Benchmark Renewal Standards: What You See Is What You Get…. (NOT)!!

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Currently, no standard procedure exists in Ontario for developing a regeneration standard using a common set of planning tools. While there has been general discussion and instruction on how various tools (i.e. density management diagrams (DMDs) and yield tables) may be used to help construct a regeneration standard, a formal procedure that provides a quantitative linkage between the renewal standard and the desired future forest condition has yet to be developed.

Problems identified with past and current renewal standards in Ontario include:

1. Variation in definition of terms

An example of (1) is the interpretation of what are considered 'acceptable' species in a regeneration standard. In the most extreme cases, the list of species in the regeneration standard may include species that: (i) didn't occur in the original stand, (ii) are not listed in the proposed future stand composition, and (iii) are not being targeted for regeneration through silvicultural activities.

In addition, the string of species may include species that are traditionally considered to be competitors with one another. For example, where jack pine (Pj) is being regenerated with the objective of creating a future forest condition of Pj9Sb1 (Sb - black spruce), the renewal standard lists Pj, Sb, balsam fir (Bf) and poplar (Po) as acceptable species. There are no limits on the amount of 'competitors' that may be permissible in the stand, yet there is an indication that, if required, tending will be used to release the Pj from hardwood competitors! So, what makes Po 'acceptable' in this instance (or Bf)? Is it truly a measure of the success of regenerating the desired Pj stand?

2. Standards don't necessarily reflect management objectives.

Multiple treatment options listed in ground rules often achieve various levels of management intensity, yet are often given similar renewal standards. For example, planting, which is tied to more intensive yield projections, is often given the same renewal standard as a more basic or extensive treatment (e.g., 40% of stocked mil-acre quadrats may be listed as the standard for both planting and natural regeneration treatments, yet the stand development information may be quite different for each of these scenarios).

3. No formal direction on how a regeneration standard is to be developed.

The key overriding issue, however, is lack of formal direction on how a regeneration standard is to be developed. How should acceptable species be defined? How may long term stand objectives be quantified? How may stocking and/or density measures be used to predict stand development? These are areas that need to be clarified. Some of these areas fall into the area of "policy", but current work is designed to help clarify the interaction of some of these components.

The basis of the idea surrounding the development of the **Objectives–Based Renewal Standards Project** came from reviewing renewal standards over a number of years and comparing these standards to various approaches used for developing objectives-based renewal standards presented in the literature (see examples below). The Objectives-Based Renewal Standards Project seeks to address the above problem areas by achieving the following objectives:

1. To outline a "model"[1] for the development of quantitative, site-specific, stand-level, objectives-based renewal standards. In this context, the word "model" is used in the broadest sense to describe the package of procedures and tools we may be generating (i.e., a toolkit).
2. To provide analytical procedures for incorporating silvicultural effectiveness monitoring data to calibrate renewal standards at the local level.

Objective 1:

This project seeks to develop a *stand-level* tool that is to be used with full regard to the fact that stand-level objectives must be developed within the context of forest-level objectives. As a consequence, the project was

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designed to develop a procedure where renewal standards could be developed locally. The process of developing the renewal standard should be completed in the context of a specific forest management plan and its forest level objectives. In a forest management plan, however, renewal standards are developed as part of a Silvicultural Ground Rule (SGR). The SGR is developed for a specific forest unit-site type combination and is applied to a 'stand' that fits the forest unit-site type description for that specific SGR.[2]

As the SGR is *site-specific*, it follows that the components of it, including the renewal standard, should also be site-specific. Due to the current scale of commercial forestry, treatments are often applied to 'blocks' which may include a number of 'stands' in actual practice. But this is not necessarily a practice that should be enshrined in our planning or operating procedures; the appropriate SGR should be applied to meet local site and stand conditions (and should come as a result of a pre-harvest inspection, but we are not there yet). Renewal standards should therefore be site-specific, while considering forest-level objectives (see below).

