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U.S. Conservation Policy Reconsidered

Amy Whritenour Ando
Dept. of Agricultural and Consumer Economics
University of Illinois at Urbana-Champaign

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Research related to the Endangered Species Act (ESA, the Act) tends to take the presence of that policy as given and focus on issues of implementation and effects. Some work has worried about whether the ESA yields enough perverse outcomes that redesign is necessary to protect species (List et al., 2006; Lueck and Michael, 2003; Zhang, 2004). I work in this paper to explore a more basic question: is the ESA based on useful conservation objectives?

The ESA identifies species as the unit of regulatory interest. This approach is problematic for several reasons. First, as George and Mayden (2005) point out, there is no single definition of “species” even in conservation science, and the Act itself does not provide a good operational definition. This lack of clarity has produced much wasteful debate amongst interest groups over the concept of species and slowed effective ESA enforcement. Second, even if there were a single accepted definition of species, one could construct numerous different “optimal” policies depending on one’s beliefs about the relative importance of species characteristics such as those identified by Metrick and Weitzman (1998): utility, distinctiveness, survivability and cost.

Third, the ESA seems formally to require that conservation efforts be spread evenly across species to prevent their extinctions regardless of how productive those species are and how much people actually care about them. While the administrative process does have a limited priority system and does allow some informal variation in how species are treated according to how expensive they are to protect and how much people value them (Metrick and Weitzman, 1996; Ando, 1999), this may provide only limited opportunity for variation in public support to be expressed in how much we do to protect different species. Hendrickson’s (2005) media analysis finds significant attention is paid in national newspapers to economic conflicts associated with the ESA, particularly in the cases of species that are not popular and are viewed as largely “obstructionist.” While the ESA as a whole retains general popular support, protection for low-valued species could undermine aggregate national willingness-to-pay for ESA enforcement. The budget for government ESA-related program activities is not fixed by legislation, and thus is subject to erosion when net public support for the program is low.

Indeed, the focus of conservation science has evolved in recent years towards ecosystems and away from species; this is discussed in the useful review by Armsworth et al. (2004). The Millennium Ecosystem Assessment captures the change in conservation science with its focus on ecosystem services rather than on the exact species that provide them (MEA 2005). Christie et al. (2006) evaluate the extent to which people value "biodiversity" for features such as production of ecosystem services. Work such as Schwartz et al (2000) has shown that ecosystem services rise only asymptotically with measures of biodiversity. Particular species may be critical to producing ecosystem services; bees, mangroves, and plankton are extreme examples of this principle (Ewel et al., 1998; Memmott et al., 2004; Richardson and Schoeman, 2004.) Biodiversity itself may also contribute to ecosystem-service production. However, society gains value from the services[1] and not necessarily from inputs to the production of services. While every species may not have intrinsic value to society, people do value some species in their own right, such as bears, pandas, tigers, butterflies, and whales. Loomis and White (1996) find that per household willingness to pay (WTP) is higher for birds and marine mammals than for less charismatic animals such as fish and reptiles, with annual household WTP for a species ranging as high as $96.

Many conservationists are reluctant to change the ESA, feeling that public support for species like wolves, grizzly bears and bald eagles translates into support for conservation efforts that provide ecosystem services for which experts fear that the public might be otherwise unwilling to pay. However, some work implies there is only limited potential for public willingness-to-pay to save charismatic species to serve as an effective instrument for protecting other elements of the natural world that are necessary for producing ecosystem services (Kontoleon and Swanson, 2003,) and the correlation between areas that harbor biodiversity and areas that provide ecosystem services may be weak (Chan et al., 2006). We might well fear that adding polar bears to the endangered-species list is an inadequate substitute for rational conservation policy.

This paper seeks to begin a national discussion about optimal conservation policy. It characterizes optimal conservation spending when species are valued for their contributions to ecosystem services and not even for their own existence. It explores the manner in which the ESA distorts resource targeting away from the optimum. It identifies circumstances under which complementary private conservation activity can remedy ESA-related misallocation, and identifies the stylized empirical relationship between ESA enforcement and private contributions to wildlife conservation groups. It concludes with a broad-ranging discussion of possible U.S. conservation policy reform.

Theoretical Model

Swanson (1994) uses a sophisticated model to analyze optimal species preservation and extinction as a function of the benefits that species provide to society. However, that paper does not shed light directly on policy-design issues associated with the ESA, and does not analyze a situation with joint government and private provision of conservation goods. In this section, I use a very simple static theoretical model to explore the nature of optimal conservation efforts for different type of species where people benefit from ecosystem services and some – but not all – species. I show scenarios under which current policy might distort our conservation resources away from that, and illustrate the consequences of such distortion. Then I present a model in which conservation is provided by government programs and privately funded NGOs, and develop alternative hypotheses about the relationship between these forms of conservation support.

The theoretical model assumes there are two types of species: charismatic species ("*B*") and non-charismatic species that are not valued for their own sake ("*N*"). This section of the paper considers only the case where both kinds of species are endangered, though other scenarios are discussed qualitatively in the conclusion. Species populations are increasing functions of the funds made available to conserve them – *b* and *n* for charismatic and non-charismatic species, respectively.

