Economic Valuations of Environmental Resources:
Where Economics and Biology Meet

Meghan Zysik
Departments of Biology and Economics
Hartwick College
Oneonta, NY

This thesis is submitted in partial satisfaction of the requirements for the degree of Bachelor of Arts or Bachelor of Sciences from the Department of Biology, Hartwick College.

_______________________________________ _________________
Thesis Advisor Date

_______________________________________ _________________
Chair, Biology Department Date

Abstract

Biodiversity loss has become a global crisis, with some experts figuring losses of 27,000 species a year. Environmental degradation is a leading cause of biodiversity loss; therefore, correct assessment of the value of environmental resources is essential to making appropriate decisions concerning land management. This research looks at the methods of valuation of environmental resources and biodiversity, from both biological and economic perspectives. The Pine Lake Environmental Campus in West Davenport was used as a case study of current techniques. The Simpson's diversity index was determined for Pine Lake utilizing past senior research projects, faculty research, and other studies. The Simpson's index was calculated to be approximately 0.096. The value of Pine Lake from a student perspective was ascertained through contingent valuation surveys. Through this, the students' "willingness to pay" and "willingness to accept" values for the Pine Lake Environmental Campus were approximately calculated to be $140,000 annually and $3 million annually respectively.

Introduction

Startling estimates of the current rate of global biodiversity loss have led scientists, economists, and world leaders to examine and correct our current path of destruction. This type of high level publicity has made biodiversity loss somewhat of a household concept. For years, people throughout America have been inundated with television spots, money requests from environmental organizations, newspaper articles, and pamphlets. Yet, the issue of biodiversity loss and its effects have always seemed to take place in some far off country, in the rain forests of Brazil or in the coral reefs off the coast of Australia, until now. Research has shown that the leading cause of U.S. biodiversity loss is habitat degradation and loss, which has been found to contribute to the endangerment of over 80 percent of U.S. species (Stein et al., 2000). This type of shocking data has led to renewed efforts within U.S. borders to more adequately manage land and make appropriate decisions regarding the environment. On Hartwick College's own campus questions regarding the Pine Lake Environmental Campus mirror those of policy makers around the country and the world. What is the value of such an environmental resource and is it worth maintaining? In order to make the right decisions policy makers must be equipped with current and correct information concerning levels of biodiversity and their respective values from biological and economic sources.

Some experts figure that 27,000 species a year or three species an hour go extinct (Eldridge, 1998). There have been "numerous independent studies [which have] concluded that the current rate of extinction is the highest in at least 65 million years and that it will remain high for the foreseeable future" (Reid, 1997). This phenomenon has been called the "sixth great extinction" by Edward O. Wilson (1992), with humans cast in the role of the "exterminator species" (Morell, 1999). Recent studies have also determined that at least 11 percent of all bird species, 25 percent of mammal species, 34 percent of fish species, 25 percent of amphibian species, and 11 percent of plant species are currently threatened (Reid, 1997). Biodiversity conservation efforts are often focused on species diversity, but that is not the only component of biodiversity.

Shakespeare referred to biodiversity as "nature's infinite book of secrecy", while *National Geographic* defined it as "the intricate web of animals, plants, and all other living things that populate the planet" (Swerdlow, 1999). Essentially biodiversity is the full array of life on Earth and can be broken down into four basic levels of biological organization; genetic diversity, species diversity, ecological diversity, and landscape diversity (Stein et al., 2000). Genetic diversity encompasses "the unique combinations of genes found within and among organisms" (Stein et al., 2000). These gene complexes and frequencies within a given population enable evolution to occur. Genetic variability is key to assuring long-term survival for most species and allows them to adjust to and cope with unpredictable changes in their environments. Species diversity is "the variety of living organisms inhabiting an area" and is commonly figured by counting the number of different types of organisms (Stein et al., 2000). Ecological diversity is "the higher-level organization of different species into natural communities; and the interplay between these communities and the physical environment that forms ecosystems" (Stein et al., 2000). Landscape diversity is "the geography of different ecosystems across a large area and the connections among them" (Stein et al., 2000). Based on this definition, one can understand how environmental resources of all types originate from and exist because of biodiversity.

The diversity of species is the main building block of ecosystems and landscapes. High species diversity indicates the presence of highly complex community structures; since a large variety of species allow for more complex and varied species interactions, such as food webs, competition, and niche fulfillment (Brower and Zar, 1977). Due in part to these factors, the promulgation of species diversity is the focus of most efforts to maintain biodiversity. Valuation of species diversity and subsequently biodiversity as a whole is essential to targeting efforts on the most needy areas. Issues arise because biodiversity does not blatantly affect humans' everyday lives in a direct manner, making it difficult for individuals to place a value on it.

The total value of biodiversity can be broken down into three categories, direct use values, indirect use values, and values independent of use (Perrings, 1996). Direct use values are those derived from using species and ecosystems for things like firewood, food, shade, and pets. These values can sometimes be captured by market pricing. Indirect values may hold the greatest value but are often difficult to quantify since the appropriate markets do not exist. They include ecosystem services like waste assimilation, watershed protection, flood control, and microclimate stabilization. A unique example of an indirect value of biodiversity is the recent finding that increased species richness reduces the risk of infection by vector-borne zoonotic diseases (diseases transmitted primarily via the bite of an arthropod), like Lyme disease (Schmidt and Ostfeld, 2001). Within this indirect value, species and genetic diversity also facilitate the resiliency of such services to changing conditions, thereby increasing community stability (Brower and Zar, 1977). The values independent of use are often the most unexplainable and elusive values in people's minds. These values include the resource's availability to others in the future and present, "the option value (the future value of the option to use resources in the future), quasi-option value (the future value of the information contained by a resource), bequest value (the value of a bequest to future generation)", the existence value (the utility gained by preserving something for its own sake whether or not it will be used in the future) (Perrings, 1996 and Gowdy, 1997).

A large survey in 1994 by the Cambridge Reports/Research International found that 86 percent of the people surveyed felt that the term "environmentalist" characterized them to some degree (Bazerman et al., 1997). Yet, why if this is the case is there such a problem with habitat degradation and species loss? Part of the problem lies in the current methods for valuing specific natural resources. Directly determining the true biodiversity value of an environmental resource would be a tedious and daunting task, with high levels of uncertainty. For example, how can one value accurately the probability of finding the cure AIDS or cancer in a species? The value of biodiversity is immense and full variables. What makes the process of economic valuation more difficult is that there is often limited time in which to make irrevocable choices concerning land management. If the world was perfect, everyone had good in their hearts, and the best interests of the planet were at the forefront of every person's mind, then decisions about the environment would be easy; environmental resources, and thereby biodiversity, would be protected at all costs. That is sadly not the world we live in and decisions about environmental resources are determined by certain guiding principles. These principles place a dollar value on resources and then weigh the costs and benefits of all possible actions. Current valuation methods, which are based on market prices, do capture the private benefits of biodiversity, but they miss many of the associated values (Perrings, 1996). So the environmentally-friendly choice tends to lose every time, and choices on whether to preserve or destroy, protect or exploit are ill-made. This detrimental trend has led to the development of new valuation methods that more accurately value environmental resources. The fate of the Pine Lake Environmental Campus is just such a decision that Hartwick's administration could make prematurely without adequate information on the property.

The Pine Lake Environmental Campus is 914 acres of temperate broadleaf forestland, which was purchased by Hartwick College in 1971. The temperate broadleaf forest biome makes up only about six percent of the world's land area and they are located in Eastern Europe, Southern Asia, and the Eastern United States (Stein et al., 2000). Not only is this a very small biome but it is also the most disturbed biome, with only six percent of it remaining undisturbed (Stein et al., 2000). This biome is perfect for human habitation, which has been a major factor in its perturbation. Forests also supply a great deal of products demanded by the increasing world population, like paper products that now use 25% of the world's timber harvest (Lindenmayer, 1999 and Bryant). The U.S. has a majority of the world's temperate broadleaf forests, comprising thirty-one percent of the total U.S. landmass (Stein et al., 2000). In 1993, New York State had approximately 18,641,300-acres of total forestland, which is about sixty-two percent of the state's land area, and of that total forestland only 3,235,800-acres were noncommercial (USDA Forest Service, 1993).

Ownership of forestland is not a common feature of American colleges and universities, some experts have estimated that about 61 institutions manage several million acres of forests (Van Der Werf, 2000). The National Association of College and University Business Officers calculated that the total value of off-campus real estate held by college endowments was nearly $8 billion in 1999 fiscal year, which is more than double the value held in 1995 (Van Der Werf, 2000). According to Van Der Werf, universities and colleges are constantly pushed and pulled when making their decisions concerning land management, having to factor in the wishes of the donors, their own bottom line, the land's required maintenance, recreation, aesthetics, and public relations (2000). At the end of these arduous decision-making processes most of these managed forests end up being logged for income, while very little of the land is preserved (Van Der Werf, 2000). Most of the academic institutions own massive tracts of land, without any amenities, that are hundred miles away from their main campuses. Few are in situation like Hartwick's where the environmental campus is only a few miles away and maintains so many college facilities and programs.

The Pine Lake Environmental Campus is located in West Davenport, eight miles from the main campus. The property is comprised of a ten-acre lake, Charlotte Creek, 12-acre glacially formed kettle-hole lake (an acid bog), a hemlock swamp, a zone of forest disturbed by a tornado in 1983, and 815-acres of forestland and nature trails (Frankel, 1986 and Malloy, 2000). The college also maintains seventeen facilities on the property; including several log cabins, a classroom, a main residential lodge, a sauna, the Vaudevillian (a multi-purpose space), challenge ropes courses, and the Robert R. Smith Field Station (Malloy, 2000 and Pine Lake Website). Pine Lake provides both recreational and academic opportunities for the Hartwick College and greater Oneonta communities. From May 1, 2000 through April 13, 2001, twenty-two outside groups, ranging from the Audubon Society to SUNY Oneonta's Children's Center, have used the Pine Lake facilities (Peter Blue, 2001). During that same period a diverse group of fourteen Hartwick academic classes reserved seventy-six class sessions at Pine Lake (Peter Blue, 2001). Daily sign-ins at the property totaled about 5,000 and research visits totaled about 450 for the time frame as well (Peter Blue, 2001). Unique programs take place at Pine Lake throughout the year, ranging from Hartwick's annual Awakenings program for First Year students to the recent *Bread and Puppet Theater* Festival. The property is also home to approximately twenty-one Hartwick students during the academic year.

According to Laura Malloy's Executive Summary on the Pine Lake Environmental Campus, the total operating expenses of the property are approximately $200,000 per year (2000). Revenues for Pine Lake primarily come from student housing fees, gifts, cabin rentals to alumni and others in the summer months, and facility rentals to outside groups (Malloy, 2000). The property's projected total operating expenses for the 2000-2001 academic year were calculated based on the current operations, three percent inflation, and two percent compensation cost increases (Malloy, 2000). The operating net expenditures without housing income for 2000-2001 were $138,400 and with housing income were $200,400 (Malloy, 2000). The theory behind figuring the expenses of Pine Lake without the housing income is that, Hartwick has not been functioning at full capacity in recent years; therefore, the 21 students residing there could be housed on the main campus at no extra cost (Malloy, 2000). If the proposed facility improvements were approved that would increase both estimates by $112,000 per year (Malloy, 2000). A comprehensive facilities assessment of Pine Lake in 1997 found that seventy percent of the facilities required attention within three to five years (Malloy, 2000). The maximum net operating expenses of Pine Lake have thereby been projected to be $312,400 (Malloy, 2000). If the student body fully assumed the maximum cost of Pine Lake (estimating the student body to be approximately 1400 students), it would cost each student about $223 per year. It seems that the Pine Lake Environmental Campus is not self-sustaining, yet the net operating expenditures and revenues fail to include some integral data, such as associated staff salaries, retention rate vis-à-vis Pine Lake, campus publicity, necessity for Biology Department research, and classroom use compensations to name a few. Although such information is more difficult to quantify, they are none the less extremely important in gaining a true sense of the property's net operating expenses. A full understanding of Pine Lake's biological and economic aspects is essential for the administration to take appropriate ecosystem management measures.

Not only are the issues of valuing Pine Lake and other similar environmental resources extremely complicated there are inherent differences in the goals, approaches, and attitudes of the involved parties. Over the question, "Is Pine Lake worth maintaining?", there are three distinct parties, the administration (which also be called the business sector), the environmental advocates (who mainly include emphatic environmentally-friendly faculty, staff, and students), and the affected communities (the Hartwick College community). Sexton et al.'s generalized characteristics of such groups' perspectives on environmental issues can be applied to the groups involved in Hartwick's dilemma over the fate of Pine Lake. These generalizations may provide deeper insight into the reasoning and decision making processes of each group.