In light of these points, the development of a regeneration standard was viewed as a *stand-level* consideration and is included as part of the SGR. That is not to say that every SGR must have a unique regeneration standard. When objectives are similar for a series of SGRs, the regeneration standards may be the same as well, especially given the current level of precision (or lack thereof) that may be applied to linking a specific regeneration objective to a precise objective.

This project is aimed at improving the linkage between the desired Future Forest Condition (the desired forest unit, stand characteristics, and development information) and the regeneration standard. It seeks to do so by establishing a renewal standard (that may be assessed during early stand development) that is quantitatively linked to the management objectives (desired Future Forest Condition) for a stand at maturity.

It is proposed that the process of developing renewal standards involves defining the 'stand' level objectives first. The procedure for developing the regeneration standard that comes from this project may incorporate an iterative process of reconsidering objectives and corresponding standards, but it is clear that objectives must come before a regeneration standard may be developed.

Objective 2:

This objective addresses several important questions:

- Once a renewal standard has been defined, how often is it achieved?
- Is it realistic to expect certain treatments to achieve desired results consistently? In what percentage of times is the standard being achieved?
- If it isn't being achieved, what is the difficulty? Is it with the standard, with assumptions about local environmental conditions, or with the way in which silviculture practices are being implemented?

Silvicultural assessment may be used to address these questions. Local silvicultural assessment information is being collected, but the use of this information varies. The assessment procedures also vary from extensive to intensive approaches. The value of consistent, reliable assessment information could be demonstrated in a method to integrate this information into a silviculture decision support tool.

This method would involve various approaches to 'decision making under risk'. For example, one approach is the use of a 'decision tree' to calibrate the likelihood of various intensities of silviculture treatments resulting in particular regeneration results on a variety of sites/stand conditions (after Bergerud 2002). The probabilities of the decision points of the decision tree could be populated with the results of reliable silviculture assessments. A demonstration of this method in the context of this project might use plot networks which document historic regeneration assessment results and current stand conditions.

How This Project Might Fit Into the Bigger Picture

This project does not state that it will be producing specific regeneration standards because the whole premise of the proposal is that the regeneration standard must be linked to an objective and there are potentially a myriad of objectives that may be stated. Objectives are developed as part of the management planning process. Specific regeneration standards could, however, be generated through this project as part of a case study to illustrate the procedure.

For example, this project could help with the provincial initiative to generate 'minimum standards'. The province

[2]An SGR is composed of: (1) current forest condition (forest unit – site type); (2) future forest condition (forest unit; stand characteristics, development information (e.g., yield curves)); (3) silvicultural treatment package (harvest and regeneration treatments, etc.); and, (4) the regeneration standard.

would first define their objectives. For example, they may decide, on a regional or provincial basis, that they want to guarantee a minimum level of productivity for regenerating stands (e.g., 80% or better of Plonski's yield), or they want to ensure the species composition of the regenerating stand is consistent with the preharvest conditions. We could work with them to generate clear objectives, and then use our procedures to generate a series of 'minimum' regeneration standards that reflect their objectives.

The Province could then decide (these are policy decisions outside our mandate) that these standards would be the benchmark regeneration standards to be used (regionally?) in forest management plans. They could also decide that planning teams could customize these standards to meet local objectives if they rationalize the adjustments using the new "objective-based regeneration standards" procedure and have the adjustments approved through the forest management planning process. The objective is to develop a procedure to improve planning procedures. As someone suggested, for this aspect of the project we are not undertaking 'new science' as much as gathering together information and tools from the literature and through consultation and developing a procedure into a tool kit that may be used in the planning process.

An Example of a New Paradigm in Forest Renewal Standards

As a result of the current definition of a renewal standard in Ontario, success in developing a framework for (as well as successfully demonstrating and applying) objectives-based renewal standards will require a substantial paradigm shift. At the present time, forest renewal standards in Ontario primarily revolve around an arbitrarily set (at least very broad), fixed figure (i.e., a percentage-based approach) for stocking of both target or acceptable crop tree species (in most cases) on a regenerating site. This approach often has only a vague link to quantitative management targets or objectives such as stand composition, yield, site quality or management intensity. Essentially, the current standards are techniques-based rather than objectives-based. An objectives-based approach would likely do away with a fixed figure; if such a figure were required it would vary substantially with management objectives. One example of a quantitative method of deriving objectives-based renewal standards is presented by Newton (1998).

