Why do inventory? To describe the resource. To represent a biological population using numeric values which can then be analysed. It provides a current picture from which future expectations can be derived.

The general approach to inventory in New Zealand is that near-term harvest is described by more detailed inventory and mid-term yields are described by less detailed inventory.

Young stands are assessed during the establishment and tending phases as part of the quality assurance and contractor payment processes. As an integral component of yield regulation, the data is used to crop type a stand and/or to monitor how the stand is performing relative to the crop type to which it is allocated.

Pre-harvest inventory provides the base data for the development of feasible harvesting, marketing and sales plans; and in the case of stumpage sales, the basis upon which purchasers write out cheques.

All inventory is, or should be, used as the basis for forest valuation – in developing the yield tables upon which future wood flows, and hence cash flows, are based.

The timing and frequency of collection of pre-harvest data is a compromise between assess-ability, reliability and cost.

Assess-ability – When the quality features of interest are actually apparent. eg branch size is a critical component of log quality for the higher value unpruned logs and hence there is diminished merit in collecting detailed descriptive data until there is sufficient crown closure such that the branches on a significant portion of the stem are no longer growing in diameter. (Tree Blossim grows branches but accuracy is likely to be better when the branch has stopped growing.)

Reliability – Inventory data is most reliable at time of assessment, and reliability declines thereafter.
Cost – Inventory costs. We are all aware of the factors which impact cost – for example - topography, access (to and within the sample area), sampling intensity, complexity of assessment, plotting technique, availability of inventory personnel, and immediacy (planning horizon). Costs have been seen as low as $60 per plot and as high as $160 per plot! Eg Some years ago it was common practice to use 1:1 basal area sweep to bounded plot to maximise the bang for the inventory dollar. Basal area sweeps are rarely used now – presumably as the risk of mis-use is greater than with bounded plots.

Essentially there are two types of inventory undertaken before harvesting: Mid-Rotation (MRI) and Pre-Harvest (PHI).

Mid-rotation inventory is strategic inventory - generally collected in the 15-23 year age bracket. The data enables development of plans with 5 to 10 year horizons – eg longer term wood flows and cash flow projections. The data forms the basis of plans which require longer lead-in (eg longer term harvest scheduling and roading plans, equipment build-in time, etc). Sampling intensities are lower (eg 1-3% by area) and the sampling quality assessment codes are sometimes less detailed.

Pre-harvest inventory is tactical inventory. It is usually more intensive and so provides more detailed data with tighter error limits. The timing – within 1-2 years of anticipated harvest - enables some re-scheduling in the harvest plan but probably only within a 2 year window due to, for example, roading – unless prior formation of access is not limiting (eg sand or pumice) and the invested capital roading cost is low. It enables specific targeting of stands to markets. Sampling intensities are generally higher (eg 4-6% range) and sampling quality codes can be very detailed.

The following are examples of approaches currently used in New Zealand.

COMPANY A – FOREST OWNER, LOG SELLER AND PROCESSOR

- Mid-rotation inventory at 15 years of age;
- Pre-harvest inventory 5 years prior to harvest; and
- Pre-harvest inventory (sample) within 1-2 years of projected harvest.

Mid-Rotation Inventory

Target Age 15 years.
Target PLE on TRV of 10%.
Sampling intensity 2% by area (inter-related with the objective above).
Bounded circular plots.
Dictionary – 4 quality codes for pruned logs
11 quality codes for unpruned sawlogs
Target 12-20 trees per plot.
**Pre-Harvest Inventory (5 year)**

Target 5 years before possible harvest ie age 23 years.
Target PLE on TRV of 10%.
Sampling intensity in the 4%-6% range.
Bounded circular plots.
Dictionary – 4 pruned log quality codes
11 unpruned sawlogs quality codes
Target 12-20 trees per plot.

**Pre-Harvest Inventory**

Target is the following year’s harvest.
Same dictionary as prior PHI.
Grow prior PHI to current date.
Re-sample approximately 10% of the plots.
Compare grown prior PHI with resample PHI. Based upon that comparison, adjust the PHI to provide an updated current description.

**Resources**

Inventory in summer using forestry students.

**Pending**

Considering 100% stem counts with field assessment of a proportion of the stems.

**COMPANY B – FOREST OWNER AND LOG SELLER**

This company undertakes three inventories:

- Mid-rotation inventory at 15-18 years of age;
- Pre-harvest inventory at around 5 years prior to harvest; and
- Pre-harvest inventory within 1-2 years of projected harvest.

**Mid-Rotation Inventory**

Two purposes:

1. growth and yield
2. measure of silvicultural performance - a good indication of crop quality.

Low intensity (eg around 1%) with coverage rather than PLE being the aim. Reasonable PLEs on TRV at the croptype rather than stand level can be expected.
Target 20 trees per plot (min 17 trees) but minimum plot size of 0.04ha.

Circular bounded plots

Quality assessment codes - 3 relevant to pruned logs (sweep, fluting)
8 relevant to unpruned sawlogs (branch size and frequency, sweep)

**Pre Harvest Inventory (5 Year)**

Purpose - Medium-term plans and wood flows. Provides for development of a harvest schedule – and hence road clearing and construction schedule.

