Dealing with Species
(and other hard to get variables)

Jacob Strunk

Two Sections

- Species (Jacob)
- DWD, Snags, etc. (Peter)

Species

Jacob Strunk

WA DNR

Background

- Stand level information is desired for tactical decision making
- Lidar provides stand level Height, BA, VOL, QMD, TPA, etc.

Perception

- “Components (e.g. species, defect, product, dbh class) are the Achilles heel of remote sensing based inventories”

Counter-argument

- Stand-level component estimate precision too low
- Useless for tactical decision making

https://jacobstrunk.shinyapps.io/species_demo/

Estimating components

- E.g. stand and stock tables
- Can’t make defensible inference from 1 tree…

Twp	Rge	Sec	Tract	Type	Acres	Plots
23N	07E	06	TIGER THINNI	0006	23.10	11

Spc	ST	DBH	Sample Trees	FF 16'	Av Ht Tot	Trees/ Acre	BA/ Acre	Logs Acre	Average Log Net Cu.Ft.	Average Log Net Bd.Ft.	Tons/ Acre
DF	L	12	2	87	82	11.520	8.53	23.04	10.1	45.0	6.63
DF	L	13	1	87	86	4.847	4.26	9.69	12.5	50.0	3.45
DF	L	15	1	87	98	3.569	4.26	10.71	14.5	50.0	4.42
DF	L	16	2	86	97	6.191	8.53	15.59	18.8	69.9	8.34
DF	L	17	7	86	102	19.204	29.85	57.61	17.9	66.6	29.34
DF	L	18	3	86	98	7.382	12.79	19.59	22.3	82.7	12.46
DF	L	19	3	85	104	6.503	12.79	17.23	25.2	96.2	12.37
DF	L	21	1	86	108	1.824	4.26	5.47	26.4	93.3	4.11
DF	L	23	1	86	105	1.478	4.26	4.43	34.0	153.3	4.29
DF	L	24	1	86	117	1.357	4.26	4.07	40.6	190.0	4.71
DF	L	26	1	82	100	1.156	4.26	2.31	57.5	185.0	3.79
DF	L	27	1	85	125	1.072	4.26	3.22	54.5	240.0	5.00
DF	L	30	1	82	117	.869	4.26	2.61	60.7	216.7	4.52
DF		Totals	25	86	97	66.972	106.59	175.58	20.7	79.7	103.43
WH	L	12	1	86	83	5.252	4.26	10.50	10.2	30.0	3.42
WH	L	15	3	86	96	10.064	12.79	26.85	17.1	66.3	14.66
WH	L	16	1	82	60	3.254	4.26	3.25	21.4	40.0	2.22
WH	L	17	1	87	102	2.642	4.26	7.93	20.3	80.0	5.14
WH	L	18	2	86	101	4.669	8.53	11.70	26.5	109.9	9.92
WH	L	19	3	86	94	6.664	12.79	15.59	28.4	108.6	14.16
WH	L	20	2	86	114	4.050	8.53	12.15	27.4	108.3	10.67
WH	L	21	2	80	100	3.579	8.53	10.74	27.5	96.7	9.45
WH	L	22	3	84	96	4.845	12.79	12.92	33.5	122.5	13.85
WH	L	23	1	82	95	1.478	4.26	2.96	45.5	165.0	4.30
WH	L	24	2	82	99	2.714	8.53	5.43	48.0	140.0	8.33
WH	L	25	2	78	104	2.502	8.53	6.25	48.5	164.0	9.72
WH	L	26	1	72	110	1.156	4.26	3.47	43.8	120.0	4.87
WH	L	29	1	78	92	.930	4.26	1.86	72.9	170.0	4.34
WH		Totals	25	84	95	53.800	106.59	131.60	27.3	97.1	115.05
DF		8	1	85	88	12.214	4.26	24.43	5.1	25.0	3.54
DF		11	4	86	86	26.502	17.05	65.98	7.2	31.1	13.63
DF		12	2	86	91	10.860	8.53	21.72	11.5	37.5	7.13
DF		14	2	85	81	8.059	8.53	16.12	14.2	42.0	6.55
DF		15	1	85	89	3.569	4.26	7.14	18.4	75.0	3.74
DF		16	1	85	106	2.906	4.26	8.72	17.6	73.3	4.38
DF		Totals	11	86	87	64.111	46.90	144.10	9.5	37.0	38.97

