Economic Analysis and Land Use Policy

PROCEEDINGS
--Session One--
Brownfields and Property Values

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Disclaimer

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Proceedings for Session 1

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Introductory Remarks of Stephen Lingle,

Director US EPA National Center for Environmental Research and Quality Assurance, Environmental Engineering Research Division -- Summarization

Mr. Lingle welcomed participants of the workshop, the fourth that has been jointly sponsored by the National Center for Environmental Research and Quality Assurance (NCERQA) and the former EPA Office of Policy, now the Office of Policy, Economics and Innovation. Mr. Lingle commented that the topic for today's workshop was a timely one, with the currently increasing realization of the link between land use and environmental quality. Mr. Lingle noted that a recent Washington Post article discussed the continuing Clean Air Act noncompliance of nine of the ten major metropolitan areas. The article noted that because the states in these cases will have to redevelop their implementation plans, some local governments may have to make difficult and unpopular decisions regarding urban sprawl. This is an example of the kind of issue that will come increasingly to the fore of environmental protection. Mr. Lingle noted that Harriet Tregoning, with the EPA Office of Policy, Economics and Innovation, has been on the forefront of this issue. For the Office of Research and Development, this workshop represents an opportunity to communicate some of the results that are being obtained from research funded by EPA's Science to Achieve Results (STAR) program, which has been part of EPA's extramural research program. For the past five year, this program has been jointly sponsored with the National Science Foundation. Three of the speakers today have been funded by the STAR program. Mr. Lingle closed by referring workshop participants to the STAR program website, where there are postings for requests for proposals and abstracts of grants funded, and summary reports of STAR research. Mr. Lingle also acknowledged Matt Clark, of who has been responsible for socio-economic research at NCERQA.

Environmental Contamination, Risk Perceptions, and Property Values

--Working Paper*--

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Environmental Contamination, Risk Perceptions, and Property Values

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I. Introduction

Stigma is a negative attribute of real estate acquired by the discovery of contamination and reflected in price (Elliot-Jones, 1996). Stigma in residential property values may be caused by path dependence or uncertainty. If path dependence is present, then cleaning up a hazardous waste site will not result in the same outcome that would occur if the hazardous waste site never existed. The presence and duration of stigma are tested for using hedonic price techniques with data from housing sales prices in Dallas County, Texas. The empirical evidence shows that stigma exists after cleanup only for houses in very close proximity to the hazardous waste site.

A related issue is that stigma may be caused by both scientifically assessed risk and perceived risk. In its prioritization of sites for cleanup, the EPA wishes to only consider risk as quantified by scientists. However, a perception of risk is enough to lower property values, as illustrated by the case of electromagnetic fields cased by high-voltage lines. Owners of properties near electrical transmission lines have claimed reductions in value due to stigma, caused by electromagnetic field-related health risks and heightened public perceptions of cancer risks (Gregory and von Winterfeldt, 1996). The public's beliefs are often very different from the experts (McClelland *et al.*, 1990). The public tends to not believe experts when they say that a previously-identified source of contamination is actually safe. An empirical analysis of the effect of perceived risk caused by environmental contamination on property values is also presented. We find empirically that media coverage increases perceived risk, and that increased perceived risk surrounding the site, in turn, lowers property values.

II. Previous Empirical Studies

The current body of literature on the empirical effects of locally undesirable land uses does not address whether the diminution of property values caused by these land uses is temporary or permanent or whether path dependence effects exist. Although there have been many previous studies which attempt to measure the effect of environmental contamination and cleanup on property values, they focus on a short-run phenomenon. Most importantly, existing studies have not analyzed post-cleanup property values. Typically, impacts of contamination on property values are examined with a cross-sectional data set at a single point in time.[1] By not including post-cleanup property values, these studies cannot structure the event analysis correctly to analyze the effects of cleanup.

Many authors have used property value data to value environmental attributes and, more specifically, study the impact of hazardous waste sites. Researchers, such as Ketkar (1992), Kiel (1995), Kiel and McClain (1995), Kohlhase (1991), Smith and Desvousges (1986), and Thayer *et al.* (1992) have consistently found that proximity to hazardous waste sites and other locally undesirable land uses (LULUs) has a negative impact on property values.[2]

Contingent valuation is an alternative approach to property value studies for estimating benefits from

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1 Exceptions include Kohlhase (1991) and Kiel (1995), who examine property values at more than one point in time, but do not consider post-cleanup property values. Kiel and McClain (1996) examine housing prices before and after a failed incinerator siting. However, for the latter analysis the incinerator was only hypothetical. Dale *et al*. (1999) do consider post-cleanup values, but they do not consider discontinuities in the price gradient on distance.

2 For additional cites and a comprehensive survey of empirical results, see Farber (1998).

the cleanup of hazardous waste sites. For example, Burness *et al*. (1983) and Smith and Desvousges (1986) have used contingent valuation to estimate willingness to pay to reduce the risk associated with a hazardous waste site. However, as Thayer *et al.* (1992) point out, "The efforts have had little success because respondents apparently have significant difficulties assessing changes in low probability events."3

In contrast to previous empirical studies, this analysis examines impact of environmental contamination on residential property values by analyzing data from before identification of the hazardous waste site, and before, during, and after cleanup has been completed. Consequently, it is possible to consider the longer-run recovery prospects.

III. Statistical Model

The price of housing and land reflects consumers' valuations of all the attributes that are associated with housing, including environmental quality. The level of environmental quality can be considered to be a qualitative characteristic of a differentiated good market. Consumers can choose the level of environmental quality through their choice of a house. Housing prices may include premiums for locations in areas with high environmental quality. If so, the price differentials may be viewed as implicit prices for different levels of environmental quality.

Following the standard hedonic price model, the price of housing, P, in Dallas County, Texas, is assumed to be described by a hedonic price function, $P = P(x)$, where x is a vector of structural,

3 Thayer *et al.* (1992), p. 266.

neighborhood and environmental attributes. The hedonic price of an additional unit of a particular attribute is determined as the partial derivative of the hedonic price function with respect to that particular attribute. Each consumer chooses an optimal bundle of housing attributes and all other goods in order to maximize utility subject to a budget constraint. The chosen bundle will place the consumer so that his indifference curve is tangent to the price gradient, P_x. The marginal willingness to pay for a change in a housing attribute is then equal to the coefficient of the attribute (Rosen, 1974).

Our study follows the previously sited literature and considered only linear and semi-log (natural logarithm of the dependent variable) functional forms. A linear specification has the obvious interpretation that a unit increase in an attribute causes the price to rise by an amount equal to the coefficient; while with a semi-log specification, the coefficients can be interpreted as a percent of the average house price. Given the presence of independent dummy variables, the following Box-Cox transformation of the dependent variable was used to choose between the linear or natural logarithmic forms for the dependent variable.

(1)
$$p(l) = \begin{cases} \dfrac{P^{l} - 1}{l}, & l \neq 0 \\ \ln l, & l = 0 \end{cases}$$

Using Box-Cox maximum likelihood analysis, l was estimated for each year. The yearly estimates of l range from -0.09 to 0.21. A value of l = 0 implies that a semi-log specification is best, and l = 1 indicates a linear form is preferred. Confidence intervals for l were also estimated. The hypothesis that l = 1 could be rejected for every year. Although the hypothesis that l = 0 could be rejected for most years,4 the estimates of l are always close to zero. Given this limited analysis of functional form, the semi-log specification below is reported:

$$\ln P(x) = b_0 + \Sigma\, b_i x_i + e \; . \tag{2}$$

Where P is the sale price of the home, the x_i's are the various attributes of the house, and e is a white noise error term.

IV. The Data Set

The data set includes over 200,000 observations with variables describing price and attributes of all single-family, detached homes sold over the period 1979 to 1995 in Dallas County, Texas (Dallas County Appraisal District). Each observation includes information about the sale price5 of the homes and different variables which affect the sale price, including house, neighborhood and environmental quality attributes. As usual, housing quality is described by the square footage of living space, number of bathrooms, lot size, and dummy variables indicating the presence of a pool, central air conditioning, house condition and similar variables. Neighborhood quality is based upon variables such as percent below the poverty level, school quality, ethnic composition and accessibility to the Dallas-Ft. Worth airport, the Dallas central business district (CBD) and the Galleria Mall.

4 The large sample size results in very tight confidence intervals.

5 Prices were deflated using the shelter housing price index (1982-84=100) from the *Economic Report of the President.*

Environmental quality is described by proximity to the RSR lead smelter and three other sites. (Other environmental indicators, e.g., air and water quality, do not vary by location and were not included in this study). Using a Geographic Information Systems (GIS) database, Dallas County was set up as a grid of *X* and *Y* coordinates. Coordinates were assigned to each house, the airport, the CBD, the Galleria Mall, and selected hazardous waste sites. Distance could then be calculated between any two points. The GIS database was also used to link each house to its census tract (and the corresponding demographic information) and its school district. A media variable was created from a stratified random sample of issues of the *Dallas Morning News* in each year. From the newspaper issues sampled in each year, the media variable is equal to the number of newspaper articles about the RSR smelter site, weighted by inverse of the page number of the start of the article. A description of the variables used in the analysis and descriptive statistics are provided in Table 1.

The most important and publicized of the contaminated sites included in this study is the RSR lead smelter. The RSR lead smelter is located in the central portion of Dallas County, approximately six miles west of the CBD. The smelter operated from 1934 to 1984 and was purchased in 1971 by the RSR Corporation. The smelter emitted airborne lead, which contaminated the soil in the surrounding areas. Lead debris created by the smelter was used in the yards and driveways of some West Dallas residences. In 1981, the EPA found health risks, and RSR agreed to remove any contaminated soil in the neighborhoods surrounding the RSR site using standards that were considered protective of human health at the time. In 1983 and 1984, additional controls were imposed by the City of Dallas and the State of Texas. In 1984, the smelter was sold to the Murmur Corporation who shut the smelter down permanently. In 1986, a court ruled that the cleanup was complete.

In 1991, the Center for Disease Control (CDC) lowered the blood level of concern for children from thirty to ten micrograms of lead per deciliter of blood. Low-level lead exposure in childhood may cause reductions in intellectual capacity and attention span, reading and learning disabilities, hyperactivity, impaired growth, or hearing loss (Kraft and Scheberle, 1995). Also in 1991, the State of Texas found hazardous waste violations at the smelter. In 1993, the RSR smelter was placed on the Superfund National Priorities List (NPL).

Three other contaminated sites are also included in our analysis. These additional sites were selected on the basis of relative importance and proximity to active housing markets in the region. Each of these sites was listed on the EPA's Comprehensive Environmental Response, Compensation, and Liability Inventory List (CERCLIS) during the study period, and none was cleaned up or removed from CERCLIS during the study period. Information about these sites is presented in Table 2.

V. Estimation Methods and Empirical Results

The analysis covers the impact of the smelter on property values over four event-driven time periods: (1) pre-1981, when the smelter operated but health risks were not officially identified nor publicized; (2) 1981-86, when health risks from soil contamination were officially identified, cleanup was initiated and a Court ruled cleanup was completed; (3) 1987-90, after cleanup was ruled completed; and (4) 1991-95, when new concerns arose and additional cleanup occurred. Slovic *et al* (1991) provides support for the use of event-driven time periods. They write, "Social amplification [of risk] is triggered by the occurrence of an adverse event."6 Kiel and McClain (1995) also divide their data into event-driven time periods in order to analyze the effect of changes in information over time about an incinerator siting on property values.

In addition to considering division by event-driven time periods, Chow Tests were performed to evaluate whether structural changes occurred. The results indicate that almost every year is significantly different from the previous one. The exception is that the data from sales in 1993 was not significantly different from the data from sales in 1994. In addition, Wald Tests for structural change, which do not assume that the disturbance variance is the same across regressions were performed to test if the event-driven periods are the same. The results indicate that each period is significantly different. In order to partially control for the differences across years within the event-driven time periods, dummy variables are included to the indicate year of sale.

Distance Model Estimation Results: We estimated the standard distance model given by Equation 12. The estimation results are presented in Table 3. The estimated coefficients have the expected signs and are statistically significant in each period, with only a few exceptions. Our first hypothesis is that people pay a premium for distance from the RSR Smelter. This hypothesis can be rejected if the estimated coefficient for the distance variable is not significantly greater than zero. The price gradient starts out significantly positive before the EPA identification of the RSR site and during cleanup of the site, indicating that a buyer is willing to pay a premium for a location which is farther away from the RSR site. The positive sign on distance before EPA identification could be interpreted to mean that effect of the RSR site is already capitalized in property values in the 1979-1980 time

6 Slovic *et al.* (1991), p. 685.

period. However, after cleanup, this coefficient turns significantly negative. This differs from the expected sign of the distance coefficient, which is either positive or zero. There are a number of explanations for the negative sign in a straight distance model estimation.

The most compelling explanation for the negative sign on the distance coefficient after cleanup is that sphere of influence of the smelter is limited. This issue is explored with an examination of the continuity price gradient and a comparative analysis of the smelter area and a control area. Another possible explanation for the negative coefficients is that before identification, houses were sold as close as 0.17 miles from the RSR site. In the period after cleanup (1987-1990), no houses within a mile of the RSR site were sold.[7] Therefore, in the first post-cleanup period (1987-1990), the discounted houses within one mile of the smelter no longer affect the coefficient on the distance variable.

Our next hypothesis is that the coefficient on distance does not change over the different event-driven time periods. This can be tested using F-tests. This hypothesis is a crude test of the duration of stigma.[8] For example, if the coefficient on distance starts out positive, and then after remediation it is no longer positive, stigma is not permanent. Our results indicate that the coefficients on distance are significantly different in each of the four periods.

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7 The usual explanation for a lack of sales around a locally undesirable land use is that there are no buyers. However, it may also be the case that potential sellers are holding on to their properties with the hope that property values will rise in the future.

8 The reason that this is a crude test for the duration of stigma is that the price gradient for distance from the smelter will be discontinuous if the sphere of influence of the smelter dissipates rapidly with distance.

Continuity of the Price Gradient: Previous studies, such as McClelland, *et al*. (1990), have found that the impact of the waste site on property values dissipates rapidly with distance. Following Thayer, *et al*. (1992), two sets of estimations were completed to allow for discontinuity of the price gradient. First, the continuous distance variable was converted into five discrete indicator variables for distance, ranging from less than one mile to greater than four miles, in one-mile increments. These distance dummy variables were used in place of an intercept term in the hedonic regressions. The next distance models that were estimated include a linear spline function on distance, which allows for a discontinuity in the price gradient. The linear spline allows for there to be one premium for distance up to a critical point and then an adjustment to the premium after that point.

We tested the hypothesis that the effect of the smelter is constant with distance. Intuitively, we conjectured that the marginal premium paid for distance from the smelter will dissipate with distance. Using the discrete distance model, the hypothesis can be rejected if the coefficients on distance are significantly different from each other. The estimated coefficients on the discrete distance dummy variables are presented in Table 4. In each period, the intercept for houses sold within a one-mile radius of the RSR site is significantly less than the others, with the exception of the first post-cleanup period (1987-1990) when there were no sales within one mile of the RSR site.

The second set of estimations involved a linear spline function. Formally, let x_1 be the distance to the site, let x_2 be the distance at which the influence of the site diminishes, and let x_3 to x_n be the other attributes of the house. The linear spline can be represented as

(3) $$P(x) = b_0 + b_1 x_1 + b_2 d_2 \left(x_1 - x_2\right) + \sum b_i x_i \ .$$

Where $d_2 = \begin{cases} 1, & if \ \ x_1 > x_2 \\ 0, & otherwise \end{cases}.$

This model was estimated twice allowing for a discontinuity in the price gradient at both one mile and four miles.9 The estimation results with a linear spline function with critical points at one and four miles are presented for the distance coefficient, b_1, and the adjustment coefficient, b_2, in Table 5. The hypothesis that the effect of the smelter is constant with distance can be rejected if the coefficient on the adjustment variable is significantly different from zero. The coefficients on the adjustment variable are significantly different from zero in each period both for the one and four mile critical points.10

The duration of stigma in close proximity to the smelter can be tested again while allowing for a discontinuity in the price gradient. The coefficients on the distance variable are significantly different in each of the four periods. The price gradient for a distance of four miles or less starts out positive before the EPA identification of the RSR site and during cleanup of the site. After cleanup, this coefficient turns negative when the critical point is set at four miles. However, when the critical point is set at one mile from the RSR site, in the second period after cleanup (1991-1995), the coefficient on distance less than one mile from the RSR smelter is significantly positive, which indicates that

9 Recall that there were no sales with one mile of the RSR smelter in the first post-cleanup period (1987-1990).

10 The coefficient on the adjustment coefficient for the period 1991-1995 with a critical point of one mile is only significant at the ten- percent level.

there is a post-cleanup stigma within a very limited (no greater than one mile) sphere of influence.

***Control Area verses Smelter Area*:** In order to isolate causality, a comparison between the smelter area and the control area is made. Two statistical models with an indicator variable were estimated, and the estimated coefficients for the indicator variable are reported in Table 6. The first statistical models has an indicator variable which is equal to one when the distance from the smelter is less than four miles and zero otherwise. The second incorporates an indicator variable which is equal to one when the distance from the smelter is less than one mile and zero otherwise. The rest of Dallas County is an appropriate control area because housing price trends in metropolitan Dallas were not in sync with other metropolitan areas of the U.S. (Abraham and Hendershott, 1996).

The tested hypothesis is that a location in the smelter area has no effect on property values. This hypothesis can be rejected if the coefficient on the smelter area indicator variable is significantly different from zero. The coefficient on the smelter-area location variable is negative and significant in the period before EPA identification of the smelter (1979-1980) for both a one-mile and four-mile radius smelter area. This means, of course, that homeowners received a discount for a smelter location. The magnitude of the discount increased in the period in which EPA identification and cleanup of the RSR smelter occurred (1981-1986). In the first post-cleanup period, the coefficient on the smelter-area location variable becomes slightly positive for the four-mile radius smelter area. However, there were no sales within one mile of the smelter during that period. This means that the houses within one mile of the smelter are no longer affecting the smelter area coefficient, and these houses are the ones likely to be the most stigmatized. In the second post-cleanup period in which there were new concerns about the smelter area, the coefficient on the smelter-area location variable again becomes negative and significant for the four-mile radius. We note that the discount for a location within one mile of the smelter is higher than the discount for a location within four miles of the smelter in each period (about three times as high in the period 1979-1980, almost eight times as high in the period 1981-1986, and about ten times as high in the period 1991-1995).

Effect of the Media: Gayer *et al*.'s (1997) analysis of risk tradeoffs at superfund sites includes a news variable based on Superfund newspaper coverage in a regional newspaper. They find that their news variable has a negative and significant effect on property values. A media variable was also created from a random sample of two issues per month of the *Dallas Morning News* in the years 1979-1995 for a total of 408 issues sampled.11 In our analysis, newspaper coverage serves as a proxy for media coverage. We acknowledge that in recent decades television coverage as a source of news has grown in importance relative to newspaper coverage. However, we justify our use of newspaper coverage because its content tends to be correlated with television coverage. A variable representing television coverage would be extremely difficult to obtain.

As Johnson (1988) points out, the impact of the media coverage depends on how prominently it is displayed. Johnson uses column inches of coverage to account for the differing impact of articles. Gayer *et al* (1997) uses the number of words on coverage to account for different impacts. In this analysis, we constructed a media variable by weighting each article to equal one plus the inverse of the page number of the start of the article. The weighted sum of articles during a given year is the media variable for that year. The media variable for year *t* is can then be expressed as the following

11 The *Dallas Morning News* is not indexed over the entire period of the data set (1979-1995), so the data was obtained by going through microfiche. Consequently, only a random sample of issues was used to construct the media variable.

(4) $$media_t = \sum_i article_{\text{i}} \left(1 + 1/_{\text{page number}_{\text{i}}}\right)$$

where *article*$_i$ is any article about the RSR hazardous waste site found in the sample issues in year *t*, and *page number*$_i$ refers to the page number at the start of *article*$_i$. Alternative methods of weighting articles should be correlated because front-page articles tend to be longer, while shorter articles are often buried in the back of the newspaper. In the period before EPA identification of the RSR site, there was no newspaper coverage in the sample. The bulk of the coverage occurred in the period in which identification of the site and cleanup occurred (1981-1986).

In order test whether the effect of the media on property values is different in the smelter area compared to the control area, two separate regressions are estimated for each time period, and the coefficients on the media variable are compared across the two regressions. The results indicate that the estimated coefficient on the media variable in this time period was negative and significant for properties sold within four miles of the RSR site, while the estimated media coefficient was positive and significant for properties sold greater than four miles away from the site. This is exactly what one would expect to be the case if increased media coverage caused people to choose not to live in close proximity to the smelter site but stay within Dallas County. Media coverage again increased in the period of new concern after cleanup (1991-1995). The media variable coefficient was again negative and significant for properties sold within the smelter area, while it was positive but insignificant for properties sold greater than four miles from the smelter. These findings could indicate an arbitrage away from controversy.

VI. Study of Perceived Risk

In order to analyze the evolution of perceived risk and its effect on property values, we estimated a system of two equations, which includes the following hedonic price equation:

(5) $$P_{ti} = b_{11} + \sum_{k=2}^{n} b_{1k} x_{kit} + b_{1n+1} \frac{R_t}{d_i^a} + e_{1t} \; .$$

Where the scalar P_{it} is the hedonic price of the house of the i^{th} observation at time t, adjusted for inflation, $\boldsymbol{x}_{it}$ is the vector of housing attributes of the i^{th} observation at time t, R_t is the scalar, unobserved variable, perceived risk, at time t, d_i^a is distance of the i^{th} observation from the hazardous waste site raised to the power a, and e_{1t} is a random variable error term. The distance from the hazardous waste site is used to individualize risk to a particular property. This variable is always greater than zero, so there is no division by zero problem in Equation 5.

Numerous previous studies, including those already cited suggest that distance between a house and a hazardous waste site can serve as a proxy for two effects--heightened perceived risk and/or general disamenities such as odor and visual disamenities. In this analysis, we include the estimated perceived risk in the hedonic equation weighted by distance to the hazardous waste site in order to individualize the perceived risk to each particular house. However, we follow McClelland *et al* (1990) and do not include distance separately in the hedonic regression because of potential problems resulting from multicollinearity with perceived risk. The functional form of the distance weighting is allowed to be flexible in a limited way. The distance is raised to the power a, which is chosen with a grid search based on minimizing the sum of squared errors.

To complete our model, we will add an equation describing the evolution of perceived risk. As Smith and Johnson (1988) argue, a complete behavioral model of how people form risk perceptions would incorporate the importance of the events at risk; the role of prior beliefs concerning the process that generates the risk; the implications of new information about that process; and the costs of acquiring that information.12 As with Smith and Johnson (1988), our model is best interpreted as a reduced form approximation of the outcomes from such a behavioral model.

Following a modified Bayesian learning approach, we assume that people update their prior risk beliefs in response to new information. To complete our model, we add a state equation that describes the evolution of perceived risk over time. Equation 6 below describes this process:

(6) $$R_t = b_{21}R_{t-1} + b_{22}media_t + e_{2t}\,.$$

Where R_{t-1} is lagged perceived risk, media is the weighted number of newspaper articles about the RSR hazardous waste site, and e_{2t} is a random variable error term. Using generalized maximum entropy techniques allows us to avoid making any assumptions about the distributions of the two error terms, e_{1t} and e_{1t}; and specifically, they are not required to have identical distributions.

12 Smith and Johnson, (1988), p. 2.

Perceived risk is unobservable and changes over time. Current posterior beliefs about risk are a function of prior beliefs about risk and current information obtained from the media. In Equation 5, people update their perception of risk with the information they receive from the media. If the media affects the public perception of risk, then media coverage of environmental damage should be a significant factor in determining property values.

In this study the problem is, given the observable variables (price, housing attributes, the distance to the smelter, and the media variable) to estimate the unobserved variable (perceived risk) and the model parameters. As with Golan, Judge, and Karp (1996), we apply generalized maximum entropy techniques to recover unknown parameters and an unobservable state variable. Golan, Judge, and Karp (1996) offer the problem of "counting the fish in the sea." They estimate a system of equations in which the dependent variable in their observable equation is fish harvest, which is a function of fishing inputs and the unobservable fish biomass in the sea. The system is completed with a state equation that describes the evolution of the fish biomass, which like perceived risk is an unobservable variable.