The variables *b* and *n* are defined as funds that benefit exclusively one species or another to highlight potential problems associated with mis-targeting conservation spending. Note that this notion of "funds" is an expositional convenience. This analysis applies to all social resources that are devoted to conservation, whether in the form of direct monetary expenditures (like captive breeding programs) or opportunity costs (from timber that can not be logged and stream flows that can not be used by growing cities). Since they are quantities of money, the prices of funds *b* and *n* are by definition equal to 1. For simplicity, I model the production of species populations as:

$$B(b) = b^{\gamma_b} \qquad N(n) = n^{\gamma_n} \tag{1}$$

These functional forms are simple but can display varied types of returns to scale: increasing when $\gamma_i > 1$, constant when $\gamma_i = 1$, and decreasing when $0 < \gamma_i < 1$. Ecologists and conservation biologists have produced many studies that support the idea that species often have minimum viable populations below which the species will not persist in the wild (Soulé, 1996). Scientists have also found thresholds in the response of species populations to habitat alteration (e.g. Guénett and Villard, 2004). In the presence of such thresholds, the functions linking conservation funds to species populations are likely to display increasing returns to scale.

The model also assumes there are two goods provided by conservation activity that people value: populations of charismatic species, *B*, and ecosystem services ("*S*") such as flood control, nutrient cycling, food production, biodiversity-based ecosystem resilience, and so forth. People do not value non-charismatic species in their own right, but they do value the ecosystem services that are produced by nature and which depend on both types of species, *B* and *N*, as inputs to their production.

Note that endangerment does not preclude the possibility that a species contributes to ecosystem services; Lyons et al. (2005) find evidence that rare species can make important contributions to ecosystem functioning. However, many ecosystem services depend largely on species that would not qualify for protection under the ESA. Species populations can fall significantly, taking the level of ecosystem function with them, before they are even close to the dire state of endangerment that is necessary before ESA protection could be invoked. I will not model this case explicitly, but it is clear that the feature of the ESA yields under-provision of ecosystem services relative to the social optimum.

I characterize the production model for ecosystem services as Cobb-Douglas, where

$$S(b,n) = B^{\delta_b} N^{\delta n} = b^{\gamma_b \delta_b} n^{\gamma_n \delta_n} \tag{2}$$

Again, this function can display varied types of returns to scale depending on the sum δ_b and δ_n . The Cobb-Douglas function assumes a moderate degree of substitutability between the two species in the process of producing ecosystem services; future extensions of this work may evaluate the impact on the findings of having more or less substitution possible between these inputs. The exact nature of such a production function will necessarily vary with the particular service of interest. Allen and Loomis (2006), for example, use predator-prey models to estimate indirect values for species that serve to support the production of something for which society has a direct value. However, such parameterized production functions are still scarce in the ecology literature.

In order to highlight the possible features of optimal conservation policy, I first focus on the case where a benevolent social planner has control over all the money in the economy, *I*. The planner can allocate that money between funds to protect charismatic species, *b*, funds to protect non-charismatic species, *n*, and funds available to spend on ordinary consumer goods, X. We can normalize price P_x to be equal to one. Also, since *b* and *n* are funds of money to be spent on conservation, there are no prices associated them.[2] The aggregate social welfare function is increasing in *B, S*, and *X*. Thus, the social planner solves the following constrained optimization problem:

$$\underset{b,n,X}{Max} \quad U(B(b), S(b,n), X) \quad s.t. \quad b+n+X = I \tag{3}$$

The solution to this problem depends critically on the form of the utility function. I first present an extended set of results where the utility function is a simple Cobb-Douglas form. I then discuss the qualitative nature of the changes that occur if preferences are quasi-linear.

Cobb-Douglas preferences:[3]

Under this assumption, we have

$$U(b,n,X) = S^{\alpha_s} B^{\alpha_B} X^{\alpha_X} \tag{4}$$

In order to simplify notation, define the following:

$$K_b \equiv \gamma_b(\delta_b \alpha_S + \alpha_B), \quad K_n \equiv \gamma_b \delta_n \alpha_S, \quad K = K_b + K_n + \alpha_X \tag{5}$$

By substituting the production functions from equations (1) and (2) into the utility function in equation (4), carrying out a monotonic transformation on the result, and employing the expressions from equation (5) to facilitate interpretation, we have that the planner must solve:

$$\underset{b,n,X}{Max} \quad b^{\frac{K_b}{K}} n^{\frac{K_n}{K}} X^{\frac{\alpha_X}{K}} \quad s.t. \quad b+n+X = I \tag{6}$$

This problem again has the standard Cobb-Douglas form and the exponents on the choice variables *b*, *n*, and *X* sum to one. Note that social preferences over funds allocated to these three categories are a function of both preferences over goods and the production functions that produce environmental goods from the funds dedicated to them. If we consider the first expression in equation (5), for example, $K_b \equiv \gamma_b(\delta_b \alpha_S + \alpha_B)$, the relative weight in social preferences given to funds for charismatic species depends on several things: how effectively those funds can be converted into increased *B* populations, how much the *B* species contributes to production of ecosystem services, and how much people value both charismatic species and ecosystem services. In contrast, the relative weight in social preferences given to funds for non - charismatic species is much simpler. The term $K_n \equiv \gamma_b \delta_n \alpha_S$ is a function only of how effectively funds for protecting such species are converted into ecosystem services, and how much people value those services.

The solution to this constrained maximization problem is the usual Cobb-Douglas result:

$$b^* = \frac{K_b}{K} I, \quad n^* = \frac{K_n}{K} I, \quad X^* = \frac{\alpha_X}{K} I \tag{7}$$

In particular, the ratio of the optimal expenditures on *b* and *n* is

$$\frac{n^*}{b^*} = \frac{K_n}{K_b} \tag{8}$$

Thus, it is highly unlikely that society should spend equal amounts of money on conserving both types of species. If the intrinsic value of the charismatic species is very high, then $b^* > n^*$ may obtain. If the value of the ecosystem service is high and the non-charismatic species is a critical input to production of that service, then $n^* > b^*$. If, however, the non-charismatic species makes only minor contributions to ecosystem functioning, optimal spending levels on that species are likely to be low in the absence of public preferences for its existence. In the presence of strong increasing returns to scale in the production of species populations from funding, imbalanced optimal levels of funding imply very large differences in the optimal populations of the two species.

