Chill Requirement of Pecans

Scott Clark August 2015

What Is Chill

- Temperate perennial fruit and nut trees enter a dormant phase over winter which is generally referred to as the plants' "rest period."
- This is an evolutionary advantage which protects trees from cold weather damage by preventing the growth of cold-sensitive shoots and flowers in response to a winter warm spell.
- As air temperatures begin to drop below 10°C, leaf fall occurs, and visible growth ceases.
- This is due to the level of growth-regulating chemicals in the buds changing.
- Growth-regulating inhibitors increase and growth-regulating promoters decrease.

- Perennial trees break dormancy after a prescribed 'sum' of winter conditions has passed.
- This ‘sum’ of cold weather to break dormancy is known as winter chill.
- The chill requirement is the number of hours below 14 degrees Celsius needed to break down growth inhibitors in the buds.
- As the chilling requirement of a plant is being satisfied by cold temperatures, the level of promoters begins increasing while the level of inhibitors decreases.
- The higher levels of promoters in the buds allow normal resumption of growth and flowering.
- At this point, the tree has determined that winter has finished and will begin to flower in response to warm temperatures.
- The number of chilling hours required to break dormancy varies considerably between varieties and Flower type.

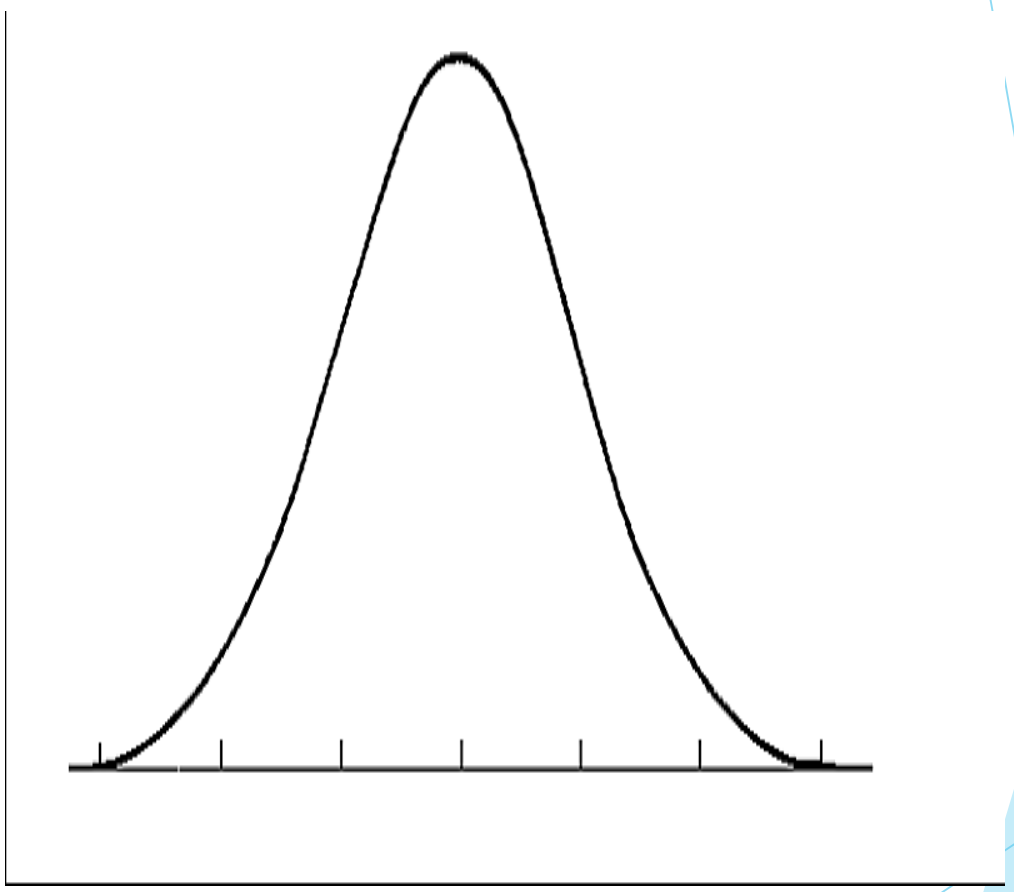
- Pecans need 200-1000 chill units or 17-83 chill portions.
- 1 chill portion is equivalent to 28hrs at 6 degrees Celsius.
- 1 chill unit is equivalent to 1hr at 0-7 degrees Celsius.

