Linkage of Conservation Activity to Trends in the U.S. Economy

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Abstract: *As an economy grows, natural capital such as timber, soil, and water is reallocated to the human economy. This conflict between economic growth and biodiversity conservation creates a conundrum for conservation biologists because traditional forms of conservation action require money. We hypothesize that conservation spending in the United States is highly correlated with income and wealth, and we tested whether selected proxies for U.S. conservation activity could be predicted by U.S. economic indicators over time scales of 7–71 years. Stock market indexes (Dow Jones Industrial Average, Standard & Poor's 500 Index), gross domestic product (GDP), and personal income (PI) explained as much as 99% of annual variation in total revenue (including contributions) to four large nongovernmental organizations (NGOs), the World Wildlife Fund, Sierra Club, Environmental Defense, The Nature Conservancy. These broad economic indicators also explained as much as 96% of the annual number of university conservation programs, 83% of membership in professional conservation organizations (Natural Areas Association, Society for Conservation Biology), 93% of national park visitation, and 99+% of national park acreage. In most analyses, the income variables GDP and PI explained more variation in conservation activity than did either of the stock-market wealth variables. After long-term growth was removed from the time series, changes in revenues to the four NGOs combined were significantly correlated with GDP but not PI over the short term. Short-term variation in park acreage was significantly correlated with GDP and PI but lagged both by 3 years. Using linear models based on GDP, we predicted increases of 2.3% in 2003 cumulative NGO revenues and 1.0% in 2006 acreage owned by the National Park Service. The conservation activity parameters we measured may exhibit positive trends even in the face of declining biodiversity, but biodiversity conservation will ultimately require the cessation of economic growth. The challenge to the conservation biology community is to retain a significant presence during and after the cessation of growth.*

Key Words: charitable giving, conservation, econometrics, economic growth, economic trends, financing, forecasting, steady state economy

Vinculación de la Conservación con Tendencias de la Economía de E. U. A.

Resumen: *A medida que crece una economía, el capital natural (como madera, suelo y agua) es reasignado a la economía humana. Este conflicto entre crecimiento económico y conservación de biodiversidad crea un enigma para biólogos de la conservación porque las formas tradicionales de conservación requieren de dinero. Planteamos la hipótesis que el gasto en conservación en Estados Unidos está sumamente correlacionado con ingreso y riqueza y probamos si se pueden pronosticar sustitutos selectos de la actividad de conservación en E. U. A. con indicadores económicos de E. U. A. en escalas de 7-71 años. Casi 99% de la variación anual*

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del ingreso total (incluyendo donaciones) de cuatro grandes organizaciones no gubernamentales (ONG) (World Wildlife Fund, Sierra Club, Environmental Defense, The Nature Conservancy) se explicó por índices del mercado de valores (Promedio Industrial Dow Jones, Standard & Poor's 500), producto doméstico bruto (PDB) e ingreso personal (IP). Estos indicadores económicos generales también explicaron hasta 96% de los programas universitarios de conservación, 83% de la membresía de organizaciones conservacionistas profesionales (Natural Areas Association, Society for Conservation Biology), 93% de las visitas a parques nacionales y 99+% de la superficie de parques nacionales. En la mayoría de los análisis, las variables de ingreso PDB e IP explicaron más variación en la actividad de conservación que cualquiera otra de las variables de riqueza del mercado de valores. Después de remover el crecimiento a largo plazo de la serie de tiempo, los cambios en ingresos de las 4 ONG combinadas estuvieron suficientemente correlacionados con PDB pero no con IP en el corto plazo. La variación en el corto plazo de la extensión de parques nacionales estuvo significativamente correlacionada con PDB e IP, pero se rezagó 3 años de ambos. Utilizando modelos lineales basados en PDB, pronosticamos incrementos de 2.3% en los ingresos acumulativos de ONG en 2003 y de 1% en la superficie propiedad del Servicio Nacional de Parques en 2006. Los parámetros de actividad de conservación que medimos exhiben tendencias positivas aun a la luz de la declinación de biodiversidad. Sin embargo, la conservación de la biodiversidad finalmente requerirá el cese del crecimiento económico. El reto para la biología de la conservación es retener una presencia significativa durante y después del cese de crecimiento.

