Precommercial Thinning of Western Larch on the Loomis State Forest – 36 year results

Scott D. McLeod

Silviculturist

Washington State Department of Natural Resources

Washington Department of Natural Resources

- Approximately 2.1 million acres of Trust land
- Schools, Buildings, etc., and County lands
- Annual harvest 660 MMbf
- Revenue about $200,000,000 annually
- HCP for Westside lands and a Lynx HCP Amendment for the Loomis

Background

- Examine effect of early precommercial thinning of western larch
- Study installed in 1978
- 7 year old naturally regenerated stand
- Companion study of late PCT in larch showed:
  - Ineffective at producing larger trees
  - Perpetuated mistletoe infections
  - Not financially attractive
  - Forego in lieu of regeneration harvest

Blue Goat Study Site

- Loomis State Forest
- 4,300 ft. elevation, mostly flat
- Precipitation about 30”
- Soils – Garlet, stony, fine sandy loam with local outcrops
- Parent material – Salmon Creek granodioritic gneiss
- Plant Association – ABLA/LIBO

Blue Goat Study

- Two replications of five spacings:
- Control was unthinned
- Other treatments thinned to desired spacing

Spacing (ft.)	Control	3 ft.	6 ft.	12 ft.	15 ft.
Trees per acre	13,140	4,838	1,210	302	196

METHODS

- Establishment - 1978
- Dbh on all trees
- Heights subsampled after 1982
- Re-Measurements
  - Every two years until 1992, 1996 and 2007
- Data compiled using FVS for RD, SDI, volumes
- FVS used to simulate future development

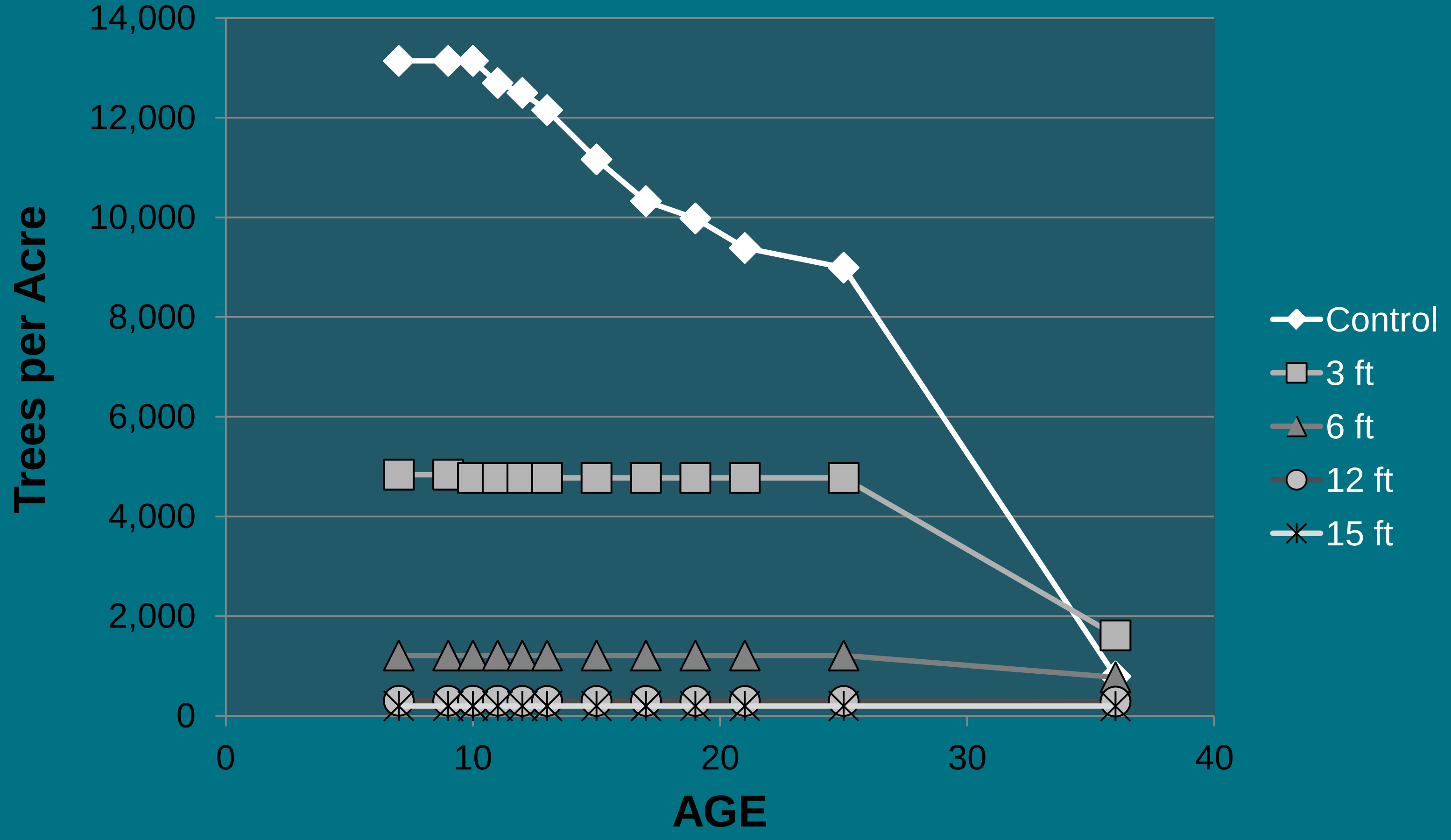
Results Overview

- Mortality
  - Density
  - Weather
- Dbh
- Height
- H:D
- Stand Density
- H:D and dbh development in relation to SDI
- Yields and NPV

Stand Conditions by Spacing at Age 36

Treatment	Initial TPA (age 7)	TPA (age 36)	QMD (inches)	Top Height (feet)	H:D	Gross Volume, ft^3/ac	Mbf/ac
Control	13,140	790	4.1	40	122	1,102	0
3 ft.	4,838	1,613	4.2	43	119	2,392	0
6 ft.	1,210	773	5.3	62	110	1,983	1.5
12 ft.	302	286	7.3	58	86	1,637	3.6
15 ft.	196	196	7.9	62	82	1,440	4.2

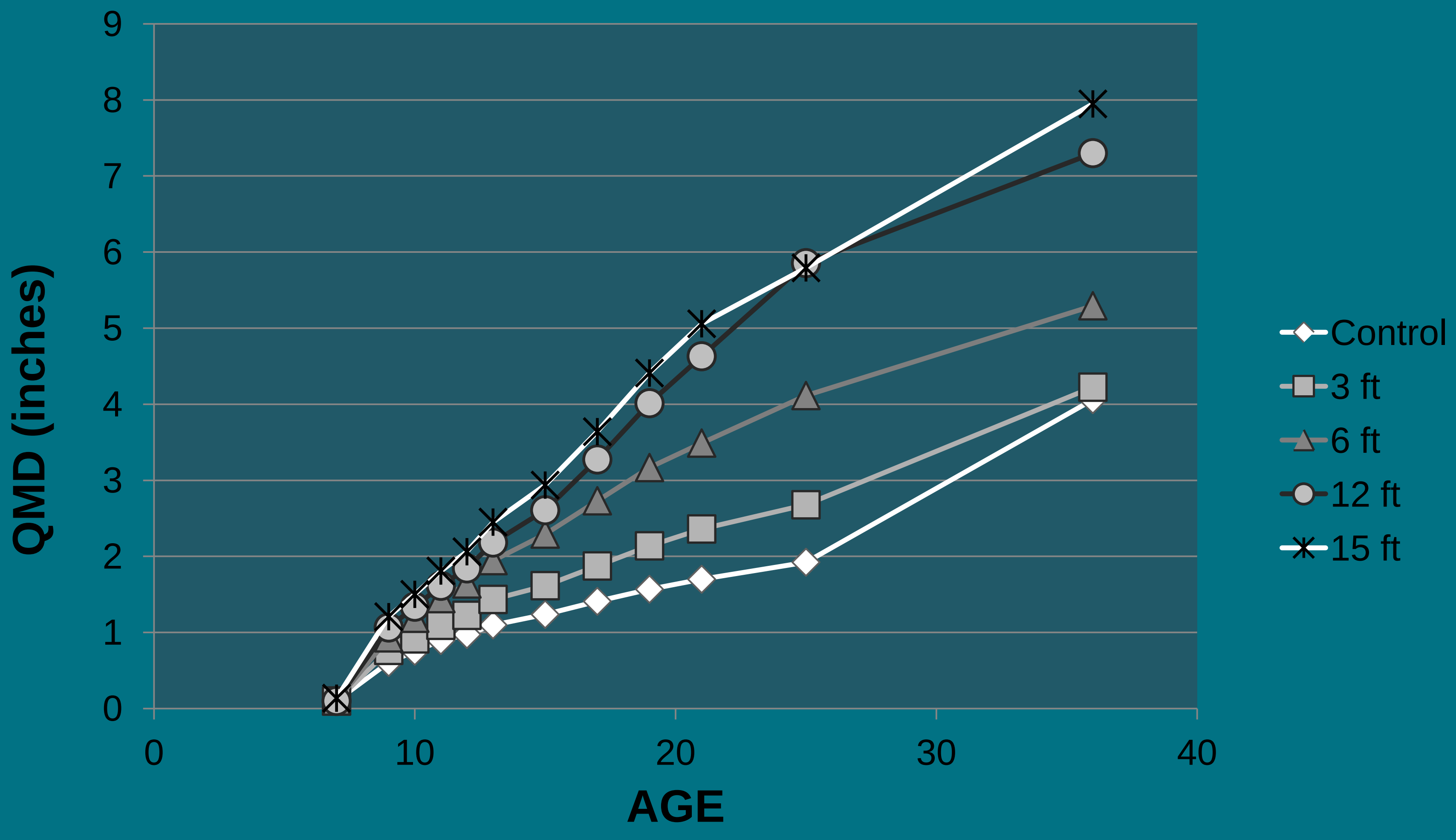
Mortality by Spacing



Mortality

- Through an age of 25 only the Control plots experienced any mortality.
- Amounted to only 1.8% of tpa annually
- Mortality on controls appeared to be leveling off prior to snow damage
- Snow related mortality left one of the control plots with no undamaged trees.

