What's he doing?

a) Painting a landscape scene

b) Admiring his fingernail polish

c) Making his prof disappear

d) Sampling a forest stand

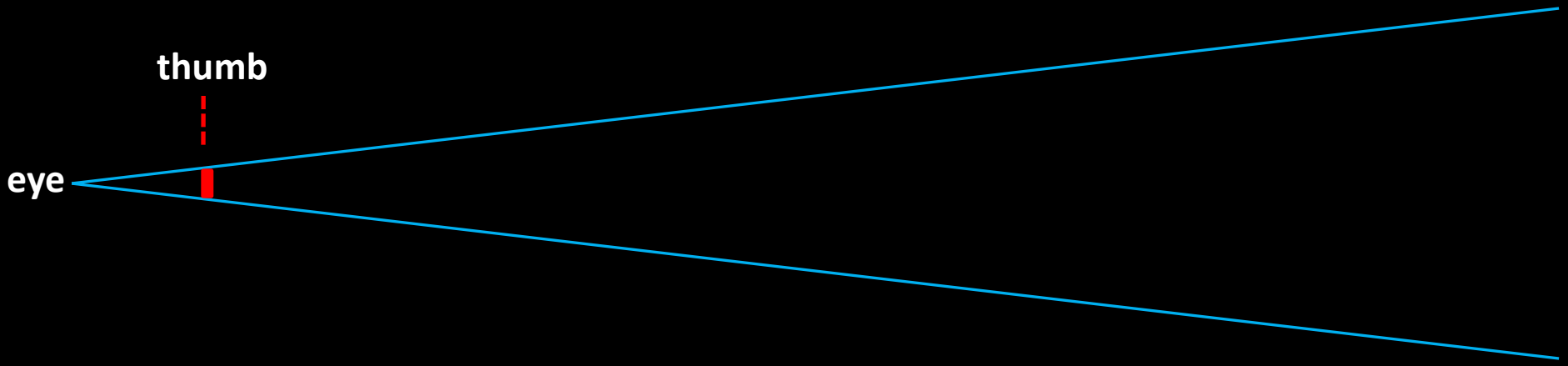
Point Sampling (or How to Measure the Forest with your Thumb)

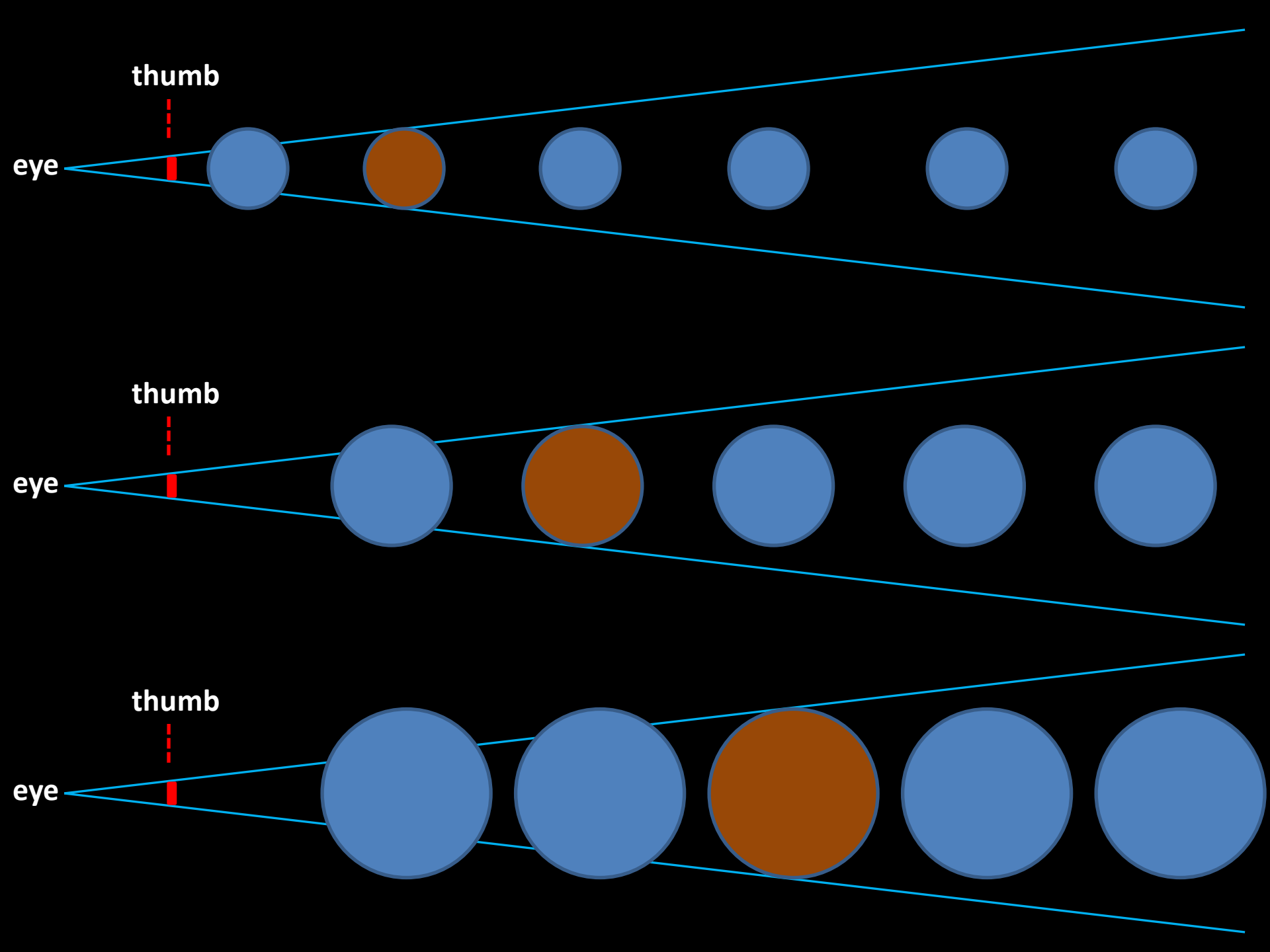
FOR 1001

Dr. Thom Erdle

Objectives

- Concepts of sampling stands via "*point*" or "angle gauge" or "prism" methods
- *Implementing* point sampling in the *field*
- *Analyzing* point sampling *data* to calculate stand inventory
- Contrasting *point sampling* and *fixed-area* sampling


thumb
eye


thumb
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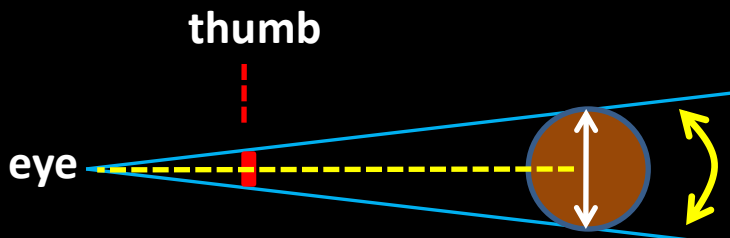
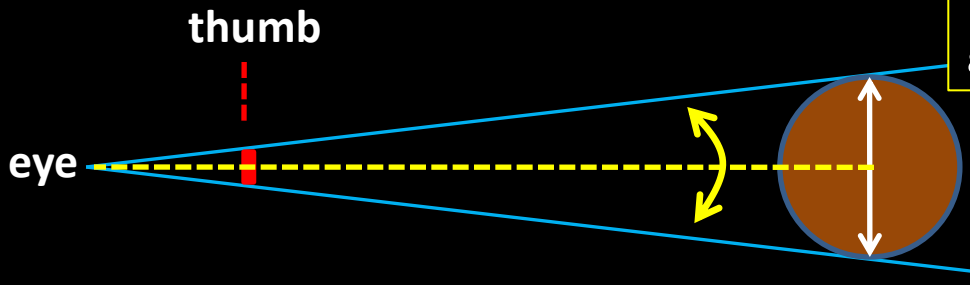
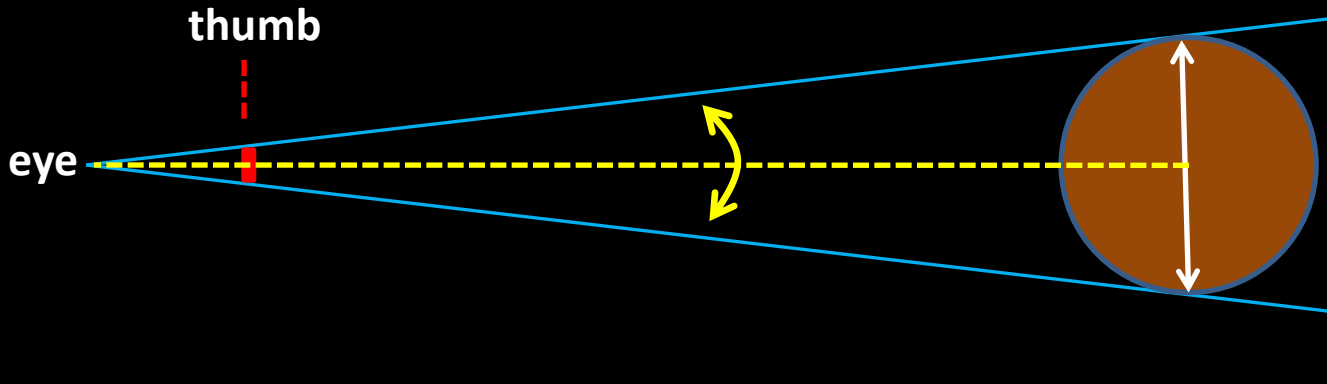


