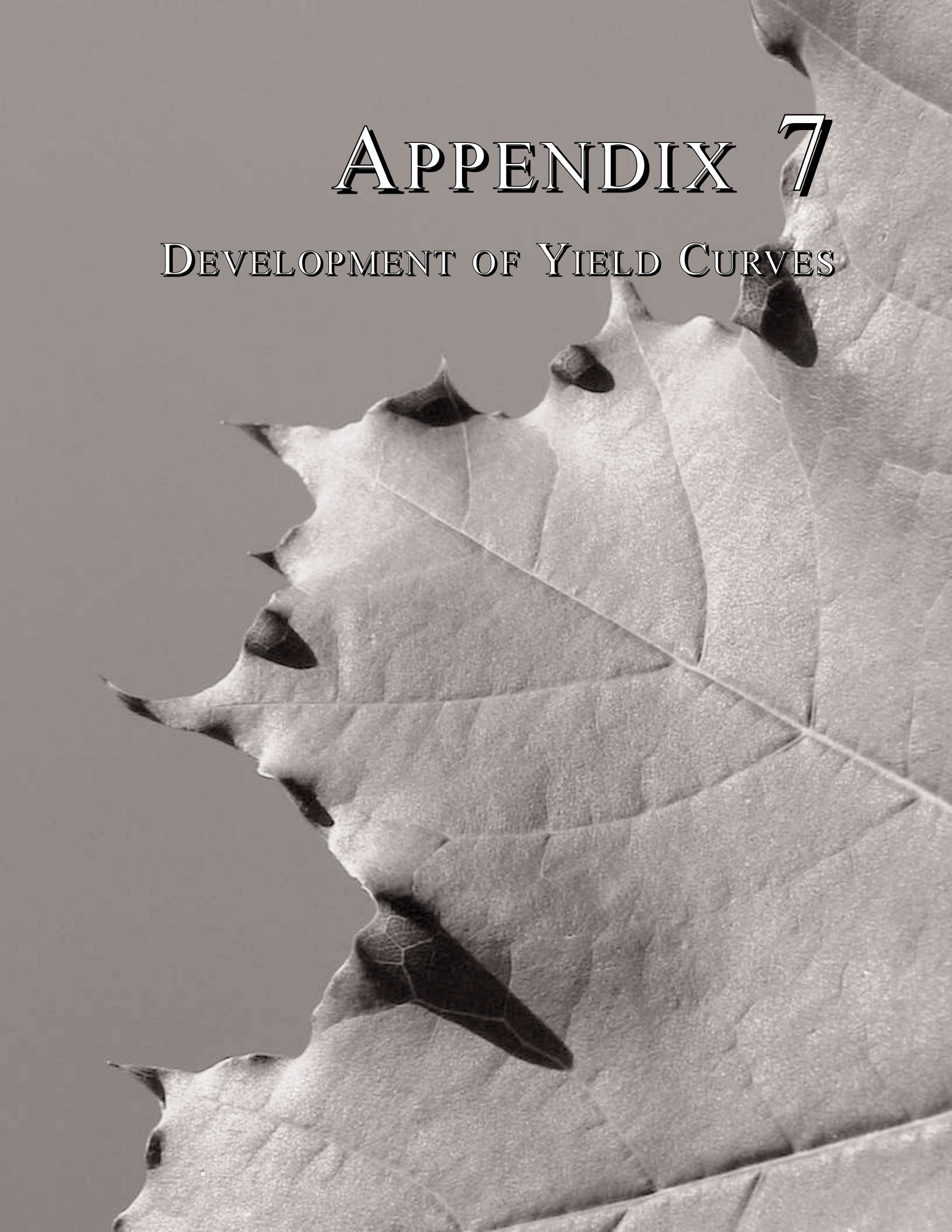

Appendix 7

Development of Yield Curves

YIELD CURVE DEVELOPMENT

INTRODUCTION

A yield curve is a projection of how a forest stand will develop through its lifetime. In its most fundamental form, it identifies the gross merchantable volume of the stand at any point in its development. More elaborate yield curves can also provide point-in-time information on stand structure including dominant height, stand density (by species), mean diameter, mean piece size, gross total volume, total and merchantable basal area, as well as other stand and tree parameters. Although a yield curve may be developed for any given stand, typically it describes the average developmental profile of a grouping of stands that are similar enough in terms of species composition, structure and growth characteristics to be considered a single stand type or stratum.

Yield curves are critical to a wood supply analysis because, collectively, they identify how much wood is available within the analysis area at any given point in time during the analysis period. For the 1994 insular Newfoundland timber supply analysis, the yield curve sets employed were constructed using growth models purchased from a forest consulting firm in New Brunswick. In 2000, given the availability of a far more robust growth data set, these same models were used again to generate a completely new set of curves. It is anticipated that in the future, as growth data sets expand and our modeling capabilities improve, the yield curves will continue to be refined and improved.