The first group of generalizations is with respect to the administration. According to Sexton et al., their imperative is to preserve the organization and make a profit; they are legitimized by markets and information; their basis for decisions is based on short- to medium-term return on investments; they believe that natural resources should be used efficiently based on cost and are a means to achieve an end; and in their view environmental protection should be based economic incentives and through harnessing market forces (1999). The environmental advocates' imperative is to preserve and protect natural ecosystems; they are legitimized by their principles and passions; their decisions are based on the long-term preservation of natural systems; they view natural resources as ends unto themselves and would prescribe use within limits; their approach towards environmental protection is to have laws safeguarding the environment derived from political will and ethical values (Sexton et al., 1999). Sexton et al. generalizes the rest of the Hartwick College community that does not have the aforementioned associations as well. This groups' imperatives lie in protecting the community's and individuals' well-being; they legitimize their decisions based on group identity and social justice; they base their decisions on the short- to medium-term preservation of the community and economic well-being; they often feel that natural resources should be used and protected in relation to the costs and benefits for the community; and they approach environmental protection as moral crusades and appeals for social justice (Sexton et al., 1999).

There is no doubt that improving environmental conditions is a positive for humankind, but there must be more focused efforts "to improve environmental decisions so that they do a better job of balancing the goals of effectiveness, efficiency and equity while at the same time becoming more sustainable and accountable" (Sexton et al., 1999). It is important to recognize that current ecosystem management decision-making is anthropocentric, or in other words coming from a human-centered prospective, where humans have the right and ability to control nature for the benefit of ourselves (Mercuro, 1997 and Stanley, 1995). Some environmentalists feel that there is certain amount arrogance in this belief that we can sustainably manage ecosystems in this manner, continuing to "manipulate and manage ecosystems to satisfy human needs and desires while protecting ecosystem integrity"(Stanley, 1995). Since there is no "cure" for the anthropocentrism of ecosystem management, decisions must continue to be made to the best of our human abilities.

The three aforementioned parties must integrate in order to foster meaningful and constructive discussion and actions that will lead to the common goal of better environmental decisions (Sexton et al., 1999). With the development of the multiparty, interdisciplinary "Pine Lake Advisory Committee", Hartwick seems to be taking strides in the proper direction by creating the proper atmosphere for cultivating effective land management options. In the end, the administration will make the final decision concerning Pine Lake's fate, but the effectiveness and sustainability of their decision will only be enhanced by more information that is accurate. The administration must work to appease the trustees, customers/students, and employees/faculty/staff. Therefore, to make decisions about Pine Lake the administration must have an accurate measure of the property's worth to all of the parties. This is where biological and economic assessments of Pine Lake become essential in the decision-making process. My appraisal of the value of Pine Lake will be broken into two sections, starting with economic valuations and then biological assessments.

ECONOMIC VALUATIONS

Theory and Literature Review

Biodiversity loss not only has the ability to fracture the fragile web of species, communities, and ecosystems, but it also has the ability to weaken the very pillars of the world economy. According to Paul Hawken in *The Ecology of Commerce*, business is on the verge of a massive transformation brought on by social and biological forces that cannot be ignored (1993). He goes on to make the claim that current business practices "are destroying the life on earth" and that "given current corporate practices not one wildlife reserve, wilderness, or indigenous culture will survive the global market economy" (Hawken, 1993). In business, limits are meant to broken through and not respected, especially ecological constraints whose warning signs are very subtle (Hawken, 1993). He maintains that businesses can slow the process of change they must undergo they cannot stop the evolution (Hawken, 1993). Hawken states that the industrial economy is "poised at a declining horizon of options and possibilities" (Hawken, 1993). These startling statements made in 1993 still ring true today as businesses have one foot off the edge of the horizon and the warning signs have become extreme. As biodiversity loss increases, once renewable resources have become nonrenewable and with the decrease in genetic diversity, resiliency to environmental changes is permanently lost. Due to such warnings, businesses and governments have begun to alter their decision-making processes concerning environmental resources.

There is no possible way to determine an appropriate value for environmental resources within the traditional framework, which is market-based. By trying to make these resources fit in the current model, they have been systematically undervalued. These undervaluations lead policy makers to make decisions that can be catastrophic and are unchangeable. With every species that we destroy, every landscape we demolition untold losses are accruing. It is like a game of Russian Roulette, where every part of the ecosystem destroyed is like another spin of the chamber. Humankind is simply waiting for the obliteration of that essential species that is necessary for our survival. Yet, by then it will be too late. With the environment, one cannot turn back the hands of time to correct the sins of the fathers. Whether in time or not, new methods of economic valuation of environmental resources is enabling truer values to be assigned.

There are two approaches to economic valuation of environmental resources, the positive approach and the normative approach (Tietenberg, 1992 and Hanemann, 1988). The positive approach "describes the actions of people and the impact of those actions on the environmental asset" (Tietenberg, 1992). The positive approach tries to describe "what is, what was, or what will be". The normative approach deals with "what ought to be", providing guidance on the optimal level of impact on environmental resources (Tietenberg, 1992). It attempts to maximize the value of environmental resources by "creating a balance between the preservation and use of that asset" (Tietenberg, 1992). With the normative approach there are two criteria for determining the optimal level and composition of services, efficiency and sustainability (Tietenberg, 1992). Efficiency refers to "maximizing the present value of net benefits to society", and sustainability allows for the judgement of fairness and at a minimum requires that future generations are no worse off than current generations (Tietenberg, 1992).

The normative approach is most appropriate for making decisions concerning potential ecosystem management plans. Cost-benefit analysis is a normative approach that determines the validity of an ecosystem management option. The decision whether to opt for a specific plan can be based on one of three criterion; the maximum net present-value, the benefit-cost ratio, or the positive net-present value (Teitenberg, 1992). The maximum net-present value criterion suggests that resources should be used in a manner that maximizes their present value of net benefits (Teitenberg, 1992). The benefit-cost ratio criterion advocates for actions whose ratio of the present value of benefits to the present value of costs exceeds 1.0 (Teitenberg, 1992). Finally, the positive net present-value criterion suggests that action should be undertaken whenever the present value of net benefits is greater than zero (Teitenberg, 1992). The most efficient allocation will be determined by the maximum net-present value criterion, while the last two techniques simply guarantee that the activity undertaken will not cost society more than it benefits society (Teitenberg, 1992). In other words, the benefit-cost ratio and net-present value criteria may cause policymakers to advocate inefficient approaches toward ecosystem management.

In order to make ecosystem management decisions based on cost-benefit analysis one must first quantify the costs and benefits of the option. The cost side of the analysis is often far easier to determine. There are several different approaches to measuring the costs of an option, but the one most suited for measuring the costs associated with Pine Lake's maintenance is the survey approach (Teitenberg, 1992). This approach is survey based and asks those "who bear the costs, and presumably know the most about them, to reveal the magnitude of the costs" (Teitenberg, 1992). The benefit measurement of a particular environmental management option is a far more difficult task. As mentioned in the introduction, measuring the value of such values are extremely difficult. Economists have come up with a few methods for the valuing market and nonmarket environmental resources.

Methods for valuing environmental resources can be categorized as indirect or direct (Adamowicz et al., 1994). Indirect methods use actual choices that consumers have made to develop "models of choice", which "constitute reveal preferences over goods, both market and nonmarket" (Adamowicz et al., 1994). Common indirect methods are travel cost models and hedonic pricing models (Adamowicz et al., 1994). Direct methods, on the other hand, "ask consumers what they would be willing to pay or accept for a change in an environmental amenity" in a simulated market (Adamowicz et al., 1994 and Portney, 1994). These methods are especially effective in eliciting values for resources where "there are insufficient data to apply other techniques" (Sexton et al., 1999). Direct methods include contingent valuations and conjoint analysis valuations (Adamowicz et al., 1994).

Both of indirect and direct methods for valuing environmental resources have advantages and drawbacks, which must be weighed on a case by case basis, along with the particulars of the method, to determine the appropriate method for the particular situation being studied. Direct methods have been criticized for their hypothetical nature and the because actual behaviors are not observed (Adamowicz et al., 1994). An advantage to direct methods is, that they currently are the only "viable alternative for measuring nonuse values, and they can be used to determine values in cases where large numbers of the environmental resources' attributes are being altered (Adamowicz et al., 1994). Experts have criticized indirect methods of environmental valuation in that the "models of behavior developed constitute a maintained hypothesis about the structure of preferences which may or may not be testable" (Adamowicz et al., 1994). Indirect methods have also been criticized because the environmental change maybe outside the current data range and simulation of such a change would require "extrapolation outside the range used to estimate the model" (Adamowicz et al., 1994).

The first indirect method is the Clawson-Knetsch method or the "travel cost" method, which uses travel costs to measure people's willingness to pay to come to a particular area (Teitenberg, 1992; Toman, 1997; and Sexton et al., 1999). This technique samples visitors to determine their zone of origin and their incurred costs to facilitate such travel (Teitenberg, 1992 and Toman, 1997). From these samplings, visitors per capita from the representative zones of origin can be calculated and a travel cost measure for each zone can be determined (Teitenberg, 1992). A demand curve can then be formulated for the particular site. This technique is best used for sites that are not congested, since this would lead to an underestimation of the benefits of the site (Teitenberg, 1992). This "travel cost" method would not be an appropriate measure of the value of the Pine Lake Environmental Campus, since the common visitor does not accrue any significant travel costs.

Another indirect method for the valuation of environmental resources is the hedonic price method, which involves inferring "environmental values from the spread of market prices reflecting different 'qualities'" (Toman, 1997). Economists most often use this method when trying to value environmental quality differences, such as air cleanliness, toxicity of ground soil, etc (Toman, 1997). For example, they would compare the prices of property in locations with high air quality to the prices of property in locations with poor air quality. Values can be elicited for people's willingness to pay for specific improvements to the environment (Toman, 1997). It is a more difficult method to use valuing other aspects of ecosystems and natural resources. Therefore, this method is neither ideal for the valuation nor applicable to the situation of the Pine Lake Environmental Campus.

Conjoint analysis is a direct method to determining community values of natural resources. This is a survey-research method, which has been used for over twenty years in other fields, first became popular in marketing literature as a technique for evaluating "consumer acceptance of multi-attribute commodities" (Adamowicz et al., 1994 and Roe et al., 1996). Recently, economists have begun using this as a stated-preference method to elicit "responses to predefined alternatives in the form of rating" (Boxall et al., 1996 and Roe et al., 1996). Traditionally, survey participants are presented with a number of environmental resource option descriptions, each one differing by the attributes (including implicit prices), and they are then asked to rate or rank the desirability of each option (Roe et al., 1996). This methodology enables economic values to be associated with each attribute of the environmental resource tested (Boxall et al., 1996). With respect to Pine Lake, this type of valuation would be excellent for determining the piecemeal values the student body holds for the specific attributes of the property, such as the kettle-hole bog, Charlotte creek, or the nature trails. This method would also be ideal for determining what type of ecosystem management plan the student body would be most favor.

A second example of direct valuation method is contingent valuation. This stated preference technique has been used by economists to value environmental goods and services for about thirty years (Boxall et al., 1996). The first academic research to use contingent valuation was in 1963, and involved eliciting a value for a particular recreational area of hunters and wilderness lovers (Portney, 1994). The name of this technique spawns from the fact that the revealed values are contingent upon the simulated market presented in the survey (Portney, 1994). Just like conjoint analysis, contingent valuation involves the use of surveys to elicit values for (what are typically) a hypothetical ecosystem management options, the difference is that in this technique participants are faced with a dichotomous choice (Portney, 1994). This method of valuation can be broken into three parts; the "scenario", a mechanism for eliciting value or a choice from the respondent, and other survey questions (Sexton et al., 1999 and Portney, 1994).

The major purpose of the contingent valuation survey is to "convey information to respondents about the so-called context of the valuation" (Sexton et al., 1999). The mechanism to determine the value or choice could be in the form of open-ended questions (i.e. "What is the maximum you would be willing to pay for an addition of one hundred acres of land to Pine Lake?"), bidding games (i.e. "Would you pay

$100 for this program? Would you pay $150? Would you pay…?"), or referendum formats (i.e. "The government is considering doing X. Your annual tax bill would go up by Y if this happens. How would vote?") (Portney, 1994). The manner of the question will elicit different value functions from the participants.

