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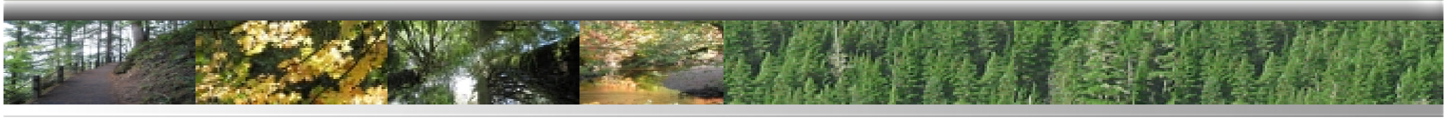

The FORSight Resource

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Upcoming Events...

SAF National Convention
Oct 23-27
Portland, OR
http://www.safnet.org/natcon-07

INFORMS Annual Meeting
WSU Convention Center
November 4-7, 2007
Seattle, WA

http://meetings.informs.org/Seattle07/

Southern Forestry and Natural Resource Management GIS Conference
March 24-26, 2008
Orlando, FL

http://soforgis.net/2008/

Inside this issue:

Deer browsing threatens hardwood regeneration

White-tailed deer (*Odocoileus virginianus*) elicit stronger emotion than any other game species in North America. Over the past century they have become a fixture of the outdoor experience, pursued by hunters and viewed by countless other outdoor enthusiasts. Despite widespread admiration, they are seen by many foresters and biologists as a serious threat to forest ecosystems. This is especially true in Pennsylvania and the surrounding states, where deer threaten the sustainability of forest management activities. In response to these threats, public agencies and private individuals have invested significant resources in constructing and maintaining deer exclusion fences. This article briefly discusses the threat posed by deer, deer exclusion fence and associated management concerns, and how harvest schedule modeling can be used to reduce fence costs.

The detrimental effects of deer on forest ecosystems are widely recognized. Over-browsing can result in partial or complete natural regeneration failure. This is particularly true in the northeastern United States, where over-browsing has eliminated tree seedling, sapling, and shrub layers from large forest areas. Regeneration is obtained naturally in nearly all these hardwood forests. Without natural regeneration, forest management cannot be conducted in a sustainable manner. Furthermore, over-browsing may shift stands toward a less diverse species composition. Deer are selective feeders, consuming preferred plants first and leaving behind non-preferred and browse-resilient species. This alters understory species composition and steers stands toward alternate successional pathways.

Deer impacts on future stand value are widely recognized. Some authors have estimated stand value losses as high as

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Is Your Inventory Up To The Task? Part I

Harvest scheduling analyses simulate alternative management regimes across a forested landscape to determine the best mix of silvicultural treatments to produce a desired objective, such as maximizing present net value, maximizing harvest levels or minimizing costs of production. In none of these different objectives should inventory data be the limiting factor in determining the scope of the analysis; instead, ownership goals (and constraints) should guide the analysis. Ideally, every acre on the ground should be tied back to good, clean, logical inventory data but at a minimum, stand attributes such as density, age, site quality, and cover type should be available such that every stand can be assigned to strata in a straight-forward manner. Unfortunately, in our experience this is rarely the situation.

Forest inventories can be described along two important dimensions, what we'll call sufficiency and suitability. Sufficiency indicates whether the data within the inventory meet or eclipse the threshold for a purpose the data are supposed to