The ESA is not written to solve the problem outlined above. It was written decades before the modern focus on ecosystem services, and takes species as its unit of concern. If we assume that the Act is administered in a manner consistent with its authorizing language, then we are providing equal protection to all species. One interpretation of that condition is that spending is constrained such that $n = b$.[4] If we define $z = n = b$, then the optimization problem in equation (6) becomes

$$\underset{z,X}{Max} \quad z^{\frac{K_b+K_n}{K}} X^{\frac{\alpha_X}{K}} \quad s.t. \quad 2z + X = I \tag{6a}$$

Under these circumstances, the best choices we can make are

$$\tilde{z}^* = \frac{K_b + K_n}{2K} I, \quad \tilde{X}^* = \frac{\alpha_X}{K} I \tag{7a}$$

Expenditures on ordinary consumer goods, X, are unchanged in the second-best outcome associated with the ESA constraint; features of Cobb-Douglas utility mean that inefficiency in the realm of conservation does not shift social spending away from conservation and more deeply into consumer goods. The same total amount of money is directed towards environmental spending n and b, but each fund receives an amount of money equal to the average of the optimal amounts b^* and n^* given in equation (7). Unless the stars are aligned such that the optimal b^* happened to be equal to n,* one fund will be too large, the other will be too small, and utility will be lower that it could have been.

In reality, there is no single social planner who controls all the resources in society. Rather, the government provides some public goods, and then people in the private sector allocate their remaining resources between public and private goods. Private provision can be an important component of total conservation funding. Thus, I now model a situation in which both agents have a role to play.

I abstract from several important features of reality in this formal modeling effort. I assume that private individuals work as a single decision-making entity to maximize social welfare given their limited resources and the actions already taken by the government. In particular, the current model assumes there is no free riding among individuals in the private sector. The existence of free riding is extremely well known (see List, Bulte and Shogren (2002) for a case related to endangered species), and such behavior would be easy to incorporate with a parameter that biases total private expenditures away from optimal levels of public good provision. However, this added notation would offer little new insight. We will instead have further intuitive discussion of the issues associated with free riding in later sections of the paper. Similarly, I abstract from issues of inefficiency in the public sector. Much has been written about the shadow cost of public funds (e.g. Triest, 1990), and a whole literature exists to evaluate whether the public or private sector makes more efficient use of funds for providing public goods (e.g. Grimsey and Lewis, 2005); the function of the current paper, however, is not to stake a claim in that debate.

In this model, the government uses a lump-sum non-distortionary tax to allocate part of total social resources, *I*, to be its budget, *T*.[5] The government chooses how to allocate that money between b^g and n^g (the *g* superscript indicates government provision of resources) subject to its budget constraint and any constraints built into the ESA. Then the private sector (modeled here as a single agent) chooses private b^p , n^p, and X^p to solve

$$\underset{b^p, n^p, X^p}{Max} \quad (b^p + b^g)^{\frac{K_b}{K}} (n^p + n^g)^{\frac{K_n}{K}} X^{p\frac{\alpha_X}{K}} \quad s.t. \quad b^p + n^p + X^p = I - T \tag{6b}$$

The problem is little changed from the government optimization problem in equation (6), except the private sector has less money at its disposal and must take government endowments of b^g and n^g as given. The optimal ratio of total resources devoted to *n* and *b* is given by

$$\frac{n^{p*} + n^g}{b^{p*} + b^g} = \frac{K_n}{K_b} \tag{8b}$$

As long as government expenditure on the environmental funds follows the ratio given in equation (8), the private sector will be able to bring society up to the first best outcome given by the total amounts of *b*, *n*, and *X* in equation (7). We will simply have

$$n^{p*} = n* - n^g, \quad b^{p*} = b* - b^g, \quad X^{p*} = X* \tag{9}$$

Even if the ESA constrains government allocations to have $b^g = n^g$, as long as the government budget *T* is small relative to optimal total spending on environmental goods, the private sector will be able to adjust its choices of b^p and n^p as in equation (9) to achieve the optimal total expenditure on *b*, *n*, and *X*. If, for example, $n* < b*$, private donors would choose to devote most of their resources to funds that supplement protection for charismatic species, thus mitigating the harm to social welfare that the ESA might have done by inducing egalitarian government-mandated protection for all species.

However, if government programs are large, there may be no way for the first best outcome to be achieved. To see this, we can look at an extreme example where $T = I - X^*$ (i.e. the government budget includes all resources that should optimally be allocated to conservation in the first-best outcome), $n^* \ll b^*$ (because $K_n \ll K_b$), and the ESA constrains $b^g = n^g = \frac{1}{2}T$. The non-negativity constraint on n^p will then be binding; the private sector might like to take some resources away from conservation of species *N* and re-allocate them, but can not. Thus, the best it can do is to set $n^p = 0$ and solve:

$$\underset{b^p, X}{Max} \quad (b^p + b^g)^{\frac{K_b}{K}} (n^g)^{\frac{K_n}{K}} X^{\frac{\alpha_X}{K}} \quad s.t. \quad b^p + X = I - T \tag{6c}$$

