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by

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Abstract

To examine factors that might influence how people subscribe to different reasons for conserving biological diversity, we modified Ehrenfeld's (1976) classic reasons for conserving species and habitats into consumption, tourism, medicine, science, education, environmental baselines, ecosystem services, intrinsic value, and added another, human cultural heritage. We then explored the opinions of undergraduates enrolled in a classic conservation biology course, or a people and conservation course, about these 9 arguments, using a 27-statement questionnaire. By matching responses made before and after each course, we found that students, in general, became more committed to using most of Ehrenfeld's arguments but that this was highly contingent on which conservation course that they had taken. None became committed to the argument that linked wildlife conservation to human culture, however. Course and grade that students attained influenced the extent to which students were sympathetic to different arguments but gender had no effect. These findings show that the type of conservation knowledge imparted to students makes them differentially sympathetic to many of the arguments used to advocate wildlife conservation.

1. Introduction

In an early and influential paper, Ehrenfeld (1976) outlined 10 reasons that can be used to argue the case for conserving biodiversity. All of these, bar one, he termed economic values of non-resources, but his final reason was that biodiversity had intrinsic value. Ehrenfeld was at pains to point out that no one method of arguing the case for conservation was better than any other but that any could be used depending on context and audience. These reasons are now widely cited in standard conservation texts (e.g. Primack, 1993; Meffe and Carroll, 1997).

One issue missing from Ehrenfeld's paper was discussion of the underlying factors that might predispose different audiences to be sympathetic to a particular conservation argument. This is potentially important because it might help a conservation educationist or biologist tailor her or his exposition so as to achieve maximum conservation effect (Jacobson, 1995). Here we explore several factors that might influence the extent to which people are sympathetic to different types of conservation argument through a simple questionnaire that ranks individuals' attitudes to a series of statements that emphasize different conservation benefits. Our subjects were undergraduates at the University of California, Davis enrolled in one of two different types of conservation course, one that focuses on the conservation of species and habitats (a "classic conservation biology" course) and the other that links the conservation of natural resources to the interests of local communities (a "people and conservation" course).

We examined four factors that might affect the degree to which undergraduates were sympathetic to different reasons to conserve species and habitats. These were

exposure to conservation science itself, gender (male or female), class grade (A or B *vs* C or D), and the course that they attended. We expected that (i) learning about conservation would make students more sympathetic to all of Ehrenfeld's and related arguments; (ii) female students would become more sympathetic to all reasons to conserve biological diversity than would their male counterparts because females discount future resources to a lesser extent than do males (Wilson et al., 1998); (iii) students scoring better would similarly become more conservation minded across the board because of their greater interest in the subject; and (iv) students enrolled in a classic conservation biology course would show a greater interest in the scientific value of conservation, environmental baselines, ecosystem services and intrinsic value (i.e., mainly scientific and ecological issues), while those in a course on people and conservation might show more interest in consumption and the importance of conserving human culture in natural settings (i.e., more utilitarian issues). We had no expectations about tourism, medicine and education suspecting that both kinds of students would value these conservation rationales equally.

2. Methods

Starting in 1996, and ending in 2000, we devised a questionnaire that examined the extent to which consecutive classes of students agreed or disagreed with 27 statements concerning a conservation issue (Appendix 1). We sought to test students' opinions about 9 different reasons to conserve biological diversity and thus assigned 3 statements to each reason. For each statement, students could check one of seven possibilities: strongly disagree, disagree, mildly disagree, no opinion, mildly agree, agree,

strongly agree, which were subsequently converted to seven ranks with 7 representing the most sympathetic conservation opinion about the statement and 1 the least.

