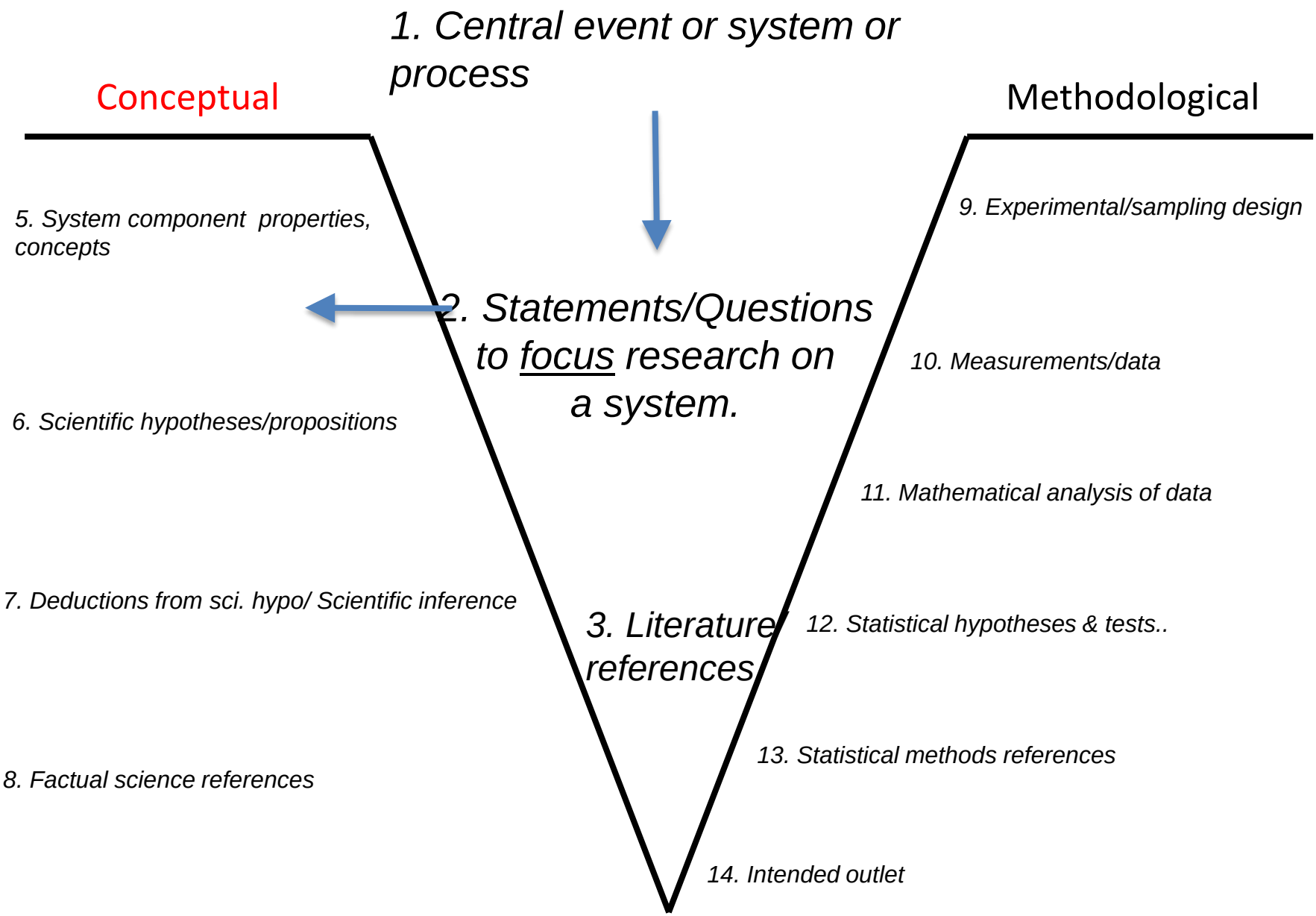

1. Central event or system or process
Conceptual
Methodological
5. System component properties, concepts
9. Experimental/sampling design
2. Statements/Questions to focus research on a system.
10. Measurements/data
6. Scientific hypotheses/propositions
11. Mathematical analysis of data
7. Deductions from sci. hypo/ Scientific inference
3. Literature references
12. Statistical hypotheses & tests..
13. Statistical methods references
8. Factual science references
14. Intended outlet
4. Problem statements (knowns & unknowns)

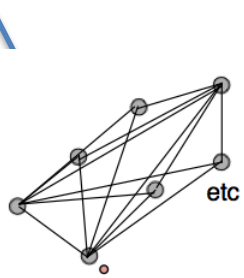
1. Central event or system or process

Conceptual

Methodological

5. System component properties, concepts

9. Experimental/sampling design



10. Measurements/data

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4. Problem statements (knowns & unknowns)

1. Central event or system or process

Conceptual

Methodological

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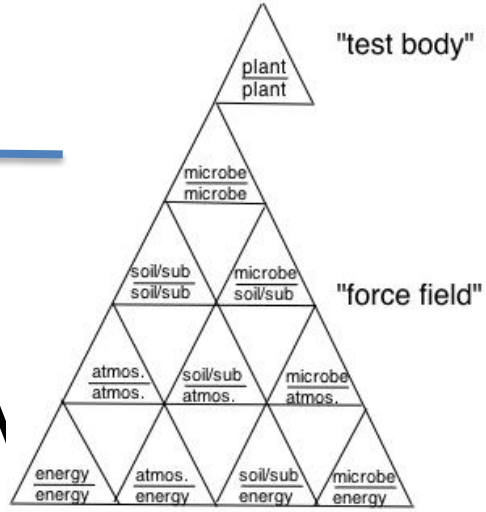
?



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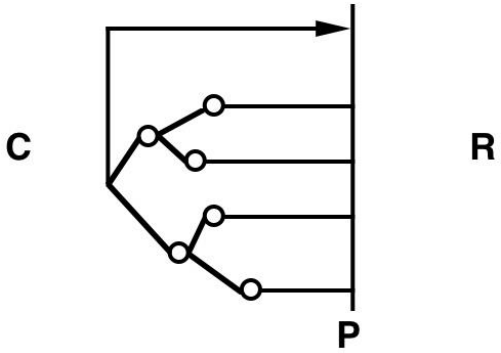
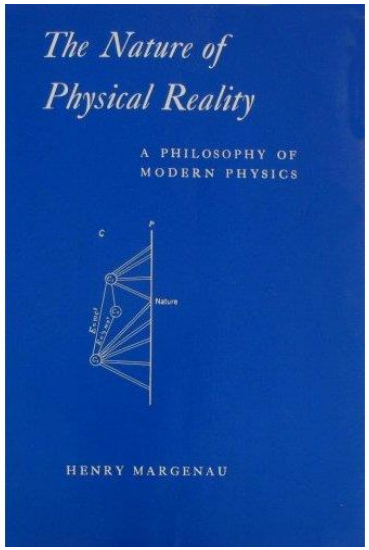
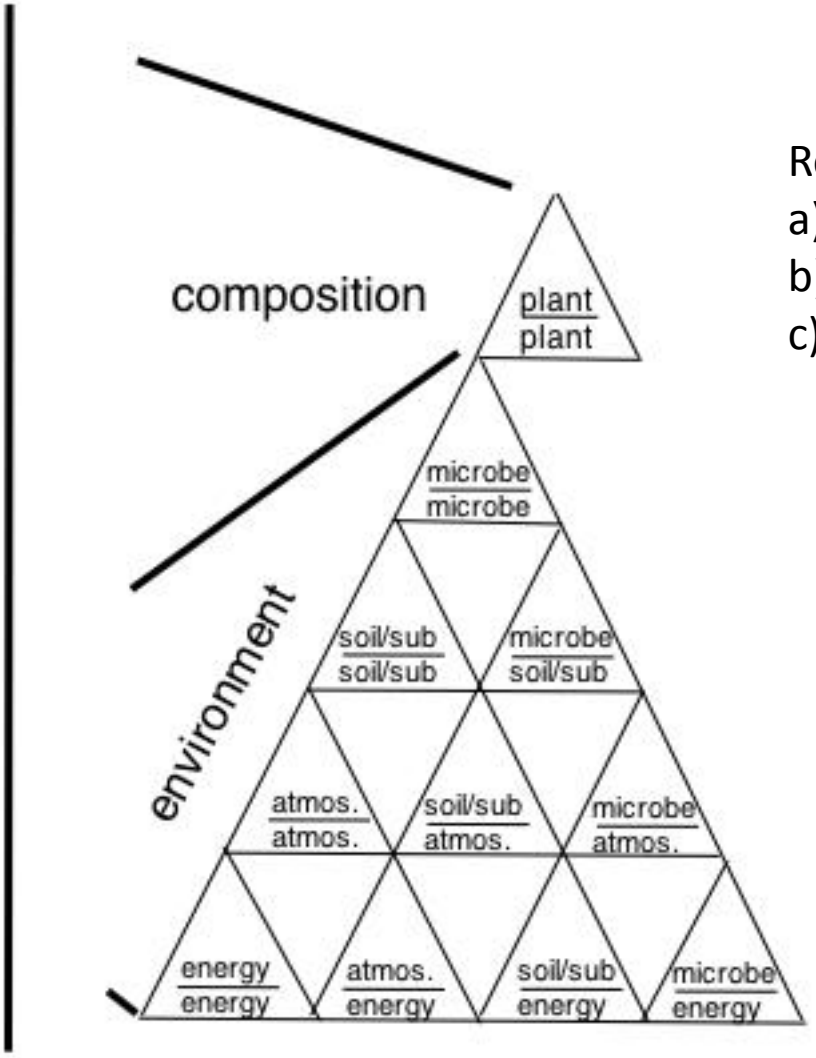
Margenau's – Plane of perception & Construct field