Blind solution of this problem yields

$$\tilde{b}^{p*} = \frac{K_b(I-T) - b^g \alpha_X}{K_b + \alpha_X}, \quad \tilde{X}^{p*} = (I-T) - \frac{K_b(I-T) - b^g \alpha_X}{K_b + \alpha_X}; \quad \tilde{n}^{p*} = 0 \tag{7c}$$

We observe no private spending on species that contribute to welfare only through ecosystem services. Private spending on charismatic species is also low; it can even be equal to zero if government spending *T* is a very large fraction of total resources *I* and $\alpha_X \gg K_b$, though that outcome is unlikely. As long as that non-negativity constraint does not bind and $\tilde{b}^{p*} > 0$, sub-optimal resources are spent on consumer goods, since $\tilde{X}^{p*} = (I-T) - \tilde{b}^{p*} < (I-T) = X^*$. Overall, there is a negative correlation between the size of the government conservation program and private donations to conservation funds. Excess total social resources are spent on the non-charismatic species, too few total resources are likely to be devoted to both charismatic species and consumer goods, and social welfare is lower than it would be in the absence of the ESA policy constraint.

Quasi-linear preferences:

Cobb-Douglas utility is widely used in applied work. However, it imposes symmetry on preferences that may be unrealistic; the marginal utility of consumer goods depends on the quantity of charismatic species just as does the marginal utility of environmental services. This section uses a graphical, intuitive approach to explore the impact of ESA restrictions on conservation outcomes when the social welfare function is instead quasi-linear. In that case, the social planner solves:

$$\underset{b,n,X}{Max} \quad u(S(b,n),B(b))+X \quad s.t. \quad b+n+X=I \tag{10}$$

Quasi-linear preferences are also widely used in economic models. The consumer good X acts as a numeraire, and the marginal utilities of the conservation goods are unrelated to the quantity of the private consumer good (and vice versa). The solution to the problem in equation (10) is subject to corner solutions. Figure 1 shows the indirect utility function when all resources I are devoted to b and n and $X = 0$, $V_{bn}(I)$, and the indirect utility function associated with $X = I$, $V_X(I)$. If the marginal utility of money devoted to b and n is diminishing[6] as shown in the figure, the planner will allocate all resources to b and n until the level of income I_0 at which the marginal utility of money spent on conservation goods is equal to one (which is the marginal utility of money spent on X). At that point, spending on b and n will not increase further with I; rather, all additional I will be spent on X: $X^* = I - I_0$.

If the ESA requires $b = n$, overall social welfare will be lower than when the planner is free to allocate conservation funds optimally between b and n. Money spent on conservation funds can not be allocated optimally between the two funds. This will lower the indirect utility function as shown in Figure 1; a given amount of income spent on b and n will yield lower utility under the ESA restriction. Thus, the social planner will spend less money in total on b and n, and more money on consumer goods:

$$X^{*ESA} = I - I_0^{ESA} > X^*. \tag{11}$$

In contrast to the case with Cobb-Douglas preferences, a social-planner without legislative mandates regarding the absolute levels of expenditures on b and n responds to the requirement that species receive equal treatment by shifting resources away from conservation and into consumer goods.

The harm done by the ESA mandate for equity might be mitigated if there is a private sector, and the government has only $T < I_0$ available to spend on ESA-related conservation. It is possible that the private sector can allocate its budget, *I*-*T*, such that $n^{p*} + n^g = n*$ and $b^{p*} = b* - b^g$ so that it makes sense to choose $X^{p*} = X* = I - I_0$, and the first-best solution is achieved. However, if the government allocation is highly skewed from the optimal ratio and government expenditures are large, then (as in the Cobb-Douglas case) private donors will be unable to use their budget to fully remedy the mis-allocation, and (unlike with Cobb-Douglas preferences) total social resources will be skewed towards consumer goods *X* at the expense of conservation.

Empirical Exploration of Public/Private Conservation Efforts

The model developed in Section II indicates that optimal aggregate private contributions to wildlife conservation funds is likely to vary negatively with the size of the government's ESA program. The enforcement agency might implicitly allocate social conservation resources among species in exactly the way that society prefers. Metrick and Weitzman (1996) find that charismatic mega-fauna are more likely to be listed under the Act. Ando (1999) finds that species move more quickly towards being listed if they are strongly supported by public comments, and move more slowly toward the list if they face public opposition and/or are in conflict with economic activity. Furthermore, Ando (2001) finds evidence that conservation supporters lobby more heavily for species to be listed in areas where few species have already been listed, indicating that much of the pressure for listings comes from environmentalists' desire to protect the ecosystems in which species live. If government resources for conservation are allocated efficiently among species, the model in this paper indicates that we would see a simple negative relationship between government conservation and private conservation donations, as the private sector merely serves to fill in whatever gap exists between the optimal level of protection funds and the resources mobilized by the government.

There might be an even stronger negative relationship between private donations and ESA enforcement if the government takes a literal interpretation of the ESA and truly mandates that equal social resources be spent protecting all endangered species. Then if the government program is large relative to the total amount that society wants to spend on conservation, increased ESA enforcement might squelch private contributions to all conservation programs, as potential donors feel their appetite for conservation has been exhausted and find the marginal utility of money spent on such programs to be greatly diminished by misallocation among species. This finding is most likely if social preferences are strongly separable between conservation goods and consumer goods.