Diameter by Spacing

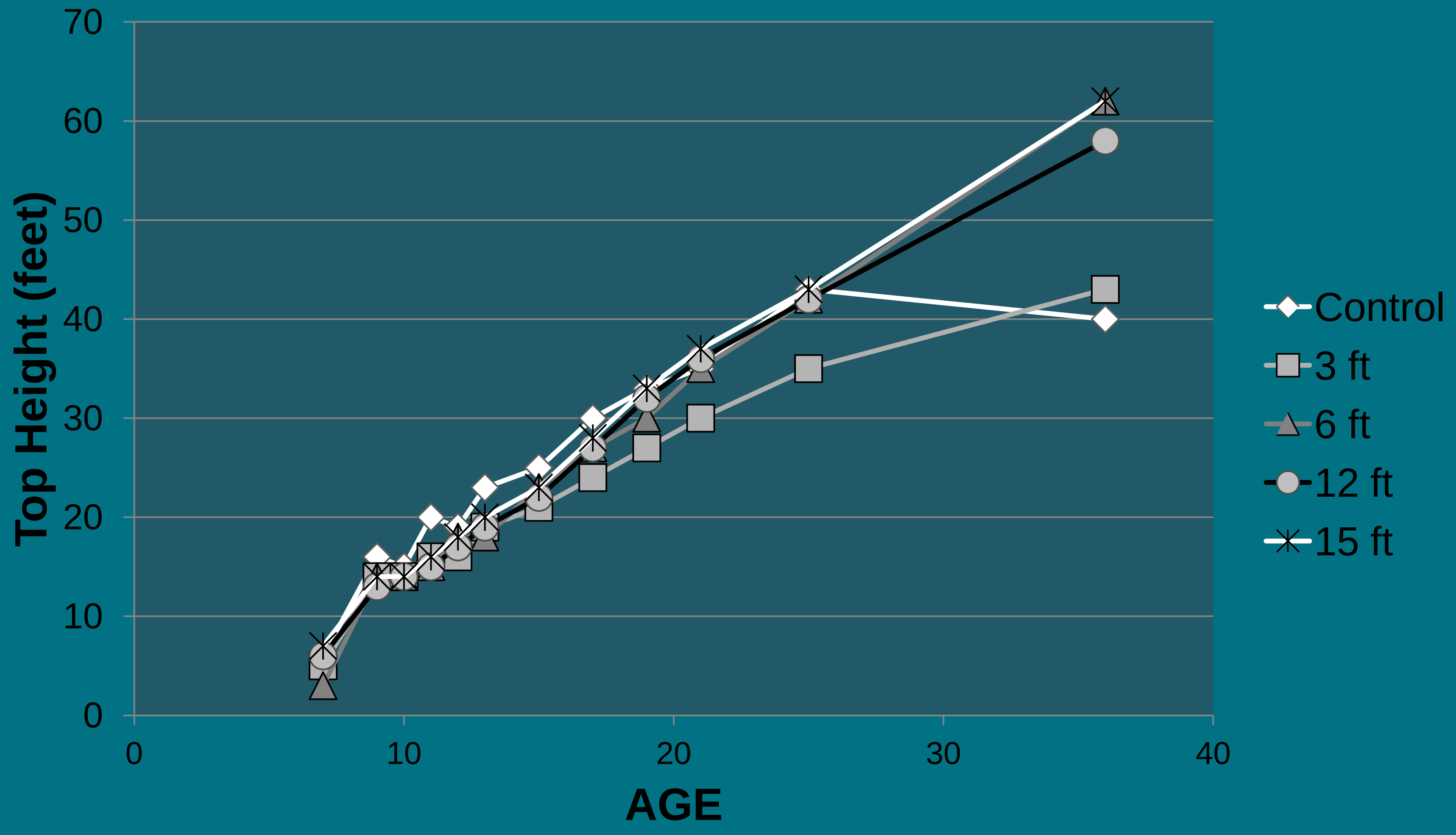


Diameter Growth

- Clear and significant spacing effects
- Larger trees as spacing increases

Treatment	Dbh (inches)[1]	Standard Error (inches)	Dbh Confidence Interval	
			Lower Limit (inches)	Upper Limit (inches)
Control	3.66 *a*	0.45	2.78	4.55
3 ft.	4.11 *a*	0.20	3.72	4.51
6 ft.	5.14 *b*	0.18	4.77	5.51
12 ft.	7.19 *c*	0.15	6.89	7.49
15 ft.	7.83 *d*	0.16	7.52	8.15

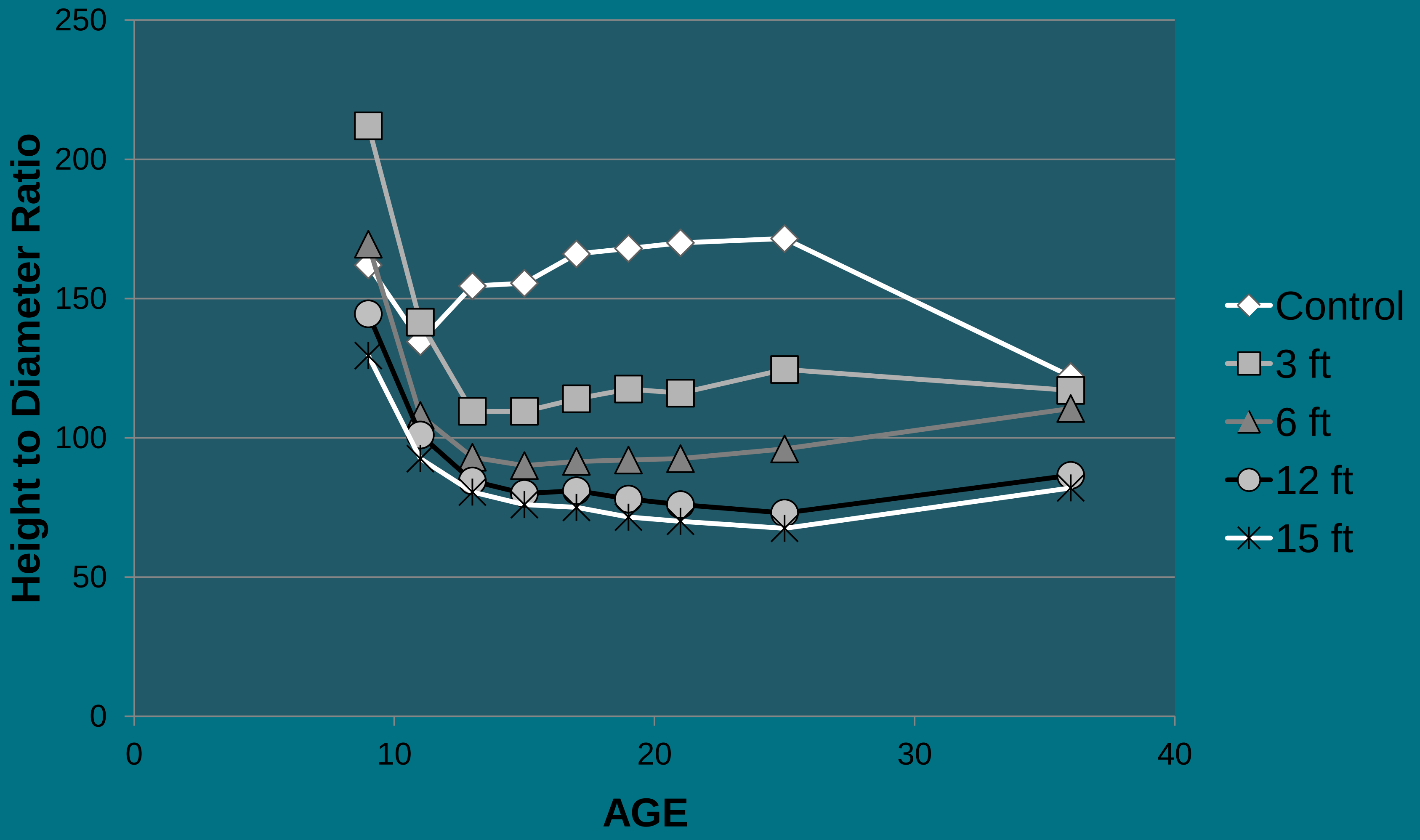
Height by Spacing and Age



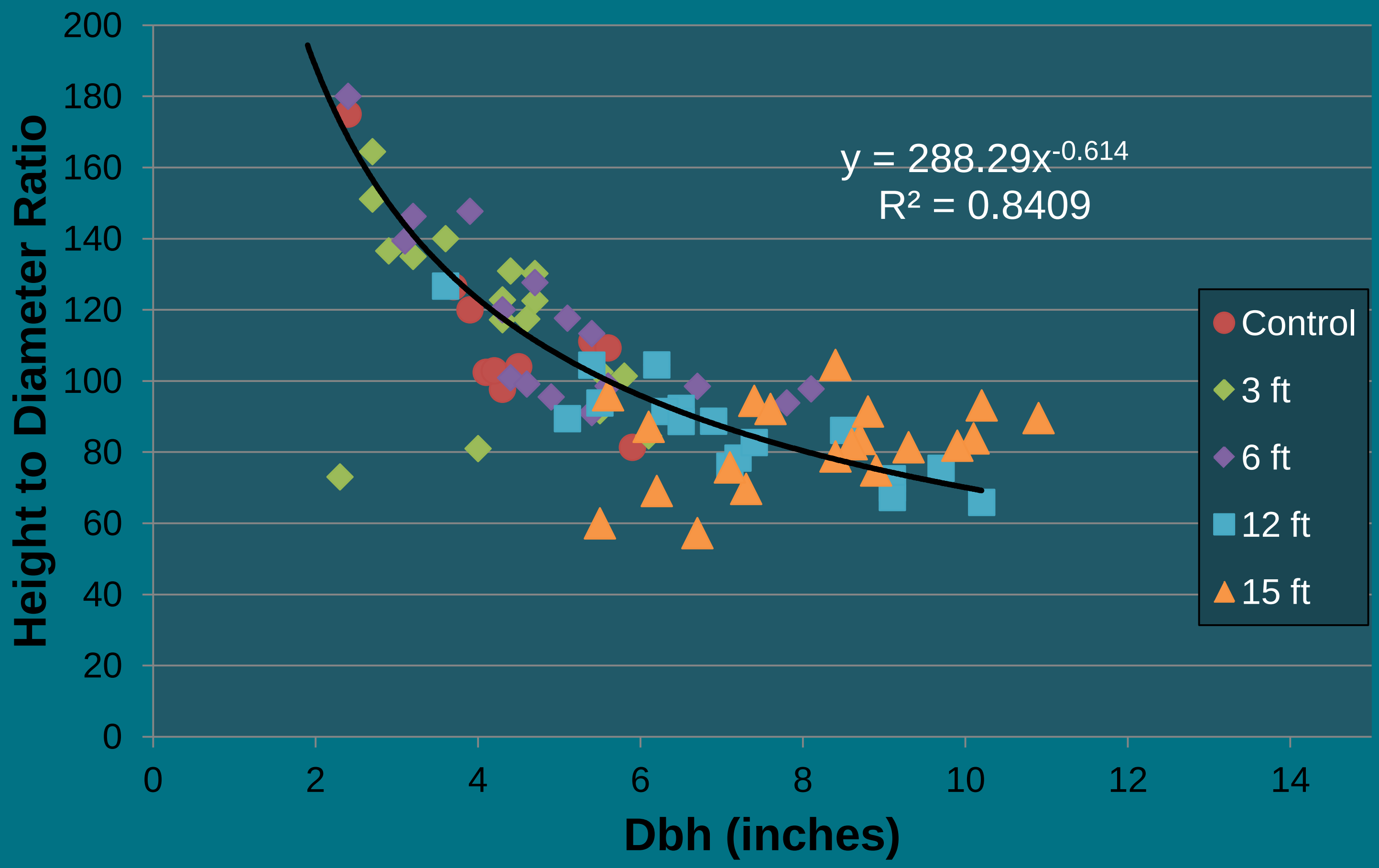
Height Growth

- Spacing had little effect
- Average height growth across all spacings:
  - 1.64 ft./year
- Cross-over effect at early age
  - Trees or plots at tighter spacings are larger at young ages than are trees at wider spacing with a subsequent 'crossing-over'
- 3 ft. spacing may be on a lower site index portion of the stand
- Snow mortality effect at last measurement

