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Knowledge of and attitudes toward population growth and the environment: university students in Costa Rica and the United States

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Summary

A clear understanding of human population growth, consumption patterns, and their effects on the environment, particularly amongst our future leaders, is essential for proper allocation of conservation efforts. We report on the results of a written questionnaire assessing the knowledge and attitudes of undergraduate university students majoring in a range of disciplines in the United States of America (USA) and in Costa Rica (CR) regarding population- and environment-related issues. Our results indicated limited knowledge about human population growth and the environment, with USA students and male students more often responding correctly to factual questions on demography and global environmental change than CR students, who nonetheless were generally more pessimistic about environmental quality and the carrying capacity of the planet. USA students, however, more often recognized the link between human population size and environmental quality. Education on population and environmental issues will be improved if: (1) linkages between population size, consumption, and environmental quality are taught; (2) the effects of individual actions on environmental quality are emphasized; and (3) environmental education is tailored to local issues.

Keywords: environmental education, environmental perceptions, global change, human population growth

Introduction

Public opinion remains sharply divided on the prospects for sustaining the environmental basis of human well-being. Whereas there is a growing consensus in the academic community that growth of population and consumption threatens the planet's life support systems (e.g. National Academy of Sciences, USA 1993; Union of Concerned Scientists 1993; Arrow *et al.* 1995), the public is barraged with misinformation from journalists, public relations firms and others (e.g. Ray & Guzzo 1993; Easterbrook 1995; see Ehrlich & Ehrlich 1996 for further discussion of the problem of environmental misinformation). In democratic societies, public education on issues of such great importance is essential, because public opinion plays a major role in the framing and implementation of policy in the context of the environment, as well as in many related areas (Arcury 1990). Popular perceptions and misconceptions of the nature of and relationships amongst environmental problems must be understood in order to make educational efforts most effective.

Here we report on the results of a survey of the knowledge and attitudes of university students in the United States of America (USA) and in Costa Rica (CR) on human population growth and its impact on the environment. Surveying university students not only provides some insight into the possible positions of powerful voting groups in the future, but it also helps to reveal the strengths and deficiencies of the formal education system. Although other surveys have assessed the knowledge and opinions of university populations on environmental issues (e.g. Gigliotti 1992; Wright & Floyd 1992; Meffe 1994), none has investigated knowledge and attitudes on both the environment and human population issues, nor compared students studying different disciplines. Similarly, most previous surveys of the general public have addressed issues of environment (e.g. Rodríguez & Borge 1985; Arcury & Johnson 1987; Harwood Group 1995) and population (e.g. Rosero Bixby 1981; Madrigal *et al.* 1987) separately without considering their relationship (Stycos 1994). Moreover, few surveys have compared the opinions of people in both developed and developing nations (Dunlap 1994).

We surveyed undergraduate students of Stanford University in the USA and the University of Costa Rica in CR, populations which we consider representative of the future elites of an industrialized and a developing nation, respectively. Our goal was to understand better (1) students' knowledge of, and attitudes towards, population growth, environmental degradation, and their interrelationship; and (2) the extent to which those perceptions influenced decisions in their personal lives. Although we have drawn from a limited sample, our results offer important insights into needed improvements in undergraduate education in both countries.

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Methods

The survey

We developed a written questionnaire designed to address the subject areas stated above; a copy of the questionnaire can be obtained from the senior author. The questionnaire consisted of a total of 59 questions: seven questions on personal background, such as year in school and major; 27 free response questions which were categorized upon completion of the questionnaires; eight questions in which students ranked the importance of certain issues (on a scale of 1 to 10); eight questions to which students responded with a 'yes', 'no' or 'not sure' answer; and eight statements to which students were asked to indicate level of agreement or disagreement on a four item scale (1 = strong disagreement, 2 = disagreement, 3 = agreement, 4 = strong agreement) or 'not sure'. The questions were designed to evaluate either knowledge or opinion. For those questions aimed at evaluating opinion, we used as neutral a tone as possible. For factual questions regarding population size, we considered answers within 20% less than or greater than the actual value to be correct; this range of acceptable answers was arbitrarily selected to be liberal in our criteria of correctness.