Thus, the model predicts that second-best aggregate private contributions to conservation would decrease if ESA enforcement increased. However, the free-riding that was finessed in the model is likely to be an important part of reality. Actual aggregate private contributions to conservation are likely to be smaller than the second-best levels. Furthermore, Andreoni (1998) shows that in the presence of increasing returns to scale, government provision of a public good can act to increase private provision by increasing the marginal returns of private spending and eliminating low levels of private giving as a Nash equilibrium. Hence, if free-riding is a big problem and private donors are aware of the increasing returns in producing wildlife populations, we could see a positive correlation between actual private donations to wildlife groups and the level of ESA enforcement.

This section of the paper conducts a simple empirical exploration to evaluate the nature of the relationship between ESA enforcement and actual private contributions to conservation groups. Currently the data set is quite limited in scope, but the results of even this limited exercise are provocative.

Data

I gathered data on contributions to private organizations that work to protect endangered species, other environmental groups, and charities that focus on non-environmental public good (such as remediation of homelessness and hunger). The list of organizations in the data set is given in table 1, with the NGOs grouped by category. I assigned groups to categories by reading descriptions of the groups' activities, and by inspecting the NTEE designations chosen by the groups to represent themselves.[7]

There are 11 groups in the "Wildlife" category, including Defenders of Wildlife, Conservation International, and the World Wildlife Fund. These groups focus on conservation efforts that benefit wildlife, and typically contribute to efforts to protect endangered species that are particularly highly valued (e.g. waterfowl valued by hunters, tigers, and pandas.) Another 14 groups are in the "Single Species" category. These groups, including Bat Conservation International and the Wolf Conservation Foundation, and the Jane Goodall Institute, are highly focused on a single species (or set of species) of threatened plants or animals. They also tend to be smaller than the groups in the "Wildlife" category, and hence may find their total donations are more susceptible to random fluctuations.

One could carry out a regression to see how donations to these groups varies with ESA enforcement, but it would be difficult to know whether unobservable changes in other policies (such as tax treatment of charitable donations) that are correlated with ESA enforcement might really be driving any changes in donations. Thus, I also use information on non-profits in slightly different categories. The ten organizations in the "Environment" group include the Environmental Defense Fund and the Sierra Club. They work to provide environmental public goods that are not necessarily related to endangered species. Finally, there are nine groups in a "Human" category, including the American Red Cross, America's Second Harvest, and Doctors without Borders, which are focused on humanitarian public goods that have nothing to do with the environment.

Information on public donations is available in the IRS Form 990 that non-profit organizations must file if their income exceeds a minimum threshold. I counted the sum of lines 1a ("Direct public support") and 3 ("Membership dues and assessments") as total private contributions[8]. I used forms from 1995 to 2006 available online from the GuideStar[9] service, a database of IRS recognized non-profit organizations. Non-profit Form 990s must be made publicly available for the most recent three years, but non-profits are under no obligation to make older forms available. Thus, forms were not available for all organizations for all years.

Some effort was needed to generate estimates of calendar-year contributions. Organizations vary widely in the set of months over which they reported activities in the Form 990s. Some reported for calendar years, but many reported for fiscal years that started in some intermediate month (ranging from April to October). I carefully estimate calendar-year contributions as weighted averages of contributions from reported fiscal years that overlap with the calendar year. Finally, I use the Consumer Price Index to normalize donations to 2006 dollars.

Table 2 gives some summary statistics on donations to groups (an observation is total donations to a single group in a given calendar year.) Wildlife groups in this sample do not attract as much funding as broader environmental groups or the big non-profits in this sample devoted to improving human food security and well-being. This may be due in part to the fact that I gathered data on fairly small organizations devoted to single species; however, even the most well funded wildlife group does not garner as much money as the largest general environmental group,

One could devise various proxies for the intensity of ESA enforcement, and hence the amount of social resources being spent on endangered species under the auspices of the ESA. Most of the costs of the ESA are opportunity costs associated with things like foregone development, timber not harvested, and water not diverted or pumped for human use (for examples of studies related to these costs, see Zabel and Paterson (2006), Waters et al. (1994), Huppert (1999), and Rucker et al. (2005)). Direct costs associated with programs such as captive breeding are only a very small tip of that iceberg. Total resources spent on endangered-species conservation are not observable to the donating public any more than to the present researcher. Thus, I considered proxies for ESA-associated conservation expenditures that would be visible to the general public. It is surprisingly difficult to find data on annual budget allocations for the particular program within the Fish and Wildlife Service (FWS) that administers the ESA[10]. Hence, I decided to use the number of new endangered-species listings[11] each year as a proxy for ESA activity.

Endangered-species listings are a very public part of the administration of the Act. Many listings emerge from petitions made by people outside the government (environmental groups, scientists, etc.) and members of the public seem to be aware of trends in listing activity. There were, for example, temporary moratoriums on new listings declared in 1995 and 2001 that provoked cries of outrage from environmental groups. As Figure 3 makes clear, however, 2001 was a productive year for listings in comparison to the years that have followed it.

Results

In the empirical exercise, I use panel data methods to explore whether there is a positive or negative correlation between donations to wildlife NGOs and government enforcement of the ESA.

$$Donations_{it} = \beta_{0i} + \beta_1 \#listings_t + \beta_2 BushInOffice_t + \beta_3 Moratorium_t + \varepsilon_{it} \qquad (12)$$

The first variable is the number of listings in that year. This is the main variable to proxy for intensity of ESA-related conservation expenditure. The second variable is a dummy for whether George W. Bush was president in that year; the alternative category is William J. Clinton. I include this dummy in case there are features of the Bush administration that altered conservation donation behavior independent of ESA listings. The last variable is a dummy for the year 2001 in which[12] a moratorium on listings was attempted (though later lifted). I include this to allow the threatened moratorium to influence contribution behavior differently from the number of listings that were eventually made that year.

