

Technical Note on Cruise Designs – June 10, 2015

Forest Biometrics Research Institute – James D. Arney, PhD

Forest Projection and Planning System (FPS) – Version 7.43

Variable-plot cruise designs became popular in the early 1970s replacing fixed-area and strip-plot designs as most efficient in the field. Most silvicultural regimes were based on clearcuts and even-aged regeneration. Total volume per acre by species was the most desired parameter when designing a new cruise. Stand structure was of minor interest only. Growth projections were based on yield tables by site, age and density.

These traditional objectives and the popularity of variable-plot cruising with a prism resulted in additional efficiencies in the field by mixing “measure” plots with “count-only” plots. The “measure” plots included both Species and Dbh on every tree along with variable intensities of sub-sampling for height, defect, age, taper and crown attributes. The “count-only” plots included only a tree tally by Species. This resulted in greater efficiency while still covering a large geographic area (a Stand). These were known as “Harvest Cruises” because the main objective was to obtain a volume estimate prior to final harvest.

Cruise objectives have changed significantly over the past 40 years. “Count” and “Measure” cruise designs are no longer adequate when only a tally of trees by Species are recorded on Count plots. Most important is that most cruising is now applied in order to update a stand-based inventory. Stand structure (Species, size, vigor and distribution) are now more important than current standing volume per acre. Silvicultural alternative regimes are focused on thinning yields and resulting residual stand growth dynamics as opposed to traditional clearcuts. Stand structure information is critical input to tree-list growth models and harvest planning.

Sixteen prism plots (33.6 Baf) were systematically distributed across a Stand. Every third plot only tallied the number of trees by Species. Sample trees were recorded by Species, 1-inch Dbh class and a sub-sample of Heights on the “Measure” plots. This resulted in 71 “Measure” trees on 11 plots and 21 “Count” trees on 5 plots. The Stand included Douglas-fir, Western Hemlock and Western Red Cedar ranging from 6 – 36 inches in Dbh.

The following table and chart provide insight into the shortcomings of “Count” plots. FPS Version 7.43 was used to compile the original cruise as designed (middle column).

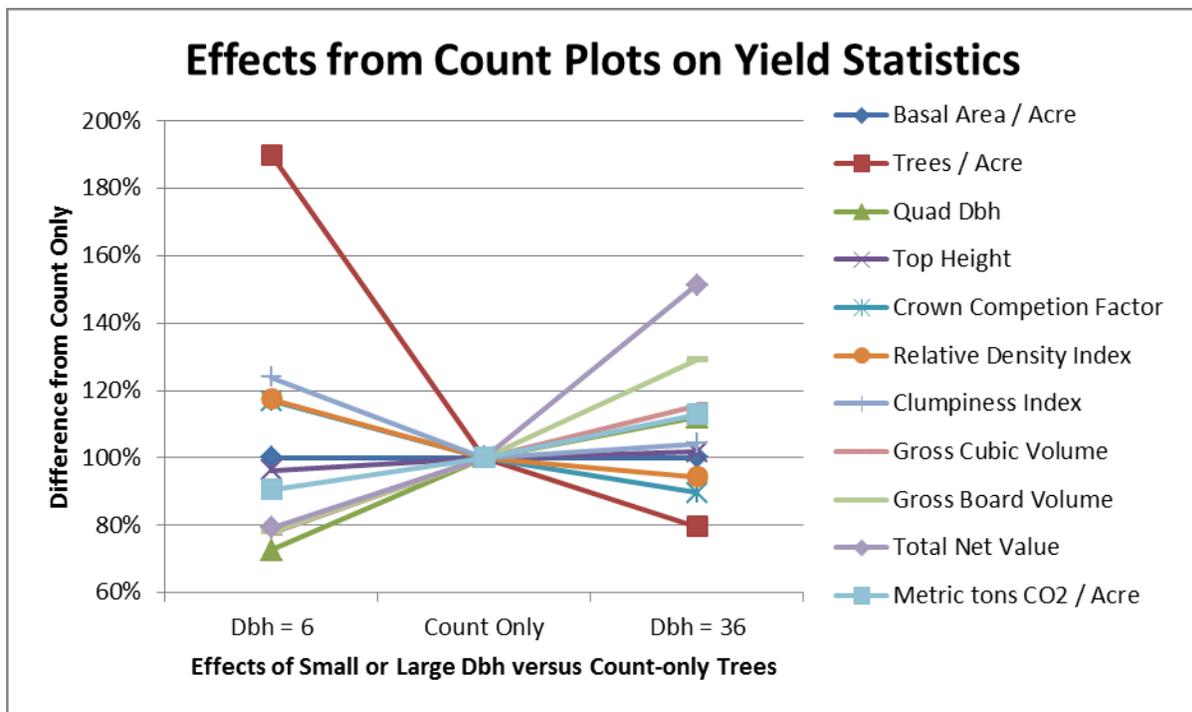
	Dbh = 6	Dbh = 0	Dbh = 36	Min-Max
	Minimum	Count Only	Maximum	Range
Basal Area / Acre	193	193	193	0%
Trees / Acre	376	198	158	-110%
Quad Dbh (in)	9.7	13.4	15.0	40%
Top Height (ft)	100	104	106	6%
Crown Competition Factor	270	231	207	-27%
Relative Density Index	62	53	50	-23%
Clumpiness Index	81%	65%	68%	-20%
Gross Cubic Volume	5,069	6,516	7,524	38%
Gross Board Volume	22,140	28,362	36,633	51%
Total Net Value	3,462	4,372	6,620	72%
Metric tons CO2 / Acre	138	152	172	22%

The Left column (“Dbh = 6”) is the compiled result if the 21 “Count” only trees were the minimum observed Dbh in the cruise. The Right column (“Dbh = 36”) is the compiled result if the 21 “Count” only trees were the maximum observed Dbh in the cruise.

As is readily apparent, the underlying assumption that the “Count” trees will have the same average Dbh as the “Measured” trees is a pivotal assumption which should not be taken lightly.

While this example is an extreme with all 21 “Count” trees being either a minimum or a maximum Dbh, it cannot be overlooked that the underlying uniformity assumption is critical. The actual Dbh values of the 21 “Count” only trees will result in up to a 50% range in the estimate of standing board-foot volume on this stand! The resulting growth projections will also demonstrate a similar range when inserted into a tree-list growth model.

Note in the following chart that not all parameters shift in a common direction or amount when small trees are replaced with large trees in the 21 “Count” only sample.



Conclusion: While traditional “Count” / “Measure” cruise designs were efficient and sufficient in the 1970s that is no longer the situation. Current total volume is no longer the primary goal. Current growth models rely on robust stand structure estimates to provide reliable growth projections. Reliance on a good estimate of basal area per acre is no longer sufficient.

“Count” and “Measure” cruise designs are acceptable if the “Count” trees are recorded by both Species and Dbh class, never by Species alone.