Distances at which these objects just become visible are called "*limiting distances*"

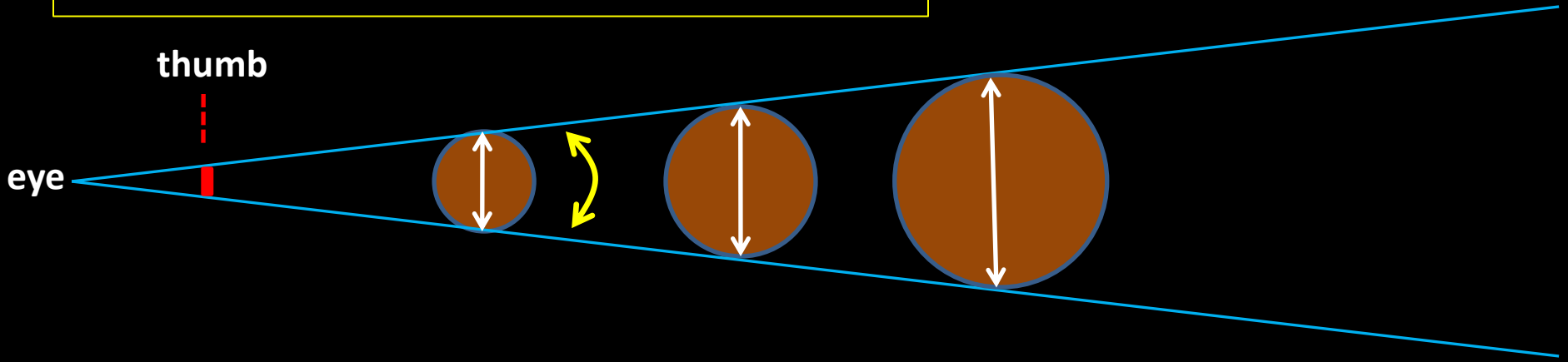


"*Limiting distances*" governed by:

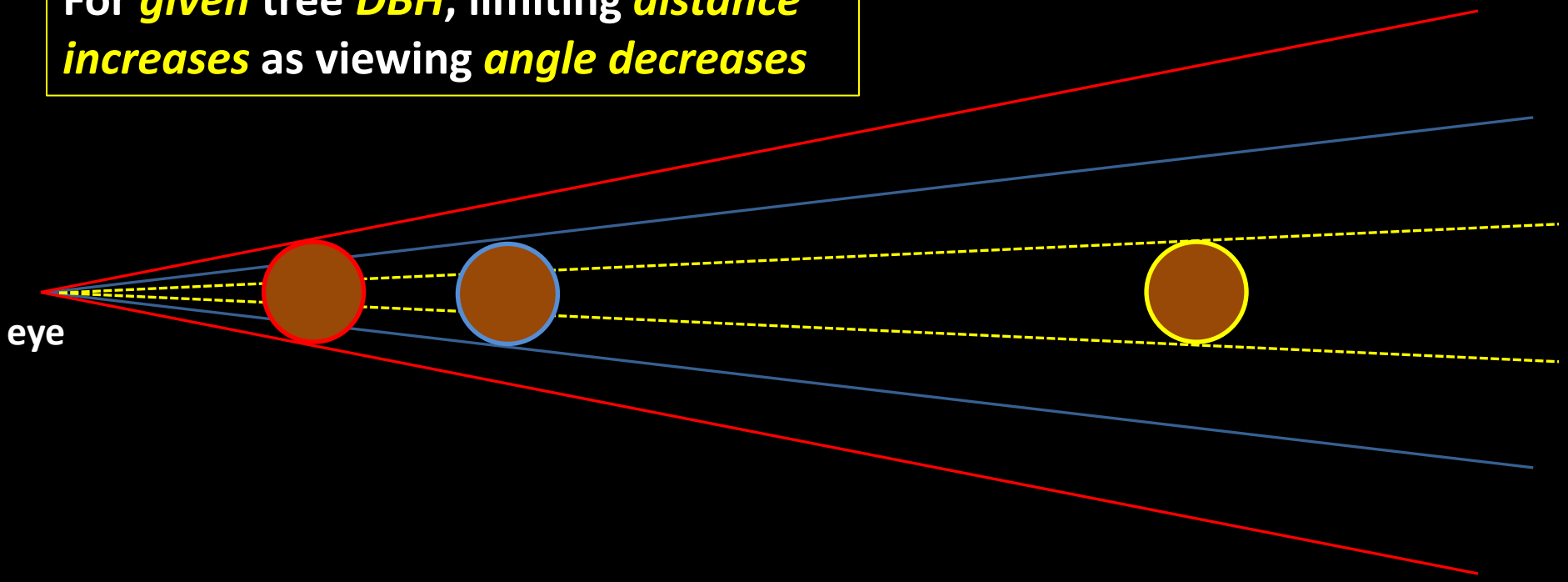
- *viewing angle* (thumb & arm)
- *diameter* of object



For *given* viewing *angle*, *limiting distance increases* as tree *DBH increases*