In order to make this dynamic estimation problem computationally feasible, a random sample, which was limited to forty observations per year for each of the seventeen years for a total of 680 observations. Each observation includes information about the sale price13 of the homes and different variables which affect the sale price, including house attributes and proximity to the RSR lead smelter. The square footage of living space, number of bathrooms, and lot size describe housing quality.

We also tested for serial correlation with the approach proposed by Burmeister et al. (1986). The residuals from both the hedonic price equation (5) and the state equation for perceived risk (6) were regressed on their lagged values up to the seventh lag. We found that the estimated coefficients on all lagged residuals are insignificant at the five-percent level. One can thus conclude that the residuals are uncorrelated with their lagged values, and that an assumed AR(1) process describing the evolution of perceived risk is appropriate.

The Dynamic Estimation Problem of Estimating Perceived Risk.

The formulation in Golan, Judge, and Miller (1996) is used to convert the system of equations (5) and (6) to a form that is consistent with the maximum entropy principle. The system of equations in 1 and 2 is transformed so that each $\boldsymbol{b}_{1k}$ and $\boldsymbol{b}_{2k}$ is represented by proper probabilities $p_k^{b_1}$ and $p_k^{b_2}$, indexed by *m*, for *m* = 1, …, *M*. The support spaces for $p_k^{b_1}$ and $p_k^{b_2}$ are $z_k^{b_1}$ and $z_k^{b_2}$, respectively, also indexed by *m*. The $\boldsymbol{b}_{ik}$ coefficients (*i* = 1, 2) can be expressed as

(7) $$\boldsymbol{b}_{ik} = \sum_m p_{mk}^{\beta_i} z_{mk}^{\beta_i}, \text{ for } k = 1, 2, \ldots, t_{\mathrm{i}} \; (i = 1, 2)$$

The matrix $\boldsymbol{b}_i$ (*i* = 1, 2) can then be written as

13 Prices are deflated using the shelter housing price index (1982-84=100) from the *Economic Report of the President*.

(8)
$$b_i = \mathbf{Z}^{\beta_i}\mathbf{p}^{\beta_i} = \begin{bmatrix} \mathbf{z}_1^{\beta_i\prime} & \mathbf{0} & \cdot & \mathbf{0} \\ \mathbf{0} & \mathbf{z}_2^{\beta_i\prime} & \cdot & \mathbf{0} \\ \cdot & \cdot & \cdot & \cdot \\ \mathbf{0} & \mathbf{0} & \cdot & \mathbf{z}_k^{\beta_i\prime} \end{bmatrix} \begin{bmatrix} \mathbf{p}_1^{\beta_i} \\ \mathbf{p}_2^{\beta_i} \\ \cdot \\ \mathbf{p}_K^{\beta_i} \end{bmatrix}.$$

Here, $\mathbf{Z}^{\beta_i}$ is a (K x KM) matrix, and $\mathbf{p}^{\beta_i} >> \mathbf{0}$ is a KM-dimensional vector of weights. Similarly, e_{it} (i = 1, 2) is represented by the discrete probabilities $w_t^{\varepsilon_i}$,(i = 1, 2) indexed by j, for j = 1 ,…, J. The support space for $w_t^{\varepsilon_i}$ is $v_t^{\varepsilon_i}$. The random variable error terms can then be expressed as

(9)
$$\varepsilon_{it} = \sum_j w_{tj}^{\varepsilon_1} v_{tj}^{\varepsilon_1}$$

The two sets of T unknown disturbances may be written in matrix form as

(10)
$$\varepsilon_i = \mathbf{V}^{\varepsilon_i}\mathbf{w}^{\varepsilon_i} = \begin{bmatrix} \mathbf{v}_1^{\varepsilon_i\prime} & \mathbf{0} & \cdot & \mathbf{0} \\ \mathbf{0} & \mathbf{v}_2^{\varepsilon_i\prime} & \cdot & \mathbf{0} \\ \cdot & \cdot & \cdot & \cdot \\ \mathbf{0} & \mathbf{0} & \cdot & \mathbf{v}_T^{\varepsilon_i\prime} \end{bmatrix} \begin{bmatrix} \mathbf{w}_1^{\varepsilon_i} \\ \mathbf{w}_2^{\varepsilon_i} \\ \cdot \\ \mathbf{w}_T^{\varepsilon_i} \end{bmatrix}$$

where $\mathbf{V}^{\varepsilon_i}$ is a (T x TJ) matrices, and $\mathbf{w}^{\varepsilon_i}$ is a TJ-dimensional vector of weights.

The support spaces for the coefficients on the explanatory variables are chosen so that they contain all reasonable possible parameter values and are symmetric around zero. By making these supports symmetric around zero, one is assuming that there is no prior information about these coefficients.

The support space range needs to be large enough so that the optimization problem is feasible given the other parameters. In this estimation, the support spaces, $z_k^{b_1}$ and $z_k^{b_2}$, have three points (M = 3) and are an equal distance from each other. Specifically, $z_k^{b_i}{}' = (-100, \; 0, \; 100)$, ($i$ = 1, 2). To calculate the width of the error support space, v_i, a three-standard-deviations rule around zero is used. The error supports range from -3σ_y to 3σ_y, where σ_y is the standard deviation of the dependent variable. In this estimation, the support spaces, $v_t^{e_1}$ and $v_t^{e_2}$, have three points (J = 3) and are symmetric around zero. For example, $v_t^{e_1}{}'$=(-3σ_y, 0, 3σ_y). Finally, in order to simplify the statement of the GME optimization problem, the independent variable R_t/d is defined as x_{n+1t}.

The entropy estimation then solves the following optimization problem with a state equation restriction:

(11)
$$\max_{\mathbf{p},\mathbf{w},R_t} H(\boldsymbol{p},\boldsymbol{w}) = \{-\boldsymbol{p}'\ln\boldsymbol{p} - \boldsymbol{w}'\ln\boldsymbol{w}\}$$

subject to

$$P_t = \boldsymbol{x}_t'\boldsymbol{z}^{b_1\prime}\boldsymbol{p}^{b_1} + v_t^{e_1\prime} w_t^{e_1} \qquad for \quad t = 1,\ldots,T$$

$$\begin{cases} R_t = 1 & for \quad t = 1 \\ R_t = z^{b_{21}} p^{b_{21}} R_{t-1} + z^{b_{22}\prime} p^{b_{22}} media_t + v_t^{e_2\prime} w_t^{e_2} & for \quad t = 2,3,\ldots T \end{cases}$$

$$\mathbf{1}_K = (\boldsymbol{I_K} \otimes \mathbf{1}_M')\boldsymbol{p}$$

$$\mathbf{1}_T = (\boldsymbol{I_T} \otimes \mathbf{1}_J')\boldsymbol{w}$$

$$x_{n+1t} = {R_t}/{d}$$

Under this framework, the unobserved perceived risk variables and the unknown model parameters are simultaneously recovered.

Results of Perceived Risk Estimation

The GME estimation results of Equations 5 and 6 are presented in Table 7. All of the explanatory variables in the hedonic price equation (Equation 5) have the expected relationship with housing price and are statistically significant at the five-percent level. The variable of the most interest for this study, perceived risk weighted by distance, has the expected negative relationship with housing price. The explanatory variables in the state equation describing the evolution of perceived risk (Equation 6) also have the expected relationship with perceived risk and are statistically significant at the five-percent level. The coefficient on lagged perceived risk is positive and less than one, which means that perceived risk is a stationary time series process. Finally, the media coefficient is positive, which means that, as hypothesized, media coverage increases perceived risk.

Specification of the model was evaluated by following Mittelhammer and Cardell (1997) and analyzing the marginal values of the data constraints in the dynamic estimation problem. The values of LaGrange multipliers on the data constraints are non-zero, which means that the data constraints are binding. The implications are similar to rejecting an F-test to test whether the coefficients are jointly zero.

The estimates of the unobserved variable perceived risk are shown below in Figure 2. Initial perceived risk is normalized to one. In the period before EPA identification of the RSR site, there was no newspaper coverage in the sample. The intense media coverage that coincided with the identification and remediation of the RSR smelter site (1981-1986) increased perceived risk, which then decayed over time. There was a dip in perceived risk in 1985, which coincides with a lull in media coverage. In 1985, remediation had been progressing normally for a few years, and the RSR smelter was no longer fresh news. In 1986, when a court ruled that the cleanup was complete, the newspaper coverage and estimated perceived risk increased. After 1987, the estimated perceived risk falls and remains relatively low. This is despite a 1991 CDC announcement about concern over lower levels of lead in the blood and additional concerns about the safety of the site. One possible explanation that before identification, houses were sold as close as 0.17 miles from the RSR site. In the period after cleanup (1987-1990), no houses within a mile of the RSR site were sold. Therefore, in the years 1987-1990, the houses within one mile of the smelter, which are the most affected by the smelter, no longer affect estimated perceived risk.

Finally, in order to evaluate whether perceived risk changes over time, we tested whether the coefficient of the lagged risk is equal to one and whether the media coefficient is equal to zero. The generalized maximum entropy estimated coefficient less the hypothesized value divided by the standard error of the coefficient is asymptotically distributed as a t-distribution (Mittelhammer and Cardell, 1997). The hypotheses that the lagged perceived risk coefficient is equal to one and that the media coefficient is equal to zero can both be rejected at the five percent level. We conclude that perceived risk does evolve over time and is affected by media coverage.

VIII. Conclusions

In our empirical analysis, we analyzed whether a stigma equilibrium or a recovery equilibrium emerged for the residential properties in close proximity to the RSR hazardous waste site in Dallas, Texas. We tested several hypotheses regarding the existence and duration of stigma in order to determine which equilibrium emerged in the residential area surrounding the RSR hazardous waste site by estimating a hedonic price model over time using data from individual housing sales prices in Dallas County, Texas.

Our empirical evidence shows that permanent stigma exists in a very limited area. The sphere of influence of the smelter is no larger than a circle around the smelter with a one-mile radius. In the years directly following cleanup (1987-1990), no properties were sold within one mile of the RSR site. In subsequent years (1991-1995), properties within one-mile were sold, but at significantly lower prices than properties located farther away from the smelter. We also found that media coverage of the environmental damage caused by the hazardous waste site has a significant effect on property values in close proximity to the site.

In our study of perceived risk, we applied generalized maximum entropy techniques to estimate the unknown parameters from the statistical model and an unobservable state variable, perceived risk, given observable variables (price, housing attributes, distance to the hazardous waste site, and a media coverage variable). Our results indicate that media coverage and high prior risk perceptions increase perceived risk. Increased perceived risk surrounding the site, in turn, lowers property value.

In terms of efficient public policy, our findings that increased risk perceptions affect property values, which are a real loss, could be used to argue that the EPA should consider risk perceptions in their cost-benefit analysis for purposes of resource allocation for remediation of contaminated sites. Ignoring perceived risk, scientists at the United States Environmental Protection Agency (EPA) currently use dose-response relationships to calculate risk in their decisions about how to allocate resources for remediation of environmental contamination. Consequently, the real effect of hazardous waste sites on property values has been neglected in cost-benefit analyses. Based on our findings, incorporating losses in property values in the analyses could yield a different conclusion about the effectiveness of remedial actions.

Finally, McClelland et al (1990) have argued that there may be a policy role for government in mitigating losses from the overestimation of risk in the area of environmental contamination. Our findings that risk perceptions evolve over time and are affected by new information supports the argument that the government could take a more active role in risk communication. However, more research is needed in the area of risk communication. Lopes (1992) writes, "[A]lthough risk experts understand that they cannot impose their views on people in a democratic society, they do tend to define their problem as one of developing techniques for communicating correct assessments to an inexpert public."14

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14 Lopes (1992), p. 67.

Table 1. Variable Definitions and Descriptive Statistics

Variable	Description	Mean	Std. Dev.
Price	Sales price of the home	104921	98168
Dprice	Deflated sales price of the home	86010	78940
Landarea	Lot size in square feet	9301.87	3969.60
Livarea	Living area in square feet	1797.43	755
Dalcbd	Miles to the Dallas central business district	10.90	3.92
Dfwair	Miles to Dallas/Fort Worth Airport	17.97	6.15
Galleria	Miles to the Galleria shopping center	10.89	5.76
Distsrs	Miles to the RSR facility	11.73	4.22
Age	Age of the house in years	19.97	16.18
Pool	1 if pool, 0 otherwise	0.14	0.34
Garg	1 if attached garage, 0 otherwise	0.87	0.33
Baths	Number of bathrooms	2.03	0.74
Pblack	% of the census track that are African Amer.	11.05	16.98
Phisp	% of the census track that are Hispanic	11.55	13.05
Pbpov	% of the census track below the poverty line	7.68	7.20
Heatcf	1 if central heat, 0 otherwise	0.88	0.32
Accf	1 if central ac, 0 otherwise	0.87	0.33
Good	1 if good condition, 0 otherwise	0.30	0.46
Average	1 if average condition, 0 otherwise	0.68	0.47
Site2	Miles to Site2	13.71	5.36
Site3	Miles to Site3	15.93	69.20
Site4	Miles to Site 4	11.49	5.08
Media	Weighted number of articles in the *Dallas Morning News* about the RSR site	0.60	1.22
	School Districts		
CF	1 if Carrollton/Farmers Branch, 0 otherwise	0.07	0.26
Dallas	1 if Dallas school district, 0 otherwise	0.32	0.47
Cedar Hill	1 if Cedar Hill, 0 otherwise	0.01	0.11
Garland	1 if Garland, 0 otherwise	0.14	0.35
HP	1 if Highland Park, 0 otherwise	0.02	.015
Irving	1 if Irving, 0 otherwise	0.06	0.23
LWH	1 if Lancaster/Wilmer Hutchins, 0 otherwise	0.01	0.11
No district	1 if no district, 0 otherwise	0.07	0.26
MS	1 if Mesquite/Sunnyvale, 0 otherwise	0.04	.021
Coppell	1 if Coppell, 0 otherwise	0.02	0.15
GP	1 if Grand Prairie, 0 otherwise	0.04	0.19
Richardson	1 if Richardson, 0 otherwise	0.13	0.34
Desoto	1 if Desoto, 0 otherwise	0.02	0.15
Duncan	1 if Duncanville, 0 otherwise	0.03	0.18

Table 2. Contaminated Sites Included in the hedonic price analysis

Site	Type of Contamination	Year Listed on CERCLIS	Status
Site1: RSR Smelter	Soil	1981	Court ordered cleanup in 1983
Site2: Superior Site	Ground water	1981	Not contained
Site3: Dallas Naval Weapons Site	Ground water, soil, surface water	1984	Not contained
Site4: Crews Plating Site	Soil	1994	Not contained

Table 3. Distance Model Hedonic Estimation Results

Variable	1979-1980	1981-1986	1987-1990	1991-1995
yr79	9.815 (220.69)	--	--	--
yr80	9.817 (220.76)	--	--	--
yr81	--	9.900 (453.87)	--	--
yr82	--	9.916 (453.35)	--	--
yr83	--	9.966 (457.08)	--	--
yr84	--	9.998 (458.14)	--	--
yr85	--	10.012 (458.25)	--	--
yr86	--	9.961 (455.40)	--	--
yr87	--	--	9.764 (395.14)	--
yr88	--	--	9.653 (390.15)	--
yr89	--	--	9.585 (386.88)	--
yr90	--	--	9.522 (384.40)	--
yr91	--	--	--	8.886 (398.96)
yr92	--	--	--	8.837 (396.70)
yr93	--	--	--	8.816 (395.52)
yr94	--	--	--	8.817 (395.20)
yr95	--	--	--	8.847 (395.40)

Table 3. Distance Model Hedonic Estimation Results (continued)

Variable	1979-1980	1981-1986	1987-1990	1991-1995
Livarea	4.19E-4	4.17E-4	4.07E-4	3.89E-4
	(92.41)	(174.32)	(153.60)	(151.38)
Baths	0.100	0.074	0.069	0.080
	(24.39)	(32.60)	(26.87)	(30.53)
Pool	0.061	0.084	0.104	0.083
	(10.42)	(29.20)	(32.40)	(24.63)
Landarea	2.61E-6	4.32E-6	6.53E-6	8.16E-6
	(5.23)	(16.94)	(19.26)	(29.01)
Garage	0.081	0.083	0.087	0.129
	(19.27)	(31.50)	(24.59)	(37.87)
Central Air	0.091	0.109	0.126	0.185
	(13.30)	(24.99)	(20.69)	32.94)
Heat	0.110	0.087	0.112	0.169
	(15.68)	(19.27)	(17.61)	(28.68)
Good	0.233	0.299	0.455	0.645
	(17.39)	(36.75)	(45.01)	(82.35)
Average	0.166	0.177	0.297	0.441
	(13.17)	(22.35)	(29.87)	(57.81)
Galleria	0.005	0.005	0.001	0.010
	(2.07)	(3.97)	(0.87)	(6.58)
CBD	-0.084	-0.092	-0.043	-0.089
	(-20.54)	(-37.90)	(-14.23)	(-30.30)
DFWAIR	0.015	-0.002	-0.003	0.013
	(4.68)	(-1.54)	(-1.86)	(8.77)
Poverty	-0.008	-0.004	-0.003	-0.005
	(-14.16)	(-14.04)	(-10.01)	(-21.75)
Black	-0.003	-0.003	-0.004	-0.006
	(-17.99)	(-34.67)	(-36.98)	(-56.88)
Hispanic	-0.005	-0.005	-0.007	-0.005
	(-15.16)	(-30.22)	(-40.35)	(-41.57)
Site2	0.043	0.044	0.039	0.06
	(27.85)	(44.54)	(33.88)	(58.36)
Site3	-0.005	0.012	0.034	0.023
	(-1.43)	(6.83)	(18.91)	(13.12)
Site4	-0.021	-0.008	0.011	-0.010
	(-5.95)	(-4.52)	(4.96)	(-4.86)
Distance	0.053	0.033	-0.052	-0.011
	(8.86)	(9.97)	(-13.66)	(-3.08)

Table 3. Distance Model Hedonic Estimation Results (continued)

Variable	1979-1980	1981-1986	1987-1990	1991-1995
School Districts				
Carrollton/	-0.122	-0.111	-0.098	-0.073
Farmers Branch	(-4.09)	(-15.67)	(-16.16)	(-11.58)
Dallas	-0.103	-0.011	-0.017	-0.025
	(-3.45)	(-1.41)	(-2.28)	(-3.27)
Cedar Hill	-0.174	0.078	0.043	0.052
	(-5.23)	(5.89)	(3.64)	(4.73)
Garland	-0.205	-0.096	-0.145	-0.154
	(-6.81)	(-12.32)	(-20.34)	(-22.52)
Highland Park	0.240	0.432	0.301	0.345
	(7.42)	(42.02)	(29.68)	(32.63)
Irving	-0.062	-0.004	-0.080	-0.003
	(-2.06)	(-0.41)	(-8.51)	(-0.30)
Lancaster/	-0.056	0.082	0.036	0.021
Wilmer Hutchins	(-1.76)	(6.84)	(2.86)	(1.82)
Mesquite/	-0.121	-0.008	-0.048	0.013
Sunnyvale	(-3.97)	(-0.97)	(-5.62)	(1.56)
Coppell	-0.095	-0.060	-0.028	0.056
	(-2.56)	(-4.72)	(-2.44)	(5.13)
Grand Prairie	-0.073	0.005	0.017	-0.033
	(-2.28)	(0.40)	(1.41)	(-2.97)
Richardson	-0.117	-0.076	-0.072	-0.078
	(-3.99)	(-10.62)	(-11.16)	(-11.76)
Desoto	-0.025	0.161	0.057	0.110
	(0.80)	(14.89)	(5.50)	(10.99)
Duncanville	-0.051	0.084	0.008	-0.010
	(-1.67)	(8.00)	(0.80)	(-1.07)

Table 4. Estimated Coefficients on Dummy Distance Variables from Discrete Distance Model

Distance from RSR	1979-1980	1981-1986	1987-1990	1991-1995
Less than 1 mile	9.365 (98.12)	8.806 (67.49)	N/A	8.560 (44.42)
Between 1 and 2 miles	9.899 (178.74)	9.957 (366.12)	9.630 (301.20)	9.082 (305.75)
Between 2 and 3 miles	9.667 (198.25)	9.820 (395.49)	9.492 (321.82)	8.817 (325.08)
Between 3 and 4 miles	9.766 (204.77)	9.885 (410.63)	9.539 (355.86)	8.847 (336.01)
Greater than 4 miles	9.842 (214.81)	9.986 (442.75)	9.508 (370.12)	8.893 (379.29)

Table 5. Hedonic Estimation Results with Linear Spline Function

Variable	1979-1980	1981-1986	1987-1990	1991-1995
Discontinuity at four miles				
Distance1	0.073	0.065	-0.025	-0.019
	(9.22)	(14.62)	(-4.52)	(-3.61)
adjustment	-0.043	-0.064	-0.048	0.014
	(-3.91)	(-10.75)	(-6.51)	(2.05)
Discontinuity at one mile				
Distance1	0.528	8.329	N/A	2.746
	(2.22)	(8.05)		(1.79)
adjustment	0.477	-8.298	N/A	-2.757
	(-2.00)	(-8.01)		(-1.79)

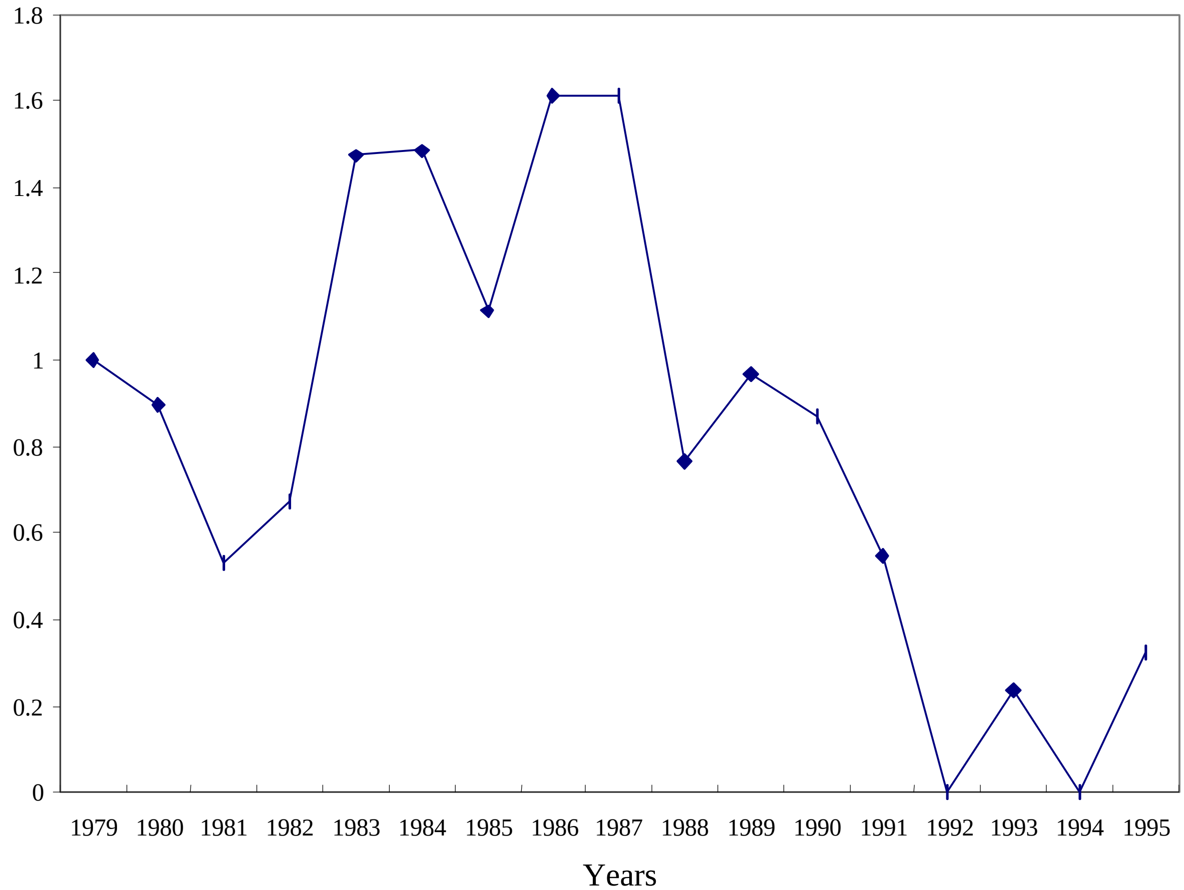
Table 6. Hedonic Estimation Results, Dummy Variable for Smelter Area Model

Variable	1979-1980	1981-1986	1987-1990	1991-1995
Four-mile radius				
Smelter Area	-0.142	-0.145	0.033	-0.029
	(-14.65)	(-23.95)	(4.07)	(-3.75)
One-mile radius				
Smelter Area	-0.438	-1.06	N/A	-0.291
	(-5.07)	(-7.91)		(-1.48)

Table 7. Perceived Risk, Generalized Maximum Entropy Results

Variable	Estimated Coefficients	Standard Errors
Intercept	9.231	0.017
Living Area	5.609E-4	1.02E-5
Bathrooms	0.052	0.0107
Land Area	2.751E-5	1.68E-6
Weighted Risk	-0.787	0.0316
Lagged Risk	0.785	0.105
Media	0.053	0.0244

Figure 1: Estimated Perceived Risk



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Undesirable Facilities and Non-Host Community Effects

--Working Paper*--

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Undesirable Facilities and Non-Host Community Effects

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ABSTRACT

Solely focusing on the host community may seriously underestimate the full costs associated with the siting of an undesirable facility. This analysis demonstrates that non-host community house values are adversely affected by undesirable facilities located in neighboring towns.