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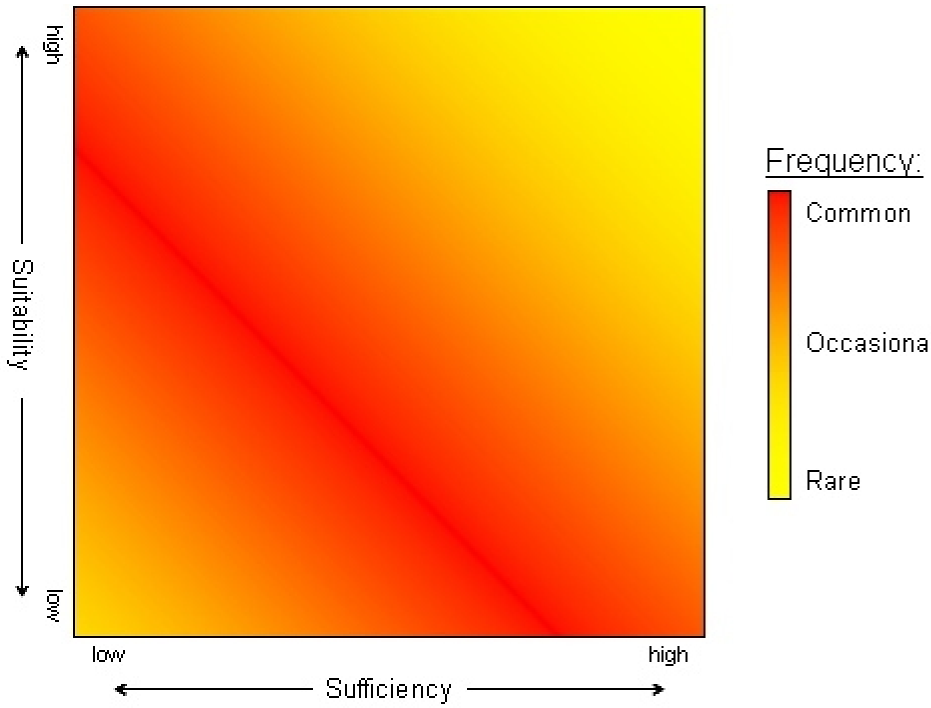
serve. For example, if the ultimate goal is to produce a harvest schedule, the data must be able to be run through growth and yield models. These models typically have a set of required inputs (age, site index, basal area, trees per acre, et cetera) and a set of suggested, but optional additional inputs. If enough information is present within the data to supply the required minimum inputs with a reasonable level of confidence, then the data are sufficient for growth and yield modeling. Sufficiency therefore has multiple thresholds, one for each purpose the data must satisfy. The data might be sufficient to run all stands through the model. Or the data might be sufficient for a particular stand to be run through the model, but not for all stands. Going a step further, the data might be sufficient to support stratification, after which the growth model can be run for each stratum. To evaluate an inventory's sufficiency, the uses to which it will be put must be known. At the ends of the sufficiency spectrum are no data and complete data. Complete data implies that the data meet all thresholds or requirements for the purposes to which they will be subjected. In the case of running growth models, this would mean the data are able to meet all the inputs, both required and optional, for the model.

Suitability indicates whether the data collected are the data that are actually needed for the purpose(s) the data are meant to serve. Data fields that are not populated, are populated with out-of-date values, or are populated with incorrect or unusable values are all considered unsuitable. For example, the database may contain a field for stand basal area. If the value in that field for each stand is only for trees greater than five inches in dbh, the value is considered unsuitable for any growth model which requires total stand basal area. Despite the fact that the field is filled in and contains a value the growth model will accept as valid, it is not correct with respect to how it is going to be used and is therefore unsuitable.



Over the years, we have worked with a lot of different inventory databases, and our experience results in the graphic above, a mapping of sufficiency and suitability in two dimensions. Here we consider sufficiency with respect to supporting a harvest planning analysis.

The yellow area in the upper right corner represents databases that are both sufficient and suitable and is the most rare condition we've encountered. These inventory data have been collected in a consistent manner and are relatively up-to-date. All the fields are populated with realistic and believable values, and the stored data satisfy the needs of the current planning exercise. The most complete inventory data, those databases that would be at the very corner, would have suitable data from the current year satisfying all the growth model(s) input requirements for all stands in the ownership.

Much more common are databases that inhabit the red band going from the upper left to the lower right. These databases are deficient in either their sufficiency or their suitability, but not both. The former are databases that have the capability to store all the relevant information needed for both inventory and planning purposes, but they are not complete, possibly having enough to run models, but not enough to satisfy all the input needs. With all the recent land transactions of the last few years, many purchasers of forestland find themselves in this situation. These land managers may have an enterprise inventory database system, but the land they purchased did not come with a complete inventory. Data fields are unpopulated, out-of-date, or simply incorrect, but the intent is to replace them with new plot data during the next inventory cycle. The latter are databases that usually have all fields populated but the detail is minimal, providing only the most rudimentary information about the forest overall. These types of databases are common early in land acquisitions, where details about forest cover type, site quality, age structure and total standing volume are provided as part of the sale prospectus. This type of inventory is sufficient to pique the interest of potential buyers, but it is unsuitable as the sole basis for a harvest scheduling exercise.

Finally, we come to the least desirable situation: the unsuitable-insufficient inventory, represented by the orange-yellow area in the lower left. No one plans for this contingency, and usually it is the spawn of low budgets and bureaucracy. Conducting regular inven-

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Deer browsing...

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50% resulting from a shift away from commercially valuable species. Delays in stand establishment have been noted as a source of economic loss since they often translate into longer rotations. A Michigan study indicated a possible quality reduction in stands developing from severely browsed seedlings. Although observed defects were not significant, a log grade reduction was noted for some trees. On a forest-wide scale, these impacts could represent significant economic losses.

Intuitive understanding of deer browsing effects existed long before much of the above described research was carried out. References to browsing damage are prevalent in the literature as early as the 1940s and '50s. The need to protect recently harvested areas was recognized soon after deer populations exploded in the early 1900s. Deer exclusion fences were erected in Pennsylvania as early as 1929 to examine the effects of excluding deer from forested areas. Since that time, fencing has been shown to be one of the most effective measures to prevent browsing damage, with numerous studies identifying positive exclusion fence benefits. Today fencing is the primary tools used by forest managers to combat intense browsing pressure.