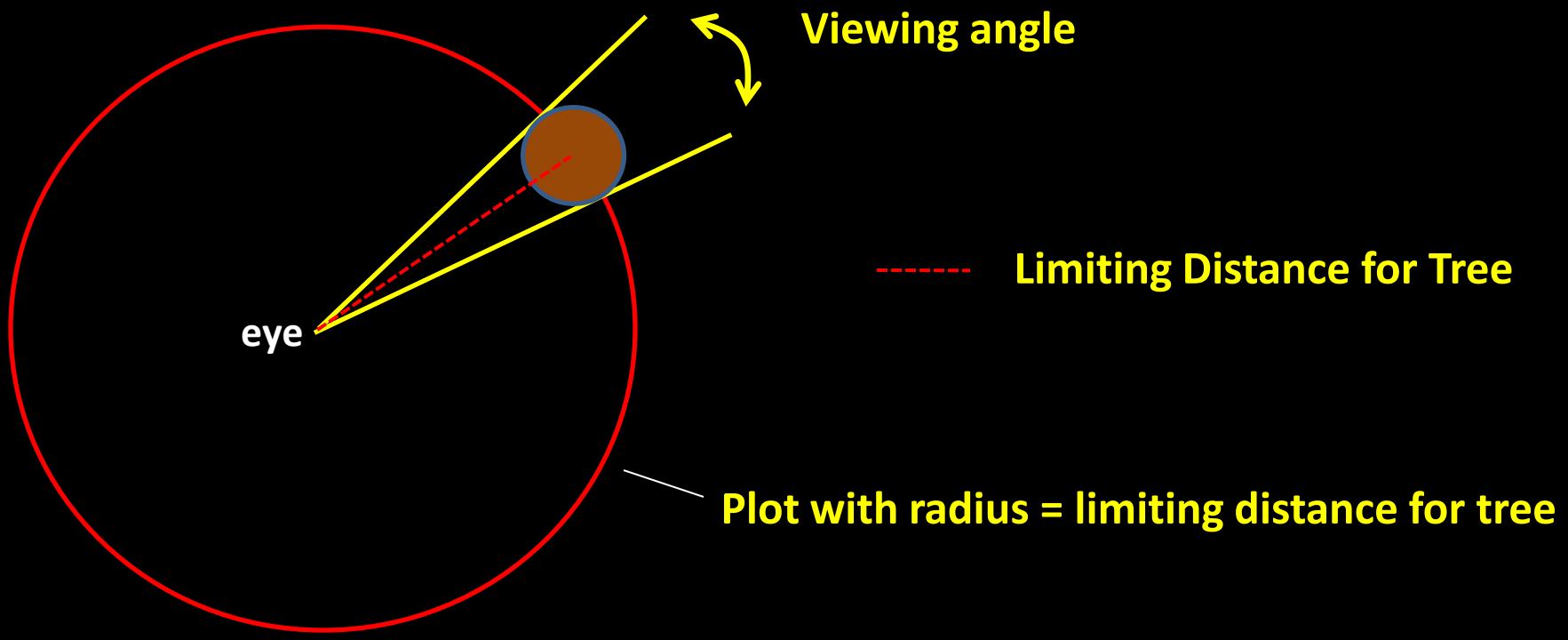


For *given* tree *DBH*, limiting *distance increases* as viewing *angle decreases*



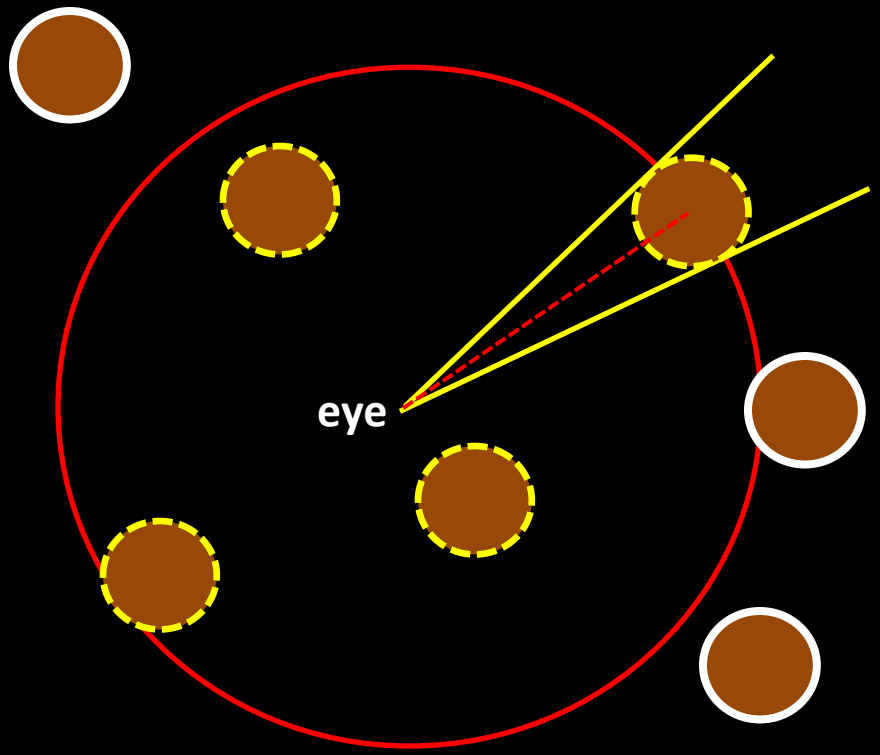
Limiting Distances

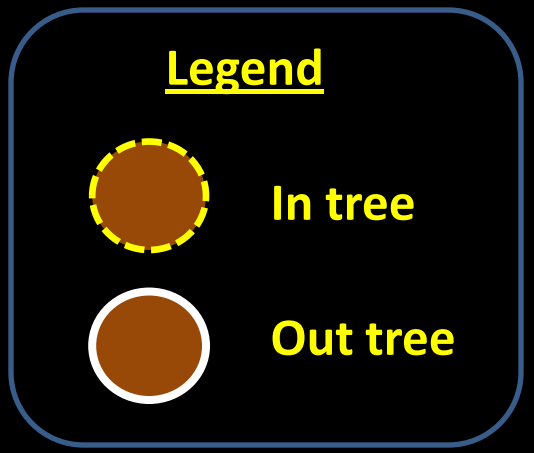
- Distance at which tree of *given DBH* is *just visible* for a given *viewing angle*
- Represent *radius* of *fixed area plot* just large enough to include a *tree of that size*



Limiting Distances

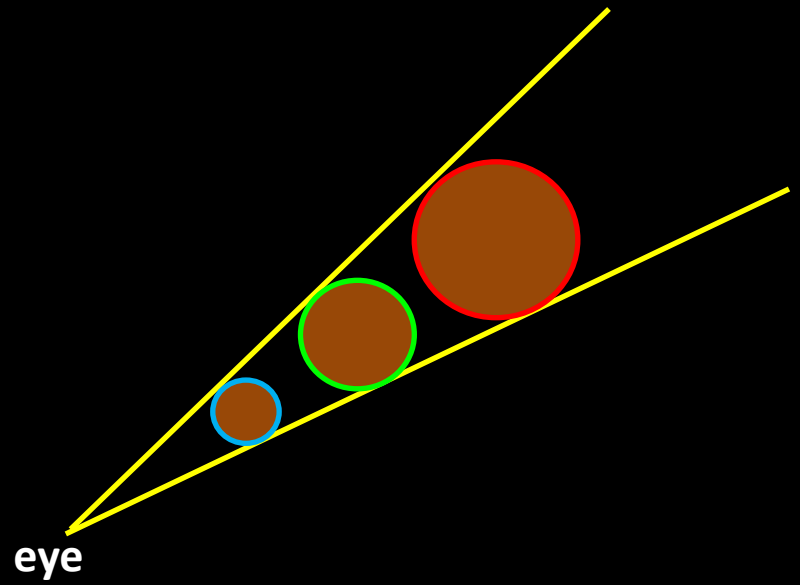
- All trees of that ***same DBH closer*** than limiting distance would be ***within the plot***
- All trees of that ***same DBH further*** than the limiting distance would be ***outside the plot***