INTRODUCTION

The two most common techniques for measuring the effects of an undesirable facility on house prices are to restrict attention to one political jurisdiction or to use a distance-from-site measurement. The first technique, usually justified on the grounds that host communities receive preferential treatment, implicitly assumes that the impacted area is bounded by a political jurisdiction, regardless of the nature of the facility or its location in the community relative to other communities. The second technique assumes that the existence of political boundaries has no effect on the impact area, even though some communities may be receiving benefits while others are not. Stoffle, Stone, and Heeringa [1993] have found that such *a priori* definitions of boundaries are inaccurate in social impact assessments and may ignore important impacts and result in ongoing disputes with omitted communities.

Although neighboring non-host communities typically do not receive the same preferential treatment or compensation as a host community, their house values may be similarly affected. The residents of Conklin, NY, only one mile from a proposed county-wide incinerator in Kirkwood, NY, were offered no compensation. However, neither environmental externalities, undesirable effects, and their associated costs are likely restricted by political boundaries. Solely focusing on the host community may seriously underestimate the full costs associated with the siting. If the facility is viewed as a disamenity whose negative effects are directly related to the distance between the site and the house, then prices in nearby real estate markets should fall regardless of their political jurisdiction. Conversely, if a facility primarily impacts the host community, spillover demand from residents moving away from the facility may increase house prices in neighboring communities.

Citizens are beginning to challenge the siting of facilities in neighboring communities. Residents of Hingham, MA protested the construction of a hazardous waste incinerator proposed for

East Braintree, MA, a community five miles away (Nealon [1989]). Residents are being urged to view the burning of 45,000 tons of toxins a year five miles away as a regional rather than local problem.

Many studies analyzing the effect of a hazardous or undesirable facility on nearby house values use the hedonic regression technique, where the value of a house is determined by its characteristics, including proximity to neighborhood amenities or disamenities. Gamble and Downing [1982], Kohlhase [1991], and Mendelsohn *et al.* [1992] detected positive, significant relationships between distance and house values. Kiel and McClain [1995] demonstrated that changes in the price levels vary across stages of the siting process.

These studies considered only the distance between the site and house and did not explicitly determine the extent of the impact area or whether houses from different communities were equally affected. Using case studies but little statistical analysis, Edmonds *et al.* [1994] found that proximity to the boundary between political jurisdictions affects property values. Differences in tax codes, liquor laws, or school districts lowered the value of properties close to a boundary line but not properties further away. Pollakowski and Wachter [1990] detected a spillover effect due to zoning restrictions from one community to another. The stricter the zoning requirements in surrounding communities, the higher house prices in the community in question. Thus actions taken by communities, especially which directly impact amenities, can influence house prices in neighboring communities. The existence or siting of a disamenity in one town could affect the real estate market in another.

BACKGROUND AND METHODOLOGY

Kiel and McClain [1995] measured the impact of an undesirable facility over the entire siting and life of a disamenity by dividing the siting process into five stages according to the level of risk as perceived by neighbors. The five stages are pre-rumor, rumor, construction, on-line, and ongoing operation. This methodology more completely measures the cost associated with a siting than methods which use only one or two points in time. They found some evidence of a drop in house values during the rumor stage and strong evidence of price declines in the groundbreaking, online, and operations stages of a waste-to-energy incinerator in North Andover, Massachusetts. The magnitude of the price responses did depend on the distance between a house and the incinerator. Only houses in North Andover were considered.

The North Andover incinerator, however, is a regional facility accepting trash from 22 nearby communities. Each member community guarantees a minimum quantity of waste, receives a fixed disposal fee (subject to inflation), and shares the revenues from the electricity generation. The host community, North Andover, receives no property taxes from the site but does receive a per ton discount on its disposal fees. The facility is located in the extreme northern corner of the town, closer to parts of Methuen, Andover, Haverill, and Lawrence than many residential parts of North Andover.[1] Refuse trucks travel through many of the surrounding communities enroute to the facility.

This study analyzes 7,120 house sales from Methuen and Andover, two towns which border North Andover and are similar socio-economically (see Table 1). The data was collected from the local Tax Assessor's offices. In addition to structural information, straight-line distances from each house to the North Andover incinerator, the Methuen and Andover central business districts, and the entrance ramps to Interstates 495 and 93 were calculated. A dummy variable was added for houses in Methuen located close to a high-crime area in nearby Lawrence, MA. Variable definitions are found in Table 2. Each town has a single school district and is relatively similar in size, population,

1 Map available from author.

race, and taxes. Prices are adjusted to control for the regional trend in sales prices over the period. The dependent variable is the natural log of the sales price in current dollars divided by an index based on the median sales price of existing single-family homes in the Boston MSA (current dollars; from the National Board of Realtors monthly series *Home Sales,* and Karl Case, private communication).

House values are typically modeled (in discrete form) as the sum, over the life of the house, of discounted rents (Phillips [1988]). If a local facility is perceived as a negative externality, rents fall when the plant goes on-line, and the value of the house falls. Assuming that the timing of the fall in rents is perfectly forecasted, the extent and the timing of the drop in values depends on the decline in rents and on discount rates. The impact of the incinerator over time can be estimated either with a separate regression for each of the five stages or over the entire sample with interaction terms of distance and time period to measure the changing impact of the incinerator. Previous results (Kiel and McClain [1995, 1996]) support the use of separate regressions for each phase. The data can also be pooled across communities, but separate regressions for each community allows the marginal impacts of house characteristics and distance to vary across communities.

RESULTS AND CONCLUSIONS

The general model is

$$\ln(PRICE/BI\ )_i = b_0 + b_1 X_{1i} + b_2 X_{2i} + b_3 LnDIST_i + e_i 0$$

where i indexes the house, $X_1 0$ is a vector of structural characteristics, and $X_2 0$ a vector of neighborhood characteristics. Using natural log of distance from the incinerator allows the effect of the incinerator to decrease at a decreasing rate, yet increasing distance is always advantageous. A quadratic function of the distance from the house to the central business district was chosen because living close to downtown means congestion and heavy traffic, but living far away is inconvenient. The distance from each house to two major interstate highways were highly collinear with each other and the North Andover incinerator. Including instead the minimum distance from a house to any highway alleviated the collinearity problem but was nearly always insignificant and added little explanatory power.

In Methuen, the structural characteristics are generally significant with the expected signs over all time periods (Table 3). Residents prefer to live away from the central business district in all but the rumor phase, but living near the border of Lawrence's high crime area does not impact house values. The coefficient on LnNANDINC, which measures the impact of the North Andover incinerator on house prices, is not significant for any of the phases. Residents of Methuen apparently did not consider an incinerator close to their houses a negative externality. Methuen residents also appear indifferent to a Haverill incinerator. Restricting attention to only those houses in Methuen within two miles of the incinerator also detected no impact from the incinerator on house prices.[2]

Only the construction, online, and ongoing phases could be estimated for Andover because of data availability. The structural characteristics are generally significant with the expected sign, but residents of Andover prefer to live closer to the downtown. They are concerned with the neighboring North Andover incinerator. The coefficient on distance is positive and significant for all three time periods, although most houses in Andover are further from the incinerator than most houses in Methuen. Two factors may explain this seemingly unintuitive result. First, Andover is a slightly more

2 Statistical results available from author.

affluent town with higher education levels, per capita incomes, and median house values. Higher priced houses are commonly considered more sensitive to negative externalities, and higher income and better educated homeowners more adverse to environmental hazards (Zabel and Kiel [1995]). Second, Andover is one of the 22 member communities while Methuen is not. More public awareness was generated in Andover as town meetings were held to discuss the project and Andover's participation. Residents were better informed on the nature of the incinerator, the expected location and traffic, and its environmental hazards. The real estate market appears to have responded to this increased knowledge by discounting house prices. The persistence of a premium through the ongoing operations phase indicates that Andover residents view the facility as a permanent disamenity.3

The marginal impact of distance on the value of an average house in Andover can be calculated. The premium in Andover is $2884 per mile during construction, $3383 during online, and $4109 during ongoing operations. The corresponding premiums for North Andover were $2283, $8100, and $6607 (Kiel and McClain [1995], p. 250). The premiums were roughly similar during the construction phase, before evidence has accumulated on the incinerator's impact on residential life of the two towns. After the incinerator went online, residents of North Andover perceived the impacts more negatively than the residents of Andover.

CONCLUSIONS

These results confirm that non-host communities are affected by undesirable facilities located in neighboring towns. The town of Andover, a participant in the siting process and beneficiary of the energy revenues, placed a premium on houses located further from the incinerator site. House prices

3 An F-test rejects the pooled phase model, although the results are very similar. Methuen is unaffected by the incinerator

in the closer town of Methuen remained unaffected by the facility, although at no time was Methuen a member of the incinerator consortium, and its residents were probably less aware of specific siting issues and more removed from the siting process. While geographically closer to the facility, the reduced flow of information to Methuen residents and their emotional detachment appears to be reflected in the local real estate market. Although the flow of environmental toxins are unimpeded by the presence of political boundaries, this feature may place less of a role in the housing market than the flow of information and thus perceptions.

The results of this analysis add to the evidence that the costs associated with an unwanted facility are far more complex and varied than previously perceived. Not only are the costs more prolonged, but they reach out to encompass neighboring communities in addition to the host community. The results also show that while neighboring communities are impacted by an undesirable facility, the host community bears a larger, uneven burden when selected as the site of an undesirable regional facility.

Siting unwanted facilities may become more difficult and expensive if neighboring nonhost communities increase their participation in siting processes, viewing a siting as a regional rather than local event. Owners and operators of these facilities may be forced to extend compensation to the non-host communities as well as the host communities, raising their costs. In addition, they will have to contend with a broader and more diverse residential population, making the siting process more difficult.

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while Andover residents prefer to live further from the f~i1ity. The F-statistic for Methuen is 5.25 and for Andover is 3.35.

TABLE 1
Community Census Data

	Andover	Methuen	N. Andover
Population	29,151	39,990	22,792
Percent White	95%	95%	97%
Land Area	32.13	23.09	27.85
Per Capita Income 1989	$26,327	$15,598	$22,957
Average Teacher Salary 1993	$39,117	$41,762	$38,797
Per Pupil Expenditure 1993	$4,574	$3,939	$4,159
Residential Tax Rate 1994	15.14	15.27	11.35
Median Value Single Family Home, 1990 Census	$254,800	$151,300	$231,300

Data from Massachusetts Municipal Profiles: 1994-95, Information Publications, Palo Alto, CA.

Table 2
Variable Descriptions

Name	Description
SALES PRICE	Nominal transaction price of house
BOSTON INDEX	Nominal transaction price of existing single family homes for the Boston MSA in hundreds of dollars
PBI	House sales price divided by Boston house price index
AGE	Age of house in years
AREA	Living area in square feet
BATH	Number of bathrooms
BED	Number of bedrooms (Methuen only)
ROOM	Number of rooms (Andover only)
LAND	Lot size in square feet
NANDINC	Distance from house to N. Andover incinerator in feet
HAVINC	Distance from house to Haverill incinerator in feet
METCBD	Distance from house to Methuen's central business district in feet
ANDCBD	Distance from house to Andover's central business district in feet
CRIME	Dummy variable for houses close to Lawrence's high crime area (affects houses in Methuen only)

TABLE 3
Dependent Variable: Ln(PBI)

	METHUEN				ANDOVER		
	Rumor 1979-1980	Construction 1981-1984	Online 1985-1988	Ongoing 1989-1992	Construction 1981-1984	Online 1985-1988	Ongoing 1989-1992
CONST	4.217*	3.992*	4.421*	3.979*	2.676*	3.220*	2.939*
	(0.414)	(0.238)	(0.175)	(0.195)	(0.483)	(0.458)	(0.418)
AGE	-0.965E-02*	-0.671E-02*	-0.497E-02*	-0.479E-02*	-0.703E-02*	-0.493E-02*	-0.415E-02*
	((0.126E-02)	(0.668E-03)	(0.435E-03)	(0.701E-03)	(0.590E-03)	(0.567E-03)	(0.527E-03)
AGESQ	0.519E-04*	0.236E-04*	0.147E-04*	0.179E-04*	0.315E-04*	0.185E-04*	0.133E-04*
	(0.125E-04)	(0.505E-05)	(0.251E-05)	(0.614E-05)	(0.332E-05)	(0.309E-05)	(0.237E-05)
AREA	0.118E-03*	0.172E-03*	0.123E-03*	0.102E-03*	0.128E-03*	0.134E-03*	0.156E-03*
	(0.292E-04)	(0.211E-04)	(0.166E-04)	(0.181E-04	(0.145E-04)	(0.119E-04)	(0.126E-04)
BATH	0.056	0.034	0.115*	0.050*	0.129*	0.091*	0.083*
	(0.030)	(0.021)	(0.016)	(0.019)	(0.016)	(0.015)	(0.014)
LAND	0.108E-05	0.147E-05*	0.253E-05*	0.308E-06	0.145E-06	0.309E-06	0.615E-06*
	(0.575E-06)	(0.364E-06)	(0.512E-06)	(0.327E-06)	(0.422E-06)	(0.387E-06)	(0.306E-06)
BED	0.392E-02	0.043*	0.970E-02	0.041*			
	(0.019)	(0.015)	(0.011)	(0.013)			
ROOMS					0.035*	0.047*	0.049*
					(0.801E-02)	(0.773E-02)	(0.746E-02)
METCBD	0.120E-04	0.172E-04*	0.134E-04*	0.200E-04*			
	(0.107E-04)	(0.854E-05)	(0.597E-05)	(0.740E-05)			
METCBDSQ	-0.989E-09	-0.815E-09*	-0.922E-09*	-0.103E-08*			
	(0.515E-09)	(0.411E-09)	(0.275E-09)	(0.336E-09)			
ANDCBD					-0.228E-04*	-0.133E-04*	-0.194E-04*
					(0.435E-05)	(0.426E-05)	(0.399E-05)
ANDCBDSQ					0.491E-09*	0.322E-09*	0.411E-09*
					(0.117E-09)	(0.118E-09)	(0.114E-09)
LnNANDINC	-0.016	0.655E-02	0.012	0.023	0.162*	0.100*	0.120*
	(0.063)	(0.027)	(0.021)	(0.025)	(0.048)	(0.045)	(0.041)
LnHAVINC	0.013	-0.672	-0.045	-0.021			
	(0.087)	(0.033)	(0.025)	(0.029)			
CRIME	-0.057	-0.037	-0.028	-0.026			
	(0.033)	(0.024)	(0.019)	(0.023)			
Sample Size	347	509	1090	1141	1407	1378	1248
Adj R	0.34	0.48	0.42	0.27	0.488	0.537	0.542
LLF	14.19	115.77	130.05	-70.20	-182.80	-120.25	-38.301

*Significant at *5%.*

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Undesirable Facilities, Neighborhood Dynamics and Environmental Equity

--Working Paper*--

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"Undesirable Facilities, Neighborhood Dynamics and Environmental Equity"

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I. INTRODUCTION

The question this paper addresses is whether neighborhoods exposed to negative externalities such as an incinerator change differently from those neighborhoods which are not exposed, and if so, in what ways do they change? This question is relevant in the framework of environmental equity issues. In many cases, it has been found that locally unwanted land uses (LULUs) are sited near minority and/or poorer populations. This may be due to racism, or to the fact that property values are lower in those areas. We know that LULUs themselves lower property values (e.g. Kohlhase 1991, Kiel and McClain 1995, Kiel 1995). The question then becomes a ‘chicken or egg’ issue: are the sites there because property values were lower, or have poorer individuals moved near the site due to the lower property values? By looking at the demographics of neighborhoods over time, whether these communities change differently from more distant communities can be tested.

A possible explanation for a community’s adjustment to sources of pollution can begin when the community becomes aware of the hazards. Either a new facility can be introduced to the area, or a previously known site can be newly classified as hazardous, such as a Superfund site. Once the site is revealed as undesirable, residents who are more sensitive to the undesirable aspects of the facility will move away, possibly selling their houses at a discount if potential buyers share their concerns about the facility but are willing to buy at a lower price. As house prices fall, a lower income group may begin to dominate the area, less able to expend income on the upkeep of their properties. House values may fall again if the neighborhood deteriorates, and residential per capita income may continue to drop as the falling house prices continue to attract poorer residents, a process called ‘filtering.’ In this scenario, the presence of the undesirable facility starts the process of neighborhood deterioration.

Conversely, the site of a polluting facility may have been chosen in part because the area's land prices were already inexpensive (Hamilton, 1993). Lower income communities and minority communities are frequently regarded as 'weak' in terms of their effectiveness in staging successful public opposition to such sites. In this scenario the existence of a lower-status community plays a significant role in the site selected for the facility.

Knowing the answer to the question of how areas respond to polluters may lead to a better understanding of the situation concerning sited LULUs: if the neighborhood naturally changes toward a lower-income population, then that needs to be considered during the siting process. The issue becomes one of neighborhood dynamics. This is not to say that LULUs should be sited in poorer neighborhoods because the neighborhood will deteriorate regardless. Rather, those doing the siting must be aware that the LULU will cause some downward spiral, unless precautions are taken or compensation is offered (Kiel and Zabel, 1996).

Therefore this paper looks at how towns located around an incinerator changes over time, and will compare the neighborhoods close to the sites to those further away. This is done using census data from 1970, 1980 and 1990 on the population's income levels, unemployment rates, stability, and ethnicity. If neighborhoods closer to the site change differently from those further from the site, this will be evidence that the LULU affects not only property values, but the population residing there as well.

Neighborhoods will first be defined by grouping census tracts; this assumes that the Census Bureau does draw their boundaries around homogenous neighborhoods. Using a second definition, neighborhoods will be determined by rings of varying distance from the site; this approach implies that the incinerator is the focus of neighborhoods. Changes over time in each of the defined neighborhoods will then be calculated. The changes will then be compared across neighborhoods to test the hypothesis that the LULU affects the demographics as well as the values.

Literature Review

Previous literature on this issue has generally ignored the 'causality' issue by looking at the relationship between demographics and toxic sites at only one point in time. One of the earliest studies, by the United Church of Christ's Commission for Racial Justice in 1987, found that race is the best predictor of the location of commercial hazardous waste facilities, even after controlling for income and house values. This finding has been reinforced by other studies. However, by looking at 'snapshots' in time, it is not clear whether the minority population was there prior to the siting of the polluting facility, or if they moved to the site later, due to lower land prices.

A few exceptions in the literature look at changes over time. Hamilton (1993) studies the expansion decisions of existing facilities from 1987 through 1992 and finds that firms did appear to consider the ability of residents to mobilize against the proposed expansions, as measured by income levels and voter turnout in earlier elections. However, this work is done at the county level, and does not look at demographic changes after expansion occurs.

Another exception is the work of Been (1993). She first examines socioeconomic data at the county level prior to, as well as after, the siting and finds that there was a disproportionate effect on minorities in the siting decision, but that the neighborhood does not experience an increase in minority population after the siting. She then uses census tract data to study another set of facilities and finds effects both before and after the siting. However, her data are quite aggregated and she does not control for other changes in the area, such as the existence of other polluters. In addition, she looks at data taken just prior to the operation of the facilities, whereas Kiel and McClain (1995a, 1995b) have shown that house price effects exist well before the facility goes on line, indeed as early as stages when there is merely a rumor that the facility is to be sited.

Methodology

This study considers how community populations change over time, and compares the neighborhoods close to the site to those further away. What defines a neighborhood is an empirical question (Kiel and Zabel, 1998), so two approaches are taken. First, following Been, census tracts will be taken as neighborhoods. The second approach considers neighborhoods to be defined by distance from the toxic site.

Census tracts are designed as homogenous areas with respect to the socio-demographic characteristics of the population. A tract usually has between 2,500 and 8,000 residents. Thus, it is possible to consider them as neighborhoods. By mapping the census tracts in the cities that contain or surround the undesirable facility, one can define census tracts as ‘near’ or ‘far’ from the facility. Then census information from those tracts is gathered and changes are computed so that one can see whether the facility leads to demographic changes in the surrounding neighborhoods.

It is possible that census tracts are too large to be considered neighborhoods. The second approach looks at all houses within a certain distance of the facility under consideration. By determining what census tract those houses are located in, one can take weighted averages of census information for all tracts within that distance, and examine changes in that information. For example, if 10 houses within one mile of the facility are in tract number one, and 30 are in tract number two, then:

$$average\ income = [(tract\ one\ income * 10) + (tract\ two\ income * 30)]/40$$

It is possible that one will get different answers from the two approaches.

Data

This study focuses on North Andover, Massachusetts, which is located approximately 20 miles north of Boston near several major highways and has a total area of 27.85 miles, see Figure 1. As the town's landfill moved to capacity in the late 1970s, an incinerator, which would turn refuse into electricity was proposed. The first mention of the facility in the local newspaper (The Citizen) was in 1978. A contract between the city and the provider was signed in early 1981. After much uncertainty about funding, groundbreaking for the facility took place in 1983, and the plant went on line in 1985.

The waste-to-energy incinerator includes an electrostatic precipitator to clean the emissions to the level required by existing environmental standards of the time. Regardless, articles in the local paper at the time the plant was proposed discussed the "environmental soundless of the plant" (September 14, 1978), as well as the possibility that the plant would present "a health threat to those living near the plant" (October 2, 1978).

Neighboring towns including Haverill, Andover, and Methuen may also suffer from environmental externalities from the plant. As discussed by McClain (1997), it is unlikely that environmental externalities will be "restricted by political boundaries" but that negative effects may be tempered by spillover demand from residents leaving the host community. She also points out that non-host communities do not generally receive compensation from the siting process. Thus the overall impact on house values in neighboring communities is unclear. Her results indicate that the incinerator in North Andover did not negatively affect Methuen house values, while Andover house values were impacted. Haverill was not included in her study.

The data set employed in this study focuses on single family homes in the four towns that include and surround the incinerator. The data have been obtained from various tax assessors' offices and include information on the house and its physical characteristics. This study focuses only on houses which sold and where they are located relative to the site. Each sale has been geo-coded using ArcView 3.0 and the census tract in which is it located has been identified. The 'hit' rate for each town was at least 89 percent; there are 3,667 sales in North Andover, 4,990 in Andover, 3,983 in Methuen, and 3,442 in Haverill. The sales date from 1974 through 1995, so the period prior to the incinerator's existence, or even its rumored existence is included.

Census information from 1970, 1980 and 1990 is attached to each census tract, giving us information on the area from well before the incinerator until well after it had gone on line. The variables used are the percent of the population in the tract that is defined as 'poor', the percent of the population that is classified as 'unemployed', the percent of the population that moved into the census tract in the previous five years, the percent of the population that is self-reported as 'foreign born', and the mean family income for families in the tract.