Construct field

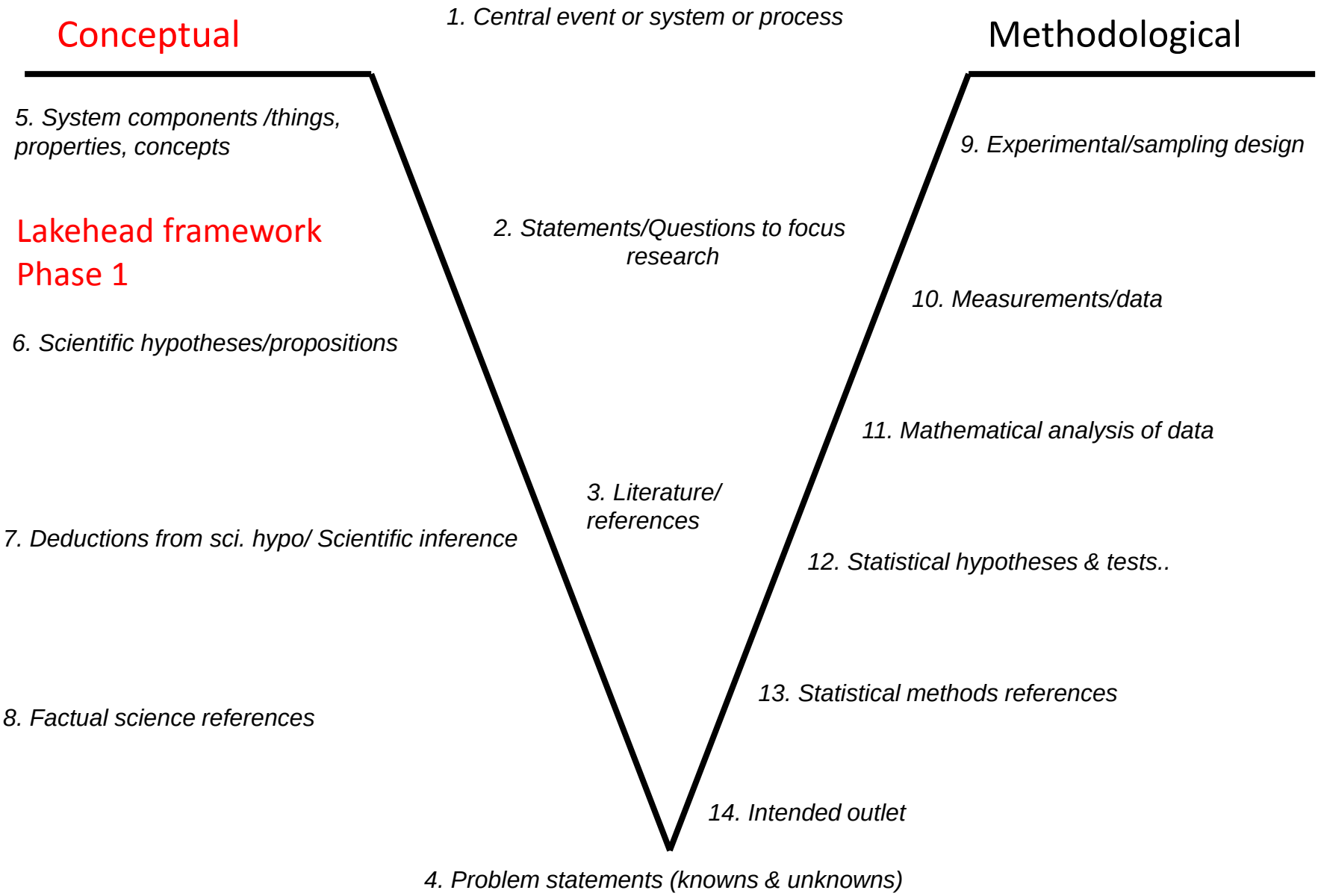


Recall: A system has:

a) Composition (elements)
b) Structure
c) Environment

Plane of perception

Real system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Lakehead framework
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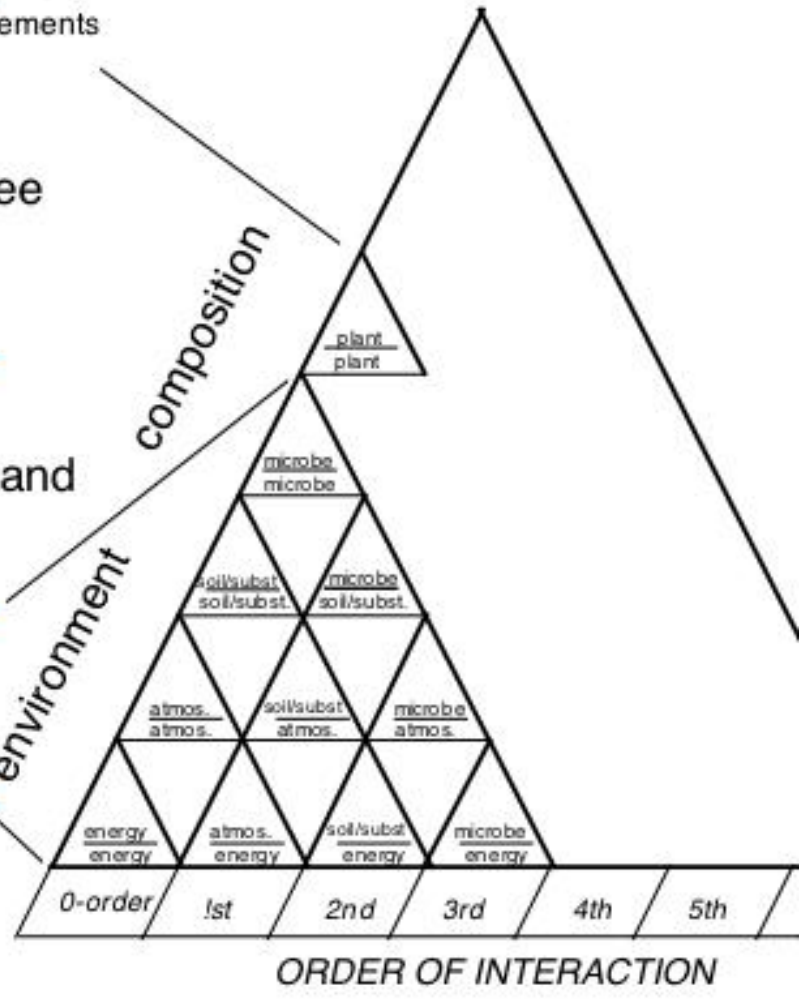
3 2 1

Lakehead Framework Phase 1

digits	numerical value	symbol	concept	property	PP
ffss	R+	d	diameter	stem size	tree
ffss	R+	h	tree height	stem size	tree
ffs	R+	cw	crown width	crown size	tree
ffs	R+	cr	crown ratio	crown size	tree
ffs	I+	n	packing / frequency	crowd-edness	stand
			soil properties	abiotic flux	environment



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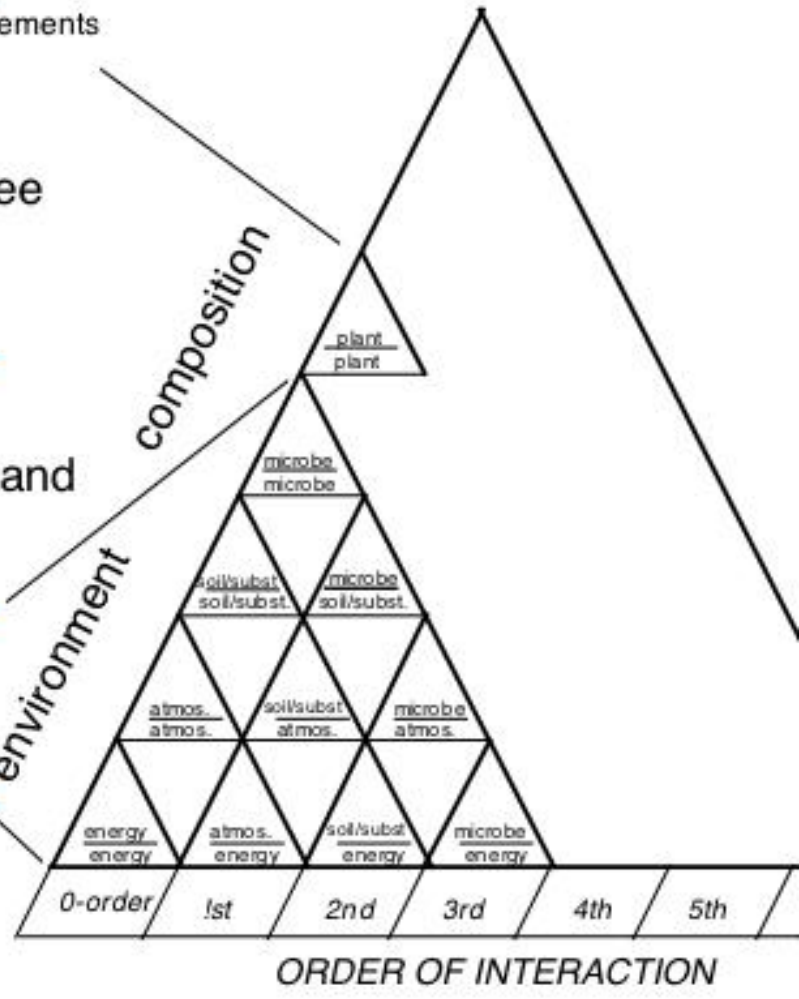

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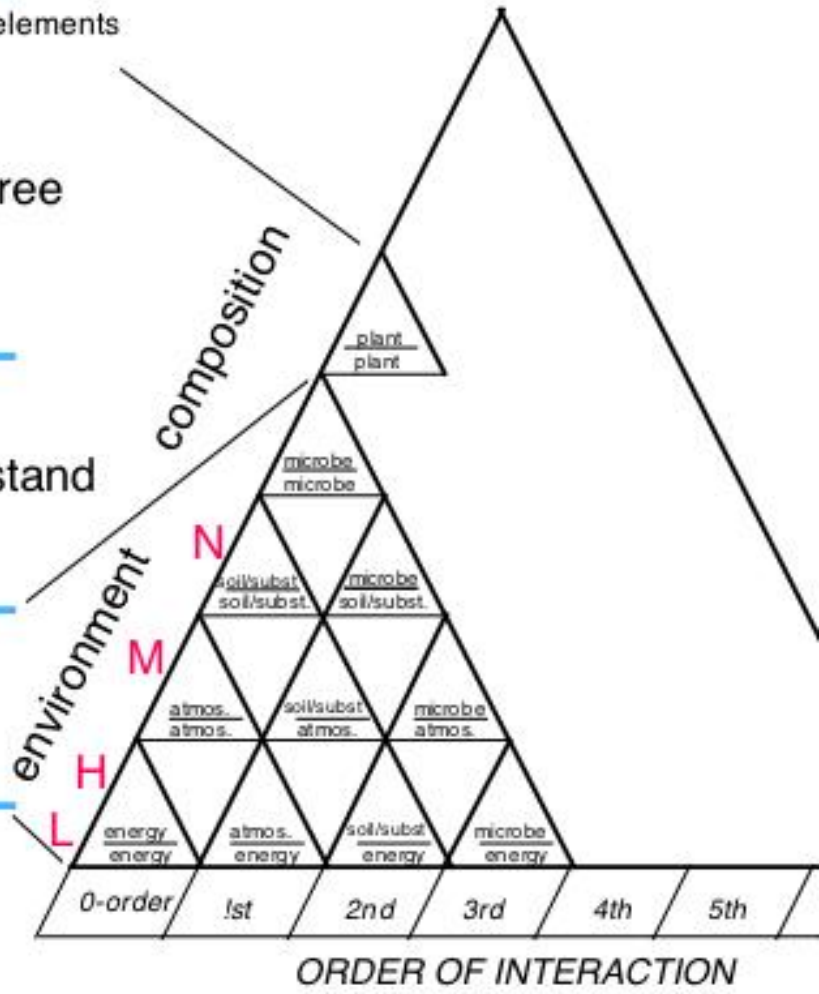
ffs	I+	n	packing / frequency	crowd-edness	stand
ffs	O	s	N, M, H, L	abiotic flux	environment