Although traditionally conjoint analysis and contingent valuation methods were used to elicit willingness to pay values, they can be used to elicit either the willingness to pay or the willingness to accept compensation values for the participant with respect to environmental resources (Knetsch, 2000). These values are the standard definitions of the monetary measures of gains and losses (Knetsch, 2000). Willingness to pay values and willingness to accept values quantify the substitutability of the good in question for another good, dollars/money are just a convenient numeraire for tradeoff ratios (Freeman, 1997). To elicit maximum willingness to pay values, stated preference survey questions would put the participants under the hypothetical scenario that they would be required to pay a certain amount of money to maintain or increase the quality of an environmental resource. To elicit minimum willingness to accept values, stated preference survey questions lead participants to assume a hypothetical scenario, under which they would be diminishing the quality of or completely losing an environmental resource. The respondents would then have to assign a dollar amount of compensation needed for their loss.

The survey questions usually try to obtain information on the socioeconomic characteristics o f the participants, like age, sex, and income level (Portney, 1994). These questions can elicit characteristics to be used as possible explanatory variables when comparing value functions (Portney, 1994). Research has shown that such surveys can elicit statistically significant socioeconomic variables correlating to different valuations (Willis and Garrod, 1998; Taylor and Douglas, 1999). A contingent valuation of a remote forest in the United Kingdom eliciting willingness to pay values of residents found that age, per capita household income, and education level achieved were significant variables in determining value functions (Willis and Garrod, 1998). Significant socioeconomic variables were also found in a contingent valuation study pertaining to values of in Trinity River northern California with respect to changes in its flow, fishery resources, and recreation amenities (Taylor and Douglas, 1999). In this particular valuation, users of the resource were found to be more willing to pay than the regional households (Taylor and Douglas, 1999).

In order to create complete and appropriate surveys a standardized method for their creation is adhered to (Portney, 1994; Sexton et al., 1999; and Adamowicz et al., 1994). To prepare effective direct valuation surveys, collaboration between economists, decision-makers, and environmental scientists is essential (Sexton et al., 1999). After the initial survey is prepared it should be tested in small focus groups to investigate the types of language respondents are using, what environmental characteristics are important to them, and how they react to information provided in the scenario (Sexton et al., 1999 and Adamowicz et al., 1994). Frequently surveys are then pretested in small samples to finalize the survey format (Sexton et al., 1999 and Adamowicz et al., 1994). Surveys should be distributed to samples of the affected community that are representative of their overall characteristics.

Recent studies by economists, psychologists, and decision analysts have shown that behavioral assumptions that form the basis of the standard theory and resource valuations does not accurately describe people's preferences, nor do they produce useful predictions as to people's reactions to real choices (Knetsch, 2000). One major issue is that the standard behavioral assumption of current valuation methods and traditional economic theories is "that people have well-defined preferences over alternative bundles of consumption goods including quantities of nonmarket goods, and that people know their preferences" (Freeman, 1993). Recent studies and empirical evidence have indicated that rather the standard theory's assumption that people's preferences are invariant over context, that people's preferences actually are to some degree dependent on the context (Knetsch, 2000).

There is a great disparity between individuals' valuations of gains and losses, in that "people commonly value a good more in the context of a loss than in the context of a gain" (Knetsch, 2000). Therefore, willingness to pay values are chronically lower than willingness to accept values. This trend adheres to the Kahneman and Tversky value function, which proposes that people do not evaluate alternatives with the conventional utility function, but instead with a value function defined over changes in wealth (Frank, 1991). The most applicable property of the Kahneman and Tversky value function is that people treat gains and losses asymmetrically; therefore the function "is much steeper in losses than in gains" (Frank, 1991). This property is similar to the law of diminishing marginal utility and states that the "impact of incremental gains or losses diminishes as the gains or losses become larger" (Frank, 1991).

Numerous studies back the Kahneman and Tversky value function's properties. One example is from a study in the early 1970s in which bird hunters were found to be willing to pay, on average, $247 to preserve a key environment for duck propagation, but would demand $1044 to agree to its destruction (Knetsch, 2000). Another experiment found that a group of individuals who paid on average $5.60 for a fifty percent chance at winning twenty dollars demanded an average of $10.87 to give up the same fifty percent chance of winning the same twenty dollars (Knetsch, 2000). Yet, with all of this evidence to the contrary the working assumption of most environmental valuations is that there are no sizable differences in the willingness to pay and willingness to accept values (Knetsch, 2000). The U.S. National Oceanic and Atmospheric Administration (NOAA) even adheres to the belief that any difference between the two values is trivial (Knetsch, 2000 and Portney, 1994). It seems logical to switch valuation methods from determining willingness to pay values to willingness to accept values, but there are underlying issues with this technique as well. There are problems with the proper eliciting of willingness to accept values, because the survey participants are often far less accustomed to the notion of receiving compensation for losing something (Knetsch, 2000). Proper questioning methods may help to lessen this effect.

Due to these factors, determining a single "true" value for a good may be impossible since the same asset will have two different values for the same person when they asked to sacrifice to avoid losing it and when they are asked to sacrifice to obtain it (Knetsch, 2000). Another difficulty pointed out by Knetsch is that people begin at different reference levels, mostly referring to what people consider the normal state, which is often the status quo (2000). The framing of the situation has also been found to play a role in determining individuals' values of resources (Knetsch, 2000). Several studies have been performed, which support this concept that people weigh negative characteristics more when rejecting one of two goods (Knetsch, 2000). Therefore, the scenario portion of indifference methods must be very careful with respect to possible biases that may inadvertently skew the results (Knetsch, 2000).

Not only are there differences between the valuation of losses and gains elicited by conjoint analysis and contingent valuation, but there are also discrepancies between the same values attained through these two survey methods. The empirical evidence is not convincing as to which if any method is biased. Boxall et al. concluded that contingent valuation results for willingness to pay is biased upward of conjoint analysis willingness to pay possibly due to "yea-saying" (1996). Stevens et al. on the other hand found that since most conjoint analysis studies count indifferent ratings or "maybe's" as yes's, the willingness to pay values are biased upward (2000).

The contingent valuation method may be best suited to determine the student body's value of the Pine Lake Environmental Campus, for several reasons. One factor being that there is only one situation necessary for the valuation to be contingent upon, which is Hartwick College's maintenance of Pine Lake. If a more in-depth study of the value of property's particular attributes were being performed then the conjoint analysis method would be more advisable. The ability to implement a rating system rather than a simple "yes" or "no" response to valuation mechanism will enable students' indifference to be factored while minimizing any upward bias. While this method of valuation is still controversial there seems to be enough evidence in its support to make it a viable technique.

Critics of contingent valuation have reasoned that responses do not actually reflect people's economic preferences but their good feelings from supporting the environment (Sexton et al., 1999). These criticisms were based upon "scope testing" done for the Exxon Valdez oil spill court battle, which determined that the respondents to the contingent valuation survey did not have a full understanding of the scope or size of the environmental changes specified in the scenario (Sexton et al., 1999). Research which directly refutes the work performed for the Exxon case showed that there were over thirty "scope tests" where contingent valuation surveys elicit values that "varied in the expected ways as the quantity or quality of environmental amenities changed across scenarios" (Sexton et al., 1999). This research also found that there were only a handful of studies where contingent valuation failed "scope tests" and those were the primary sources for the Exxon case's critique (Sexton et al., 1999). Research has also been performed to refute the notion that contingent values do not truly reflect people's economic preferences. A study by Carson et al., looked at "eighty-three studies that supported 616 comparisons of contingent valuation values with values arrived at using revealed preference methods for the same environmental amenities" (Sexton et al., 1999). Statistical analysis of this data revealed that the ratio of contingent values to revealed-preference values for the same ecosystem resources average 0.89, with a 95 percent confidence interval of 0.81-0.96 (Sexton et al., 1999). Research has shown that properly performed contingent valuation studies can estimate economic values with "sufficient accuracy to be useful both in the policy arena and court" (Sexton, et al., 1999). A contingent valuation study of the Grand Canyon also shows that participants feel that their responses are relevant, 95 percent felt that the results of the study should be used in deciding whether to follow through with the action outlined (Sexton et al., 1999).

Methods

In order to elicit the Hartwick College student body value of the Pine Lake Environmental Campus two forms of contingent valuation surveys were created, a willingness to pay survey (Appendix A) and a willingness to accept compensation survey (Appendix B). The surveys were created mirroring the format used in the Steven et al. contingent valuation of landowner's willingness to pay for ecosystem management on non-industrial private forestland (2000). Both surveys utilize a rating system instead of dichotomous choice to reduce the numbers of nonresponses and to reduce the upward bias noted by Boxall et al., which they attributed to "yea-saying" (1996). The scenarios were created to be neutral and not impose any biased contexts, which could influence the students' value functions. The hypothetical scenarios used to create shadow markets for the Pine Lake Environmental Campus were different in each survey. The willingness to pay survey involved the necessary sale of Pine Lake due to the college's economic hardships unless students were willing to pay for the maintenance of the property through tuition increases. The willingness to accept survey involved the sale of the Pine Lake Environmental Campus contingent upon adequately compensating the student's for their loss. The mechanisms to elicit the respective values were a mixture of bidding games and referendum formats, both of which are outlined in Portnay's article (1994). A post-survey questionnaire (Appendix C) was also distributed to determine any socioeconomic variable significance in value functions.

The surveys were distributed in a nonrandom manner to a diverse group of classes. Half of each class received the willingness to accept survey and the other half received the willingness to pay survey. Students were surveyed from the Legacy club, Introduction to Anthropology, General Psychology, Plant Biology, General Physics, and Managerial Accounting on May 9th, 2001. The same day was used for all of the testing to ensure that the hypothetical premise would maintain its believability. After the surveys were completed and collected the students were debriefed (Appendix D) in order to inform them of the falsehood of the hypothetical scenario. The ratings and questionnaire responses were compiled. Various value function curves were calculated and t-tests were performed to determine any socioeconomic variable significance.

Results

The surveys were distributed to a total sampling of 117 students. Sixty student participants completed the willingness to accept (WTA) survey and fifty-seven students completed the willingness to pay (WTP) survey. The majority of both the WTP and the WTA surveys were taken by females, 58 percent and 60 percent respectively (Appendix F). All of the class years were equally represented each comprising about 30 percent of the respondents for each survey, except for the class of 2001,which was only represented about 15 percent of each survey's total sampling (Appendix F). Over 60 percent of each survey was completed by a nonscience major (Appendix F). About 50 percent of the total survey respondents felt that their families were in the middle income bracket (Appendix F). Between 70 to 80 percent of the survey respondents reside on campus (Appendix F). About 95 percent of all the survey participants have been to Pine Lake at least once (Appendix F). Of the WTP survey and the WTA survey participants, about 30 percent and 50 percent were student athletes (Appendix F). In both survey pools, Greek organization members were slightly over 20 percent of the respondents (Appendix F). Students working on- or off-campus comprised about 75 percent and 60 percent of the WTP and WTA surveys respectively (Appendix F). Approximately 50 percent of the respondents felt they had an average outdoor experience level (Appendix F). About 70 percent of each surveys' participants came from either suburban or small town environments (Appendix F). Over half of the survey respondents felt that the Pine Lake Environmental Campus played at least a small role in their decision to enroll at Hartwick (Appendix F). Over 80 percent of both the WTP survey participants were involved in extracurricular activities (Appendix F).

The WTP survey found that the average amount of money students would increase their tuition by to maintain the Pine Lake Environmental Campus was $100 annually with an average peak rating of 7.88 (Figure 1).