Results

Table 1 indicates the percentage change in the census tract variables when neighborhoods are defined based on how close a census tract is to the incinerator. If the facility causes accelerated filtering then we should see neighborhoods that are closer increasing in poverty rates over time, relative to those neighborhoods that are further away. We do see that, if we look at tracts that are within one mile of the site, and compare them to tracts within two miles in both time periods. However, the impact is reversed at three miles, which suggests either that increased filtering is not occurring, or that the effect extends out to three miles.

The hypothesis suggests that there should be increased unemployment in closer tracts over time, relative to further tracts. The pattern here is similar to that observed when examining poverty rates. The increase in mobility that is observed to decrease over the first three miles in the first period, and then is see to be positive in the first mile in the second period while decreasing in size in the other tracts, suggests that the hypothesis holds. This variable indicates that the site does cause the neighborhood to become less desirable.

The results are mixed in the changes in percent foreign-born variable. The neighborhoods one mile from the site do see an increase, as do the tracts that are three miles away. It is possible that the effect extends out further than one mile.

The changes in mean family income seem to reject the hypothesis that filtering has increased. Here the neighborhoods closest to the incinerator have the largest percent increase in income. Thus although house prices are falling, incomes are increasing more rapidly than in tracts further from the facility.

Table 2 summarizes the results when houses within a certain distance from the incinerator define neighborhoods. Unlike the previous definition of a neighborhood, these results suggest that there is increased filtering in the first mile, but also in the second, third and even fourth. The largest percentage increase is in mile three, suggesting that the impact of the incinerator does extend further then previously thought. The percent unemployed and the percent foreign-born results mimic those for the poverty variable.

The increase in mobility indicates that the facility has an increased impact on the first mile, but then less of an impact further away. This is very similar to the results with the previous definition of a neighborhood.

The mean family income variable has the largest increase in the first mile in both periods. This rejects the hypothesis that the facility is an undesirable neighbor, as those neighborhoods closer in actually see an increase in income. This result is similar to that found in the previous definition of a neighborhood.

Conclusions

The findings reported here suggest that the total impact of an undesirable facility on its neighbors is the result of a complicated process. Although some of the variables suggest that the site does increase filtering so that the neighborhood is worse off after the site, others suggest the opposite. One also gets different results depending on how neighborhoods are determined.

These results suggest several things. The first is that looking at areas with such facilities at any one point in time is inappropriate. Clearly the process takes time, and some facilities may be placed in areas where filtering has already begun. This research, which has information on only three points in time, provides mixed results. It is possible that with more data points over time, the results would be stronger.

In addition, these results indicate that how the researcher defines a neighborhood can skew the results. It may be that the relevant neighborhood dynamics are played out on a much smaller scale; this would call for more studies on a micro level, rather than a continuation of studies that employ more aggregated data.

Finally, these results suggest that the siting decision and the final effect on the neighborhood may well be linked. Modeling this process is clearly the next step.

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Figure 1

Table 1

Using Tracts within Certain Distances

Percentage change in Percentage Poor	Between 1970-1980	Between 1980-1990
Within One Mile	0.076596	1.34476285
Within Two Miles	-0.2127	-0.0411794
Within Three Miles	0.435294	1.63491803
Within Four Miles	0.507185	0.51174282
Percentage change in Percentage Unemployed		
Within One Mile	-0.03731	0.481415
Within Two Miles	0.03125	0.296439
Within Three Miles	0.27717	0.650936
Within Four Miles	0.27149	0.2709
Percentage change in Percentage Moved		
Within One Mile	-0.06688	0.00721
Within Two Miles	-0.00596	-0.03431
Within Three Miles	-0.11758	-0.06776
Within Four Miles	-0.0682	-0.21297
Percentage change in Mean Family Income		
Within One Mile	0.97570922	1.401826
Within Two Miles	0.94319385	1.084181
Within Three Miles	0.65903421	1.143706
Within Four Miles	0.52267045	1.288634
Percentage change in Percentage Foreign Born		
Within One Mile	-0.22388	0.195048
Within Two Miles	-0.14465	-0.06096
Within Three Miles	-0.27711	0.22725
Within Four Miles	-0.03169	0.018655

Table 2

Using Houses within Certain Distances

Percentage change in Percentage Poor	Between 1970-1980	Between 1980-1990
Within One Mile	0.10102	0.36246752
Within Two Miles	0.005004	0.36450764
Within Three Miles	-0.00981	1.35813301
Within Four Miles	0.133707	1.15711963
Percentage change in Percentage Unemployed		
Within One Mile	0.00341	0.693287
Within Two Miles	0.03248	0.451903
Within Three Miles	0.02967	0.71639
Within Four Miles	0.08066	0.410246
Percentage change in Percentage Moved		
Within One Mile	-0.04791	0.024797
Within Two Miles	-0.04355	0.005169
Within Three Miles	-0.03032	-0.0604
Within Four Miles	-0.03207	-0.03615
Percentage change in Mean Family Income		
Within One Mile	1.02779208	1.52839
Within Two Miles	0.98229245	1.296183
Within Three Miles	0.95140291	1.108982
Within Four Miles	0.92228325	1.400198
Percentage change in Percentage Foreign Born		
Within One Mile	-0.23015	0.17297
Within Two Miles	-0.18864	0.076455
Within Three Miles	-0.18938	0.136946
Within Four Miles	-0.23567	0.149573

Policy Discussion of Session One

By Robin R. Jenkins, US EPA Office of Economy and Environment

All of these papers are valuable contributions to a literature that is helping government understand the neighborhood impacts of locally unwanted land uses. McCluskey and Rausser's paper studies the impact of one particular locally unwanted land use that's especially important to the EPA -- a hazardous waste site. They also study the impact of cleaning up the site. Kiel and McClain study the impact of an incinerator.

The McCluskey and Rausser and the McClain papers both examine neighborhood impacts via hedonic property value models. Kiel, on the other hand, simply examines percentage changes in socio-economic variables at varying distances from an incinerator. I enjoyed reading each of the papers. As a group they illustrate nicely the wide range of questions that can be addressed with property value and other neighborhood quality data.

The remainder of my comments are directed at individual papers going in the same order in which they were presented.

McCluskey and Rausser's paper is the furthest along and thus was the most provocative. I spend a bit of a disproportionate amount of time of it.

A unique contribution of the McCluskey and Rausser paper is to study property values from before identification of a hazardous waste site, and then before, during, and after cleanup of the site. Having data for these different time periods permits them to examine how permanent the property value effects of a hazardous waste site are. McCluskey and Rausser conclude that properties are only permanently stigmatized in a very limited area -- a 1-mile radius of the site. This conclusion is based on the finding that distance from the site has a positive effect on property value before identification of the site by EPA and during clean-up of the site. After clean up, distance actually has a negative effect for a 4-mile distance, but it's still positive for a 1-mile distance.

Accepting their conclusion as correct that stigma persists for the nearest properties, this is mixed news to an EPA policy maker. On the positive side, the paper **is** finding that most property values rebound following site remediation. On the negative side, this rebounding might not occur for the properties closest to the hazardous waste site. Or in the language of McCluskey and Rausser, stigma persists for the nearest properties.

However, I wonder if perhaps the fact that the values of the closest properties remain depressed is indeed a result of a stigma. Instead of stigma maybe the properties values stay depressed because they are experiencing continued negative effects that are unrelated to health and thus not remedied by cleanup. I'm not talking about ecological or non-use effects but the more mundane negative effects -- such as truck traffic and noise for an active site or just unsightliness for a closed site. In fact, this alternative interpretation can also explain a second of McCluskey and Rausser's findings B that distance positively affected property values even in the period before identification of the hazardous waste. In other words, even before the health risks from the site were known, people paid a premium to live further from it. Again, the reason could be other negative, though non-health, effects like unsightliness. Of course, these other negative effects are outside the purview of the EPA. They are not addressed by clean-up actions. I think this alternative interpretation gives better news to the policy maker -- Clean-up and reducing health risks is not futile even for close-in sites but it also isn't a panacea since other negative effects not within the purview of the EPA should be expected to persist and to depress property values.

Another important finding by McCluskey and Rausser is that media coverage of the hazardous waste site lowers property value. It does this both directly and indirectly by increasing households perceived risk from the site. The authors suggest that because increased risk perceptions affect property values and these declines in prop values are a real loss, that the EPA should consider risk perceptions in their benefit-cost analyses used to determine which sites to clean up first. And that the real effect of hazardous waste sites on property values has so far been neglected by the EPA. However, I think to some, the finding that media coverage is important might suggest just the opposite of the conclusion reached by the authors. The economics literature states that the validity of the property value method for valuing different levels of environmental quality rests on the assumption that property owners understand the risks posed by a nearby hazardous waste site. And that they understand the reduction in these risks caused by site cleanup. It's not at all clear that the EPA should determine the value of its programs by relying on the perceptions of householders when its been demonstrated that those perceptions are manipulable by the press.

This is not to say that EPA's current method of assessing such programs as RCRA and Superfund which consists of counting and then sometimes valuing health effects is ideal either. Perhaps the most valuable contribution of McCluskey and Rausser's paper is that it suggests a practical alternative -- to value a site cleanup by estimating the changes in property values that clean up induces. This would be an improvement over the current method because it would be more comprehensive by capturing all the health as well as any non-health benefits from clean up like ecological or non-use benefits. (Even though EPA clean up is directed at improving human health, usually there are ecological and resource preservation benefits as well. These are typically not valued by the EPA simply because they are so hard to value.) However, using property values to estimate the benefits of RCRA or Superfund, for example, would be criticized, I fear, because the method's credibility rests on householders having a clear understanding of the actual risks of the site. Which leads to another valuable contribution of this paper -- the suggestion that government would do well to improve its ability to communicate effectively with the public about health risks. Right now the public is very suspicious of government and other outside experts. However, the current Envirofacts program which includes the Toxics Release Inventory, Surf your Watershed and other data bases is a big success and hopefully marks a trend towards more successful risk communication.

Katherine McClain's paper is in-between the other 2 in terms of how far along it is. She does conduct hedonic property value analysis. She studies the same region and unwanted land use as Kiel an incinerator in North Andover, Massachusetts but asks a different research question:

will non-host communities experience negative house price effects from the incinerator? Since environmental and other negative externalities are not restricted by political boundaries, property value effects might not be either. The facility she studies is located in the Extreme northern corner of the town, closer to parts of 2 other towns, Methuen and Andover, than to many residential parts of North Andover. Thus she analyses house sales from these two other communities. She finds that the incinerator did not effect house prices in the nearer but lower income Methuen but that it did affect prices in the further but higher income Andover. She offers two theories B the higher income community was also more educated and more sensitive to negative externalities. And/or, this community was one of the communities contributing to the incinerator and so was included in the public discussion of the incinerator project. She concludes that her results confirm that non-host communities are affected by undesirable facilities located in neighboring towns. However, her results also show that the host community's property values are most strongly affected.

What are the implications for policy? Her findings corroborate McCluskey and Rausser's -- that the media or other forms of public discussion are important to property value impacts. As an EPA analyst with an immediate interest in relying on property values to estimate the benefits of site clean-up, the results suggest that we need to be careful to include a media or other public discussion indicator variable on the right hand side of property value models alongside the risk variable.

There are additional policy implications of this paper for local government. I'll leave the bulk of that discussion to the next speaker. I just wanted to mention a 1995 paper in JEEM by Daniel Ingberman which argues that unwanted land uses will be disproportionately sited at jurisdictional borders precisely because such locations export the negative externalities to non-host communities. He looks at the locations of landfills in PA and finds that a significant number are near borders. It is usually the decision of the host community to cooperate or fight a siting decision since it's the host community who has jurisdiction over the property. Nearby but non-host communities do not have nearly as strong a say over zoning decisions or other decisions that could make siting difficult. McClain's finding suggests that non-host communities should perhaps be given a bigger voice in siting decisions. How that would happen I have no idea and as I say I'll leave the bulk of this discussion to the next speaker. However, an interesting policy question is at what point do the non-host externalities become serious enough that there is a legitimate case for state or even federal oversight?

Katherine Kiel's paper is very preliminary, not based on a hedonic property model just on changes in socio-economic variables as you move further from an unwanted land use.

Katherine Kiel's paper investigates whether communities respond to the introduction of a unwanted land use by filtering that is by prop values spiraling downward which ultimately could lead to neighborhood deterioration. My first comment from a policy perspective is that if filtering is a common response, then there are immediate implications for the policy assessment suggested by the McCluskey and Rausser paper. That is, if identification of a hazardous waste site, for example, causes property values to spiral downward, then site clean-up might not result in restored property values since by the time clean-up occurs, property values might already have spiraled downward below what could be attributed to the presence of a health risk. In this scenario, clean up would not be expected to restore neighborhood property values. In fact, there might be so many secondary and tertiary effects that relying on property values to assess clean up would involve too much noise.

However, Kiel does not find clear evidence of filtering. If she had, perhaps one policy response would be to hurry-up clean-up efforts. In fact Superfund cleanups used to take forever. Reportedly they are now moving more quickly. Other than speeding up clean ups, however, its not clear what other policy response would follow. After all, siting decisions are private sector choices. At present it is not the EPA's role to intervene in the siting process because of neighborhood effects that are only indirectly related to health. Rather, the role of EPA is to ensure that the unwanted land uses are safe and we are doing that with both RCRA, Superfund, air quality regulations, etc. If anything, we err on the side of making at least hazardous waste sites too safe from an economists perspective. Evidence suggests that remediation costs greatly exceed monetized benefits at most Superfund sites. However, a relevant policy implication of Kiel's paper (since she does find partial evidence of filtering) is that RCRA and Superfund might be policies that disproportionately benefit the poor.

In closing, I enjoyed the opportunity to read this interesting set of papers and appreciate the researchers' efforts to expand policy makers' knowledge of neighborhood effects from unwanted land uses.

Policy Discussion of Session One

Joseph Schilling, International City/County Management Association Β Summarization

Mr. Schilling began by saying he would try to broaden the policy context of the discussion and provoke thought about the larger policy implications. Mr. Schilling's organization, the International City/County Management Association (ICMA) is the professional membership organization for city and county managers, so ICMA's members are the people who implement these policies, and rely upon these studies to try and make these studies work at the ground level.

Mr. Schilling posed a question for the panelists: how can this information impact environmental decision-making at all levels of government, but also in non-governmental organizations, to the extent that they have become involved in the process of developing policies for redeveloping brownfields and contaminated properties? Mr. Schilling also observed that these papers illustrate the increased integration between what happens at the local land use level with federal environmental regulations. This occurs on a number of fronts, including debates over smart growth and brownfields redevelopment. It is sometimes difficult, however, for federal agencies to become involved with decisions that are essentially local in nature, sometimes at the neighborhood level. Mr. Schilling noted that Dr. Kiel had expressed a desire to look at data the census block level, and commented that this is an example of how necessary it is to integrate local land use decisions with state and federal policies. There is no easy way to do this, as the lead smelter example presented by Dr. McCluskey illustrates. Coincidentally, ICMA is performing research on EPA's 16 showcase brownfields sites, including a site in Dallas, and Mr. Schilling was one of the researchers assigned to talking to local residents to assess the impacts of facilities such as the lead smelter. Mr. Schilling noted that this was a highly time-consuming exercise, illustrating again the difficulty in integrating the local impacts of such undesirable local land uses with federal decisions.

Mr. Schilling expressed agreement with Dr. Jenkins's observation that there are many other variables involved in assessing the impacts of land use decisions, as ICMA's research has uncovered. West Dallas and its planning history (or lack thereof) provides a good example of this complexity. The West Dallas area is across the river from the heart of Dallas, and as recently as the post-World War era, has been the home of people of color and other socio-economically disadvantaged populations of the city. The fact that a smelter was located there thus introduces a number of additional variables, perhaps those that are outside of EPA's regulatory jurisdiction. The question is thus: what role should EPA play in the land use planning process? EPA has been playing the role of a facilitator, providing information on public health risk, and working as a convening party in bringing different parties together. While EPA's participation has been positively received in some instances, EPA has played a positive role in many cases. For example, in some cases in EPA's Superfund recycling initiative, EPA is playing the role of the catalyst, bringing together local regulators, developers, environmental organizations, engineers, and integrating the re-use plan with the cleanup process. There may be room for further study on the relationship between the re-use and the cleanup. The Dallas lead smelter is a good example because even though it has been cleaned up, it is still idle, so that the stigma is apparently persistent. Thus, policies to expedite the re-use of such sites and integrate the re-use with the cleanup process will only accelerate the revitalization of the neighborhood, which appears to be the direction that EPA is taking with its Superfund recycling initiative. Another observation or issue for further examination is the impact of brownfields generally, in terms of the planned re-use. The planned re-use will be tied very closely to cleanup, in that the cleanup standards will be different for different re-uses. This is another reason for integrating the re-use plan with the cleanup process.

Mr. Schilling also noted that the papers illustrate the micro and macro views of these siting and cleanup issues. Dr. McCluskey's paper focused on the neighborhood level, in looking at the impacts of properties very close to the smelter, while Dr. McClain's and Dr. Kiel's papers focused on the impacts on a more regional level, so these papers provide different viewpoints on the same question. As Dr. Jenkins noted, this is clearly a large challenge for local governments. Mr. Schilling also noted that it is interesting to compare Massachusetts, which has very small incorporated towns (potentially making siting decisions more controversial and difficult), to Texas, which has local governments with very large boundaries (at least reducing the number of jurisdictions that need to agree on a siting decision), although siting decisions are still difficult in both cases. One conclusion from these studies is still that agreement on unwanted land uses will have cross-boundary effects and will still be difficult, and bringing together these different cities, communities and constituencies will be difficult. One possible model for accomplishing this can be found in a fairly complex process for siting low-level hazardous waste sites in Massachusetts, which has delegated a large part of the responsibility for handling these types of cases to their state office of dispute resolution. Neutral mediators were thus brought in to help these communities making more collaborative decisions for siting low-level hazardous waste facilities.

The papers also illustrate the need for risk communication. All of the studies show that perceived risk is very influential, not only in property values and siting, but also in terms of choosing a cleanup remedy. There are a number of different avenues of risk communication, but one example that Mr. Schilling provided was the Isles Group in Trenton, N.J., a non-profit organization which does some brownfields redevelopment, but also provides public education for neighborhoods with brownfields issues. The Isles Group has established brownfields academies, in which they hold seminars in people's homes for eight to ten week sessions, and teach people about brownfields redevelopment, going over the definition of a brownfield and the land use and legal issues involved with brownfields redevelopment. This has the effect of empowering the community, and has had a very large impact in Trenton which has a Superfund-sized site. Mr. Schilling held up this model as an example for other communities to follow in working out brownfields decisions. Mr. Schilling closed by complimenting the papers for their relevance and helpfulness in informing ongoing brownfields debates.

Question and Answer Period for Session One

Don Snyder, Utah State University, expressed some concern that analysts' estimates of the cost of undesirable facilities on housing prices, as estimates for the social cost of the undesirable facilities were quite high, higher perhaps than a scientific assessment would justify. Dr. Snyder asked if Dr. McClain or Dr. McCluskey were concerned with this discrepancy between perception and the scientific reality. Dr. McCluskey replied that as long as the cost could be considered a true economic loss, there was no discrepancy, regardless of whether scientific evidence deemed the loss to be reasonable. As long as the housing prices reflect public perception of the value of the property, and as long as the decrement in housing price attributable to the undesirable facility was actual, then she saw no problem with any inconsistency with scientific evidence on harmfulness of undesirable facilities.

Dr. Snyder asked if it was bothersome that there was a difference in the perceived risk and the actual risk based upon science, and that the perceived risk served as the basis for determining social costs of undesirable facilities. Dr. McClain acknowledged that there was an extensive literature in the psychology field on the difference between perceived risk and the scientific assessments of risk, and that public perceptions of high risk are persistent despite strong scientific evidence to the contrary. Dr. Snyder wondered if such estimations of risk are thus appropriate for determining social costs. Dr. McClain replied that if she were a homeowner, then she would say yes. Dr. Bockstael commented that economists worry a great deal about people’s perceptions when doing revealed preference studies. The housing market is even more complicated than a revealed market problem, because it is not just one’s own perception that matters, but also other people’s perception that matter, much like the stock market. It doesn’t matter if a homeowner has an Accurate perception if everybody else has an inaccurate perception, because those perceptions affect the homeowner’s welfare. Dr. McCluskey reiterated this point, noting that her research was an example of a problem of self-fulfilling expectations. As in the stock market, the homeowner can wind up a loser because everybody else is scared. Dr. Kerry Smith, North Carolina State University, commented that the stock market analogy is imperfect because a homeowner has a use value in her home. Even if other people have negative and inaccurate perceptions about the value of a home, the homeowner still can use the home as a residence. There is thus a difference in the way that renters perceive a danger and owners that occupy their homes. The issue, Dr. Smith stated, is how informed people need to be. At a certain point, it becomes a public policy matter to say that people are insufficiently informed.

Sid Wolf, Environmental Management Support, noted that from EPA's perspective in regulating Resource Conservation and Recovery Act (RCRA) sites and Superfund sites, there seem to be four aspects of damages accruing from these sites: the ecological value loss, the human health aspects, the property value loss (although Mr. Wolf acknowledged that this is evidently a complicated matter) and the neighborhood effects. Mr. Wolf noted that the research presented in this first session measured the willingness to pay to avoid some, but not all of these four aspects of damages from undesirable facilities. Mr. Wolf asked if there was any effort to measure the human health aspects and ecological loss of undesirable facilities, and if there is any overlap that would be picked up by any such research design. Dr. McCluskey responded that these aspects are inter-related, that there should certainly be some research as to the human health aspects, and that it would help alleviate the problem of perceptions being different from scientific assessments. Dr. McClain added that the advantage of using property value data to measure damages was that the data consist of actual transactions, where someone actually writes a check, reflecting a greater reliability than other types of data.

Pamela Bingham, US EPA, asked if the researchers are proposing as a policy matter that the kinds of losses identified by this research will be an actual cost of doing business for companies engaging in undesirable land uses, in that compensation be paid for homeowners negatively impacted by such undesirable land uses. Ms. Bingham also noted that US EPA's Office of Solid Waster and Emergency Response has guidelines on relocation costs and asked if this was a cost that facilities will incur as a cost of doing business (http://www.epa.gov/superfund/tools/topics/relocation/index.htm. Dr. McCluskey acknowledged that there needed to be a mechanism for sorting out which people were actually harmed by an undesirable land use or siting decision. In response to Ms. Bingham's question, Dr. McClain noted that there will be pressure not from the federal government but from the local level that the property value losses of undesirable land uses should indeed be a cost of doing business. Some of these issues are still to be determined in the courts. As local entities become more savvy it is likely that these costs will be internalized by companies attempting to site undesirable land uses, as illustrated by Kirkwood, N.Y., a community that had rejected an undesirable land use siting.

Steve Winnett, US EPA Region 1, commented that he was having trouble understanding the economic jargon that was being used in discussions, and expressed a desire to have some of the economic concepts explained. Mr. Winnett also wondered if, in the McClain research, Haverhill was downwind of the undesirable land use, and whether that affected Haverhill residents' property values. He offered a regional analogy in that some Northeast states are suing Midwestern states and utilities because of acid rain problems that originate from power plants in the Midwest. Mr. Winnett also asked Dr. McCluskey if there was a smell associated with the smelter studied in her research or if there were other signals such as increased garbage truck traffic. Mr. Winnett also wondered if there couldn't be some mitigation undertaken to alleviate the property value impacts. Dr. McCluskey replied that there was no smell, but that the smelter produced lead that posed a risk to children, through contact with the soil. Dr. McCluskey also replied that the people in the vicinity of the smelter knew of the smelter and of the risk posed by the smelter. Dr. Kiel replied that in the New England study, they tried a windrows variable to capture a downwind effect, but the variable was not statistically significant. Dr. Kiel also noted that there has not yet been a non-host town taking action against a host-town for compensation, but believed that this could be forthcoming. Dr. McClain also commented that in another situation south of Boston, an undesirable facility approached the problem as a regional one, and contacted a number of potential stakeholders as far away as ten or fifteen miles away. Dr. McClain added that they could not figure out why the windrows variable did not work, except that they used the windrows from Boston's Logan Airport, and not the windrows from the actual site.