The most commonly used deer exclusion fences are eight-foot-tall, woven wire. Although high-tensile electric fences are used, their effective lifetime is much shorter (five to seven years compared to several decades). As a result, their use has been marginalized and is generally limited to stands dominated by fast-growing species in areas with low browsing pressure. Fences may surround areas up to 100+ acres, but are generally kept to 50 acres or less whenever possible. Fences exceeding 50 acres encourage deer to penetrate the fence rather than circumnavigate it. When areas larger than 50 acres are harvested, several smaller fences should be constructed with a travel corridor 50-150 feet wide between them. Fences are erected at the time of harvest and are maintained until regeneration becomes established. At that time, the fence can be removed and deer can be allowed back into the area.

Exclusion fence construction represents a significant management cost. Pennsylvania Bureau of Forestry regeneration expenditures for the nine-year period ending in 2003 show that more was spent on exclusion fence construction than herbicides, mechanical control of competing vegetation, and ground fertilization combined. It should be noted, however, that per acre fence cost estimates are often flawed. Cost per acre is highly variable, dependent upon both fenced area size and shape. Therefore, true fence costs can only be accurately measured on a per linear foot basis. Current fence construction costs are $1.70 - $2.25 per linear foot. Expected increases in steel prices over the next several years may drive these costs even higher. This result alone indicates the importance of considering deer exclusion fence costs during management planning.

Sapling stripped by deer browsing.

Most discussions focus exclusively on deer exclusion fence construction costs and indeed, many managers only quantify construction costs when calculating overall management costs. Recent work suggests that this is flawed: fence maintenance may make up nearly 60-70% of total average annual fence costs and failing to properly account for maintenance costs can lead to substantial underestimates in total fence costs.

Past planning models largely ignored deer exclusion fence in developing a harvest schedule. Exclusion fence costs were included as per-acre regeneration costs. The inappropriateness of this cost structure has already been identified. Spatially explicit planning models must accurately represent true management costs, and thus the linear-foot cost structure, in their development of a solution. Significant cost saving can be achieved through careful fence layout, since reducing the length of fence constructed, maintained, and dismantled will in turn reduce costs. As an example, if a fence is needed on a management unit while fence is being dismantled on an adjacent unit, the fence segment along the shared boundary could be re-used. Furthermore, altering the spatial and temporal arrangement of management unit treatments may result in aggregation of harvest blocks with lower perimeters, and thus lower fence costs.

In addition to a mechanism for cost reductions, a set of implicit spatial constraints must also be considered. Fence size guidelines create de facto harvest opening size limits which are often lower than regulated maximums. Larger openings are possible, but several smaller fences with travel corridors between them would be required. Corridors create long narrow forest blocks that would be difficult to manage in future periods. Management becomes disassociated with the fenced units and may be limited by commerciality. As a result, orphaned stands are created throughout the landscape, leading to increased edge effect and forest interior area reduction. Although seemingly insignificant, consider that approximately 440 feet of fence adjacency will account for one acre of land (assuming 100-foot buffer width). Large fence adjacencies and multiple fences across the landscape could result in large acreages trapped between fences. Over time, substantial economic losses could occur. In addition, failing to explicitly account for areas maintained as travel corri-

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tory updates is expensive but if the organization lacks the resources to conduct regular inventory updates there is no alternative to an increasingly inaccurate and out-of-date inventory. Sometimes the problem is not data-collection but manpower and the processes to handle it. An organization with a single individual tasked with updating the database may find that he cannot keep up with the pace of updates, either through sheer volume and a need to process the most pressing issues first, or through internal processes that bypass the inventory manager (e.g. harvest block designations passed directly from a silviculture forester to procurement on hand-drawn paper maps). Regardless of the underlying causes, these inventories are rife with inaccurate, obsolete, and missing data, making them unreliable bases for current inventory or value estimates, and worse as predictors of future productivity and growth.

So how do you go about evaluating sufficiency and suitability of your inventory for forest planning purposes? First you need to determine what sorts of questions you are trying to address. Is the forest you are managing geographically compact or spread across a wide range of physiographic regions? Does the silviculture you propose to practice incorporate multiple entries into the stand (spacing, fertilizing, commercial thinning) or is it simply a regime of establishment and final harvesting? Do you have many species and products to contend with, or is the forest largely composed of plantations of a single species? By and large, the answers to these questions will quickly lead you to one or two candidate growth models. Once you determine your preferred growth and yield model, many of the determinants of sufficiency and suitability are made for you by its input specification.