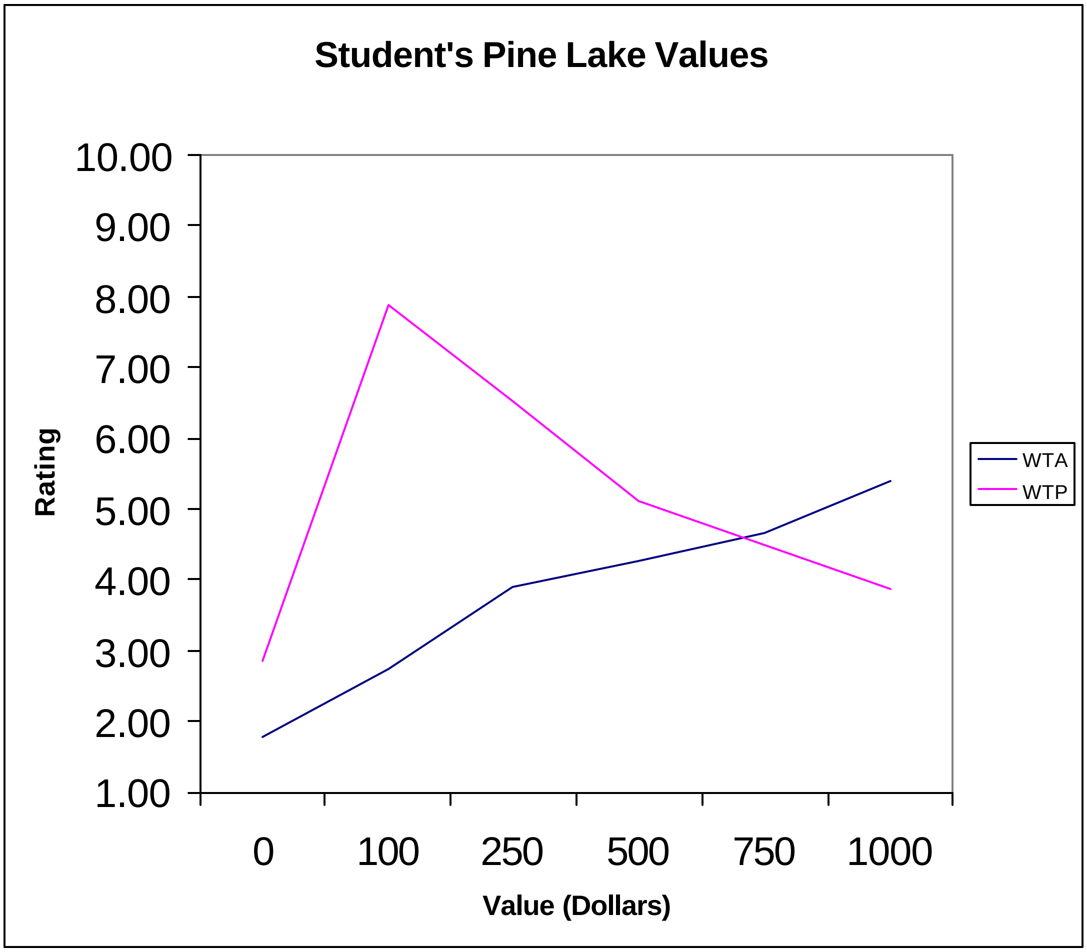

Figure 1. The willingness to pay (WTP) value function peaks at $100 with an average rating of 7.88. The willingness to accept (WTA) value function never peaks. The slope of the line is 0.0036.

Across Hartwick College's student body, estimating the average size to be 1400 students, this would bring in $140,000 annually. The WTA survey did not capture the minimum monetary compensation required by the student body for the loss of the Pine Lake Environmental Campus. Nineteen students filled in values ranging from $2000 to $6000 in the optional blank at the end of the WTA survey (Appendix B). An additional sixteen WTA survey respondents filled in the blank with "priceless" or an equivalent response. Therefore over 58 percent of the WTA participants were unsatisfied with the WTA value range, compared to only one respondent of the WTP survey who wrote in a maximum WTP value of $2000. The maximum compensation (WTA) value on the survey was $1000 off tuition annually (Appendix B). The slope of the WTA value function was approximately 0.0036. If the WTA value function were carried out to meet the "10" rating, which corresponded with full compensation, the associated monetary value would be approximately $2300. This puts the WTA value of the Pine Lake Environmental Campus at over $3 million annually.

The socioeconomic variables identified by Post-Survey Questionnaire showed very few statistically significant differences in their WTA or WTP value functions. One variable that was close to statistical significance was the difference between male and female WTP value functions (Figure 2). Females were found to maximize their WTP value at $250 annually, with an average rating of 7.88 (Figure 2). Males' peak WTP value was $100 annually, with the same average peak of 7.88 (Figure 2). The p-value of this difference was approximately 0.14, therefore there is no statistically significant difference between the to value function.

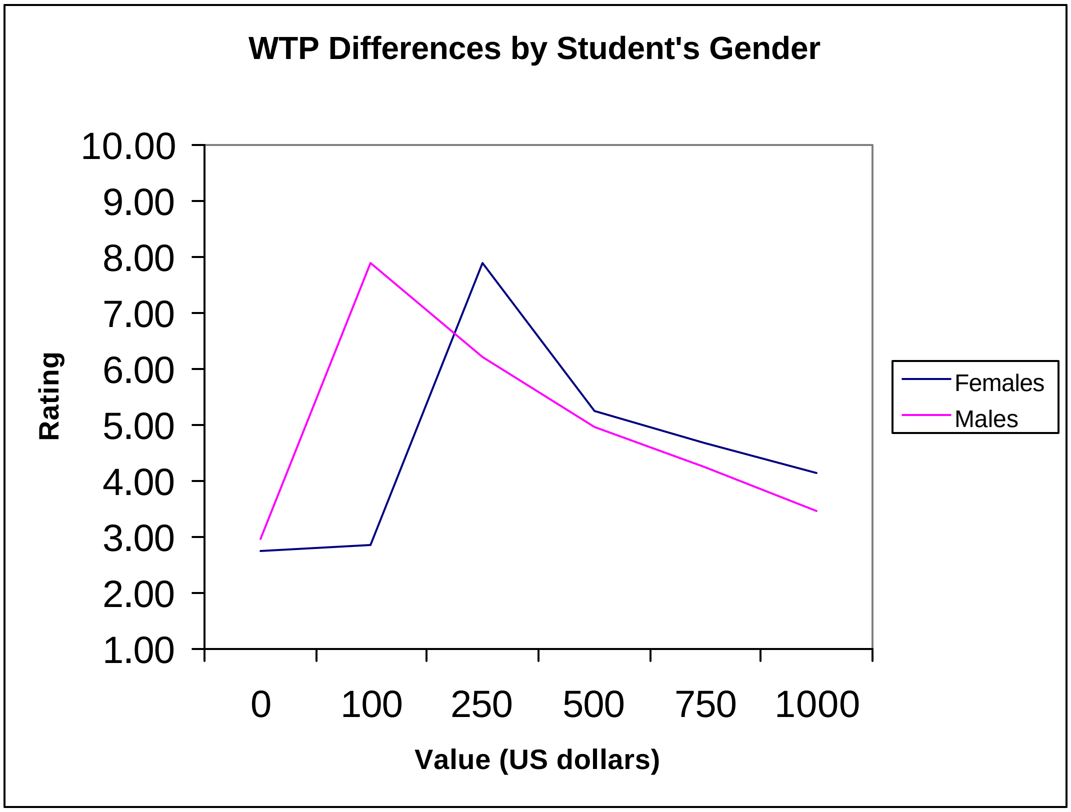

Figure 2. The female WTP value function spikes at the $250 alternative with an average rating of 7.88. The male WTP value function spikes at the $100 alternative, also with an average rating of 7.88.

Interesting trends may be noted with respect to the number of visits to Pine Lake per semester that each student experienced (Figures 3,4,and 5). Those students who visit Pine Lake more than once exhibited a statistically significant difference in the intensity of their WTP value than those students who visit Pine Lake one time or fewer (p-value = 0.047). The peak rating for those students visiting Pine Lake more than once was 8.28 and the peak rating for those who visited Pine Lake once or less was 5.80, which approximately a neutral stance (Figure 5).

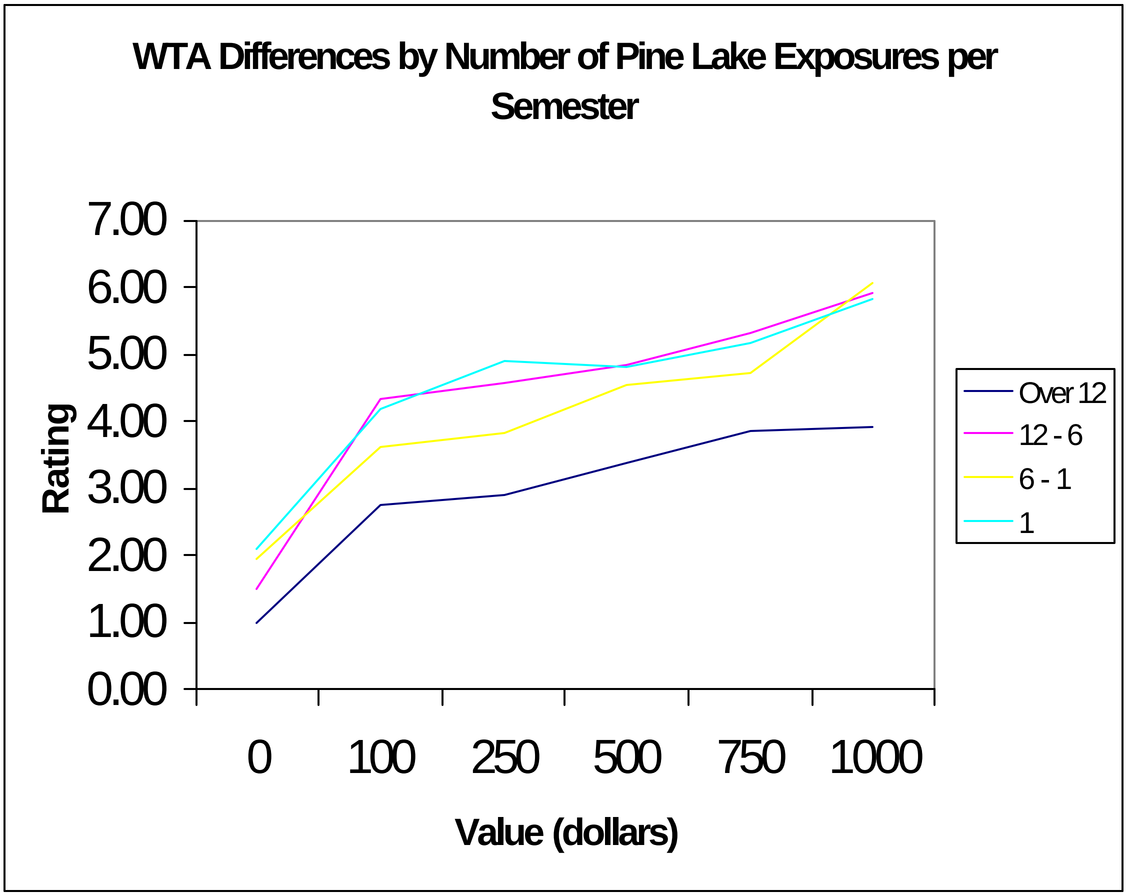

Figure 3. The WTA value functions for the students with fewer than 12 visits to Pine Lake a semester all tend to follow the same slope. While those students with over 12 visits to Pine Lake a semester, had a lower slope to their WTA value function.