Variety	Chill units	Chill portions
Choctaw	300-350	25-29
Kiowa	200-350	17-29
Pawnee	300-350	25-29
Wichata	250-400	21-33
Western	300-400	25-33
Stuart	600-1000	50-83
Desirable	400-500	33-42

- Pecan bud break will occur with fewer than 100 chill hours, but this may lead to uneven bud-break, and subsequent problems with pollination.
- The chilling requirement for pecan can vary with autumn conditions.
- If trees are exposed to cooler autumn temperatures (<1 degrees C), the number of chilling hours required for bud break increases.
- Therefore trees of a single variety growing in areas with warm autumns and winters require fewer chill hours than those growing in a colder climate.
- Terminal buds, tend to have a lower chilling requirement than lateral buds.
- Thus, the main consequence of warm winters with low chill are usually a sporadic, staggered, and non-uniform bud break.

General aspects of chill accumulation

- Freezing temperatures do not contribute to dormancy breaking.
- There are optimum temperatures for the accumulation of winter chill.
- Temperatures either side of the optimum decrease in ability to contribute to winter chill.
- High temperatures can undo previously accumulated chill.
- Cycling moderate temperatures with effective chilling temperatures enhances the accumulation of winter chill.



Heat Requirement

- Pecan bud break does not have a critical requirement for either chilling or heating but is instead under the interactive control of both.
- At any given chill requirement, bud break has a heat requirement that decreases with chill accumulation.
- Heat units in the spring, rather than winter chill units, are the more limiting to the growth of Pecan.
- With high chilling, minimal heat is required for spring bud break, allowing the tree's shoots to begin growing as soon as possible.
- Bud break may occur without chilling if sufficient heat accumulates.

- Once chilling is completed, the heat requirement is set.
- The date of bud break will vary depending on the rate at which heat accumulates following completion of chilling.
- When growth does begin, it moves rapidly.
- This increases the likelihood that the fruiting cycle will be completed within a relatively short period.

How are Heat Units Calculated

- Rate of development can be characterized using a system called growing-degree days (GDD) or heat units (HU).
- This GDD concept assumes that:
  - There is a base temperature below which growth is very slow or stops.
  - The growth rate increases with temperature above the base temperature.
  - Growth and development are closely related to daily temperature accumulations above the base temperature.
- GDD are calculated by determining the mean daily temperature and subtracting it from the base temperature needed for growth. Limits are usually set on low and high temperatures so only temperatures that result in additional growth are considered.

- GDD = (Tmax +Tmin)/2 - Tbase

- Tmax is maximum daily temperature and is set equal to 30°C when temperatures exceed 30°C.
- Tmin is the minimum daily temperature and is set equal to 10°C when temperatures fall below 10°C.
- Tbase is the base temperature for growth.
- Pecans requires 1000-1500 hours above 18°C.
- Therefore, 1 Heat Unit (HU) for pecans is 1 degree above 18°C for the average daily temperature.
- So, If the temperature range for a day was 10-28°C then the heat units for the day would be:
- 28+10/2-18 = 19-18 =1 HU for the day.