We slightly modified Ehrenfeld's (1976) rationales for conserving biodiversity in the following way, sometimes combining and splitting his categories in ways that were both more easily captured in a questionnaire and more readily accessible to incoming students. (i) *Consumption, food or exploitation* corresponded to Ehrenfeld's "undiscovered or undeveloped values"; (ii) *tourism* matched his "recreation and aesthetic values"; (iii) *medicine* also related to his "undiscovered or undeveloped values"; (iv) *science* corresponded to Ehrenfeld's "scientific research values", (v) *education* related to his "teaching values"; (vi) *environmental baselines* related not only to his "environmental baseline and monitoring values" but also to his "examples of survival" and "habitat reconstruction values"; (vii) *ecosystem services* corresponded to Ehrenfeld's "ecosystem stabilization values"; and (viii) *intrinsic* matched his "biocentric rationale" based on the inherent value of nature (see Sagoff, 1988; Norton, 2000). We also added one further reason: (ix) *human culture* that seeks to conserve biodiversity on the grounds of it being part of a cultural heritage. These nine different reasons are here termed composites for convenience. The three statements about each of these reasons for conservation were scattered throughout the questionnaire (Appendix 1). Composite scores were derived by averaging each student's score on the three questions pertaining to that composite reason. We failed to carry out systematic pilot testing of the questionnaire; however, TC and MBM each constructed different statements in the questionnaire and then asked the other to verify the attitude construct that each statement sought to test. In addition, informal

discussions with students indicated that they were well aware of the nature of the dilemmas posed.

At the start of each of the two classes, students were asked to fill out the questionnaire in class. At the end of a 10-week quarter in which they either attended TC's classic conservation biology course or MBM's people and conservation course (see Table 1 for lecture topics), they were asked to fill out the questionnaire again; students who attended both were dropped. Thus every student took the questionnaire before and after their course. While students put their names on each questionnaire and thus knew they were being tracked, it is unlikely that they could remember previous answers to so many questions after a 10 week period, and furthermore they were told repeatedly that the questionnaire had nothing to do with their exams.

We had 176 subjects, a total of 143 of whom attended TC's course (given 3 times over 5 years) and 33 of whom attended MBM's course (given twice over 5 years); 116 were women, 60 were men. Generally, students in the two courses were taking different university curricula. Only two additional students failed to fill out the questionnaire on the second occasion and were omitted from analysis. We did not see a promising way to test reliability of the questionnaire as any student who took our courses would have been unable to fill out the questionnaire in the same way as if they had not attended it, nevertheless every student was their own control. We tested the validity of the questionnaire through a principal components analysis that sought to match individual statements to the composites that we tried to test (see Results).

Scores on the first questionnaire and the second questionnaire for each statement and for composite measures were checked for normality. Student scores on the first and

second questionnaire for the 27 statements were not normal, but those on the nine composite measures were. Thus the 27 statements were analyzed using non-parametric tests, whereas the composites were analyzed parametrically. For each statement and each composite we looked for differences according to gender, course and grade in student answers using a general linear regression model (GLM) in SPSS. The p-value was set at 0.05.

3. Results

We found substantial and significant changes in student responses to statements after they had taken our courses. Out of 27 statements, Wilcoxon matched-pairs tests showed that students became significantly more conservation minded (in the sense of agreeing with the reason for conserving a species or habitat) on 19 of these statements. These were statements 2, 4, 5, 6, 8, 9, 11, 12, 14, 15, 17, 18, 20, 21, 23, 24, 25, 26, 27 (see Appendix 1).

Before analyzing results by composite, we wanted to determine whether statements that we had allocated to each composite fell into nine different categories. We therefore carried out a principal components analysis on the scores that all students gave to each of our 27 statements. The first factor to emerge from this analysis exhibited very high eigen values (which measure the strength of clustering of variables) on all composites except consumption, while a third factor showed high values on consumption statements on the second questionnaire, and a fifth factor high values on consumption on the first questionnaire. From the almost uniformly high loadings on the first factor, we concluded that students were treating most of the statements in the same way and were

not viewing them as testing their responses to different aspects of conservation. Either our statements were not written explicitly enough to highlight different reasons to conserve biological diversity, or the students were not sophisticated enough to distinguish between the different reasons. Since further analyses of the principal components showed many fewer main effects with respect to the independent variables (data not presented), we surmised that our own composites offered a better measure of "conservation values" than the statistically derived principal components. We nevertheless acknowledge that our measures cannot be considered independent of one another, and all bear the print of an overall conservation value. We therefore applied a standard Bonferroni procedure that devalued the p-value of 0.05 by a factor of 9 representing nine composite measures to be sure that multiple statistical testing was not generating statistical significance simply by chance.