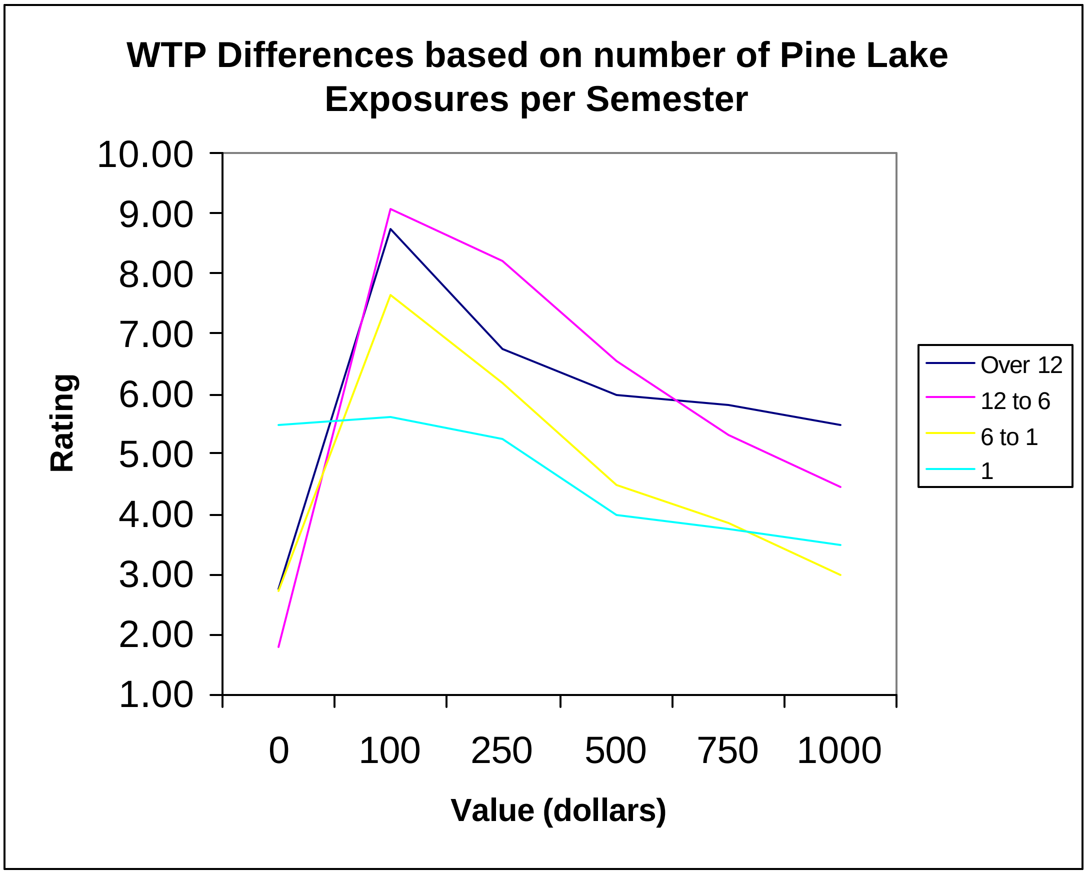

Figure 4. The student groups with over six visits to Pine Lake a semester showed a much greater intensity of willingness to pay for the property at the $100 alternative the one visit group. The over 12 group's average WTP value function spiked at 8.75; the 12 to 6 group's peaked at 9.08; and the 6 to 1 group capped maximized their WTP function at a rating of 7.64. The one visit per semester group did not exhibit a true peak in ratings, but their average rating did maximize at the $100 alternative at 5.63.

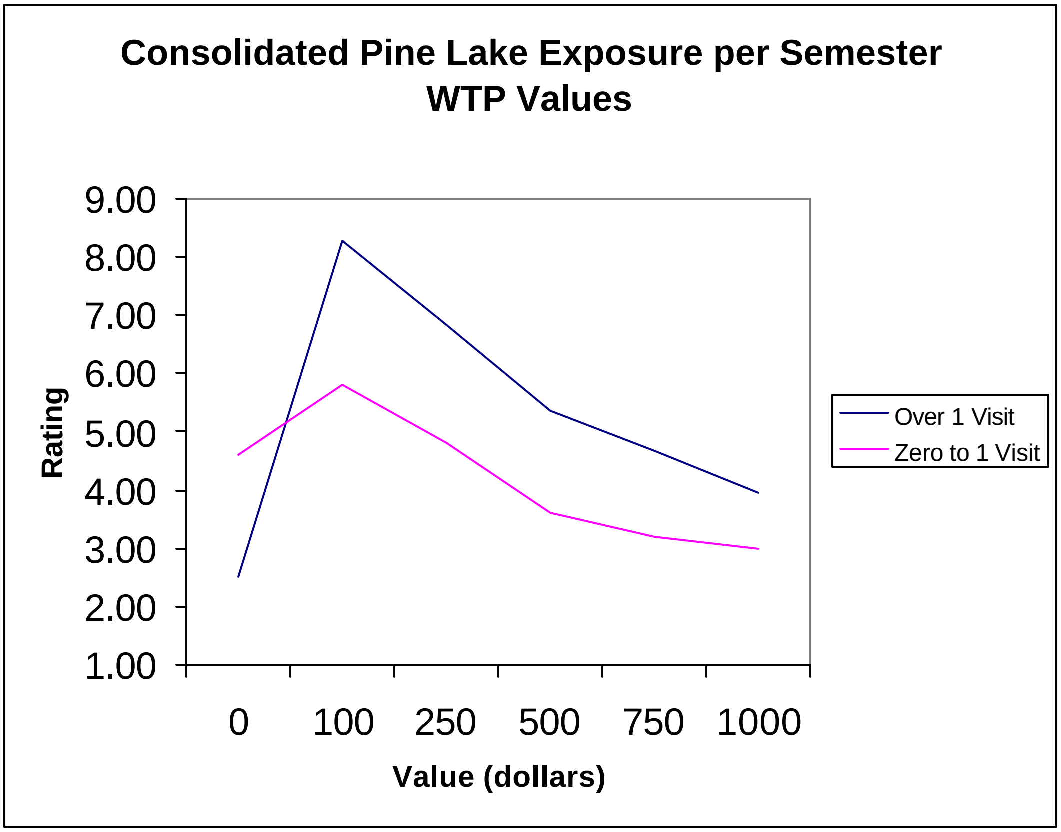

Figure 5. The WTP value functions for the student groups visiting Pine Lake more than one visit expressed an average peak rating of 8.28 for the alternative of $100. The WTP value function shows a small averaged peak at the $100 alternative with an average rating of 5.80.

Another interesting trend can be seen in the comparison of WTP value functions of each class year (Figure 6). The 2001 class does not exhibit a maximum WTP value within the range of options presented by the survey (Figure 6). The other classes experience peaks at the $100 alternative. The average peak rating for all the classes, excluding 2001 is above seven (Figure 6).

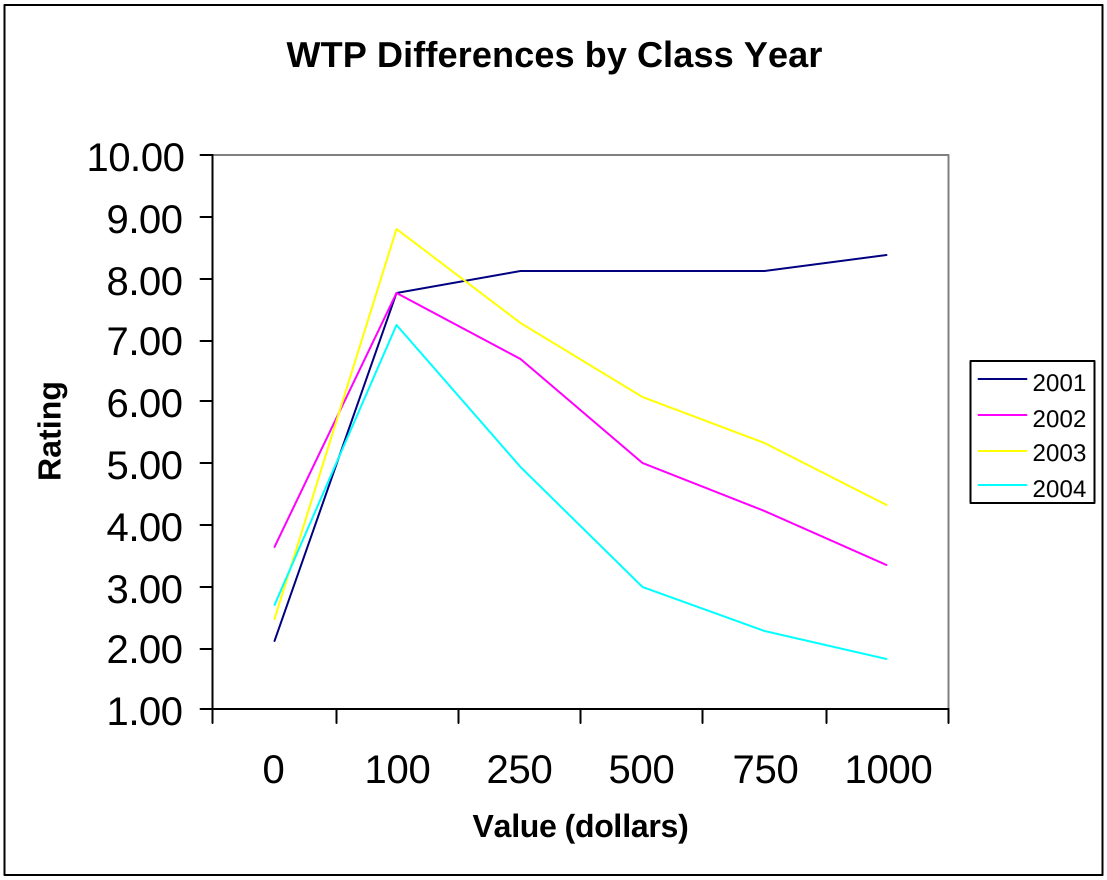

Figure 6. The class years 2002, 2003, and 2004 all experience their maximum WTP value at the $100 alternative, with all average rating values at about 7. Note the WTP value function for the class of 2001 does not reach a peak, but does experience a slowly upward slope after the $100 alternative.

Discussion

Across both surveys, the sample of students surveyed was a relatively good representation of the current student population, except for the academic major breakdown where there was a definite bias toward science majors. In the actual Hartwick student population, only 9 percent are science majors, 79 percent are nonscience majors, and12 percent are undeclared (Datatel statistics from registrar, May 2001). According to the Admissions Department's *Think Hartwick* brochure, 45 percent of the student body are men and 55 percent are women (Appendix E). The male and female respondents of both surveys were near this percentage breakdown, with some bias toward females (Appendix F). The college residence statistics were very close as well, with about 80 percent of the true student body living on campus compared to 81 percent of WTP participants and 73 percent of WTA participants (Appendix E and Appendix F). The percent of survey respondents who were student athletes was biased upwards in the WTA survey and downwards in the WTP survey, with over 33 percent of actual Hartwick College students participating on athletic teams (Appendix E and Appendix F). The Greek life association member percentages in the real student population, the WTP respondents, and the WTA respondents were all very close, around 20 percent (Verbal Admissions counselor communication and Appendix F). Approximately 75 percent of Hartwick students are involved in extracurricular activities, where as both surveys exhibited upward biases with over 80 percent of participants involved in extracurricular activities (Appendix E and Appendix F).

An interesting discovery in this survey may be that Hartwick students may actually use Pine Lake more often and over a broader range of students than previous studies have shown. The survey data may be off though, due to the disproportionately high amount of science major survey participants. This survey indicated that over 95 percent of those surveyed had been to the Pine Lake Environmental Campus at least once, and 91 percent of those surveyed had been there for reasons outside of class (Appendix F). A 1999 survey found that approximately 65 percent of graduating seniors had visited Pine Lake for recreational purposes (Malloy, 2000).

While there is very little statistical significance between the various socioeconomic variable tested for the trends exhibited indicate that a more comprehensive and random survey technique could elicit some significant values. The one statistically significant variation was the amount of semester Pine Lake exposure that students get with respect to the intensity of their maximum WTP value (Figure 5). This result makes intuitive sense since it would seem logical that the more time one spent at a location the more they would value that location. Surprising was the very little amount of exposure to Pine Lake (more than one visit) that was required to create such large WTP values. These differences indicate that the students' use values for the property are a large component of their WTP values. The student group that only visited Pine Lake once a semester or less actually indicated a preference to sell the property in nearly all cases, since their maximum rating of any alternative was only slightly above the neutral rating. Their rating of the sale of Pine Lake with no amount paid by the student body was exactly neutral at 5.50. These results lend evidence to the belief that getting people to highly value environmental resources takes the effort of actually get them out and enjoying the particular natural asset. Without such exposure to the resource in question, people are ambivalent to decisions concerning its maintenance.

The trend exhibited by the senior class to have a very high maximum WTP value (Figure 6), may be attributable to the fact that this particular subset of students are actually leaving Hartwick this year and subsequent increases in the tuition will not affect them. Therefore, they may not have been truly rating the options based on their actual willingness to pay, but simply because they do not want Pine Lake sold and will not experience the negative impacts expressed in each alternative. The seniors' maximum WTP value was not actually captured within the range of options. The other classes tended to exhibit similar WTP value functions.

The surveys used in this contingent valuation of Pine Lake could be used as pilot surveys for a more comprehensive, accurate, and in-depth look at students' WTA and WTP values for this property. Conjoint analysis could also be performed to determine the specific values of Pine Lake's various attributes. In further studies the surveys' instruction for the valuation mechanism should be revised, some confusion of participants as to the rating scheme led to incorrectly rated alternatives. The specific questions in the WTA valuation mechanism should be made clearer. Confusion there may also have led to some ill-completed surveys.