Nominal
Ordinal
Interval
Ratio

Moisture,
Nutrients,
Heat,
Light



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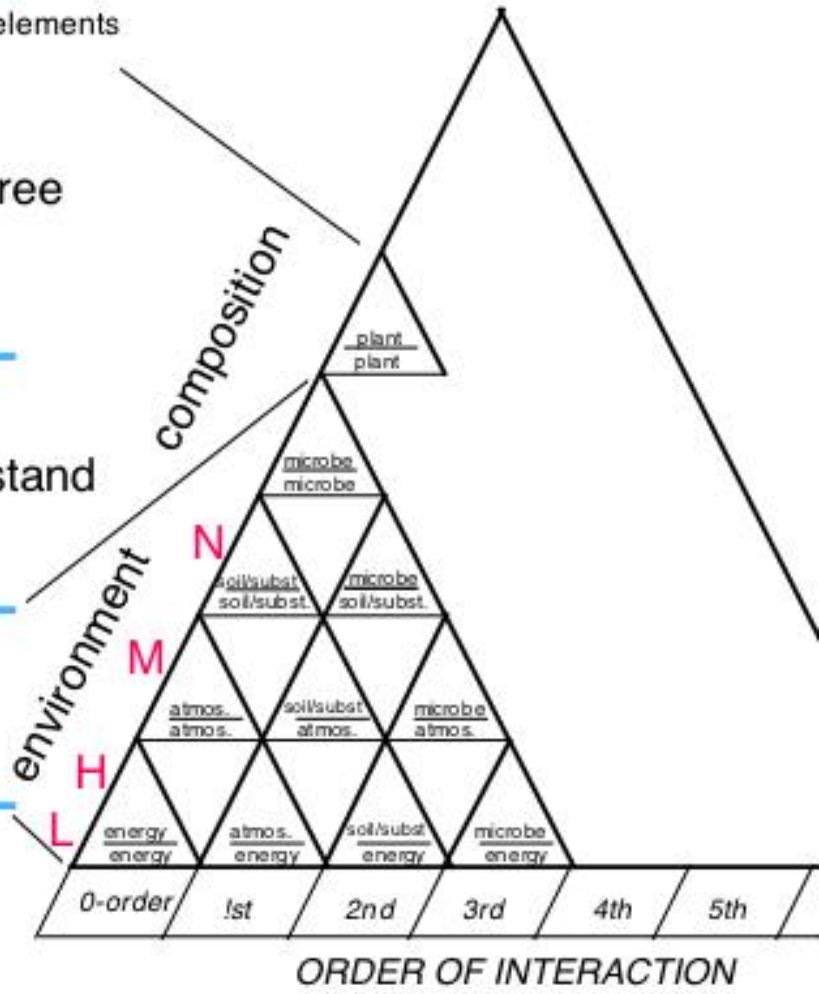
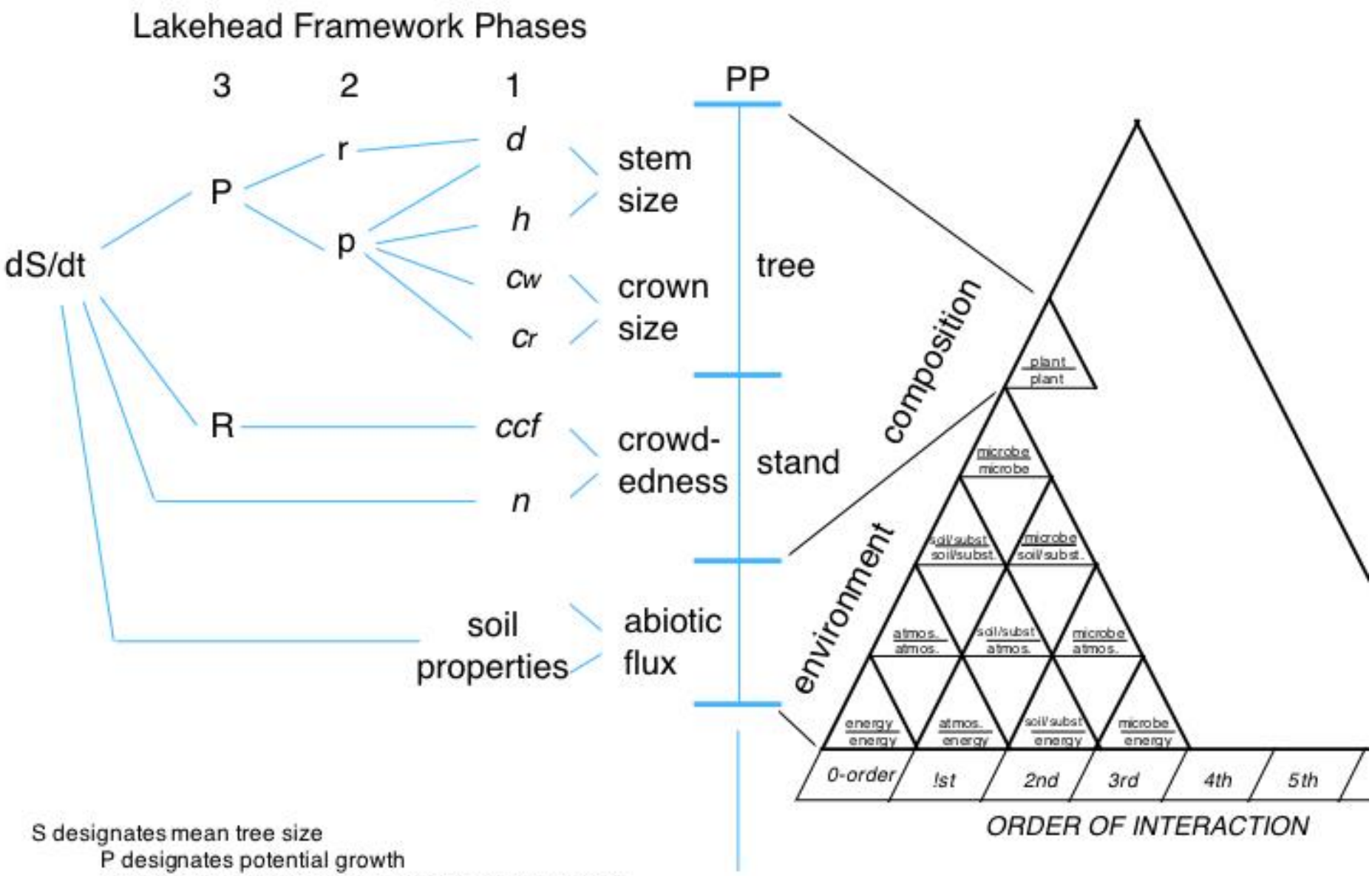
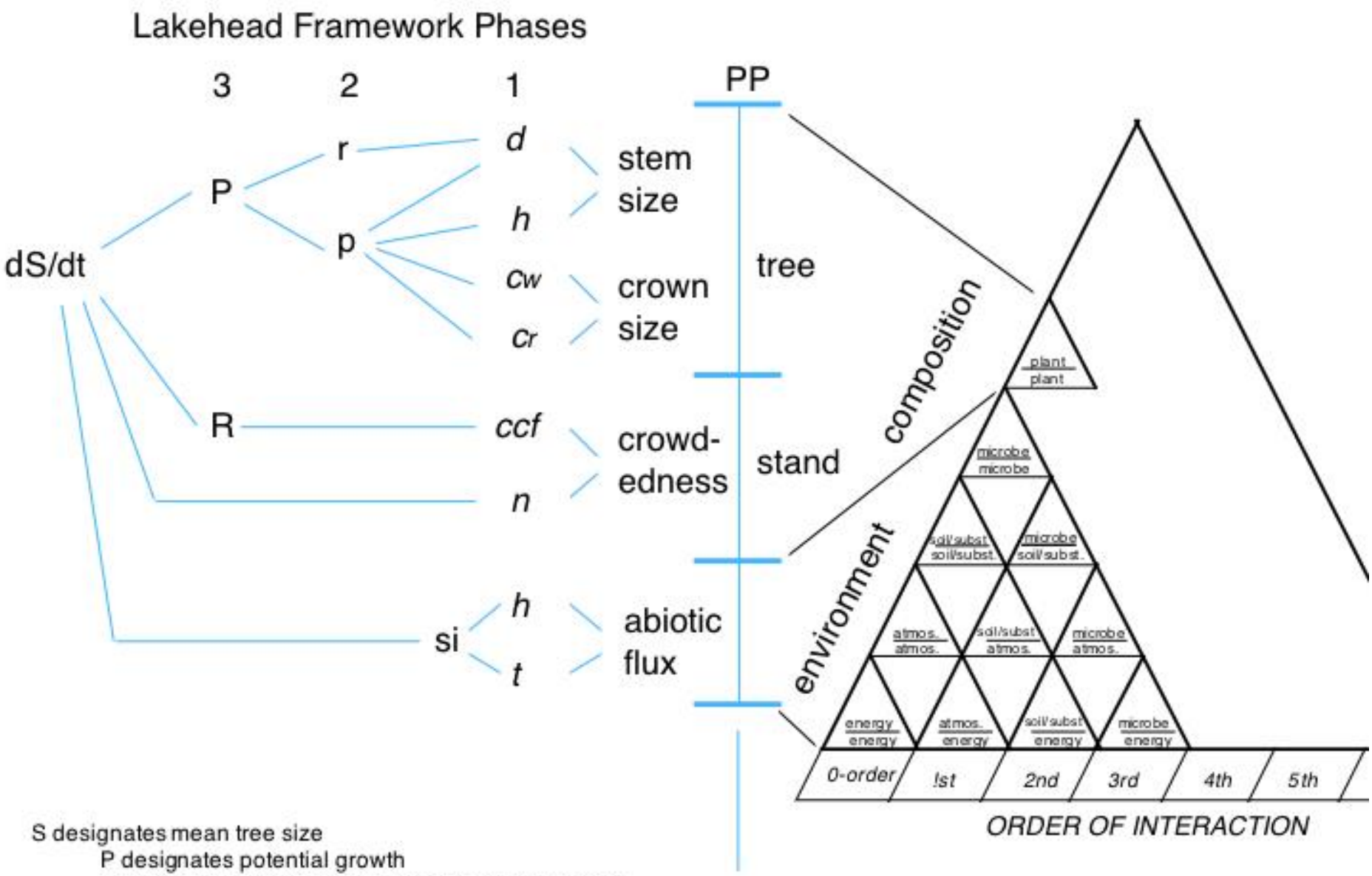