In regard to the nine composite measures, paired t-tests showed that all of the students taken together became significantly more conservation minded on six; the exceptions were education, human culture and intrinsic value where no significant changes occurred after Bonferroni correction (Table 2a). Note that students rated consumption, and to some extent intrinsic value, as a relatively poor reasons for conserving biological diversity both before and after their course, and also that they rated education, ecosystem services and environmental baselines most highly after learning about conservation.

Separating students by type of course revealed an interesting pattern. Most students in the classic conservation biology course (Table 2b) became increasingly sympathetic to education, environmental baseline, science, tourism and medicine reasons

to conserve biodiversity but they became less sympathetic to the reason that stressed the consumption value of resources; they showed no significant change in opinion on ecosystem services, human culture and intrinsic value reasons. In contrast, "people and conservation" students (Table 2c) showed no significant changes on any of the nine reasons. Since students had selected to take each course themselves, it was not surprising that people and conservation students were highly interested in human cultures at the beginning of the course.

When we examined differences in responses to composite measures by gender taking other factors into account (grade and course), we found no significant differences between male (*N*=60) and female students (*N*=116) on questionnaires 1 or 2 following Bonferroni corrections (Table 3).

When we compared responses of students entering the classic conservation biology course (*N*=143) and those entering the people and conservation course (*N*=33) taking other factors into account, we found that the former scored more highly on science (*Xs*=5.57, 5.10 respectively) and on tourism (*Xs*=5.36, 4.95, Table 3). At the end of the courses, classic conservation biology course students still scored higher on science (*Xs*=5.84, 5.00 respectively) and on tourism (*Xs*=5.71, 4.94) but now scored higher on environmental baseline (*Xs*=5.93, 5.63) and intrinsic value (*Xs*=5.18, 4.74) reasons.

Finally, when we compared high scoring students that attained an A (*N*=53) or B (*N*=82) grade (combined to increase sample size) with those that achieved a C (*N*=28) or D (*N*=13) grade (combined) and taking other factors into account, we found a large number of consistent differences in how they responded to different statements (Table 3). Students that would eventually attain high grades gave greater weight to science (A,B,C

and D respective *Xs*=5.54, 5.61, 5.21, 5.03), tourism (*Xs*=5.30, 5.41, 5.01, 5.03) and environmental baseline (*Xs*=5.62, 5.51, 5.01, 4.92) reasons than lower scoring students before taking the courses. After the courses, high scorers were more sympathetic to education (*Xs*=6.21, 6.01, 5.57, 5.46), tourism (*Xs*=5.70, 5.63, 5.48, 4.79), environmental baseline (*Xs*=6.08, 5.92, 5.58, 5.44) ecosystem services (*Xs*=6.06, 5.95, 5.64, 5.46), consumption (*Xs*=4.85, 4.56, 4.26, 3.90) and human culture (*Xs*=5.92, 5.87, 5.33, 5.33) reasons for conserving biological diversity. There were so few interaction effects between independent variables that we did not pursue them further.

4. Discussion

We found that students altered their commitment to different reasons to conserve biological diversity as a result of taking one of our two courses in conservation biology. For 19 out of 27 statements and six out of nine composite measures, students became significantly more conservation minded (Table 2a). In short, students became more committed to using each sort of argument except those involving the worth of education, helping human cultures, and intrinsic value. Relaxing the stringent Bonferroni correction, this exception reduced to human culture only and may reflect one objective of MBM's people and conservation course – to encourage critical thinking among entering students about the idea that working with local communities is a panacea for the conservation of biological diversity (Borgerhoff Mulder & Coppolillo, in press) (see Table 2c). Overall, these results parallel findings that show that student attitudes towards the natural world are crystallized as a result of taking a conservation biology course (Caro et al., 1994).