Plot Level Height to Diameter Ratios by Spacing



Height to Diameter Ratios by Spacing and Dbh at age 36

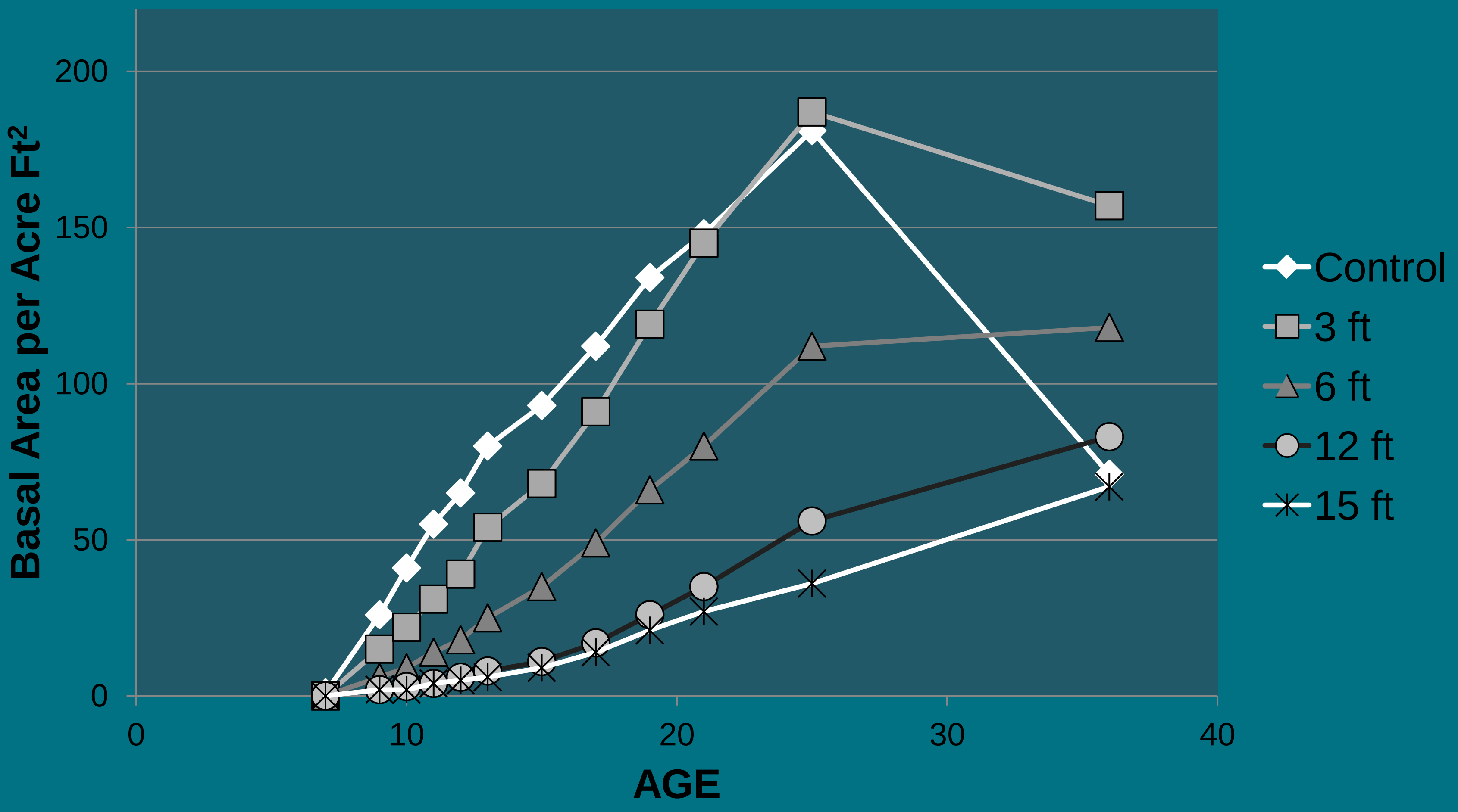


WASHINGTON STATE DEPARTMENT OF Natural Resources
www.dnr.wa.gov

H:D Development

- Ratios established early and maintained over time
- Spacing resulted in distinct ratios
- 15 ft. spacing did not follow common trend in H:D by dbh
- Catastrophic mortality did not significantly improve H:D ratios

Basal Area by Spacing and Age



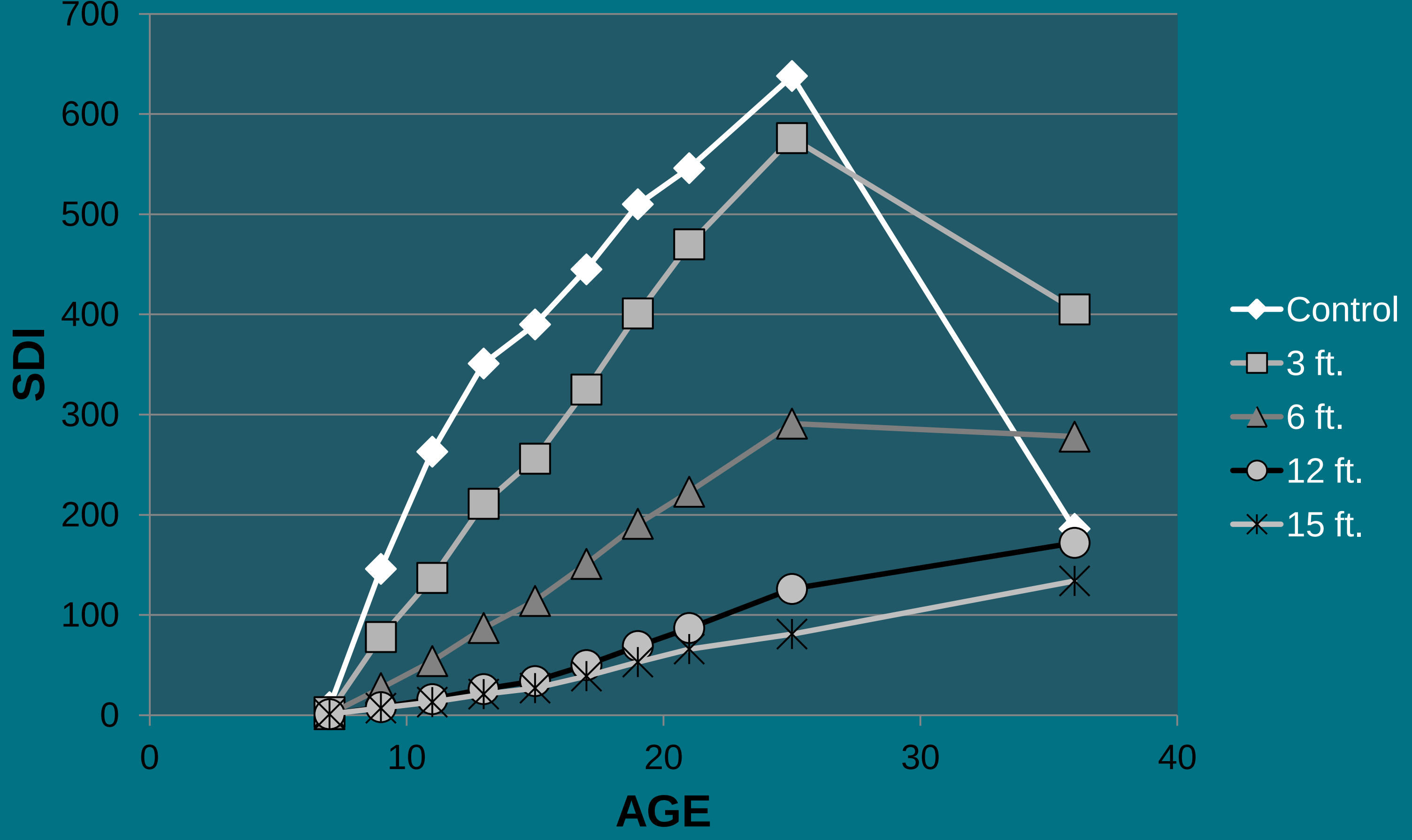
WASHINGTON STATE DEPARTMENT OF Natural Resources
www.dnr.wa.gov

STAND DENSITY INDEX

$$SDI = TPA * (QMD / 10)^{-1.605}$$

- Size and quantity assessment
  - how many trees of what dbh.
- Developed by Reineke in 1933 for a species specific maximum density estimation independent of site.
- Plotting QMD by TPA defines max SDI and generally follows the -3/2 power law.
- Indexed as number of ten inch dbh trees per acre.

Stand Density Index by Spacing



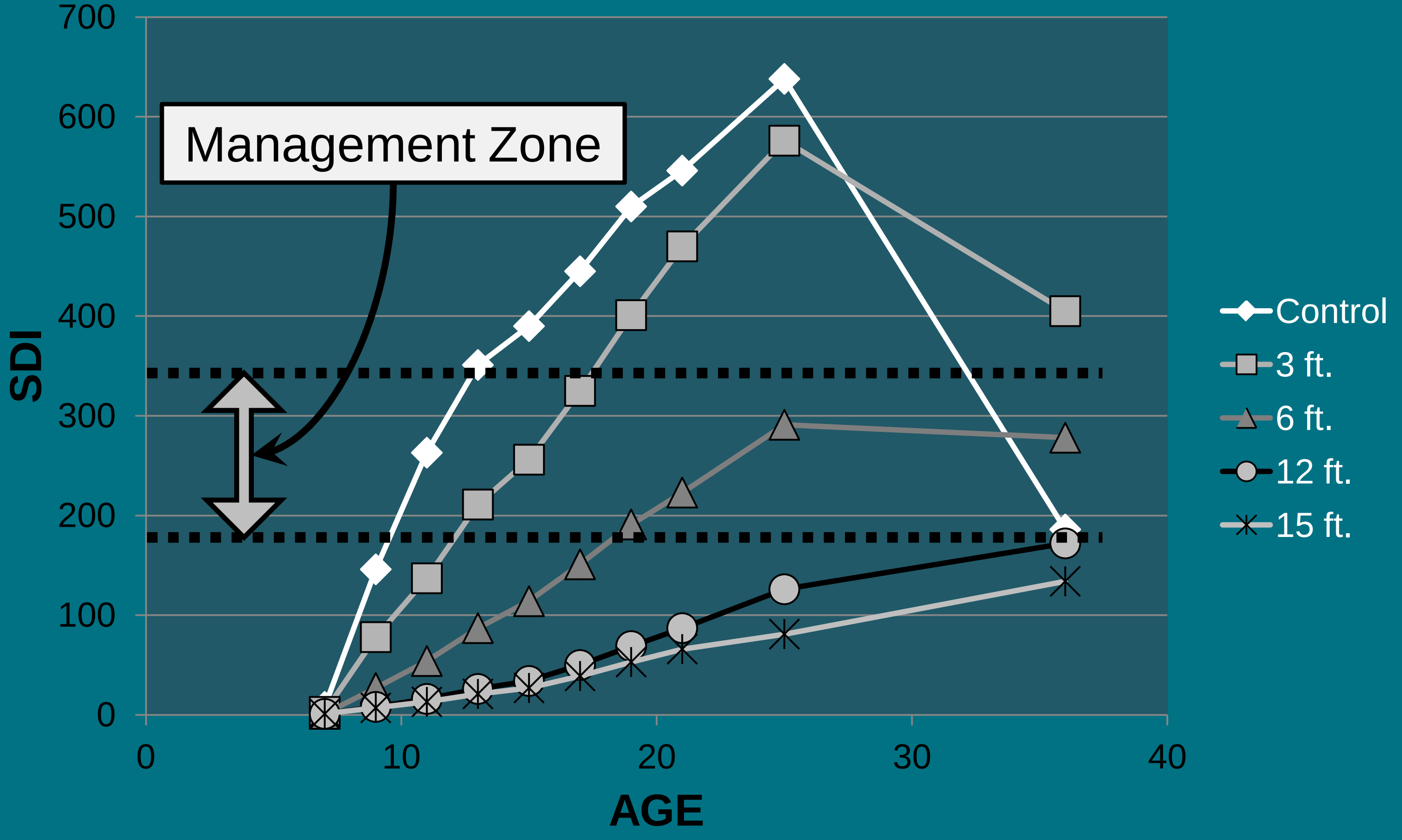
WASHINGTON STATE DEPARTMENT OF
Natural Resources
www.dnr.wa.gov