Palabras Clave: conservación, crecimiento económico, donación caritativa, economía de estado estacionario, econometría, financiamiento, pronóstico, tendencias económicas

Introduction

In a technical review published by The Wildlife Society, Trauger et al. (2003:2) described a "fundamental conflict between economic growth and wildlife conservation." This conflict exists because, as the economy grows, natural capital such as timber, soil, and water is reallocated to the human economy (Fig. 1). The empirical evidence is consistent with this finding. For example, nearly all the causes of species endangerment in the United States may be classified as economic sectors (Czech & Krausman 1997). Many believe that technological progress may reconcile the conflict between economic growth and conservation, but technological progress expands the breadth of the human niche and, in the service of economic growth, exacerbates the conflict (Czech 2003). These findings suggest that, ultimately, biodiversity conservation in the context of human civilization depends on the establishment of a steady-state economy with stable populations and material throughput (Daly 1997).

The conflict between economic growth and biodiversity conservation creates a conundrum for conservation biologists because traditional forms of conservation action require money, which is derived via the liquidation of natural capital (Czech 2000*a*). These forms of conservation include habitat and species management, the establishment of parks and other protected natural areas, mitigation banking, and assessment of damage to natural resources. To some extent, these conservation activities depend on charitable giving, which in turn depends to a large extent on income (McClelland & Kokoshi 1994; Randolph 1995). Yen et al. (1997) surveyed three Canadian provinces to determine the variables affecting contributions to conservation. Income had the largest effect on the probability and amount of donation. The authors speculated, as a result, that economic recessions may have a negative effect on conservation contributions. Cain and Cain (1985) used various corporate accounting statistics to determine whether corporate giving to charity is motivated by philanthropic or profit motives. Regression results showed strong support for profit as a motive. Pickering (1985) found that income and employment rate were the key determinants of religious contributions. Kitchen (1992) compared religious and nonreligious contributions and found income to be an important factor in both.

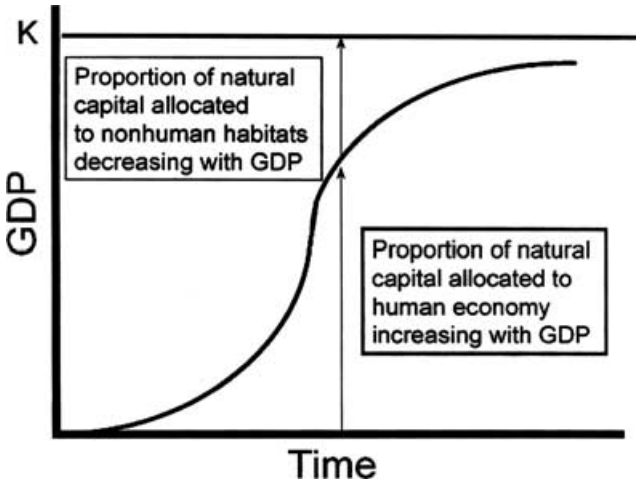

*Figure 1. Natural capital reallocated from diversity to humans in the process of economic growth (modified from Czech 2000*b*) (GDP, gross domestic product).*

Tax rates also have been cited as determinants of charitable giving (e.g., Brown 1987; Lankford & Wyckoff 1991). Using 10 years of tax return data, however, Randolph (1995) found that previous studies underestimated

the effects of income and overestimated the effects of taxes. Kitchen (1992) found that changes in marginal tax rates have virtually no impact on religious contributions, though they may have an impact on nonreligious contributions. Yen et al. (1997) stated that the effect of income on conservation contributions was not offset by increases in participation in wildlife-related activities or changes in marginal tax rates.

