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International Public Opinion on the Environment

David E. Bloom

This article analyzes public opinion data on environmental issues collected in two major surveys. The data reveal substantial concern about the environment in both developing and industrial countries along with perceptions that the quality of the environment has declined and will continue to decline. Developing country respondents rate their local and national environmental quality lower than do industrial country respondents, whereas both groups rate global environmental quality about the same. The data also reveal considerable willingness among the developing and industrial countries to accept responsibility for the world's environmental problems and recognition of the importance of governments in addressing local and national environmental issues and of strong international agencies in addressing transnational issues.

Free markets tend to work poorly in allocating resources for preserving and enhancing the environment. Indeed, negative externalities, public goods, or common property—all classic (and related) causes of market failure—are at the heart of most environmental problems (*1*).

Whether by voting or government fiat, societies must make decisions about allocating resources to "environmental quality" (*2*). Voting mechanisms are at their best when political leaders know their constituents' preferences for environmental quality relative to their preferences for alternative uses of society's resources. Presumably, fiat rulers also benefit from having information about mass opinion. In this connection, public opinion polls are emerging as a potentially valuable source of information on people's perceptions about the seriousness and causes of environmental problems, their preferences for environmental quality, and their preferences among alternative solutions to different environmental problems. Unfortunately, as the various polls have been conducted mainly in industrial countries, little information has been available about developing countries.

Notable attempts to collect comparable public opinion data on environmental issues in a range of developing and industrial countries are a 1992 Gallup survey ("The Health of the Planet") of 29,618 individuals in 24 countries (12 developing and 12 industrial), whose total population represented 29% of the world's population at that time, and a survey conducted by Louis Harris and Associates in 1988–89 ("Public and Leadership Attitudes to the Environment in Four Continents") which gathered information from 8325 individuals in 16 countries (12 developing and 4 industrial), whose total population represented 29% of the world's population in 1989. Although individual responses to the Gallup and Harris survey questions are not readily available, country-level tabulations of responses to most questions have been published, allowing within-country comparisons of responses to different questions and between-country comparisons of responses to the same questions (*3*).

This article addresses three sets of issues: (i) What is the nature and extent of public concern about environmental quality? (ii) What are the perceived causes of environmental problems, and what countries are being blamed for those problems? (iii) To what extent is the public willing to bear the cost of environmental protection and cleanup, and do people recognize the essential role of governments and international agencies in that effort? The article distinguishes between local, national, and global environmental issues and compares industrial and developing countries (*4*).

Methodological Issues

The collection of opinion data by polling representative samples of large populations has expanded rapidly in the United States and abroad during the last six decades. At the same time, an extensive literature has developed on the information content of public opinion data. In a classic study, Schuman and Presser (*5*) reported on a series of rigorous analyses of the sensitivity of survey results to question form, wording,

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and context. Their analyses generally show that the way in which questions are asked may affect the results. This finding suggests that the results from a particular survey and comparisons between Gallup and Harris survey responses are not as meaningful as comparisons of Gallup survey responses across countries and of Harris survey responses across countries. Even cross-country comparisons of responses to the Gallup survey should be interpreted cautiously given possible differences in the way particular questions are interpreted in different countries and cross-country differences in sample designs [see (6, 7) for details]. All of the Gallup surveys (except in India, where the survey was administered predominantly in urban areas) and the Harris industrial country surveys relied on sample designs ordinarily used by respected local organizations to generate nationally representative samples. Because of the expense of surveying rural populations, most of the Harris surveys of developing countries are representative of adults living in major metropolitan areas.

The public opinion literature also addresses other important technical issues, such as nonresponse bias, nonrepresentative samples, sampling error, sample design effects, and the effects of political context, along with more general issues of interpretation, for example, whether media coverage and the attitudes of elites are a cause or a consequence of public opinion and the connection between intentions and behavior (8, 9). Notwithstanding these important issues, it is well established in democratic societies that carefully designed public opinion surveys do reflect public awareness and concerns, do influence political leaders, and are generally a valid predictor of popular behavior, especially changes in behavior over time and differences in behavior between groups (*10*).