Stand Development Benchmarks and Relative Density Thresholds

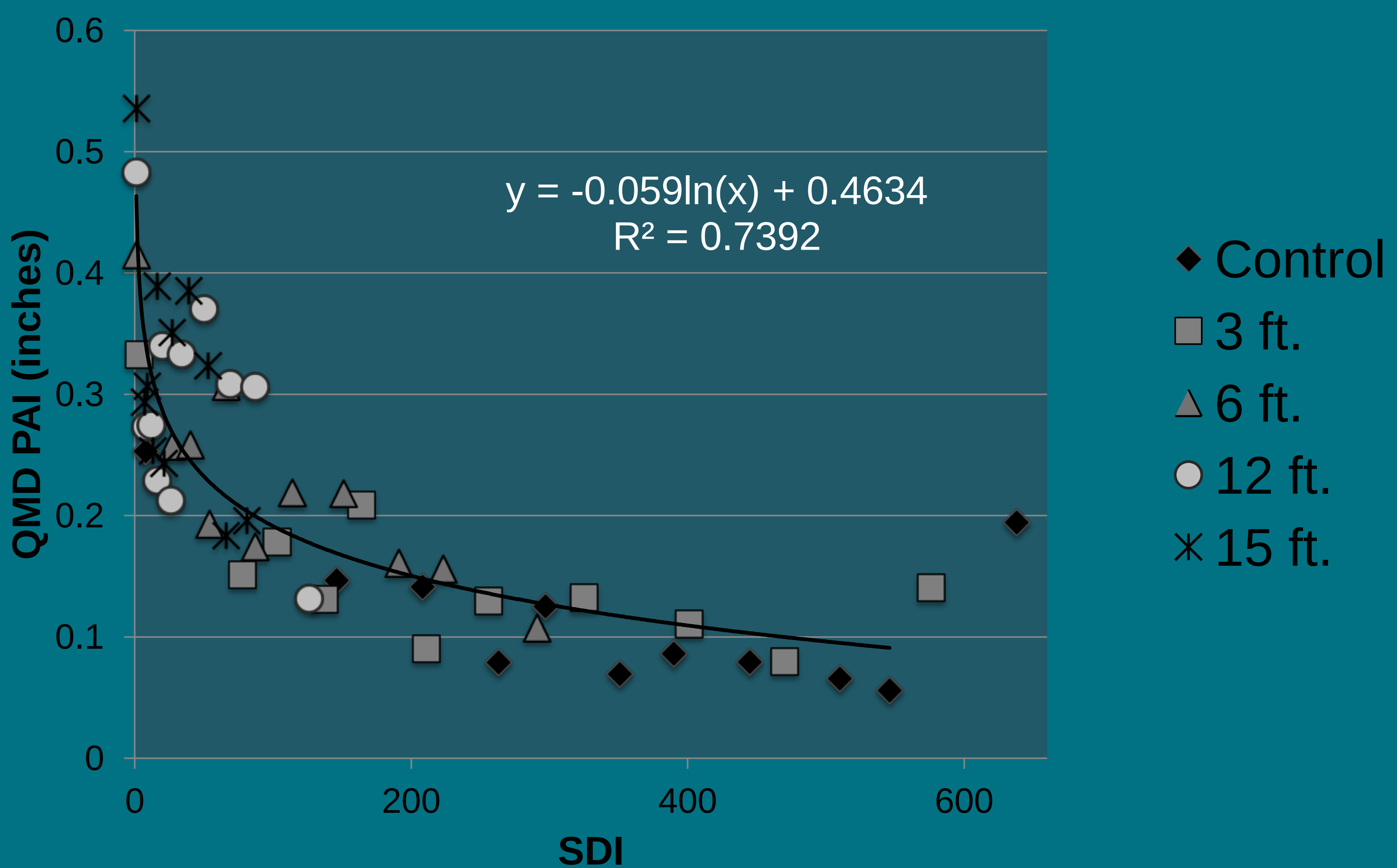
Benchmark or Threshold	Relative Density
Density caused mortality is catastrophic	80%+
Density causes excessive mortality	60-80%
Upper limit of the management zone	60%
Management Zone	35-60%
Lower limit of the management zone	35%
Non-stocked to site occupancy	0 to 20%

Similar to: Powell, D. F14-SO-TP-03-99, April 1999

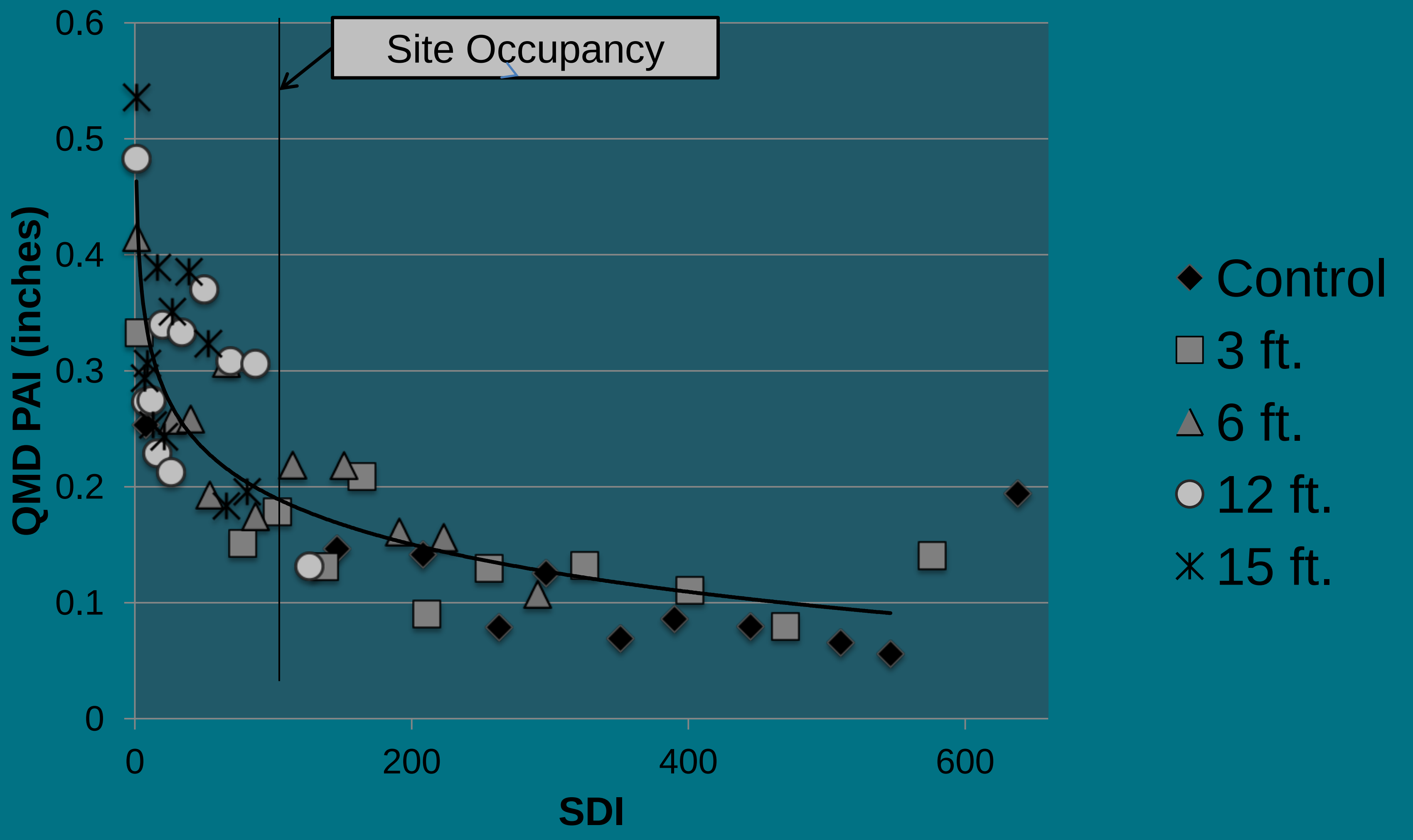
SDI and Developmental Benchmarks



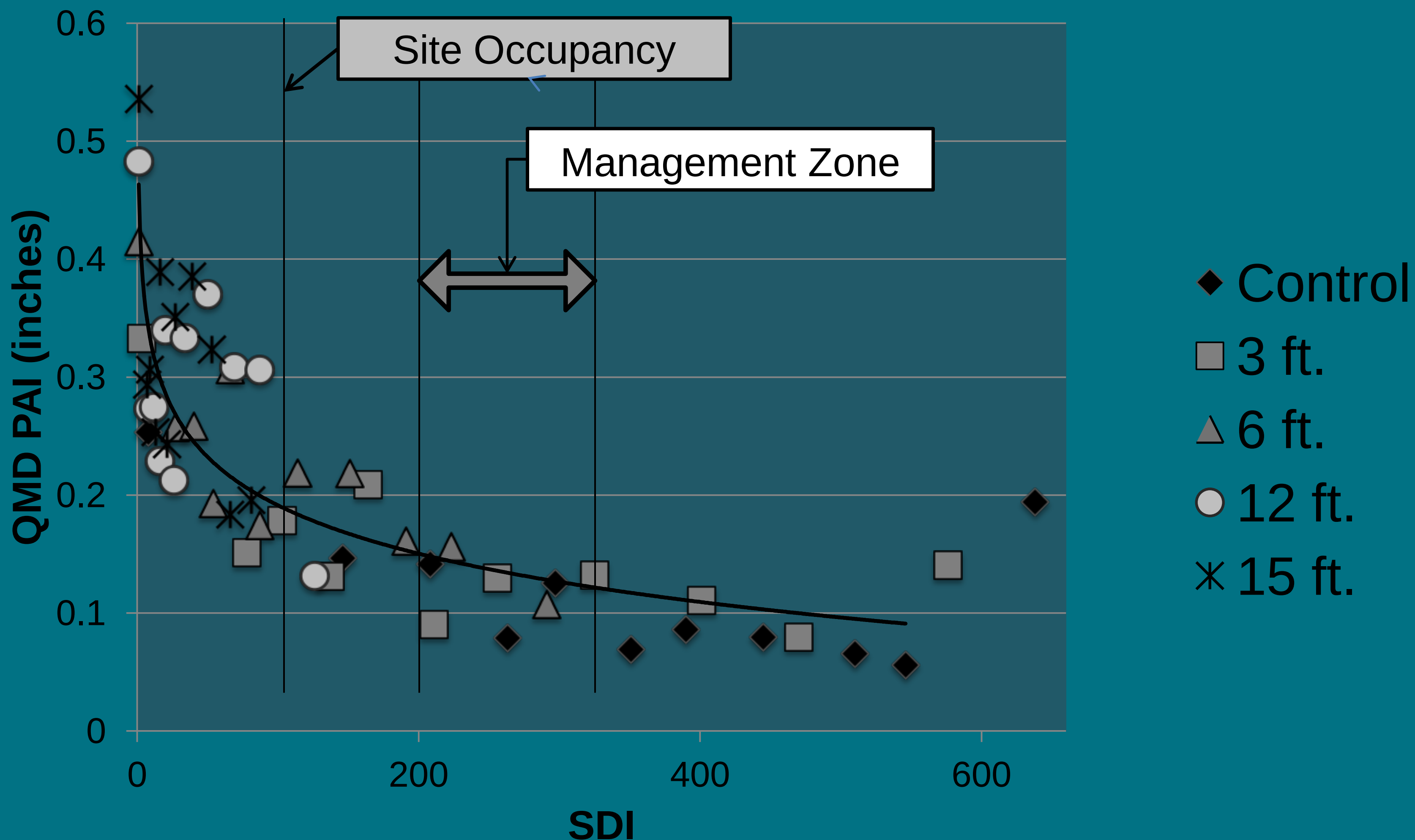
QMD PAI by period beginning SDI and Spacing