BIODIVERSITY ASSESSMENTS

Literature Review and Theory

The best estimates of biodiversity values involve estimating the richness of genes or characters, since genetic diversity is actually the building block of species diversity (The Natural History Museum Website). A direct measurement of gene richness would be an extremely time intensive process, so biologists have proposed phylogenetic or taxonomic measures of diversity, which would "predict the biodiversity value of different biotas, using knowledge of the genealogical (or hierarchical) relationships among organisms in combination with models of gene or character evolution" (The Natural History Museum Website). The problem with this method is that phylogenetic information is usually unavailable. Since the best estimates of biodiversity value are simply to difficult to measure it has led to the popularity of species richness measurements instead. Species richness is normally an appropriate surrogate for gene or character richness, when the species numbers sampled are large (The Natural History Museum Website).

Armed with this knowledge, ecologists and other scientists have begun to focus on determining species diversity measurements as a means of targeting potential areas for conservation efforts, like hotspots of diversity where there are combinations of high richness, narrow endemism, and threat (The Natural History Museum Website). In 1995, the United Nations Environment Program commissioned the Global Biodiversity Assessment (GBA), which was "an independent analysis of the state of scientific knowledge about biodiversity" (Reid, 1997). This collection of knowledge spurred a movement to assess the biodiversity of large ecosystems, eventually combining into national biodiversity measurements. The GBA recognized that while direct species appraisal was the most accurate measurement of species diversity it is not often a practical option. Across vast landscapes where there are immense numbers of individual organisms, as well as complex species distribution patterns across time and space, other methods must be established (Nagendra and Gadgil, 1999). In order for a global species diversity assessment to be made, the GBA advocates a combination of remote sensing, especially with satellites, linked with localized sampling (Nagendra and Gadgil, 1999). In areas where species numbers are too large to enumerate in full, higher taxon richness measurements are being used as surrogates (The Natural History Museum Website). The U.S. National Park Service is faced with the dilemma of needing biodiversity assessments performed but having too many species to calculate within a reasonable span of time. To solve this problem they decided to do an all-taxa diversity assessment to measure their parks' taxon richness values (U.S. National Park Service Website).

Smaller ecosystems, like Pine Lake, are not as overwhelming and scientists have the capability of performing direct species sampling in these locations in order to determine a biodiversity assessment. While Pine Lake is not a hotspot of biodiversity loss, nor have any of the rare or endangered species listed by the New York State Natural Heritage Program been found on the property, but it still has a biodiversity value, which can be based upon species diversity (Kowalczyk, 1992). Forests, like Pine Lake's temperate broadleaf forest, are species-rich ecosystems that support a wide array of taxa (Lindemayer, 1999). Unlike other terrestrial ecosystems, like deserts or grasslands, forests have a three-dimensional quality and more vertical stratification, which is shaped by the tree structures and the microclimate (Hunter, 1990). These unique characteristics enable forests to provide an environment suitable for numerous species to flourish. Forests are diverse ecosystems for several reasons; one is because they exist in environments were there are relatively abundant resources (Hunter, 1990). Forests are also routinely subjected to disturbances, which makes it "difficult for a few species to predominate" and "limitations effected by animals and disease may be important to forest diversity" (Hunter, 1990). The combination of vertical stratification and the abundance of organic matter in forests create ideal niches for a multitude of organisms, from insects to parasitic plants to birds to mycorrhizal fungi (Hunter, 1990).

Species diversity, which is sometimes called the species heterogeneity, can be used to describe a community's structure (Brower and Zar, 1977). When a community, like a forest, has high species diversity this means that many equally, or nearly equally, abundant species are present (Brower and Zar, 1977). When only a few species in a community are abundant then the species diversity is low (Brower and Zar, 1977). In the past, these types of communities would be ignored and only those ecosystems rich in species diversity would receive aid and attention. Yet, recent studies have show that "biodiversity loss matters everywhere, not just in megadiversity zones" and that "species deletion may impose much higher costs in species-poor systems than in species-rich systems" (Perrings, 1996). High species diversity also indicates a highly complex community by allowing for a larger array of species interactions (Brower and Zar, 1977). Due to the overarching implications of the species diversity level for a region, scientists and policymakers alike frequently focused upon it as a general biodiversity indicator.

There are numerous biodiversity indexes available such as the Shannon index, Brillouin's index, and Simpson's index. The Shannon index and the Brillouin's index are both information-theoretic indices, or in other words they are related to the uncertainty, and calculate "hierarchical diversity" measures (Brower and Zar, 1977). The Shannon index is best used when the sampling data is from random collection (Brower and Zar, 1977). Brillouin's index is best used when nonrandom species abundance data is available and the sample can be said to have representatives from all species (Brower and Zar, 1977). These two indices should only be used in a relative nature, to compare species diversity within two communities (Brower and Zar, 1977). Their values taken by themselves have no relevance. Simpson's index does have relevance on its own and elucidates the level of species diversity for particular communities (Brower and Zar, 1977). The Simpson's index is actually the application of an econometric diversity measure, called the Gini diversity measure, to ecology (Brower and Zar, 1977). The Simpson's index has been praised by some ecologists as being biologically meaningful (Hurlburt, 1971), while others criticize it for giving too much weight to rare species within a sampling.

Methods

Two different measurements of the biodiversity at the Pine Lake Environmental Campus were performed, both using preexisting data. By using preexisting data, these types of biodiversity assessments are extremely cost efficient and expedient, both characteristics which are ideal for making timely decisions regarding ecosystem management. The first assessment method is a somewhat simple and involves the direct numeration of the unique species existing on the property. To determine a number of species at Pine Lake, various senior research projects, studies, faculty research and checklists from the archives and herbarium were compiled.

The second method of biodiversity assessment was the calculation of a biodiversity index for the Pine Lake property. The Simpson index was used in this research because, its value is reflective of the particular environmental resource's biodiversity level without being compared to another community, which would be difficult in this case, since there are not many other large-scale biodiversity assessments completed at this time. The index was determined for the property by again examining senior research projects, studies, and faculty research. Applicable data must contain specific information about the sample sizes of each species studied and it must have the total number of individuals sampled. The valid data points were then applied to Simpson's equation for dominance (l): $l = \frac{\Sigma ni(ni - 1)}{N(N-1)}$ (Brower and Zar, 1972).

The variable, ni, is the number of individuals belonging to the i^{th} species. The variable, N, refers to the total number of individuals in the sample. From the dominance calculation the Simpson's diversity index, Ds [Ds = 1 – l], the probability of interspecific encounter, can be determined (Brower and Zar, 1972). Another diversity index that some ecologists find useful, the inverse of Ds, ds [ds = 1/ l], can also be calculated (Brower and Zar, 1972).

Results and Discussion

The total enumeration of the Pine Lake Environmental campus led to a rough estimate of the catalogued species living at Pine Lake to be 712. That value is comprised of 518 vascular plant species, 40 lichen species, 130 vertebrate species, and 16 amphibian species (Smith and Rabeler, 1976; Hildreth, 1977; Sessions, 2001; Murphy, 1996). Outside of this number of species, there are 19 families of insects, 18 orders of benthic invertebrates, and 26 algal taxa (Shabanowitz, 1973; Quinn, 1998; and Smith, 1997). This species count is a vast underestimation of the total number of species living at Pine Lake. The unquantified number of insect species alone will vastly increase the total number of species at Pine Lake, since insects will often account for over half the species in an ecosystem.

In determining the Simpson's index, useful data was collected from seven different research projects, ranging from 1986 to 2000 (Murphy, 1996; Parzek; Sheridan, 1999; Ahl, 1995; Schank, 1986; Hodgens,1999; and Quinn, 1998) . The data necessary for the calculation could only be obtained for 81 species (Appendix G). A research project involving eight benthic invertebrate orders had the appropriate sample information and was thereby added to the calculation (Quinn, 1998) (Appendix G). A total of 3,935 individuals were sampled for this calculation (Appendix G). The Simpson's dominance index (l) was calculated to be approximately 0.044. This measure means that if two individuals were taken at random from the community sampled, the chance that the two would belong to the same species is about a four percent (Brower and Zar, 1977). The Simpon's index (Ds) was calculated for the sample to be about 0.96. The Simpson's index indicates that the probability for an individual in the community to encounter a member of another species is about 96 percent (Brower and Zar, 1977). The inverted Simpson's dominance was calculated to be approximately 22.7 and is an "expression of the number of times one would have to take pairs of individuals at random from the entire aggregation to find a pair from the same species" (Brower and Zar, 1977). Therefore, in this community about 23 pairs would have to be picked at random before a pair of the same species would be found. The inverted Simpson's index may also be "an expression of how many equally abundant species would have a diversity equal to that in the observed collection" (Brower and Zar, 1977). In cases such as this one, where the Simpson's index is close to 1.0, the inverted index is often preferred, because it gives more discrimination when comparing this community with others (Brower and Zar, 1977). Compared to hypothetical data points and their respective diversity index calculations supplied by Brower and Zar (1977), the Pine Lake Environmental Campus can be considered an ecosystem of high biodiversity.

Currently, this type of larger ecosystem biodiversity indexing is being performed around the world in order to better equip policymakers with data necessary to set conservation efforts. Normally biodiversity indexes are calculated for much smaller communities, like those found in logs or in petri dishes. It is difficult to interpret large-scale studies of biodiversity due to the large differences in organism sizes (Brower and Zar, 1977). A better index should be found that accounts for the size of the community. National biodiversity data is being collected in order to create such an index for the United States. The U.S. National Park Services as was aforementioned are even performing all-taxa biodiversity indexing of their parks.

For the Pine Lake Environmental Campus to take part in such compilations, new biodiversity sampling should be performed in order to supply a comprehensive index. Usually herbarium records and archived research projects supply enough data to develop biodiversity indices, but Hartwick's current stores of studies and reports are incomplete. This makes it impossible to form an accurate biodiversity index. There are also problems with the data from some reports are recorded within the written documents. Many of the senior theses are missing data such as sample sizes for each specific species and the numbers of total individuals sampled. These two factors make determining an appropriate biodiversity index for Pine Lake through paper research alone impossible. Field research would be necessary to capture population sizes of the many missing species. A random survey of the property would be best.

Overall Conclusion

When individuals make an economic valuation of an environmental resource, they are not consciously determining a value for the asset's biodiversity level, in most cases. The average Hartwick student probably is not making such an assessment with respect to Pine Lake either. Yet, what the individuals are often valuing are nonmarket goods like their recreational use of the asset, the survival of specific species, and the aesthetics. Yet, when it comes down to it, none of those opportunities would exist if biodiversity levels were diminished immensely. Therefore valuations based upon the aesthetics and the recreational opportunities afforded to an individual by a resource are really valuations of the level of importance the individual places on maintaining the biodiversity there, contingent upon those receiving those benefits. The education of people by the scientific community with respect to the benefits they receive from biodiversity is essential to ensuring that people will eventually value biodiversity for biodiversity's sake. In the same manner that the stated-preference surveys indicated Hartwick students who experience the Pine Lake Environmental Campus first hand a few times, will value it far more than those students not afforded the same opportunity.

The terms, economics and ecology, are derived from the same Greek root *oikos*, which means "household" (Mercuro, 1997). Economics tries to understand "human behavior across society's institutions and purposeful choice" (Mercuro, 1997). Ecology tries to understand the interactions of all other living things with their environment and other organisms (Mercuro, 1997). Although these two studies are vastly different in subject matter, some of the same principles are true. Economists and ecologists try to understand and create smoothly running, efficient mechanisms. Getting the economic valuation of environmental resources right is like getting the world's household back in to order, where the proper resources are valued to the fullest.

Hartwick has to get its household back in order with respect to its valuation of the Pine Lake Environmental Campus. It is safe to say that Pine Lake is most likely worth somewhere between $100 annually to $2300 annually per student to the average student, but what one must recognize this value is not all-inclusive of what Pine Lake is worth as an entity. The biodiversity assessment of Pine Lake indicates that the forest is very species rich, with a Simpson's index of about 0.096. Yet, even knowing this does not fully capture the worth of Pine Lake. The sum total of Pine Lake's qualities, attributes, and possibilities are tremendous and beyond the capabilities of current economic valuation. If a small forest of less than one thousand acres can hold so much value is it even fathomable to imagine the value of all of the forests all over the world, imagine the value of all the ecosystems all over the world. Hopefully, this type of understanding will lessen the anthropocentric view human have of the environment and will move people, business, and governments closer to living in harmony within the constraints of the Earth's resources.

LITERATURE CITED

Adamowicz, W., J. Louviere, and M. Williams. 1994. Combining Revealed and Stated Preference Methods for Valuing Environmental Amenities. *Journal of Environmental Economics and Management.* 26: 271-292.