Ted Su, US Bureau of Land Management, posed environmental justice issues. A program that relies upon property value as the only variable and seeks to find the optimal choice of siting may well choose to locate all undesirable facilities in poor or minority communities. Dr. Su also noted that it may be worthwhile to consider the benefits from siting decisions, since an economist is charged with equating marginal social costs with marginal social benefits. Dr. Kiel agreed that there is a danger when using property value as the criteria for determining optimal sites. There are several alternatives, however, including the use of a percentage change in property value rather than absolute changes property values. Dr. Kiel agreed that it is difficult to talk about equity in terms of equating marginal social costs with marginal social benefits, because equity and social considerations are left out of that consideration. Dr. Kiel added that it is important when making siting decisions to also ask what can be done to mitigate the harm from such facilities. Dr. Kiel added that it was interesting, but probably the exception rather than the rule, that a wealthy community such as North Andover would want construction of a facility such as an incinerator.

Matt Clark, US EPA, commented that it should not be overlooked that the Superfund program has an insurance value for the country as a whole. This program provides some assurance that if there is a hazardous waste site, someone will assume the role of coming in and cleaning up the site and making the “bad guys,” or polluters pay for the clean up. While Dr. Clark admitted that he did not know how to conduct research to estimate this value, he noted its importance. Dr. Clark made a second comment that although equity considerations are important, it is not necessarily a problem if lower-income people are getting higher-quality housing as a result of this transfer. If a transfer payment is made, it may be important for a researcher to tease out what fraction of a compensation payment is a transfer and what fraction is deadweight loss. Dr. Kiel noted that her point was not that devaluation of property was occurring, but rather how quickly it occurred. Dr. Jenkins responded that she was only proposing that using property value as the means of estimating the cost of siting undesirable facilities be considered a lower bound of the cost estimate. Dr. McCluskey agreed that lower-income people can evaluate their own trade-off of housing quality with environmental risk, but pointed out that as a society, it is still necessary to establish some minimum level of exposure. Although Dr. McCluskey acknowledged that this might seem paternalistic, she pointed out that this is often the role of government.

Dr. Kerry Smith proposed drawing a lesson from the sulfur dioxide emissions trading permit program and implementing a tradable permit scheme for houses near an undesirable land use. Dr. Smith proposed an endowment-equalizing payment whereby the highest-valued house gets zero, and other houses get a payment equal to the difference between the house value and the value of the highest-valued house. The effect is to provide an equal endowment among all the homeowners, so that heterogeneous preferences can be accommodated. Dr. McCluskey noted that it is still desirable to establish a lower bound for risk. Dr. Smith agreed, but pointed out that this mechanism ensures that compensation is actually made to those who lose out from the siting decision.

Dr. Smith posed a question as to whether any work had been done on the time pattern of effects and how hedonic data changes over time. There are now firms that sell hedonic data, and that this could lead to a Lucas, rational expectations phenomenon, in that people will anticipate changes in value of property and react accordingly, the effect being that property values will go to an equilibrium value more quickly. Dr. McCluskey agreed this was possible, that this hedonic information could present arbitrage possibilities, but that there were also temporary changes in neighborhoods that could have long-term effects.

Eric Slaughter, a Washington, D.C. businessman, asked if there was any evidence of redlining by lending institutions or other financing anomalies that might have affected property value changes. Dr. Kiel responded that they only looked at completed sales, so that they do not know if there were substantial failed sales. Although their research also looked at raw numbers of sales in other areas, there was no way to infer that lenders were more hesitant to issue loans for certain areas due to the siting of undesirable facilities. Dr. McCluskey also noted that there is some data on how long houses were on the market, giving some indication as to whether there was trouble selling the house. Again, however, this is not definitive data as to the salability of a house.

Ms. Bingham asked for a clarification of a remark by Dr. Jenkins regarding why it was that the poor disproportionately benefit from the Superfund program. Dr. Jenkins responded that the evidence seems to indicate that sites are disproportionately located in lower-income minority neighborhoods, so any program designed to clean up these sites naturally confers more benefits to those located near the sites. Ms. Bingham pointed out that it is more accurate to refer to lower-income and minority neighborhoods separately, since the two are not necessarily one and the same. Sven-Erik Kaiser speaker also proposed the clarification that perhaps it is more accurate to say that these programs *proportionately* benefit lower-income and minority people, since these people bore a disproportionate burden to begin with.

Ken Acks, Environmental Damage Valuation and Cost Benefit News, asked if people might get used to the stigma of undesirable facilities, and that properties might appreciate over time, reflecting the convergence of public opinion with scientific opinion. Dr. McCluskey replied that this was similar to the situation of the engineers who lived near the nuclear facility in Hanford, Washington, who knew what the risk was and were thus not unduly afraid of the stigma of being near the facility. Dr. McClain pointed out that mobility also still matters, that even if people know the actual risk, they still cannot easily simply move, because of the perceptions of others of property values near undesirable facilities.

Mr. Wolf noted that in the Kiel research, the decrement in housing value appeared to be on the order of $2,000 to $8,000 per mile from the facility and queried whether that was enough to change the neighborhood. Dr. Kiel noted that their research got mixed results, and that she had no definitive answer to that question. Dr. McClain added that their research indicated that housing value appreciation rates did seem to be affected by the undesirable land use.

Economic Analysis and Land Use Policy

PROCEEDINGS
-- Session Two --
Land Use and Tradeoffs in Rural Areas

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Proceedings for Session Two

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Changing Land Use Patterns at the Urban/Rural Fringe

Nancy Bockstael, University of Maryland B Summarization

Dr. Bockstael began by thanking and crediting EPA for its early support of her land use planning research. Dr. Bockstael also expressed her appreciation for the cooperation of the Office of Planning for the State of Maryland, and noted that this office had compiled an excellent land use database, making Maryland a good study site for land use researchers.

Dr. Bockstael commented that land use patterns have clearly become an emerging national political issue, despite the fact that it is still largely a matter of *local* policy control. Nevertheless, land use and urban sprawl have clearly affected elections on a much larger scale than locally. EPA has been involved with this issue, and it has a smart growth website (http://www.smartgrowth.org).

Dr. Bockstael noted a list of a handful of recent studies on sprawl, and noted the variety of sponsors of these studies, including the Bank of America, the Sierra Club, the Lincoln Land Institute, and the American Farmland Trust, to name a few. The reason that there are a spectrum of sponsors is because there are a spectrum of problems. Perhaps the leading problem is the public finance problem. Sprawl is defined as the proliferation of low-density residential development in a fragmented pattern. This has become expensive for local governments because of the high cost of providing public services to such a dispersed a population. Sprawl also chews up open space; the growth in land use for residential purposes is twice the rate of population growth. Sprawl also presents a potential ecological problem, but the effects of sprawl on the ecosystem are as yet unclear, and Dr. Bockstael has been working with ecologists and other environmental scientists to study the ecological implications.

The title of the paper that Dr. Bockstael presented was “Interacting Agents, Spatial Externalities, and the Evolution of Residential Land Use Patterns,” by Dr. Elena Irwin and Dr. Bockstael. Dr. Bockstael acknowledged that most of the contribution to this paper was made by Dr. Irwin, one of Dr. Bockstael’s former graduate students. The question addressed by this paper was: why do we see the emerging land use patterns of development? Dr. Bockstael showed a map of the Baltimore-Washington area that indicated areas of development, and noted that recent development has followed a speckled, dispersed pattern in the rural-urban fringe. The economics literature on the spatial pattern of urban development has predominantly been based upon the monocentric city model, which predicts that development will radiate outward from a city center. Allocating existing land use according to that theory produces a map which clearly does not approximate the observed pattern of development. As a second cut, the authors allocate land use according to the monocentric city model, but constrained by existing zoning and road networks (even though both these features of the landscape are realistically the result of the land use pattern not its determinant). The model based on the monocentric assumptions and these additional constraints more closely approximated the observed pattern, but was still lacking in explaining the fragmented pattern of growth in the rural-urban fringe.

New theoretical, spatial models are emerging in the economics and regional science literature. Based on work by individuals like Arthur, Krugman, and Page, interactions-based models motivate the evolution of land use pattern as the result of interactions among spatially-distributed agents. In the monocentric city model location matters only in relation to some city center, or some other exogenously-placed features of the landscape. The interactions-based models, however, allow agents' location decisions to be driven, not only by exogenous features of the landscape, but also locational decisions of other agents. This means that the evolution of the spatial structure is path-dependent. This also means that a variety of spatial structures can emerge from an initial set of conditions. The early literature in this area emphasized the formation of edge cities, and not the sprawl phenomenon, and generally lacked empirical evidence.

Some empirical work has been undertaken in the related literature of interactions in "social space". This literature, which draws upon the physics literature and uses particle interactions as an analogy, concerns itself with the question of how to aggregate up from micro level decisions that are spatially inter-related to a macro-level spatial pattern. The work by Irwin and Bockstael take off from these various literatures, as well as the econometric literature on an important identification problem. It is inherently difficult to disentangle the real interactions between agents and unobserved spatially-correlated heterogeneity.

The paper begins with a micro-level model in which agents optimize the timing of development, and then uses a cellular automaton model to simulate land use development patterns based on this model. The paper proceeds by empirical estimating and testing for endogenous interaction effects and then uses the results to compare predicted and actual patterns to see how closely the model can match the observed pattern.

The micro-level model of optimal timing of development is:

Develop in time T if:

$$V(i,T) - \sum_{t=0}^{\infty} A(i,T+t)d^{T+t} > 0 \quad \text{and}$$

$$V(i,T) \geq dV(i,T+1) + A(i,T)$$

where

$V(i,T)$ = one time net development returns from parcel *i* at time *T*

$A(i,t)$ = one period returns from undeveloped use of parcel *i*.

d = discount rate

The model also assumes that

$$V(i,T) = g\left[X(i), g(T)\right]$$

where

$X(i)$ are parcel characteristics that tend to vary spatially but not temporally

$g(T)$ are growth pressures that tend to vary temporally but not spatially

Incorporating the interaction effects requires consideration of how much of a surrounding neighborhood is developed, and the inclusion of a term to account for resulting repelling or attracting effects. This is accomplished in the following equation:

$$V(i,t) = g\left[X(i), g\,(t)\right] + l\,I(i,t)$$

where the latter term represents the interactive effect.

The micro model needs to be aggregated up to a macro level. Existing aggregation models, however, have a problem in that the aggregation from a micro level to a macro level only allows for positive effects; the effects are likely to be both positive and negative. Also, these models tend to characterize an equilibrium solution, whereas Dr. Irwin and Dr. Bockstael's interest lay in the dynamic process of the evolution of land use, not it's result when all possible rounds of development have occurred. Irwin and Bockstael thus developed their own cellular automaton model, and compare a land development simulation that assumes: (a) a monocentric city model, (b) a monocentric city model with additional endogenous but repelling interaction effects, and (c) a monocentric city model with both repelling and attracting effects. The latter led to the "clumpiness" characteristic of the observed pattern of development in the Baltimore-Washington area. From this experiment, Irwin and Bockstael concluded that incorporating endogenous interaction effects between agents, owners of parcels, *could* provide an explanation for the observed pattern of development.

Whether it does provide such an explanation is an empirical question. Irwin and Bockstael then set out to empirically test their theory using a hazard model, which is designed to explain a dynamic decision. The hazard model captures the probability that a parcel of land that has not yet been developed will be developed in the next time period. This model was estimated using data from the rural-urban fringe areas of several counties in the Baltimore-Washington area (Howard, Anne Arundel, Calvert, Charles and St. Mary's). These areas (Census block groups) have densities of at least 1000 per square mile, but are not in the immediate suburban areas of Washington, D.C. A proportional hazards model is used to avoid the problem of baseline hazard rates, and only the relative timing of parcels is considered.

In performing the empirical estimation, the problem of identification needed to be addressed. The problem is that one cannot observe all of the factors that affect parcel development, yet these factors are likely to be spatially correlated. The question then becomes: how does one distinguish true endogenous interaction effects from the unobserved spatially correlated effects? The solution was to adopt a Heckman and Singer bounding strategy. This works because the spatial correlation tends to be positive; this is a reasonable assumption, since close neighbors are likely to have similar characteristics. Thus, if the estimated interaction is negative (i.e., the neighbors are behaving differently), then the underlying endogenous interaction must truly be negative.

The dependent variable for the estimation was the probability of conversion to residential subdivision in a given year from 1991 to 1997. The estimation process utilized successively more inclusive combinations of the following independent variables:

Percent of neighboring land use within $s*$ (different distances, e.g., 800 meters or 1000 meters) in developed use

Percent of neighboring land use between $s*$ and s_{max} (1600 meters) in developed use

Commuting distance to central city

Dummy variable for prime agricultural land

Dummy variable for soils and slopes that raise construction costs

The empirical estimation found statistically significant repelling effect between similar land uses that became more significant as more explanatory variables (that are expected to be spatially correlated) were removed from the error and included in the hazard model estimation. This suggests that unobserved spatial heterogeneity tends to bias the interaction effect in the positive direction. The more of that spatial heterogeneity that can be included in the model rather than left unobserved, the more negative the estimated interaction effect becomes. Comparing predicted vs actual spatial patterns for a) a model without the interaction effects and b) one with those effects for a snapshot of Charles County provides convincing evidence that incorporating endogenous interactions effects generates more realistic predictions of the spatial pattern of land use change.

Dr. Bockstael concluded by offering the observation that analysis of growth control policies in the economics literature is restricted to models based on the monocentric city construct. Yet, that model is clearly inadequate in explaining the very growth patterns that growth control policies are being used to address.

Land Management with Ecological and Economic Objectives

--Working Paper*--

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Introduction

Public land managers are called upon to meet multiple, and sometimes, conflicting ecological and economics goals. The debate on how to promote both timber sales and continued survival of species such as the marbled murrelet, northern spotted owl and various stocks of anadromous salmon in the Pacific Northwest is a case in point.

Multiple ecological and economic objectives are often explicitly specified in laws and regulations governing agency behavior. The National Forest Management Act (NFMA) states that "fish and wildlife habitat shall be managed to maintain viable populations of existing native and desired non-native vertebrate species in the planning area". The NFMA regulations define a viable population as "one which has the estimated numbers and distribution of reproductive individuals to insure its continued existence is well distributed in the planning area." NFMA further requires the Forest Service to develop alternative forest plans that "represent the most cost efficient combination of management practices examined that can meet the objectives established" and "alternatives shall be formulated to facilitate evaluation of the effects on present net value, benefits, and costs." Recently, an interdisciplinary Committee of Scientists (1999) released a report to the Secretary of Agriculture entitled "Sustaining the People's Lands: Recommendations for Stewardship of the National Forests and Grasslands into the Next Century". In this report the Committee recommended that "ecological sustainability provide the foundation upon which the management for national forests and grasslands can contribute to economic and social sustainability." Specifically the report states that the Forest Service needs to provide the ecological conditions necessary to protect the viability of selected focal species and of threatened, endangered and sensitive species. Despite the emphasis on ecological sustainability, the committee recognized the importance of traditional resource production such as timber harvest to the economic, social and cultural sustenance of many local communities.

Much of the existing research on land management has focused exclusively on economic issues (e.g., timber production or profitability) or exclusively on ecological issues (e.g., survival of a key species). Less common, until fairly recently, are studies that consider both ecological and economic issues in an integrated fashion. In this paper, we integrate models of wildlife population dynamics and timber economics to search for land management regimes that achieve ecological and economic objectives specified in terms of viability for a small set of target species and timber harvest volume. Land management decisions determine the habitat conditions that in turn influence species viability as well as determine timber harvests. We develop our approach and then apply it to a case study using GIS data on a forested landscape in the Central Cascades of Oregon. However, the approach itself is general and can be adapted to accommodate additional or different species, different geographic areas and additional or different land management activities and economic concerns.

Using the approach developed, we examine the production relationships between wildlife population survival and the value of timber harvest. Using our analysis we attempt to trace out the "production possibility set" showing the feasible combinations of species survival and the value of timber harvest. Ideally, we would solve for the production possibility frontier illustrating the maximum feasible combinations of survival probabilities and timber harvest. Doing so would illustrate the tradeoff between these goals under efficient land management.

Further, land management that generates results inside the production possibility frontier would be shown to be inefficient and the degree of inefficiency could be calculated. However, the problem of optimal landscape management is suitably complex that finding an optimal solution cannot be guaranteed. The decision space is huge as there are a large number of landscape units over which the analysis must be done. Further, the analysis is dynamic. When, as well as where, management actions are taken matters. In our analysis, we use a heuristic approach, specifically a simulated annealing algorithm, which generates a good solution without imposing overwhelming computational burdens.

In the next section of the paper we describe how the integrated model fits together and give details on each major component of the model. We then report results for a preliminary application of the model using GIS data for a region of the central Cascades in western Oregon. We discuss the results obtained so far and the direction of future work in the final section.

The Integrated Model

The objective of our study is to trace out the production possibility frontier showing the maximum feasible combinations of survival probabilities and timber harvest. Because the decision space grows exponentially with the number of land units and the time periods included in the analysis and the solution space is likely to be non-convex, we use heuristic algorithms to find good, though not necessarily optimal solutions to the problem. Therefore, the results that we find are close to but not necessarily on the production possibility frontier.

The general framework of the integrated model and the linkages between the components are illustrated in Figure 1. We begin with two pieces of information: the initial landscape that defines the land class of each land unit in the study area and species life history characteristics. These two pieces of information are fed into the wildlife population simulation model. Using a logit regression model, we compare the results using the wildlife population simulation model with several landscape indices and simple statistics calculated by the model to see whether there are computationally simple metrics that correlate with the results of the simulation model. We do this to simplify the process or searching for good solutions to the land management problem. We then use the simple metrics as the objective function in our search for optimal solutions. Upon finding land management solutions that score well with the simple metrics, we then use these solutions in the wildlife population simulation model and record the species viability and timber harvest scores. We repeat the analysis for various levels of timber harvest to trace out a production possibility frontier. We now describe each model component in more detail.

Species Population Simulation Model

We make use of a spatially explicit life history simulator called PATCH (a Program to Assist in Tracking Critical Habitat) (Schumaker 1998). PATCH reads GIS imagery directly and uses the data to link species' life history attributes and habitat preferences to the quality and distribution of habitats throughout the landscape. The PATCH model breaks species' life histories into three distinct components. Vital rates (survival and reproduction) determine the growth rate of a species, and are entered into the model using a population projection matrix (Caswell 1989). Habitat preferences describe an organism's use of habitat. Lastly, movement behavior governs a species' ability to navigate a landscape in search of high quality habitat. This approach allows

PATCH to link its projections of population viability to changes in landscape pattern, habitat quality, and habitat connectivity. Landscape pattern strongly controls the distribution of suitable breeding sites (and those ill-suited for breeding), while habitat quality determines what survival and reproduction rate will be experienced by the individuals occupying these sites. Habitat connectivity influences the ability of individuals to locate high quality habitat, which influences an individual's fitness as well as the ability of the species to re-colonize parts of the landscape that have experienced local extinctions.

PATCH includes stochastic demographic and environmental elements so that it is a stochastic rather than a deterministic simulation model. For any given landscape management profile, the model was run multiple times to generate a distribution of likely outcomes. We ran 100 population simulations of 100 years within the PATCH model for each alternative landscape. We define the probability of survival on a landscape as the number of times out of the 100 runs when the final population after 100 years is non-0.

Logit Regression Model

PATCH is a very detailed model that takes a long time to run. For computational reasons, there is utility in attempting to find an easily calculated index that correlates well with PATCH results. Therefore, we undertook the following analysis. For each of 50 different landscapes, a set of standard landscape indices and PATCH specific indices were calculated. We then used regression analyses to see whether combinations of these indices were highly correlated with species survival.

The indices we used were chosen from the existing literature on landscape patterns and PATCH model output. Indices were chosen to include some of the more popular indices that have been identified to impact wildlife dispersal and survival success. Indices analyzed include habitat patch area, habitat edge, habitat core area, fractal dimension and shape. Additionally, PATCH specific output was analyzed including the number of source breeding sites, the sum of habitat weights, and the number of expected source sites. Source breeding sites are defined within PATCH as sites with an expected dominant eigenvalue greater that 1.0. A dominant eignevalue greater than 1 indicates that birth and out-migration is expected to exceed mortality and in-migration for the site. For this application, the determination of source breeding status is dependent solely on the amount and quality of habitat within a given territory. Table 1 includes a list of the variables used in this a brief description of each.

In the regressions, the dependent variable was the proportion of times that the final population was non-0. Various combinations of the indices were included as regressors. Because the dependent variable is a proportion, it is bounded between 0 and 1. We used a logit model in the regression analysis. Define y_i as an indicator variable for survival of species i: $y_i = 1$ if species i survives and equals 0 otherwise. The probability of viability (P_i) given X_i (a vector of landscape indices) is:

$$P_i = \Pr (y_i=1| X_i) = E (y_i \mid X_i).$$

The logit model takes on a particularly simple form:

$$\ln(P_i/(1-P_i)) = X_i B$$

The logistic model is not designed to handle 0 or 1 results. Therefore, a small positive constant (.005 in our case) was added (subtracted) to 0 (1) results to handle these data points as suggested by Greene (1990).

Results for selected regressions are included in Table 2 as well as correlation coefficients for selected variables in Table 3. A regression including all relevant variables produced an R-squared of .870. Regressions including the number of source breeding sites and the sum of the eigenvalues for all source sites performed best in regressions including only a single variable (R-squared of .817 and .820 respectively). As can be seen in Table 3 the number of source sites and sum of eigenvalues for source sites are almost perfectly correlated creating results that are quite similar. Traditional landscape indices proved to have low explanatory power in predicting population survival. A regression including all of the traditional indices (habitat area, sum of habitat weight, habitat edge, core area, fractal dimension, and shape index) produced an R-squared of only .451. Based on these results of simulation runs on static landscapes, the number of source breeding sites was established as the objective function. Though the sum of the eigenvalues for all source sites performed slightly better, the number of source breeding sights is easier to calculate and has a more intuitive appeal.

Optimization Module

Maximization of an objective function where the choice variables are decisions on when and where to harvest is inherently a very large problem. Complete enumeration of the solution space for harvest-scheduling problems are exponential in number of harvest units and number of time periods analyzed. Standard optimization techniques such as integer programming become intractable as the number of harvest units or the number of time periods becomes large. Furthermore, traditional gradient search techniques are typically inappropriate because the solution space is likely to be non-convex. Gradient search techniques tend to converge to a local optimum dependent on initial conditions and are unlikely to find global optimum.

Heuristic optimization techniques have been applied to problems where complete enumeration of the solution space is unrealistic due to the size of the problem and where gradient search techniques fail, due to the objective function not achieving the necessary convexity requirements. Heuristic algorithms typically use intelligent programming or randomness to establish rules to accept inferior solutions that allow the algorithm to extract itself from local optima and explore a larger subset of the entire solution space. In most large problems where heuristic programming is appropriate, global optimality of the heuristic solution cannot be assured. However, heuristic techniques have been applied to large computationally solvable problems and have been shown to identify “good” (i.e. close to the globally optimal) solutions at low levels of computational effort. Several different heuristics optimization techniques have been developed including simulated annealing, tabu search, and genetic algorithms. Heuristic optimization techniques have been gaining favor in forest management applications, most notably Session’s (1993) work with SNAPII, and Bettinger et al. (1997, 1998) and Boston and Bettinger’s (1999) work on maximization of timber production with aquatic and wildlife habitat constraints.

We used simulated annealing (SA) in our analysis. SA uses a random acceptance criterion to allow the algorithm to accept inferior solutions to the optimization procedure. By allowing inferior solutions to enter the solution space, SA is able to explore a larger set of the solution space than traditional gradient search techniques that would be likely to converge to local (non-global) optimum. Simulated annealing uses a temperature parameter and a cooling schedule to initially accept a large number of non-improving solutions. As the temperature is cooled the probability of accepting inferior solutions is reduced to zero.