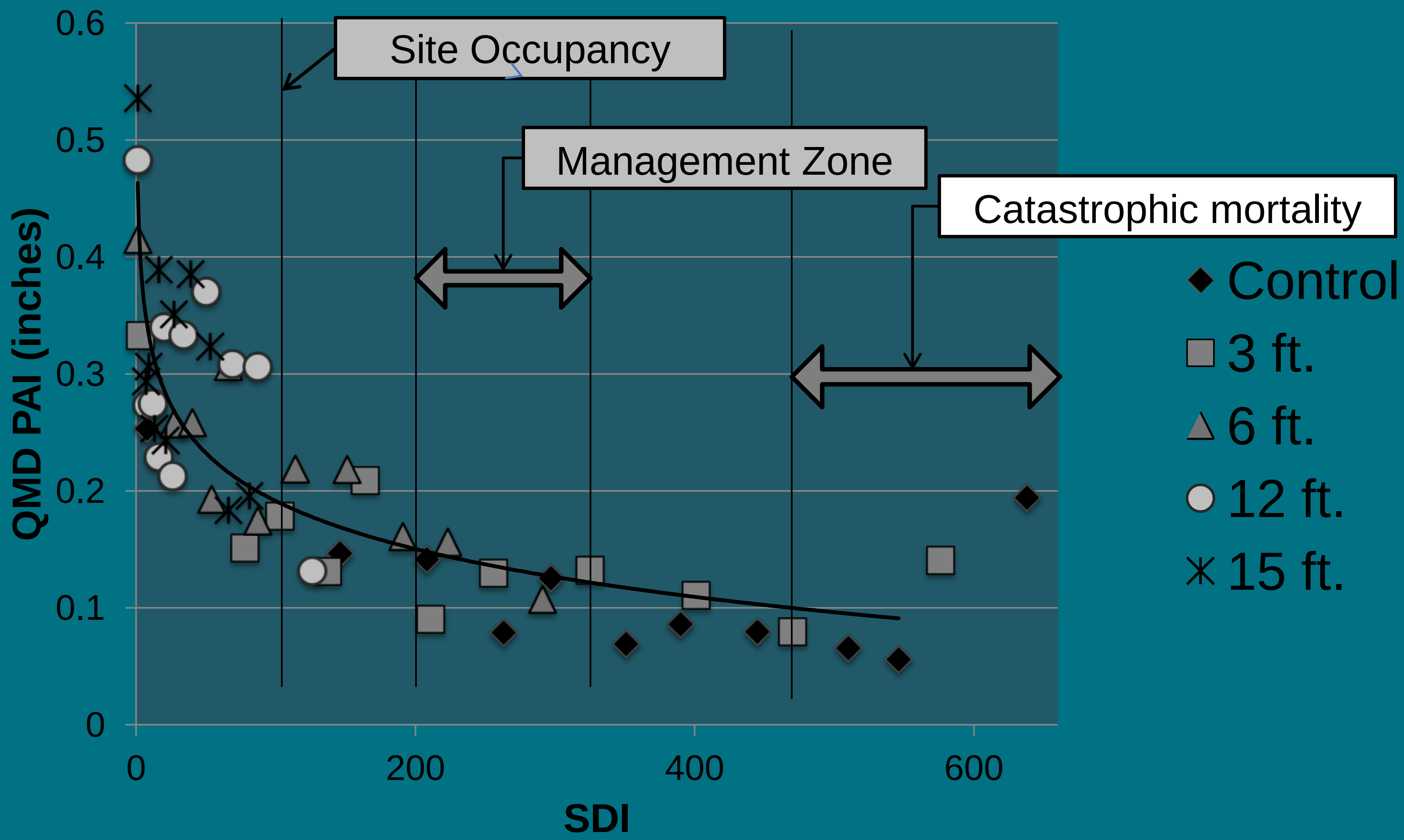
QMD PAI by period beginning SDI and Spacing