Possible concepts to represent 'packing'

s	stocking -- full, partial, etc	subjective	
ba	basal area (diameter)		
sp	Wilson's spacing percent (height)	objective + absolute	
boa	Bole area (height and diameter)		
sdi	SDI (# trees vs. diameter)		
rdi	RDI (mean tree volume vs. # trees)	objective + relative to induced change	in other stands
rba	Relative BA (actual / 'normal')		
ccf	Crown competition factor (open grown crown vs. forest-grown crown dimensions)	objective + relative to spontaneous change	in open grown trees



S designates mean tree size
P designates potential growth
R designates resistence to potential being realized
r designates respiration
p designates photosynthesis
d designates stem diameter at b.h.
cw designates crown width
n designates stem frequency
t designates age in years
h designates total tree height
cr designates crown ratio
ccf designates crown competition factor
si designates ht at 50 yrs



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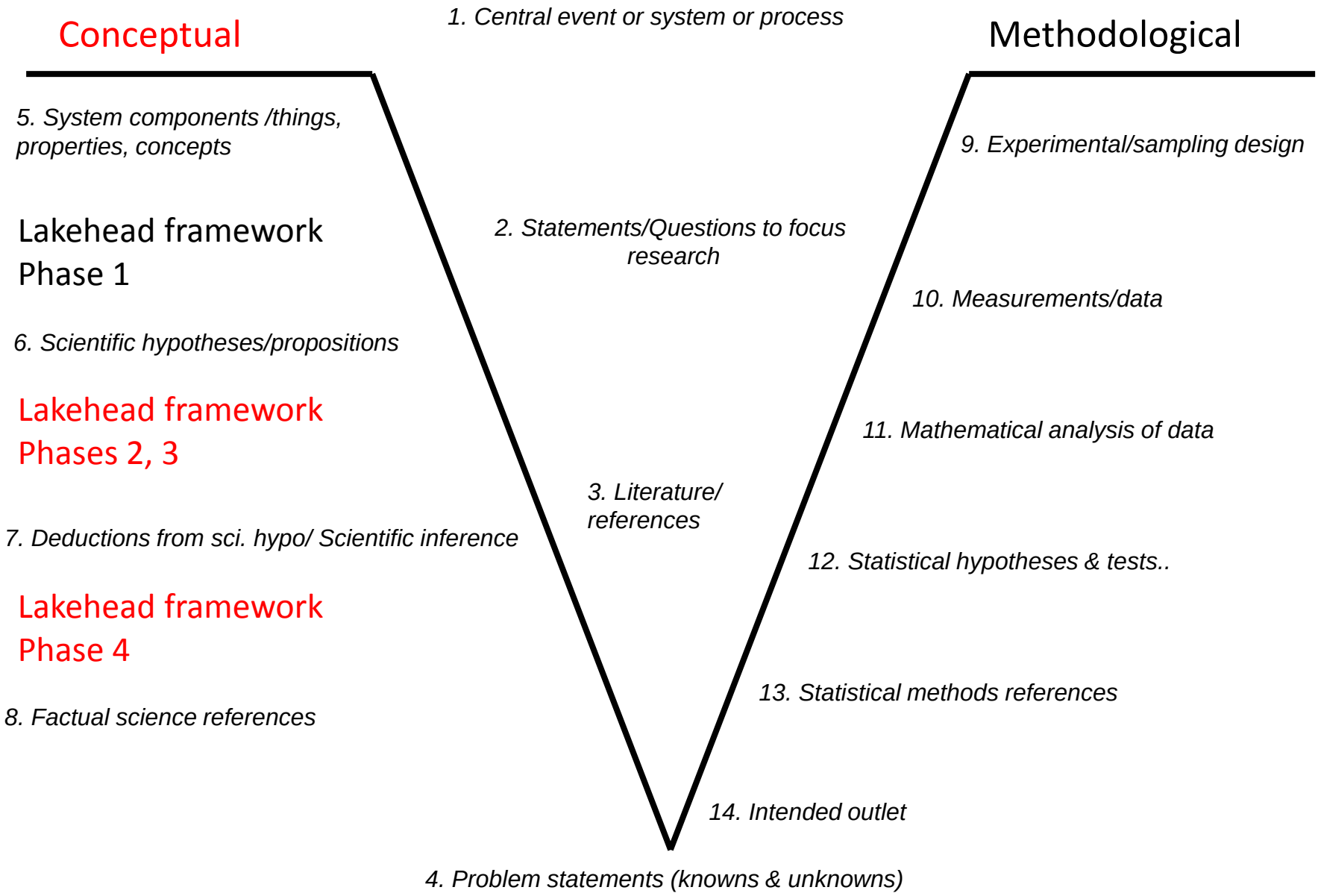
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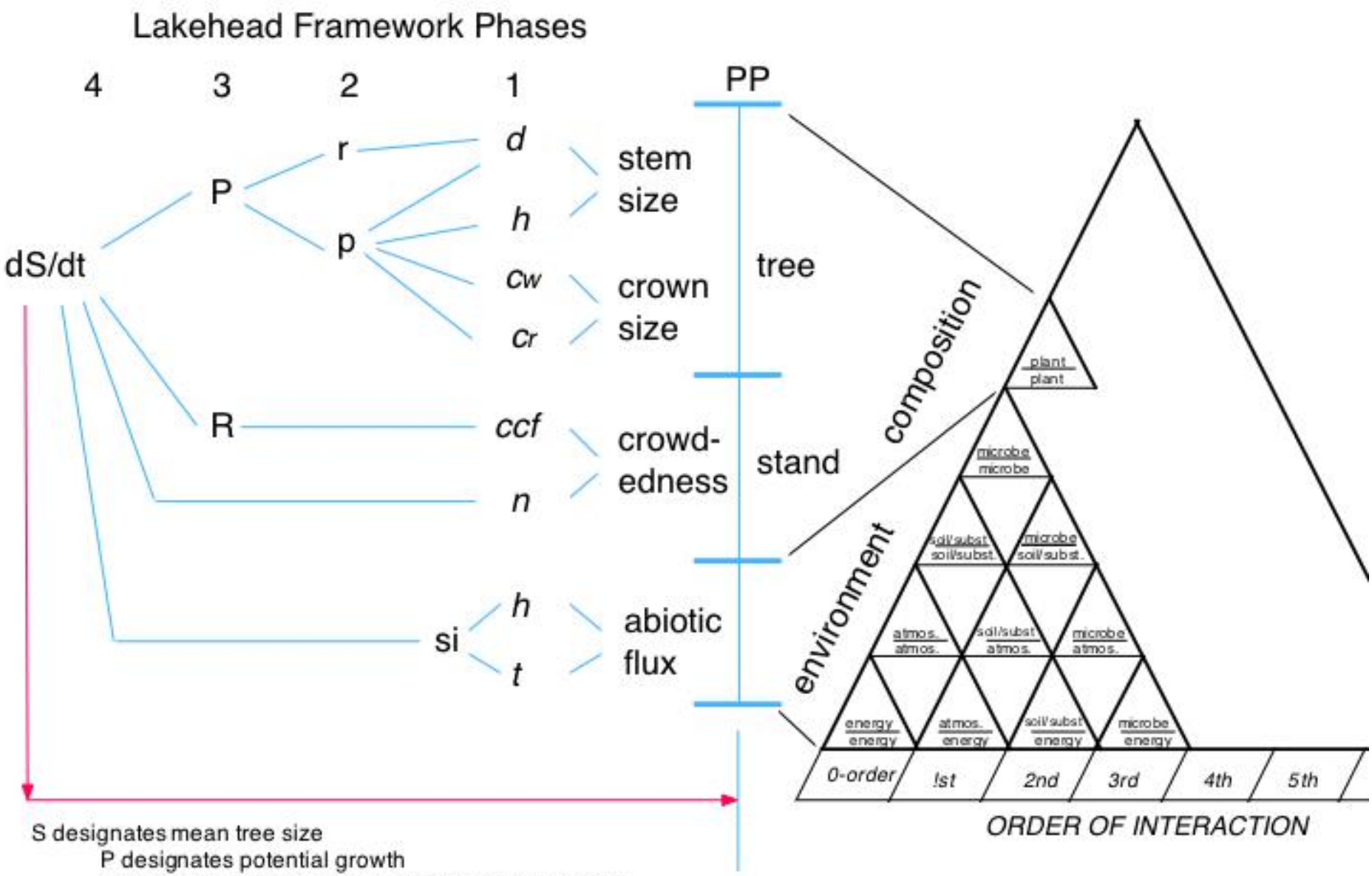
10. Measurements/data
6. Scientific hypotheses/propositions
Lakehead framework Phases 2, 3
11. Mathematical analysis of data
3. Literature/ references
7. Deductions from sci. hypo/ Scientific inference
12. Statistical hypotheses & tests..
Lakehead framework Phase 4
13. Statistical methods references
8. Factual science references
14. Intended outlet
4. Problem statements (knowns & unknowns)