The same questionnaire, in English and Spanish, was completed by 602 students at Stanford University (Stanford, CA, USA) and 392 students at the University of Costa Rica (San José, CR) in spring 1993. Questionnaires were distributed to four classes at each university: a freshman, general education course and one course each in engineering, biology and social sciences. The courses we selected in the three specific subject areas were large, yet sufficiently specialized that the students enrolled were majoring in the given area. Since there were some first year students in the specialized courses and a few second, third and fourth year students in the general education courses, it was impossible to compare the effect of year in school by comparing the specialized and general education courses. Therefore, responses were coded by major and year in school (as indicated by the students on the questionnaire), rather than by course.

Students were asked to indicate their religious affiliation. It was impossible, however, to analyse the effect of religion separately from the effect of country given that the majority of CR students (81%), like the Costa Rican population as a whole, were Catholic, compared to only 16% of USA students. Moreover, previous studies have suggested that religion has little effect on attitudes toward population growth (Reeder *et al.* 1974) and fertility patterns (Goldscheider & Mosher 1991; Madrigal *et al.* 1992; Holl *et al.* 1993).

Students were not informed of the survey prior to the time of distribution. The questionnaires typically took between 15–25 minutes to complete. Due to time constraints, Stanford's engineering class received a shorter version consisting of 26 questions, that typically took between 10–15 minutes to complete. Unless indicated otherwise, the questions were answered by all groups.

Although the terms attitude, belief and perception carry specific definitions in the technical literature, we use the three synonymously to refer to a view or opinion toward something that may influence actions. We define the term knowledge as the awareness and understanding of existing information.

Statistical analyses

The questionnaire answers were analysed considering country, major (engineering, natural sciences, social sciences/humanities, undeclared), gender and year in school (first or second year, at least third year) as independent variables. Further subdivision by year in school or major would have resulted in insufficient sample sizes. For ordinal variables, multi-way analysis of variance was used. For categorical variables, log-linear models were used. The partial F (ANOVA) or additional χ^2 (log-linear) of adding each variable into a model containing the other three variables was tested for significance. Preliminary analyses indicated that interaction terms rarely explained a significant amount of variance in the models, and that the few significant interaction terms were not consistent between related questions; therefore, we report only the test of significance for the main effects. χ^2 tests for independence were used for questions in which only between-country comparisons were considered. Throughout, $p < 0.05$ is considered significant.

Results

Table 1 gives the distribution of all participants by gender, year in school, and major. As would be expected, major and gender were not independent ($df = 3$, $\chi^2 = 96.2$, $p < 0.001$). The engineers were predominantly male, whereas more than half the students in the general education and social sciences classes were female; the biology students were evenly divided by gender. The majority of students indicated that they re-

Table 1 Distribution of survey participants by gender, year in school and major.

	Number of respondents (% in parenthesis)		
Variable	*Overall (n=994)*	*Costa Rica (n=392)*	*United States (n=602)*
Gender			
Male	522 (53)	184 (47)	338 (57)
Female	466 (47)	206 (53)	260 (43)
No response	6 (0.6)	2 (0.5)	4 (0.7)
Year in school			
First/second year	681 (68)	262 (67)	419 (70)
> Second year	313 (32)	130 (33)	183 (30)
Major			
Engineering	260 (26)	118 (30)	142 (24)
Humanities/ Social sciences	266 (27)	124 (32)	142 (24)
Natural sciences	346 (35)	110 (28)	236 (39)
Undeclared	122 (12)	40 (10)	82 (13)

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ceived most of their information on the environment from the media (CR: 82%, USA: 65%); some received most of their information in high school or college classes (CR: 27%, USA: 20%) or through conversation with others (CR: 7%, USA: 11%): (Note-some students indicated that they received most of their information on the environment from more than one source).

Assessment of factual knowledge

Overall, factual knowledge about the environment and human population growth amongst the students surveyed was low. For example, only half of the students (50%) were able to correctly identify the curve best describing human population growth (Fig. 1).

