leagues have set their sights on building the telescopes on two of the best mountaintops in the world—Mauna Kea in Hawaii and Cerro Pachon in Chile. With such remarkably clear views, the new larger 8-meter mirrors should produce images that are a factor of 4 to 16 times better than those produced by current ground-based telescopes, says Wolff.

NOAO astronomers feel so strongly about access to both hemispheres that when faced with limited funds of about $88 million, they decided it would be better to ask the NSF to pay for half of each telescope, rather than all of one. NSF director Erich Bloch then encouraged them to seek international partners to share the cost.

This proposal has led to complaints from the astronomical community, some of whom are calling Bloch "Mr. Internationalization," and who think the United States should be able to afford its own national observatories. The community is split over whether it is better to have one national observatory or half of two international telescopes. Some are worried that construction could be delayed by involving so many different groups and funding agencies.

"I think there's some disappointment in that it's already taken so long to arrange the funding for this," says Harvard University astronomer George Field, whose committee advised the National Research Council in 1982 to build the NNTT. "After all, the recommendation for funding for an optical telescope came out in 1982 and it's taken 8 years to even put it in a proposal." Most astronomers, however, seem to agree with CalTech physicist Ed Stone when he says, "Half a telescope is better than none."

The proposed international partnership is by no means a sure thing, however. The two main potential partners are the British and the Canadians. The British are expected to decide this summer whether to sign up with the United States or with other Europeans to build their own 8-meter telescope on La Palma in the Canary Islands—a site where they would get more viewing time for less money. The Canadian astronomical community likes the proposal but has budgetary hurdles of its own to overcome and won't make a decision until next year.

The NSF staff is reviewing the proposal now; it expects to give the National Science Board a recommendation by fall. How serious is the NSF? "I think you get a good sense of how serious we are by the fact that a significant start on it is in the (proposed) 1991 budget," says Laura Bautz, director of NSF's division of astronomical sciences. "In a sense, we have made an important decision to go forward with some kind of 8-meter telescope partnership." ■ ANN GIBBONS

Census Adjustment Battle Heats Up

Statisticians have methods to adjust—even supersede—the census count, but the decision to use them is a political matter

DEMOCRATIC POLITICIANS INSIST ON IT. Their Republican counterparts denounce it as a political manipulation of virgin data. Statisticians are divided as to its feasibility. But for the first time in history, the Census Bureau is gathering data for what may be the first statistical adjustment of its decennial count of the American population—one intended to account for the 3 to 5 million citizens the census is expected to miss this year.

Passions run high where the census is concerned. Census figures chart the ebb and flow of population movement and the legislative apportionments that result. More than $50 billion in federal revenue is distributed among the states according to census figures. With such political and economic resources at stake, it's hardly surprising that talk of manipulating the numbers is taken very seriously.

Indeed, the idea of an undercount already has a long history of heated tempers. Following a spate of lawsuits after the 1980 census, the Commerce Department, which oversees the Census Bureau, developed methods for correcting the undercount, which is concentrated among the poor and minority "underclass." In 1987, the department backtracked and announced that there would be no adjustment for the undercount. But now, in the face of further legal action and recent protests from congressional Democrats, Commerce is reconsidering.

> *"It's obvious that the first phase of the census process was a failure."*
>
> – Vic Fazio (D-Calif.)

The census operates under a constitutional mandate to "enumerate" the population every 10 years, which it attempts to fulfill in the simplest possible manner: by counting every man, woman, and child in the country. Over the years, this effort has evolved into a two-step process. In the first phase, forms are mailed to every household on the Census Bureau's master list. Perhaps as a result of a declining sense of civic responsibility, or perhaps as a result of the growth of the underclass, this year only 64% of the forms distributed were mailed in.

That was the lowest response rate ever; the Census Bureau had expected 70%. The second phase of the census is designed to account for missed households and delinquent respondents. In phase two the bureau sends trained enumerators to every household that failed to return forms. This phase is now under way and is due for completion by 6 June. Visiting 37 million households, the enumerators may count as many as 50 million people.

Even when both phases work smoothly, the census invariably misses a fraction of the population. And that undercount isn't evenly distributed. In 1980 the census missed 1.4% of the total population, but considerably larger numbers of minority groups: blacks, for example, were undercounted by 5.9%. And the undercount will probably be even worse in the 1990 count. "Given the growth of the underclass over the past decade, I can't see how the undercount could be any smaller," says Stephen Fienberg, a professor of statistics and social science at Carnegie-Mellon.

The undercount is a particularly emotional issue for congressional and big city Democrats, since the low count is concentrated among the poor and urban areas in their constituencies. "It's obvious that the first phase of the census process was a failure," said Representative Vic Fazio (D–CA), one of several House Democrats who called for statistical adjustment during a recent hearing. Several months ago, Representative Charles Schumer (D–NY) criticized the Bush Administration in the *New York Times*, writing that "someone in Washington doesn't want an accurate count in largely Democratic urban areas." Republicans are quick to articulate their own political concerns; Representative Vin Weber (R–MN) calls the movement for adjustment "an attempt to use a statistical device to achieve political objectives."

The techniques that are now raising such

a political fuss were developed in response to more than 50 lawsuits over the 1980 undercount. The Census Bureau spent 6 years developing a method to correct the official figures: a post-census survey of 150,000 households designed to gather enough data to estimate the undercount with confidence. That method was endorsed by committees of both the National Academy of Sciences and the American Statistical Association. But in 1987 Undersecretary of Commerce Robert Ortner announced that the 1990 census would not be adjusted, telling a press conference, "We don't play with the numbers." Later, facing court action from many of the same plaintiffs who sued in 1980, the Commerce Department reluctantly agreed to reconsider its stand.

