served by *rapid* reporting or by *accurate* reporting? Toth infers that speed should be the overriding consideration. He is impatient with the reviewing system that the scientific community has voluntarily adopted in the interest of preserving the integrity of its record. If he had to wait 4 to 6 months to check his story, one might be sympathetic with his impatience. However, when the period required for publication is only 3 to 4 weeks, during which time the article has been critically reviewed by a qualified individual, one wonders, "Why all the fuss?" Indeed, it seems that express-letters journals offer a service to the general public as well as to the research community. At the cost of only a small temporal inconvenience, the public may now obtain through news media information which has been reviewed and which therefore bears a much stronger claim to objectivity and accuracy. In the same sense, express publication can be considered a service to the science news writer himself: He has reasonable assurance that the facts in his story have been checked at a level of competence higher than he can muster without a considerable degree of inconvenience.

These remarks should in no way be construed as disparaging of the valuable service rendered by science reporters. Theirs is a difficult calling and their efforts deserve the respect of both scientists and the general public. Moreover, there should be no fear that scientific journals will ever compete with the daily press or that their editors will as a matter of deliberate policy obstruct the reporter's access to information. Rather, I am convinced that the innovation of express journals will assist the science reporter in his important function of linking the scientist with the general public.

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Consumption of Water

The article, "Human water needs and water use in America," by Charles C. Bradley [*Science* **138**, 489 (1962)] appears to be based on erroneous assumptions. It is conceivable that Malthusian limits will be imposed upon the population of North America, but it will not be in the foreseeable future and least of all will it be because of lack of water resources.

If we accept Bradley's argument that "3300 billion gallons per day are productive of crops or surplus water," and that this figure less unconsumed runoff gives "a remainder of about 2500 billion gallons per day which we are *consuming,* though perhaps wastefully, to produce our crops," then we can agree with him that, after "metered consumption" is added in, the total of 15,200 gallons per day per person is reasonable.

In the literature, however, *consumption* is generally taken to refer to the loss of water as a result of its withdrawal from streams, lakes, reservoirs, and ground-water storage by man. In effect we ask how much the "loss" due to natural causes has been increased by human development and use of the resource. *In toto* man's activities have had a number of consequences, but the impact has been small. Evapotranspiration in the humid East, the area with which Bradley is mainly concerned, has probably not changed greatly from the days of the pristine forests.

Bradley indicates that the figure for consumption is to be obtained "by subtracting the water which we are not using [runoff] from the total water available." This appears to correspond to the familiar formula: evapotranspiration = precipitation − runoff. Consumption so defined is relatively constant through time, if no great climatic change occurs. Application of the formula for an earlier year—1910, for example—yields results as follows. In 1910, when the population of the United States was half what it is now, the per capita consumption would have been 28,470 gallons daily, if we assume the withdrawal to have been only half that cited by Bradley. Hence, it appears that per capita use of water has been rapidly diminishing, and that this trend will continue with rising population.

Bradley proceeds to multiply the figure for present per capita "consumption" by that for anticipated population and concludes that "young Americans alive today will see a significant deterioration in their standard of living before they are much past middle age." To determine the validity of this prediction let us find whether a prediction made 50 years ago on the basis of per capita "consumption" and the anticipated population for 1960 would have been borne out, had the population been correctly predicted.

Using the 1910 per capita figure of 28,470 gallons per day in this manner, we find that by 1960 the use of water should have been 5125 billion gallons per day, or more than the total daily supply of 5000 billion gallons which Bradley claims is now available in the United States (exclusive of Hawaii and Alaska). The limit should already have been reached, and Americans should now be experiencing a significant decline in their standard of living.

Readers may wish to consult the most comprehensive estimates, to date, of present and future water use—those prepared by Nathaniel Wollman for the recent Senate Select Committee ["Water Resources Activities in the United States: Water Supply and Demand," *Select Committee on National Water Resources, U.S. Senate, 86th Congress, 2nd Session, Print No. 32* (Government Printing Office, Washington, D.C., 1960)]. These estimates indicate that consumption (in the widely accepted use of the term) in 1954 was 109 billion gallons per day, estimates for the years 1980 and 2000 being put at 190 and 253 billion gallons per day, respectively.

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I share Bradley's concern over the need to manage our water supplies wisely, and in general I accept his figures on water supply. But my interpretation of those figures leads me to more optimistic conclusions for the future.

For the portion of the country accounting for the bulk of our crop production, Bradley gives a figure of 2500 billion gallons per day for evapotranspiration—the return of water to the atmosphere through transpiration from plants and by evaporation. This may be divided into two parts. (i) Evapotranspiration from cropland and nonforested pastureland. This was estimated for 1959 at about 1000 billions of gallons per day for the United States, by Ackerman and Löf in their book *Technology in American Water Development*. (ii) Evapotranspiration primarily from forest land, of which about a third is grazed, and from other rural land not used for farming.