I estimate this simple equation using fixed-effects estimators[13] to control for organization-specific factors (such as year founded, size, and reputation for effectiveness) that are likely to affect the average annual level of giving to each group. I estimate the regression on three samples: the whole sample, a subsample containing just the wildlife-oriented groups (those like the WWF and those focused on a single species), and a subsample containing all groups except those oriented toward wildlife.[14] The results are found in table 3.

When the regression is run on the subsample of wildlife groups, we see that endangered species listings are significantly positively correlated with the amount of money people give to such groups. Nearly half the variance in the dependent variable is due to difference in the organization-specific fixed effects, but the F-statistic for the coefficients on the explanatory variables is highly significant – intertemporal variation correlated with species listings is important. The point estimate of the coefficient on the number of species listed indicates that one additional listing is associated with an increase in donations to a given wildlife group of $800,000. This is modest compared to the average annual donations to such groups of over $18 million, but the difference in annual listings from the high of 94 in 1996 to the low of 2 in 2003 would be associated with an expected drop in the average annual donation to a representative wildlife group of over $75 million. Neither the change to the Bush administration from Clinton nor the threatened moratorium on listings has an additional impact on donations to wildlife groups.

We might be concerned that the result is completely spurious, and endangered species listings are just correlated with other time-varying factors that influence contributions to non-profit organizations, such as changes in consumer confidence, unemployment rates, and tax incentives for charitable giving. If this were the case, we might expect to see similar results in the regression of donations to other groups (not focused on wildlife) on endangered-species listings.

As we see from the middle column of table 3, there is no significant correlation between listings and donations in the regression on non-wildlife focused groups. In the right-hand column, we see that the effect on wildlife groups does not dominate the results when the whole sample is included; nothing is significant in that regression. This supports the idea that there is a meaningful positive correlation between ESA enforcement and donations to groups to work to protect endangered species.

Conclusions

The ESA clearly fails to provide ecosystem services when the species that provide them happen to be widespread enough not to be endangered. Society has begun to fill this gap with a small number of efforts that are targeted at ecosystems more broadly; policies such as the Wetlands Reserve Program protect ecosystem services associated with wetlands, and a growing slate of local initiatives have sought to purchase open space around cities to protect other services associated with having such lands remain undisturbed. However, there remain many parts of the country where ecosystem services are inefficiently low, and no policy exists to remedy the market failures at hand.

The ESA is also unlikely to yield optimal conservation levels even of endangered species. This paper shows that social welfare is unlikely to be maximized by a policy like the ESA that requires equal protection for all listed species. Such a policy would yield inefficiently low relative support for efforts to protect relatively high valued species. If social preferences are separable between conservation and non-conservation goods, that inefficiency could even push excess total social resources away from conservation and towards consumer goods.

I show that private conservation can help to remediate inefficient distribution of government activity among species. However, the private sector can not act effectively if the government program is so large that it exhausts society’s appetite for conservation, or if irreversible commitments to species are made that exceed total social WTP to protect those species. This observation provides support for the notion that it could be wise to keep the scale of government programs modest, to leave room for private initiatives to remedy accidental government misallocations.

There is reason to worry, though, that private provision of conservation resources will suffer from free-riding and thus be sub-optimally low. Preliminary econometric findings indicate there is a positive correlation between ESA enforcement and private donations to groups that protect endangered species. That finding is consistent with the hypothesis that there is significant free-riding among private donors (and hence under-provision of conservation resources from the private sector), and that government conservation acts to seed in private conservation efforts by overcoming threshold effects and increasing the marginal returns to private funds.

The tide of federal politics is currently undergoing a large sea change away from political forces that are hostile to conservation policy. This may be an opportune moment to seriously reconsider U.S. conservation policy; how could the ESA be usefully reformed? Since society gains value from ecosystem services and from the existence of some species, we might consider adopting a two-pronged policy that addresses those needs independently.

As suggested by Loomis and White (1996; p. 205), "Rather than the current approach of valuing individual species, which misses both ecological complementarity among species… and substitution effects…, a habitat-based evaluation is likely to be more useful." We could have a policy that identifies places where ecosystem services are declining, and mobilizes resources to promote the recovery of such services even if no particular species in the area are in danger of extinction. Such a law would still be subject to the conflicts between winners and losers that plague the current ESA, but the transaction costs would be greatly reduced by not fighting separate battles for all individual species involved. Furthermore, policy makers could take the opportunity to incorporate many of lessons we have learned from the ESA about providing incentives for private economic agents directly into the law (Innes et al., 1998; Langpap, 2006; Polasky et al, 1996).

To complement such an "Endangered Ecosystem Service Act," we could continue to have a reformed Endangered Species Act that would serve to protect the species that society values for their own existence, without being shackled with the burden of also protecting species that are valued only for the role they play in providing ecosystem services. We do have some policies that have sought to address the ESA's inability to direct adequate resources toward protecting popular charismatic species; the African Elephant Conservation Act and the Rhinoceros and Tiger Conservation Acts are the most prominent examples. However, current efforts are likely to be inadequate because they do not cover enough charismatic species, and it seems highly inefficient to have to pass a new law every time a species has broad support for increased conservation efforts. A reformed Endangered Species Act could provide government funds to match private conservation funds aimed at conservation of charismatic endangered species. This would mitigate the free-rider problem in private conservation, while letting revealed public preferences guide government expenditures on species-specific conservation activity.