When changes in opinion were broken down by course, students in the classic conservation biology course showed significantly greater sympathy for six out of nine reasons but the people and conservation students showed none (Tables 2b and c). Students in the former course became less sympathetic to consumption but those in the latter course became more so (here, relaxing the Bonferroni correction). In short, there appeared to be major differences in how different courses affected students' opinions about reasons to conserve biodiversity although we cannot exclude other variables such as differences in curricula or students with different conservation leanings self selecting their courses.

The main independent variables that affected commitment to certain arguments before the course were the eventual grade that the student would attain in the class and the class in which he or she had enrolled; gender of the student had no effect. The lack of hypothesized gender effect probably reflected low discount rates among the self-selected sample of students enrolling in conservation courses. As regards grade, our hypothesis was supported insofar as students who scored well were generally more sympathetic to a whole gamut of reasons to conserve biodiversity than students who scored poorly, particularly after taking the course. Regarding our predictions about the effect of type of course, classic conservation biology students were more responsive than people and conservation students to a variety of conservation values at the end, in particular science, tourism, environmental baseline and intrinsic value reasons, almost as we had predicted.

Our results suggest that being educated about conservation has a strong influence on the extent to which students become committed to arguments for conserving species and habitats, and this depends crucially on the type of teaching to which they are

exposed. Intellectual achievement had an important influence on the extent to which students subscribed to different arguments for conserving species and habitats, with type of conservation course playing rather less of a role, and gender playing none. Our results clearly speak to the importance of knowledge of conservation issues in engendering sympathy about different conservation arguments but they equally stress the way that such knowledge is presented strongly influences the extent to which people subscribe to classic arguments such as Ehrenfeld's for wildlife conservation.

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Table 1. (a). Course outline for a 27, 1-hour lecture course called *Conservation biology* taught be TC (taught 3 times).

1. What is conservation biology?
2. How many species on earth?
3. Mass extinctions and recent extinctions
4. Causes of extinctions
5. Case studies in decimation: North America
6. Case studies in decimation: the Amazon
7. Exploitation of charismatic megavertebrates
8. International trade in wildlife
9. Rarity and endemism
10. Small populations: genetic effects
11. Small populations: demographic and environmental effects
12. Relative importance of genetic and environmental factors in conservation
13. Small populations: catastrophes
14. Small populations: exotics and hybridization
15. Why conserve natural diversity?
16. Important concepts in conservation biology
17. Methodological techniques in conservation biology
18. Design of reserves: SLOSS
19. Design of reserves: connectivity and siting of reserves
20. Problems with maintenance of reserves
21. Extractive reserves
22. Captive (ex situ) breeding programs
23. Restoration biology: reclamation, rehabilitation and reintroduction
24. Conservation movements and environmental politics
25. Global warming: physical effects
26. Global warming: biological effects
27. What can you do to help?

(b). Course outline for a 20, 1.5 hour lecture course called *Indigenous peoples and the conservation of natural resources* taught by MBM (taught twice).

1. Introduction & overview
2. Why conserve biodiversity?
3. The evolution of conservation policy
4. Ecology, natural resources and conservation biology
5. Contemporary conservation policy in action
6. Indigenous people, harmony with nature, and self interest
7. Environmental degradation and “tragedy of the commons” models
8. Rethinking common pool resources and property rights
9. Political ecology: anthropology’s new perspective
10. Conservation through compensation via tourism
11. Conservation through compensation in kind

12. Integrated conservation and development projects
13. Extractive reserves
14. Community wildlife management projects
15. Environmental economics, bioprospecting, and private solutions
16. Conservation education
    17-19. Student Project Presentations
20. What can I do?

Table 2. Mean scores and paired t-tests between questionnaire 1 and 2 on the nine composite measures. (a) all students, df=175 in all cases, (b) classic conservation biology course students, df=143 in all cases, (c) people and conservation students, df=33 in all

cases. P-values are those following Bonferroni correction; * denotes P<0.05 without Bonferroni correction; - denotes not significant.