However, we have found no studies that attempt to forecast contributions based on economic indicators other than income or tax rates, nor have we found any studies attempting to forecast measures of conservation effort other than contributions. Is conservation effort in the aggregate tied to easily accessible, broad economic indicators? Are there predictable time lags between funding availability and actual or potential conservation efforts? If the answer to these questions is yes, conservation planners might better anticipate the fiscal resources available to them for implementing important conservation projects, at least in the short term.

We examined temporal relationships among various measures of conservation effort and economic conditions. We hypothesize that conservation spending in the United States is highly correlated with income and wealth. Our approach places an emphasis on tracking the components of conservation finance.

Methods

Broad Economic Indicators

We used four conventional measures of economic condition. Two were income variables: gross domestic product (GDP), or the market value of all goods and services produced in the United States, and personal income, an individual's total earnings from wages, passive enterprises, and investment interest and dividends. Two were wealth variables: the Dow Jones Industrial Average, an index of 30 blue chip stocks; and the Standard and Poor's 500 Index (S&P) of 500 big-cap stocks. Gross domestic product, personal income, and the Dow Jones provided a 73-year time series. More years of data exist, but we only attempted to match our longest conservation-indicator time series (71 years, acreage managed by NPS). Standard and Poor's provided a 63-year time series. All data were in the form of annual time series. These and all other dollar-denominated values were inflation-adjusted to the value of the dollar in 1996, the same year to which the Federal Reserve Bank adjusted at the time we wrote this paper. All raw data are posted on the Web site www.iqt.org in spreadsheet form, along with detailed citations of their origins.

Selected Indicators of Conservation Effort

To reflect the wide variety of conservation efforts undertaken, we used proxies that tracked diverse conservation activities, both direct and indirect. One major source measured total revenue (including contributions) to several large conservation organizations: World Wildlife Fund (WWF; 22 years), Sierra Club (SC; 45 years), Environmental Defense (ED; 31 years), and The Nature Conservancy (TNC; 22 years). The cumulative total revenues of all four nongovernmental organizations (NGOs) was also analyzed. All of these NGOs are headquartered in the United States, although some also have programs in other countries. We contacted three of the NGOs to get a sense of what percentage of their revenues came from outside the United States. Foreign revenues of the SC have been under 1% of total for at least the last 10 years (L. Barnes, personal communication) and less than 1% of TNC donors have non-U.S. addresses (J. Wiens, personal communication), whereas foreign revenues of the WWF were 10–12% of total for the last 2 years (G. Warnock, personal communication).

We also used the number of existing university graduate programs in conservation biology (UCB; 28 years), our criterion for which was their designation as such by the National Wildlife Federation's annual Conservation Directory (National Wildlife Federation 1970–2001), our source for this data set. Two additional gauges of effort were the per capita visits (weighted by U.S. census numbers) made by individuals to national parks (NPV; 63 years) and the total acreage of land managed by the National Park Service (NPS; 71 years). Finally, we used the number of members in two professional conservation organizations, chosen arbitrarily: the Natural Areas Association (NAA; 23 years) and the Society for Conservation Biology (SCB; 7 years). These memberships were also weighted per capita.

Time series were chosen on the basis of data available to authors. Much of these data were obtained from the original sources (e.g., the NGOs themselves), and we were often unable to get data as far back as the age of the organization. In some cases we were told that records no longer existed and in others that records were only archived in paper form and the organization was not willing to access them. In every case we used all the data available to us.

Statistical Analyses and Criteria

We used Spearman rank-order correlations to test relationships between selected indicators of conservation effort (dependent variables) and broad economic indicators (independent variables). We ran these nonparametric tests for raw values of each conservation indicator against each broad economic indicator as a level model. Positive correlations would support the null hypothesis that conservation effort is positively associated with economic conditions. Insignificant or negative correlations would refute our hypothesis.

Because relatively constant long-term economic growth in the various time series could be responsible for a large

part of any correlation found, we sought to remove this potential artifact by examining any short-term linkages. To do so, we compared the percent change from year to year instead of the raw values of all conservation and broad economic indicators, except individual NGO revenues and SCB, in a difference model.

