A CRASH COURSE ON FOREST INVENTORY

Cruising your forested land

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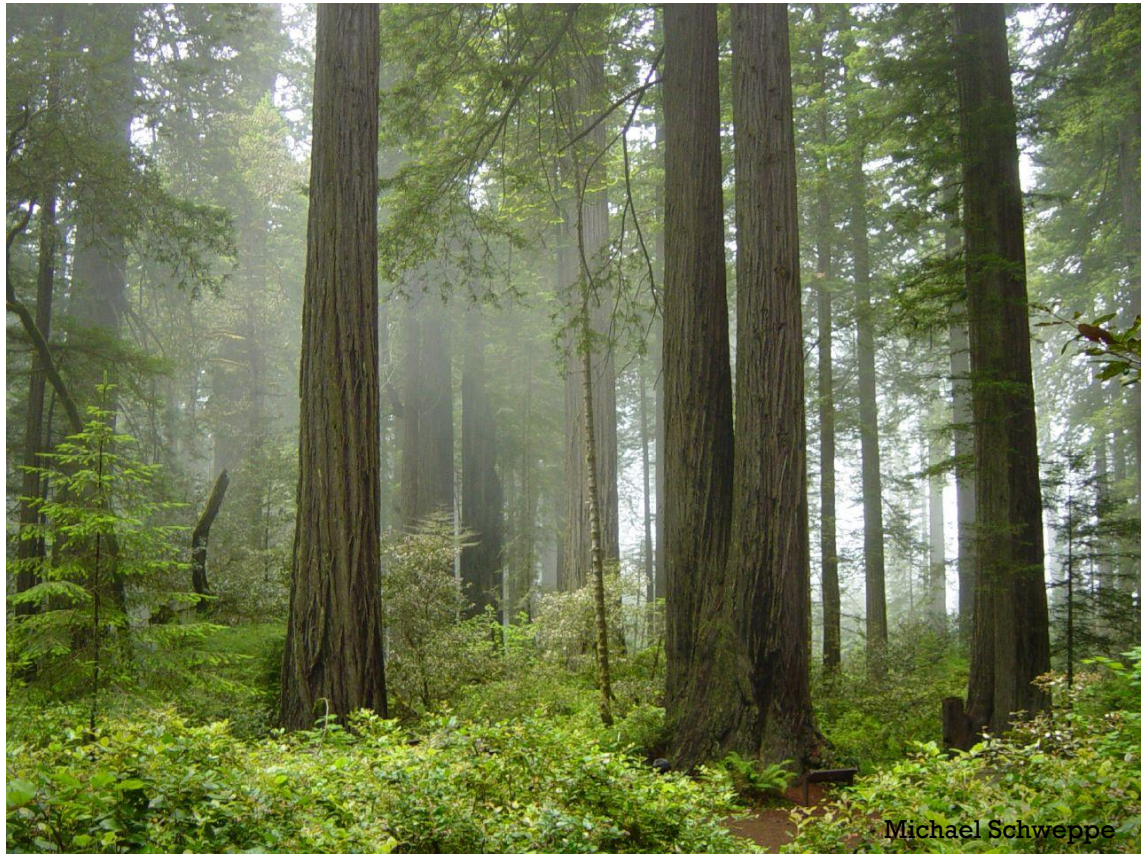
UC CE | UNIVERSITY OF CALIFORNIA Agriculture and Natural Resources

WHAT IS AN INVENTORY

- Systematic collection of data on forest resources (and/or risks and hazards) within a given area
- Sampling conducted by plot surveys
- Process called Cruising



PURPOSE OF AN INVENTORY

- Helps determine your management objectives
  - Timber resources, wildlife, recreation, water quality, carbon storage, fire, forest health, etc.
- Forest composition and structure
- Stand Characteristics
- Tree Measurements
  - Trees Per Acre (TPA)
  - Basal Area (BA)
  - Volume of species
  - Productivity of site (Site Quality)
- Non timber resources

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HOW TO CONDUCT AN INVENTORY

TOOLS OF FORESTRY

- Cruiser vest
- Compass
- Survey tape
- DBH tape (calipers)
- Hypsometer
- Clinometer
- Range finder
- Prisms
- Angle gauge
- Increment borer

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DATA COLLECTED

- Stand characteristics
  - Slope, aspect, elevation, etc.
- Non timber resources (infrastructure, water courses, wildlife habitat, cultural sites, etc.)
- Tree species
- DBH (diameter at breast height, 4.5 ft or 1.3 m)
- Height
- Live Crown Ratio
- Symptoms of biotic (insects/disease) or abiotic (windthrow) damage
- Dendrochronology (tree age)