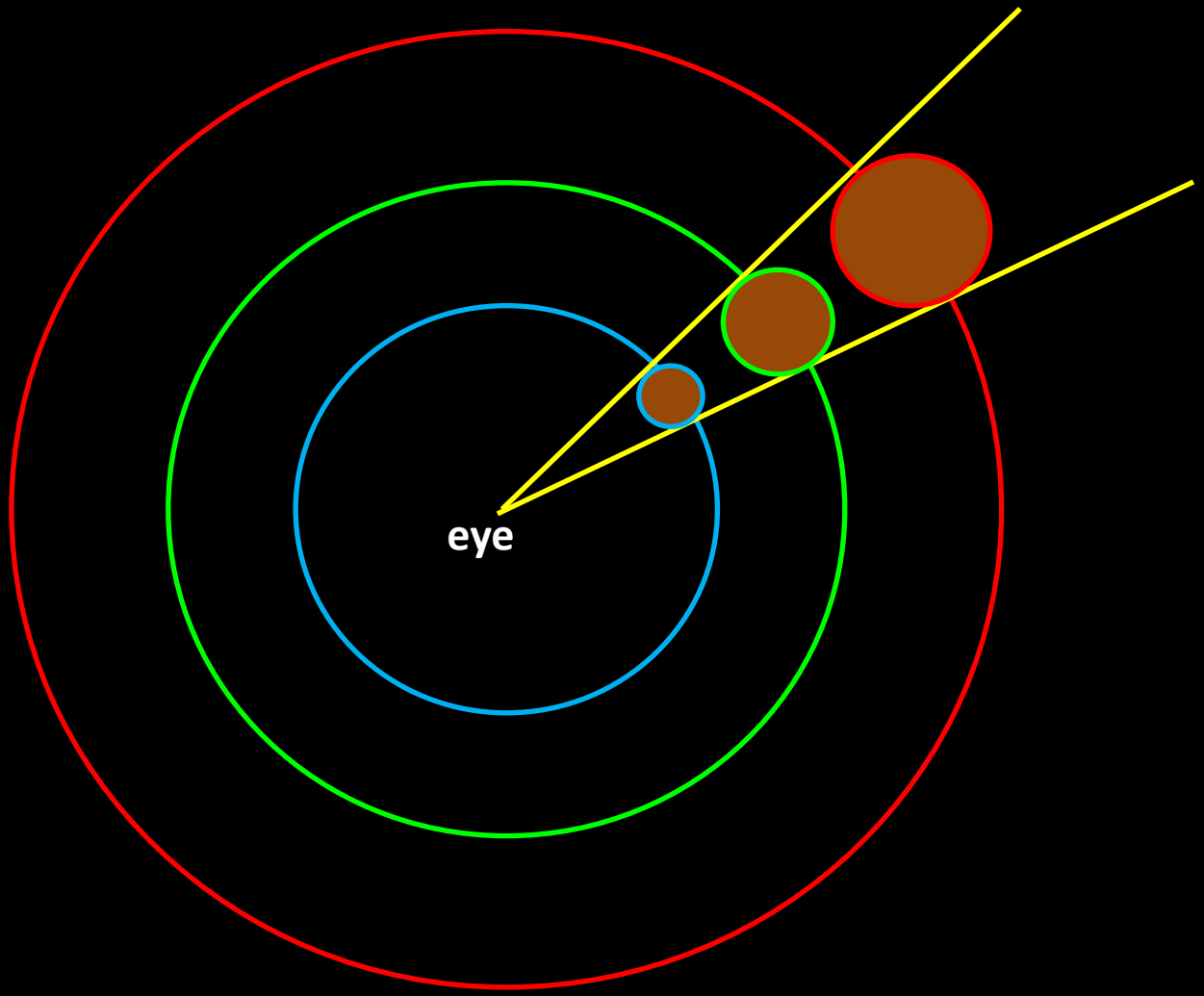
Limiting Distances

- For given *viewing angle*, *limiting distance varies* with *tree DBH* (larger DBH = larger limiting distance)



Limiting Distances

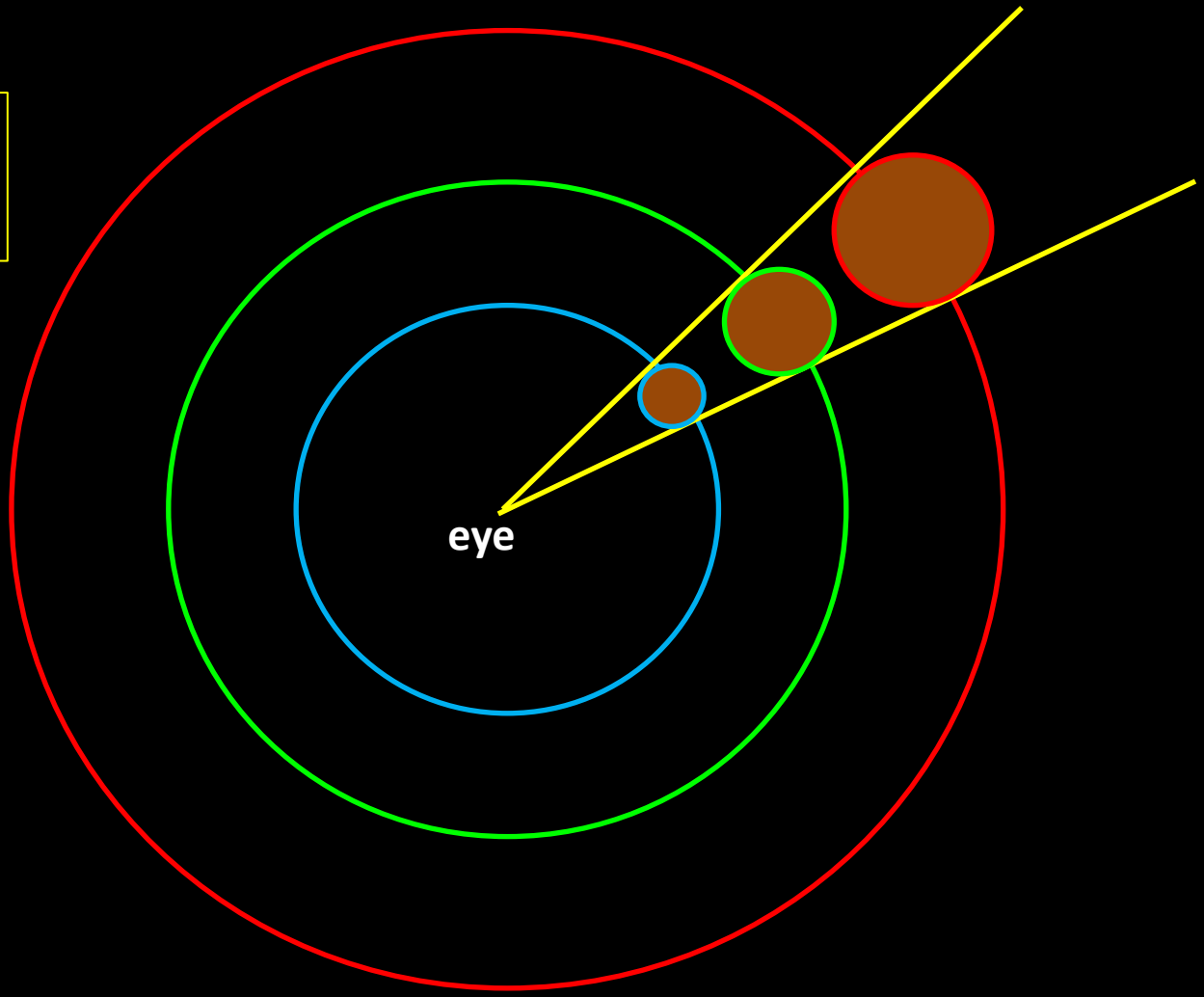
- For given *limiting distance*, associated *plot radius* and *area vary*



Limiting Distances

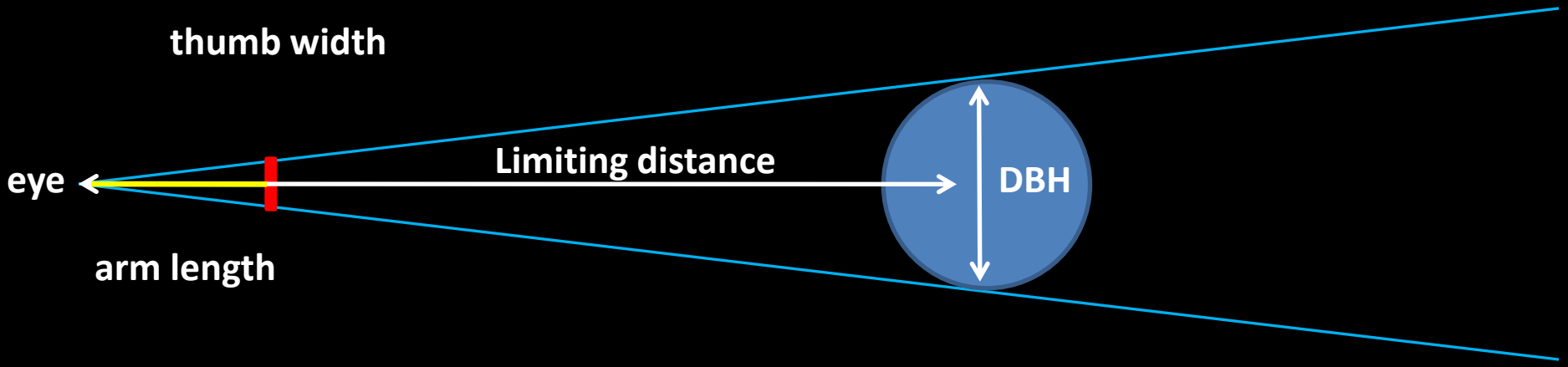
- Therefore, ***plot area*** **associated with each tree** ***increases*** **with** ***tree DBH*** **(and therefore** ***scale-up factor*** **varies)**

Varies in what way?



How to Calculate Limiting Distances?