The objective function we used is the sum of the number of source breeding sites in each of the 10 decades minus two penalty functions. Penalty 1 reduces the score of solutions that do not meet the total volume constraint. Penalty 2 is structured to penalize solutions with total source sites in individual decades less than an established level.

$$\text{Habitat Score} = \Sigma \text{ Source breeding sites} - \text{Penalty 1} - \text{Penalty 2.}$$

$$\text{Penalty 1} = \text{Volume dependent constant / SA temperature parameter.}$$

$$\text{Penalty 2} = \Sigma \text{ (\# of source sites less than established goal)}^2$$

During simulation experiments it was found that at lower harvest volumes a smaller constant in the numerator of Penalty 1 produced better results than higher constants. As the harvest volume constraint was increased we were less likely to find feasible solutions at the lower constant levels. Therefore, the constant in the numerator of Penalty 1 was increased with the harvest level so that the algorithm was likely to find feasible solutions. The denominator in Penalty 1 creates lower penalty values in the early stages of the optimization allowing a more liberal search of the entire solution space. As the temperature parameter decreases the size of Penalty 1 increases making infeasible solutions less attractive in the late stages of the optimization. Only feasible solutions are presented in the following tables (Penalty 1 = 0), and thus all solutions are in the same scale for all harvest volumes.

Penalty 2 acts to smooth the number of source sites in each decade. Initially an objective function of a simple 10 decade sum of source sites was tried. As harvest volumes were increased in these simulations the algorithm would reserve all source sites from harvest until the last decade at which time the number of source sites required to reach the volume constraint were harvested. Thus the algorithm was only penalized 1 point for each unit harvested in the last decade despite creating a significant risk to species survival in the last decades. We, therefore, desired to identify a penalty structure to encourage a relatively stable number of source breeding sites. The following penalty was created:

$$\text{Penalty 2} = \Sigma \text{ (40- number of source sites in a decade if less than 40)}^2$$

This quadratic penalty structure imposes a strong penalty for large deviations from the identified source site goal and imposes a small penalty for small deviations from the established goal (no penalty is imposed if the goal is achieved). The goal of 40 source sites per decade was established from the static analysis of landscape indices. It appeared that there was little risk of species extirpation on static landscapes with 40 or more initial source sites.

Figure 2 shows the basic structure of the simulated annealing algorithm used to solve this problem. Parameterization of the initial and final temperatures, cooling schedule and number of iterations per temperature are established on a problem-by-problem basis in simulated annealing. Several different parameter levels were tested for solution quality. The following parameters were identified as producing the highest objective function values of those parameters tested: initial temperature = 150, final temperature =.1,
cooling =.65 * previous temperature, iterations=15,000.

Timber Harvest and Species Survival Results

Once landscape trajectories over the study time period are found, this solution is fed into PATCH, which simulates the probability of species survival. We also calculate timber harvest volume. Plotting solutions for various levels of the timber harvest constraint we can trace out a frontier that comes close to the production possibility frontier.

Application of the Model to the Central Cascades Region

The time horizon for the current analysis is 100 years, with management activities occurring once each decade. On each management unit in each decade a management decision on whether to harvest or not is made. Timber stand growth and harvest yield are governed by relationships developed for Douglas fir and western hemlock stands in western Oregon (Curtis et al. 1981). Within the GIS image, coniferous forests are divided into 20 year age classes. Every second decade we update the age class on a unit by one, assuming there has been no harvest on the unit in that time interval. For simplicity, we define management units so that they correspond to spatial units used in the species population simulation module, which is a 17 hectare hexagon.

The study area is a 1.2 million hectare GIS image developed by Cohen (1995) of the Central Cascade region in Oregon that includes the Willamette National Forest. Population simulations were conducted on 50 randomly selected 62,500 ha sub-units of the Central Cascade image. The choice of this size analysis unit included consideration of several factors. Most importantly, we wish to have a landscape of sufficient size so that population persistence is not limited due to the number of territories. However, as stated previously, the size of the harvest-scheduling problem is exponential with the number of harvest units. Therefore, it is desirable to have a landscape that will have a relatively low number of harvest units when conducting the optimization process.

For this study we use a hypothetical wildlife species that is characterized by long life and low fecundity with a preference for older coniferous forests. In the future, we plan to parameterize the PATCH model to simulate species with combinations of small versus large body size, that are short versus long distance dispersers, and that are generalists versus specialists.

Simulation Results

We report results for a single initial landscape. The characteristics for this landscape are as follows:

- The landscape includes approximately 700 of 3800 units that meet the minimum 50% conifer constraint and are therefore, available for harvest.

- There are 23 initial source breeding sites with a total of 72 initial breeding sites on this landscape.

- There are 97 potential source breeding sites during the 100 year simulation.

We ran twenty simulations (2 sets of 10) at each harvest volume. The solution with the highest objective function of the set of 10 simulations at each volume was saved (2 solutions at each volume). Ten landscape maps were created from these resulting harvest schedules within PATCH (one for each decade). These maps were created from the original landscape image and represent the characteristics of the landscape each decade resulting from timber growth and scheduled harvest. We ran 100 wildlife population simulations of 100 years on each set of images with the wildlife species parameters in PATCH.

Table 4 shows the output from the simulated annealing algorithm and the corresponding simulation runs with graphical representation presented in Figure 3. Figure 3 represents a feasible production relationship between timber harvest and wildlife population persistence on the specified landscape. Timber harvest significantly competes with wildlife population survival at total 100 year harvest levels between 2.05 million mbf and 2.25 million mbf. At harvest levels below 2.0 million mbf solutions can be identified that do not result in the harvest of any of the source breeding sites. At these levels population survival is very high and is constrained primarily by the initial number of breeding sites on this landscape. At harvest levels greater than 2.25 million mbf population persistence is unlikely due to a majority of source breeding sites entering the harvest solution.

Figure 4 shows the relationship between the objective function score and harvest level. Variation in the objective function increases at higher harvest volumes. This result is likely due to the quadratic penalty function (Penalty 2) that dominates solutions with very high harvest volumes. Additionally, several solutions at the higher harvest volumes resulted in non-feasible solutions (the solution did not meet the harvest volume constraint).

Discussion

Due to the life history parameterization, the wildlife species used in the application in this paper can survive on an intensively managed landscape if a sufficient number of very high quality sites (source breeding sites) are maintained. The number of source breeding sites was the key determinant to species survival probabilities. Limited analysis was conducted to determine if the spatial location of a source site relative to nearby source sites was an important factor in determining the contribution of the site to overall population survival. It did appear that sites that were more than 10 units from their nearest neighbor were less likely to contribute to species survival than those units with neighbors less than 10 units away. Therefore, a spatial aspect that would discount source sites more than 10 units removed may improve solution quality. However, due to the inherent clumpy nature of the source site locations on the landscape we decided to postpone inclusion of this type of spatial component for future research.

In future work, we will explore different species with potentially more complex habitat objective functions. For different life history parameterizations, it is possible that different landscape features other than the number of source breeding sites will turn out to be most important. In addition, we plan to examine landscape management with multiple species, possibly with competitive habitat requirements, to examine tradeoff relationships among these species as well as between species and timber harvest volumes.

In the analysis conducted so far, we took as the economic objective total timber harvest volume over the 100 year period. Under this objective, there is no economic penalty for widely fluctuating harvest volumes (though there may be low species survival if there is little remaining habitat in some time period). Economic considerations such as downward sloping stumpage demand or costs of adjusting the levels of labor and capital in production would induce a penalty to fluctuations in harvest volume. However, due to the relatively small size of the landscape analyzed, a downward sloping stumpage demand curve is unrealistic. If we were to examine a larger landscape a downward sloping stumpage demand function may be appropriate. Also, using total timber harvest over time as the objective also assumes there is no penalty for delaying harvests as there would be positive discounting. In future work we plan to incorporate discounting and downward sloping demand.

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TABLE 1 Variable Definitions

RUN	Simulation run number.
N0	Number of 100 runs when final population >0.
LNP0	Logistic transformation of N0.
STS	Number of breeding sites identified by PATCH.
STS.1	Number of expected source breeding sites (PATCH).
LNST1	Log of STS.1.
LMBD	Sum of the expected dominant eigenvalues of all breeding sites.
LM.S	LMBD/STS.
LMB.1	Sum of the expected dominant eignevalues for all source sites.
L1.S1	LMB.1/STS1.
ST1.ST	ST1/STS
AREA	Area of all pixels qualifying as wildlife habitat.
WEIGHT	Number of habitat pixels times their weighted values.
EDGE	Length of habitat area edge.
CORE1	Habitat core area at least 1 pixel from non-habitat.
FRAC	Fractal dimension.
SHAPE	Landscape shape index.

TABLE 2 Selected logit regression results

LNP0 ~ STS + ST.1 + LM.S + L1.S1 + ST1.ST + AREA + WEIGHT + EDGE + CORE1 + FRAC + SHAPE

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	-58.9062	38.9087	-1.5140	0.1383
STS	0.0334	0.0261	1.2801	0.2083
ST.1	0.0670	0.0633	1.0584	0.2965
LM.S	26.8439	37.7022	0.7120	0.4808
L1.S1	26.9698	18.4234	1.4639	0.1514
ST1.ST	6.8831	7.1036	0.9690	0.3387
AREA	0.0000	0.0000	0.5965	0.5544
WEIGHT	0.0000	0.0000	-0.6448	0.5229
EDGE	0.0000	0.0001	-0.2116	0.8336
CORE1	0.0000	0.0000	-0.6420	0.5248
FRAC	-9.0854	13.7120	-0.6626	0.5116
SHAPE	0.0160	0.0827	0.1934	0.8477

Residual standard error: 1.02 on 38 degrees of freedom
Multiple R-Squared: 0.8698
F-statistic: 23.07 on 11 and 38 degrees of freedom

LNP0 ~ ST.1

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	-2.8848	0.3155	-9.1449	0.0000
ST.1	0.1395	0.0095	14.6275	0.0000

Residual standard error: 1.076 on 48 degrees of freedom
Multiple R-Squared: 0.8168
F-statistic: 214 on 1 and 48 degrees of freedom

LNP0 ~ AREA + WEIGHT + EDGE + CORE1 + FRAC + SHAPE

Coefficients:

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	11.1679	9.6761	1.1542	0.2548
AREA	-0.0001	0.0001	-2.2145	0.0321
WEIGHT	0.0000	0.0000	3.0577	0.0038
EDGE	0.0002	0.0001	1.8328	0.0738
CORE1	0.0000	0.0000	1.0453	0.3017
FRAC	-10.6493	25.4907	-0.4178	0.6782
SHAPE	-0.2449	0.1510	-1.6214	0.1122

Residual standard error: 1.968 on 43 degrees of freedom
Multiple R-Squared: 0.4511
F-statistic: 5.891 on 6 and 43 degrees of freedom

LNP0 ~ STS + ST.1 + L1.S1

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	-30.3906	18.5362	-1.6395	0.1079
STS	-0.0141	0.0076	-1.8484	0.0710
ST.1	0.1752	0.0237	7.3805	0.0000
L1.S1	26.4847	17.5728	1.5071	0.1386

Residual standard error: 0.9989 on 46 degrees of freedom
Multiple R-Squared: 0.8488
F-statistic: 86.06 on 3 and 46 degrees of freedom

LNP0 ~ LMB.1 + ST1.ST

	Value	Std. Error	t value	Pr(>|t|)

```
(Intercept)  -4.7724   0.6871    -6.9453   0.0000
      LMB.1   0.1151   0.0099    11.6828   0.0000
     ST1.ST   8.6973   2.8506     3.0510   0.0037

Residual standard error: 0.986 on 47 degrees of freedom
Multiple R-Squared: 0.8495
F-statistic: 132.6 on 2 and 47 degrees of freedom
```

LNP0 ~ LMB.1

```
               Value Std. Error  t value Pr(>|t|)
(Intercept)  -2.8685   0.3116    -9.2060   0.0000
      LMB.1   0.1316   0.0089    14.7693   0.0000

Residual standard error: 1.068 on 48 degrees of freedom
Multiple R-Squared: 0.8196
F-statistic: 218.1 on 1 and 48 degrees of freedom
```

TABLE 3 Correlations coefficients for selected variables

	RUN	N0	LNP0	ST.1
RUN	1.000	-0.031	0.048	0.050
N0	-0.031	1.000	0.946	0.893
LNP0	0.048	0.946	1.000	0.904
N5	-0.026	0.993	0.962	0.898
LNP5	0.050	0.944	0.989	0.885
N10	0.007	0.958	0.974	0.911
LNP10	0.031	0.939	0.983	0.900
STS	0.030	0.806	0.754	0.907
ST.1	0.050	0.893	**0.904**	1.000
LNST1	0.003	0.880	0.844	0.941
LMBD	0.033	0.815	0.766	0.917
LM.S	0.018	0.596	0.641	0.540
LMB.1	0.052	0.893	**0.905**	**0.999**
L1.S1	0.043	0.288	0.333	0.212
ST1.ST	0.022	0.586	0.642	0.545
AREA	0.222	0.428	0.380	0.531
WEIGHT	0.174	0.627	0.555	0.733
EDGE	0.266	-0.030	-0.001	0.040
CORE1	0.118	0.590	0.509	0.688
FRAC	0.209	0.418	0.384	0.543
SHAPE	0.206	-0.428	-0.348	-0.422

TABLE 4 Simulation Results of Model Output

#	Harvest Volume	Habitat Score	Pr(Survival)
1	2.05	-194	.80
2	2.05	-232	.85
3	2.10	-601	.53
4	2.10	-568	.50
5	2.15	-1191	.27
6	2.15	-1057	.25
7	2.20	-1410	.10
8	2.20	-1660	.06

Table 5 Decadal Harvest Volumes and Source Site Examples

Decade	0	1	2	3	4	5	6	7	8	9	Total
Solution 1											
Volume (1000mbf)	366	391	259	150	56	43	76	73	282	355	2,050
Source Sites	23	22	36	36	49	48	55	55	61	37	422
Solution 8											
Volume	425	414	247	141	27	51	101	99	288	409	2,200
Source Sites	22	21	30	25	37	36	39	34	34	11	289