In general, knowledge of population and environmental issues was most strongly affected by country and gender, with USA students and male students more often answering questions correctly (Table 2). For example, more than twice as many USA as CR students knew the global human population within 20% (CR: 24%; USA: 57%). Only one student in CR could cite three greenhouse gases and none listed four. Although higher than in CR, only 12% of USA students correctly cited three or four greenhouse gases. The most commonly cited greenhouse gas in CR were CFCs, making it possible that students were confusing global warming with depletion of the stratospheric ozone layer; in the USA, CO_2 was the most commonly cited gas. In contrast to most factual questions, more CR than USA students accurately stated their own country's population size (CR: 75%, correct answer: 3.3 million, accepted range: 2.6–4.0 million; USA: 49%, correct answer: 260 million, accepted range: 204–312 million).

On a scale of 1 (strong disagreement) to 4 (strong agreement), significantly higher percentages of CR students agreed with the statement that 'Deforestation is easily remedied because it is always possible to plant more trees' (CR: 2.26 ± 0.05, USA:1.49 ± 0.03; df = 1, F =210.0, $p < 0.001$).

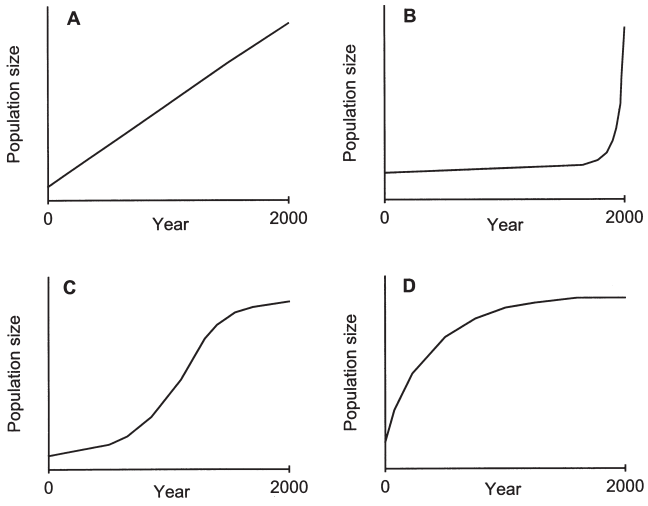

Figure 1 Possible responses to the question 'Which one of the following curves best describes the global human population size over the past 2000 years?' Correct answer: B.

A majority in both countries and a higher percentage in Costa Rica agreed with the statement 'There is a lot of vacant land in CR/US that is suitable for agriculture or urbanization' (CR: 2.57 ± 0.05, USA: 2.30 ± 0.04; df = 1, F = 19.5, $p < 0.001$). These responses did not differ significantly by gender, major or year in school.

When there were significant differences by major, biology and engineering majors were more often correct than social science majors. Students further along in their college education answered a few questions correctly slightly more frequently than first and second year students, but this was not a consistent trend.

Attitudes towards the environment

In order to assess the relative importance that the students placed on environmental issues compared to other societal

Table 2 Selected questions of factual knowledge regarding the environment and population growth. Results of analyses: * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$, NS = not significant.

		Costa Rica		*United States*					
Question	*Correct answer*	*Male*	*Fem.*	*Male*	*Fem.*	*Country*	*Gender*	*Major*	*Year*
		Per cent correct							
Per cent of world's energy supplied by fossil fuels	77%[1]	43	26	49	30	NS	***	**	*
Current global population	5.5 billion (10^9)[2]	34	15	68	41	***	***	NS	NS
Population growth curve	see Fig. 1	35	10	75	58	***	***	*	NS
		Mean number correct							
Four greenhouse gases that have increased anthropogenically	CO_2, CH_4, CFCs, N_2O, O_3	1.2	0.6	1.5	1.3	***	***	***	**
Four countries with largest populations	China, India, USA Indonesia, USSR[3]	2.6	2.0	3.3	2.8	***	***	NS	NS

[1] Source – Hall *et al.* 1993, accepted answer: 67–87%; [2] Source – Population Reference Bureau 1993 Population Data Sheet, accepted answer: 4.4–6.6 billion (10^9); [3] The former Soviet Union was also accepted as correct because it had broken up shortly before the surveys were conducted.