Let us consider first the evapotranspiration from cropland and pastureland. According to *Land and Water Resources, a Policy Guide*, published in

1962 by the U.S. Department of Agriculture, we are expected to provide for 261 million Americans in 1980 from a smaller acreage of cropland and pasture than was needed to support 180 million in 1959. Certainly, the continued yield increases required to make this possible will result in materially increased evapotranspiration per acre, but at a much lower rate of increase in water use than in population growth. As yield increases, evapotranspiration does not rise in proportion.

This argument applies even more strongly to the share of evapotranspiration from forest land and other rural lands. With increased population these lands will require more intensive management for increased timber harvests, recreation, and other uses. But more intensive use does not always imply much higher evapotranspiration. Conceivably it may even mean less evapotranspiration in some cases.

Therefore it seems to me that lack of water need not be a bar to a rise in population and a sustained high standard of living, provided, as Bradley points out, that we make full use of human ingenuity to prepare for the future.

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It is probably true, as Burton and Kates say, that man's activities have not altered very significantly the total evapotranspiration figure since 1910, although I strongly suspect these activities have shifted the balance significantly from transpiration to evaporation. However, in 1910 Americans were still a long way from complete utilization of America's arable land. Transpiration was not yet working directly for us on a full-time annual basis. In 1910 we were at the peak of our exploitation of renewable resources—we were "mining" our forests, grasslands, and natural reservoirs. This amounts to living mainly off water capital instead of income. Those days are almost gone, and as a nation we are about down to income and are using our land (and the water that falls on it) far more fully than we did in 1910. I suggested in my article that we may have about 10 percent of highly productive land left to put into use. Gains beyond this will probably be marginal. While I could be wrong in this assumption, I do not believe the error would have any long-run significance when we are considering a population that is now doubling every 40 years. It is one thing to double the 1910 population of 60 million, quite another to double the 1960 population of 180 million.

My remarks on the American standard of living were, to a certain extent, made tongue-in-cheek. The rich flavor of chlorine in my drinking water, an open sewer named Clearwater Creek, the green scum and aroma of dead fish coming from my old swimming hole all tell me that something obscene has long since affected the *quality* of my "water standard of living." More important, perhaps, is the fact that, in the last 10 to 15 years, *quantity* of water has become an expanding problem in more and larger areas of the United States. There are very few major areas left where no water problem exists. Some places are in deep trouble. It therefore really takes no sophisticated mathematical insight to see that the limits of water supply in the nation as a whole, for the ways in which we are now using it, are practically at hand. In other words, I don't argue too much with Burton and Kates's manipulation of my figures since to me they merely suggest that we already have *passed* the peak in our water standard of living.

Regarding Gertel's comments, is he saying that increased yield of crops (forest and pasture included) per acre will not require a linear increase in *transpired* water, or does he perhaps mean that by more thorough plant cover and management a larger proportion of the rainfall can be shifted from evaporation to transpiration? If he means the former the statement should be documented. If he means the latter I agree. In fact I hinted in my article that herein lies our biggest opportunity to effect water conservation.

Gertel suggests that the "people versus water" picture is not as bleak as I have painted it. Would he care to apply his own figures toward answering the question posed in my article: How many more years can we sustain our present water standard of living with the projected population curve?

I realize that the timetable for Malthusian limits to be imposed on the population of the United States is not really foreseeable. I merely indicated that present population trends and present rate of rainfall would, in 200 years, bring us to the point of using all our rainfall to raise our food; I based the calculation, of course, on the transpiration ratios and the assumed diet of 2 pounds of bread and 1 pound of meat per day per person. I understand that the latest census studies indicate a slight leveling in the population growth curve, and this curve, of course, is the key to any calculation of timetables. Furthermore, I am certain that long before we begin to approach Malthusian limits we will not be insisting on a daily ration of steak. Any wholesale dietary shift from bread and meat to, say, marine plankton would make the transpiration ratios meaningless although few Americans today would construe such a shift as a gain in our standard of living.

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"Critical Periods" in the Development of Behavior

Scott's interesting article (*1*) on "critical periods" in behavioral development merits a thoroughgoing critical review bearing on the validity of his general conceptions of behavioral ontogeny basic to the idea which he has extrapolated from embryology to the study of behavior. Here, however, we comment specifically on certain inferences that might be drawn from his allusion to our recent article on behavioral development in cats (*2*).

In discussing his concept of critical periods, Scott reports us as having "suggested that there are critical stages of learning—that what has been learned at a particular time in development may be critical for whatever follows."

Although we are not disposed to dispute this broad statement, it is not ours. In our view, any such sentence should have a more comprehensive context, to the effect that what the young animal may attain in behavior at any phase of ontogeny depends upon the outcome of earlier development in its every aspect. The point we wish to emphasize here, however, is that our position might be seriously misunderstood in at least two important respects from Scott's allusion to our article. (i) Although, as our study of social behavior in newborn kittens (*2, 3*) indicated strongly, learning is involved at all phases in behavior development, our findings have broader and very different implications for social ontogeny than might be gathered from Scott's mention of the work. (ii) The