The ESA has helped to hold the line against excessive rates of land development, timber harvesting, and water diversion in many parts of the U.S. However, it was written without the benefit of our current understanding of the relationships between endangered species, biodiversity, and ecosystem services. Endangered species, ecosystems, and society might all well fare better if policy makers, biologists, and economists work together to reform the law.

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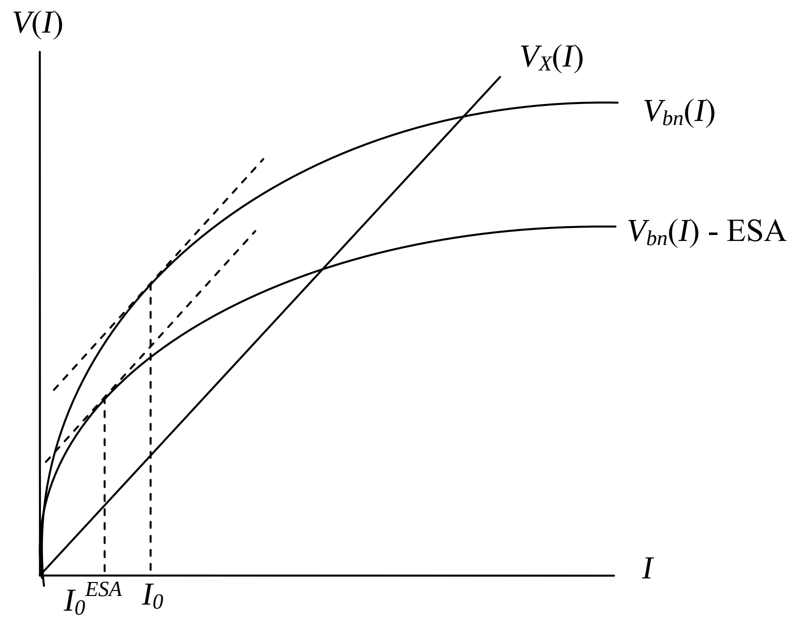
Figure 1: Utility as a Function of Income under Quasli-linear Preferences



$V_{bn}(I)$ is the indirect utility function when all income is spent on *b* and *n*.

$V_{bn}(I)$ – ESA is the indirect utility function when all income is spent on *b* and *n*, but the ESA requires b=n.

$V_X(I)$ is the indirect utility function when all income is spent on *X*.