Measure	Questionnaire 1	Questionnaire 2	t-test	p-value
(a) All students				
Education	5.78	5.96	-2.706	*
Ecosystem services	5.69	5.90	-3.228	0.0009
Environmental base	5.42	5.88	-7.310	<0.0009
Human culture	5.70	5.76	-1.146	-
Science	5.48	5.68	-3.049	0.0234
Tourism	5.29	5.56	-3.952	<0.0009
Medicine	5.26	5.54	-3.911	<0.0009
Intrinsic value	4.90	5.10	-2.212	*
Consumption	4.06	4.55	-5.816	<0.0009
(b) Classic conservation biology course students				
Education	5.75	5.99	-3.315	0.0108
Ecosystem services	5.70	5.89	-2.677	*
Environmental base	5.43	5.93	-7.362	<0.0009
Human culture	5.62	5.71	-1.491	-
Science	5.57	5.84	-4.123	0.0009
Tourism	5.36	5.71	-4.978	<0.0009
Medicine	5.31	5.64	-4.155	0.0009
Intrinsic value	4.95	5.18	-2.312	*
Consumption	4.08	4.55	-5.385	<0.0009
(c) People and conservation students				
Education	5.89	5.85	-2.217	-
Ecosystem services	5.66	5.92	-1.898	-
Environmental base	5.38	5.63	-1.680	-
Human culture	6.05	5.97	0.772	-
Science	5.10	5.00	0.498	-
Tourism	4.95	4.94	0.046	-
Medicine	5.06	5.15	-0.489	-
Intrinsic value	4.69	4.74	-0.253	-
Consumption	3.99	4.49	-2.261	*

Table 3. Main effects of GLM analyses of variance. Q1 and Q2 refer to the first and second questionnaires respectively. P-values are those following Bonferroni correction; * denotes P<0.05 without Bonferroni correction; - denotes not significant.

Effects of:	Gender		Professor		Grade	
	Q1	Q2	Q1	Q2	Q1	Q2
Science	-	*[f]	0.009[c]	<0.0009[c]	0.018[h]	*[h]
Education	-	-	-	-	*[h]	<0.0009[h]
Tourism	-	-	0.045[c]	<0.0009[c]	0.027[h]	<0.0009[h]
Medicine	-	*[f]	-	*[c]	-	-
Env baseline	-	*[f]	-	0.036[c]	0.009[h]	0.009[h]
Eco services	-	-	-	-	*[h]	0.009[h]
Consumption	-	-	-	-	-	0.036[h]
Intrinsic value	-	-	-	0.045[c]	*[h]	-
Human culture	-	-	*[p]	-	-	<0.0009[h]

[f] denotes females scored higher than males.

[c] denotes students scored higher in classic conservation biology course; [p] denotes that students scored higher in the people and conservation course.

[h] denotes students with A and B grades scored higher than those with C and D grades.

Appendix 1. Questionnaire given to students before and after their course. Square brackets refer to our composites and were not included. Numbers were not shown on the origin questionnaires.

Name

_____

PLEASE ANSWER ALL THE FOLLOWING QUESTIONS. FOR EACH QUESTION CIRCLE ONLY ONE OF THE 7 POSSIBLE ANSWERS.

1. Plans for building an important university observatory have been held up for years because the site lies at a key cultural mountain location revered by the local tribal elders. There are no other appropriate mountains in the state on which to build this observatory. Do you agree that construction should go ahead? [**Human culture**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
7	6	5	4	3	2	1

2. The University of California owns an extensive natural reserve system which it uses primarily for educational purposes. A plan is presented to the Regents to sell off these reserves in order to finance a larger number of low income students to benefit from a college education. Do you agree with the plan? [**Education**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
7	6	5	4	3	2	1

3. Inland lakes undisturbed by industry and tourism are critical to biologists in understanding the evolution and ecology of freshwater fishes. If a new fish facility was initiated at a lake near Davis but necessitated excluding all sport, industrial and residential uses, would you agree to support it? [**Science**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