For both the Gallup and Harris surveys a variety of quality control mechanisms were adopted in their design and implementation. The Gallup survey was developed with the assistance of an experienced international advisory panel, with considerable input from the local Gallup affiliates that reviewed, translated (when necessary), pretested, and implemented the survey in each country. The Harris survey was also carefully designed and pretested, with considerable attention paid to the development of questions whose meaning would not vary from country to country. The translation quality of both the Gallup and Harris surveys was guaranteed by independently translating the local language questionnaire back to English and comparing it with the original, then revising the translation accordingly. The order of survey questions and responses was the same in every country for both surveys. In addition, both Gallup and Harris provided a common set of detailed instructions to experienced interviewers in each country.

Information on nonresponse is not readily available. Most questions allowed for a "not sure–don't know–refused answer" response, thereby minimizing problems of missing data. No data were imputed. Coverage of broad geographic regions and income groups and the availability of experienced local survey research companies that could conduct the surveys were the primary concerns in selecting countries to be included in the Gallup and Harris surveys. Although countries included in the Harris survey are slightly below the world average in terms of their per capita income, countries in the Gallup survey are sufficiently above the world average to limit their generalizability to the rest of the world.

International Concern About Environmental Quality

The surveys reveal substantial, though not overwhelming, concern about the environment (Table 1). Of the Gallup population, 12% views the environment as the most important problem facing their nation, with 37% expressing a great deal of concern about the environment (*11*). Sizeable shares of both the Gallup and Harris populations perceived the quality of the environment to be poor, especially the global environment. Both surveys also revealed a widespread perception that environmental quality has declined over time and a belief that it will continue to decline in the future. Indeed, a large proportion of the Harris population reported that the environment where they live had deteriorated in the preceding decade. In addition, the proportion of the Gallup population that expected environmental problems to affect the health of their children and grandchildren "a great deal" was substantially greater than the proportion that felt that environmental problems had affected their health "a great deal" at the time of the survey or 10 years earlier.

The second column of numbers in Table 1 reports differences between developing and industrial countries in people's opinions about the environment. Although equal proportions of the population in each country group view the environment as their nation's most important problem, the developing country population rates the

Table 1. International public opinion about the seriousness of environmental problems. Values are the cross-country population-weighted averages in percent. DCs, developing countries; ICs, industrial countries; G, Gallup survey; H, Harris survey. See (*16–20*) for additional explanatory notes.

Survey question	Specific response	Respondents giving specific response (%)	
		Overall	DCs − ICs
What do you think is the most important problem facing our nation today? (G)	Environment†	12	0
How concerned are you about the environment? (G)	A great deal‡	37	12*
How would you rate the quality of the environment in this country? (H)	Poor§	30	9*
Hou would you rate the quality of the environment in:			
Your local community? (G)	Very bad‖	14	15*
Your nation? (G)	Very bad‖	19	15*
The world as a whole? (G)	Very bad‖	24	−5
Do you feel the environment where you live has become better or worse or stayed the same in the last 10 years? (H)	Worse¶	53	8
Did environmental problems affect your health 10 years ago? (G)	A great deal‡	13	5
Do environmental problems affect your health today? (G)	A great deal‡	33	20*
Do you expect environmental problems to affect the health of your children and grandchildren? (G)	A great deal‡	53	11*

*$P < 0.05$, two-tailed test. †This is an open-ended question, asked before it was revealed that the focus of the survey was on the environment, except in Ireland, where it was known to be an environmental survey at the outset of the interview. ‡Other possible responses were a fair amount, not very much, not at all, and not sure/don't know. §Other possible responses were excellent, pretty good, fair, and not sure. ‖Other possible responses were very good, fairly good, fairly bad, and not sure/don't know. ¶Other possible responses were better, worse, stayed the same, and not sure.

quality of its local and national environments considerably lower than the industrial country population rates theirs. These differences are consistent with comparisons of objective measures of environmental quality between developing and industrial countries (*12*, *13*). The difference between the developing and industrial populations in the proportion who rate the quality of the global environment as very bad is statistically insignificant.