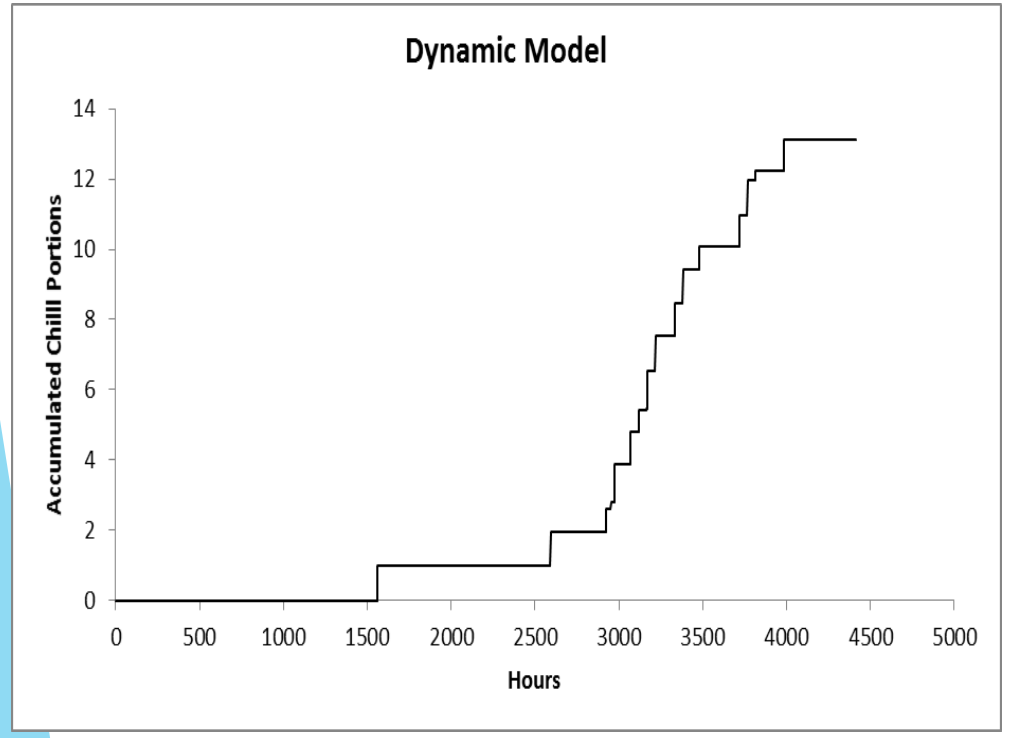
Chill Estimation models

- Many models of winter chill have been developed using the observed effects of temperature on dormancy breaking.
- The Chill Hours model (Weinberger, 1950) was the first to be developed and estimates winter chill based on hourly temperatures.
- This is a 'yes/no' model with temperatures between 0–7.2 °C allocated 1 chill hour and temperatures outside of that interval allocated a 0 chill hour. These chill hours are summed over autumn and winter to give an estimate of total winter chill.
- Chill Hours for pecans range from 200-1000.