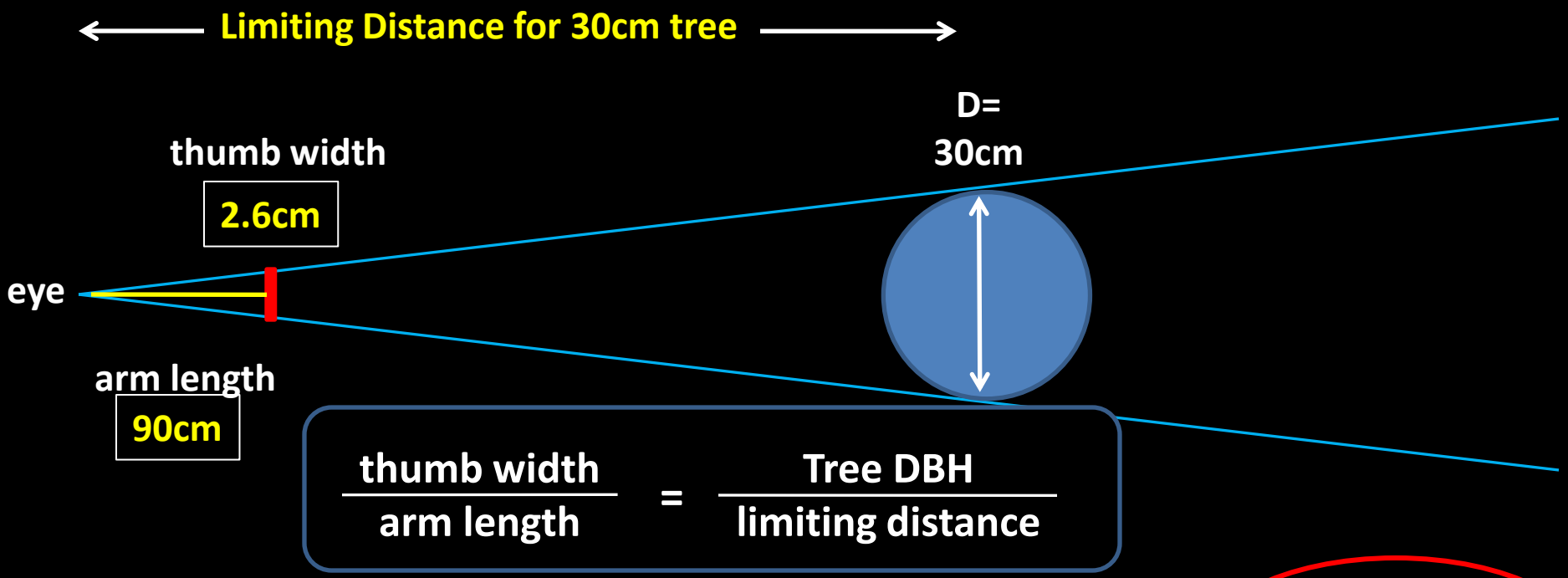
- Use similar triangles



$$\frac{\text{thumb width}}{\text{arm length}} = \frac{\text{Tree DBH}}{\text{limiting distance}}$$

How to Calculate Limiting Distances?

- Use similar triangles



$$\frac{\text{thumb width}}{\text{arm length}} = \frac{\text{Tree DBH}}{\text{limiting distance}}$$

$$\frac{2.6\text{cm}}{90\text{cm}} = \frac{30\text{cm}}{\text{limiting distance}}$$

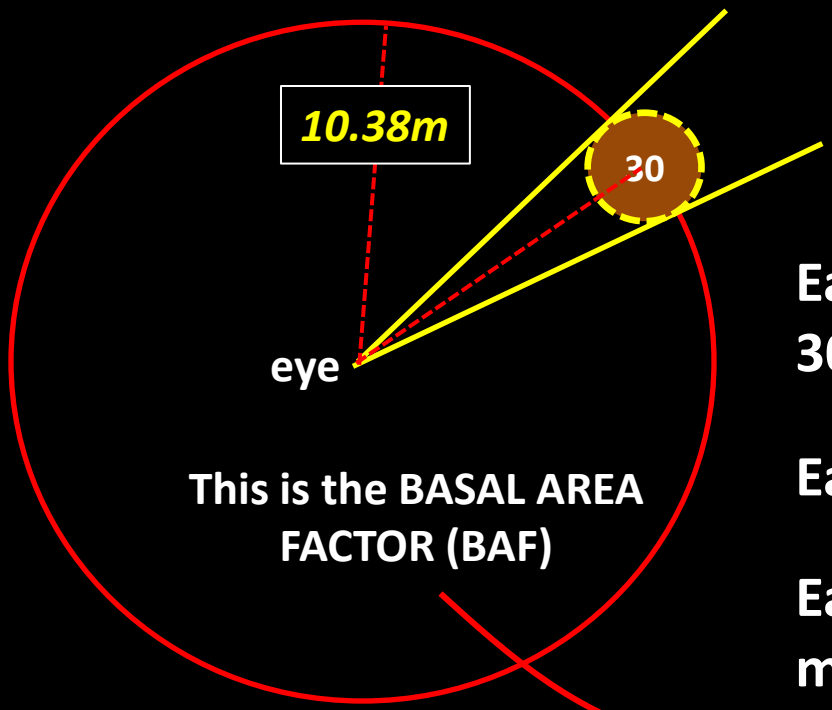
For a tree @ 30cm DBH

$$\text{Limiting distance} = \frac{30\text{cm} * 90\text{cm}}{2.6\text{cm}} = 1038\text{cm} = 10.38\text{m}$$

What's the Significance of Limiting Distances?

- Represent *radius* of *fixed area plot* just large enough to include a *tree of that size*

$$LD_{DBH30} = \frac{30\text{cm} * 90\text{cm}}{2.6\text{cm}} = 1038\text{cm} = 10.38\text{m}$$



10.38 m *radius* plot = 0.034ha

Scale-up factor = 1/0.034 = *29.5*

Each 30cm tree within limiting distance for 30cm trees represent *29.5* 30cm *trees/ha*

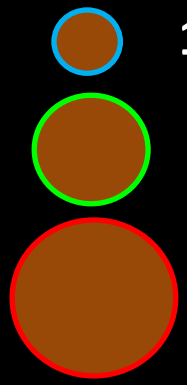
Each 30cm tree = 0.071 m^2 basal area

Each 30cm tree represents 29.5 * 0.071 m^2 basal area = 2.09 m^2/ha (BAF)