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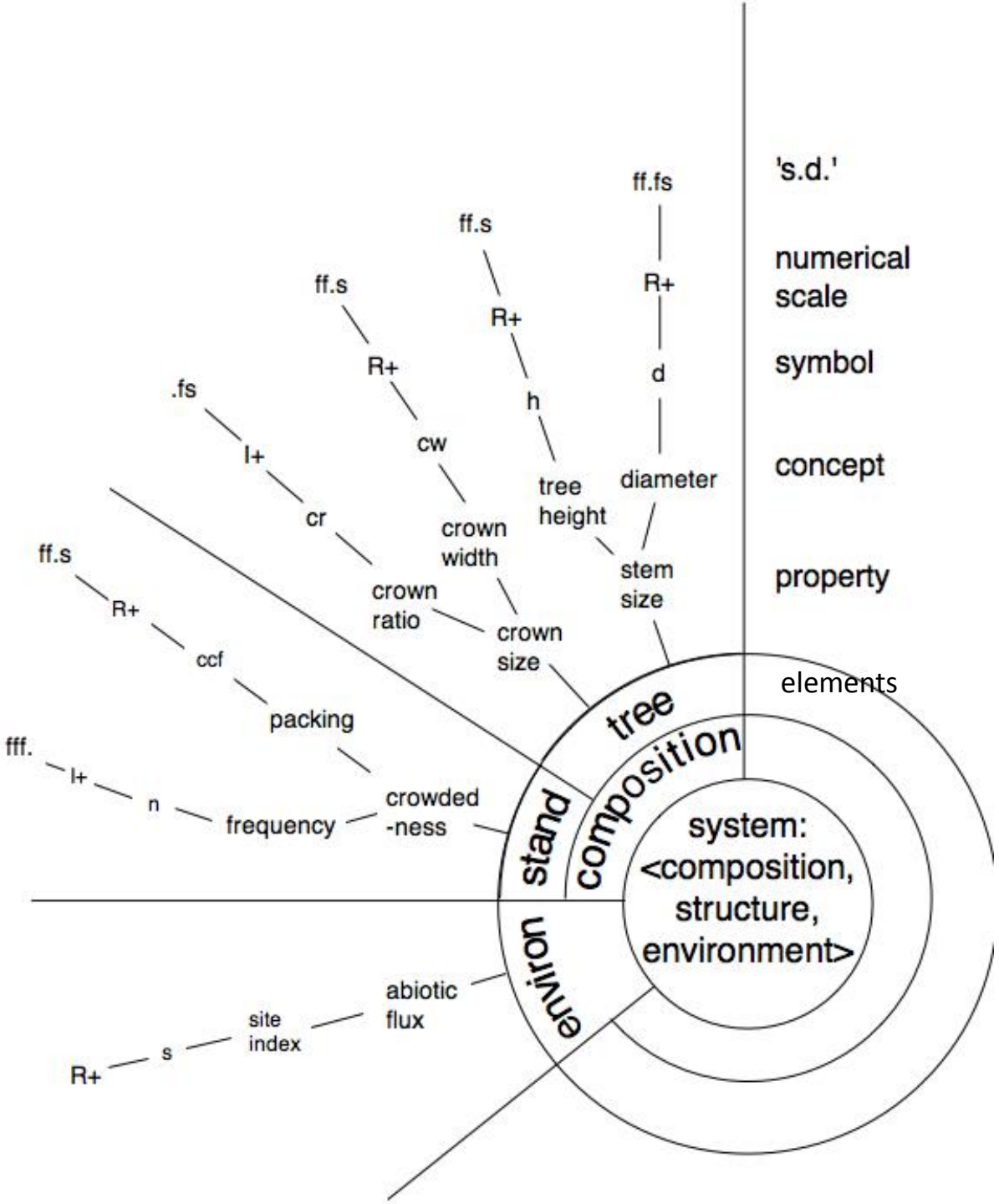
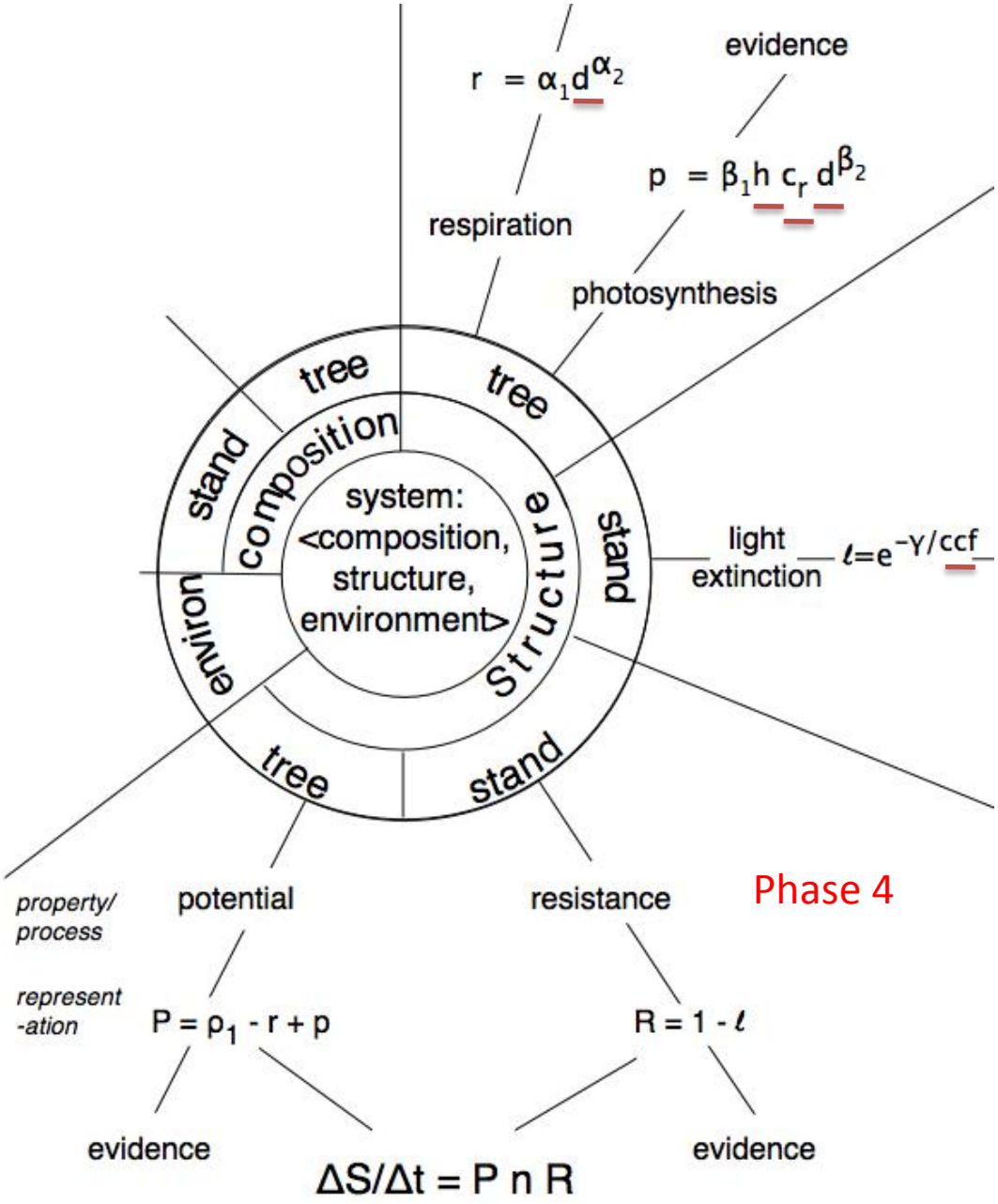
Phase 2

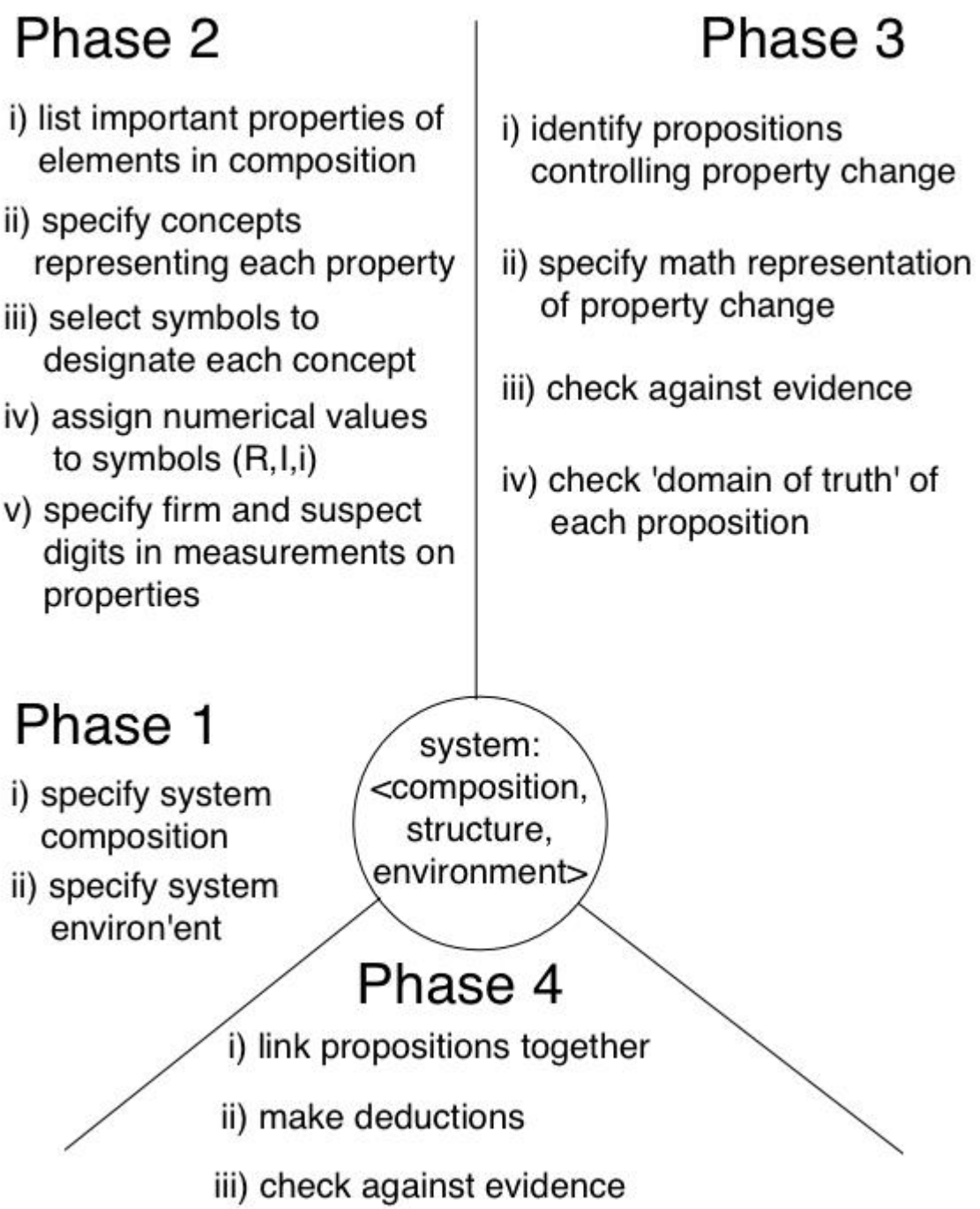

's.d.'
numerical scale
symbol
concept
property
elements
ff.fs
R+
d
diameter
ff.s
R+
h
tree height
ff.s
R+
cw
crown width
.fs
l+
cr
crown ratio
ff.s
R+
ccf
packing
crowded -ness
fff.
l+
n
frequency
R+
s
site index
abiotic flux
stand
tree
composition
environ
system: <composition, structure, environment>