Of serious local problems (Table 2), the largest proportions of the developing country population rate "inadequate sanitation, sewage, and garbage disposal" and "poor water quality" as very serious. "Poor water quality" is also the problem most often rated very serious by the industrial country population, although this response might reflect different underlying concerns than the same response in the developing countries (for example, recreational and aesthetic concerns as opposed to health concerns). Note, however, that the developing country population rates each local environmental problem as very serious significantly more often than the industrial country population.

In contrast, concerns about worldwide environmental issues (Table 2) are more congruent between developing and industrial country respondents. Thus, the hypothesis that people in developing and industrial countries have the same perceptions about the seriousness of environmental issues facing the world cannot be rejected for seven of the eight issues specified. However, transnational environmental problems—acid rain, global warming, ozone depletion, species loss, and loss of rainforests—are generally perceived to be very serious by more than half of the developing and industrial country respondents, considerably more than the proportions perceiving environmental issues as very serious in their local communities.

Although not reported in the tables, the correlations between pairs of industrial countries in the proportions of respondents rating different environmental issues as very serious are quite high: 0.88 on average for issues in the local community and 0.72 for issues in the world. Perceptions about local environmental issues are also reasonably consistent among the developing countries, with an average correlation of 0.66. However, the average correlation among pairs of developing countries is just 0.30 for issues in the world. This may indicate that the quality of knowledge about environmental issues facing the world is more uneven or lower in developing than in industrial countries (*14*).

Table 2. International public opinion about the seriousness of selected environmental issues. Values are the percent of those surveyed responding "very serious." Abbreviations as in Table 1. See (*16–20*) for additional explanatory notes.

Environmental issue	Cross-country population-weighted averages		
	DCs	ICs	Difference
"Very serious" in local community†			
Poor water quality (G)	43	19	24*
Poor air quality (G)	35	17	18*
Contaminated soil (G)	23	12	11*
Inadequate sanitation and garbage disposal (G)	45	16	29*
Overcrowding (G)	26	10	17*
Too much noise (G)	28	9	19*
"Very serious" in the world†			
Pollution of rivers, lakes, and oceans (G)	61	65	−4
Air pollution and smog (G)	65	55	10*
Soil erosion, polluted land, and loss of farmland (G)	51	48	3
Loss of animal and plant species (G)	57	51	6
Loss of rainforests and jungles (G)	60	64	−4
Global warming (G)	46	52	−6
Loss of ozone in Earth's atmosphere (G)	53	60	−7
Pollution caused by acid rain (H)‡	71	78	−7

*$P < 0.05$, two-tailed test. †Other possible responses aside from "very serious" were somewhat serious, not very serious, not serious at all, and don't know. ‡Other responses were minor problem, not a problem, and not sure. The reported percent is that of people responding "major problem."

Perceived Causes

In the Gallup survey, both developing and industrial country respondents identify business and industry being more concerned about economic growth than the environment as the leading cause of their nations' environmental problems (Table 3). In addition, more than half of the developing country population perceived lack of knowledge about how to protect the environment and individual wastefulness as contributing a great deal to their nations' environmental problems. A large share of the industrial country population also perceived individual wastefulness as contributing a great deal to their nations' environmental problems. One of the lesser causes identified is government not placing enough emphasis on protecting the environment. Nonetheless, 48% of the developing country population and 38% of the industrial country population cited this as a problem. Overpopulation, which is the least cited cause of national

Table 3. Causes of national environmental problems. Values are the percent of respondents that said each cause contributes "a great deal" to the nation's environmental problems. Abbreviations as in Table 1. See (*16–20*) for additional explanatory notes.