Point Sample Example

- ***Tree count*** **: number of trees within their** ***limiting distance***

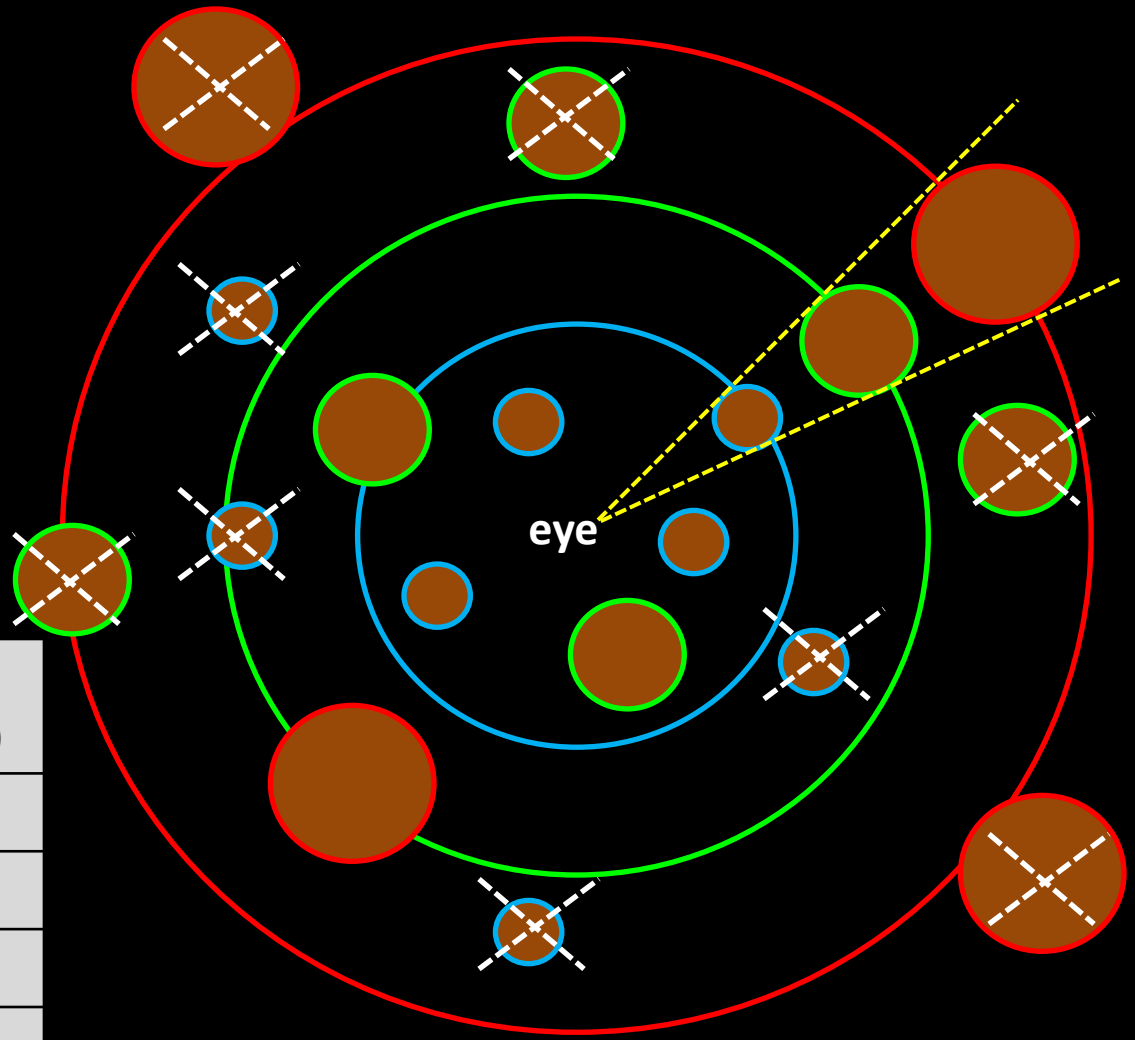
Tree DBH



10cm **IN = 4**

30cm **IN = 3**

50cm **IN = 2**



DBH (cm)	Tree Count	BAF (m^2/ha/tree	BA (m^2/ha)
10	4	2.09	8.36
30	3	2.09	6.27
50	2	2.09	4.18
All	9	2.09	18.81

Basal Area Factor - BAF

- So far, we have *set* the *viewing angle* (our thumb & arm) and have *calculated* the resulting *Basal Area Factor* (BAF)
- *BAF my* thumb(2.6cm) & arm (90cm) is *2.09* m^2/ha
- We will each have *different BAF* (no standard)
- *Standardize*:
  - set *desired BAF*
  - *calculate* viewing angle
  - devise *means* to *create* that *viewing angle*

Basal Area Factor - BAF

- Set desired *BAF*
  - Use nice *round numbers*
    - 2 m^2/ha
    - *5 m^2/ha*
  - Easy: *basal area /ha* = *tree count * BAF*

- Calculate viewing angle
  - What *viewing angle* will achieve a *BAF* of *5m^2/tree/ha*?

Basal Area Factor - BAF

- Devise a means to *create viewing angle* for desired BAF

  - *BAF 5* results from a *2.54º viewing angle*
  - Machine glass prism to *deflect light* by that angle