4. Some developing countries set up national parks primarily to attract the substantial tourist revenue that these parks generate. However, tourists are often advised by their embassies not to visit developing countries during periods of elections or civil strife. Do you agree that it is justifiable for a country undergoing civil disturbance to temporarily suspend the protected status of its national parks and turn them over to agriculture until tourist numbers build up again? [**Tourism**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
7	6	5	4	3	2	1

5. Many plants in rain forest appear to have medicinal properties but they are poorly documented. Do you agree that it is justified to set aside certain areas of rainforest solely as playgrounds for pharmaceutical companies to investigate these species? [**Medicine**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

6. To counteract possible ecologically damaging effects of their activities, Dutch industries working in the third world are required to plant large numbers of trees there. This increases the costs of their products to consumers in the West. Do you agree with this policy? [**Ecosystem services**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

7. Large hydroelectric schemes designed to supply the water requirements of city inhabitants are sometimes halted because they will destroy the habitat of small species of fish of no obvious economic value or biological significance. Do you agree that this is justifiable? [**Intrinsic value**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

8. An inordinately expensive project is currently making an inventory of every species of animal, plant, fungus and bacterium in a Costa Rican forest. This will eventually give us the most complete documentation of what a dry neotropical forest contains and is crucial to attempts to recreate such forests should all disappear. Do you agree that such a venture is reason enough to conserve this area? [**Environmental baseline**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

9. A uninhabited plateau in Tibet has recently been gazetted as a national park principally on the basis of its rich biodiversity. The flora and fauna are not unique to the area, and tourism is impossible. Furthermore, the administrative costs of running the park are substantial. Do you agree that the park should have been set up? [**Intrinsic value**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

10. Each year, the National Cancer Institute in Washington screens thousands of plant and animal species for cures for cancer resulting in great cost to the taxpayer. Very occasionally anticarcinogenic agents are uncovered. Would you agree that these rare discoveries are sufficient reason to conserve pristine habitats? [**Medicine**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

11. Many wetland areas in South-East Asia are being converted to rice cultivation. To protect the few remaining wetlands in this area, some conservationists propose a controlled culling of large lizards, such that the income earned from selling their skins (for making shoes and purses) will compensate the

farmers who would otherwise have cultivated rice. However the expense of developing an appropriate technology for curing lizard skins is so high that no net profits will be reaped from the culling project for at least 10 years. Do you agree with the culling proposal? [**Consumption/food/exploitation**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

12. We know that soil erosion follows tree removal in areas of high rainfall. In many such areas rural communities have depleted trees for firewood and building purposes. Having removed most timber from flat areas, they are turning their attention to hillsides where risks of erosion are acute. To stop further tree felling, an international aid organization proposes substituting gas for firewood, and bricks for timber, brought in from elsewhere. The cost of this project will seriously reduce funds for agricultural development in the area. Do you agree this proposal should be implemented? [**Ecosystem services**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

13. A biosphere Reserve in South America protects both an important area of rainforest and the territory of an Amerindian tribe who still depend for their food primarily on fishing. Unfortunately river traffic through the Reserve seriously disrupts fishing, causing malnutrition among the children, yet towns further upstream depend on this river traffic for basic supplies and trade. A proposal to protect the rights and traditional life style of the Amerindians by redirecting river traffic by bus around the Reserve will be financially costly, and must be borne by the townspeople. Do you agree this plan should be implemented? [**Human culture**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

14. While the tourist revenue earned from trekking holiday-makers in the Himalayas allows the Nepalese government to establish national parks, this mass influx of tourists inevitably leads to high levels of prostitution and sexually-transmitted diseases in the major cities. Do you agree that the government is right to promote trekking tourism? [**Tourism**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

15. The great plains of North America were converted to wheat fields and cattle pasture by poor settlers fleeing the crowded conditions on the East Coast. As a consequence, very little original prairie habitat remains. Contemporary restoration conservationists thus have limited sources and knowledge from which to recreate the habitat of 150 years ago. Do you agree that the early settlers should have been required by the government to reserve one third of their land holding from agricultural and rangeland use? [**Environmental baseline**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