Cause cited in survey	Cross-country population-weighted averages		
	DCs	ICs	Difference
Overpopulation ("There are too many people using up resources.")† (G)	47	26	21*
Government ("It does not place enough emphasis on protecting the environment.")† (G)	48	38	10*
Waste ("Individuals use more resources than they need and throw away too much.")† (G)	54	61	−7
Lack of education ("People just don't know what to do to protect the environment.")† (G)	58	40	19*
Business and industry ("They care more about growth than about protecting the environment.")† (G)	65	61	4
Technology ("The way products are made uses too many resources and creates too much pollution.")† (G)	56	46	10*
Cutting down of forests is a "major cause" of pollution or damage to the environment.‡ (H)	73	66	7
Failure of countries around the world to work together is a "major cause" of damage to the environment.‡ (H)	56	60	−4

*$P < 0.05$, two-tailed test. †Other possible responses aside from "a great deal" were a fair amount, not very much, not at all, and not sure/don't know. ‡Other possible responses were minor cause, not a cause of pollution or damage to the environment, and not sure.

environmental problems among the industrial country respondents (26%), is identified as a serious cause by 47% of the developing country respondents. This difference corresponds closely to the much higher rate of population growth among the developing than among the industrial country populations (1.83 versus 0.68% per year from 1980 to 1992). Interestingly, 45% of the industrial country respondents felt that overpopulation contributed a great deal to developing countries' environmental problems.

The Gallup survey assessed the attribution of responsibility for the world's environmental problems (Table 4). The most common response was that developing and industrial country populations are equally responsible. Indeed, there is little evidence of a systematic tendency for the developing and industrial countries to blame each other for the world's environmental problems. The Gallup data reveal a remarkable willingness among more than half of both the developing and industrial country populations to accept at least partial responsibility for the world's environmental problems.

Acceptance of responsibility is also evidenced by data (not reported in the tables) on the willingness to pay for environmental protection. Although the questions were rather vaguely worded, more than half of the Gallup population expressed a willingness to pay for environmental protection, either in the form of slower economic growth or higher prices. More than two-thirds of the Harris population expressed the view that their nation was not spending enough to protect and improve the environment.

Mechanisms for Addressing Environmental Issues

Both the Gallup and Harris surveys reveal that the public looks primarily to government to address environmental issues. Government is identified more frequently (44%) than business and industry (21%) or individual citizens and citizens' groups (29%) as having the primary responsibility for protecting the nation's environment, with no significant differences between the developing and industrial country populations. Of the Harris population, 92% believes the government has a major responsibility for environmental protection, although slightly less than one-third expressed a willingness to pay "somewhat higher taxes" to finance more spending on the environment.

The public also seems to recognize that many environmental issues transcend national boundaries, and that international agencies need to be funded to address these issues and empowered to influence the policy of national governments. Indeed, most respondents in each of the 24 countries included in the Gallup survey either strongly or somewhat favor these views, with stronger support in every country for funding than for giving authority. The perceived need for greater international cooperation is also revealed in the Harris survey, where (insignificantly different) majorities of both the developing and industrial country populations point to countries' failure to work together as a "major cause" of damage to the environment (see the last row of Table 3).

Table 4. Assigning responsibility for the world's environmental problems. Results from the Gallup survey. See (*16–20*) for additional explanatory notes.

Assignment of responsibility	Respondents giving specific response		
	DCs	ICs	Difference
More responsibility to DCs	11	6	6*
More responsibility to ICs	33	37	−4
Equal responsibility to DCs and ICs	48	48	−1
Not sure/don't know	8	9	−1

*$P < 0.05$, two-tailed test.