FIGURE 1 MODEL COMPONENTS

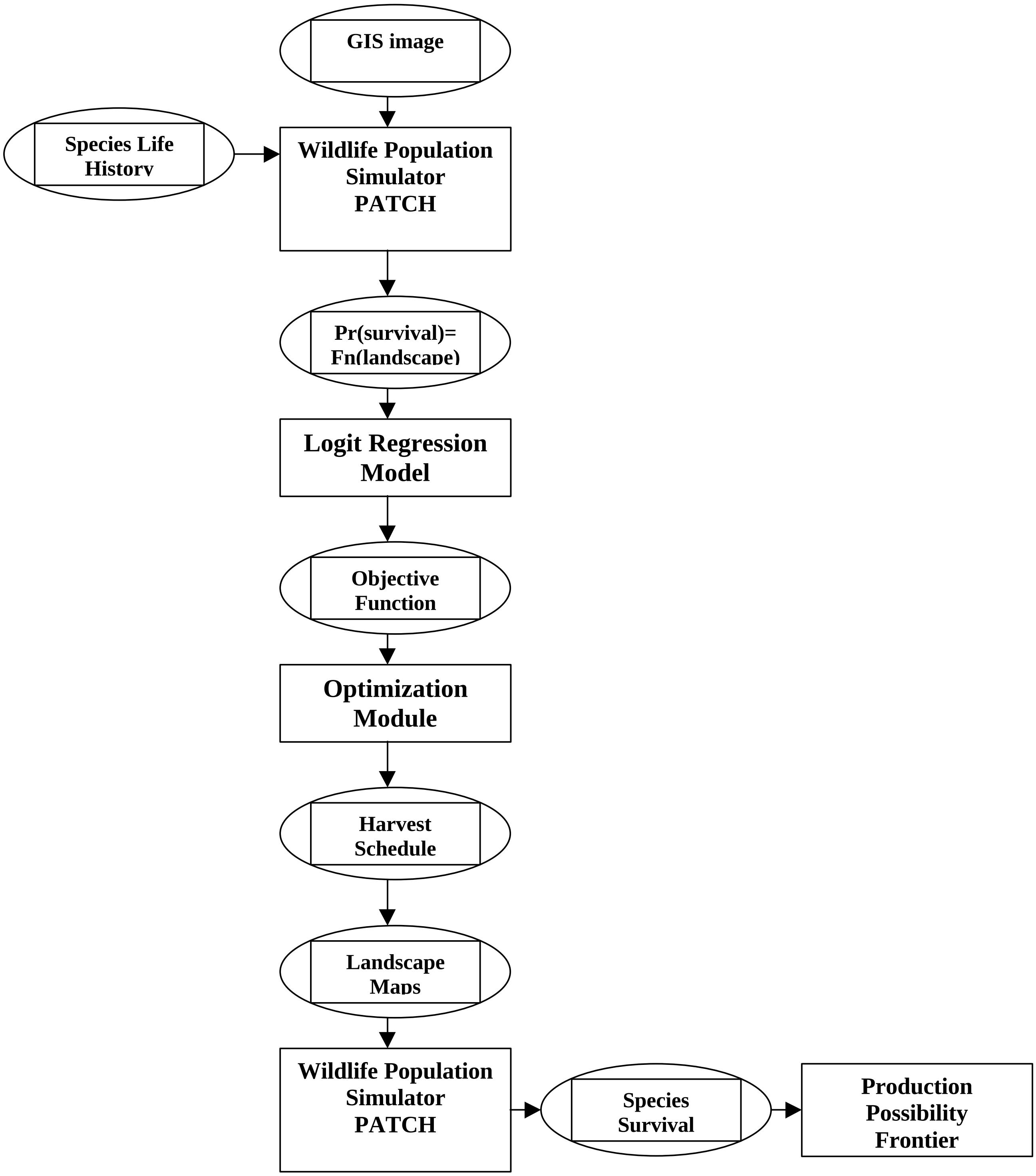


FIGURE 2 SIMULATED ANNEALING FLOW CHART

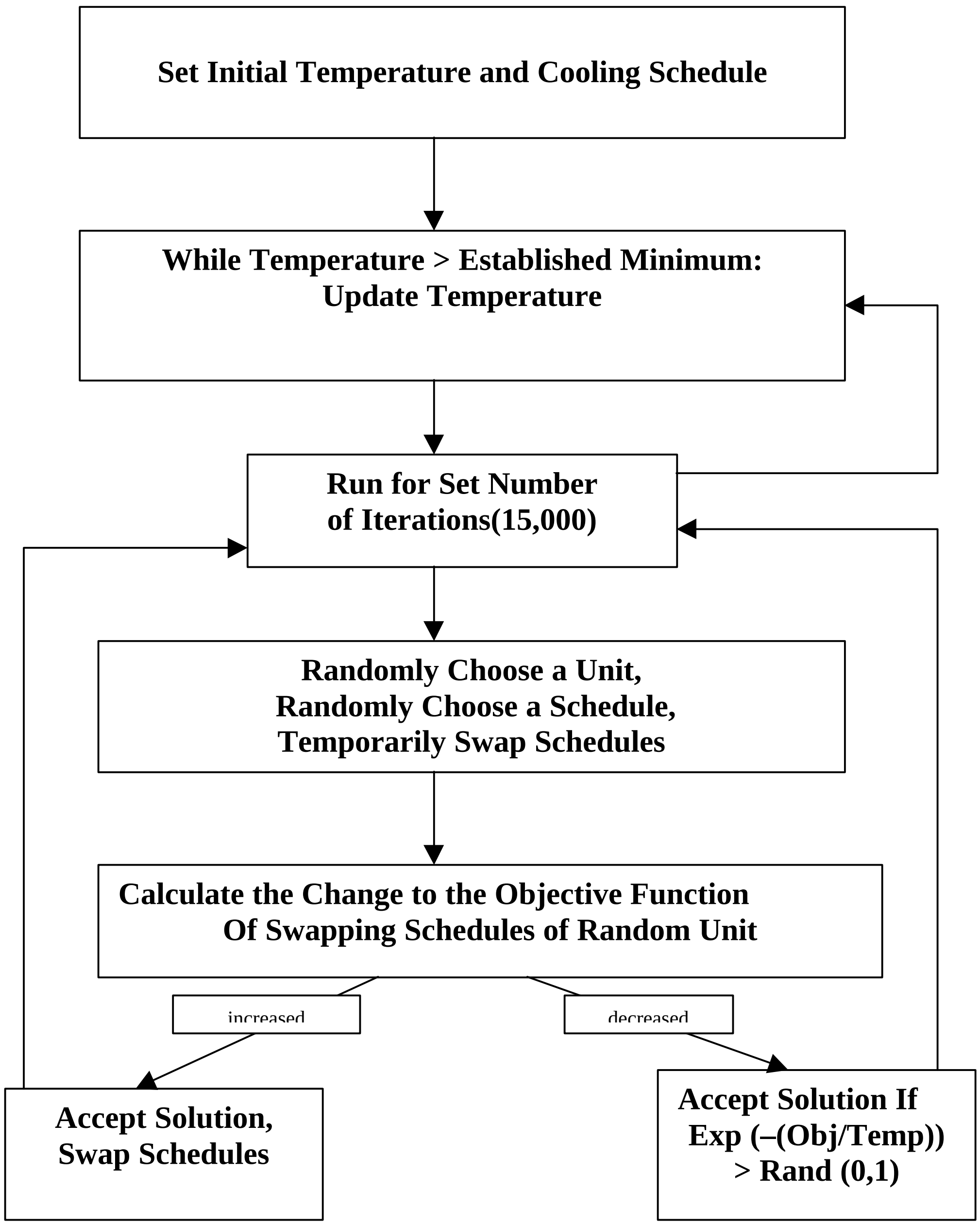


FIGURE 3

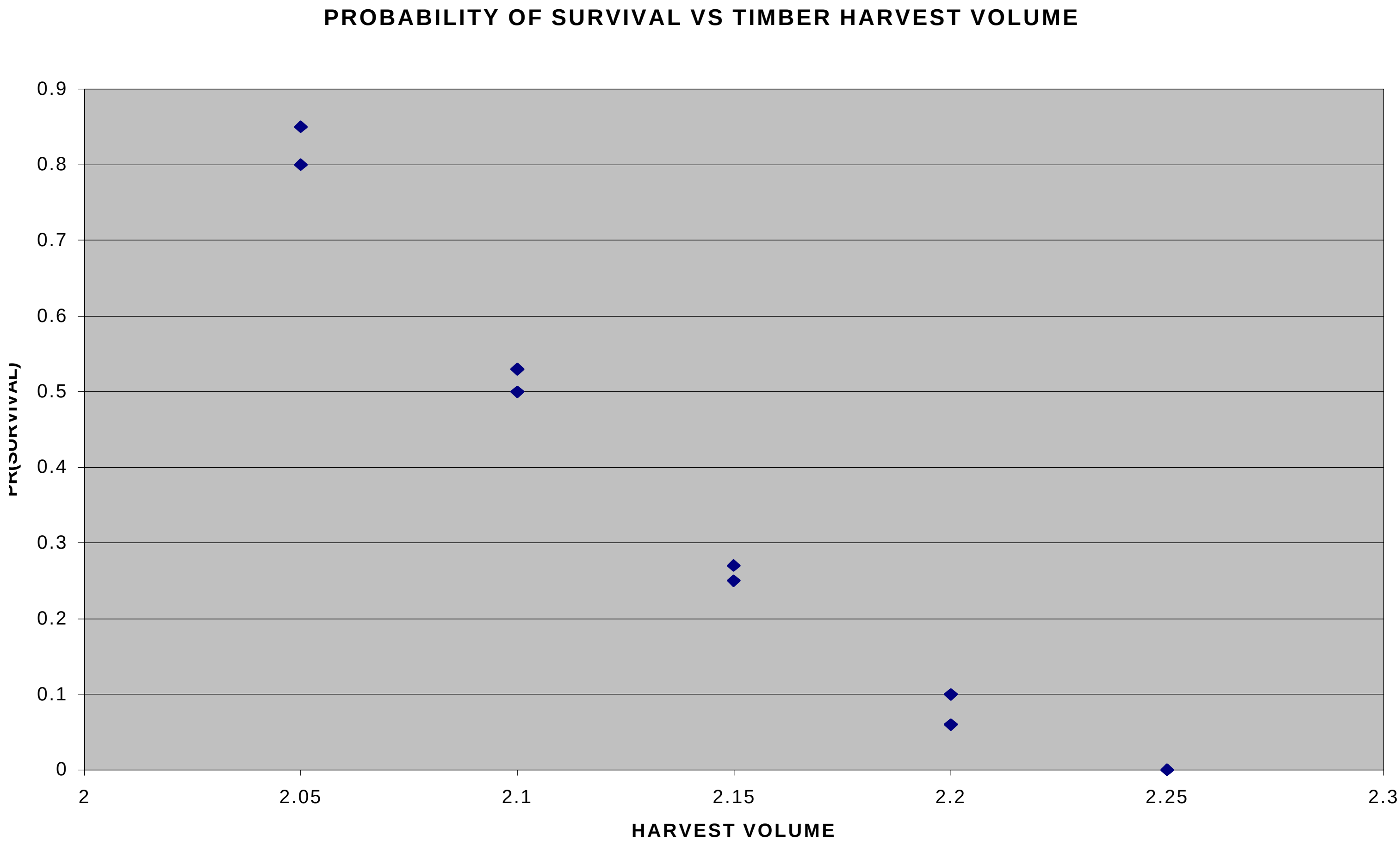
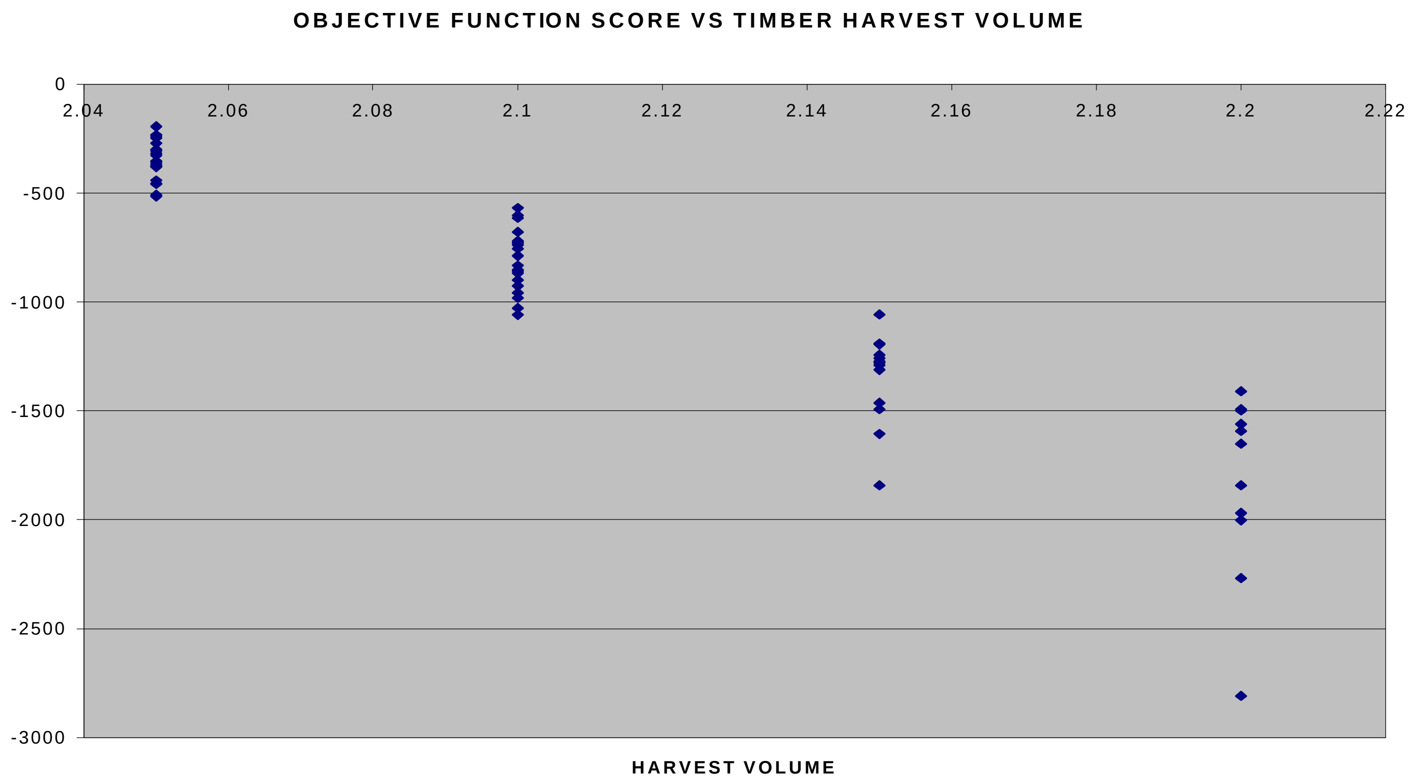

PROBABILITY OF SURVIVAL VS TIMBER HARVEST VOLUME
PR(SURVIVAL)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2
2.05
2.1
2.15
2.2
2.25
2.3
HARVEST VOLUME

FIGURE 4


OBJECTIVE FUNCTION SCORE VS TIMBER HARVEST VOLUME
0
-500
-1000
-1500
-2000
-2500
-3000
2.04
2.06
2.08
2.1
2.12
2.14
2.16
2.18
2.2
2.22
HARVEST VOLUME

Valuing Outdoor Recreation Effects of Rural Conservation Programs: Constructing Travel Cost Models When Recreational Sites Are Ill-defined

Daniel Hellerstein, USDA, Economic Research Service B Summarization

Dr. Hellerstein's presentation is made in light of the growing importance of land conservation programs, such as the U.S. Department of Agriculture (USDA) Conservation Reserve Program (CRP). A basic premise behind this program is that it is desirable to ameliorate the negative impacts of agriculture. Rural conservation programs such as the CRP can have substantial effects on outdoor opportunities, effects whose value can be measured using non-market valuation techniques. For example, such programs can ameliorate bad agricultural practices that can muddy waters, and lower fishing and swimming quality of waterways. Dr. Hellerstein's analysis focuses upon the CRP, but the problems in analyzing the CRP (e.g., heterogeneity and dispersion) are likely to be present in a number of other rural conservation programs.

Dr. Hellerstein provided a summary for his talk, noting that he would discuss the impacts of agriculture on the rural environment, how federal programs modify these impacts, how the CRP and "environmental targeting" improves the rural environment, and finally some methodological issues of their study.

Dr. Hellerstein made the assertion that agriculture is a natural resource-intensive activity. In the lower 48 states, agriculture accounts for over one-half of all land use, and three-quarters of all freshwater withdrawals. Dr. Hellerstein showed a map illustrating the extent of agricultural lands in the U.S., and noted that 70% of the U.S. population lives in a county in which at least 10% of the county is farmland, and 23% of the U.S. population lives in a county in which at least 50% of the county is farmland. Agriculture affects the rural environment by causing siltation and nutrient runoff, groundwater contamination (it has been estimated that 50 million people live in an area that has some groundwater contamination resulting from agriculture), air quality impacts (the dustbowl effect, to take an extreme example), habitat loss and harm to threatened and endangered species (it has been estimated that 383 species that are listed as threatened or endangered are listed in part because of the effect of agriculture).

A number of federal programs, however, aim to reduce these impacts by encouraging farmers to use environmentally benign practices. Dr. Hellerstein noted that in his ten years of service at USDA there has been an increased emphasis on environmental quality, and that there are a variety of USDA programs that are quite expensive. Also, some USDA agricultural support programs condition receipt of government support payments on compliance with conservation objectives, such as the Swampbuster law.

USDA spends a great deal on land set-asides, the largest of which is the CRP. The CRP was established in 1985 and currently covers about 30 million acres (about 10% of cropland acres) and costs about $1.3 billion per year. The CRP typically pays a farmer 50% of the cost of establishing some perennial cover, and also gives the farmer an annual rental payment. In exchange, the farmer is expected to idle the land for ten to fifteen years, after which the land much more resembles a natural state in which there is less erosion and more habitat for naturally occurring species.

Dr. Hellerstein showed a map of CRP lands as of 1992, which is not much different from a map of how it looks today. Dr. Hellerstein noted that most of the CRP lands are in places where land is inexpensive, raising the question of whether this is a good criteria by which to award CRP funds. Maximizing the benefits of the CRP may well improve the environmental performance of the CRP, giving rise to the environmental targeting method, in which some judgment is made as to how valuable the agricultural land is as set-aside.

The goals of the CRP include:

- reducing soil erosion, which was the main focus of the CRP when the program was initiated in 1985,
- reducing sedimentation,
- improving fish and wildlife habitat,
- providing income support for farmers (this was a much more salient goal in 1985),
- protecting soil productivity,
- improving water quality, and
- curbing the production of surplus agricultural commodities.

The results of Dr. Hellerstein's April 1999 study examined how environmental targeting could be used in the CRP to provide greater environmental benefits, and more outdoor recreational opportunities. The study is titled "Economic Valuation of Environmental Benefits and the Targeting of Conservation Programs: the Case of the CRP," by Peter Feather, Daniel Hellerstein and LeRoy Hansen (USDA AER #778, http://www.econ.ag.gov/epubs/pdf/aer778). Environmental targeting is defined as "... the practice of directing program resources to lands where the greatest environmental benefit is generated for a given expenditure, or alternatively, specific environmental goals are achieved for the least cost." Or, it can be stated more simply as getting the biggest "bang" for the buck.

Where can we invest the $1.3 billion so that we maximize the environmental benefits, or more importantly, where can it be invested so that it can benefit people the most? So the study asks the question, "what happens when alternative mechanisms are used to allocate land to the CRP?" In particular, the study examines the impact of the CRP on outdoor recreation. There are two forms of environmental targeting: first, using the original 1985 erodibility criteria, essentially assigning most CRP lands to erodible lands, and second, using the Environmental Benefits Index (EBI) used in the 1997 sign-up of the CRP. Using the EBI, farmers offer parcels of land for enrollment under the CRP, and each parcel is rated on different attributes of environmental value, such as cost, erodibility, soil leachability, proximity to water bodies, and measures of locally affected populations. Since more land is offered by farmers for participation in the CRP than there is money to accept, parcels are accepted on the basis of some index. The EBI is one such index.

Dr. Hellerstein's study focused upon three recreational activities: (i) freshwater-based recreation, (ii) wildlife viewing, and (iii) pheasant hunting. These activities are important, and are also conducive to analysis that uses revealed preference techniques. Other CRP benefits such as duck hunting, and improvement of habitat for endangered or threatened species may be very important but are hard to measure because of the lack of revealed preference data.

The study's primary results were that switching CRP targeting criteria from erodibility to the EBI approximately doubles the benefits of freshwater-based recreation and wildlife viewing. CRP wildlife recreation benefits are significantly larger than freshwater-based recreation benefits. The study also found that population should be considered when targeting CRP lands, an aspect that had previously been accounted for only indirectly. Finally, the study concluded that valuation-based targeting of the CRP is feasible and may improve the environmental performance of the CRP.

Using an EBI instead of an erodibility index for targeting CRP lands results in an increase in estimated benefits of $92.5 million (from $36.4 million to $128.9 million) for freshwater-based recreation, and an increase of $287.4 million for wildlife viewing (from $347.7 million to $635.1 million), and a decrease of $10.1 million for pheasant hunting (from $80.2 million to $70.1 million). This is out of a total of about $30 billion in freshwater-based recreation, $6 billion for wildlife viewing. Dr. Hellerstein noted that this might be considered a substantial though not very large portion of the total value of these forms of recreation.

Dr. Hellerstein then began discussion of the methodological issues associated with the study. In order to model the impact of the CRP on outdoor recreation, behavioral data is needed to ascertain how people use the rural environment for outdoor recreation. Also, biophysical data is needed to help measure the features of the rural environment that might affect outdoor recreation. Also, data is needed as to where people visit to link behavioral data to biophysical data. Finally, demand models are needed to predict how changes in land uses impact the value, which can generate estimations of surplus and allow the welfare analysis that is needed to assess the CRP.

The broad geographic dispersion of the CRP complicates this analysis, in that the CRP does not change a particular site, and the individuals visiting these sites are not highly committed to visiting these sites. Also, some CRP programs change the quality of many recreational sites. Both of these factors make all four of the analytical steps for conducting welfare analysis more difficult.

Behavioral data answers the question: "what is the American public's use of rural environment for outdoor recreation?" The behavioral data used consisted of the 1992 National Survey of Recreation and the Environment for water-based recreation, which consisted of 1500 respondents; and the 1991 Fishing, Hunting and Wildlife Associated Recreation Survey for pheasant and wildlife, which consisted of 22,000 hunting and fishing respondents and 23,000 other respondents who engaged in non-consumptive uses. The former survey was fairly detailed in that a serious attempt was made to identify where people visited. On the other hand, the latter survey was fairly thin on where people visited, but consisted of count data on the number of trips that were taken by each respondent. So the latter data base was larger but required more econometric manipulation.

Biophysical data is needed to answer the question: “how do changes in land use influence environmental quality?” The data used for all three models were derived from the 1992 National Resources Inventory, developed by the Natural Resources Conservation Service, which consists of an 800,000 point sample, and includes information on over 100 variables, including land use, vegetative cover, and soil type. This information does not say very much about water quality or wildlife, and sometimes does not identify location very well.

Data on where people visit is needed to answer the question: “how to determine influence of environmental and socioeconomic characteristics on the recreational uses of the rural environment?” Aggregated sites were used. Thus, rather than interpreting data as an individual visited a particular site, the data is aggregated to reflect the assumption that individuals visited some county or sub-county. The hope is that the characteristics of sites within a county or sub-county are relatively homogeneous.

For the freshwater-recreation model, 14,400 sub country areas, or NRI polygons, were used. For the pheasant hunting model, sixteen semi-circular “quadrants” were drawn around each respondent, and the attributes of each zone were measured. For the wildlife viewing model, nineteen semi-circular “quadrants” were drawn around each respondent. Dr. Hellerstein presented a graphical illustration for each set of geographical units.

Characteristics of aggregated sites were determined using NRI point data and information gathered using Geographic Information Systems surface techniques to determine the fraction of land in the CRP. To determine what aggregated sites were visited, there was a common problem in determining exactly which aggregated site was visited. Ancillary information on site names was used to determine the NRI polygon visited. Where the respondent did not know the site name, she was asked if she knew how far and what direction the site was. For the pheasant hunting model, an indicator function based on the breeding bird survey was used to determine the correct quadrant. For the wildlife-viewing model, flexible aggregation, was used to create quality and price indices.

For modeling demand, a two-stage discrete/count model was used to model demand of water-based recreation, and consumer surplus was computed using the count of trips made. A two-stage discrete/count model was also used to model demand for pheasant hunting trips. A gravity model was used to model demand for wildlife viewing trips, and consumer surplus was computed using a benefit transfer analysis of per-trip values.

The study concluded first, that it is possible to value the impacts of changes in the rural environment on outdoor recreation; second, that targeting the CRP can substantially increase the benefits generated by several outdoor recreational activities; and third, that determining the site visited in data sets such as the ones used in this study requires careful consideration.

Policy Discussion of Session Two

Katherine Smith, USDA, Economic Research Service B Summarization

Perhaps the most important lesson that the presentations provide is that when discussing issues of rural land use policy, context is very important. When one considers the variety of contexts in which policy can affect land use decisions, the decision-making process becomes quite complicated. Dr. Smith thus adopts a land use designation by one of four types of values or goods produced from the land: goods of commercial value, recreational and related values, option or existence value, and development value (see Table 1: Policy Influences on Rural Land Values).

With respect to land that produces goods of a commercial value (typically agricultural products), the goods are generally of a private nature, accruing mostly to the benefit of local farmers, yet policies affecting the value of such goods are generally not local. While there are some local policies pertaining to nuisance law and right-to-farm laws, federal agricultural policies affect the value of these goods much more. In addition to federal agricultural policy, state and federal environmental policy and tax policy have a significant influence on these values, by affecting the net returns from agricultural activity. Thus, although the value affects local farmers, the policies affecting the value are typically of a national or state level, possibly giving rise to a disconnect between the site of the value of the goods and the site of the policy-making.

For lands that yield recreational and related values, the goods can take on a variety of natures. The goods can be private and local, private and valued by a distant (urban, for example) population, club goods (which may be local or distant, but are typically non-rival insofar as a group is able to exclude all others), or public goods (which may be local or distant, but are both non-rival and non-excludable). Recreational and related land use value is affected by state and federal environmental laws such as the Endangered Species Act, but also by federal policies, which have been used recently to preserve rural amenities. The rural amenity preservation use of national agricultural policy has been notable lately because it is sometimes claimed in the international trade arena to be a barrier to trade, a topic of considerable controversy as evidenced by the World Trade Organization protests in Seattle. Recreational and related land use value is also affected by local zoning policy. Thus, there are several different levels of policy that can affect recreational and related use values. Which is "best" to use, or how policies unrelated to recreational use value might need to consider implications for that use value, are the kinds of questions that attention to the context of the land use policy raises.

A third set of values produced by rural land is option or existence value as open space, which is the value of the option of retaining the land as open space, since development of the land is irreversible. Existence value is the value of knowing that the land is preserved in an open space state, even if one does not plan to visit the land and use it. These values reflect public goods, and also luxury goods because they are things which are valued more as income increases. Dr. Smith thus hypothesizes that the option and existence values of land as open space are centered in urban areas, where income is greater and more concentrated. The value is thus distant from the land itself. Although some federal environmental policies affect option and existence value, the more typical policy intervention affecting these nonuse land values involves local zoning laws. This again suggests the potential for a big gap between the beneficiaries of the open space and those who enact the policies that affect it.

The fourth type of value that might be produced by a single parcel of land that also has agricultural use, recreational use, and option and existence values, land is value directly related to its potential developed use. Development of land is highly path-dependent, and as Dr. Bockstael's work illustrates, is influenced greatly by nearby land that is used in similar ways. The development value of land is privately held and locally observed. But because the development value of land is affected both by relative spatial and intertemporal dimensions, this land value is influenced by all of the policies that affect all three of the other types of values -- agricultural use value, recreation use value, and option and existence value. This is why when one asks about the federal role in rural land use policy, or the appropriate level of government for addressing sprawl or farmland preservation issues, it is very difficult to come up with a simple answer. Given the spatial and temporal interactions demonstrated by several of the papers presented in this session, and the potential differences between the initiators and beneficiaries of land use policy as outlined by Table 1, it is clear that more conferences of this type are needed to further discuss the types of policies that are appropriate and effective in governing rural land use.

Table 1: Policy Influences on Rural Land Values

Rural land value	Realized as…		Influenced by…	
	Type of good	Proximity	**Type of public policy**	Geopolitical level
Commercial agricultural use	Private	Local	Farm legislation Environmental regs. Nuisance; Right to Farm Tax	Federal Federal, State Local State, Local
Recreational and related use	Private Club Public	Local; Distant Local; Distant Local; Distant	Farm legislation Environmental regs. Zoning	Federal Federal, State Local
Option and Existence	Public	Distant; Local	Some environmental (e.g., Endangered Species Act) Zoning	Federal Local
Potential developed use	Private	Local	All of the Above	

Policy Discussion of Session Two

By Brian Heninger, US EPA, Office of Economy and Environment

I want to begin by briefly describing my own background and perspective on land use policy and economic analysis. While my main area of research at the EPA has been in air quality issues, I also have a background in land use issues from teaching Land Economics at the University of Massachusetts in Amherst for two years, and at the University of Connecticut I did research into landowners knowledge and attitudes about the preservation of their privately owned forested and other undeveloped land. I will draw upon these experiences through out my talk.

I applaud the contributions of the three papers and want to begin by briefly describing the very different approaches each of the authors used in discussing economic analysis and land use policy. Nancy Bockstael's paper took the approach of trying to explain land use patterns and discussed the lessons we can learn from this analysis, while Stephen Polasky's paper focused on how to efficiently pursue multiple land uses on the same parcel of land by balancing economic and ecological goals. The third paper by Daniel Hellerstein looked at valuing the multiple recreational effects of the Conservation Reserve Program (CRP). The three papers taken together help to increase our understanding of the value of open space, how to preserve it and how to use it efficiently.

First, I would like to provide a brief synopsis of the three papers. Beginning first with the paper presented by Nancy Bockstael, "Changing Land Use Patterns at the Urban-Rural Fringe," I agree with the authors of the importance of incorporating "interaction effects" into the model, as it leads to predicting very different patterns of land use conservation (than plain monocentric models). I also find the adaption from interacting particle system theory extremely interesting. One of the policy implications from this work are better insights into the repelling and attracting influences of development, as described in Dr. Bockstael's presentation. The negative externalities of denser development has to balance with the increased transportation costs of getting around and the increased difficulty of being supplied with public services. The "tug of war" between these repelling and attracting influences is where policy makers can have their influence. For example, I am an avid researcher and proponent of increased gasoline taxes for the control of air quality. I want to emphasize that this policy tool can have impacts on land use, as an increase in these taxes will not only have the short run effects of decreasing the average yearly miles traveled by individuals, but it will also have the longer run effects of influencing individuals' and businesses' locational choice, leading to denser development patterns. Another example of a policy relevant tool to this paper is zoning. More zoning rules or increased enforcement of existing zoning rules can reduce the negative externalities of denser development patterns.

Stephen Polasky's paper dealt with reconciling conflicting economic and ecological goals on a parcel of land. He developed a modeling framework to trace out the production possibilities frontier between a species survival and timber harvest. This gives us the efficient combinations of wildlife population and value of timber harvest. Future work could incorporate multiple species and more complex habitat objective functions. Multiple use is an increasingly popular land use objective. With this comes increasing conflicts; between economic type goals such as recreation; e.g., cross country skiers vs. snowmobilers or between ecological goals, such as species populations; e.g., wolves vs. elk.

The paper presented by Daniel Hellerstein focused on valuing the multiple benefits (particularly recreation benefits) of the Conservation Reserve Program (CRP.) The CRP encourages planting of protective cover, grasses, trees, buffers, wildlife habitats etc. It is a voluntary program where the participating landowners can get annual rental payments, utilize incentives and take advantage of cost sharing. This represents the costs of the program, while the benefits of the program are: water quality protection, erosion prevention, protection of wildlife habitat and much more. The program can even use "environmental targeting" since the number of applicants for entrance into the program is greater than the available openings. This allows the program managers to rank applicant's land based upon its characteristics and its location, so the land is where people want it and where it can provide the most benefits. Valuing these multiple benefits of land uses encouraged by the CRP is important to justify the program.

However, EPA has a limited set of tools to directly affect land use patterns. Most land use decisions are decided locally. National lands are managed by the Department of the Interior, or the Department of Agriculture, which also influences land uses of agricultural land through its policies. However, EPA can indirectly affect land use in a variety of ways. It can promote its agenda through regulations which indirectly influence land use, or through partnerships with other federal agencies, states, localities, industry, and civic groups. EPA is also often involved with funding research which helps us better understand our environment and land.

Sometimes the relevant policy tool is education. In the state of Connecticut, 60% of the land is forested, and 88% of that forested land is what is termed non-industrial private forests or land owned by regular folk. Forty two percent of the forested parcels in the state are less than 50 acres and 21% are less than 20 acres. The average age of a forest land owner in the state is over 60. So, as land is passed on to multiple heirs, it is often split up into several sub-parcels. And even when all the heirs agree that they would like to keep the whole parcel of land forested and protected, it is often not possible as, escalating land prices in the 1980's have caused the amount of estate taxes owed on the land to be extremely high. Surveys show that many heirs are unprepared or unable to pay these high estate taxes and are forced to sell their land or a portion of their land just to pay their estate taxes. This all too common situation causes the further fragmentation of forest land in the state. Several other states are likely to be in the same situation as Connecticut. The average value per acre of forest land decreases as fragmentation occurs, since larger tracts of forests are better for wildlife habitat and the protection of water quality. So, in this case, educating land owners as to how to prepare for estate taxes, and teaching them about the wide variety of conservation tools and options available to them is a useful policy tool to influence private land use.

There is a vast literature on methods to conserve open space. I remember a paper which advocates subsidizing dairy production (supporting milk prices) in New England in order to encourage the positive externalities of open space land used in dairy production. While this type of policy will help to preserve beautiful landscapes, it will also lead to surplus milk, cheese and other dairy products being produced unnecessarily. There are many more direct ways to preserve open space and influence land use.