Figure 2: New Species Listed each Year under the Endangered Species Act

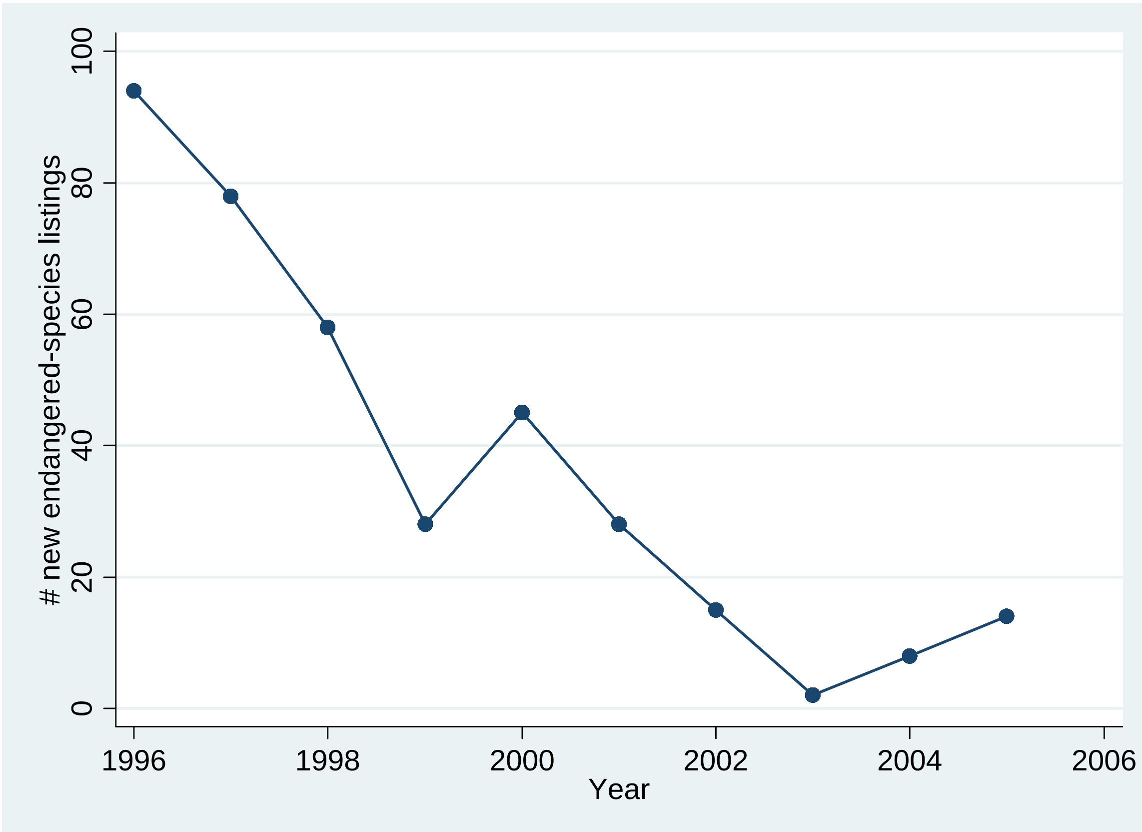


Table 1. Organizations in Data Set, by Category

Organization Name	Category	Year Founded
African Wildlife Foundation	Wildlife	1961
Biodiversity Conservation Alliance	Wildlife	1988
Conservation International	Wildlife	1987
Defenders of Wildlife	Wildlife	1947
Ducks Unlimited	Wildlife	1937
Massachusetts Audubon	Wildlife	1896
National Coalition for Marine Conservation	Wildlife	1973
National Fish and Wildlife Foundation	Wildlife	1984
National Wildlife Federation	Wildlife	1936
Wildlife Conservation Society	Wildlife	1895
World Wildlife Fund	Wildlife	1961
Bat Conservation International	Single Species	1982
Bonobo Conservation Initiative	Single Species	1998
CCC Sea turtles	Single Species	1959
Center for Plant Conservation	Single Species	1984
Cheetah Conservation Fund	Single Species	2000
International Crane Foundation	Single Species	1979
Jane Goodall Institute	Single Species	1977
Lemur Conservation Foundation	Single Species	1996
Owens Foundation	Single Species	1986
Peregrine Fund	Single Species	1970
Pheasants Forever	Single Species	1982
Save the Redwoods League	Single Species	1918
Trout Unlimited	Single Species	1959
Wolf Conservation Center	Single Species	1999
American Rivers	Other Environment	1973
Chesapeake Bay Foundation	Other Environment	1966
Environmental Defense Fund	Other Environment	1967
Natural Resources Defense Council	Other Environment	1970
Sierra Club	Other Environment	1960
World Resources Institute	Other Environment	1982
National Audubon Society, Inc	Other Environment	1972
Nature Conservancy	Other Environment	1951
The Conservation Fund	Other Environment	1985
Trust for Public Land	Other Environment	1972
American Red Cross	Human	1881
America's Second Harvest	Human	1979
Amnesty International	Human	1961
Doctors Without Borders	Human	1971
National Coalition for the Homeless	Human	1984
OXFAM – America	Human	1970
Southern Poverty Law Center	Human	1971
UNICEF	Human	1947
United Way of America	Human	1932

Table 2. Summary Statistics of Donations to Non-Profits

	Type of Organizations			
	Wildlife	Other Environment	Human	Whole Sample
# Observations	187	79	73	339
Mean donations	246	908	2420	868
Minimum donations	.58	47	2	.58
Maximum donations	5233	6017	25713	25713
Standard deviation of donations	592	1456	4747	2493

Note: Annual donations to a given group are expressed in $100,000

Table 3. Regression Results

	Wildlife	Human, Other Environment	Whole sample
# species listed	8.16***	-5.78	1.88
	(3.09)	(19.6)	(9.13)
Bush	191.5	104.7	169.20
	(135.9)	(850.2)	(399.3)
Moratorium	-124.9	1194.6	459.1
	(115.3)	(755.7)	(346.0)
Constant	-67.6	1574.4	655.4
	(155.3)	(969.4)	(455.9)
Fraction of variance due to fixed effects	.45	.51	.53
F Statistic	3.14***	1.46	1.23
# Observations in sample	187	152	339
# Organizations in sample	25	19	44

Note: Standard errors in parentheses

*** significant at 1% level; ** significant at 5% level; * significant at 10% level;

Endnotes

[1] Note that ecosystem services include intangibles such as moral and cultural values, and need not be limited to practical things such as flood control and food production.

[2] The current version of this paper does not study policies that change the relative prices of any of these goods, so there is little to be gained by carrying price notation around in the equations.

[3] I obtain qualitatively similar results when I use a utility function that is less symmetric than Cobb-Douglas: $U = SBX + SB$, a member of a family of functions put forth by Bergstrom and Cornes (1983) to handle problems when public goods are important. In ordinary consumer choice problems, this function yields demand functions that display less symmetry in cross-price effects than does Cobb-Douglas. However, the general findings of my model are not changed by using this function instead of the Cobb-Douglas.

[4] Another interpretation of the ESA constraint might be to insist that all species have populations in excess of some minimum value; future versions of this work will explore that alternative formulation.

[5] I do not model that choice, but rather take the quantity T as exogenously chosen. The optimal value of T depends on the tradeoffs between free-riding in the private sector and inefficiency in the public sector.

[6] Note that if $u(S,B)$ is Cobb-Douglas, the marginal utility of money spend on b and n is constant, and so there will be a single corner solution to the optimization problem; either all money is always spent on conservation goods, or all money is always spent on X. I consider a more interesting general set of sub-utility functions in this discussion.

[7] The National Taxonomy of Exempt Entities (NTEE) Classification System was developed by The National Center for Charitable Statistics.

[8] I include membership dues in the total because many people donate to big organizations such as the Sierra Club only in the form of purchasing membership, but still feel they are supporting the organizations activities without additional donation.

[9] See http://www.guidestar.org/.

[10] The National Oceanographic and Atmospheric Administration is responsible for a small part of ESA administration, but the FWS really presides over most such activity.

[11] Future versions of this work may also use data on critical habitat designations (present for 484 out of 1285 U.S. species on the list, habitat conservation plan approval (there are 695 currently in place), and/or recovery plan approval (complete for 1071 species.)

[12] To be precise, the moratorium was announced in October 2000; I expect the effects on donations to appear in the following calendar year.

[13] The results are qualitatively similar when the random-effects model is used.

[14] I would like to estimate the regression on a sub-sample including “Other Environment” groups only, but there are relatively few such groups in my sample and group-level fixed effects currently dominates the results of such a regression completely. More data would need to be collected to make this possible.