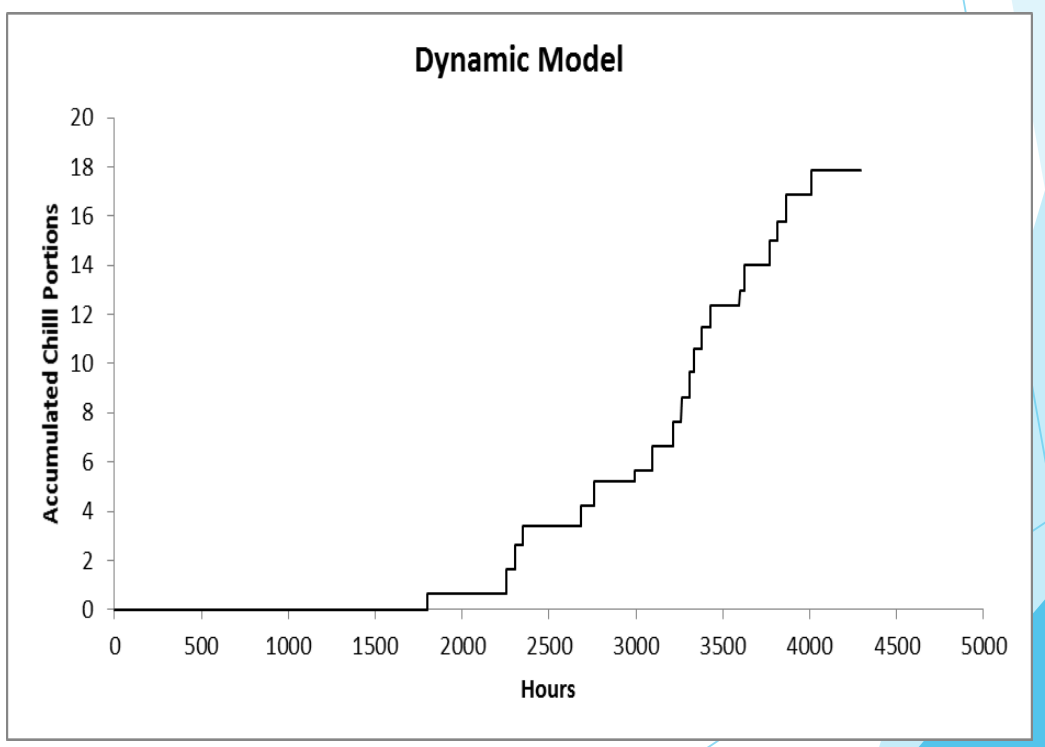
- Knowledge of temperature effects on winter chill has expanded and the Dynamic chill model (Fishman et al., 1987) is the current best practice model.
- It calculates chill based on hourly temperatures expressed as **'chill portions'**.
- The Dynamic model has features which capture known temperature -winter chill relationships which are lacking in other models.
- The Dynamic model charts effective winter chill temperatures following a bell shape with an optimum chilling temperature at 6 °C, tapering to zero at –2 °C and 14 °C.