Finally, we used complete linear regressions as models for predicting short-term (year-to-year) changes in conservation effort. For these regressions, we used those variables and lag periods for which the most significant correlations in year-to-year changes (%) were observed.

Results

Long-Term Trends in Economic Condition and Conservation Activity

Long-term growth occurred in all four of the broad economic indicators examined (Fig. 2). Total revenue to each of four large conservation NGOs also grew substantially over most of this period, albeit more erratically (Fig. 3). For example, dips and/or declines in revenues that corresponded to the 1987 market correction or early 1990s recession were apparent in the time series.

The trend in number of university conservation biology programs was also one marked by growth (Fig. 4). Membership in NAA (Fig. 4) grew slowly from the late 1970s until the early 1990s, when it flattened.

Recreational per capita visitation to national parks grew from the late 1930s until about 1987 (Fig. 5). Thereafter, a gradual decline occurred, breaking a 50-year uptrend.

Total acreage under management by the National Park Service more than quadrupled between 1920 and 2000 (Fig. 6). An idiosyncratic data point occurs when more than 43 million acres of new parkland were set aside in 1980 as a result of passage of the Alaska National Interest Lands Conservation Act. This data point was excluded from correlation and regression analyses.

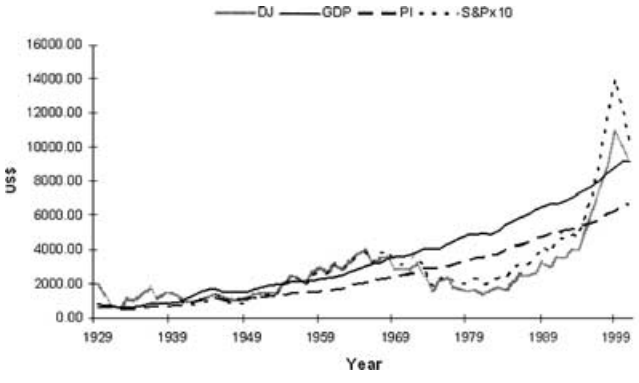

Figure 2. Trends in four broad indicators of the U.S. economy, 1929–2001: GDP, gross domestic product; PI, personal income; DJ, Dow Jones Industrial Average; S&P, Standard and Poor's 500 Index (multiplied by 10 to match scale).

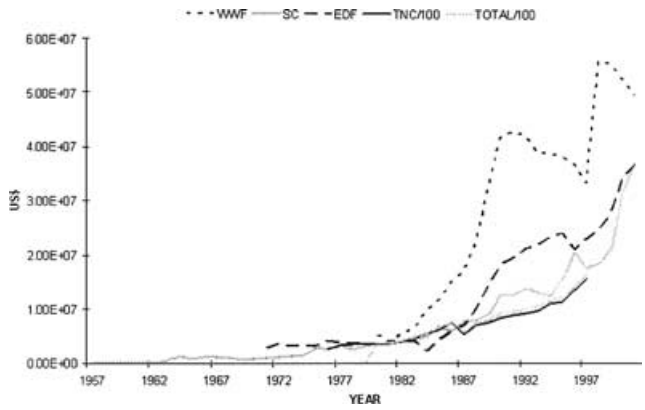

Figure 3. Individual and aggregate revenue (including contributions) to four large nongovernmental conservation organizations, 1957–2001. Abbreviations: EDF, Environmental Defense; SC, Sierra Club; TNC, The Nature Conservancy (divided by 100 to match scale); WWF, World Wildlife Fund. Total contributions (TOTAL) also divided by 100 to match scale.

Long- and Short-Term Linkages of Conservation Activity to Economic Indicators

Revenues of each of the four NGOs, as well as cumulative revenues, were significantly correlated with each of the four economic indicators (Table 1). Notably, GDP and personal income accounted for no less than 89% and as much as 99% of variation in total revenues to each of the four NGOs. Revenues of each individual NGO were also significantly correlated with the Dow Jones and S&P, though generally less so than with GDP and personal income.