Ahl, Robert S. 1995. *The Pine Lake Fish Community: Analysis of Structure, Condition and Change Over a Ten Year Period.* Unpublished thesis, Hartwick College.

Bazerman, Max H., et al. *Environment, Ethics, and Behavior.* San Francisco: The New Lexington Press, 1997.

Blue, Peter. *Summary of Pine Lake Use – May 1, 2000 through April 13, 2001.* Unpublished internal data, Hartwick College.

Boxall, Peter C., et al. 1996. A comparison of stated preference methods for environmental valuation. *Ecological Economics.* 18: 243-253.

Brower, James E. and Jerrold H. Zar. *Field & Laboratory Methods for General Ecology,* second edition. Dubuque, Iowa: William C. Brown Publishers, 1977.

Bryant, Peter J. *Biodiversity and Conservation.* (A hypertextbook from UC Irvine, School of Biological Sciences). http://darwin.bio.uci.edu/~sustain/bio65/Titlepage.htm

Daily, Gretchen C., ed. *Nature's Services.* Washington, DC: Island Press, 1997.

Eldridge, Niles. 1998. Life in the Balance. *Natural History*.

Franklin, Jerry F. Structural and Functional Diversity in Temperate Forests. *Biodiversity.* E.O. Wilson, ed. Washington, DC: National Academy Press, 1988.

Frank, Robert H. *Microeconomics and Behavior.* New York: McGraw-Hill, 1991.

Frankel, George. April 1986. *Pine Lake Management Plan.* Unpublished internal document, Hartwick College.

Freeman III, A. Myrick. Nonuse values in natural resource damage assessment. *Valuing Natural Assets, The Economics of Natural Resource Damage Assessment.* R.J. Kopp and V.K. Smith, eds. Washington, D.C.: Resources for the Future, 1993.

Freeman III, A. Myrick. On Valuing the Services and Functions of Ecosystems. *Ecosystem Function and Human Activities.* R. David Simpson and Norman L. Christensen, eds. New York: International Thomson Publishing, 1997. Pp.241-254.

Gowdy, John M. February 1997. The Value of Biodiversity: Markets, Society, and Ecosystems. *Land Economics.* 73(1): 25-41.

Hanemann, W. Michael. Economics and the Preservation of Biodiversity. *Biodiversity.* E.O. Wilson, ed. Washington, DC: National Academy Press, 1988. pp.193-199.

Hawken, Paul. *The Ecology of Commerce.* New York: HarperBusiness, 1993.

Hildreth, Katherine C. 1977. *The Lichens of Pine Lake.* Unpublished thesis, Hartwick College.

Hodgens, Lynn S. 1999. *Long-term dynamics of a forest-interior avian community.* Unpublished thesis, Hartwick College.

Hunter, Malcolm, Jr. *Wildlife, Forests, and Forestry*. Englewood Cliffs, NJ: Regents/Prentice Hall, 1990.

Hurlburt, S.H. 1971. The nonconcept of species diversity: a critique and alternative parameters. *Ecology*. 52: 577-586.

Knetsch, Jack. Environmental valuations and standard theory: behavioral findings, context dependence and implications. *The International Yearbook of Environmental and Resource Economics 2000/2001*. Tom Tietenberg and Henk Folmar, eds. Northampton, MA: Edward Elgar, 2000. pp.267-299.

Kowalczyk, Paul N. December 21, 1992. *Forest Stewardship Plan for Hartwick College*. Unpublished report by the Pocono Forest and Wildlife Service.

Lindenmayer, D.B. March 22, 1999. Future directions for biodiversity conservation in managed forests: indicator species, impact studies and monitoring programs. *Forest Ecology and Management*. 115(2): 277-287.

Malloy, Laura. 2000. *Pine Lake Environmental Campus Executive Summary and Recommendations*. Unpublished internal document, Hartwick College.

Miller, Jean. 1972. *A Study of the Flora Algae Birds Inhibiting the Outlet Area of the Outlet Area of Pine Lake*. Unpublished thesis, Hartwick College.

Mercuro, Nicholas, ed. *Ecology, Law, and Economics*. New York: University Press of America, 1997.

Morell, Virginia. 1999. The Sixth Extinction. *National Geographic*. 195(2): 42-56.

Murphy, Michael T. 1996. *An Ecological And Economic Assessment of the Deep Woods Study Site of the Upper Tract*. Unpublished research, Hartwick College.

McQuillan, Alan G. and Ashley L. Preston. *Globally and Locally*. New York: University Press of America, 1998.

Nagendra, Harini and Madhav Gadgil. August 1999. Biodiversity assessment at multiple scales: Linking remotely sensed data with field information. *Proceedings of the National Academy of Science USA*. 96: 9154-9158.

The Natural History Museum Website. 2001. Biodiversity and World Map. http://www.nhm.ac.uk/science/projects/worldmap

Norton, Bryan. Commodity, Amenity, and Morality: The Limitations of Quantification in Valuing Biodiversity. *Biodiversity*. E.O. Wilson, ed. Washington, DC: National Academy Press, 1988. pp.200-205.

Parzek, Julianne. *Woody Plant Community Analysis of a Bog, Mud Lake*. Unpublished thesis, Hartwick College.

Perrings, Charles. June 6, 1996. Economics, ecology, and the Global Biodiversity Assessment. *Tree*. 11(6): 270.

Pine Lake Website. http://www.hartwick.edu/pinelake/main.html

Portney, Paul R. Fall 1994. The Contingent Valuation Debate: Why Economists Should Care. *Journal of Economic Perspectives*. 8(4): 3-17.

Prugh, Thomas, et al. *Natural Capital and Human Economic Survival*. Solomons, MD: ISEE Press, 1995.

Quinn, Jessica E. 1998. *The Biodiversity of Benthic Invertebrates at Pine Lake.* Unpublished thesis, Hartwick College.

Reid, Walter. September 1, 1997. Strategies for Conserving Biodiversity. *Environment.* 39(7): 16-20, 39-43.

Roe, Brian, Kevin J. Boyle, and Mario F. Teisel. 1996. Using Conjoint Analysis to Derive Estimates of Compensating Variation. *Journal of Environmental Economics and Management.* 31: 145-159.

Schank, Melissa A. April 1986. *A Study of the Species Diversity of the Fauna Along Six Transects Studied at Two Different Bogs – These Transects Begin in the Bog Continue Through the Ecotone and Terminate in the Forest.* Unpublished thesis, Hartwick College.

Schmidt, Kenneth and Richard S. Ostfeld. 2001. Biodiversity and the Dilution Effect in Disease Ecology. *Ecology.* 82(3): 609-619.

Sessions, Stanley. May 2, 2001. *Amazing Biodiversity*. Personal communication via e-mail.

Sexton, Ken, et al., eds. *Better Environmental Decisions: Strategies for Governments, Businesses and Communities.* Washington, DC: Island Press, 1999.

Shabanowitz, R. 1973. *Preliminary Examination of Pine Lake and Pine Lake Swamp Insect Fauna.* Unpublished thesis, Hartwick College.

Smith, Catherine D. 1997. *Algal Periphyton Growth on Nutrient-Diffusing Substrata: Insight into the Eutrophication of Pine Lake.* Unpublished thesis, Hartwick College.

Smith, Robert and Richard Rabeler. 1976. *Checklist of the Vascular Flora of Pine Lake 1976.* Unpublished research, Hartwick College.

Stanley, Thomas R. April 1995. Ecosystem Management and the Arrogance of Humanism. *Conservation Biology*. 9(2): 255-262.

Stevens, T.H., R. Belkner, D. Dennis, D. Kittredge, C. Willis. January 2000. Comparison of contingent valuation and conjoint analysis in ecosystem management. *Ecological Economics.* 32(1): 63-74.

Stein, Bruce A., Lynn S. Kutner, and Jonathan S. Adams, eds. *Precious Heritage: The Status of Biodiversity in the United States*. New York: Oxford University Press, 2000.

Swerdlow, Joel. 1999. Biodiversity – Taking stock of life. *National Geographic.* 195(2): 42-56.

Taylor, Jonathan G. and Aaron J. Douglas. Diversifying Natural Resources Value Measurements: The Trinity River Study. *Society and Natural Resources.* June 1999. 12(4): 315-336.

Tietenberg, Tom. *Environmental and Natural Resource Economics.* Third Edition. New York: HarperCollins Publishers, 1992.

Toman, Michael A. Ecosystem Valuation: An Overview of Issues and Concerns. *Ecosystem Function and Human Activities.* R. David Simpson and Norman L. Christensen, eds. New York: International Thomson Publishing, 1997. pp. 25-44.

U.S. National Park Service Website. http://www.nps.org

USDA Forest Service. New York Statistical Tables 1993.
http://www.fs.fed.us/ne/fia/states/ny/tables/ny001.html

Van Der Werf, Martin. The Almighty Sawbuck: Colleges Struggle to Balance Interests Over Their Forested Lands. *The Chronicle Of Higher Education.* Sept. 29, 2000. A36 – A38.

van Jaarsveld, Albert, S. Freitag, S.L. Chown, et al. Biodiversity Assessment and Conservation Strategies. *Science*. March 27, 1998. 279(5359): 2106-2018.

Willis, K.G. and G.D. Garrod. Biodiversity values for alternative management regimes in remote UK coniferous forest: an iterative bidding polychotomous choice approach. *The Environmentalist.* Fall 1998. 18(3): 157-166.

Wilson, Edward O. *The Diversity of Life.* Cambridge, MA: Harvard University Press, 1992.

Appendix A.

Pine Lake Student SurveyWTP

Administered by: Meghan Zysik; Box 422; X7233
Thesis Advisor: Carli Cochi-Ficano

Please consider the following situation.

Pine Lake is Hartwick's environmental campus located eight miles from the main campus in West Davenport. This 914-acre property includes a lake, stream, a lodge, several cabins, the vaudevillian, the Robert R. Smith Field Station, challenge courses, a sauna, classrooms, and hiking trails. Pine Lake also provides recreational opportunities such as swimming, canoeing, fishing, cross-country skiing, snow shoeing, and hiking. Concerts and festivals for the college and Oneonta communities are held at Pine Lake throughout the year. The land is open to all Hartwick students, faculty and staff as well as to the community at large.

Approximately 21 students can live at Pine Lake each year either in the main lodge or in one of the cabins. Numerous science classes, ranging from Ecology and the Environment to Plant Biology, take advantage of Pine Lake's resources. A number of current research experiments addressing environmental concerns are being performed at Pine Lake, including deformed amphibian research, seasonal and spatial variations in Pine Lake Water Chemistry, and soil classifications. Nonscience classes also visit the Pine Lake campus, including; Creative Writing, Mountain Biking, Sculpture, Musical Theatre, and Architecture of the Sacred. The Awakenings program is run at Pine Lake as well for freshman prior to orientation.

Not only does Pine Lake serve as a residence for 21 students but it is also home to over 650 different species of organisms. This total only accounts for small fraction of the total biodiversity at Pine Lake since it does not count insects, spiders, mites, millipedes, earthworms, and mollusks to only name a few of the uncatalogued species. So the current estimation of 650 species is a large underestimation, since insects alone usually account for more than half of the total number of species in a given ecosystem.

Due to Hartwick's recent financial hardships, the administration and trustees are looking for ways to save money. They are looking to make cut backs in the funding for departments and are proposing the elimination of programs that chronically exceed their budgets.

At this past board meeting, the trustees and administration have identified Pine Lake as such a program. One proposed solution is that students must take on the complete monetary burden of Pine Lake. This survey will aid them in their decision making process.

Please read the following alternatives, each of which consists of several attributes. Please consider and compare all of the alternatives presented and then indicate how you would rate each on a scale of 1 to 10. Use 10 for alternatives, if any, that you WOULD DEFINITELY undertake. Use 1 for alternatives, if any, that you WOULD DEFINITELY NOT undertake. If you are not sure use 2 through 9 to indicate how likely you would be to enter into each alternative arrangement.

Alternative 1 –

You would not pay any amount of money in order to maintain the Pine Lake environmental campus. Therefore, the property would be sold to various private parties, thereby ending all Hartwick affiliation with Pine Lake and eliminating student access it.

Your rating….(please circle one value)

1 2 3 4 5 6 7 8 9 10

Appendix A. (continued)

Alternative 2 –

You feel that Pine Lake is an important part of your college experience and you are willing to increase your tuition by $100 a year in order to maintain the property and its programs.

Your rating….(please circle one value)

1 2 3 4 5 6 7 8 9 10

Alternative 3 –

You feel that Pine Lake is an important part of your college experience and you are willing to increase you tuition by $250 a year in order to maintain the property and its programs.