QMD PAI by period beginning SDI and Spacing

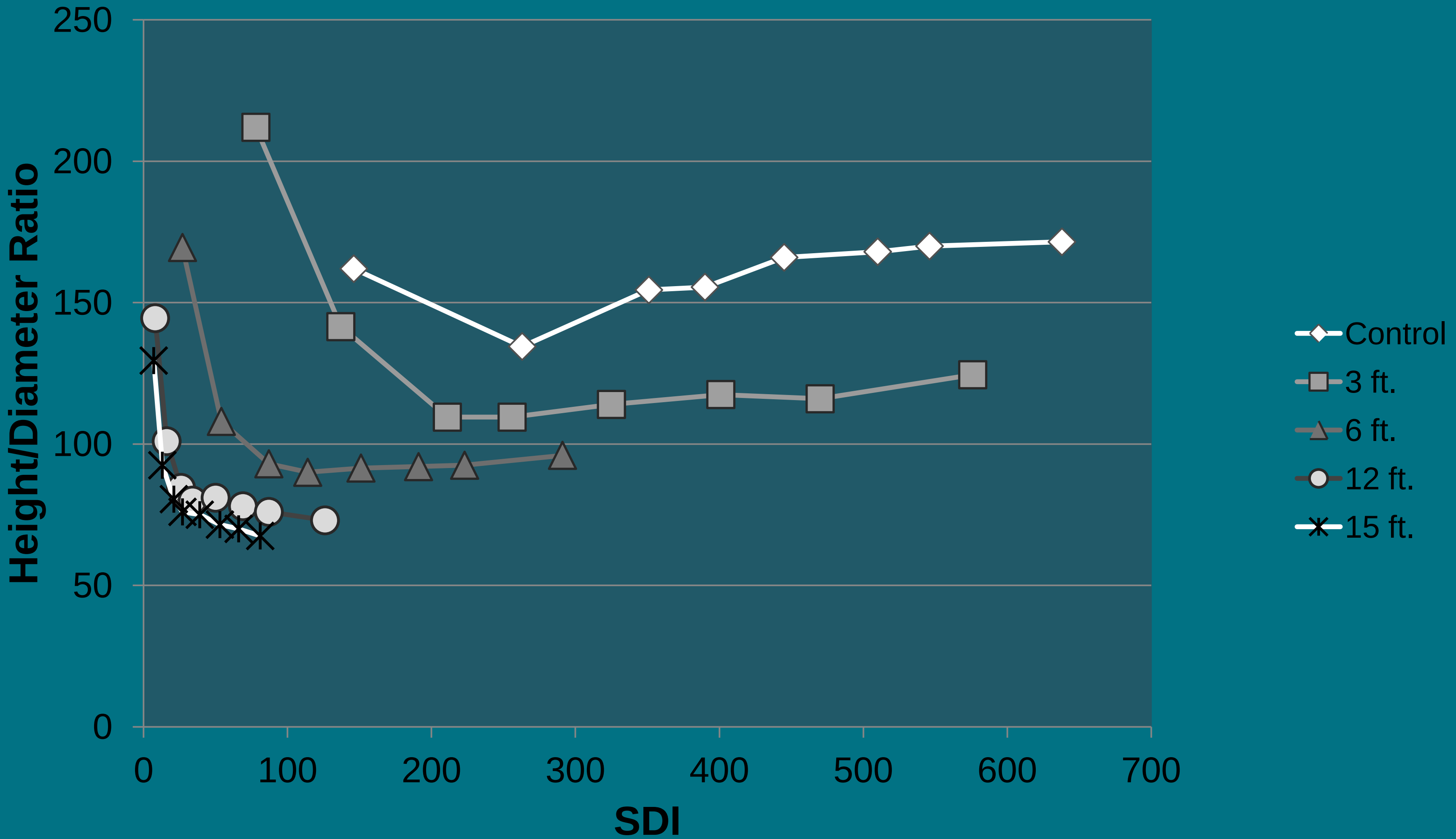


QMD PAI by period beginning SDI and Spacing

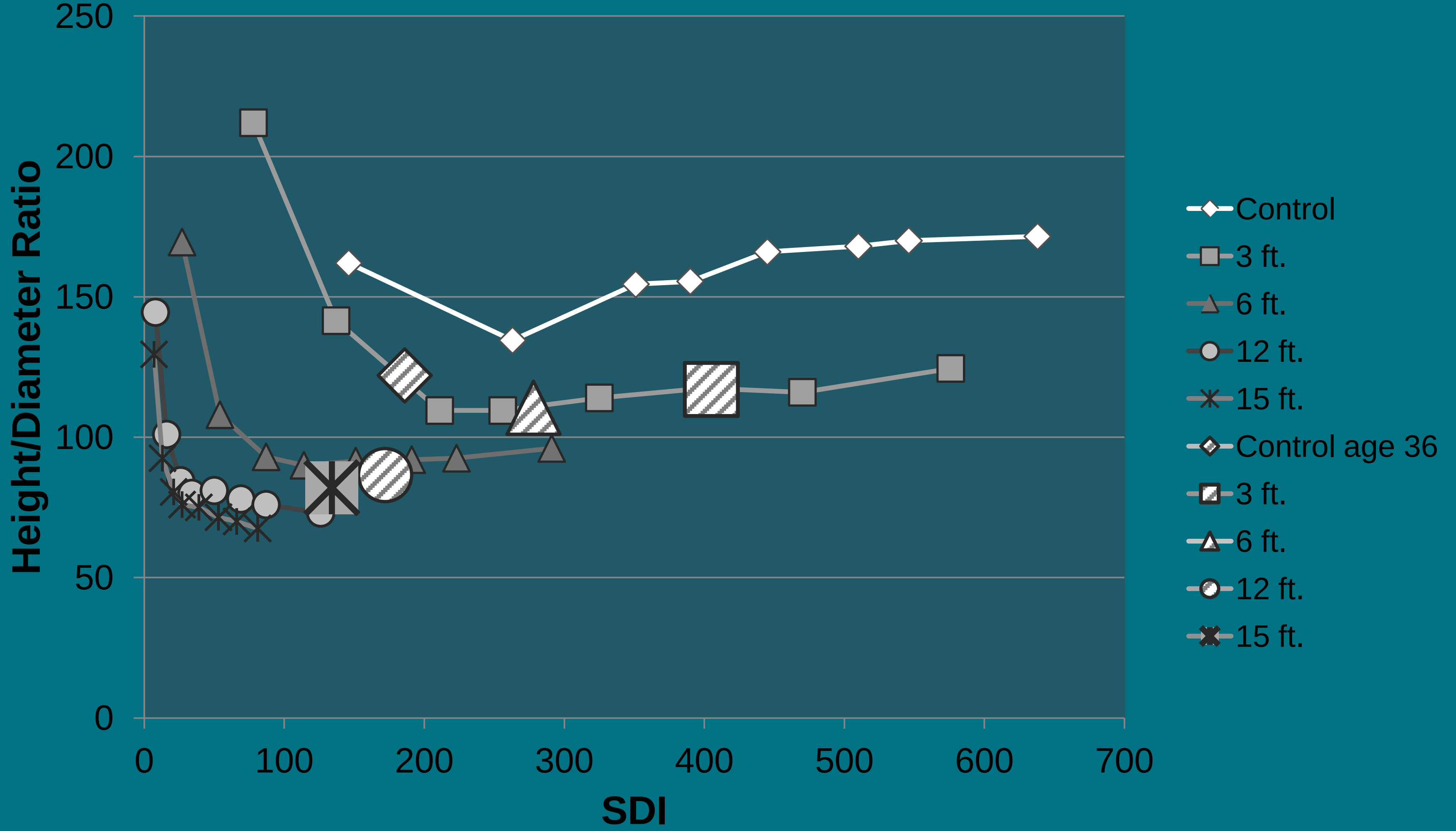


SDI and Diameter Growth

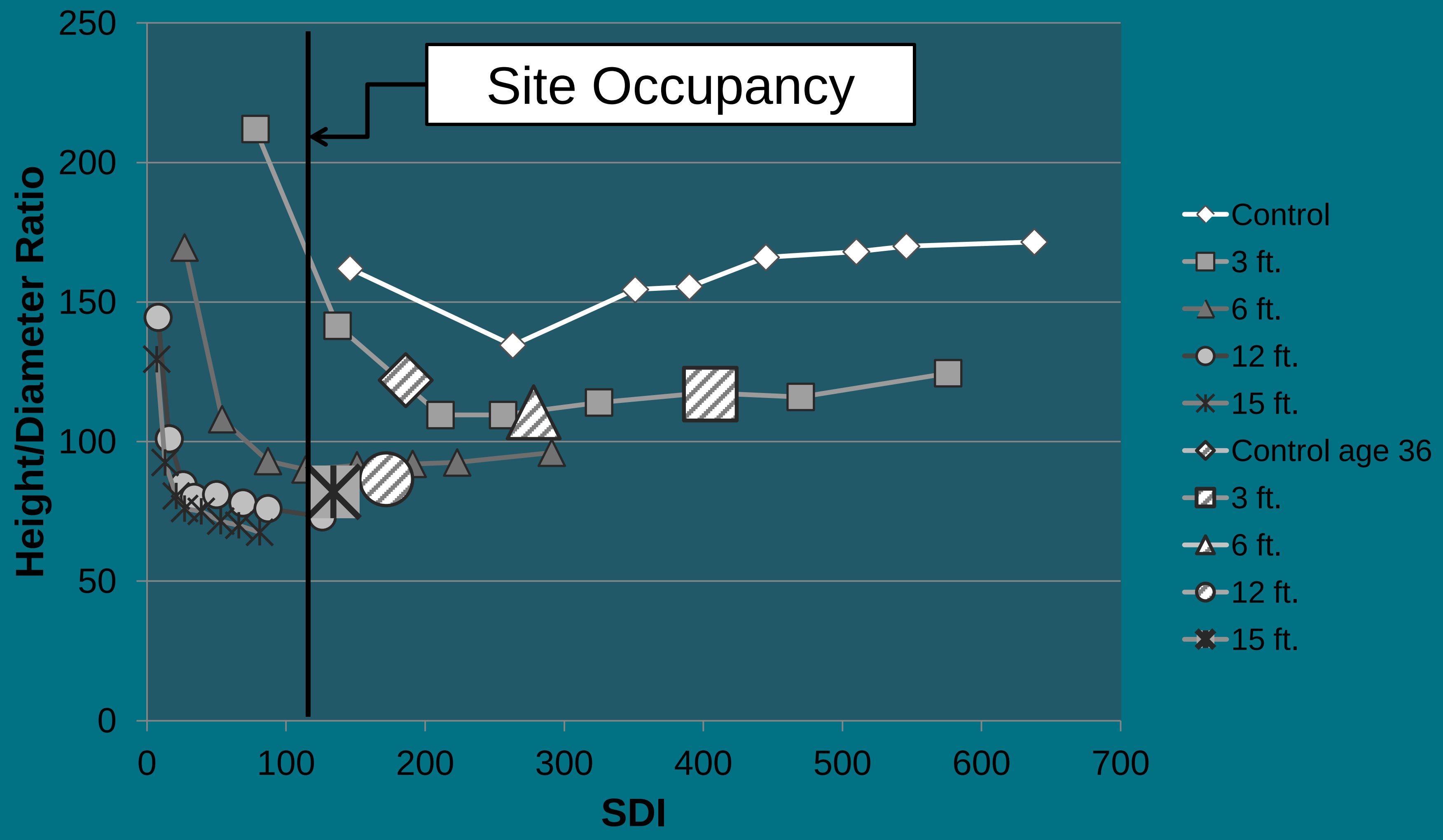
- SDI strongly related to diameter growth regardless of spacing
- Best growth occurs as the site becomes occupied
- Diameter growth within the management zone was 0.1 to 0.15”/year
- Maximum SDI may be set too high (562)
- Management zone definition may be too high for this site



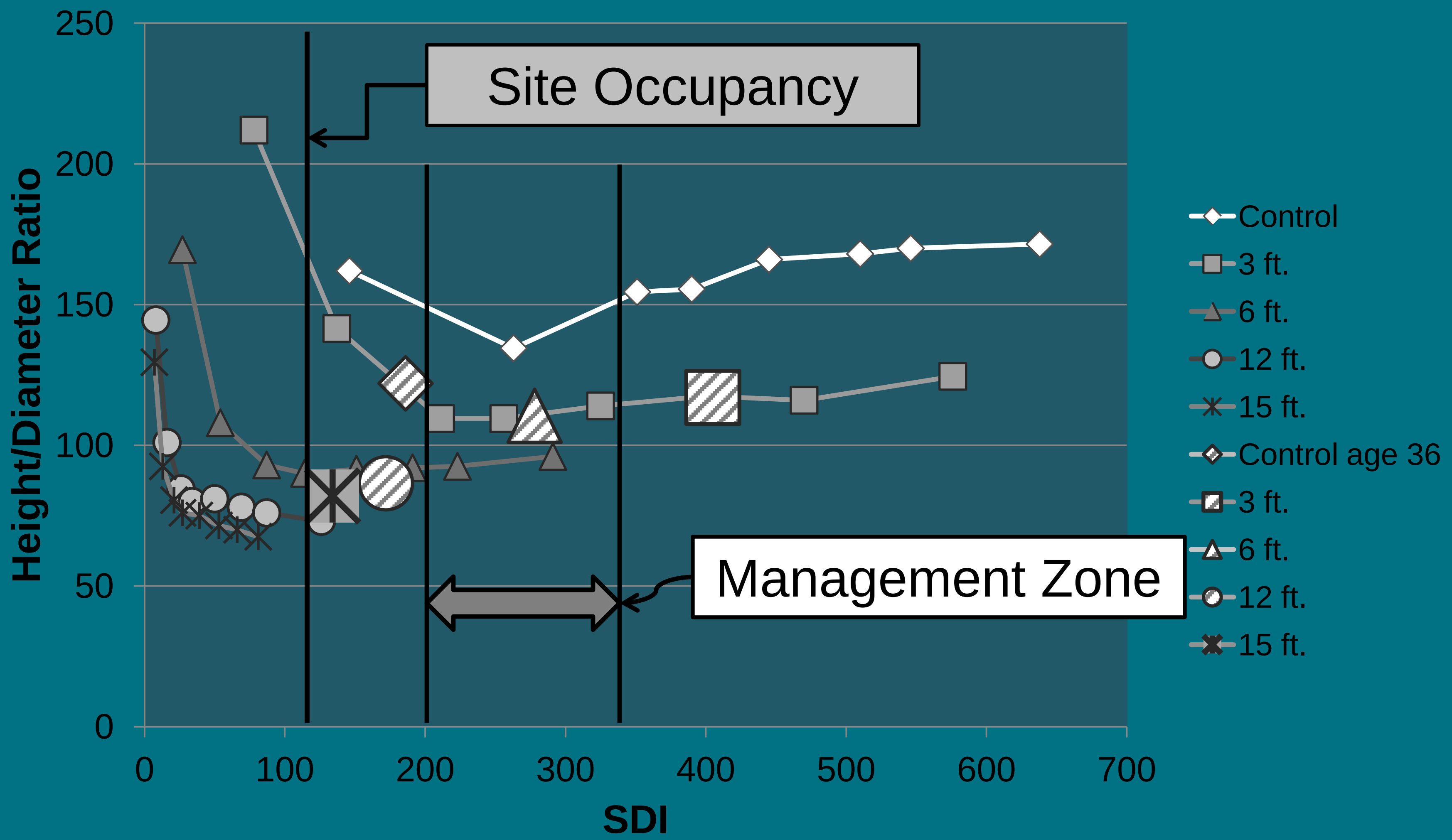
Height to Diameter ratios by SDI and spacing



Height to Diameter ratios by SDI and spacing



Height to Diameter ratios by SDI and spacing



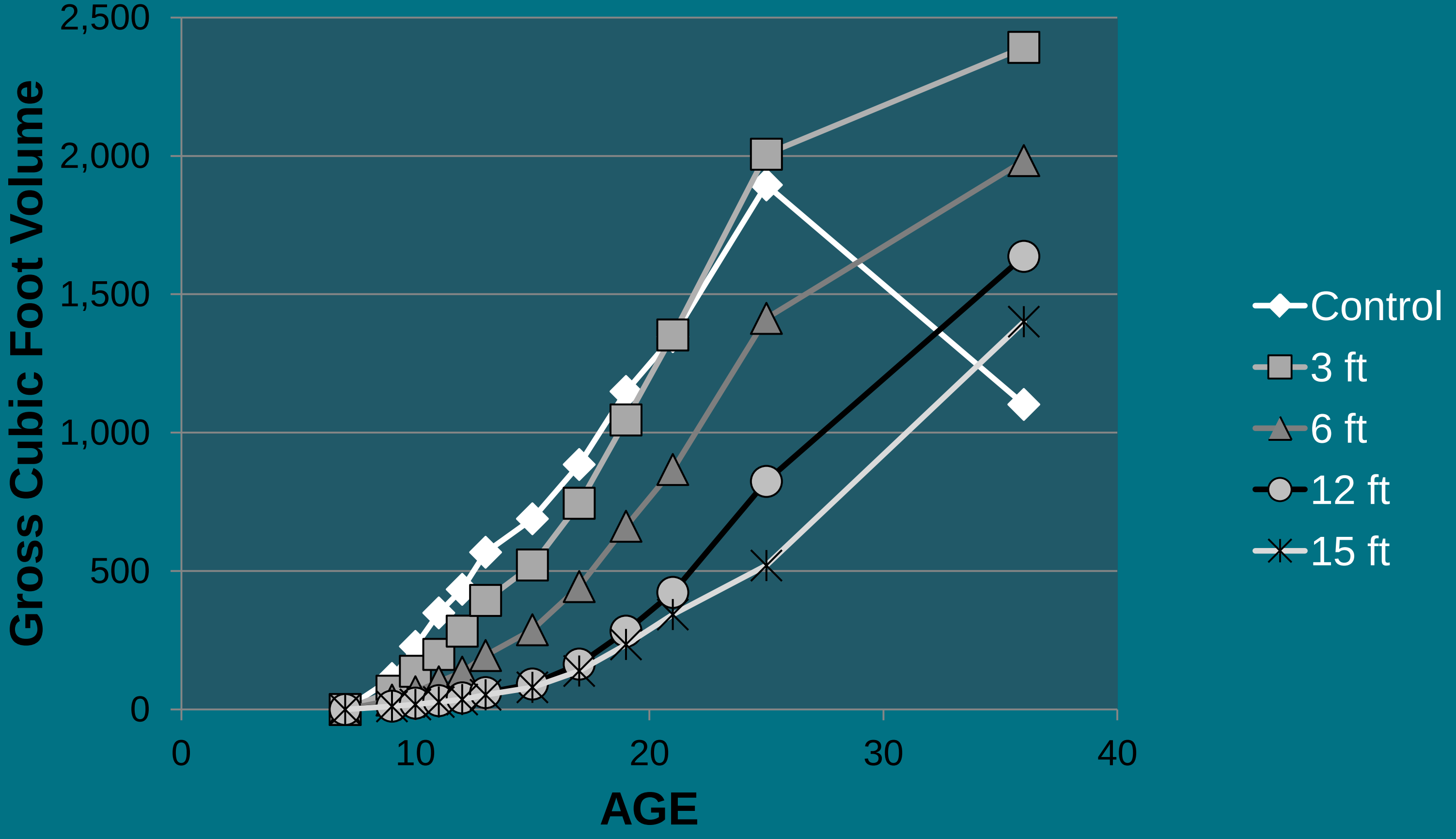
Height to Diameter ratios by SDI and spacing