Image just touching tree = **BORDER tree**

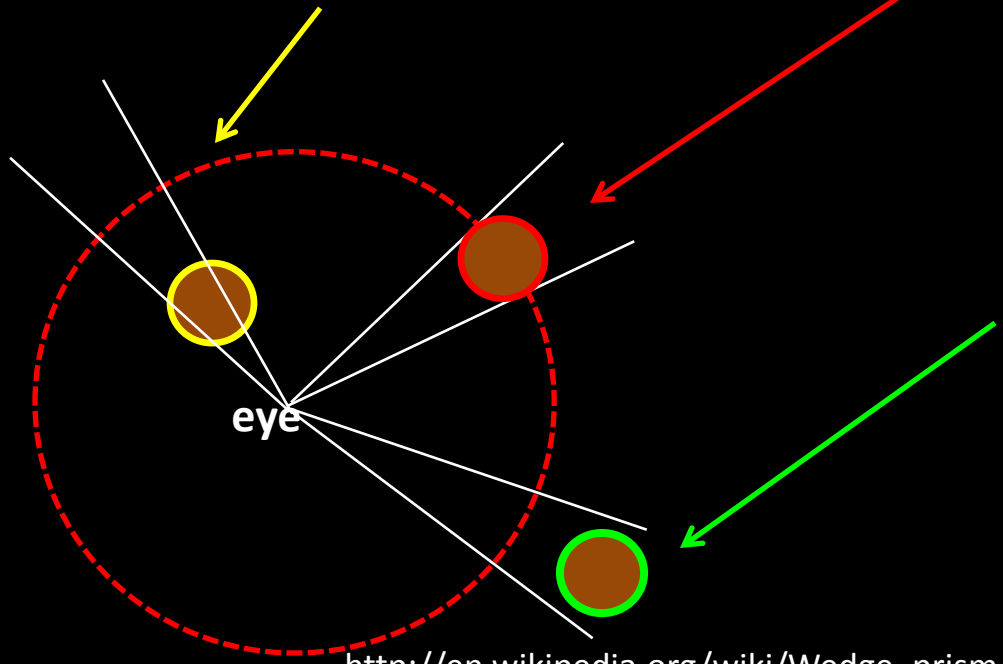


Image not overlapping = **OUT tree**

http://en.wikipedia.org/wiki/Wedge_prism

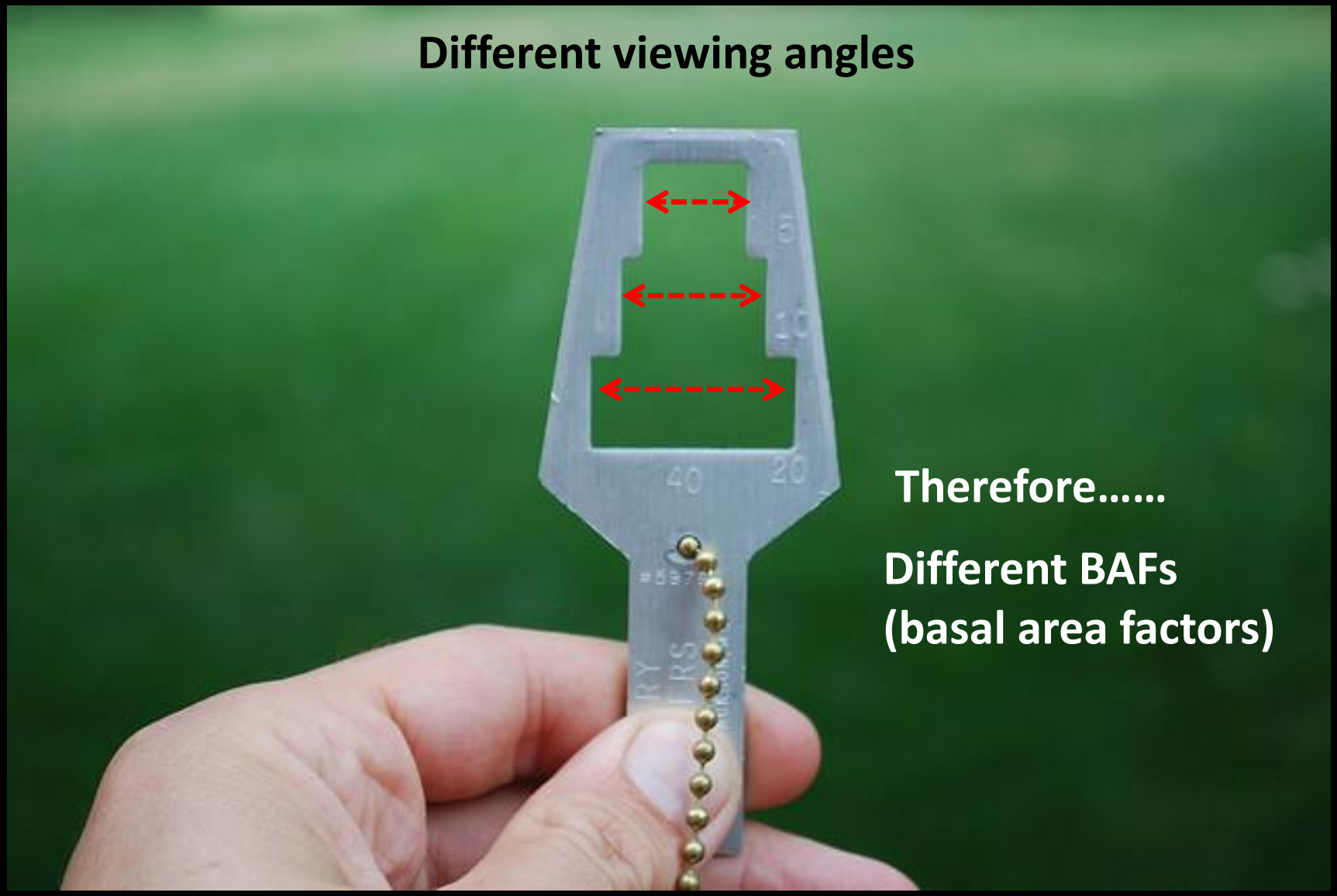
Basal Area Factor - BAF

- Devise a means to *create viewing angle* for desired BAF

  - *BAF 5* results from a *2.54º viewing angle*
  - Machine glass prism to *deflect light* by that angle

Start Here

Different viewing angles



Therefore……

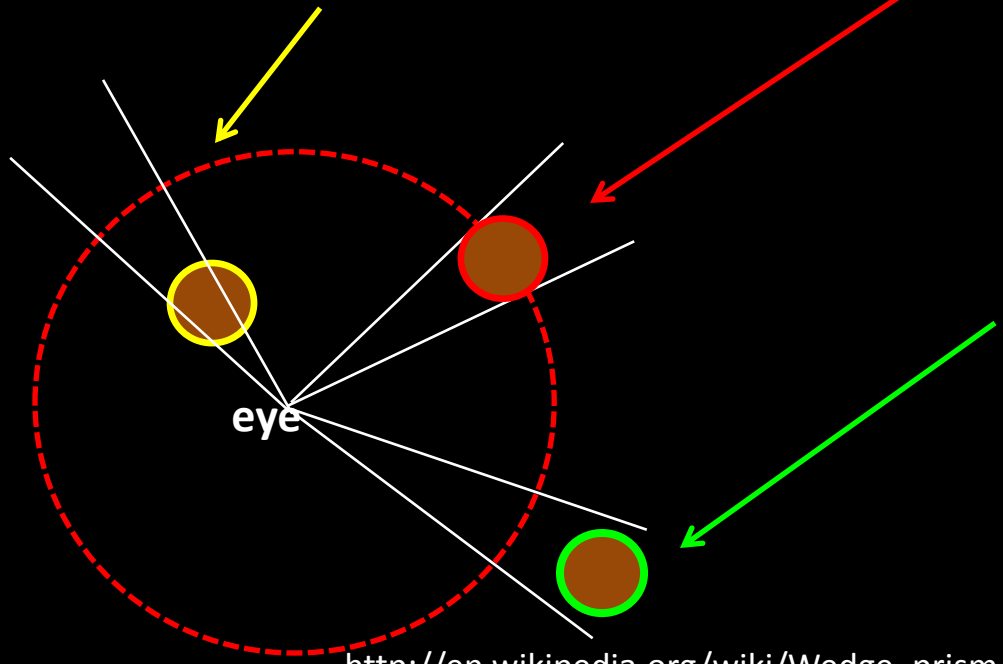
Different BAFs (basal area factors)

Therefore……

Different viewing angles

Different BAFs (basal area factors)

Image just touching tree = **BORDER tree**



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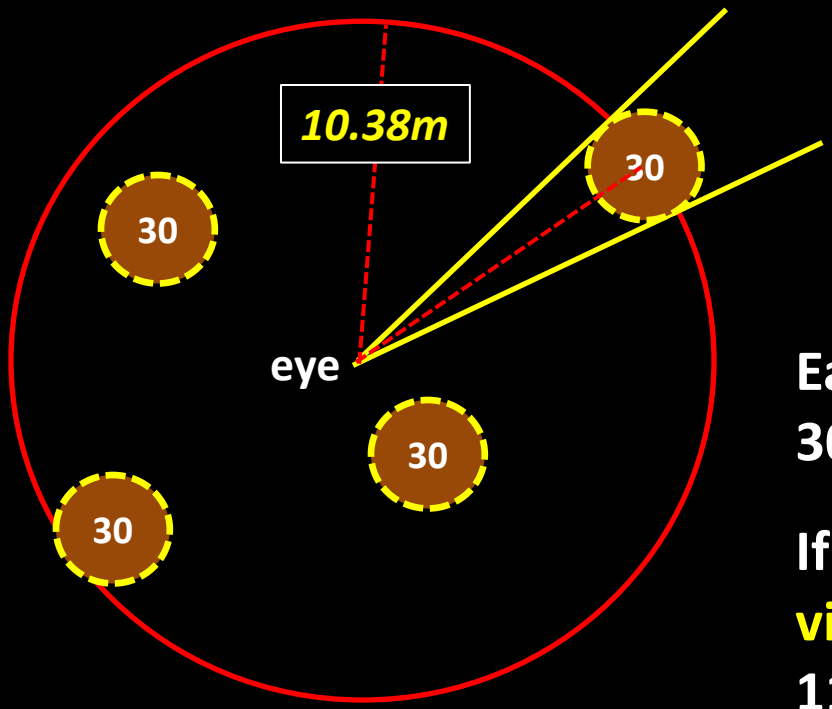
What's the Significance of Limiting Distances?

- Represent *radius* of *fixed area plot* just large enough to include a *tree of that size*

$$LD_{DBH30} = \frac{30\text{cm} * 90\text{cm}}{2.6\text{cm}} = 1038\text{cm} = 10.38\text{m}$$



10.38 m *radius* plot = 0.034ha

Scale-up factor = 1/0.034 = *29.5*

Each 30cm tree within limiting distance for 30cm trees represent *29.5* 30cm trees/ha

If four 30cm trees are viewable given our viewing angle, they represent 4*29.5 = 118 30cm trees/ha

What's the Significance of Limiting Distances?

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
DBH	Basal Area	Limiting Distance	Plot Radius	Plot Area	Scale-up Factor	Values Represented by One Tree w/I Limiting Distance	
						Trees	Basal Area
cm	m^2/tree	m	m	ha/plot	plots/ha	stems/ha	m^2/ha
30	0.071	10.38	10.38	0.034	29.5	29.5	2.09

[2] *Basal Area*$_{m2/tree}$ = pi * DBH$^2_{cm}$ / 40000

[3] *Limiting Distance* = as just shown on last page for given thumb & arm

[4] *Plot Radius* is the Limiting Distance (see last figure)

[5] *Plot Area*$_{ha}$ = pi * Plot Radius$^2_{m\ 2}$ /10000 $_{m2/ha}$

[6] *Scale-up* $_{plots/ha}$ = 1 / Plot Area $_{ha/plot}$

[7] *Trees* $_{stems/ha}$ = Tree Count $_{trees/plot}$ * Scale-up $_{plots/ha}$

[8] *Basal Area* $_{m2/ha}$ = Tree Count $_{trees/plot}$ * Basal Area $_{m2/tree}$ * Scale-up $_{plots/ha}$

What's the Significance of Limiting Distances?

DBH	Basal Area	Limiting Distance	Plot Radius	Plot Area	Scale-up Factor	Values Represented by Each Tree w/I Limiting Distance	
						Trees	Basal Area
cm	m^2/tree	m	m	ha/plot	plots/ha	stems/ha	m^2/ha
10							
30	0.071	10.38	10.38	0.034	29.5	29.5	2.09
50							

What's the Significance of Limiting Distances?