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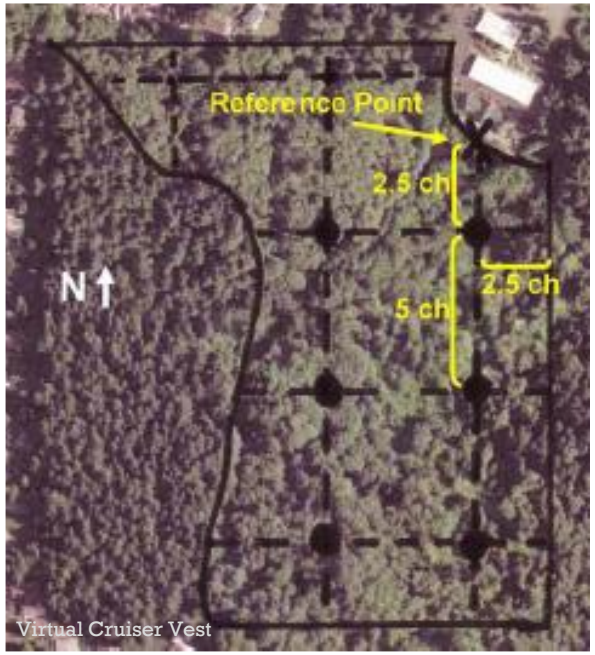
SAMPLING DESIGN

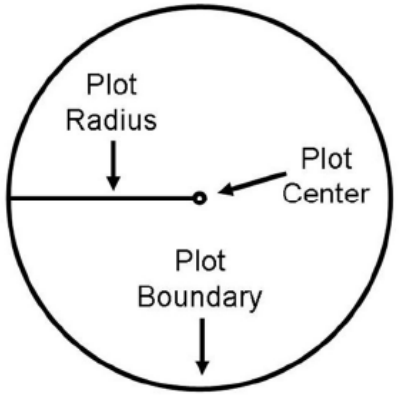
- Stratified – divide site into stands with similar forest structure
- Systematic – gridded plots points evenly spaced across sites
- Random – starting point based on convenience
- Sample 2–5% of the stand
  - (Ex. 10 acre stand, at least two 1/10th acre plots)

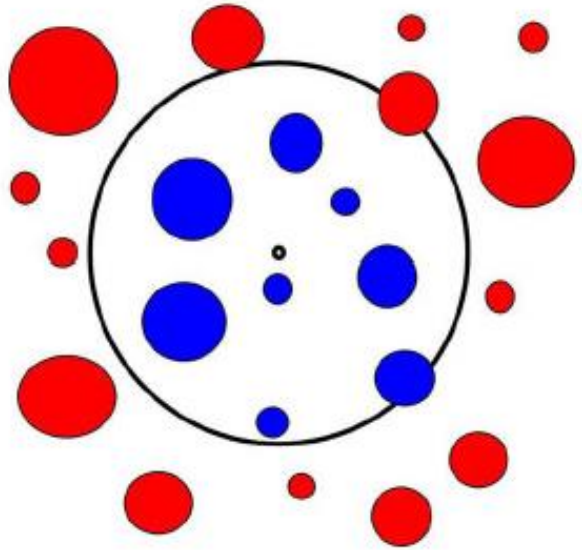


FIXED AREA PLOTS

- Plot size depends on many factors (i.e. time and effort, stand structure, etc.)
- At least 1 plot for every 10 acres
- ≥ 5 trees/plot

Plot Size (acres)	Radius (ft)
1/5	52.7
1/10	37.2
1/20	26.3
1/30	21.5
1/40	18.6
1/50	16.7





- Note: Can also use variable plots

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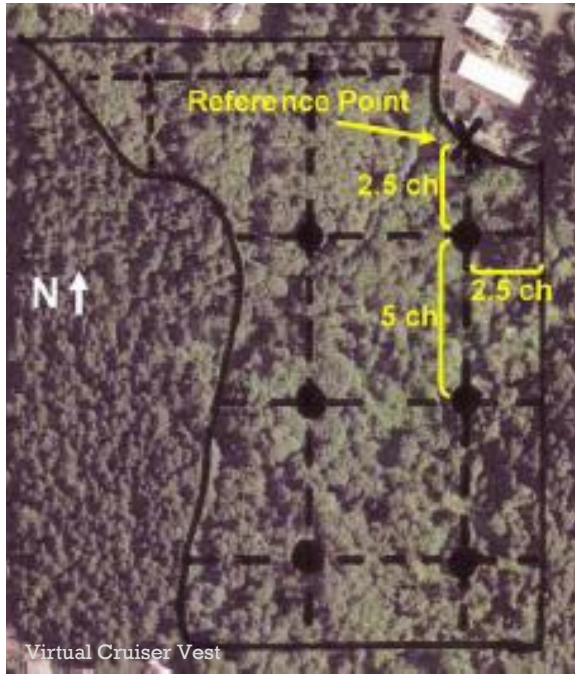
ESTABLISHING PLOTS