Provides data for individual stand yield tables.

Target maximum PLE on TRV of 10%-15%

Sampling intensity – minimum of 2% by area

Target 20 trees per plot (min 17 trees) but minimum plot size of 0.04ha.

Circular bounded plots

Quality assessment codes - 3 relevant to pruned logs (sweep, fluting)
8 relevant to unpruned sawlogs (branch size, frequency, sweep)

**Pre Harvest Inventory (1-2 Year)**

Purpose - Tactical plans. Enables refinement of the harvest schedule to improve alignment with markets.

Provides final inventory data for individual stand yield tables.

Target maximum PLE on TRV of 10%.

Sampling intensity – approximately 4% by area.

Target average 20 trees per plot (min 17 trees) and a minimum plot size of 0.04ha.

Circular bounded plots.

Quality assessment codes - 3 relevant to pruned logs (sweep, fluting)
8 relevant to unpruned sawlogs (branch size, frequency, sweep).

**Resources**

Field assessment undertaken by contracted external service providers.

**Other data**

Increment cores, for estimation of average stand basic outerwood density, are collected during all radiata pine inventory from age 15 years to clearfell.
The above approaches are very similar. The differences are the target PLE for MRI - by stand or crop type; the final pre-harvest inventory; and the other data collected. These example the general approach in New Zealand; though the approach is not always implemented as planned!

**STUMPAGE SALES**

**Seller (Forest Owner)**

Inventory Objective: To provide the most cost-effective data by specific Sale Area to potential bidders that ensures that they are confident of the data provided so that they fully value the Sale Area.

The aim is to obtain a very accurate, consistent (sale to sale) and precise assessment by Sale Area. The target PLE for total volume is <10% per Sale Area.

It is important to note that the grade outturn also forms the basis of sales of stands and for this the inventory must be accurate and precise. A sampling intensity of 5% is used in the first instance. Where a PLE of <10% on total volume is not achieved, additional inventory is done.

Audit plots at the rate of 1 in 10 are undertaken to ensure compliance with inventory specifications.

Plot size is determined so as to get, on average, between 15 and 20 trees per plot. Blocks which contain more than one regime or age class are stratified.

Data provided to Bidders includes:

- pre harvest inventory data files (including raw plot data);
- a map showing plot locations;
- a copy of the harvest plan and associated maps;
- a copy of the stand records and latest area map;
- recent aerial photos (if any);
- pruned log assessment (if any) – either through “desk top” analysis or via destructive sampling and mill studies;
- standing tree sonic sample results (including regression of standing tree to Hitman results for bidders to relate Sale Area to structural log properties);
- Sale Area density results; and
- if requested, plot audit data.

Inventory data is collected as close as possible to sale date, with a target of no more than 12 months, which in reality is within 2 years.
**Purchaser (Cheque Writer)**

Inventory data as supplied is used if there is confidence in the provider’s inventory processes and the inventory field crews.

Current inventory (eg within 6 months of harvest) is required otherwise risk adjustments are built in. The inventory data is grown from assessment date to intended date of harvest.

**Volume**

There is volume risk if it is a lump sum sale. It is common to make some adjustment to volume - for example, reduce the TRV by half of the PLE – so the lower the PLE the lower the risk adjustment (reduction).

Area confidence is critical but comparatively easier to measure.

No volume risk with pay-as-cut sales.

**Log Mix**

Experience shows that pruned volume should be reasonably well estimated.

S-grade is often over-estimated, especially for the smaller sed grades. Why? Optimistic assessment of branch size, frequency (ie distribution of larger branches) and/or form.

Utility grades are usually under-estimated, corresponding to the over-estimate of S-grade.

Pulp estimates are usually reasonable except at the extremes. Ie Where the pulp content is high (eg 30%+), actual recovery is often less than PHI; and conversely when pulp content is low (eg <10%).

Rough sawlog estimates balance out the pulp variance.

Blocks with a long boundary relative to the area tend to produce a poorer mix than estimated in pre-harvest inventory.

The stumpage is analysed on several potential log-making strategies to look at alternative marketing plans and to provide inputs into risk models.

In short, PHI is a very good guide but experience in harvesting similar stands is essential.
FOREST VALUE

PHI is the basic tool for the measurement of a forest resource. It should provide consistent estimates against which actual recovery can be compared to validate the description (given existing market dynamics).

Earlier inventory (eg MRI) can be compared with PHI to identify bias in the MRI. The comparison of PHI and actual recovery can then be overlaid to provide an indication of the reliability of the MRI estimates, again given existing market dynamics.

Recovery relative to PHI – ie actual harvest outturn relative to the resource description - is very important to any forest owner, but especially to one with debt (ie money has been borrowed using the forest asset as collateral). It is also very important to fund managers (who report to their investor owners and whose remuneration is likely linked to the value of the forest).

The impact of the comparison of actual harvest recovery to PHI estimates will likely feed directly into the description of the existing resource, and hence directly into forest value. Forest owners with debt ratios to maintain, and fund managers, are extremely conscious of forest value and therefore bring an intensity to the twin disciplines of inventory and harvest reconciliation. To forest valuers, harvest reconciliations are therefore a critical tool in assessing the credibility of yield projections provided by the forest owner or manager.