- High temperatures act to negate previously accumulated chill and moderate temperatures can enhance chill.
- Chill Portions for pecans range from 17-83.
- The major growing centres in Georgia are Dougherty & Mitchell Counties they had an average of 32 chill portions in 2014/15 and 10 chill portions in 2013/14.

LISMORE
Chill Estimate for 2014 & 2015

Accumulated chill portions
March – August 2014 = 13



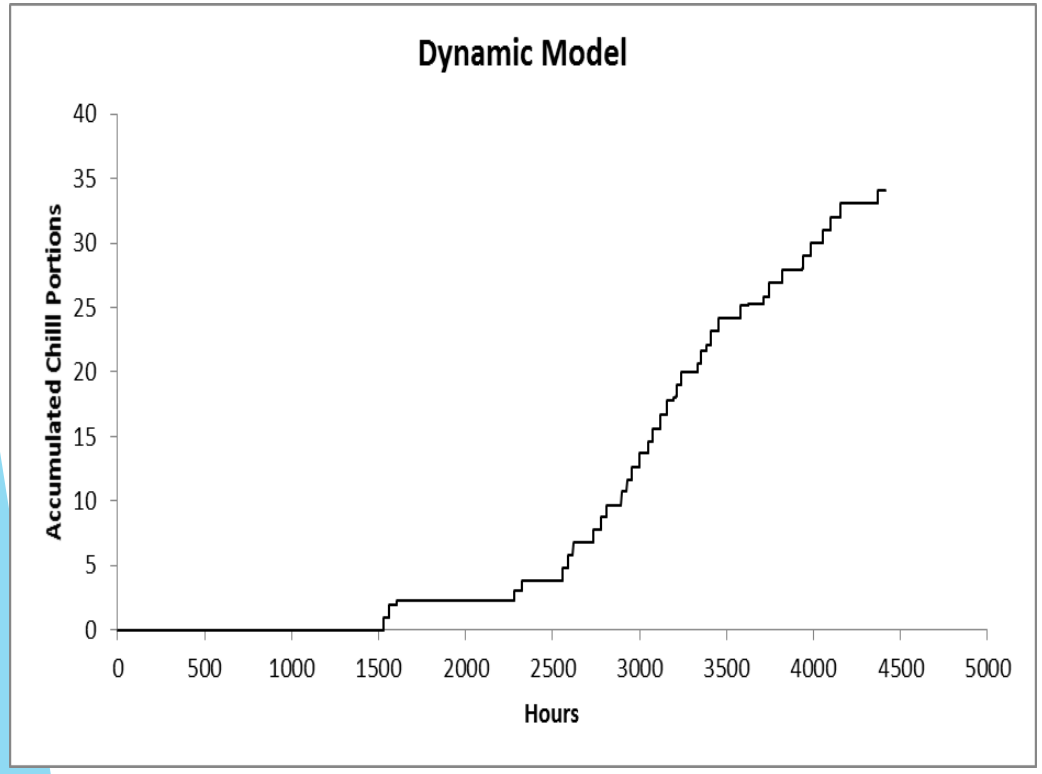
Accumulated chill portions
March – August 26th 2015 = 18