Tree-level growth models generally require more detailed data than stand-level growth models and are appropriate for mixed-species stands where value varies a great deal by species and product. Sufficiency is often an issue with mixed-species forests because current markets may be different than they were when the inventory model was developed. For example, only recently has red alder become a highly valued species on the west coast, and many inventories may still lump it with other hardwoods because the inventory was developed when hardwoods were all considered low-value trees. An inventory may be sufficient in that there are data fields for red alder, but it may be incomplete because the tree lists for all hardwoods were merged into "mixed hardwoods." Unless you can resurrect the original plot data, it may be impossible to accurately value the red alder resource now, or project it into the future.

Suitability is also more commonly an issue with mixed-species forests which require tree-level models. Precision levels for the different components of the data are typically high, for example tenths of an inch in dbh measurements and one foot or less increments in total height, in order to more accurately characterize between-tree competition. Suitability is also frequently a question when archived data are used. Cruising methods change and what was once standard procedure may no longer provide the data necessary to support the current demands placed on the inventory. Stand and tree parameters that were once considered unnecessary to measure may now be considered more important.

The inventory's age is also an important factor. Archived data, while still useful, are less reliable. Older data must be grown forward to current day and then projected into the future for the planning analysis. The older the data, the more likely the projected values will differ from the actual current year inventory. However, it is still better to have older data, including planting information, than no inventory data whatsoever.

As we've discussed earlier, planning analyses may be based on individual cruise plot data, plot-level data aggregated and stored at the stand level, stand summary data (no actual cruise plot data, only stand summary statistics such as BA, TPA, standing volume, etc.), a partially complete set of stand-level data, strata-level data, or no data at all. Next time, we're going to discuss alternative methods for growing the available inventory, and how sufficiency and suitability of your inventory data affect these different options.

Fall colors, Mt Rainier National Park. Photo courtesy K. Walters.

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dors means the acreage available for future harvests is lower than what was assumed during planning. Meeting strategic goals will become increasingly difficult as reductions in the manageable landbase are magnified over time, and discrepancies between strategic and tactical plans will develop.

Steven Mills and Marc McDill recently developed spatially explicit harvest schedule models that accurately account for fence costs and spatial considerations. In addition to harvest scheduling decisions, the models include construction, maintenance, and removal decisions for each potential fence segment. Interactions between harvest and fence activities are recognized, allowing accurate calculation of the management costs for a scheduled activity. Results show that the spatial and temporal arrangement of management unit treatments is altered, taking advantage of fence segment reuse and creating harvest blocks with lower perimeters. Total fence cost reductions of 10-20% were achieved over models failing to explicitly include fence scheduling decisions. When one considers that average annual fence costs may be over $250 per acre, cost reductions of this magnitude can result is substantial savings at the landscape level. In the models examined, cost reductions increased discounted net revenue by as much as 5.5% over a 50-year period. In addition to direct cost savings, travel corridor creation was avoided, reducing fragmentation and preventing future management limitations. Because models properly accounted for fence spatial constraints, harvest schedules were suitable for on-the-ground implementation.

Although this article paints a somewhat bleak picture of the costs of sustainable hardwood management in some northeastern forests, it is not all bad news. Significant efforts are being made to reduce deer populations, which has translated into lower browsing pressure in some areas. As a result, managers may experience a reduced need for fencing. As the discussion here illustrates, detailed analyses that recognize management costs and spatial constraints at a high level of detail can pay off with substantial reductions in management costs. Such models serve as a valuable tool for forest managers, providing a means for ensuring the spatial feasibility of long-term strategic goals while minimizing spatially-related costs and controlling landscape structure.

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Management of Timber Under a Habitat Conservation Plan (HCP) in the Pacific Northwest

Karl R. Walters and Gene McCaul. 2007

Abstract– West Fork Timber Company (WFTC) is a private timber company that manages approximately 55,000 acres on the western slopes of the Cascade Mountains. West Fork's goal was to develop a long-term harvest plan that would improve asset value over time, while simultaneously ensuring that habitat requirements set forth in their Habitat Conservation Plan (HCP) would be realized. The primary constraint set forth in the HCP is the maintenance of a unique Dispersal Landscape Index (DLI) within a narrow (+/- 5%) range of pre-determined levels for the life of the HCP.

The DLI is derived by assigning different values to areas within specific distances of existing dispersal habitat (DH) in a complex formula; the dispersal habitat (DH) values are then summed and divided by the total number of acres in the forest to arrive at a DLI value for the ownership. This paper discusses DLI calculation and the challenges involved in modeling this problem, including the types of constraints needed in the strategic model, the spatial allocation of activities associated with existing and future stands in a Model II framework, and the development of a rapid DLI calculator to facilitate the evaluation of alternatives. Overall, West Fork was able to meet objective of higher returns from the forest while simultaneously demonstrating improvement in dispersal habitat over the next four decades.
For a copy of this paper, visit our website:
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Suburbia is where the developer bulldozes out the trees, then names the streets after them.
- Bill Vaughan