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problems, students were asked to rank the importance of seven societal problems (crime, drugs, education, environment, health, social inequity and unemployment) on a scale of one to ten. CR students ranked the environment as the most serious problem, whereas USA students ranked it second to education. To correct for overall differences in ranking, we created a new variable (Dunlap & Mertig 1995); we subtracted the mean ranking of the other six problems from the ranking of the environment. CR students ranked the environment as significantly more important compared to other problems than did USA students ($df = 1$, $F = 86.6$, $p < 0.001$); gender, class and year in school did not significantly affect the response.

CR students ranked (on a scale of one to ten) the importance of a 'healthy natural environment to sustaining civilization' much higher than did USA students (CR: 9.5 ± 0.1, USA: 7.8 ± 0.1; $df = 1$, $F = 138.8$, $p < 0.001$). Major was also a significant ($df = 3$; $F = 7.7$; $p < 0.001$), though less important, factor in explaining this response; engineering majors ranked environmental quality as being slightly less important (8.1 ± 0.2) than did biology (8.8 ± 0.1) or social science majors (8.7 ± 0.1). Correspondingly, CR students were more likely than USA students to respond affirmatively to a statement indicating that the environment had a positive effect on their own lives (CR: 94%, USA: 79%; $df = 1$, $\chi^2 = 16.7$, $p < 0.001$). Women responded affirmatively to this statement slightly more often than did men (88% vs 82%; $df = 1$, $\chi^2 = 4.2$, $p < 0.05$).

Despite the lower importance placed on the environment by USA compared to CR students, a higher percentage of USA students responded affirmatively to the question of whether they had made a change in their life to reduce their impact on the environment (CR: 61%, USA: 87%). In the USA, recycling was cited three times more often than any other change, with minimizing personal automobile use, choosing environmentally friendly products, and conserving water also cited by a number of students. In CR, the most commonly cited changes were throwing garbage in appropriate receptacles, recycling, and not using sprays that damage the ozone layer.

Most students from both countries attributed environmental problems to rich and poor countries alike (CR: 70%, USA: 58%), with a larger percentage of USA students attributing these problems primarily to rich countries (CR: 30%, USA: 39%) and a negligible number in both countries attributing them to only poor countries.

The eight environmental problems most commonly cited in an open-ended question were the same in the USA and CR; perceptions of the relative importance of these problems, however, varied by country (Fig. 2). Pollution and deforestation were more commonly cited by CR compared to US students, whereas population growth and global warming were cited more frequently in the USA than CR (Fig.2).

Attitudes towards population growth and its relationship to the environment

Overall, approximately three-quarters of students agreed with the statement that there was a link between the size of their country's population and the environment. USA students and men were more likely to agree that there was a relationship (Table 3). USA students who responded that

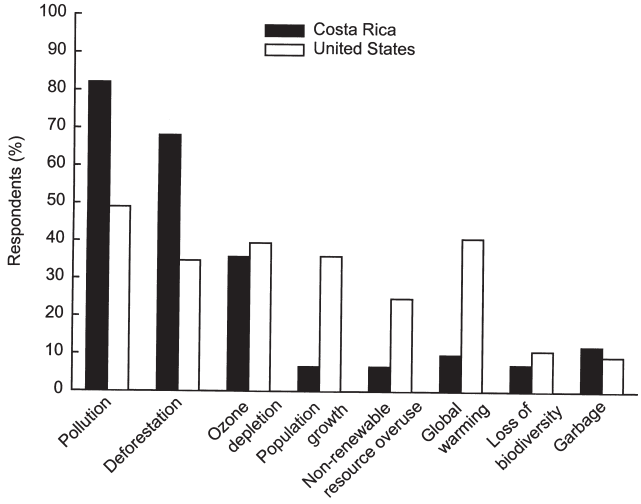

Figure 2 Percentage of respondents citing certain environmental problems amongst the top three (problems categorized according to student responses).

Table 3 Per cent responses to selected questions assessing attitudes towards population growth and the environment. Results of analyses: * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$, NS = not significant.