Conclusion

Within the confines of the available data, international public opinion on the environment reveals little evidence of major impediments to addressing environmental problems. First, people in both developing and industrial countries perceive that environmental quality has been and is continuing to worsen, and they express substantial concern about environmental quality overall and about a range of specific environmental issues. Second, in assigning responsibility for the world's environmental problems, the data indicate a willingness to accept responsibility rather than exclusively to blame others. Finally, people generally recognize the government's natural role in addressing local and national environmental issues and the equally natural role of strong international agencies in addressing transnational issues. Although the promotion of environmental quality faces many barriers, this analysis of international public opinion data suggests that at least some of those barriers are not as formidable as they might otherwise appear.

REFERENCES AND NOTES

1. Externalities arise when one economic agent's consumption or production activities impose costs on another agent with no compensation paid. Smoke billowing into the atmosphere from a steel plant is a classic example. Presumably less smoke would be emitted if the steel producer took account of the health and aesthetic costs the release of smoke imposed on the local population. Public goods are goods whose consumption cannot be restricted and whose supply is undiminished by additional consumers. National defense is the classic example of a public good, although clean air and clean oceans are more relevant in the present context. Because economic agents can "free ride" on the environmental protection activities of others, they will tend to understate their preferences for those activities, thereby resulting in the underproduction of environmental protection activities in a free market economy. Finally, common property is a resource whose consumption cannot be restricted, although its supply is diminished by additional consumers. The stock of fish in international waters and the density of forests situated on collectively owned land are examples of common property. Overuse of common property resources—the so-called "tragedy of the commons"—occurs because individuals receive full benefits from their usage of common property but bear only a small share of the cost of any degradation they induce.
2. Another approach to decision-making involves conducting cost-benefit analyses of alternative choices and implementing those that yield the highest net benefits. Unfortunately, conducting reliable cost-benefit analyses in this area is often difficult, mainly because of problems involved in measuring and monetizing the benefits of environmental quality [see P. A. Diamond and J. A. Hausman, *J. Econ. Perspect.* **8** (no. 4), 45 (1994)]. Also, it may be difficult to implement cost-beneficial choices.
3. Other recent multicountry surveys that focused partly or wholly on the environment include the European Community's semi-annual Eurobarometer public opinion surveys, which date back to 1982 and cover the 12 member states of the European Community [see *The Europeans and Their Environment in 1986* (Commission of the European Communities, Brussels, Belgium, 1986); E. Marlier, *Europeans and the Environment 1992* (Eurobarometer no. 37, Commission of the European Communities, Brussels, Belgium, 1992); and a 1985 public opinion survey covering six industrial countries participating in the International Social Survey Program (see J. D. Skrentny, *Int. J. Public Opin. Res.* **5** (no. 4), 335 (1993)]. See R. M. Worcester [*Int. J. Public Opin. Res.* **5** (no. 4), 315 (1993)] for a summary of the results from these and several other surveys.
4. For additional analyses of the Gallup data focused on similar issues to those addressed here, see R. E. Dunlap, in *Green Globe Yearbook 1994,* H. O. Bergesen and G. Parmann, Eds. (Oxford Univ. Press, Oxford, UK, 1994); R. E. Dunlap, G. H. Gallup Jr., A. M. Gallup, *Health of the Planet* (George H. Gallup International Institute, Princeton, NJ, 1993); *Environment* **35** (no. 9), 7 (1993); and R. E. Dunlap and A. G. Mertig, unpublished material (this material to be presented at the International Sociological Association's 13th World Congress of Sociology, Bielefeld, Germany, July 1995). For additional analyses of the Harris data, see (*7*). See D. Coursey, unpublished material, for a cross-country analysis of the demand for environmental quality.
5. H. Schuman and S. Presser, *Questions and Answers in Attitude Surveys* (Academic Press, Orlando, FL, 1981).
6. "Health of the Planet: Documentation" (George H. Gallup International Institute, Princeton, NJ), unpublished material.
7. *Public and Leadership Attitudes to the Environment in Four Continents* (Louis Harris and Associates, New York, 1989).
8. P. E. Converse [in *Ideology and Discontent,* D. E. Apter, Ed. (Free Press, New York, 1964), pp. 206–261; in *The Quantitative Analysis of Social Problems,* E. R. Tufte, Ed. (Addison-Wesley, Reading, MA, 1970), pp. 168–188] reports provocative evidence that the information content of public opinion data is limited, although later analyses attribute this finding more to the difficulty of eliciting information than to the absence of meaningful attitudes and beliefs among the public [see the discussion in chapter 1 of (*15*)].