Here's how the adjustment would work. From more than 300,000 census blocks—geographic areas that include an average of 300 households apiece—Census Bureau statisticians have drawn a sample of 5,000 blocks that is intended to reflect national demographic characteristics but also to be clustered more heavily in densely populated urban regions. In each of the chosen blocks, teams of survey-takers will attempt to visit every household to obtain basic information about the residents: name, age, and ethnic background.

Once this information is collected, census demographers will match addresses from the enumerated census—designated the "E-sample"—and the post-enumeration survey—the "P-sample." The aim of the matching is to estimate the number of people who were left out both times, and the statistical technique employed is a method called "dual-systems estimation."

In this case, the dual systems are the E-sample and the P-sample. In any given census block, a certain percentage of people will have been omitted from the E-sample. This percentage should be reflected in the P-sample, allowing statisticians to estimate the total number of people in the census block. Technically, this number is a ratio of those counted only in the P-sample to those counted both times, multiplied by those counted only in the E-sample.

Once this number is calculated for each of the surveyed census blocks, statisticians can pool the data from all surveyed blocks and divide it into nearly 20,000 demographic categories by age, ethnicity, home ownership, and urban or rural residence. An adjustment ratio will then be calculated for each category. Finally, the data in census blocks across the country can be multiplied by these adjustment ratios to yield an adjusted count.

There is general agreement among statisticians that such methods can provide a good estimate of the national undercount. Yet some members of the statistical community argue that, because of the tremendous variability present in urban neighborhoods, finer grained corrections are unrealistic. "When you walk around the city, blocks are different," says David Freedman, a statistician at the University of California at Berkeley. "It's a fact of life." Freedman compares the small-scale adjustments to predicting the outcome of a single coin flip. "Your chances aren't very good," he says. "But if you're going to toss it several thousand times, you can predict the number of heads with some accuracy."

Considerations of accuracy will no doubt play a role in the decision of whether or not to adjust. But they probably won't be the only consideration. Deciding whether to adjust is the responsibility of one man—Commerce Secretary Robert Mosbacher, who must announce his decision by 15 July 1991. According to a set of Commerce Department guidelines, Mosbacher must not only ensure that an adjustment would be both constitutional and more accurate than the enumerated count down to the census block level, but must consider the "potential disruption" on redistricting and the effect on public confidence in the census that adjustment might have.

To some, these guidelines are unconscionably vague. "The guidelines are crap," says Robert Rifkind, an attorney representing a coalition of large cities, including New York, Chicago, Los Angeles, Houston, and many others, that are back in court over this very point. "They permit the secretary to reject adjustment even if he believes it would materially increase the accuracy of the census. They permit him to reject adjustment if he can't make up his mind by 15 July 1991, even if he hasn't done his homework." But Charles Jones, assistant director of the Census Bureau, disagrees. "I think the guidelines are fair and present a balanced playing field for the decision."

Regardless of which way Mosbacher leans next July, statistical adjustment will no doubt play a larger role in the future. The Census Bureau has used statistical methods in the past—although not for an overall adjustment of the count. In 1970, the bureau's emergency National Vacancy Check sampled 13,500 apartments listed as vacant, found 11% occupied, and projected the occupancy rate for all "vacant" apartments. And since 1970 the bureau has "imputed" household counts for unenumerated apartments which are known to be occupied, a procedure which added 763,000 people to the census rolls in 1980.

In fact, the idea of the census as a head count may be out of date; it may be more efficient and cost-effective to replace enumeration with statistical sampling. The logistical difficulties involved in knocking on 37 million doors to complete the enumeration are severe and may introduce additional error. "Overall, there's growing distrust of the government, survey-like activities, and the government's effort to collect personal information," says Carnegie-Mellon's Fienberg. "This is a sociological problem."

"I've suggested taking 120 samples, one a month for 10 years," says Leslie Kish, a University of Michigan statistician. "The undercount is hot right now, but obsolescence of the census data is the real problem." There are at least two obstacles to using statistics instead of a head count. To calibrate the sample, the Census Bureau would need something like a national identification registry, a step Americans have always resisted. Furthermore, a sampled census may not be constitutional, since the Constitution specifies "enumeration" of the population. But if civic responsibility continues its downward slide, the Census Bureau may have no alternative.

■ DAVID P. HAMILTON

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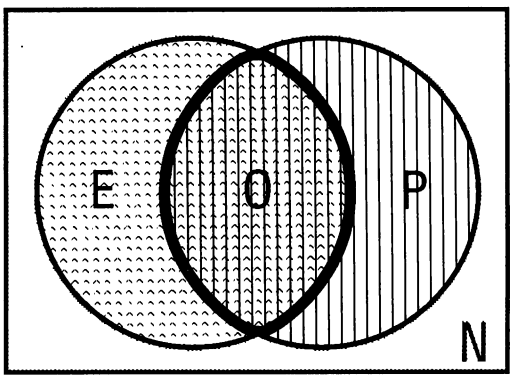
Adjusting the Undercount



The panel shown above represents a typical census block, the working unit of the census. Each block includes about 300 households. **E** is the "enumerated sample," the population counted by conventional census methods. **P** is the "post-enumeration survey" sample, a detailed count made for the purposes of adjusting the census undercount. **O** is the overlap, the population counted in both samples. **N** is the population not counted in either the **E**-sample or the **P**-sample. The total population can be estimated by the formula **P/O x E**.