Question	*Gender*	*Costa Rica*			*United States*			*Country*	*Gender*	*Major*	*Year*
		Yes	*No*	*Not sure*	*Yes*	*No*	*Not sure*				
Do you think the size of the CR/US	M	71	20	9	82	7	11				
population influences the environment?[1]	F	65	15	20	77	6	17	***	***	—[2]	NS
Do you think the number of children in your	M	46	12	42	80	1	19				
family influences the environment?	F	43	14	43	82	0	18	***	NS	—[2]	NS
Do you think there will be enough natural											
resources for the well-being of your	M	10	63	26	47	17	36				
children when they reach your present age?	F	6	75	19	33	21	46	***	***	NS	NS

[1] Students were asked questions with respect to their own country only; [2] engineers in the USA did not answer these questions so the results were not analysed by major.

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there was a relationship between population size and the environment, often explained this relationship by the high consumption of most USA citizens compared to that of people in other countries. CR students who did not recognize a link between human population size and the environment commonly noted that the CR population was fairly small relative to that of other countries. Corresponding to this question, USA students were slightly more in agreement than CR students with the statement that 'population growth is a principal cause of environmental deterioration' (scale 1 to 4; CR: 2.69 ± 0.05, USA: 2.87 ± 0.04; df = 1, F = 7.0, $p < 0.01$).

USA students were much more likely to acknowledge that the size of their own family affects the environment (Table 3); less than half of the CR students acknowledged a linkage. In both countries, those responding positively to this question explained their answer by describing the scaling-up effect from the family to the entire population, whereas those disagreeing usually mentioned that the size of their family was sufficiently small that it did not have an effect. (The engineering majors in the USA did not respond to the two questions relating country population and family size to the environment, which probably did not influence the overall result, as few attitude questions varied significantly by major.)

Students were asked 'Given today's technologies and consumption patterns, what population size could the planet support sustainably?' Given the inaccuracy of the students' population estimates, we created a scale dividing the number of people students thought the planet could support by their global population estimate (Fig. 3). USA students, men, and engineers were more optimistic about how many people the planet could support (country: df = 1, F = 207.8, $p < 0.001$; gender: df = 1, F = 21.8, $p < 0.001$; major: df = 3, F = 2.9, $p < 0.05$). Sixty-eight per cent of USA students (compared to only 19% of CR students) thought that the planet could sustainably support more people than currently exist. Similarly, 40% of USA students, compared to only 8% of CR students, thought there would be sufficient natural resources for their children in the future (Table 3).

Despite their pessimism regarding the carrying capacity of the planet, CR students were more likely to agree that increased population growth was necessary in order to have young people to support old people (scale 1 to 4; CR: 1.98 ± 0.05, USA: 1.63 ± 0.03; df = 1, F = 26.5, $p < 0.001$) and to stimulate the economy (scale 1 to 4; CR: 2.57 ± 0.05, USA: 1.70 ± 0.03; df = 1, F = 155.7, $p < 0.001$).

A high percentage of students in both countries responded affirmatively that they would support 'social or economic policy incentives to reduce fertility rates' in the USA (CR: 74%, USA: 69%) and CR (CR: 78%, USA: 79%). When asked in an open-ended question to list the types of policies that should be implemented, students most commonly indicated their support for providing family planning services and increasing educational and economic opportunities for women. A smaller percentage supported tax incentives to reduce fertility. There was nearly equal agreement and disagreement in CR and slightly higher disagreement in the USA with the statement that 'Couples in CR/US should have no more than two children to help preserve the environment' (scale of 1 to 4; CR: 2.50 ± 0.05, USA: 2.31 ± 0.04; df = 1, F = 8.17, $p < 0.01$).

When students were asked the number of children they would ideally like to have, the desired number of children was higher than two (replacement rate) in both countries (CR: 2.50 ± 0.05, USA: 2.32 ± 0.04). Moreover, when students were asked in an open-ended question to list changes they had made to reduce their impact on the environment, only two students in the USA and no students in CR cited limiting the number of children they would have.