Phase 3



Phase 4

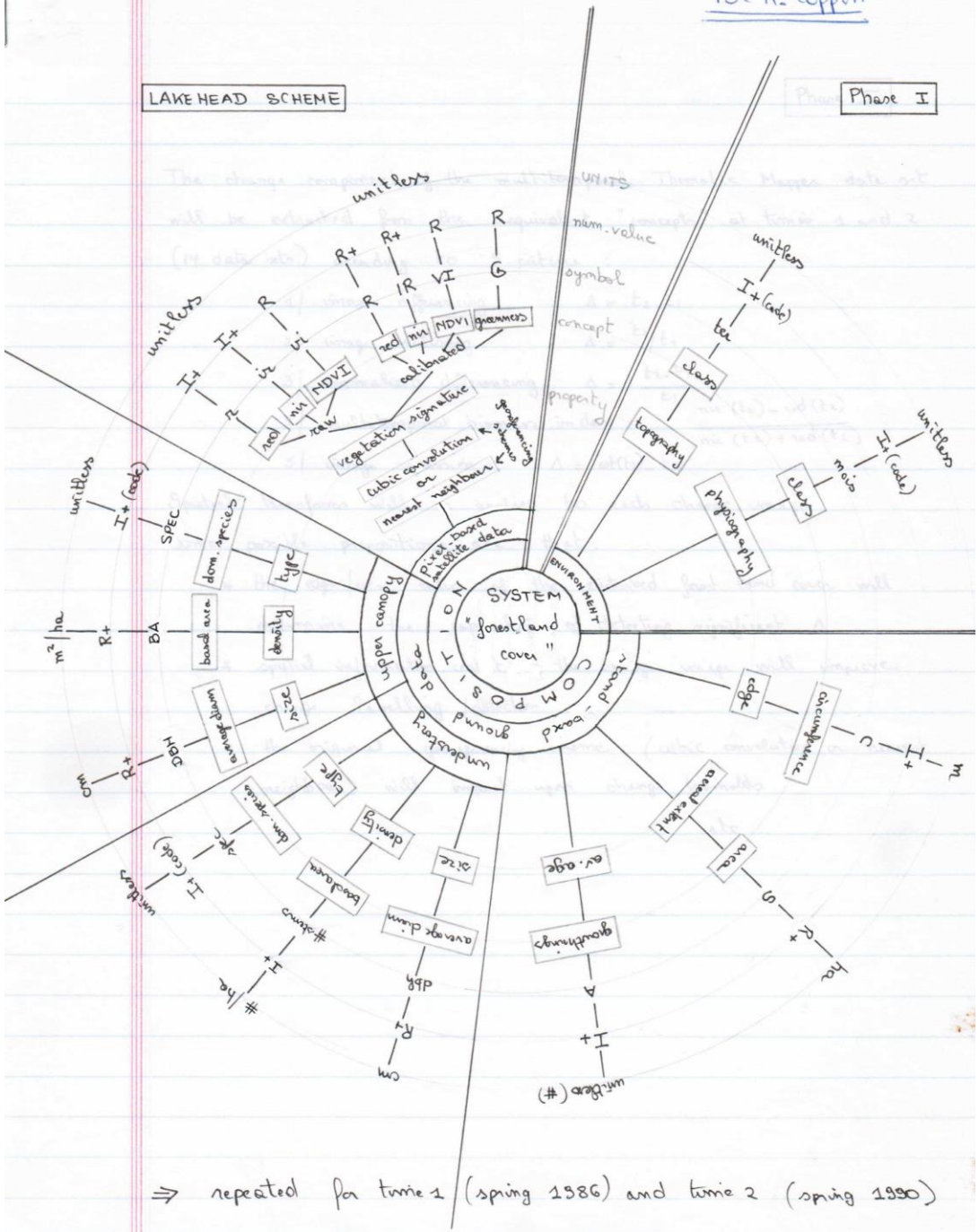
Lakehead
Review:



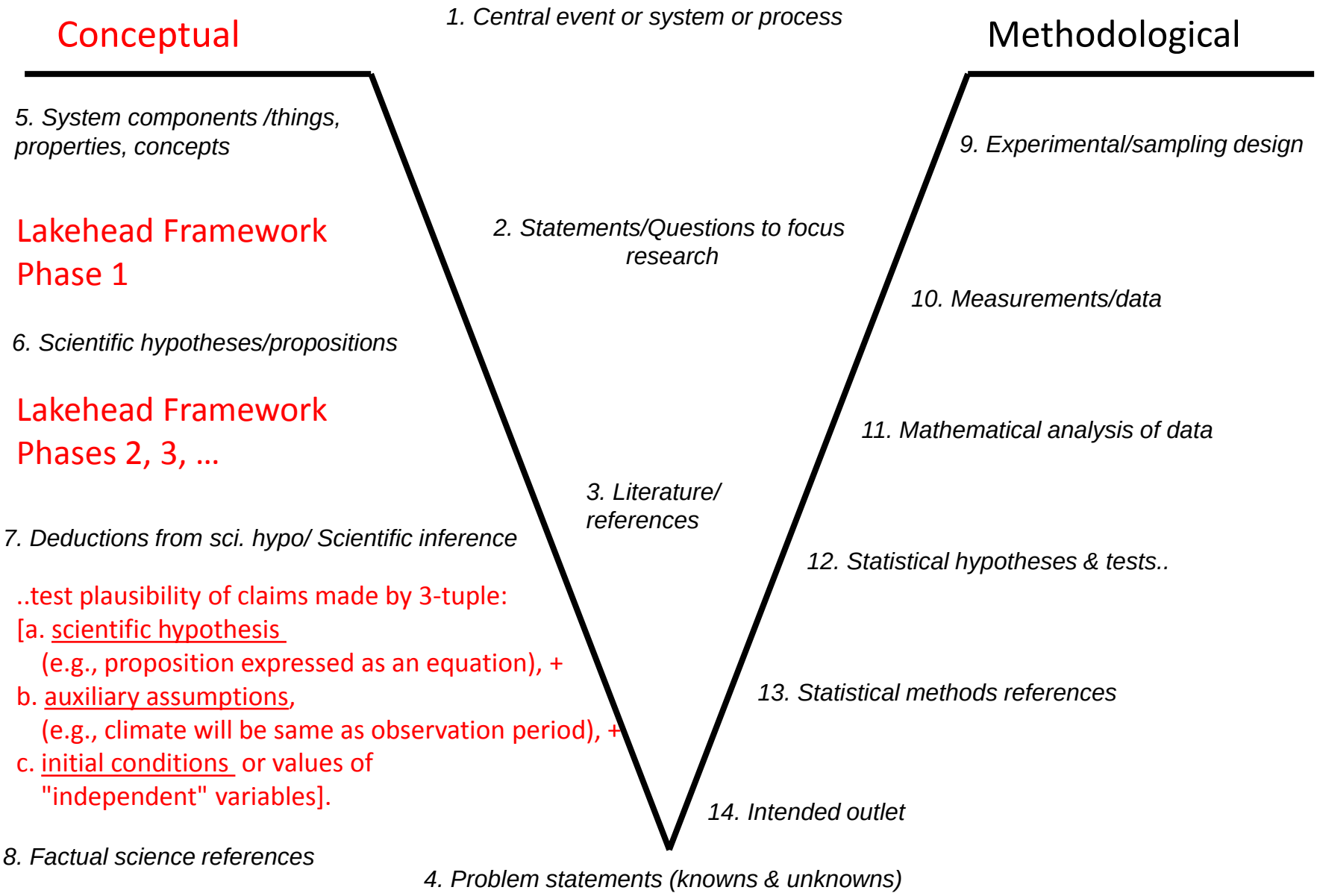
Pol R. Coppin

LAKE HEAD SCHEME

Phase I



⇒ repeated for time 1 (spring 1986) and time 2 (spring 1990)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Methodological
5. System components /things, properties, concepts
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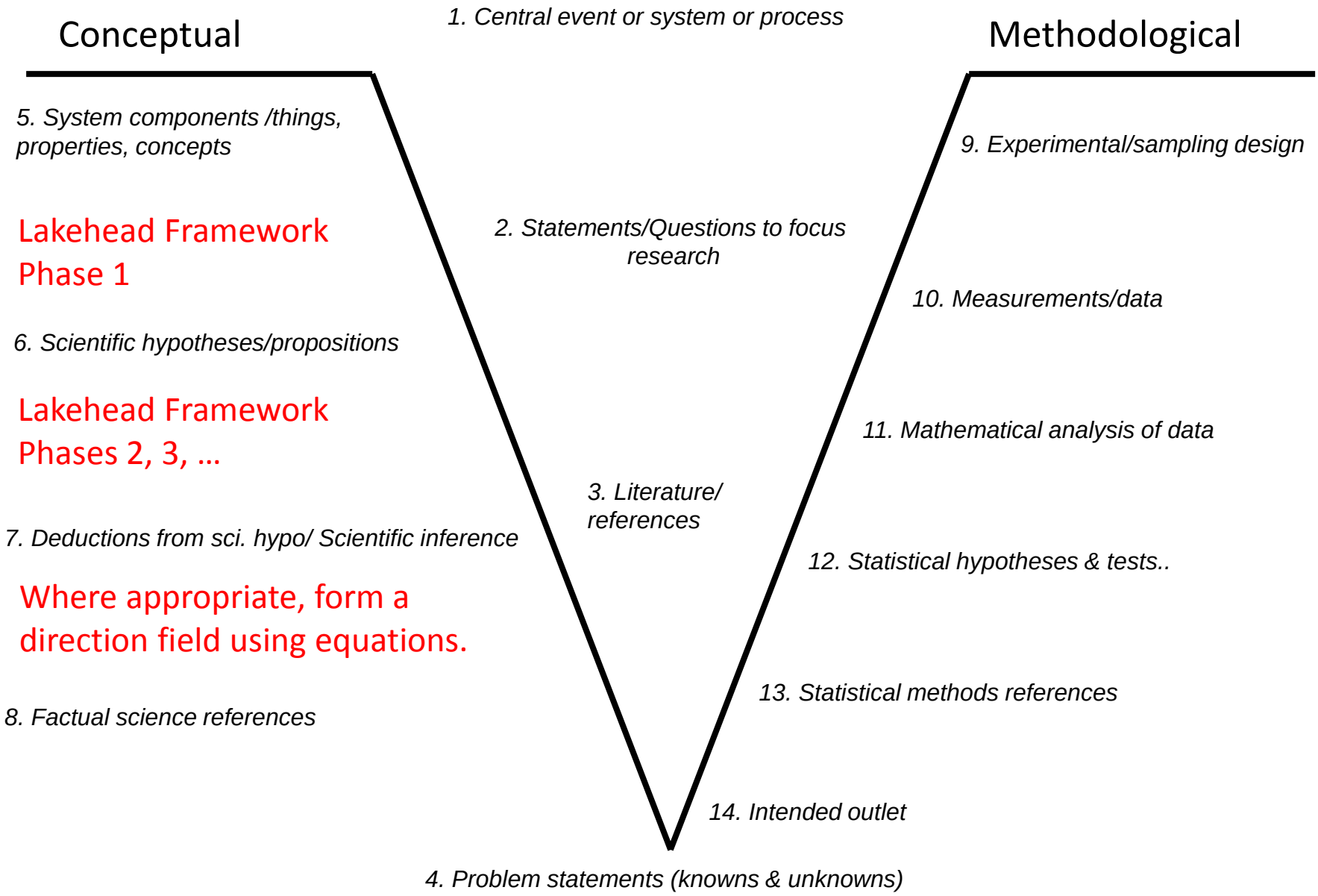
Lakehead Framework Phase 1
2. Statements/Questions to focus research
10. Measurements/data
6. Scientific hypotheses/propositions
Lakehead Framework Phases 2, 3, …
11. Mathematical analysis of data
3. Literature/ references
7. Deductions from sci. hypo/ Scientific inference
12. Statistical hypotheses & tests..
..test plausibility of claims made by 3-tuple:
[a. scientific hypothesis
(e.g., proposition expressed as an equation), +
b. auxiliary assumptions,
(e.g., climate will be same as observation period), +
c. initial conditions or values of
"independent" variables].
13. Statistical methods references
14. Intended outlet
8. Factual science references
4. Problem statements (knowns & unknowns)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12. Statistical hypotheses & tests..
Where appropriate, form a direction field using equations.
13. Statistical methods references
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14. Intended outlet
4. Problem statements (knowns & unknowns)

$$\frac{\Delta D_g}{\Delta T} = a_1 D_g^{a_2} e^{a_3 D_g^2 N}$$

$$\frac{\Delta N}{\Delta T} = b_1 N^{b_2} e^{b_3 D_g^2 N}$$

governing equations for self thinning of Norway spruce plantations in

- Denmark (1997) FSL model.

$$\frac{d\ln(V)}{dt} = a_{10} + a_{11}\ln N + a_{12}\ln V$$

$$\frac{d\ln(N)}{dt} = a_{20} + a_{21}\ln N + a_{22}\ln V$$

- Hara model

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$$\frac{\Delta N}{\Delta T} = b_1 N^{b_2} e^{b_3 D_g^2 N}$$

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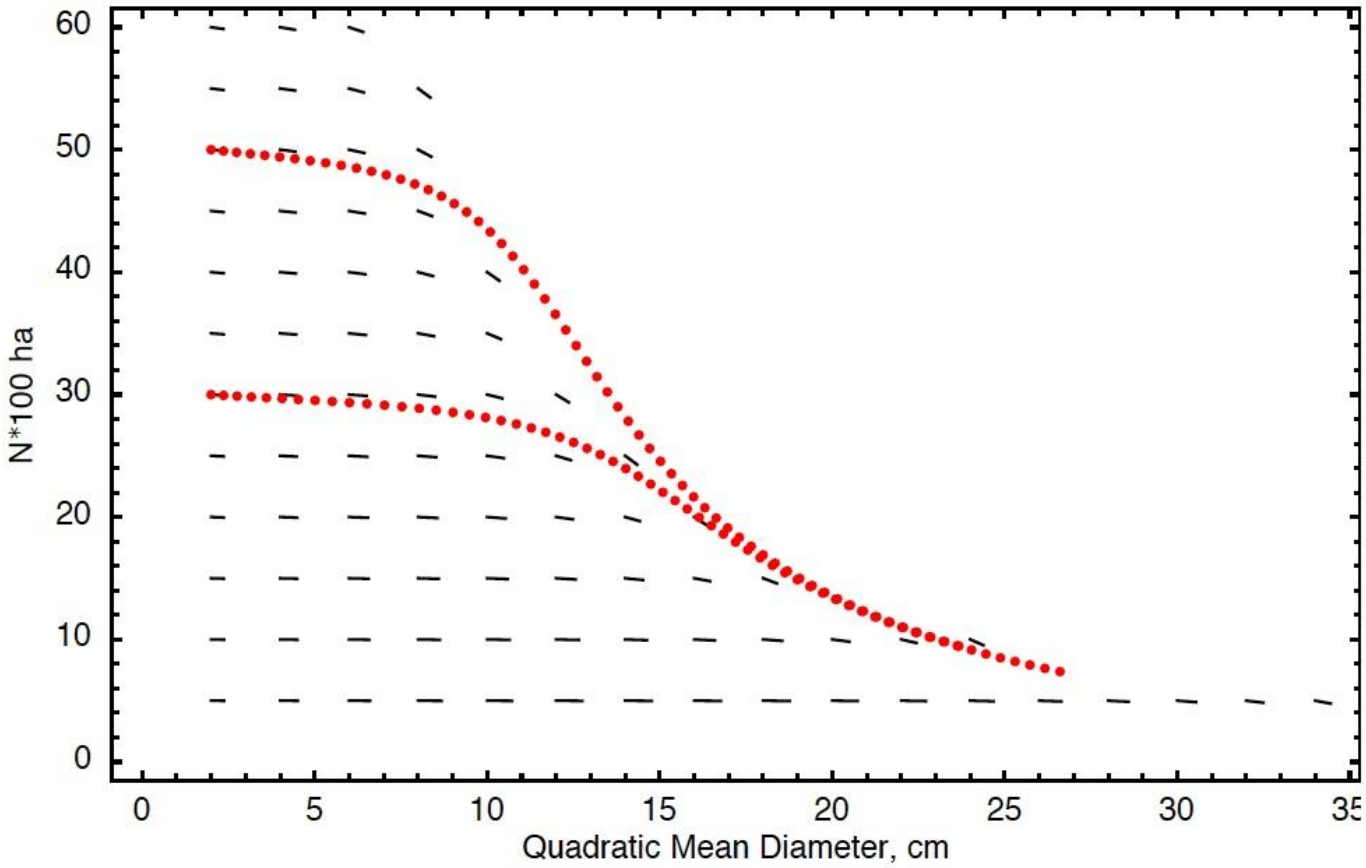
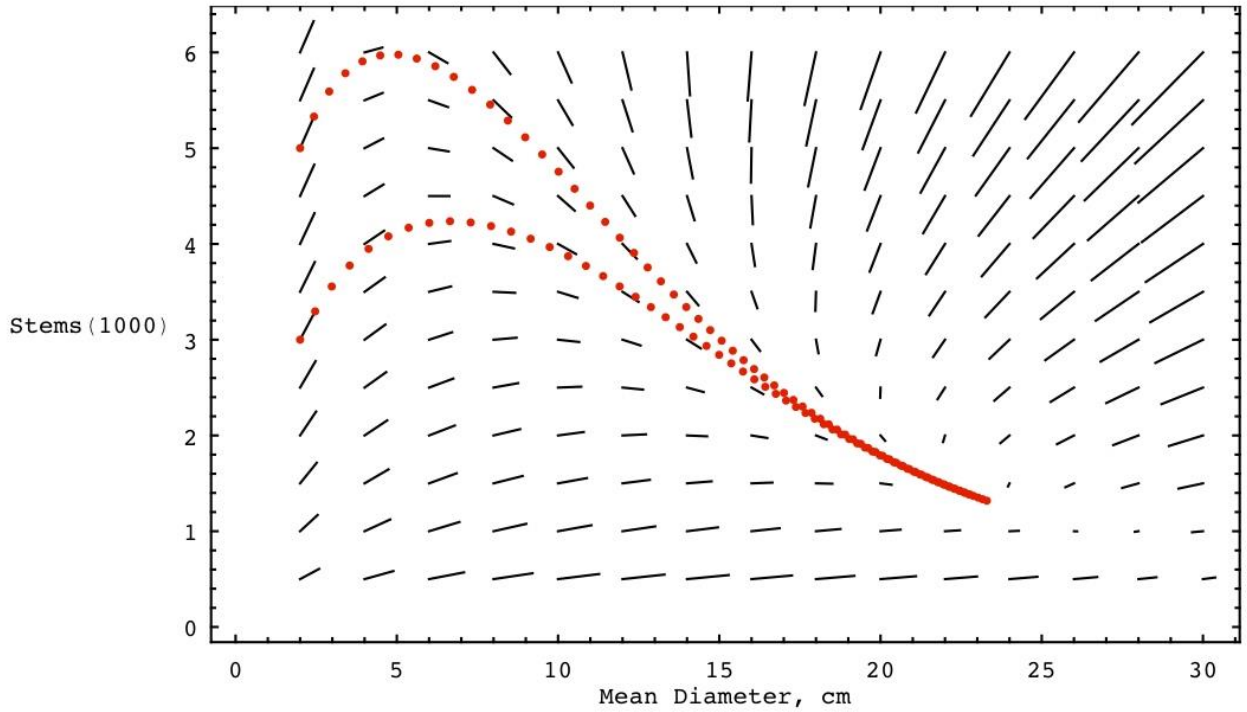