In closing, I would like to thank the three presenters for their interesting work. Although, their papers were very different from one another, each had its own contribution to make, as to how we think about land, and what role EPA and other regulatory agencies can play in influencing land use and private land use decisions.

Question and Answer Period for Session Two

Molly Espey, Clemson University, asked Dr. Bockstael if she had data on the size of parcels, and if that had any effect on the decision to develop. Dr. Bockstael replied that this data was being analyzed in other work she was doing, and this data was being used along with zoning data to actually predict the value of parcels. In the research presented in this workshop, Dr. Bockstael did not include data on parcel size, but only included parcels that were zoned in such a way that they could be developed.

Kerry Smith, North Carolina State University, asked Dr. Hellerstein about calculating the net benefits of the Conservation Reserve Program (CRP). Dr. Smith noted that in recent years the CRP has been an auction program in that individuals are required to state how much payment they would require to be brought into the CRP. Dr. Smith asked if these bids are the values that are used to calculate net benefits. Dr. Hellerstein replied that the bids were considered a cost for purposes of calculating the Environmental Benefits Index (EBI), and was a fairly important factor in terms of ranking parcels and identifying parcels to be enrolled.

Dr. Kerry Smith asked a second question regarding a comment made by one of the discussants to the effect that EPA does not have a role in land policy. Dr. Smith was hesitant to agree with such a statement, and noted the example of non-attainment areas, and how EPA is responsible for managing the consequences of land use. Although it is currently not the norm to think about land use as a reason for non-attainment, it seems like a natural connection, especially in that non-attainment often simply has to do with the fact that people live in the non-attainment area. Dr. Smith likened the situation to water quality regulation, where we tend to think about point sources and technology-based standards, but that we could as well think of non-point sources and management strategies for an entire watershed. Fundamentally, Dr. Smith proposed meeting a set of more comprehensive goals with a different framework of regulation. Dr. Brian Heninger, US EPA, replied that he did not mean to say that EPA did not have a role in determining land use, but that EPA did not have a large *direct* role in such issues. However, Dr. Heninger agreed that EPA does have a number of indirect tools. For example, the designation of an area as non-attainment does carry with it significant land-use implications, including the location of new facilities or transportation projects.

Katherine (Kitty) Smith, USDA ERS, emphasized that although land use may not be a principal policy goal, federal policy can have a substantial effect on land uses. The important question to be answered now is whether these federal programs with other goals ought to be directed at land use goals. Dr. Bockstael noted that the Chesapeake Bay provides an interesting example, in that there are many different goals for the area, particularly nutrient loading, so tributary strategies and tributary goals have been developed for meeting these goals. These tributary strategies do not align themselves with any political jurisdiction. In looking at these strategies, it is important to realize that generally speaking, there is usually very little any jurisdiction can do to forbid the construction of a house. Subdivision development can be postponed, but usually can’t be prevented, because local jurisdictions have no bases on which to stop development. Rural development, in particular, may pose environmental problems in that when there is no public sewer service, septic systems used in lieu of sewer service leak and exacerbate nutrient loading problems. On the other hand, a Bay Journal article recently reported that the wastewater treatment for the region is close to capacity, so that wastewater treatment may not even be an option. The problem of where to put people becomes a very complicated one, especially since there is this non-alignment of ecological domains, economic domains, and political jurisdictions. Sven Kaiser, US EPA Brownfields Office, added that EPA has traditionally had an end-of-pipe approach, but has looked at changing that approach in favor of a more comprehensive approach. For example, Mr. Kaiser's Brownfields Office is working with the EPA Office of Air and Radiation to look at State Implementation Plans to develop programs where credits can be issued for land uses that are likely to have favorable air impacts. The same thing can be done for water quality regulation, in light of the Total Maximum Daily Load requirements that are being developed by states. Dr. Kitty Smith pointed out that USDA has been doing this for 50 years, providing direct payments to landowners, and noted that there are problems there as well, so that using the local jurisdiction as an arbiter may be effective.

John Miranowski, University of Iowa, asked Dr. Bockstael, in light of her statement that there is little that a local jurisdiction can do to prevent development, if there are control variables for economic incentives in their model that might modify development patterns. Dr. Bockstael replied that this was not considered in this work, but other research she is conducting looks at how these land management tools affect the probability of development. Some of the policy tools that Dr. Bockstael considered include minimum lot-size zoning, provision of public water and sewer services, land preservation programs (Dr. Bockstael's STAR grant research addresses this), and adequate public facilities moratoria. Smart growth is aimed at two things: buying land and removing it from the pool of developable land, and taking away incentives for sprawl development by not investing in infrastructure (including transportation) in places where development is undesirable. These are the policies that are being built into the land use models Dr. Bockstael is working on. The zoning and sewer policy tools, which attempt to make development more expensive, do not seem to be as effective as local public jurisdictions have expected them to be. The desire to leapfrog development out to those areas is so great that these disincentives are insufficient to stall sprawl development. Were Dr. Bockstael able to calibrate her models sufficiently, she might be able to predict the level of disincentive that would be necessary to stall sprawl development. Dr. Bockstael noted that these policies actually have had the opposite effect; for example, large-lot zoning requirements have provided perverse incentives to develop low-density housing. Dr. Bockstael also wondered if we were thinking ahead enough regarding possible new instruments.

Clay Ogg, US EPA Office of Policy Development, complimented Dr. Hellerstein for his work because of its relevance to a program that was already in place. Dr. Ogg noted that Dr. Hellerstein had focused upon the Environmental Benefits Index, and asked if Dr. Hellerstein had looked at continuous sign-up programs, which half of the state agricultural land preservation enrollment programs have adopted. Dr. Hellerstein replied that their research did not look explicitly at this, although it could be incorporated into their model.

David Martin, Davidson College, asked Dr. Bockstael if it was appropriate to incorporate the probability of successful habitat preservation or some environmental benefits index into her model so that it could map out how future development would look if we were being environmentally conscious. Dr. Bockstael replied that this was being incorporated in her other models as part of her current research with a number of ecologists, who are able to identify spatial development patterns that are better for various species. There is currently not a great deal of feedback from this sub-model, because development is not generally located next to the habitat of sensitive species. Dr. Bockstael added that some fragmentation patterns were generally not harmful to some species. Dr. Polasky added that his research considered this, particularly since the forest management model essentially allowed the modeler to play God, so to speak, in terms of being able to prescribe management solutions and trade off timber harvests against species survival. Ideally, species survival information could be fed back into the PATCH model utilized by Dr. Polasky. Dr. Martin also asked Dr. Bockstael if the clustering pattern of development was a reflection of the land simply becoming available for development or if it was the result of utility maximization by landowners. Dr. Bockstael replied that the clustering development pattern was neither occurring randomly, nor as the result of the monocentric central business district model, when tested against the repelling forces model, although the latter test was the focus of her presentation.

Matt Clark, US EPA NCERQA, cited predictions that there will be 100 million more people in the U.S. in the next 50 years, and asked the speakers if they had any ideas of what a model of optimal growth would look like. Dr. Hellerstein responded that even with an additional 100 million people, there will still be very much rural land available, and that the notion that population growth will eat up agricultural land is wrong, except for certain places, such as the Central Valley of California. Dr. Bockstael replied that whether population growth impacts rural land does indeed depend on where you are. The coastal states are experiencing high population growth and are under strong pressures. If land development patterns do not change, there will be dramatic effects. Dr. Bockstael also noted that we are bumping up against constraints such as water quality requirements, which may become even more binding in the future. Dr. Polasky referred to a recent National Academy of Sciences study that discussed big environmental problems and trends over the next 50 years, and one problem the study identified was land use conversions, including but not limited to conversions from agriculture to residential land uses. Dr. Polasky commented that this problem is more pressing in developing countries, both in terms of population growth pressures as well as species richness.

Ted Su, Bureau of Land Management (BLM), commented that federal land management agencies such as BLM should have had something to say about the topic of land management, and that EPA alone will probably be unable to solve complex land use problems. Dr. Su, commented that BLM management emphasizes multiple use and sustainable yield. That is, consider the natural and cultural resources, what is the best way to manage activities such as mineral development and grazing, or in short, what is the best way to manage the land. Dr. Su asked if indeed there is a mathematical solution in which all of the alternatives can be identified and modeled, commenting that such a model would necessarily be complicated. Dr. Kitty Smith commented that one can model multiple objectives over time and space, but that it was difficult to get the right weights, incorporating social preferences.

Dr. Kerry Smith asked Dr. Polasky about the proper measurement of timber output. Dr. Smith noted that Dr. Polasky's model used board-feet, and asked Dr. Polasky if it might not be more accurate to use present value of prices of timber or expected present value of prices. Dr. Polasky replied that it would be easy to put in present value and expected values. One reason that Dr. Polasky's team has not done this thus far is that the objective function is highly sensitive to species breeding patterns. Introducing discounting when the species breeding aspect of the model is not yet highly refined leads to strange results, such as cutting a lot of timber in some time periods. However, Dr. Polasky agreed that looking at dynamic prices would be interesting. A second question posed by Dr. Kerry Smith referred to species interaction effects, and what to do to take into account such effects, since disturbing the habitat of one species necessarily disturbs a number of other species as well. Dr. Polasky replied that even taking into account the simplest predator-prey relationship, the model becomes considerably more complicated. While one way of attacking this problem is to attempt to model a multitude of species, another way is to attempt to address the needs of a "flagship" species such as the grizzly bear, such that by addressing the needs of this species one can be reasonably certain that the needs of a multitude of other species will be addressed as well. A third question posed by Dr. Kerry Smith hypothesized that it is simply impossible to solve these problems in time to influence any policy outcomes, so that a more appropriate question might be one of how much insurance should we buy, or what do we think we need to repair damaged ecological resources? Dr. Polasky replied that we are currently only answering very rough questions of insurance, and that this may give us some idea of where to concentrate resources.

Mary Ahearn, USDA ERS, commented that she was impressed that Dr. Hellerstein and Dr. Polasky were able to actually quantify program benefits. Dr. Ahearn posed two questions: first, given that there is much uncertainty over the economic benefits and costs of programs, how much longer do we have to wait for good information, and second, can we use economic models? Dr. Polasky replied that economists are accustomed to framing things in terms of objective functions, which makes economic models simpler.

Steve Winett, EPA Region 3, asked the speakers about the effects of climate change. Dr. Polasky replied that there is some concern that environmental changes will affect land set-asides. Dr. Hellerstein replied that there is work being done at USDA ERS, but that it is focused on the effects on agriculture. Dr. Bockstael replied that one way of thinking about this question is in terms of rising sea levels and how we protect ourselves and avoid investing in infrastructure that will be under water. Dr. Bockstael commented that the Federal Emergency Management Agency was interested in this work.

Economic Analysis and Land Use Policy

PROCEEDINGS
Panel Discussion on Innovative Approaches to Land Use

A workshop sponsored by the
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Proceedings for Panel Discussion

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Panel Discussion of Innovative Approaches to Land Use

Tim Torma, EPA Office of Policy, Economics, and Innovation --Summarization

Mr. Torma began by noting that his presentation involves not a paper but a project, the Atlantic Steel Redevelopment project, which is innovative from a policy standpoint and which has significant smart growth implications. Mr. Torma noted that one indication that the research being done in this area is exciting is the number of ballot box measures that are being considered that involving land use. There has been an upward trend since 1996 in ballot initiatives, when there were 100 initiatives nationwide, up to 240 in1998, and even in this off-election year, in which there are approximately 100.

The Atlantic Steel Redevelopment project is a brownfields redevelopment project in Atlanta, Georgia. Atlanta has been touted as the "capitol of the New South," has attracted a number of desirable industries including the 1996 Summer Olympic Games, and has generally experienced high population growth. Atlanta's economic expansion, however, has also had its negative impacts, including increased traffic congestion - Atlanta moved from 24th among major metropolitan areas to sixth in traffic congestion. Vehicle miles traveled per capita is 35, the highest in the U.S. Atlantans drive a total of 100 million miles per day. The reason for this congestion is sprawl development. A recent Time magazine article called the sprawl development in Atlanta a thirteen-county eruption which consumes 500 acres of open space every day.

Some recent developments have forced Atlantans to consider smart growth strategies. One is that Hewlett Packard decided not to construct their planned headquarters building in Atlanta, citing traffic and congestion as a main factor in changing their plans. Another event is when Atlanta fell out of conformity with Clean Air Act requirements and lost their federal transportation funding. A number of things are now being done to change the way Atlanta develops property, including the Atlantic Steel redevelopment project.

The Atlantic Steel site was a steel mill since the late 1800's, and is currently unused. The location is very desirable, but has poor local access. The Jacoby Development Corporation obtained an option to construct a mixed-use development on the property, and obtained the requisite city rezoning approvals. The 140-acre proposal is expected to contain 2400 residential units, 17,000 jobs, and 1.2 million square feet of retail space. The site is a regionally central location, which is good for smart growth purposes, and is located across the interstate 75 from a MARTA (Metropolitan Atlanta Rapid Transit Authority) station. Local access is poor because of the blocking effect of the interstate, which is fourteen lanes wide. Despite the existence of foot bridges across the interstate, access is poor because the trip across is extremely unpleasant. Mr. Torma also noted that high rises have sprung up on the downtown side of the interstate, but not on the other side, because of the poor local access.

EPA became involved with the redevelopment project because Atlanta requires the project to include a multi-modal bridge with a mass transit link and on/off ramps to the interstate, and because Atlanta is out of compliance with Clean Air Act requirements. The bridge could not be built because Atlanta is out of conformity, and could not be built without federal funding. EPA's regional managers considered using Project XL to assist the developer. Project XL, which stands for Excellence and Leadership, is a regulatory reinvention initiative developed in1995 by the President and Vice-President that is aimed at finding cleaner and cheaper ways of protecting the environment. To the regulated community, EPA proposes that if regulations are unsatisfactory to them, that they propose their own regulations to achieve superior environmental performance. Through Project XL, then, EPA granted the Atlantic Steel developer some flexibility in developing the site, in exchange for superior environmental results. EPA wanted to allow construction of the bridge because, through much modeling work, it was determined that the redevelopment would result in fewer vehicle miles traveled, reduce consumption of open space and achieved the cleanup of a brownfield site. The presumption is that growth will occur, and EPA considered the impacts of development in three alternative sites, all of which would lead to greater vehicle miles traveled and consumption of open space, and would not have the benefit of a brownfields clean-up. EPA predicted that this dense 140-acre project in mid-town Atlanta, if placed in an urban fringe greenfield area, would consume 600-1000 acres. A 1997 groundwork study by EPA's Office of Policy showed that infill development could lower vehicle miles traveled would be 50% lower than comparable urban fringe, greenfield development. Infill sites also had lower CO_2 and NOx emissions, and reduced infrastructure costs than comparable greenfields developments.

The federal role of EPA has been a sensitive subject, since local officials would prefer not to have EPA involved in local zoning decisions, and EPA would similarly prefer not to be involved. EPA has identified three appropriate federal roles in development decisions: developing tools and information, creating incentives and providing resources, and removing barriers, which was the most important EPA role in the Atlantic Steel project. The first lesson from the Atlantic Steel project is that EPA is especially interested in creating local partnerships with state and local governments, and with citizens and environmental groups, because none of these entities can deal with land use issues alone. All of these entities need to be involved for these initiatives to occur. The other lesson to be learned from this project is that economic growth must occur hand-in-hand with environmental protection. That is, growth must be assumed to be occurring, and the strategies must focus upon how to manage that growth.

Mr. Torma displayed a list of contacts:

Web site address for Project XL: http://www.epa.gov/projectxl/

EPA headquarter contacts:	Geoff Anderson	202-260-2769
	Tim Torma	202-260-5180
EPA Region 4 contact:	Michelle Glenn	404-562-8674

Panel Discussion of Innovative Approaches to Land Use
Sven-Erik Kaiser, US EPA Brownfields Program -- Summarization

Mr. Kaiser began by reinforcing Tim Torma's point of how visionary it was for the Atlantic Steel brownfield site developer to construct a bridge across the 14-lane highway running through downtown Atlanta.

Mr. Kaiser introduced the EPA Brownfields Program, which is working with more than 300 communities in assessing, cleaning up and redeveloping brownfields sites. The program has leveraged more than $1.5 billion in public-private funds, and supported the creation of more than 5,000 jobs, using grants, tax incentives, revolving loan funds and job training programs. The term "brownfields" is a condition of property, and is defined as abandoned, idle, or underused industrial or commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination problems. Brownfields could also be more simply described as properties where re-use is complicated by environmental contamination issues. The wider universe of brownfields sites includes:

> 1300 federal "Superfund" sites, those on the Superfund law's National Priority List;
>
> 11,000 that are potential Superfund sites;
>
> 30,000 sites that were potential Superfund sites but were determined to be inappropriate candidates for Superfund listing;
>
> 70,000 sites in state hazardous waste site listings;
>
> 3600 sites that are subject to Resource Conservation and Recovery Act regulations that require special federal or state permitting for treatment, movement or storage;
>
> 300,000 underground storage tank sites
>
> 42,000 solid waste facilities

This totals up to approximately 430,000 total sites. After screening out these sites for overlap and duplicate permits, the total is approximately 380,000 sites. However, if we account for the fact that cities under-report by almost 50%, then the total goes back up to 500,000 or 600,000 total sites. A Cleveland State University professor estimated that if all of the brownfields properties in the Great Lakes area were cleaned up, there would be enough real estate to accommodate growth for 100 years.

The EPA brownfields program is designed to facilitate clean-up of all sites, particularly those other than the federal Superfund sites that are on the National Priority List. EPA awards grants, changes regulations, funds research, and works with other agencies and organizations to accomplish this. Some of the issues considered by EPA include the costs and effects of cleaning up and re-using these properties. EPA funded a recent report that looked at 107 redeveloped brownfields sites and examined the costs of clean-up, the sources of funding for clean-up, how the funding was used, the re-uses to which the properties were put, the effects of the clean-up and re-use, and the populations impacted. The report findings included the following:

- the average size of the site was five acres;
- sites tended to be smaller when located inside cities;
- the average cost of assessment per site was approximately $50,000;
- the average cost of clean-up was approximately $50,000 per acre;
- for every dollar of public monies spent on brownfields redevelopment, $2.50 of private monies were contributed; and
- job creation costs, mostly from job creation programs, were approximately $14,000, which is low compared to the environmental benefits.

Another study currently being done for EPA is a greenspace study, which is pointing toward a finding that an acre of brownfields redevelopment saves three acres of greenfields from development. Brownfields redevelopment thus has the multiple effects of reviving urban communities, helping suburban communities reduce sprawl, and helping rural communities deal with growth. The long-term implications of brownfields redevelopment, however, are still not clear. As opposed to the short-term impacts of siting decisions for undesirable land uses, little is known about the land use costs and other costs of removing the undesirable land uses, such as for example, an incinerator. There is a wide perception or feeling that the benefits of removing undesirable land uses, which include such intangible benefits as job creation, and re-using these properties is very large, but it has not been quantified.

Mr. Kaiser raised a question of public subsidies, in that EPA is awarding grants and funding research in attempting to encourage brownfields redevelopment activity. Mr. Kaiser posed the question of the level of subsidy that is required to induce the activity. The initial assessment, which Mr. Kaiser characterized as "lifting the rock," is perceived as being a critical step, and has proven to be very important to attracting private investment in brownfields redevelopment. Mr. Kaiser also announced that EPA is putting on a brownfields redevelopment conference in Dallas, Texas the following week.

In closing, Mr. Kaiser emphasized how fertile an area this was for research, incorporating questions of transportation choices, land use choices, water quality choices, and air quality choices. Mr. Kaiser provided the EPA website for brownfields redevelopment, www.epa.gov/brownfields. Mr. Kaiser also provided his phone number, 202-260-5138.

Question and Answer Period for Panel Discussants

Dr. Kerry Smith, North Carolina State University, asked how brownfields redevelopment relates to policies of the Department of Housing and Urban Development (HUD). Mr. Kaiser noted that the properties being developed are not strictly urban. Mr. Kaiser added HUD generally has provided approximately $4.6 billion per year for community development block grants, and works with 20 different federal agencies in distributing these funds. EPA is one of these agencies, although most of the other agencies have as their mission economic development.

Dr. Bockstael asked if cities are becoming hollowed out because of poor infrastructure decisions. She used the example of a 14-lane highway in mid-town Atlanta, which has the effect of creating great noise and air pollution, and driving away residents. Moreover, these hollowing-out effects, because of the permanent nature of the infrastructure, seem irreversible. Mr. Torma responded that much of the 140-acre site is insulated from noise pollution. He also noted that noise is one of the factors people consider when trading off the convenience of living in the city with such disamenities. Mr. Torma added that in some cities, sufficient political will has been generated to remove roads for various reasons, including the disamenities produced by roads. Mr. Kaiser responded by citing the example of Milwaukee Mayor Richard Norquist, who spoke of the "Berlin Walls" of our cities, in which partitions are cutting people off from each other. Milwaukee has thus dug up some of the roads that run through the downtown area.

Dr. Bockstael asked the panelists if local governments ever welcome EPA's presence because it provides them with a way to say "no" to developers. Mr. Torma replied that EPA is not trying to slow growth, but rather provide tools to better manage growth, believing that these tools will lead to better decisions and to better environmental quality, the only reason that EPA is involved in this area. Mr. Kaiser agreed that for EPA to talk about slow growth is politically dangerous, so that it is better for EPA to speak in terms of growth choices. Even using the term "sustainability" is dangerous. EPA has thus been careful not to say they are slowing growth, but are talking about re-using properties (in the brownfields case), re-directing growth, and about creating jobs. Mr. Kaiser also recognized that EPA had not dealt extensively with rural areas. Mr. Kaiser's office also works with National Association of Development Organizations to look at rural development projects. A study on rural brownfields development is forthcoming.

Sid Wolf, Environmental Management Support, commented that EPA's brownfields policy is moving towards giving local communities more say about what is going on. However, it may be important for EPA to assume more of a role in planning, especially since EPA is designing the cleanup remedy, and undertaking other measures. Mr. Torma emphasized again that it is important to avoid the appearance that EPA is interested in assuming a larger role by perhaps changing local zoning regulations. Mr. Kaiser added that some people have thought the brownfields program to be the federal effort to inject itself into the land use planning process, but Mr. Kaiser assured that rather, the brownfields effort is to redress the land use planning to re-use property. Shi-Ling Hsu, Environmental Law Institute, pointed out that EPA may need to assert itself in the planning process because there is a national interest in even local land use planning decisions. Without representation from a federal agency, local land use agencies will ideally arrive at a set of land use planning decisions that may be optimal from a local perspective, but sub-optimal from a national perspective. There may be, in a sense, a "race to the bottom" in terms of local land use decisions. Mr. Torma responded by emphasizing that a number of local elections have revealed that local land use has become an important political issue, but EPA still cannot enter the process and operate from a top-down regulatory role. Mr. Kaiser noted that air quality and water quality standards do, in effect present a floor, or “bottom,” and that the threat of punishing local communities that violate these standards is something that must be balanced against the efficacy of EPA's role in local decisions.

Dr. Kerry Smith asked if an alternative to many of the proactive brownfields incentives is simply to change the liability scheme. It has been clear that the joint and several liability provisions of the Superfund law has caused the price to redevelop browfields to be too high. Mr. Kaiser replied that EPA has long advocated the removal of the innocent purchaser liability provisions, yet has been unsuccessful because the large companies that are actually responsible for the original pollution have fought reform. Dr. Smith also asked if the money being spent on brownfields program was effective enough, and provided enough incentives for people to move back into these areas, or was ineffective, and was tantamount to “shoveling sand against the sea.” Mr. Kaiser replied that there are many cities and many projects all over the country that are successfully redeveloping brownfields sites, and disagreed that the brownfields program was futile.

Ken Acks, Environmental Damage Valuation and Cost Benefit News, pointed out that the liability issue is also a state issue, in that states have worked out their own brownfields laws, and have worked with EPA in redevelopment efforts. Mr. Kaiser agreed, adding that several states, including New Jersey and Pennsylvania, have reconciled environmental and economic issues in moving properties through their brownfields programs. In those states that have not resolved this issue, large sums of money have been set aside, but are not being used by cities because the entry barriers posed by the legal issues are still too great.