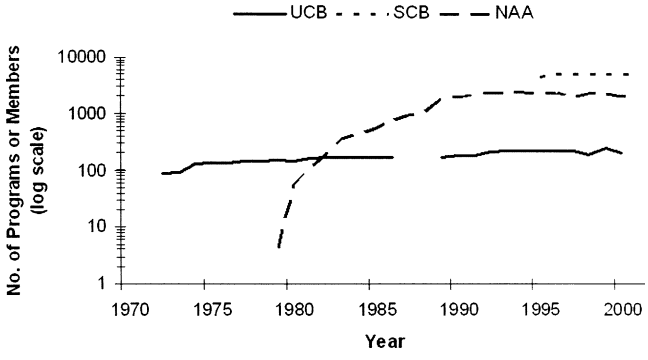

Figure 4. Number of U.S. university programs in conservation biology (UCB) and individual membership (per capita weighted by U.S. population census) in two professional conservation organizations, National Areas Association (NAA) and Society for Conservation Biology (SCB).

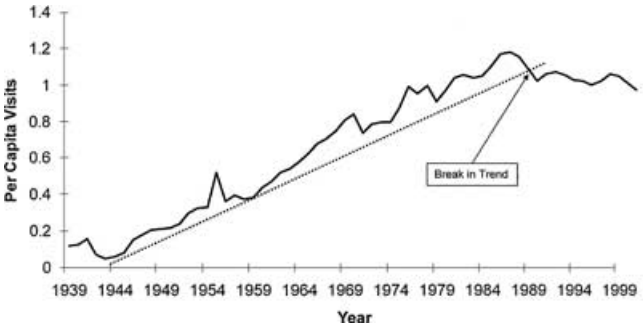

Figure 5. Visitation to national parks (per capita, weighted by U.S. population census), 1939–2001.

Among the NGOs examined, the Sierra Club's revenues were least strongly linked to the two market indices. Cumulative revenues were about equally highly correlated with each of the four broad economic indicators.

Economic indicators explained from 70% to 96% of the variation in the annual number of university programs in conservation biology (Table 2). Here, too, GDP and personal income (both 96%) were better predictors of these numbers than were the two market indices (70–76%). No less than 83% of annual changes in membership for the Natural Areas Association were explained by the economic indicators. However, membership in the Society for Conservation Biology was not significantly correlated with any of the four economic indicators, probably as a result of the relatively short length (7 years) of this particular time series.

Total acreage and visitation to national parks were significantly and strongly correlated with all four economic indicators (Table 2). Acreage and visitation, however, were both more strongly linked to GDP and personal income than to the two market indexes. Gross domestic product and personal income explained 93% to over 99% of the variation in both acreage and visitation, whereas the two stock-market indices explained 58–77%.

After the effects of long-term growth were factored out through the use of percent year-to-year changes, cumulative revenues remained significantly correlated with GDP ($r_s = 0.63$, $p < 0.005$, $n = 22$) but not personal income, Dow Jones, or S&P. This relationship held for same-year comparisons only; no lagged correlations were detected. Acreage of national parks remained significantly correlated with GDP ($r_s = 0.31$, $p < 0.005$, $n = 71$) and personal income ($r_s = 0.27$, $p < 0.05$, $n = 71$) but not with Dow Jones or S&P. Responses of national park acreage lagged both GDP and personal income by 3 years. No other significant correlations were detected, lagged (up to 5 years) or unlagged, between conservation and economic indicators. Correlations of percent year-to-year changes were not performed on individual NGO revenues or on per capita membership in SCB.