$$\frac{d\ln(V)}{dt} = a_{10} + a_{11}\ln N + a_{12}\ln V$$

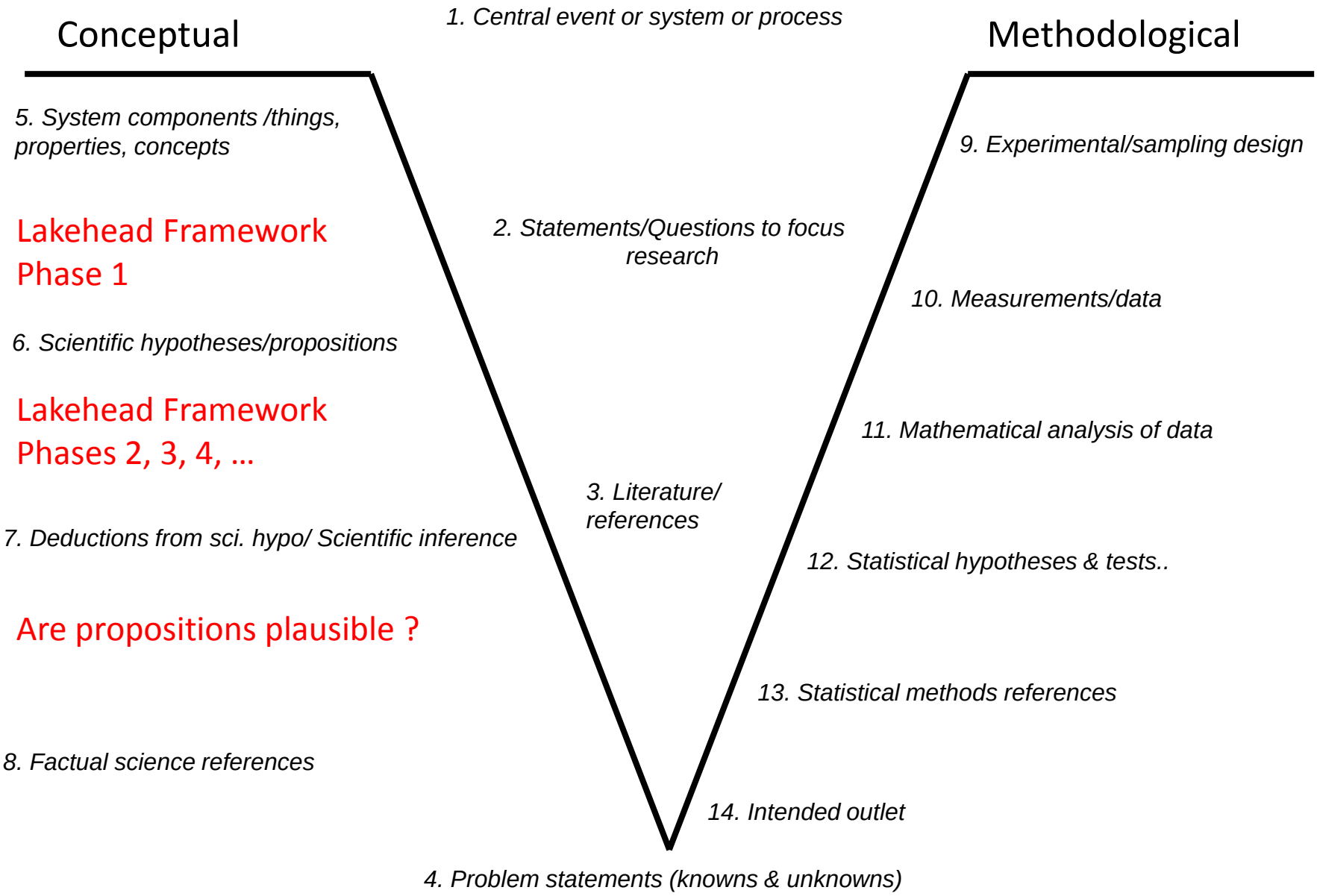
$$\frac{d\ln(N)}{dt} = a_{20} + a_{21}\ln N + a_{22}\ln V$$

Hara model

```
nIterateSolution[
    {
        {{2, 5}, 60, {30, 70}}, {{2, 3}, 60, {30, 70}}
    }]
```



- Graphics -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Are propositions plausible ?
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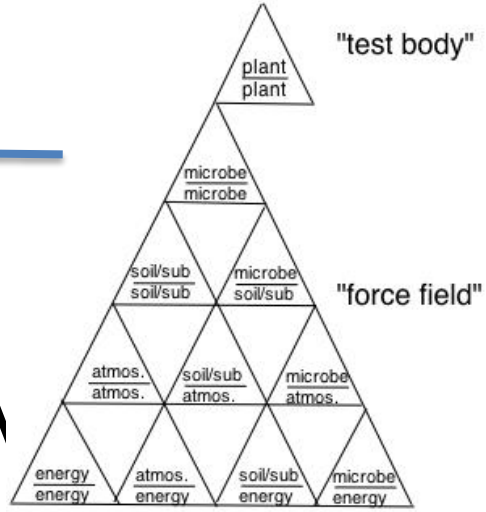
Conceptual

Methodological

5. System component properties, concepts

?

9. Experimental/sampling design



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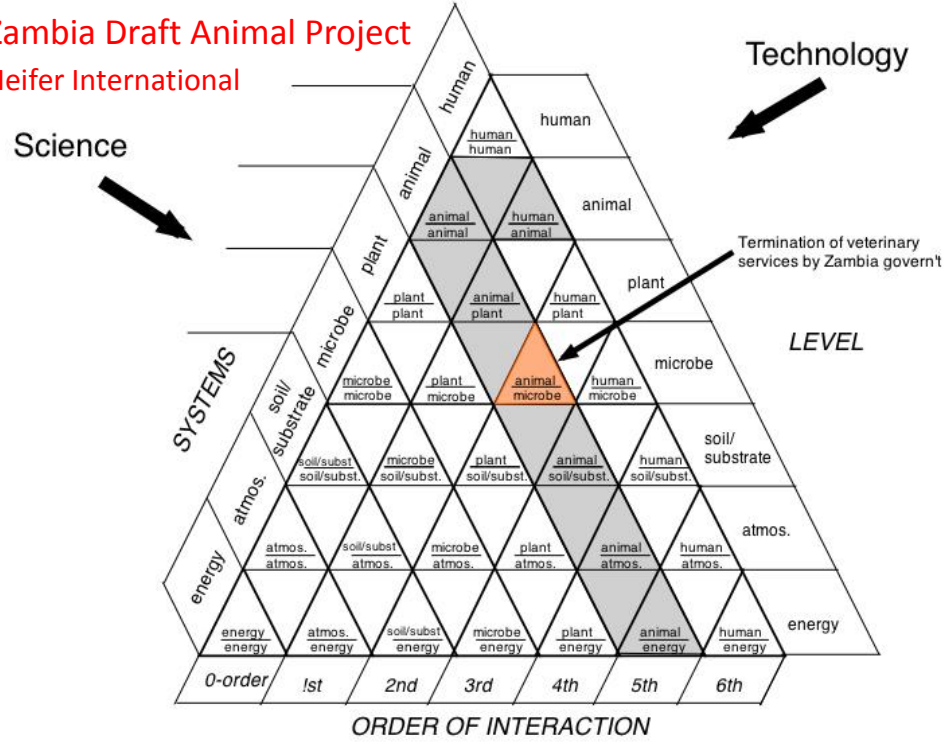
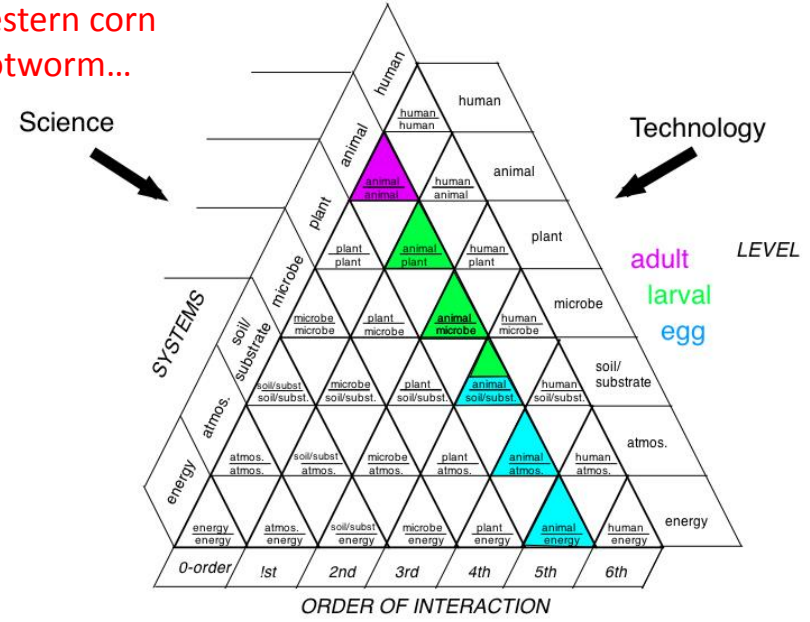
Zambia Draft Animal Project

Heifer International

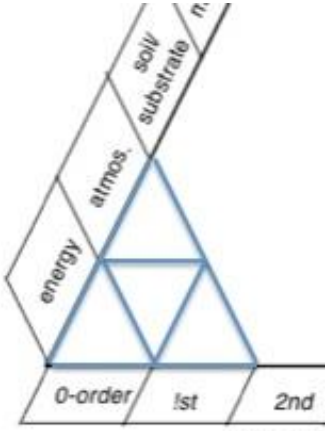


Western corn rootworm…



Aspen FACE (Free-Air Carbon Dioxide Enrichment) Experiment

Haines fire index



Thank you