WASHINGTON STATE DEPARTMENT OF Natural Resources www.dnr.wa.gov

SDI and H:D

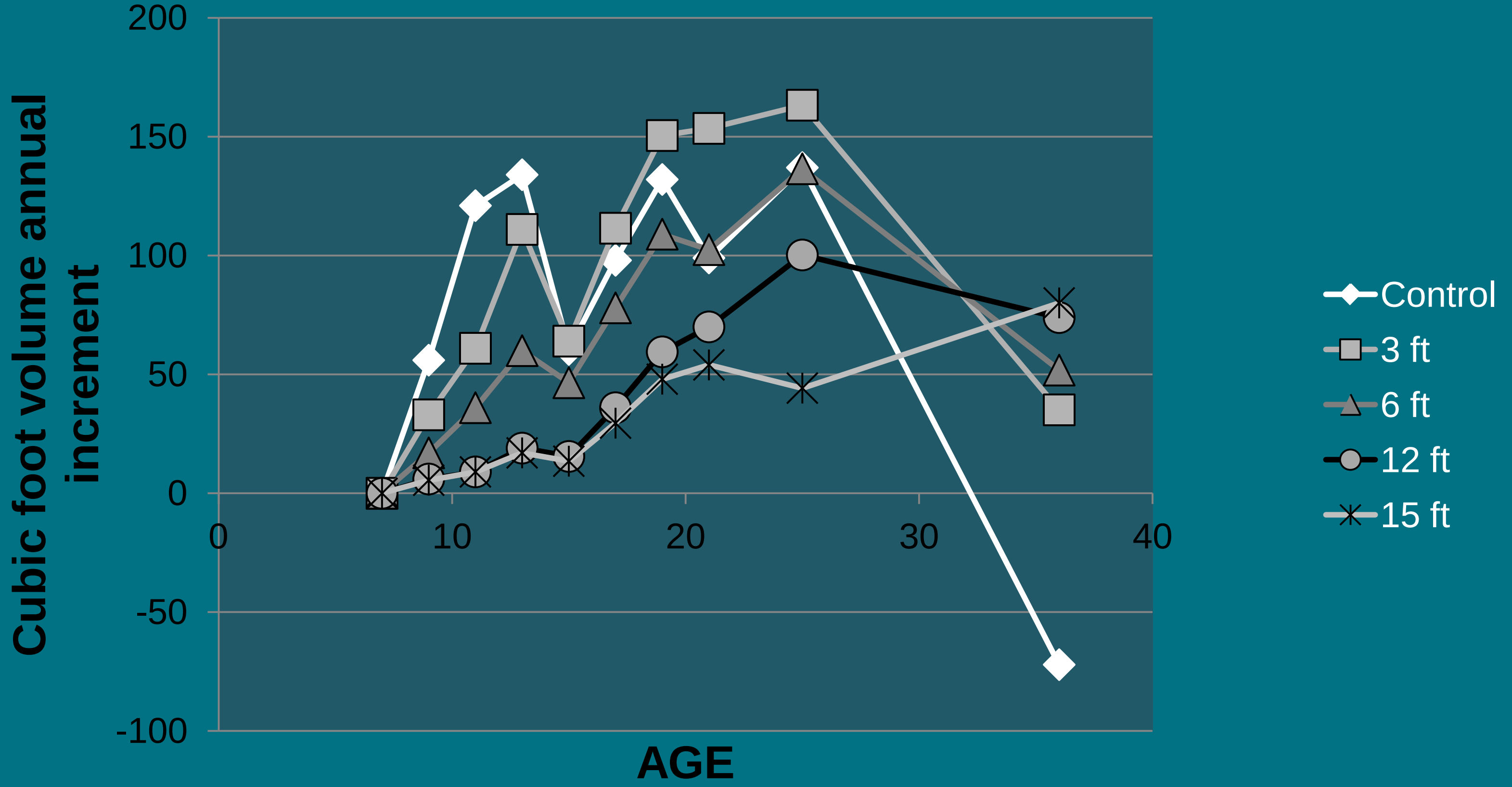
- Site occupancy coincided with minimum dbh growth to maintain stable H:D ratios
- Early established H:D ratios did not improve with significant mortality
- Rapid early increases in SDI indicate the need for earlier thinning as tpa increases
  - Between the ages of 7 and 9 the control plots went from SDI 8 to SDI 146

Cubic Foot Volume Growth by Spacing

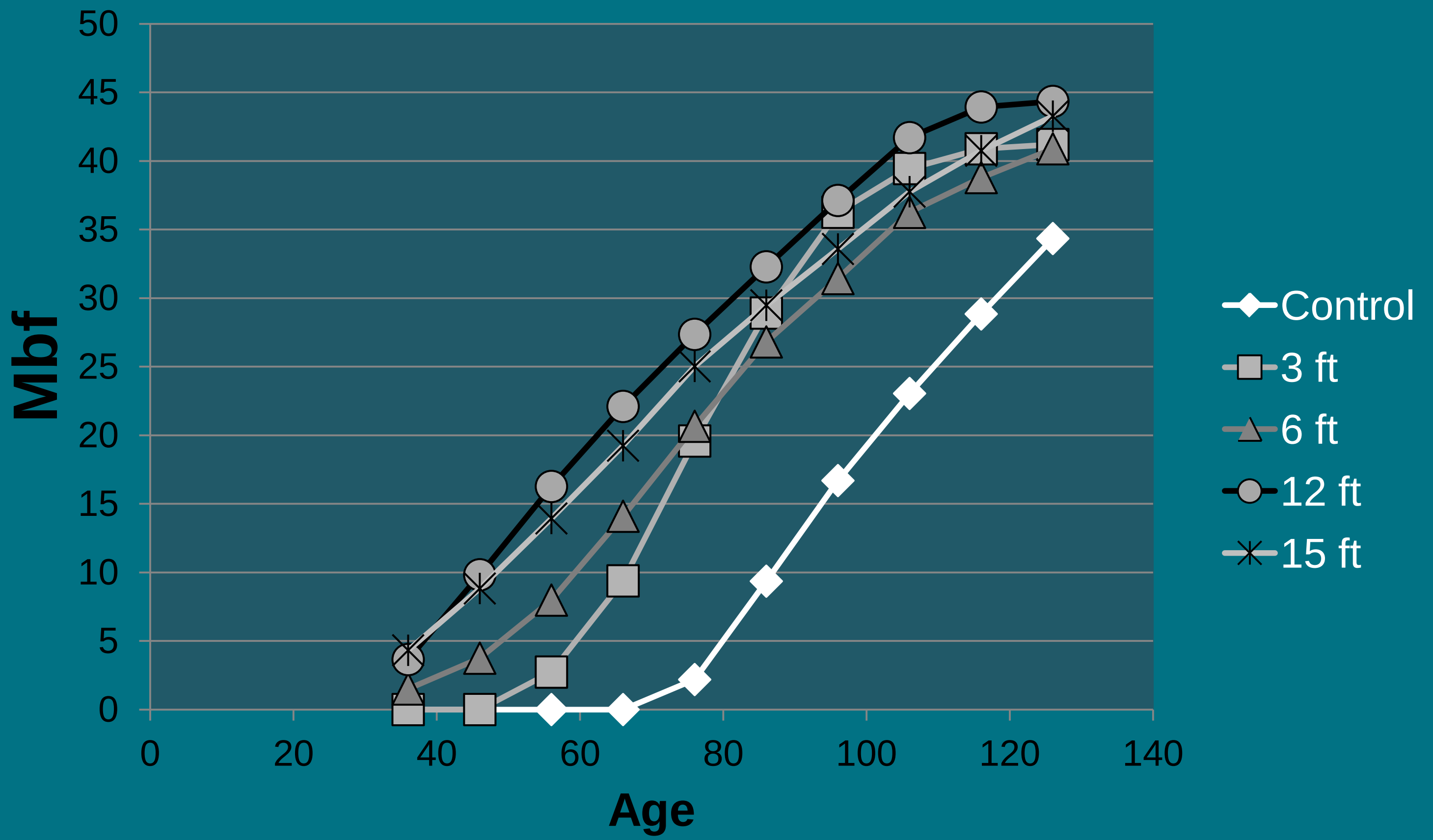


WASHINGTON STATE DEPARTMENT OF Natural Resources
www.dnr.wa.gov

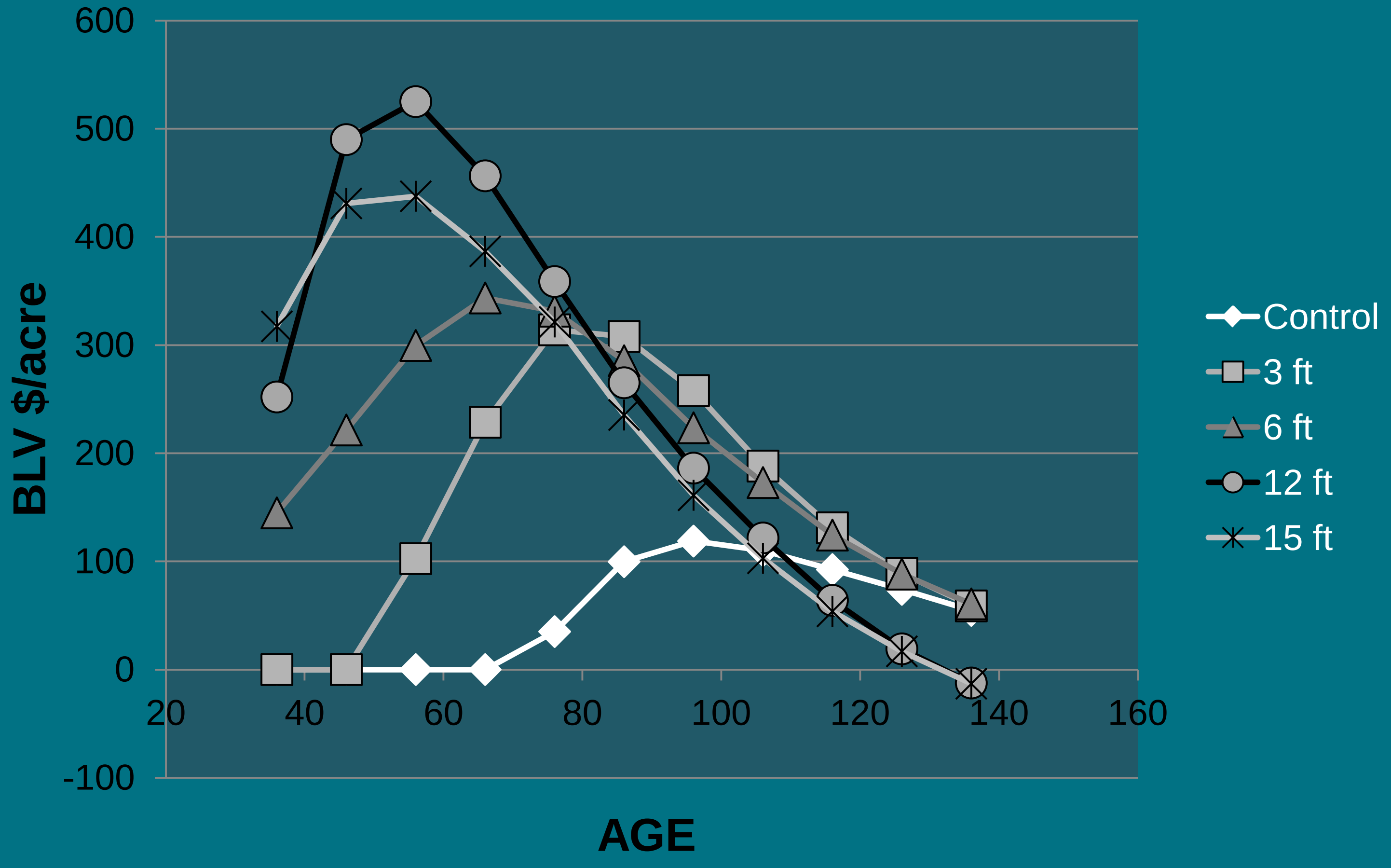
Periodic Annual Increment in Cubic Volume by Spacing



FVS Simulated Board Foot Volume Growth by Spacing



Bare Land Value at Various Rotation Ages by Spacing



WASHINGTON STATE DEPARTMENT OF
Natural Resources
www.dnr.wa.gov

Rotation Length

- Examined culmination of volume metrics and BLV
- All metrics showed increased rotation length with decreased spacing
- Wide spacings had rotation lengths of about 56 years
- PCT reduced rotations by 30 to 50 years
- cMAI-bf occurred at age 96 for wide spacings, but had not occurred by age 136 on the controls

Density Effects Begin Early and Last Forever

- Early onset of effects to diameter growth
  - By age 7 at closest spacing
  - By SDI of 100
  - By the time the site becomes occupied
    - Relative density levels of about 20
- Lack of density effects to height growth
- If density exceeds SDI 100, diameter growth cannot keep up with height growth
  - Results in high H:D ratios and greater risks to structural failure

Stagnation

- Lack of density related mortality led to stagnation
- Spindly stems kept growing in height
- Unthinned stands exist in unstable condition until an external event triggered catastrophic mortality
- Stagnated trees did not respond with improved H:D ratios even after losing 95% of stems per acre