- Space plots out so they do not overlap or edge of stand
- Paper maps, use scale bar and ruler to find plot locations
  - Use survey tape or pacing to find approx. location of plots centers
- Mapping software (i.e. Avenza), drop points on map
  - Navigate using GPS



- A chain as a unit of measurement commonly obs. in forestry
  - Originated 15th century in agriculture, used in US surveying, 1700's
  - 1 chain = 66 ft, 80 chains = 1 mile, 1 acre = 10 sq chains (furlong)

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STAND DATA CALCULATIONS

- Trees per Acre (TPA)
  - Basic measure of stand density
  - *TPA = total trees x expansion factor*
    - Expansion factor = denominator of plot size / # of plots
    - Ex. 25, 1/10th acre plots = 10/25 = 0.4 expansion factor
- Basal Area (BA, ft^2)
  - Function of number of trees and size of trees
  - Measure of competition for resources b/n trees
  - *Tree BA = 0.005454 x DBH^2*
  - *Tree BA/acre = Tree BA x expansion factor*
  - *Total BA/acre = sum of Tree BA/acre*
- Optional: Separate into size classes

Basal Area (ft^2/ acre)		
Species	Live	Dead
Redwood	472.3	0.2
Douglas-fir	58.9	0.2
Tanoak	10.7	21.8
Madrone	0.0	0.0
CA Bay	0.0	0.0
Bigleaf Maple	0.0	0.0
Alder	0.0	0.0
White Oak	0.0	0.0
Live Oak	0.0	0.0
Black Oak	141.6	0.0
Pine Spp	0.0	0.0
Other Softwood	0.0	0.0
Other Hardwood	0.0	0.0
SUM	683.5	22.3
	705.7	

Trees Per Acre		
Species	Live	Dead
Redwood	70.0	10.0
Douglas-fir	50.0	10.0
Tanoak	10.0	10.0
Madrone	0.0	0.0
CA Bay	0.0	0.0
Bigleaf Maple	0.0	0.0
Alder	0.0	0.0
White Oak	0.0	0.0
Live Oak	0.0	0.0
Black Oak	30.0	0.0
Pine Spp	0.0	0.0
Other Softwood	0.0	0.0
Other Hardwood	0.0	0.0
SUM	160.0	30.0
	190.0	

Size Breakdown (Live)		
Trees Per Acre		
DBH	Live	Dead
1	0	0
2	20	20
3	0	0
4	0	0
6	0	0
8	0	0
10	0	0
12	30	0
14	10	0
16	0	0
18	20	0
20	10	10
22	0	0
24	10	0
26	10	0
28	0	0
30	10	0
32	0	0
34	0	0
36	10	0
38	10	0
40	10	0
42	0	0
44	0	0
46	0	0
48	0	0
50	10	0
SUM	150	30

Mean BA	3.999232	# of sampled trees
		19.00

Number of Plots in Stand	Plot Size (1/x)
1.00	10

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STAND DATA CALCULATIONS

- Tree Volume (total volume and MBF of commercial species)
  - Trees taper, not simple to measure accurately
  - Estimated from volume tables using DBH and height

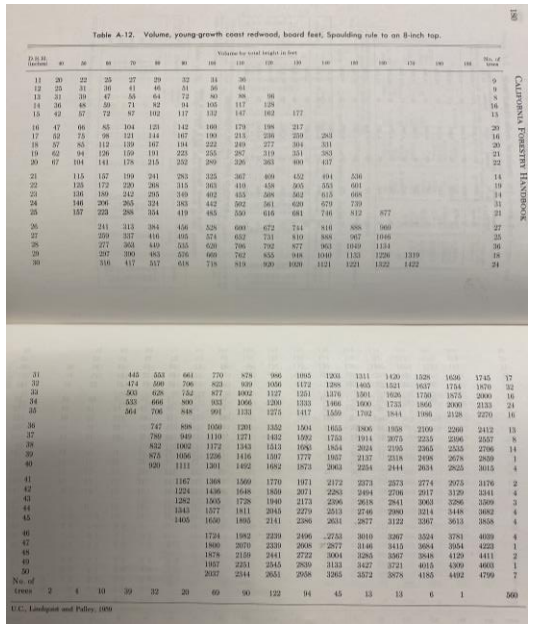

Table A-12. Volume, young-growth coast redwood, board feet, Spaulding rule to an 8-inch top.

