RELATIONSHIPS BETWEEN HOUSING DENSITY AND TIMBER HARVEST IN THE UPPER LAKE STATES

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Introduction

Natural resource managers throughout the United States frequently cite the increasing proximity of forestland to human development as a growing concern (Wear et al. 1996, Riemann and Tillman 1999). The expansion of urban areas, suburban development, and the influx of residential and recreational development into previously forested areas may reduce the amount of forest interior habitat, exacerbate the invasion of exotic species (Theobald et al. 1997), limit the range of forest management practices that can be used (Cubbage et al. 1995, Wear et al. 1999), and alter the structure of native vegetation (Riemann and Tillman 1999).

Nonmetropolitan areas throughout the U.S. Midwest are undergoing significant increases in housing growth rates. Such rural sprawl is especially prominent in areas with attractive recreational and aesthetic amenities (Radeloff et al. 2001, Hammer et al. 2003). In the Upper Great Lakes, many summer-oriented recreational counties have 30-50% of all housing units rated as seasonal-use dwellings (Beale and Johnson 1998). While each single new house causes negligible impact, the accumulation of these individual changes over time and within a landscape or region may constitute a major impact (Theobald et al. 1997). Housing change may affect timber harvest when forest area declines due to deforestation and when management practices on the remaining forests are altered in response to a changing social context (Hull and Stewart 2002).

Prior research has indicated that timber-harvesting rates may be closely related to human population density (Barlow et al. 1998, Dennis 1989, 1990, Wear et al. 1999). However, by using population density as a predictive variable these studies do not consider the possible effects of seasonal homes, which increase housing density without corollary increases in population density. Solid assessments of these effects are thus critical to predicting future timber production and sustainable harvest levels. ***Here, we examine the relationship of housing density to basal area, removals, and mortality of forests in Michigan, Minnesota, and Wisconsin***.

Approach

Forest Inventory and Analysis (FIA) data from the Minnesota 1990, Michigan 1993, and Wisconsin 1996 inventory cycles provided information on timber removals, basal area, and mortality rates (Hahn and Hansen 1985). U.S. Decennial Census data were used to calculate housing density at the partial block group level (see Hammer et al. 2001, Radeloff et al. 2001).

Using ArcGIS, we calculated housing densities within 1 km buffers placed around each FIA plot. Scatterplots, logistic regression, and analysis of variance (ANOVA) were then used to examine the relationships between housing density and timber removals, standing basal area, and mortality. Variables included in logistic regressions and ANOVAs were considered significant at the p=0.05 level. Prior to performing these analyses, the data were transformed if necessary to ensure that statistical assumptions were met.

Results and discussion

Scatterplots comparing volume of timber harvest to housing density within a 1 km radius indicated a strong negative relationship between these two variables. 90% of all harvest events occurred at housing densities below 5.5 houses/km^2 in aspen, 10.3 houses/km^2 in maple/beech/birch, 10.8 houses/km^2 in jack pine, 12.0 houses/km^2 in red pine, and 16.8 houses/km^2 in oak-hickory (Fig. 1). Timber harvests generally occurred at lower housing densities in pine and aspen forests as compared to hardwood stands. Regression of logit harvest against log housing density indicated that housing density was significant at $p = 0.002$.