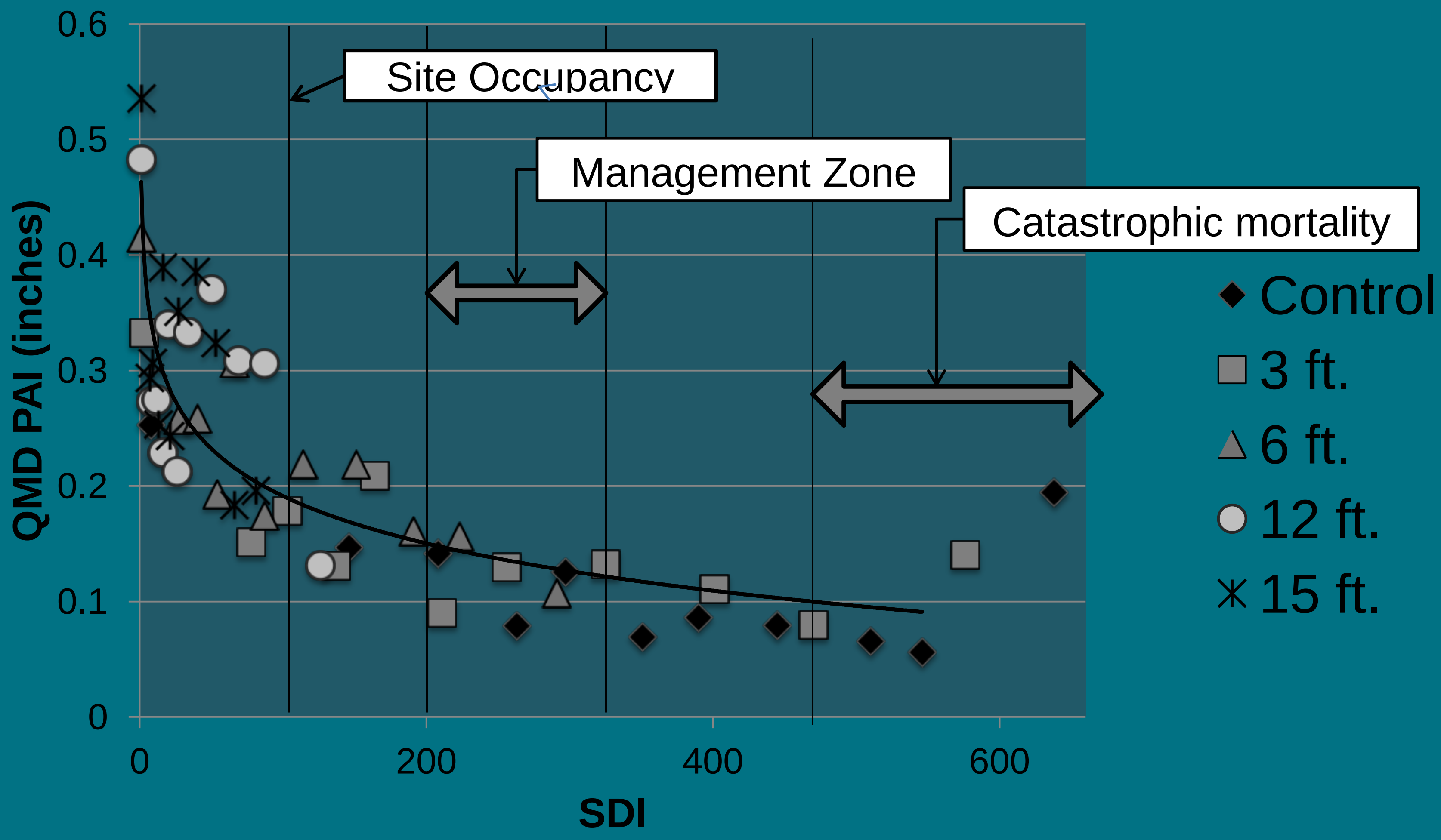
Consequences to Future Stand Development

- Stagnation stymies development of large trees
- Stagnant stands cannot progress to more complex developmental stages
- Duration of early rapid diameter growth associated with open grown conditions determines:
  - Long-term structural stability
  - Rotation length
  - Financial performance.

PCT Direction

- PCT should occur early
  - – Prior to site occupancy – SDI ~ 110

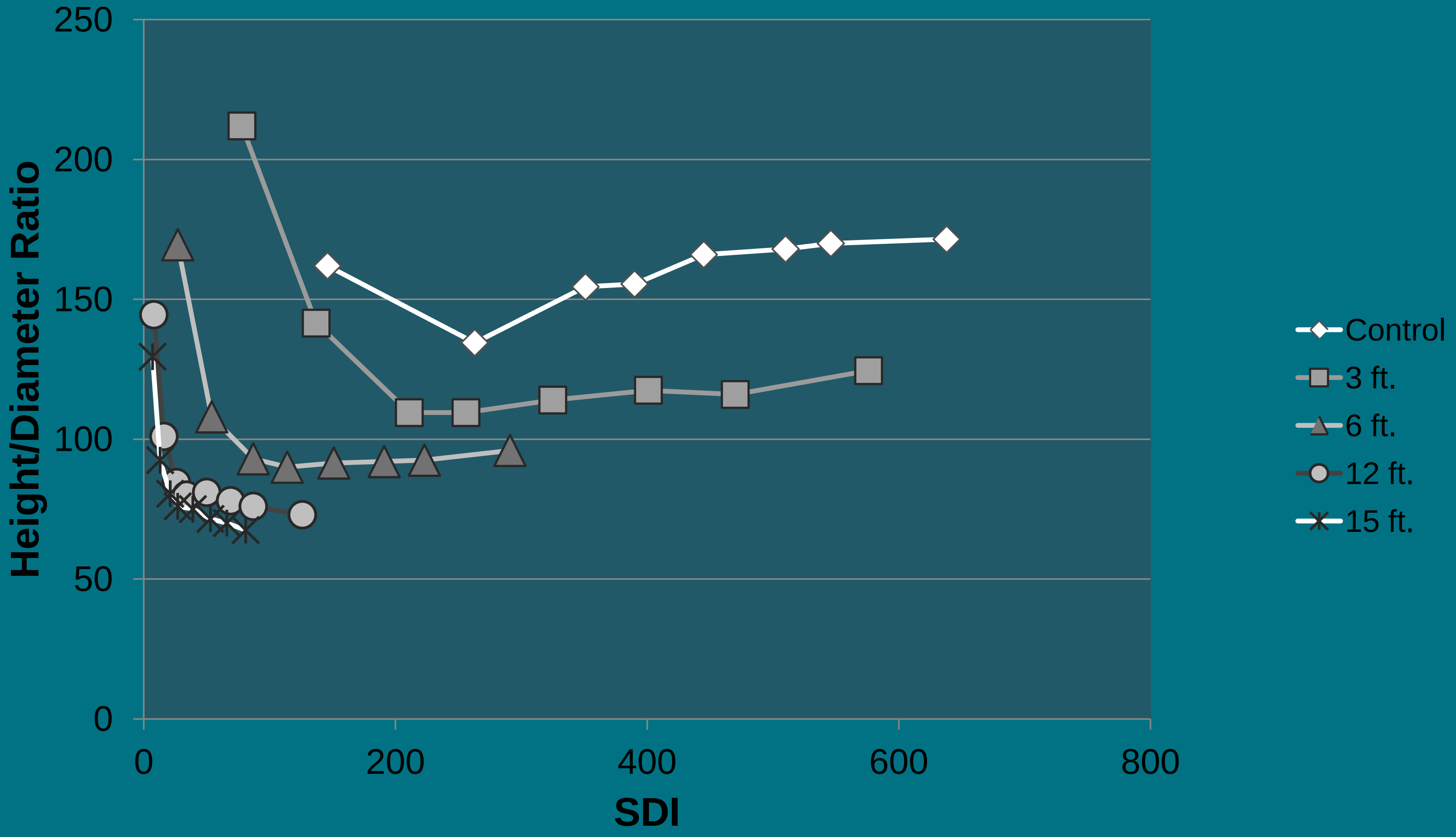
QMD PAI in relation to period beginning SDI



WASHINGTON STATE DEPARTMENT OF Natural Resources
www.dnr.wa.gov

PCT Direction

- PCT should occur early
  - Prior to site occupancy – SDI ~ 110
  - Higher tpa and earlier thinning
- TPA greater than 1,000 need to PCT

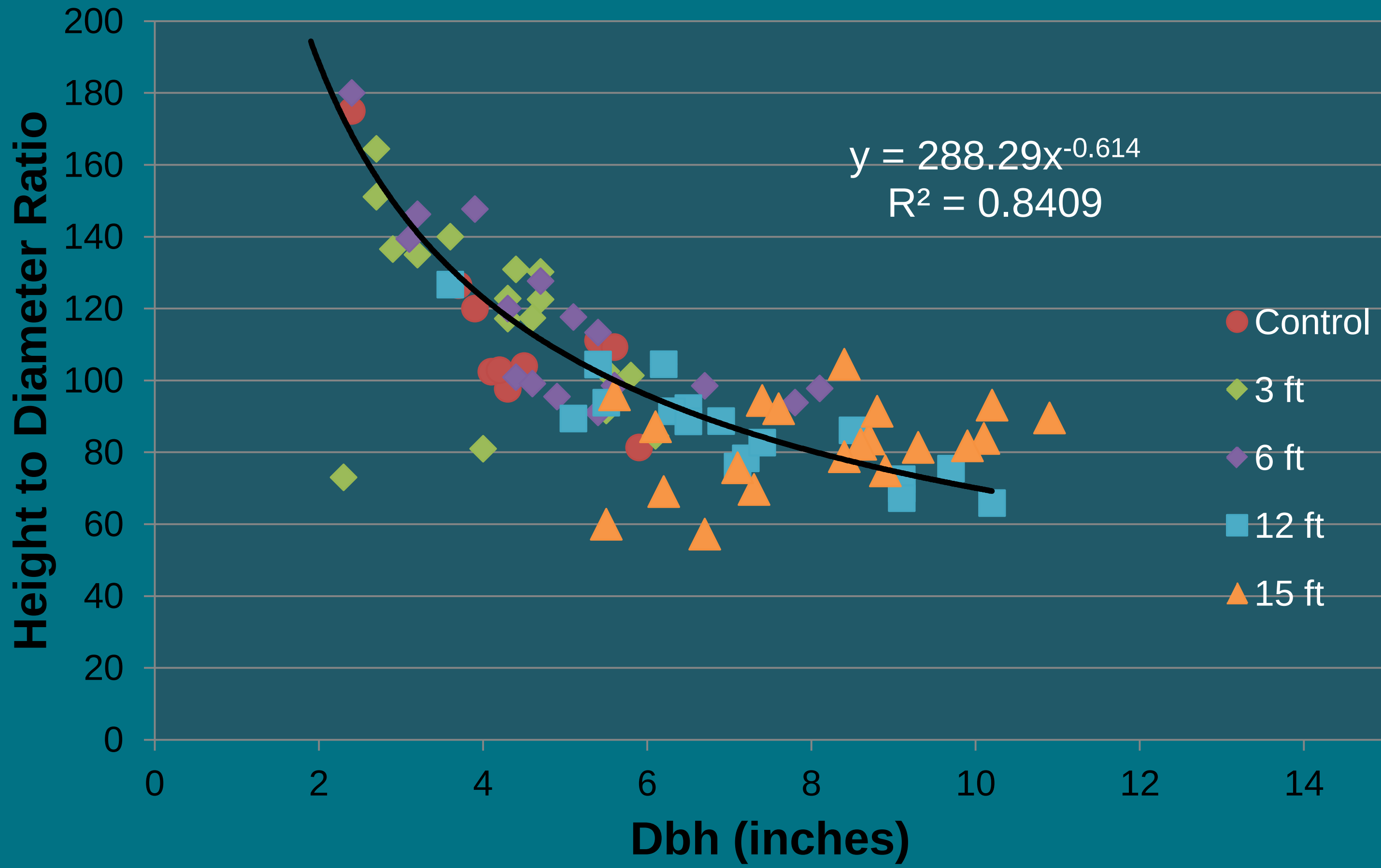


Height to Diameter ratios by SDI and spacing

PCT Direction

- PCT should occur early
  - Prior to site occupancy – SDI ~ 110
  - Higher tpa and earlier thinning
- TPA greater than 1,000 need to PCT
- PCT to 12 to 15 ft. spacing for growth and

Height to Diameter Ratios by Spacing and Dbh at age 36



WASHINGTON STATE DEPARTMENT OF Natural Resources
www.dnr.wa.gov

CONCLUSIONS

- Excessive density has negative effects on tree growth as early as age 7
- Early negative effects will persist throughout the life of the stand
- SDI is a useful index of stand density because it captures both size and number of trees
- Relative density levels impart an understanding of the developmental dynamics and thresholds trees are exposed to
- Site carrying capacity is a useful management indicator given dynamic growth relationships

Questions?