9. See H. Taylor [*Public Perspect.*, 3 (February–March 1995)] for an informative and thoughtful review of cross-country differences in public opinion polling practices.
10. See (*15*) for extensive evidence on these points and further references. See W. P. Davison and A. Leiserson [in *International Encyclopedia of the Social Sciences*, D. Sills, Ed. (Macmillan and Free Press, New York, 1968), pp. 188–204] for an introduction to the subject of public opinion.
11. Among the nine countries in both surveys, the correlation in the proportion of respondents who rate the environment in their country as very bad (Gallup) or poor (Harris) is 0.67. Given the time and other differences between the surveys, this high correlation is consistent with the view that the data do reflect meaningful and stable preferences.
12. World Bank, *The World Development Report 1992* (Oxford Univ. Press, Washington, DC, 1992).
13. World Resources Institute, *World Resources 1992–93* (Oxford Univ. Press, New York, 1992).
14. Multiple regression analysis was also used to examine cross-country associations between the survey responses and per capita income, education, urbanization, region, and population density and growth. However, there are few interesting results to report, perhaps because of small sample sizes. Further study of the covariates of international public opinion on the environment must await the analysis of data on the characteristics and responses of individual survey respondents.
15. B. I. Page and R. Y. Shapiro, *The Rational Public* (Univ. of Chicago Press, Chicago, IL, 1992).
16. The standard errors of the population-weighted averages were computed using the following formula.

$$\left[\frac{n}{n-1}\cdot\sum_{i=1}^{n} p_i(y_i-\sum_{i=1}^{n} p_i y_i)^2\right]^{1/2}$$

where n is the number of countries in the sample (24 for the Gallup survey, 16 for the Harris survey, and so on for the various developing and industrial country samples), p_i is the ratio of the ith country's population to the total population represented in all n countries, and y_i is the proportion giving a particular response in country i [I. Guttman, S. S. Wilks, J. S. Hunter, *Introductory Engineering Statistics* (Wiley, New York, ed. 2, 1971), pp. 72–74].
17. Reported differences (DCs – ICs) are sometimes not equal to those calculated from the table due to rounding off of the values.
18. Unless otherwise noted, the Gallup surveys were administered from January to March 1992, the Harris surveys were administered from February to July 1988, and all were conducted in person, in local languages, to a representative national sample of the total adult population. Only an abridged version of the Harris survey was administered in the continental United States, by telephone to individuals over the age of 18. The developing countries (sample size) included in the Gallup survey were Brazil (1414), Chile (1000), Hungary (1000), India (4984, urban areas only), Korea (1500), Mexico (1502), Nigeria (1195), Philippines (1000), Poland (989), Russia (964), Turkey (1000), and Uruguay (800); and the industrial countries included in the Gallup survey were Canada (1011), Denmark (1019), Finland (770), (the former West) Germany (1048), Great Britain (1015), Ireland (928), Japan (1434), Netherlands (1011), Norway (991), Portugal (1000), Switzerland (1011), and the United States (1032). The developing countries (sample size) included in the Harris survey were Argentina (400, urban areas only), Brazil (500, urban areas only, conducted during the first half of 1989), China (509, urban areas only), Hungary (500), India (538, urban areas only), Jamaica (300, urban areas only), Kenya (300), Mexico (399), Nigeria (600, urban areas only), Senegal (300, urban areas only), and Zimbabwe (300, urban areas only); and the industrial countries included in the Harris survey were West Germany (513), Japan (510), Norway (1006), Saudi Arabia (398, men only in urban areas), and the United States (1253, conducted during the first half of 1989).
19. Because the Gallup survey in India was administered solely to the urban population, only the urban portion of India's population is used in constructing population-weighted averages. Similarly, because the former East Germany was not in either survey, only West Germany's population was used in calculating the population weight for Germany. Population figures for 1988 and 1992 were used to construct the population weights in the Harris and Gallup surveys, respectively.
20. The values in the tables are population-weighted averages of the percentage of respondents in each of the country samples giving the response indicated. As such they may be interpreted as estimates of the proportion of the total population in the surveyed countries with the specified perceptions or preferences. In the interest of parsimony and conservatism, the focus is generally on the most extreme of the possible responses to each question. For example, statistics are reported on the percentage who say they have "a great deal" of concern about the environment, but not on the larger percentage who say they are concerned either "a fair amount" or "a great deal." The weights used are based on 1992 country population estimates for the Gallup survey results and 1988 estimates for the Harris survey results. For convenience, the populations to which the reported results correspond are referred to in the text as the Gallup and Harris populations, respectively. Analyses were also performed on averages weighted by gross domestic product, which reflect both population and income per capita differences across countries, and simple cross-country averages, which give equal weight to every country. As these alternative measures generally exhibit patterns that are qualitatively similar to those based on the population-weighted averages, they are not reported here. All figures reported include "not sure/don't know" responses in the base.
21. The author is indebted to S. Glied, D. Krane, C. Kyle, W. Noor, B. O'Flaherty, A. Reddy, R. Sah, R. Shapiro, and two anonymous referees for helpful discussions and comments. R. Sah and W. Noor also provided excellent research assistance.

