing over Santa Barbara County, and so forth. It will be realized that, given the necessary observations, the randomized design of the experiment will provide an opportunity for clarifying many problems of this kind.

With this in mind the President's Advisory Committee on Weather Control decided to use the Santa Barbara experiment for certain additional radar observations, not originally contemplated. However, there is little doubt that much more can be done in this same direction.

On 4 Dec. a conference was held in the Statistical Laboratory to consider the opportunities offered by the Santa Barbara project. In addition to Robin R. Reynolds of the California State Department of Water Resources, R. D. Elliott of the North American Weather Consultants, and the hosts at the Statistical Laboratory, this conference was attended by James E. McDonald of the Institute of Atmospheric Physics of the University of Arizona and Walter S. Hopkins and Arnold Court of the California Forest and Range Experiment Station.

At this conference the prevailing opinion was that the opportunities provided by the Santa Barbara experiment should be exploited to the utmost. As a consequence, it was decided to make public the existing arrangements with the hope that individuals, agencies, and institutions interested in artificial weather modification might undertake various observational programs in addition to those already planned. The following particular points were raised.

1) *Two independent sets of observations of precipitation.* In order to avoid any possible doubts about the reliability of records of rain in the target and in the comparison areas, it is desirable to have for analysis two independent sets of observations. Thus, some of the rain gages now available could be installed and serviced by the California State Department of Water Resources, as originally planned. The remaining rain gages could be entrusted to a recognized scientific institution that would undertake responsibility for installing them in the target and in the comparison areas and for servicing them in order to obtain a set of observations independent of those of the Department of Water Resources.

2) *Radar observations.* The aid of President Eisenhower's Advisory Committee on Weather Control has already been promised in providing radar observations using an APS-15 3-centimeter radar to be located on the summit of La Cumbre peak in the Santa Ynez Mountains. There is need for a vertical-pointing cloud-base-and-top indicating radar located somewhere on the coastal plain near Santa Barbara to give a continuous record of the cloud structure of the storms moving into the target area from the Pacific. Special interest centers around the question of generating cells and small convective elements imbedded in the storm cloud systems, for experience in other areas indicates that these elements may be the chief natural units for release of precipitation from frontal-cyclonic storms. A much more illuminating analysis of the target and control rainfall data will become possible if such a radar could be made available.

3) *Freezing nuclei observations.* Inasmuch as there is virtually no observational data on natural freezing nuclei counts prevailing during seeding experiments that have been carried out in the past, and inasmuch as the entire rationale of silver iodide seeding is based on the premise that a deficit of freezing nuclei exists in certain places and at certain times, it follows that a properly planned experiment should include nuclei counts. It is hoped that some agency or institution can offer assistance leading to provision of such counts during the Santa Barbara trials.

Ideally, counts should be made upwind of the generators and also downwind in the silver iodide plumes. It is desirable to measure nuclei at least at sea level on the Santa Barbara coastal plain upwind from all generators and, if possible, also on the summit of the Santa Ynez range. Identical nuclei counters are desirable in the latter case, but counts of any kind, in the face of current paucity of knowledge concerning nuclei, will be of substantial aid to the over-all experiment.

4) *Airflow observations.* Among the current uncertainties in the cloud-seeding problem are those concerned with the details of movement of nuclei from generator to cloud. During an experiment of the type to be started in Santa Barbara in 1957, there is compelling need to perform all possible experiments aimed at defining the trajectories of the nuclei in order to state which parts of passing storms have been seeded and which have been unaffected by ground-released nuclei. Three means of securing this kind of information suggest themselves. They are not all of equal feasibility.

As a minimum, a series of zero-lift pilot balloon runs should be made during a number of seeded situations. These will give some insight into the paths followed by nuclei from ground at least up to cloud base level and will reveal the effects of the first main orographic barrier encountered by the nuclei.

Second, the more complete information obtainable by using tracer techniques, such as those employing fluores-

cent zinc sulfide and aircraft impactor equipment, should be added if at all possible. These give information as to particle concentrations downwind from the generator, and concentrations are of key interest in assessing the numbers of ice crystals per unit volume of seeded storms.

Third, actual counts of silver iodide nuclei in the plumes emitted by the generators should be carried out if it becomes possible to obtain airborne nucleicounting equipment. It is recognized that cloud base heights and general storminess during seeding situations, plus the hazard of the mountains themselves, pose serious problems here, but the need is a very real one.

5) *Synoptic analysis.* Meteorologists familiar with past seeding trials will recognize the need for much more thorough synoptic analysis of the storms seeded during any given program. In the Santa Barbara experiments there is need for some institution or agency to undertake the analysis of the Pacific frontal-cyclonic systems that comprise the seeded population, in order to gain badly needed physical insight into the reasons for the statistical answers that may be forthcoming. Whether the final answers prove positive or negative there will be great scientific interest in the detailed processes that are involved in the seeded storms of this experiment. Thermodynamic analyses and airflow analyses are needed. Fortunately, it is in the nature of this problem, that the analysis can be done later, without any immediate provision of additional facilities. However, the interest of other groups in attacking this problem is invited now.