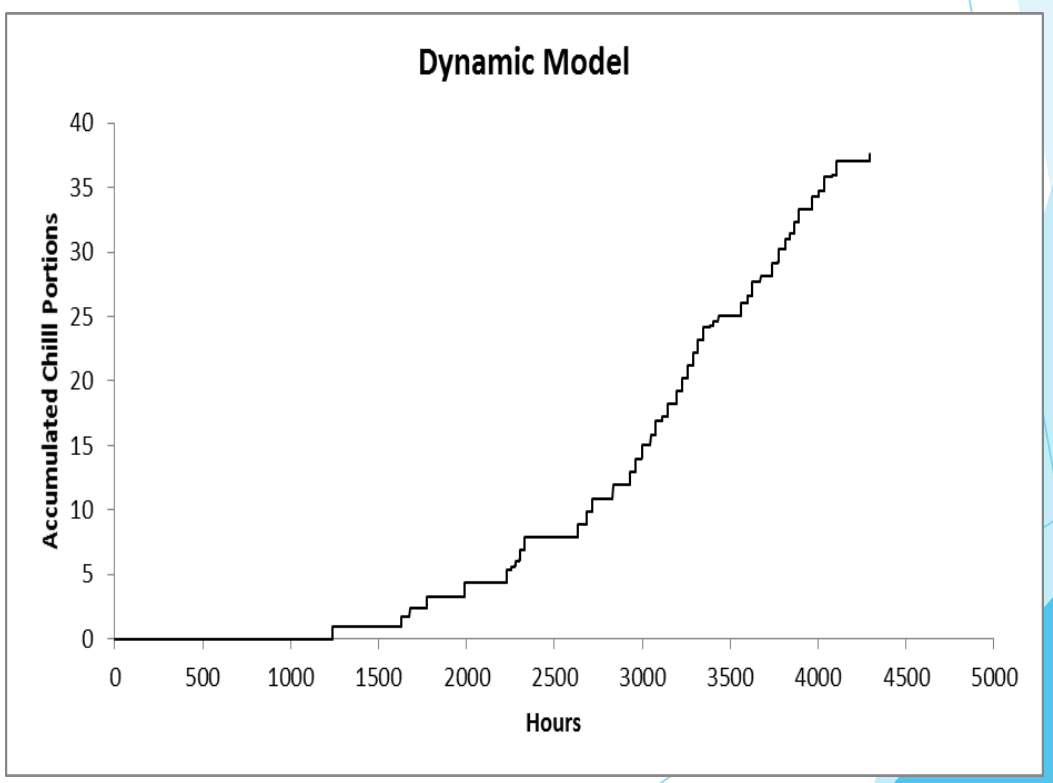
MOREE

Chill Estimate for 2014 & 2015

Accumulated chill portions
March – August 2014 = 34



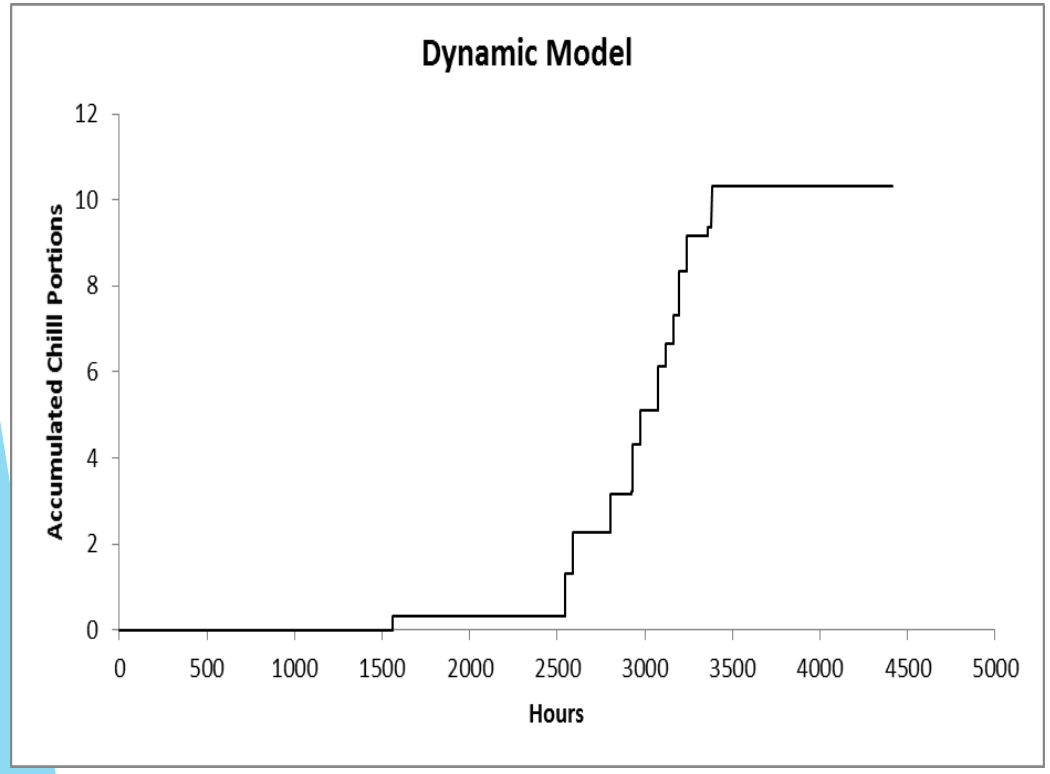
Accumulated chill portions
March – August 26th 2015 = 38