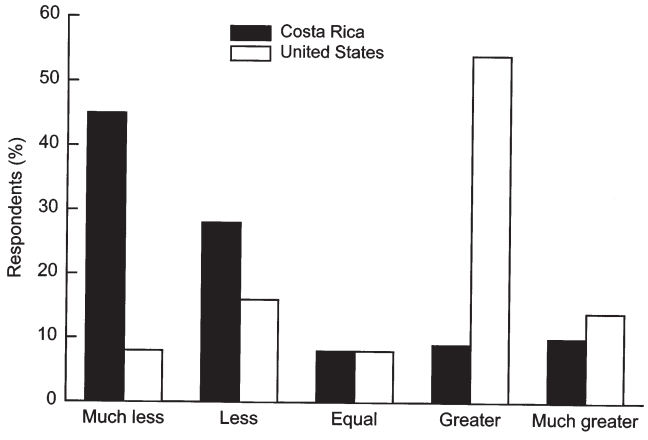

Figure 3 Percentage of respondents stating different sustainable sizes of the global human population compared to the current population. Much less = less than half current population, Less = at least half of but less than the current population, Equal = the current population, Greater = up to double the current population, Much greater = at least twice the current population.

Discussion

Given that the country in which students resided was the factor that most often affected students' knowledge and attitudes toward population and the environment, we discuss our results highlighting interesting similarities and differences in the responses of students in CR and the USA. We then briefly discuss the other factors analysed. It is important to reiterate that we are basing our comparisons on a single university in each country. Both universities draw students from throughout their country and a range of socio-economic backgrounds, but have an over-representation of higher-income students. Moreover, Costa Rica is one of the more affluent countries in the developing world. Both these points must be considered in interpreting our results.

Factual knowledge

Previous studies have demonstrated that people in the USA (Arcury & Johnson 1987; Bostrom *et al.* 1994; Read *et al.*

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1994) and CR (Holl *et al.* 1995) often have a superficial understanding of environmental problems. The low level of factual knowledge in the current survey is somewhat surprising, however, considering that these students are amongst the most educated in their respective countries, and previous studies have shown that young, better-educated people have the highest level of environmental knowledge (Ostman & Parker 1987; Arcury 1990; Roper Organization, Inc. 1992). Although, factual knowledge tended to be lower in CR, much needs to be done both in CR and the USA to convey information on human population growth and the environment both through the educational system and the media. It is important to note that Costa Rica is well ahead of most other developing nations in this area (Holl *et al.* 1995).

Attitudes towards the environment

Students in both countries expressed a high level of concern about environmental degradation. CR students indicated more concern about the state of the environment. Other recent studies have indicated a similarly high concern regarding the environment (e.g. Gigliotti 1992, 1994; Wright & Floyd 1992; Bloom 1995), with residents of developing nations usually indicating slightly greater concern than residents of industrial nations (Bloom 1995). These results contradict the common assumption that environmental quality is a 'luxury good' that is only likely to be of concern to the more affluent (discussed in Dunlap & Mertig 1995).

Students in both countries attributed environmental problems to rich and poor countries alike; previous studies in both developed and developing countries concur with this result (Dunlap 1994; Bloom 1995; Holl *et al.* 1995).

Students in the two countries varied with respect to the importance they placed on different environmental problems. As in a previous study (Holl *et al.* 1995), pollution and deforestation were the most commonly cited environmental problems in CR. This is not surprising given that much of the primary forest in CR has been cleared in the past 50 years (Ramírez & Maldonado 1988; Sanchez-Azofeifa *et al.* in press), and there is little control of air and water contamination in the Costa Rican capital of San José, where the university is located. It is also logical that overuse of non-renewable resources would be cited more often in the USA, one of the countries with the highest consumption rates in the world. Interestingly, population growth and global warming were also cited more often in the USA. Dunlap and Mertig (1995) found that people in less developed countries usually ranked the quality of their local environment lower than did residents of industrialized nations, whereas people in industrialized nations often ranked global problems as being worse than did people in developing countries. Similarly, in our study CR students focused more on local environmental problems, whereas USA students cited global environmental problems more often.