CALIFORNIA FORESTRY HANDBOOK

U.C. Lindquist and Palley, 1959

Table 8-3. Blue oak, coast live oak, and interior live oak merchantable wood volume (cubic feet per tree). From: N.H. Pillsbury and M.L. Kirkley. 1984. *Equations for total, wood, and sawlog volume for thirteen California hardwoods.* USDA Forest Service Research Note PNW-414. 52 pp.

dbh	TOTAL TREE HEIGHT (ft.)														
	20			30			40			50			60		
(in)	Blue	Coast	Interior	Blue	Coast	Interior	Blue	Coast	Interior	Blue	Coast	Interior	Blue	Coast	Interior
4	1	1	1	1	1	1	1	1	1	1	1	2	1	1	2
6	2	1	2	2	2	3	3	2	3	3	2	4	3	3	5
8	4	3	4	5	4	5	5	4	6	6	5	8	7	6	9
10	7	5	6	8	7	8	9	8	10	11	9	12	12	10	14
12	11	8	9	13	11	12	15	13	15	17	14	18	18	16	21
14	16	12	12	19	16	17	22	18	21	25	21	25	27	24	29
16	22	17	16	27	22	23	31	26	28	35	30	34	38	33	39
18	30	23	21	36	29	29	42	35	36	47	40	43	52	45	50
20	39	30	27	48	38	36	55	46	46	62	52	54	68	58	62
22	49	38	33	61	49	45	70	58	56	79	67	66	86	74	77
24	62	48	39	76	61	54	88	72	67	98	83	80	108	93	92
26	76	58	47	93	74	64	107	89	80	120	102	95	132	113	110
28	91	70	55	112	90	75	130	107	94	145	123	112	159	137	129
30	109	84	63	134	107	87	154	127	109	173	146	129	190	163	149
32	128	98	73	157	126	100	182	150	125	204	172	149	223	192	171
34	149	115	83	183	147	114	212	175	142	238	200	169	261	224	195
36	173	133	94	212	170	129	245	202	161	275	232	191	301	259	221

STAND DATA CALCULATIONS

- Site quality
  - Measure of how productive a site is
  - Site Index
    - Determined from dominant/co-dom. tree ht. and tree age
  - Site index curves
    - Specific to each species
  - Site Class (Class I–V)
    - Class I – highly productive, growing on rich soil, access to moisture, protected from wind; e.g. alluvial sites at low elevation
    - Class V – poor soils, droughty climates; e.g. upper edge of elevational range
  - NRCS Web Soil Survey

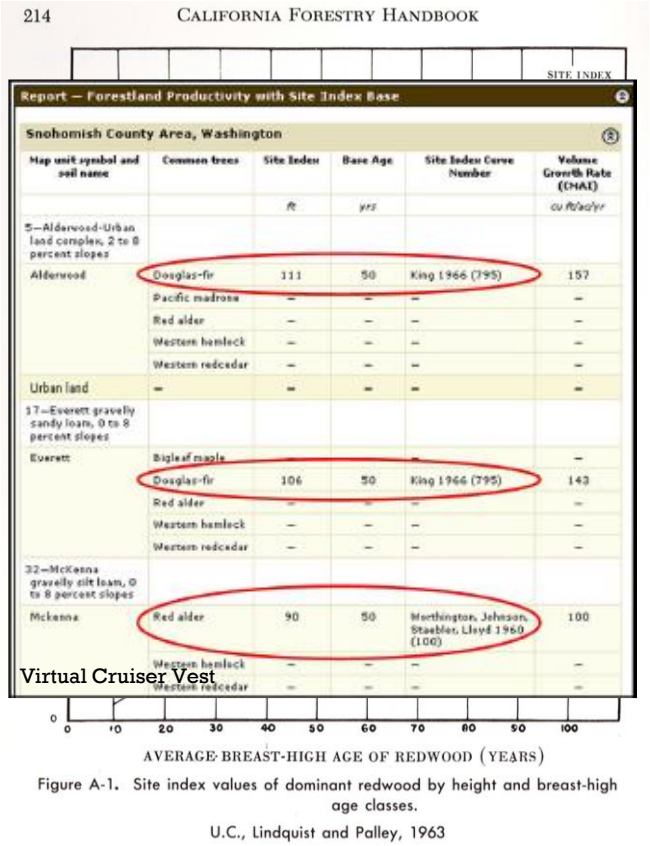

Figure A-1. Site index values of dominant redwood by height and breast-high age classes.