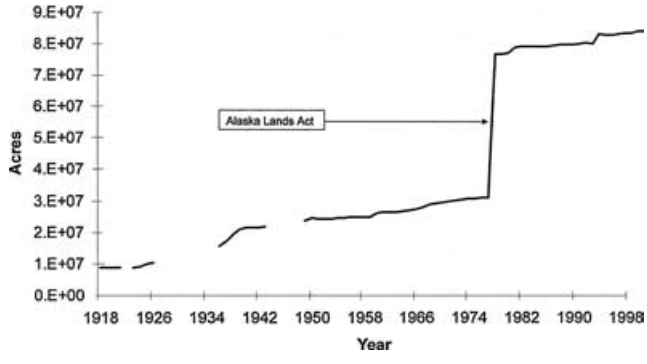

Figure 6. Total acreage managed by the U.S. National Park System, 1919–2001. The very steep increase in park acreage in 1980 stemmed from passage of the Alaska National Interest Lands Conservation Act, which provided for 43,585,000 acres of new national parklands in that state.

Table 1. Spearman rank correlations (r_s) between four broad economic indicators and total revenue, including contributions, to each of four large nongovernmental organizations (NGOs).[a]

NGO (time-series length, years)	*Economic indicator[b]*			
	S&P	*DJ*	*GDP*	*PI*
WWF (22)	0.89	0.89	0.89	0.90
SC (45)	0.55	0.37*	0.98	0.98
ED (31)	0.85	0.82	0.93	0.94
TNC (22)	0.92	0.89	0.98	0.99
TOT (22)	0.97	0.98	0.98	0.98

[a] *Abbreviations: WWF, World Wildlife Fund; SC, Sierra Club; ED, Environmental Defense; TNC, The Nature Conservancy; TOT, cumulative total of all four organizations.*
[b] *Level of significance on* r_s *is* $p < 0.0005$ *for all except those marked with an asterisk,* $^*p < 0.005$. *Abbreviations: S&P, Standard and Poor's 500 Stock Index; DJ, Dow Jones Industrial Average; GDP, gross domestic product; PI, personal income.*

Table 2. Spearman rank correlations (r_s) between four broad economic indicators and five indicators of conservation effort.[a]

Indicator of conservation effort (time-series length, years)	*Economic indicator[b]*			
	S&P	*DJ*	*GDP*	*PI*
UCB (28)	0.76	0.70	0.96	0.96
SCB (7)	0.39	0.29	0.21	0.21
NAA (23)	0.83	0.83	0.83	0.83
NPA (71)	0.77	0.69	0.999	0.999
NPV (63)	0.71	0.58	0.93	0.93

[a] *Time series for each indicator of conservation effort: UCB, number of university academic programs in conservation biology; SCB, Society for Conservation Biology per capita membership; NAA, Natural Areas Association per capita membership; NPA, national parks acreage; NPV, national park system per capita visitors.*
[b] *Level of significance on* r_s *is* <0.0005 *for all except SCB values.*

Predictive Models for Conservation Activity

Either same-year or lag-year regression models accounted for significant variation in two types of conservation activity: cumulative revenues and acreage managed by the NPS. For same-year comparisons, total revenue to the four large conservation NGOs was modeled by

$$x_1 = 0.006 + 0.793y_1, \quad (1)$$

where x_1 is the percent year-to-year change in total revenue and y_1 is the percent year-to-year change in GDP in the same year ($p < 0.0005$).

For NPS-managed land, conservation activity trailed economic trends by 3 years. A relationship between NPS-managed lands and GDP was modeled simply by

$$x_2 = 0.332y_2, \quad (2)$$

where x_2 is the percent year-to-year change in national park acreage and y_2 is the percent year-to-year change in GDP from 3 years earlier ($p < 0.0005$).

As a practical exercise, we used these regressions to forecast changes in these two conservation variables. Gross domestic product, inflation-adjusted to 1996 dollars (real GDP), was +2.9% from 2002 to 2003 (the final 2003 number). Using Eq. 1, we forecast a change of +2.3% from 2002 to 2003 in TOT, the cumulative revenues of the four NGOs. Using Eq. 2, we forecast a change of +1.0% from 2005 to 2006 in NPA, acreage owned by the National Park Service.