Deriving Site-Specific Regeneration Standards by Yield Objective – Newton's (1998) Approach

Newton (1998) examined the development of regeneration standards in terms of their practical application in answering two common operational questions often faced by silviculturists:

1. Given current juvenile stand conditions, what yield can be expected in the future from this stand/site?
2. What current juvenile stand conditions are required to obtain a target yield objective at rotation age?

To answer these questions, Newton (1998) developed a technique that quantitatively linked regeneration survey results to future stand yields using a stand density management diagram (DMD). In developing his approach, Newton (1998) noted the limited utility that stocking (i.e. a percentage-based approach) has in estimating future yields. In particular, it was noted that a single stocking figure for a regenerating stand could describe a multitude of variable stand conditions, from high-density clumps irregularly spaced throughout the stand to uniformly-distributed, evenly-spaced lower density trees across the site. These two situations would result in very different yields for the site due to the crop trees developing under different circumstances (Newton 1998).

Accordingly, Newton (1998) used an early stand development assessment based on mean-point density, adjusted for stocking, to get an idea of the true densities occurring in the stand. Development of the stands was then simulated using DMDs to obtain estimates of quantitative stand parameters such as diameter and volume at periodic intervals to rotation. Multiple regression models were then developed that predicted these stand parameters based on the assessment results (Newton 1998).

These models could then be used to obtain reliable, site-specific, quantitative estimates of future forest condition based on current stand assessment results; ***or***, a site-specific, required value for the stocking-adjusted density (juvenile stand assessment result) could be generated for a specific yield objective (Newton 1998). This required value could then serve as a regeneration standard for the site/stand. Stands not meeting this requirement could be targeted for remedial action to bring them up to the standard.

This approach is not without limitations, and Newton (1998) noted that it assumes stocked areas are

contiguous, and that stocking levels will not change as the stand matures. These assumptions are not unique to Newton's (1998) approach; they reflect limitations of many stand development models.

Silvicultural Monitoring and Forest-Level Objectives

Silvicultural (and regeneration) success is typically investigated and viewed at the level of the individual cutblock or stand. Across a large area of forest such as an SFL or FMA, however, aggregates of stands are typically managed together for the achievement of one management objective. From the perspective of timber production, it is rare, or even unlikely, that a single stand in an FMA would be managed for the achievement of its own unique objective, independent of any other stand or aggregate of stands in the management area (though individual stands frequently have their own unique silvicultural prescriptions as a result of variation in site quality, composition and other concerns). Setting management objectives for groups of stands (i.e. Forest Units) is more efficient and is currently standard practice. It therefore makes sense that we should think of regeneration success at the stand aggregate [forest unit] level, rather than passing or failing individual stands (Martin et al. 2002), and summarizing these results to the forest or provincial level.

Thinking of stands at this level has the added advantage of allowing more productive or successfully regenerated stands within a forest unit to make up for shortfalls on less productive or successful stands, since regeneration success is viewed in terms of the achievement of a future management objective for an entire forest unit, not just a pass/fail approach for an individual cutblock (Martin et al. 2002). This could potentially allow for greater efficiency and effectiveness of silviculture (e.g. remedial action isn't necessary for a less productive stand if other, more productive stands are compensating for it at the forest unit level).

While the development of renewal standards at this level (and in this context) is not within the realm of this study, it is (and should be) of interest in terms of seeing how the stand-level toolkit being developed in this study might fit into the bigger picture. It is particularly interesting to examine how a similar approach can be taken with regulation and monitoring of renewal on a broader scale (e.g., SFL or even provincially) – see Martin *et al.* (2002) for an approach British Columbia is taking.

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