Your rating….(please circle one value)

1 2 3 4 5 6 7 8 9 10

Alternative 4 –

You feel that Pine Lake is an important part of your college experience and you are willing to increase you tuition by $500 a year in order to maintain the property and its programs.

Your rating….(please circle one value)

1 2 3 4 5 6 7 8 9 10

Alternative 5 –

You feel that Pine Lake is an important part of your college experience and you are willing to increase you tuition by $750 a year in order to maintain the property and its programs.

Your rating….(please circle one value)

1 2 3 4 5 6 7 8 9 10

Alternative 6 –

You feel that Pine Lake is an important part of your college experience and you are willing to increase you tuition by $1000 a year in order to maintain the property and its programs.

Your rating….(please circle one value)

1 2 3 4 5 6 7 8 9 10

If none of these alternatives fully capture the amount of tuition increase you would be willing to undergo in order to maintain the Pine Lake campus please fill in the blank below with an appropriate value.

$__________

Appendix B.

Pine Lake Student SurveyWTA

Administered by: Meghan Zysik; Box 422; X7233
Thesis Advisor: Carli Cochi-Ficano

Please consider the following situation.

Pine Lake is Hartwick's environmental campus located eight miles from the main campus in West Davenport. This 914-acre property includes a lake, stream, a lodge, several cabins, the vaudevillian, the Robert R. Smith Field Station, challenge courses, a sauna, classrooms, and hiking trails. Pine Lake also provides recreational opportunities such as swimming, canoeing, fishing, cross-country skiing, snow shoeing, and hiking. Concerts and festivals for the college and Oneonta communities are held at Pine Lake throughout the year. The land is open to all Hartwick students, faculty and staff as well as to the community at large.

Approximately 21 students can live at Pine Lake each year either in the main lodge or in one of the cabins. Numerous science classes, ranging from Ecology and the Environment to Plant Biology, take advantage of Pine Lake's resources. A number of current research experiments addressing environmental concerns are being performed at Pine Lake, including deformed amphibian research, seasonal and spatial variations in Pine Lake Water Chemistry, and soil classifications. Nonscience classes also visit the Pine Lake campus, including; Creative Writing, Mountain Biking, Sculpture, Musical Theatre, and Architecture of the Sacred. The Awakenings program is run at Pine Lake as well for freshman prior to orientation.

Not only does Pine Lake serve as a residence for 21 students but it is also home to over 650 different species of organisms. This total only accounts for small fraction of the total biodiversity at Pine Lake since it does not count insects, spiders, mites, millipedes, earthworms, and molluscs to only name a few of the uncatalogued species. So the current estimation of 650 species is a large underestimation, since insects alone usually account for more than half of the total number of species in a given ecosystem.

Due to Hartwick's recent financial hardships, the administration and trustees are looking for ways to save money. They are looking to make cut backs in the funding for departments and are proposing the elimination of programs that chronically exceed their budgets.

At this past board meeting, the trustees and administration have identified Pine Lake as such a program. One proposed solution is that the Pine Lake campus will be sold to various private parties, thereby eliminating all Hartwick affiliation with and access to the property. This survey will aid them in their decision making process.

Please read the following alternatives, each of which consists of several attributes. Please consider and compare all of the alternatives presented and then indicate how you would rate each on a scale of 1 to 10. Use 10 for alternatives, if any, that you WOULD DEFINITELY undertake. Use 1 for alternatives, if any, that you WOULD DEFINITELY NOT undertake. If you are not sure use 2 through 9 to indicate how likely you would be to enter into each alternative arrangement.

Alternative 1 –

You feel that the Pine Lake should be sold and you feel no need for monetary compensation for the loss.

Your rating….(please circle one value)

1 2 3 4 5 6 7 8 9 10

Appendix B. (continued)

Alternative 2 –

You feel that the Pine Lake campus is important to you and in compensation for your loss, you would need a $100 decrease in your tuition.

Your rating….(please circle one value)

1 2 3 4 5 6 7 8 9 10

Alternative 3 –

You feel that the Pine Lake campus is important to you and in compensation for your loss, you would need a $250 decrease in your tuition.

Your rating….(please circle one value)

1 2 3 4 5 6 7 8 9 10

Alternative 4 –

You feel that the Pine Lake campus is important to you and in compensation for your loss, you would need a $500 decrease in your tuition.

Your rating….(please circle one value)

1 2 3 4 5 6 7 8 9 10

Alternative 5 –

You feel that the Pine Lake campus is important to you and in compensation for your loss you would need a $750 decrease in your tuition.

Your rating….(please circle one value)

1 2 3 4 5 6 7 8 9 10

Alternative 6 –

You feel that the Pine Lake campus is important to you and in compensation for your loss, you would need a $1000 decrease in your tuition.

Your rating….(please circle one value)

1 2 3 4 5 6 7 8 9 10

If none of these alternatives fully capture the amount of monetary compensation you would need for the loss of the Pine Lake campus please fill in the blank below with an appropriate value.

$__________

Appendix C.

Post Survey Questionnaire

Please circle the appropriate answer or fill in the blank where necessary.

1. Male or Female

2. Class Year 2001 2002 2003 2004

3. Major(s) ____

   Minor(s) ____

4. Income Bracket of Parents (in your best estimation):

Upper Upper Middle Middle Lower Middle Lower

5. Where do you live?

On Campus (Special Interest included) Off-campus (Greek housing included) At Pine Lake

6. Do you receive a scholarship and/or grant and/or financial aid? YES NO

7. Have you been to Pine Lake? YES NO

   (if no, skip to question 10)

8. How often do you go to Pine Lake a semester (in your best estimation)?

More than 12 times _____ Between 12 and 6 times _____

Less than 6 times but more than 1 time _____

1 time _____

9. Why did you go to Pine Lake (check all that apply)?

Relaxation _____ Class _____ Visiting friends _____ Recreation _____ Band _____ Special Event _____

10. Are you a student athlete? YES NO

11. Do you work on- or off-campus? YES NO

12. Are you a member of a Greek organization? YES NO

13. What is your outdoor experience level (in your best estimation)?

Extensive Average Low

14. What type of setting are you from?

Urban Suburban Small Town Rural

Appendix C. (continued)

15. When you chose Hartwick, what role did Pine Lake play in your decision?

____

____

16. What extracurricular activities are you involved in?

____

____

____

Comments :____

____

____

Appendix D.

Debriefing

Thank you for participating in this survey and in my senior research project. The information pertaining to the trustee board and the administration's decision to eliminate Pine Lake was completely fabricated, although the fate of Pine Lake is still undetermined. This premise was necessary to elicit the appropriate responses from you with respect to your willingness to pay for the Pine Lake property. This method of environmental valuation is called contingent valuation. In order for me to come up with an appropriate value for Pine Lake it is essential that the participants do not know that the premise is untrue. So, please do not mention the particular details of this survey until my surveying is completed on May 10th. Thank you once again.

Appendix E.

Information from Hartwick Admissions' 2000-2001 brochure – *Think Hartwick*

"1400 students from 30 states and 37 countries; 45% men and 55% women; 11% ALANA students (students from African, Latino, Asian and American Indian descent, 61 international students."

"More than 80 percent of Hartwick Students live on campus in 10 residence halls."

"75 percent of the students are involved in 57 student clubs."

"More than 33% of students participate on 25 athletic teams."

"78% of Hartwick students receive financial aid."

Appendix F.

Respondent Characteristics

	Survey Type:	
	Willingness To Pay	**Willingness to Accept**
Male	42%	36%
Female	58%	60%
Class Year		
2001	14%	15%
2002	30%	25%
2003	26%	30%
2004	30%	25%
Majors		
Science	35%	30%
Nonscience	65%	63%
Perception of Parental Income		
Lower to Lower Middle	19%	23%
Middle	51%	42%
Upper Middle to Upper	30%	28%
College Residence		
Off-campus	14%	20%
On-campus	81%	73%
At Pine Lake	5%	2%
Visits to Pine Lake (per semester)		
Zero	4%	5%
Once	14%	18%
More than once less than 6	39%	30%
More than 6 less than 12	23%	20%
More than 12	21%	22%
Student athletes	28%	47%
Greek organization members	23%	22%
Work on- or off-campus	75%	63%
Outdoor Experience Level		
Low	14%	5%
Average	49%	58%
Extensive	37%	32%
Home Setting		
Urban	12%	7%
Suburban	30%	28%
Small Town	42%	45%
Rural	16%	15%
Role That Pine Lake Played In College Choice		
None	44%	41%
Small to Medium	28%	23%
Large and Very Large	26%	27%
Extracurricular Activity Involvement		
None	5%	3%
Between 1 and 3	54%	73%
4 and over	33%	8%

Appendix G.

Species Name	ni	ni - 1	ni(ni - 1)
Red-eyed Vireo	410	409	167,690
Red Maple	392	391	153,272
Ovenbird	363	362	131,406
Bluegill sunfish	232	231	53,592
Least Flycatcher	151	150	22,650
Yellow-bellied Sapsucker	142	141	20,022
Eastern Wood-pewee	127	126	16,002
Eastern Hemlock	125	124	15,500
Diptera [benthic invertebrate order (bio)]	98	97	9,506
Red Oak	93	92	8,556
Scarlet Tanager	90	89	8,010
White Birch	84	83	6,972
Black-throated Green Warbler	82	81	6,642
Ephemeroptera (bio)	78	77	6,006
American Beech	76	75	5,700
Largemouth bass	73	72	5,256
Plecoptera (bio)	67	66	4,422
Trichoptera (bio)	60	59	3,540
Veery	58	57	3,306
Hermit Thrush	54	53	2,862
Ectoprocta (bio)	53	52	2,756
Black Birch	53	52	2,756
Pumpkinseed sunfish	50	49	2,450
White Oak	47	46	2,162
Black-capped Chickadee	42	41	1,722
Great-crested Flycather	39	38	1,482
Black Spruce	39	38	1,482
White-breasted Nuthatch	38	37	1,406
American Redstart	36	35	1,260
B-T Aspen	35	34	1,190
Yellow Birch	34	33	1,122
Sugar Maple	32	31	992
Larch	31	30	930
Eastern Chipmunks	28	27	756
Hairy Woodpecker	27	26	702
Blue Jay	27	26	702
Brown Bullhead	26	25	650
Yellow perch	25	24	600
White sucker	25	24	600
Coleoptera (bio)	25	24	600
Chain pickerel	23	22	506
American Chestnut	18	17	306
Shadbush	18	17	306
Mountain Holly	18	17	306
Redbreast sunfish	17	16	272
Canada Warbler	17	16	272
Wood Thrush	16	15	240
Earwigs	16	15	240
Rock bass	15	14	210
Rose-breasted Grosbeak	15	14	210
Quaking Aspen	15	14	210
Fisher Spiders	12	11	132
Hophornbeam	12	11	132
Dark-eyed Junco	11	10	110
Dragonflies	11	10	110
Pileated Woodpecker	10	9	90
Damselflies	10	9	90

Appendix G. (continued)

Species Name (continued)	**ni**	**ni - 1**	**ni(ni - 1)**
Whirlgig Beetles	9	8	72
Red Ants	9	8	72
Odonata (bio)	8	7	56
Carapidae	8	7	56
Ironwood	8	7	56
Moths	7	6	42
Huckleberry	7	6	42
Water Boatmen	6	5	30
Crab Spiders	6	5	30
Highbush Blueberry	5	4	20
Creek chubsucker	4	3	12
Ambush Bugs	4	3	12
Grasshoppers	4	3	12
Centipedes	4	3	12
Oeneis jutta (butterfly)	3	2	6
Zygoptera (bio)	2	1	2
Spring Tails	2	1	2
Incisalia lanoraieensis (butterfly)	2	1	2
Assassin Bugs	2	1	2
Mites	2	1	2
Wood Frog	2	1	2
Water Snake	1	0	0
Lycaena epixanthe (butterfly)	1	0	0
Crickets	1	0	0
Rana Cares	1	0	0
Slugs	1	0	0
Red Belly Snake	1	0	0
Aulonium	1	0	0
White Pine	1	0	0
Witchhazel	1	0	0
Chokeberry	1	0	0
Total Number of Individuals:	**3935**		
		Sum of ni(ni - 1):	**681,516**
		Simpson's dominance (l):	**0.044024757**
		Simpon's index (Ds):	**0.955975243**
		Simpson's ds:	**22.714924**