Attitudes towards population growth and the environment

Fewer CR students compared to USA students acknowledged the human population growth/environment quality link and more CR students perceived the need for population growth to support the economy. There are a number of possible explanations for these results. First, they may stem from the relatively small population of CR. In a previous study of the general Costa Rican population (Holl *et al.* 1995), a number of people indicated that Costa Rican population growth warranted little concern given that the rate of population growth was much lower than in neighbouring countries. Another possible explanation for these results may be societal differences. In Costa Rica, young people more often play a great direct role in supporting aging parents, and the economy remains largely agrarian, depending on a large labour force (Holl *et al.* 1993). A final possible explanation is the differences in attitudes expressed through the mass media, government and educational system in the two countries (Holl *et al.* 1993).

University of Costa Rica students were less optimistic about the carrying capacity of the planet and the availability of resources for the well-being of their children. Similarly, a previous poll of a number of developing and industrialized nations indicated that residents of poorer nations were usually more concerned about the effect of the environment on their health (Dunlap *et al.* 1993). These results support the suggestion of Dunlap and Mertig (1995) that 'environmental degradation is increasingly seen, especially in poor nations, not as a postmaterialist quality of life issue but as a basic threat to human survival.' It is possible that Stanford students are more confident, based on past experience and the political and economic power of the USA, that their children will have access to sufficient resources.

Both CR and USA students responded with interesting contradictions regarding fertility decisions at the societal and personal level. The vast majority of students in both countries agreed that there was a link between population growth and the environment, and supported governmental incentives to reduce fertility. At the same time, the average ideal family size of students in both countries was higher than replacement rate, and students rarely cited limiting their own family size as a change they would make in their life to reduce their impact on the environment. In Costa Rica, far fewer students acknowledged a link between their own family size and the environment compared to a link between the national population size and the environment. These results, along with a previous study (Holl *et al.* 1995) suggest that support of fertility reduction on the national level does not readily translate into personal reproductive decisions. Clearly, some caveats must be considered in making this statement. First, authors have long debated whether ideal family size is (e.g. Freedman *et al.* 1965; Coombs 1974; De Silva 1992) or is not (e.g. Mauldin 1965; Hauser 1967; Rosero *et al.* 1980) a good predictor of realized family size. Second, given the young age

of most of the students interviewed in the current study, they may not have given a great deal of thought to their personal reproductive decisions.

Differences between other factors

Compared to the differences between countries, other variables explained far less of the differences in students' responses. Gender was the only other variable that influenced responses to a number of questions. Although other studies have shown that men often have higher factual knowledge about the environment (Arcury *et al.* 1987; Blum 1987; Arcury 1990), it is somewhat surprising that this trend is observed amongst students acquiring university-level education. It suggests that there is still a need to improve the science education opportunities available to women. Women appeared to be slightly more concerned about environmental quality than men, based on responses to questions regarding the importance of environmental quality to their own lives and the availability of resources for their children; previous research has generated mixed results as to whether men (Arcury 1990) or women (McStay & Dunlap 1983; Roper Organization, Inc. 1992) are more concerned about the environment.

In only a few cases was major an important factor in explaining responses. With some factual questions, engineers and biologists responded correctly more often than did social science students. This result suggests that students who chose to major in the former topics are slightly more knowledgeable about the environment and population growth. Given that their knowledge generally did not increase with time at university, it is not likely that these differences resulted from the courses the students had taken. It is also important to note that many of the students interviewed were in their first or second year of studies, and students often change majors during the course of their undergraduate studies.

Surprisingly, year in university was rarely important in explaining responses. We also did preliminary analyses comparing first year students to all other students and saw no differences. We had expected that, as in a previous study (Wright & Floyd 1992), third and fourth year students would have higher environmental knowledge than first year and second year students. Our results send a strong message that we need to improve population and environmental education at the college level.

Improving population and environmental education

We must reiterate that our results are based on students from only two universities. Given, however, that our results are consistent with many previous studies (e.g. Arcury *et al.* 1987; Arcury 1990; Dunlap *et al.* 1993; Meffe 1994; Harwood Group 1995; Gambro & Switzky 1996), we feel that some recommendations are warranted.