16. In the last 5 years smallpox has been eradicated throughout the world, and the virus exists now only in a few laboratories. Since the benign cow pox virus is a better model for treating related diseases, would you agree to support a proposal to destroy the remaining smallpox specimens once and for all? [**Intrinsic value**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
7	6	5	4	3	2	1

17. In contrast to developed countries where children learn about wildlife on television, wildlife education in developing countries depends on young people actually visiting national parks. However, in recent years, even in developing countries the proportion of households owning a television set is increasing rapidly. Would you agree that governments in developing countries are justified in turning over some of their national parks to food production once wildlife education programs become widely available on television? [**Education**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
7	6	5	4	3	2	1

18. Deer hunters in Michigan argue that the forests of the Mid-West can only be maintained through sport hunting. Yet every year innocent hikers lose their lives to stray bullets. Do you agree with deer hunting as a means of habitat protection? [**Consumption/food/exploitation**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

19. The educational value of reserves set close to major cities is unquestioned but they prevent the building of dormitory towns that would allow thousands of commuters easy access to their work in the city. Would you agree that children should therefore be encouraged to learn about the natural world in other ways? [**Education**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
7	6	5	4	3	2	1

20. No one would argue that the northern spotted owl has the cure for cancer. Nevertheless many do argue that the insects, amphibians and plants that inhabit the old growth Northwest forests in which it lives might provide products that could combat human diseases. The cost is well known; many people in the timber industry will lose their jobs if these forests are conserved. Do you agree that the potential medicinal value of these species is justification enough for saving these forests? [**Medicine**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

21. If we are to reintroduce rare species bred in zoos back into their natural habitat, we will need to set aside wilderness areas expressly for this purpose. Yet it is difficult to justify the protection and infrastructure associated with a reserve that at the time of setting up has no individuals of this high profile species introduced to it. Would you agree that this is reason enough to conserve an area? [**Environmental baseline**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

22. Many areas of great natural beauty, such as caves, rock formations and natural springs, are held sacred by the Aboriginal peoples of western Australia, who traditionally have protected the flora and fauna at these sites. These geological areas are often found to contain rich mineral deposits, such as uranium and gold. Backed by the government wanting increased revenue, mining companies are pressuring the Aborigines to give up their land. Do you agree with the mining companies objectives? [**Human culture**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
7	6	5	4	3	2	1

23. In the wet tropics of South East Asia, successful cultivation depends on the existence of forested watersheds in areas adjacent to human settlement. These forests are often awarded protected status by the government, because of their important role in encouraging local rainfall. Since the poor farmers of these regions practice shifting cultivation, they are always looking for more land to bring into production, consequently it is common for them to start encroaching on and cutting down areas of protected forest. Do you agree with government policy of preventing encroachment into forests from farming areas? [**Ecosystem services**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

24. An important method for studying the evolution of insects is to compare related species, so entomologists are keen to conserve as much insect diversity as possible. Many of these insects are agricultural pests, however, and their continued existence in the wild results in a constant source of insect infestation on adjacent agricultural land. Do you agree with the conservation of these insect species in nature? [**Science**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

25. In areas of southern Africa antelope meat is a delicacy. The sustainable harvest of antelopes therefore justifies the protection of large savannah areas. However the proximity of wild animals to cattle ranches puts the health of domestic livestock at risk, thereby jeopardizing lucrative beef export sales from nations in this region. Do you agree that it is reasonable to conserve these areas on the basis of sustainable antelope harvests? [**Consumption/food/exploitation**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

26. In third work countries many national parks are supported by international tourism. These foreign visitors expose nationals to all sorts of consumer items that are unavailable or unaffordable locally. This generates dissatisfaction because people's material aspirations cannot be met. Do you agree that this is a cost worth bearing to protect national parks? [**Tourism**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

27. Two Davis faculty members and their graduates work in Nature Reserve in Belize. This 350 km2 area of wet tropical forest is set aside solely for the purpose of scientific research, and no other visitors are allowed in. Since it lies close to main road, it is accessible to local hunters and the government is now having to finance and organize a task force to prevent poaching. Do you agree that this is worth the time and effort? [**Science**]