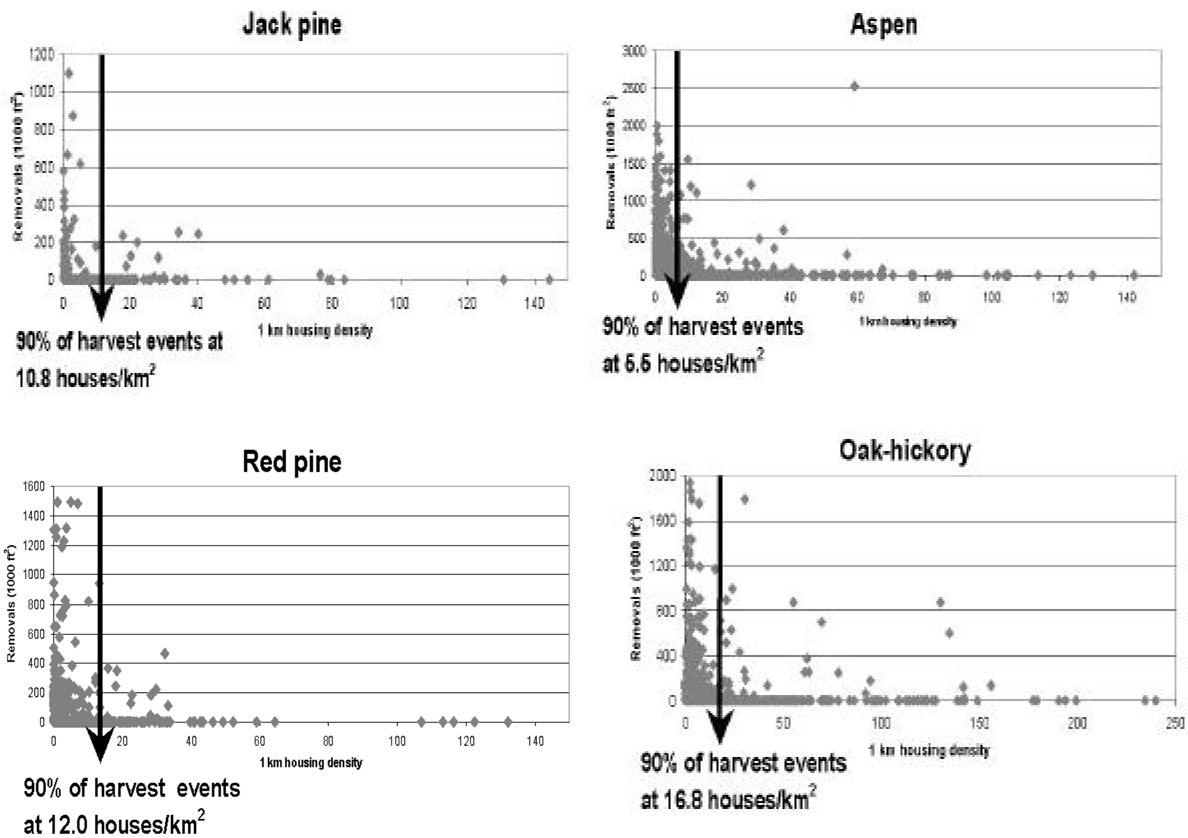

Figure 1. Timber removals vs. 1 km housing density for four forest types in the Upper Lakes States

The relationship between housing density and timber harvest varied across ecological subsections. For example, in subsections that contained 100 or more maple/beech/birch plots, the housing density below which 90% of harvest events occurred varied from fewer than 5 houses/km^2 to nearly 30 houses/km^2 (Fig. 2). A general linear model fitted to these data indicated that not only was log housing density significant, but ecological subsection, forest type, and interaction between housing density and forest type were all significant at $p \leq 0.02$ (Table 1).

Scatterplots indicated possible negative relationships between housing density and both basal area and mortality. When linear models were fitted to these data, log housing density, ecological subsection, forest type, and interactions between ecological subsection and both forest type and housing density were significantly related to log mortality at $p \leq 0.03$ (Table 1). Housing density was not significantly related to standing basal area alone, but ecological subsection, forest type, and interactions between ecological subsection and both forest type and housing and housing density were significantly related to log basal area at $p < 0.0001$ (Table 1).

	Log Housing Density (HD)	Ecological Subsection (ES)	Forest Type (FT)	FT*ES	FT*HD	HD*ES
Log Harvest	0.023	0.003	0.014	ns	0.015	ns
Log Mortality	0.03	< 0.0001	< 0.0001	< 0.0001	ns	0.004
Log BA	ns	< 0.0001	< 0.0001	< 0.0001	ns	< 0.0001

Table 1. P-values for linear models of harvest, mortality, and basal area

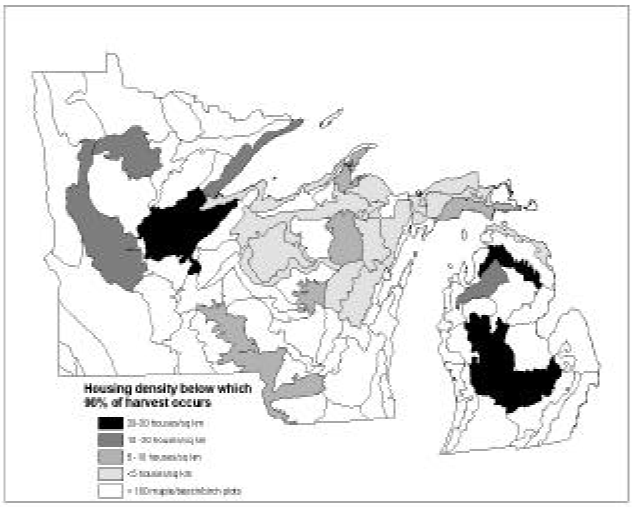

Figure 2. Housing densities below which 90% of maple/beech/birch harvests occurred, by ecological subsection

Conclusions

Harvesting rates are closely related to housing density, even in sparsely populated areas. This may be due to negative public attitudes towards silvicultural treatments, ownership fragmentation, or changing management objectives. Our analyses indicated the importance of controlling for ecological subsection and forest type when analyzing the effects of housing density on timber harvest. Similarly, housing density, ecological subsection, and forest type all significantly affect mortality. These results suggest the Upper Lakes states may experience substantial decreases in timber harvest if housing density continues to increase in the future.

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