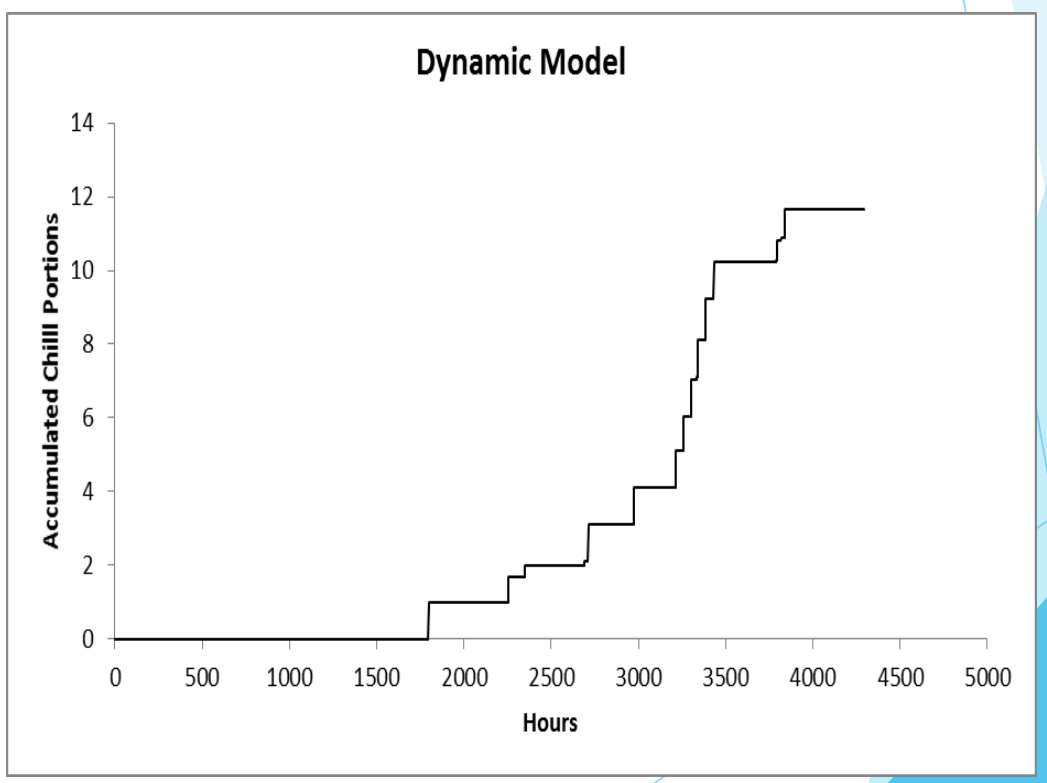
MONTO

Chill Estimate for 2014 & 2015

Accumulated chill portions
March – August 2014 = 10



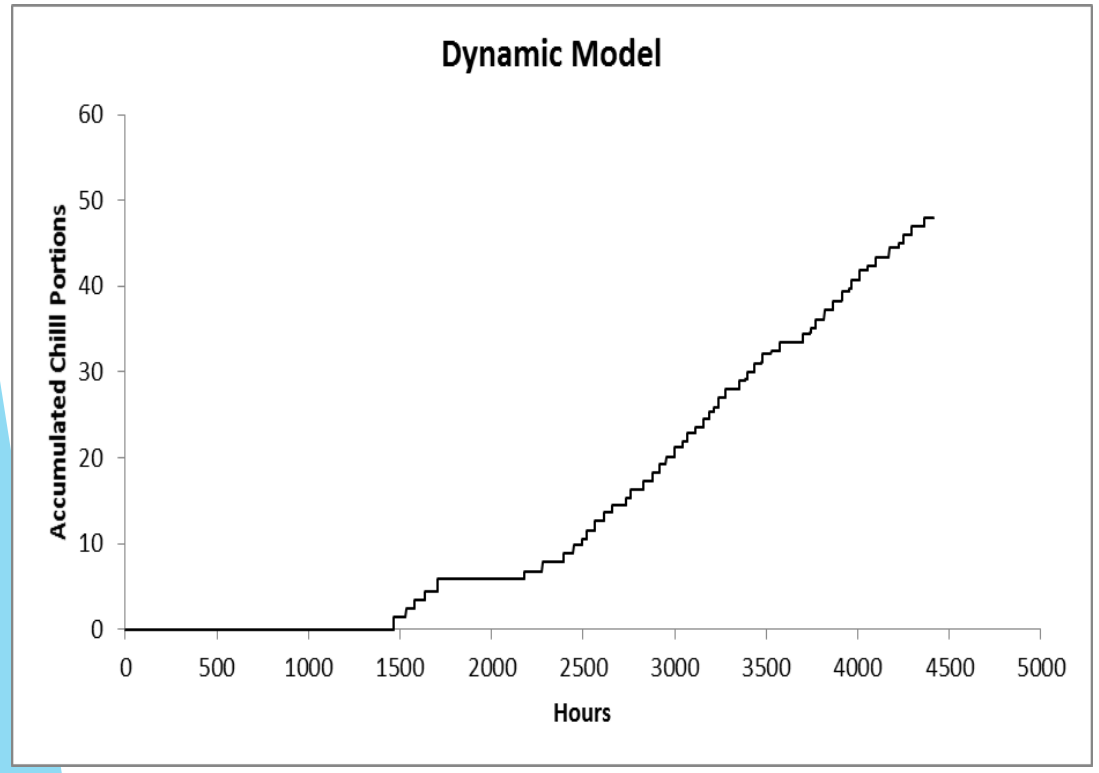
Accumulated chill portions
March – August 26th 2015 = 12



SINGLETON

Chill Estimate for 2014 & 2015

Accumulated chill portions
March – August 2014 = 48



Accumulated chill portions
March – August 26th 2015 = 46