THE MODELS

Yield curves were developed using one of two stand projection models, both of which were developed by Vanguard Forest Management Services Ltd. of Fredericton, New Brunswick. The first of these, STAMAN, was used to build curves for unmanaged (i.e., natural regeneration with no subsequent intervention) strata. The second, MANSTAND, was used to build curves for managed (i.e., silviculturally enhanced) strata. The growth functions in both models are calibrated using empirical growth data, typically generated from permanent sample plot (PSP) remeasurement and stem analysis. They are then validated (and corrected, if necessary) using data from temporary sample plots (TSPs) established randomly throughout the stratum in question. Additionally, in order to initiate the yield curve development process, both models must be initialized, or seeded, with the stand structure of a juvenile stand typical of the stratum under investigation.

DATA SETS

Model Calibration

The growth relationships required for the calibration of MANSTAND are: maximum potential diameter growth, maximum potential height growth and survival. We did not attempt to build our own survival relationships. Instead, the default relationships were built into the model. The maximum potential diameter and height growth relationships were built using data from natural stand PSP remeasurements and stem analysis. It is noteworthy that data from managed forests was

not used to calibrate the models. Though the Forest Service has been collecting such data for some time now, there is still not enough information to adequately meet our yield curve development needs.

The growth relationships required for the calibration of STAMAN are: average diameter growth, survival and ingrowth. No ingrowth relationships were used in the building of our curve sets. In the case of survival, the relationships constructed during the 1994 round of yield curve development were used, which in turn were generated from natural stand PSP remeasurement data. The average diameter growth relationships were constructed using data from natural stand PSP remeasurements and stem analysis.

Model Initialization

As noted earlier, both models must be seeded with the structure of a juvenile stand typical of the stratum in question. This young forest must be described in terms of age, species, total stem density and diameter distribution. In the case of MANSTAND, starting structures were selected from amongst the RSP plot network, a series of surveys carried out in juvenile stands. In the case of STAMAN, starting structures were selected from amongst Forest Inventory's TSP network.

Model Validation

Once the model makes a yield curve projection, based on the initial starting structure and growth relationships defined by the user, the output must be compared to empirical data from the stratum in question in order to evaluate the model's accuracy (i.e., the output must be validated). If the projection varies from the pattern suggested by the empirical data, model inputs (or internal coefficients) must be modified, and the model re-run. This process is repeated until the model-generated growth projection matches the validation data to an acceptable degree.

In the case of STAMAN, Forest Inventory's network of 8,000+ TSPs were used for validation purposes. In the case of MANSTAND, 300 new TSP's were established in the oldest thinnings on the island.

CURVE SETS

Curve sets were developed for strata in four insular Newfoundland regions: east, central, west and north. Curve sets were not developed for Labrador. The Eastern Region curves apply to Districts 1, 2 and 3. Those in Central Region apply to Districts 4 through 13 and the eastern one third of District 16 (i.e., the portion east of Sandy Lake). Western Region curves apply to Districts 14, 15 and the western two thirds of District 16 (i.e., west of Sandy Lake). The Northern Region curves apply to Districts 17 and 18. Within each region, curves were developed for good (G), medium (M) and poor (P) sites.

In the case of STAMAN, within each region/site type combination, curves were developed for balsam fir, black spruce and softwood/hardwood stands. Additionally, for each species/region/site class combination, curves were developed for three crown closure classes (i.e., 1, 2 and 3). Therefore, there is a basic set of 27 curves per region and 108 curves in all (4 regions X 3 species X 3 site classes X 3 crown closure classes).

Of the various types of silviculturally enhanced forest in Newfoundland, MANSTAND was used to develop curves for precommercially thinned balsam fir and black spruce strata only. Curves were not developed for plantations due to a shortage of calibration and validation data. As a temporary remedy, plantation curves were approximated by scaling up PCT curves for the relevant region/site type combination. All plantations are assumed to be black spruce. In each region, curves were developed for balsam fir and black spruce on good, medium and poor sites for a basic set of six PCT curves per region and 24 PCT curves in all (4 regions X 2 species X 3 site types). An additional 12 scaled black spruce plantation curves (i.e., three per region) brings the total to 36 basic MANSTAND curves. Crown closure was not used as a stratifier in the development of the managed stand curve sets.

In addition to the basic regional curve sets, curves were also developed for a number of anomalous situations. These include:

- balsam fir and softwood/hardwood strata in the balsam fir sawfly infestation area of western Newfoundland
- balsam fir and softwood/hardwood strata in the balsam woolly adelgid infestation area of southwestern Newfoundland
- hi-graded stands in district 2
- all strata in the Main River area of district 16
- all district 1 strata