Environmental Unknowns

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Among the environmental problems ahead, the most important ones could be those that are still unknown to us. This conceptual article explores this prospect on the grounds that it is important not only to supply answers to recognized questions but to raise appropriate new questions.

It might seem fruitless to speculate about seemingly unknown problems in the environmental field. But recall that at the time of the first major international conference on the environment in Stockholm in 1972, there was next to no mention of what have now become established as front-rank problems: global warming, acid rain, and tropical deforestation. Environmental scientists could have gone at least partway toward anticipating these problems. They had had 100 years of warning from the Swedish scientist Arrhenius about the possibility of global warming. For decades acid rain impacts were accumulating unseen and unsuspected; could we not have asked whether all of those SO_2 and NO_x pollutants would eventually have an adverse effect on biotas? We could readily have alerted ourselves to tropical deforestation through remote-sensing surveys if only we had thought to identify it as a problem. So does the difficulty lie with "ignorance" or "ignore-ance"?

In the midst of much scientific uncertainty about our world—a world on which we are imposing multitudes of simultaneous new insults—we can be all but certain that there are environmental processes at work, or waiting in the wings, with the capacity to generate significant problems and to take us by ostensible surprise. Of course a true surprise is, by definition, beyond our purview. But is it truly beyond our scientific scope to identify a few likely candidates for semisurprises, especially those that could develop into outsize problems? The issue surely ranks as a prominent challenge for environmental science, yet it receives scant research attention (*1*).

Recent portents of environmental problems include the decline of amphibians, the bleaching of coral reefs, the appearance of phytoplankton blooms, the decline of sea urchins, mass mortality among seals and dolphins, and cancer epizootics in fish. All these share several characteristics. First, they are regional or even global phenomena. Second, they are unprecedented in our scientific experience and in our general ecological understanding. Third, there is no immediate or obvious explanation, although a primary or contributory cause is probably widespread pollution. Fourth, this pollution seems to cause the most harm when it works in conjunction with other stresses such as aquatic eutrophication, other forms of habitat disruption, and whatever else can induce immunosuppression, all operating in possibly reinforcing unison (*2*). Most important of all, they may add up to a whole flock of miners' canaries singing.

Discontinuities

One category of impending problems for environmental processes comprises discontinuities. The classic instance of a discontinuity is when liquid water suddenly changes to ice or steam. Environmental discontinui-

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