Discussion

Our results support the hypothesis that conservation spending in the United States is correlated with income and wealth. The state of the national economy exerts a significant impact on philanthropic giving. The Philanthropic Giving Index assesses climate for fundraising twice each calendar year (Center of Philanthropy at Indiana University 2003). After reaching its apex in summer 2000, the Philanthropic Giving Index declined by more than 22% during the most recent economic recession in the United States. This decline reflected lowered optimism about raising capital for conservation (and other philanthropic) projects going forward 3 months, especially if the funding base was national rather than regional in scale (Center of Philanthropy at Indiana University 2003).

Confirming survey results for the Philanthropic Giving Index, large drops in cumulative revenues (Fig. 3) corresponded with the large drops in the stock market (Fig. 2) that began in 1987 and 1999. This occurred in spite of the fact that percent year-to-year changes of cumulative revenues were not significantly correlated with the Dow Jones, S&P, or personal income (though they were significantly correlated with GDP). Perhaps only large stock moves have an impact on NGO revenues, whereas small stock-market moves do not, but GDP changes appear to have immediate impacts regardless of magnitude.

It is not clear what caused the break in the long trend of increasing per capita visitation to national parks (Fig. 5), but it may reflect a decline in the marginal utility derived by visitors caused by more crowded parks resulting from economic and population growth. Other causes of the decline in per capita park visitation may include a declining propensity for outdoor activity (due in part to increased interest in electronic media), increased foreign ecotourism by Americans at the expense of national park visitation, and/or shrinkage of the American middle class.

The generally high Spearman correlations of economic and conservation variables were not surprising, given the long-term growth exhibited by most of the variables. However, some correlation values were exceedingly high. Several categories of NGO contributions, including cumulative revenue, exhibited correlations with GDP and personal income of 98–99% ($p < 0.0005$). This corroborated the finding by Yen et al. (1997) of the importance of income as a direct factor in conservation contributions. The correlations between national park visitation and GDP and personal income were both 93% ($p < 0.0005$), the correlations between university programs in conservation biology and GDP and personal income were both 96% ($p < 0.0005$), and the correlations between national park acreage and GDP and personal income were almost 100% ($p \ll 0.0005$).

For short-term projections, we correlated percent year-to-year changes of economic and conservation variables. In this way we removed long-term growth from the analysis and switched from a level model to a difference model. With this methodology we found three significant correlations. Given the literature we reviewed on income and corporate contributions, one would expect an immediate impact of GDP on NGO revenues. But why was personal income not significantly correlated as well? Perhaps individual contributions have relatively little impact. Also, it is interesting that there was no apparent lag based, for instance, on tax-filing considerations.

The 3-year lag between GDP and purchase of new national park lands is explained by the fact that it takes time for the government to legislate and negotiate land acquisitions. Here personal income was a predictor as well, though a weaker one than GDP.

In general GDP was the best predictor of conservation activity, followed closely by personal income, with the two stock market indices a distant third and fourth. In other words, income variables were clearly better predictors of conservation effort than wealth variables. Gross domestic product accounts for corporate income as well as individual income. Our results suggest that yearly corporate income may be the most important predictor of

conservation effort, with individual income next in importance.

We explored conservation financing in the United States. Recent studies have shown that even when funds are available and distributed globally, inefficiencies in their regional use may hamper the effectiveness of conservation projects on the ground (Smith et al. 2003). When and where such inefficiencies are great, we would not expect to observe the high correlations between economic indicators and conservation activity found in this study.

We hope our findings are of predictive or interpretive value for conservation organizations, but we emphasize that none of our findings alter the fundamental conflict between economic growth and biodiversity conservation. The conservation activity parameters we measured may exhibit positive trends even in the face of declining biodiversity. Our long-run vision is that of a national (and eventually global) steady-state economy with stabilized population, consumption, throughput, and (to the extent that real dollars represent the liquidation of natural capital) expenditure. If and when that vision materializes, we hope that the conservation community remains a prominent and steady presence in the U.S. economy.

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