Clearly, we need to improve understanding of human population growth and its effects on the environment both through the educational system and through the media. One of the most discouraging results of our study was that, despite their considerable time in the formal education system, only about a quarter of the students cited classes as one of their main sources of environmental information. Previous studies have demonstrated that classes can have a large effect on students' environmental knowledge (Benton 1993; Caro *et al.* 1994; Mangas *et al.* 1997). In addition to requiring students to take at least one environmental course, efforts should be made to integrate environmental issues into various disciplinary courses (Gigliotti 1992; Collett & Karakashian 1996; Orr 1996).

It is also important for scientists and demographers to work with the media to disseminate more detailed information about the environment, population, and their relationship. Certainly, the majority of the population will continue to obtain their information through the media (Blum 1987; Ostman & Parker 1987; Holl *et al.* 1995) and previous research suggests that the media have a large influence on knowledge and attitudes (Brothers *et al.* 1991; Harwood Group 1995; Gillilan *et al.* 1996). Therefore, we must work to improve the quality of information presented.

Our call for improved environmental education is not the first (Arcury 1990; Gigliotti 1992; Meffe 1994; Holl *et al.* 1995; Collett & Karakashian 1996; Orr 1996). It is nonetheless important to focus on some specific recommendations that are highlighted by our study. These changes are needed at all levels of education and must start at an early age. This need, however, is particularly acute at the college level where we are training our future educators and political leaders.

First, it is important to teach about linkages between different issues. Although teaching these linkages is challenging given that students are accustomed to learning specific disciplinary topics separately (Andersson 1986; Orr 1996), it is essential that students understand that environmental problems are related to population size, consumption rates, available technology, and socio-economic institutions (Ehrlich & Ehrlich 1990; Dasgupta 1993). In discussing environmental issues the question of human population growth is commonly overlooked (Meffe & Ehrlich 1993; Stycos 1994; Holl *et al.* 1995). Although the focus of our study was on the population/environment linkage, you could easily argue that linkages between environmental problems and consumption, technology, and socio-economic and political conditions are overlooked with similar frequency.

Second, it is important for students to understand the relationship between individual actions and the quality of the environment. As discussed previously, responses in our survey suggested that many students either did not understand or chose not to acknowledge the degree to which their own reproductive decisions affect the environment. Ours is not the first study to report that people see environmental problems more as the problems of others. Gigliotti (1990) emphatically states 'What I am proposing is that environmental education has produced ecologically concerned

citizens who, armed with ecological myths, are willing to fight against environmental misdeeds of others but lack the knowledge and conviction of their own role in the environmental problems.' While teaching linkages between individual actions and their larger-scale effects is difficult (Membiela *et al.* 1993; Gambro & Switzky 1996), it is absolutely essential if we are going to produce an educated, mobilized citizenry. Educators must encourage students to consider the effects of their personal behavioural decisions on the environment (Gigliotti 1994).

Third, it is important to tailor information on environmental problems and solutions to the local and individual level. Ecologists often take such a broad (often global) perspective that it is hard to discern how actions at the individual level could have any impact (positive or negative). For example, large numbers describing global population statistics are difficult for people to comprehend when not expressed within a more familiar, local context (Gehrt 1996; Dunning 1997; this study). This is probably one of the main reasons why people have generally demonstrated more knowledge about the environment than willingness to act (Maloney & Ward 1973; Gigliotti 1992, 1994; Harwood Group 1995). To motivate people, they must be provided with examples that are direct, comprehensible, and yield perceived personal benefits. For example, in California one might focus on successful local efforts to preserve 'open space'. Individuals benefit on a personal level from increased property and recreational values, while simultaneously conserving biodiversity (Press *et al.* 1996). In Costa Rica, increasingly degraded lands are being reforested with native tree species (e.g. Alfaro Bonilla & Barrantes Arias 1995; Butterfield & Espinoza 1995). The local benefits, such as improved water quality and maintaining soil fertility, are the primary motivating factors; but, clearly, there are benefits on the global scale, such as CO_2 fixation.

In summary, it is very difficult for us to envision an ultimately successful effort to preserve biodiversity without a substantial improvement in population and environmental education of decision-makers and the general public. This may be the most important challenge facing conservation biologists.

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