Species Approaches with Lidar in Inventory

1) Predict species directly
2) Stratum level estimates
3) Obtain species elsewhere
4) Ignore species?

1) Predict Species

A. Areal prediction

B. Tree prediction

A. Areal prediction

Predict dominant species (or HW / SW) in a pixel from environmental variables:

- Spectral data
- Intensity
- environmental gradients
- Etc.

DNR Experience – areal prediction

- Lidar intensity can be highly informative

- Intensity is ***too variable*** between projects
  - With a lot of effort, some success at the project level
  - Cannot scale up across projects
  - Lots of noisy/ useless intensity data
  - ***We need an intensity specification for lidar acquisitions***

- DNR uses wall to wall Landsat derivatives to identify HW / SW areas
  - Fit with stand level models
  - Not nearly as good as intensity in some project areas
  - Stable across state
  - Far superior to NAIP from 2013

B. Predict individual trees

1) Stem map plots (e.g.)
2) Use OBIA to segment individual trees
3) Model / predict individual tree species

    alpha shape metrics, spectral signature, texture, size, intensity, environmental gradients

Operational status (tree prediction)

- Expensive
  - Need high density lidar
  - Likely need auxiliary imagery
  - Need a fairly sophisticated analysis
  - Need stem-mapped plots
- May be effective for individual projects – scaling up not demonstrated
- May be cheaper than traditional inventory
- Arguably much better product than a traditional inventory

2) Stratum level inference

2) Stratum level inference

- Approach
  - Post-stratify lidar plots
  - Make strata-level inferences about components from plots
  - Predict stand level structure attributes (ba, vol, etc.) from lidar

  - Optionally: densify plot grid with prism plots for improved strata proportion estimates

Operational status (strata approach)

- Arguably the most operationally feasible
- Strata analyses well documented, common

3) Leverage existing data

Is it feasible?

- Conceivably most cost-effective, useful
- Practically most difficult
  - Requires careful planning / foresight
  - Requires integrating many systems
  - Requires careful data stewardship
  - Payoff may require many years
  - Software investments must work across all parts of organization
- Operationally least viable (IMHO)

4) Ignore species ?

Is stand-level species really important?

- “We use it to decide which stands to harvest”
- “We put it in reports”
- “It is the basis of our valuation”
- “We use it for habitat reporting”
- **“Stand exams…”**

When is stand-level species really important?

- “We use it to decide which stands to harvest”
  - Probably not that effective for this – aside from dominant species
- “We have to put it in reports”
  - Mmnn…
- “It is the basis of our valuation”
  - Strategic level estimates can be obtained from plots across large areas
- “We use it for habitat reporting”
  - The data don’t support fine scale component estimates….
- **“Stand exams…”**
  - Component estimates likely poor (e.g. calculating minimum bid)
  - Sort sales rarely match small area cruise (minimal impact – inventory again on log deck)
  - Purchasers perform their own inventories.

There’s more to forests than the trees: snags, down wood, shrubs, and other components

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Why do we care?

- Wildlife Habitat
- Biomass components
- Forest health, fire severity

Why are these difficult things to predict?

- They’re not captured well by lidar
  - Occluded by the canopy
  - Difficult to differentiate (snags)
  - Relatively little vertical structure (down wood)

- They’re not captured well on the ground
  - Down wood transects subsample plots
  - Large snags are rare
  - difficult measurements (shrubs: dbh, height, volume, area?)