U.C., Lindquist and Palley, 1963

EXERCISE

- Find plot center
- Collect tree data for each plot

Directions		# of Plots	
First, enter the number of plots measured in the stand here =>		2	
Then enter the size of the plot he =>	1/	10	th acre plot

Next, fill out the columns in the 'Data' tab using the stand data collected. Instructions for what the columns mean have been given below, and labels for the species codes are listed in the only other table on this page. Super easy.

Plot_ID	Insert plot ID number for tracking purposes. This does not affect calculations
Tree Count	Number of trees in the individual record. No problem if there are multiple similar records (i.e. 2 records of 18" DF)
History	Living trees receive a 1. Dead trees receive a 6.
Species	Insert the species code for the listed species based on the table included on this page
DBH	Diameter at Breast Height. Insert this as a whole number. If listed on plot cards with decimal, round numbers down at the 0.1 inch mark.
HT	Record height if included. This spreadsheet does not currently utilize height in any direct calculation, as of version 1. However height can be used to focus stand tables.

Species Codes	
rw	Redwood
df	Douglas-fir
to	Tanoak
cl	California Bay Laurel
ma	Madrone
bm	Big Leaf Maple
ra	Red Alder
or	Oregon White Oak
bo	California Black Oak
lo	Live Oak
vo	Valley Oak
pi	Pine Species
oh	Other Hardwood
os	Other Softwood
bl	Blue Oak

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	A	B	C	D	E	F	H	I
1	Plot_ID	Tree_Count	History	Species	DBH (in)	Ht (ft)	Notes	
2	1.00	1.00	1.00	df	34.10			
3		2.00	1.00	df	21.30			
4		1.00	1.00	rw	45.00			
5		1.00	1.00	bo	26.50			
6		1.00	1.00	ma	18.00			
7		2.00	6.00	df	40.00			
8		1.00	6.00	bo	20.10			
9		1.00	1.00	rw	57.50			
10		1.00	1.00	df	23.00			
11		1.00	1.00	ma	25.60			
12		1.00	1.00	bo	35.60			
13		1.00	1.00	bo	14.50			
14		1.00	6.00	rw	2.00			
15		1.00	1.00	df	12.00			

Basal Area (ft^2/ acre)		
Species	Live	Dead
Redwood	298.9	0.2
Douglas-fir	162.7	174.5
Tanoak	0.0	0.0
Madrone	54.5	0.0
CA Bay	0.0	0.0
Bigleaf Maple	0.0	0.0
Alder	0.0	0.0
White Oak	0.0	0.0
Live Oak	0.0	0.0
Black Oak	127.4	26.4
Pine Spp	0.0	0.0
Other Softwood	0.0	0.0
Other Hardwood	0.0	0.0
SUM	643.6	201.1
	844.7	

Trees Per Acre		
Species	Live	Dead
Redwood	20.0	10.0
Douglas-fir	50.0	20.0
Tanoak	0.0	0.0
Madrone	20.0	0.0
CA Bay	0.0	0.0
Bigleaf Maple	0.0	0.0
Alder	0.0	0.0
White Oak	0.0	0.0
Live Oak	0.0	0.0
Black Oak	30.0	10.0
Pine Spp	0.0	0.0
Other Softwood	0.0	0.0
Other Hardwood	0.0	0.0
SUM	120.0	40.0
	160.0	

Size Breakdown (Live)		
Trees Per Acre		
DBH	Live	Dead
1	0	0
2	0	10
3	0	0
4	0	0
6	0	0
8	0	0
10	0	0
12	10	0
14	0	0
16	10	0
18	10	0
20	0	0
22	20	10
24	10	0
26	10	0
28	10	0
30	0	0
32	0	0
34	0	0
36	20	0
38	0	0
40	0	20
42	0	0
44	0	0
46	10	0
48	0	0
50	10	0
SUM	120	40

Mean BA	7.781505	# of sampled trees	
		16.00	
Number of Plots in Stand		Plot Size (1/x)	
1.00		10	

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