Strongly Disagree	Disagree	Mildly Disagree	No View	Mildly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

We found substantial and significant changes in student responses to statements and composite measures after they had taken our courses. Out of 27 statements, Wilcoxon matched pairs tests showed that students became significantly more conservation minded (in the sense of agreeing with the reason for conserving a species or habitat) on 19 of these statements. These were statements 2, 4, 5, 6, 8, 9, 11, 12, 14, 15, 17, 18, 20, 21, 23, 24, 25, 26, 27. In regard to the 9 composite measures, paired t-tests showed that students became significantly more conservation minded on 8; the only exception was human cultures where no significant change occurred (see Table 2).

When we examined responses by gender, we found remarkably few differences between male and female students. Male students scored significantly higher on statement 18 (consumption) when they first took the questionnaire whereas female students scored higher on statement 19 (education) when they first took the questionnaire and on statement 20 (medicine) when they answered it a second time. Gender differences on composite measures showed that females had significantly higher scores than males on education reasons after the course (Ns=116, 60 respectively, Xs=6.07, 5.74, t=-2.38, df=174, p=0.019), medicinal reasons after the course (Xs=5.66, 5.33, t=-1.98, df=174, p=0.05) and environmental baselines after the course (Xs=5.98, 5.68, t=-2.30, df=174, p=0.023).

Regarding grade, we found that top students were consistently more committed to certain statements especially after the course. They scored significantly higher on statements 4 (tourism), 6 (ecosystem services), 20 (medicine), 22 (human cultures) and 25 (consumption) before taking the courses and statements 6 and 23 (ecosystem services), 8 (environmental baseline), 17 and 19 (education), 22 (human cultures) and 24 (science) after taking the course. Turning to composite measures, students with higher grades showed greater sympathy with the following: consumption (Ns, A=53, B=82, C= 28, D=13; Xs=4.85, 4.56, 4.26, 3.90 respectively; F=3.48, p=0.017), educational (Xs=6.21, 6.01, 5.57, 5.46; F=5.13, p=0.002), tourism (Xs=5.70, 5.63, 5.48, 4.70; F=3.59, p=0.015), environmental baseline (Xs=6.08, 5.92, 5.58, 5.44; F=3.55, p=0.016), ecosystem services (Xs=6.06, 5.95, 5.64, 5.46; F=4.49, p=0.005) and human cultures (Xs=5.92, 5.87, 5.33, 5.33; F=5.40, p=0.001) after the course, as well as with environmental services (Xs=5.62, 5.51, 5.01, 4.92; F=4.09, p=0.008) and ecosystem services (Xs=5.81, 5.73, 5.64, 5.08; F=3.08, p=0.022) before the course.

When the effect of the two sorts of course were examined, students taking the classic conservation biology course scored significantly higher on statements 5 (medicine), 18 (consumption), 24 and 27 (science) before the course whereas students on the indigenous peoples course scored higher on statements 1, 13 and 22 (human cultures) and 19 (education). After the courses, the conservation biology set of students scored higher on statements 4 and 26 (tourism), 5 (medicine), 21 (environmental baseline), 24 and 27 (science) whereas indigenous students scored higher on statement 1 (human cultures). Regarding composite measures, students in the classic conservation course scored higher than students on the indigenous peoples course on science (Ns= 143, 33 respectively; Xs=5.57, 5.10; t-test= 2.60, df=174, p=0.10) and tourism (Xs=5.36, 4.95; t=2.32, df=174, p=0.021) before the course; and indigenous peoples students scored higher on human cultures (Xs=6.05, 5.32; t=-3.13, df=174, p=0.002) before the course. After finishing the course, classic conservation students scored significantly higher than indigenous peoples students on science (Ns=143, 33 respectively; Xs=5.84, 5.00; t=4.93,

df=174, p=<0.0001), tourism (Xs=5.71, 4.94; t=4.43, df=174, p<0.0001), medicine (Xs=5.64, 5.15; t=2.44, df=174, 0.016), and aesthetics (Xs=5.18, 4.74; t=2.19, df=174, p=0.030).