Inquiries regarding the Santa Barbara Cloud Seeding Experiment should be addressed to either of the present three participating institutions, preferably with copies to the remaining two, as follows: (i) California State Department of Water Resources, Sacramento, Calif.: Attention Mr. Robin R. Reynolds; (ii) North American Weather Consultants, Santa Barbara Municipal Airport, Santa Barbara, Calif.: Attention Mr. Robert D. Elliott; (iii) Statistical Laboratory, University of California, Berkeley 4, California: Attention Professors J. Neyman and E. L. Scott.

J. NEYMAN
Statistical Laboratory, University of California, Berkeley

Fertile Field for Communist Propaganda?

A federal judge has aroused the scientific community by commenting publicly that the younger generation of pure scientists seems to have succumbed to Communist propaganda. Alexander Holtzoff made this observation in Washington, D.C., when he sentenced Bernard Deutch, a graduate student in physics at the University of Pennsylvania, to 90 days in jail for contempt of Congress.

Deutch was a witness before the House Un-American Activities Committee at a hearing in Albany, N.Y., in April 1954. He admitted membership in a Communist group while attending Cornell University and answered questions about his personal activities. However, he refused on moral grounds to name other members of the group.

In November 1955 Federal Judge James R. Kirkland dismissed a contempt indictment against Deutch because it had failed to specify "willful" intent. However, the indictment was reinstated last July by the Federal Court of Appeals, which ruled that Deutch's refusal to answer had been a "positive, affirmative act" and "by its very nature deliberate and willful."

When Judge Holtzoff found Deutch guilty of these charges on 13 Dec., he addressed the court as follows:

"From evidence admitted in other cases that have come before the court, the court has gleaned the inference that the younger generation of pure scientists, specifically engaged in research in physics, has succumbed to Communistic propaganda."

He went on to explain that he was referring particularly to younger persons "engaged in pure science," and stated that a "dangerous" number of nuclear scientists have been found to be Communists. He said further that because of the brilliance of these scientists, they were potentially especially harmful "as subversive instruments." He then observed that "our educational methods have so changed in recent years" that young scientists lack "a proper cultural background" and are "abysmally ignorant of history, political science and economics." Deutch remains free on $500 bond pending an appeal.

So far two organizations have responded vigorously to Holtzoff. Charles C. Price, chairman of the Federation of American Scientists and head of the chemistry department at the University of Pennsylvania said in a letter that at least 1000 research physicists and teachers had been indicted by the jurist.

"While there have been instances of a few scientists, including physicists, whose thinking led to their association with the Communist cause at some time in their lives, we of the Federation strongly believe that the facts do not support your broad indictment of a whole generation of research physicists." Price added that Holtzoff's charges "poorly serve our national efforts to encourage young people to seek careers in science."

The Philosophical Society of Washington, an organization that is composed of 700 natural scientists, has also written a letter to Holtzoff. Malcolm C. Henderson, research professor of physics at Catholic University, was chairman of the committee that composed the communication, which included the following:

"We consider that not only is the distinction you draw between the alleged susceptibility to communistic propaganda of the 'pure' versus the 'applied' scientist a fallacious one, but that there is no evidence that young scientists of any sort are more susceptible to such propaganda than other groups of young people within the general population. . . . We feel that you have been guilty of generalizing from an exceedingly small sample, and one which has been given most undue weight in the public press. . . . The damage that such ill-advised statements as yours may do is to be found in the divisive effect that they have, setting off the scientist even further from the general public, which is only too ready to distrust and dislike the habit of thought of the scholar or scientist. . . . Anything that makes a career in science less attractive to our young people, or which influences their elders to advise against it, can but weaken the country in the long run."

Expanded Conservation Program

The United States Fish and Wildlife Service will develop a greatly broadened conservation program for fish and wildlife resources. The goals of the program are to solve problems of destructive drainage threatening marshes and wetlands for migratory waterfowl and to initiate a planned program of land acquisition to meet Federal and state needs in wildlife management.

As the result of legislation approved by the 84th Congress, the service now has the authority to undertake greatly expanded programs for commercial fisheries. The service is reviewing every possibility that will benefit the fishing industry. All this material will be used in developing the new program.

Additional Declassification

A large additional volume of technical information essential to the development of a civilian nuclear industry here and abroad is authorized for open publication under a 1956 revision of the Tripartite Declassification Guide. The United States, Great Britain, and Canada use this guide to determine what atomic energy information, jointly held, may be published and what information is to remain classified.

The information declassified by the new guide, now approved by the three nations, relates to all phases of nuclear power from ore recovery and fabrication of fuel elements to the design and opera-