DBH	Basal Area	Limiting Distance	Plot Radius	Plot Area	Scale-up Factor	Values Represented by Each Tree w/I Limiting Distance	
						Trees	Basal Area
cm	m^2/tree	m	m	ha/plot	plots/ha	stems/ha	m^2/ha
10	0.008	3.46	3.46	0.004			
30	0.071	10.38	10.38	0.034	29.5	29.5	2.09

What's the Significance of Limiting Distances?

DBH	Basal Area	Limiting Distance	Plot Radius	Plot Area	Scale-up Factor	Values Represented by Each Tree w/I Limiting Distance	
						Trees	Basal Area
cm	m^2/tree	m	m	ha/plot	plots/ha	stems/ha	m^2/ha
10	0.008	3.46	3.46	0.004	265.7	265.7	2.09
30	0.071	10.38	10.38	0.034	29.5	29.5	2.09

What's the Significance of Limiting Distances?

DBH	Basal Area	Limiting Distance	Plot Radius	Plot Area	Scale-up Factor	Values Represented by Each Tree w/I Limiting Distance	
						Trees	Basal Area
cm	m^2/tree	m	m	ha/plot	plots/ha	stems/ha	m^2/ha
10	0.008	3.46	3.46	0.004	265.7	265.7	2.09
30	0.071	10.38	10.38	0.034	29.5	29.5	2.09
50	0.196	17.31	17.31	0.094			

What's the Significance of Limiting Distances?

DBH	Basal Area	Limiting Distance	Plot Radius	Plot Area	Scale-up Factor	Values Represented by Each Tree w/I Limiting Distance	
						Trees	Basal Area
cm	m^2/tree	m	m	ha/plot	plots/ha	stems/ha	m^2/ha
10	0.008	3.46	3.46	0.004	265.7	265.7	2.09
30	0.071	10.38	10.38	0.034	29.5	29.5	2.09
50	0.196	17.31	17.31	0.094	10.6	10.6	2.09

Basal Area Factor - BAF

- Basal Area (m^2/ha) represented by ***each tree*** in the plot

DBH	Basal Area	Limiting Distance	Plot Radius	Plot Area	Scale-up Factor	Values Represented by Each Tree w/I Limiting Distance	
						Trees	Basal Area
cm	m^2/tree	m	m	ha/plot	plots/ha	stems/ha	m^2/ha
10	0.008	3.46	3.46	0.004	265.7	265.7	2.09
30	0.071	10.38	10.38	0.034	29.5	29.5	2.09
50	0.196	17.31	17.31	0.094	10.6	10.6	2.09

- ***BAF*** function only of ***viewing angle*** (thumb width & arm length)
- ***BAF*** my thumb(2.6cm) & arm (90cm) is ***2.09*** m^2/ha

Point Sampling Example

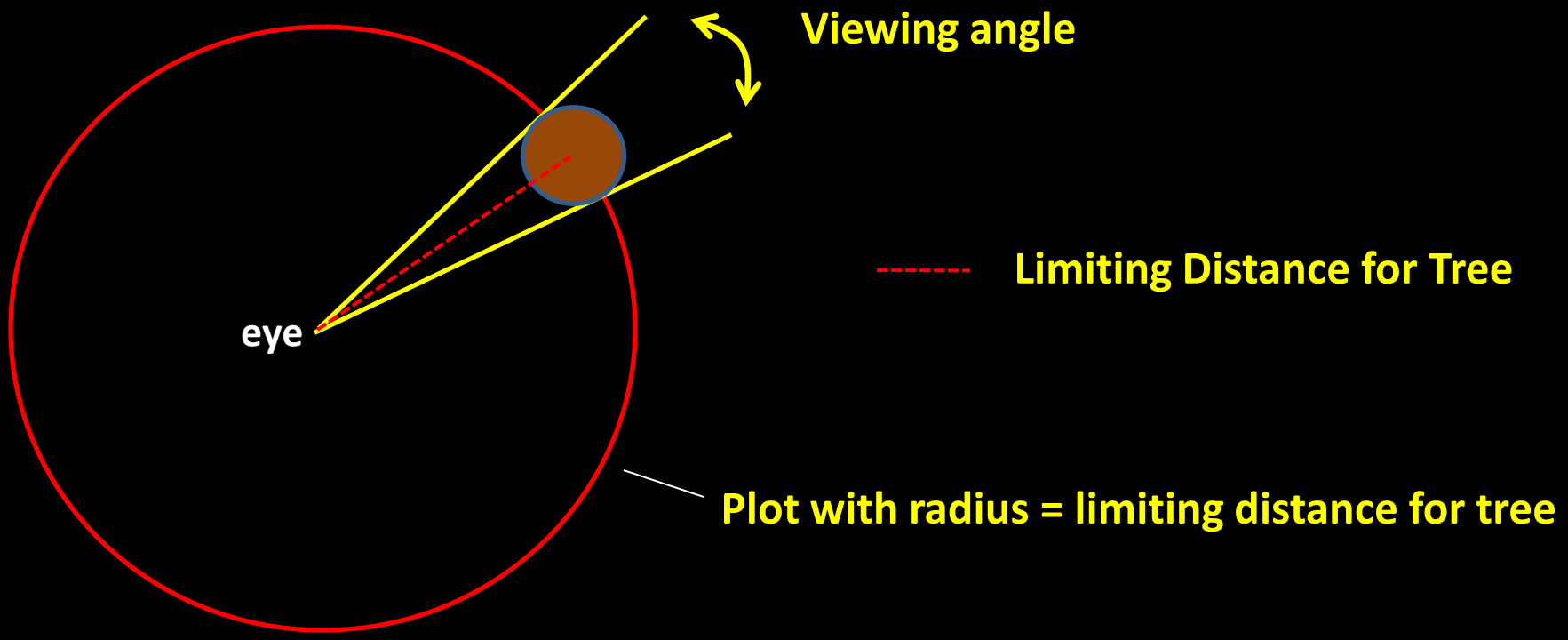
DBH	Basal Area	Limiting Distance	Plot Radius	Plot Area	Scale-up Factor	Values Represented by Each Tree	
						Trees	Basal Area
cm	m^2/tree	m	m	ha/plot	plots/ha	stems/ha	m^2/ha
10	0.008	3.46	3.46	0.004	265.7	265.7	2.09
30	0.071	10.38	10.38	0.034	29.5	29.5	2.09
50	0.196	17.31	17.31	0.094	10.6	10.6	2.09

Fixed Area Sampling Example (assume 0.05 ha plot size)

DBH	Basal Area	Limiting Distance	Plot Radius	Plot Area	Scale-up Factor	Values Represented by Each Tree	
						Trees	Basal Area
cm	m^2/tree	m	m	ha/plot	plots/ha	stems/ha	m^2/ha
10	0.008		12.6	0.05	20	20	0.16
30	0.071		12.6	0.05	20	20	1.42
50	0.196		12.6	0.05	20	20	3.92

Limiting Distances

- Distance at which tree of *given DBH* is *just visible* for a given *viewing angle*
- Represent *radius* of *fixed area plot* just large enough to include a *tree of that size*



Basal Area Factor - BAF

- Basal Area Factor *5 m^2/ha*

DBH	Basal Area	Limiting Distance	Plot Radius	Plot Area	Scale-up Factor	Values Represented by Each Tree w/I Limiting Distance	
						Trees	Basal Area
cm	m^2/tree	m	m	ha/plot	plots/ha	stems/ha	m^2/ha
10	0.008	2.24	2.24	15.7	636.6	636.6	5.0
30	0.071	6.71	6.71	141.4	70.7	70.7	5.0
50	0.196	11.18	11.18	392.7	25.5	25.5	5.0

Summary

	Fixed-Area Plot Sampling	Point Sampling
Plot Area	Fixed dimensions	Varies with tree DBH
Defined by	Distance tape	Viewing angle
Each tree represents	Same #trees/ha	Different #trees/ha according to DBH
Each tree represents	Different basal area/ha according to DBH	Same basal area/ha

Summary

- **Can sample using *viewing angles* as alternative to *fixed areas***
- **Termed "*point sampling*" because there is no fixed plot (varies with tree size)**
- **Contrast to "*fixed area*" sampling where there is single and explicit plot size selected for the area sampled**
- **Each has *merits* – elaborate on further**
- **General computational process are *similar*, but with some specific *differences***