

Unifying Concepts in Environmental Monitoring

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Why am I **talking** about it?

Because I believe it is important to keep the dialog going

Been involved in environmental monitoring for >3 decades,
and got my hands wet with many protocols

Spent a lot of time talking to folks who are collecting and using
environmental data in a variety of Agencies, Programs,
disciplines, and Areas of Inquiry

Spent a lot of time developing guidance, training tools, and
data management tools for small monitoring entities

And I want to share what I have learned

Why am I talking about it NOW?

Because a lot of good folks are working NOW to address our prominent information management challenges.

Here are three I can see from my ‘perch’:

- (a) Language: variations in use of terms by different agencies and different roles**
- (b) Process: very few people see the entire process of information management, from field observations and data sheets to the database, the queries, and the interpretive reports.**
- (c) Mindset: field person, QA Officer, data user, scientist, Program manager/decision maker – each has a set of different perceptions and understanding of priorities**

More challenges: everyone has their own point of view

Minnow:
Shelter!

Kingfisher: **Bummer!**

Angler:
Snag!



Water
Strider:
Shade!

Geomorphologist:
Scour!

Restoration Designer:
Opportunity!

Lateral pool with LWD & root wad

...and likes to collect and classify bugs **Their Way**

High **vs** Low
gradient

Perennial **vs**
Intermittent streams

500 **vs** 220
micron net

3 'replicates' **vs**
pool entire Reach

Riffle **vs** Other
habitat type

Embeddedness
Criteria?

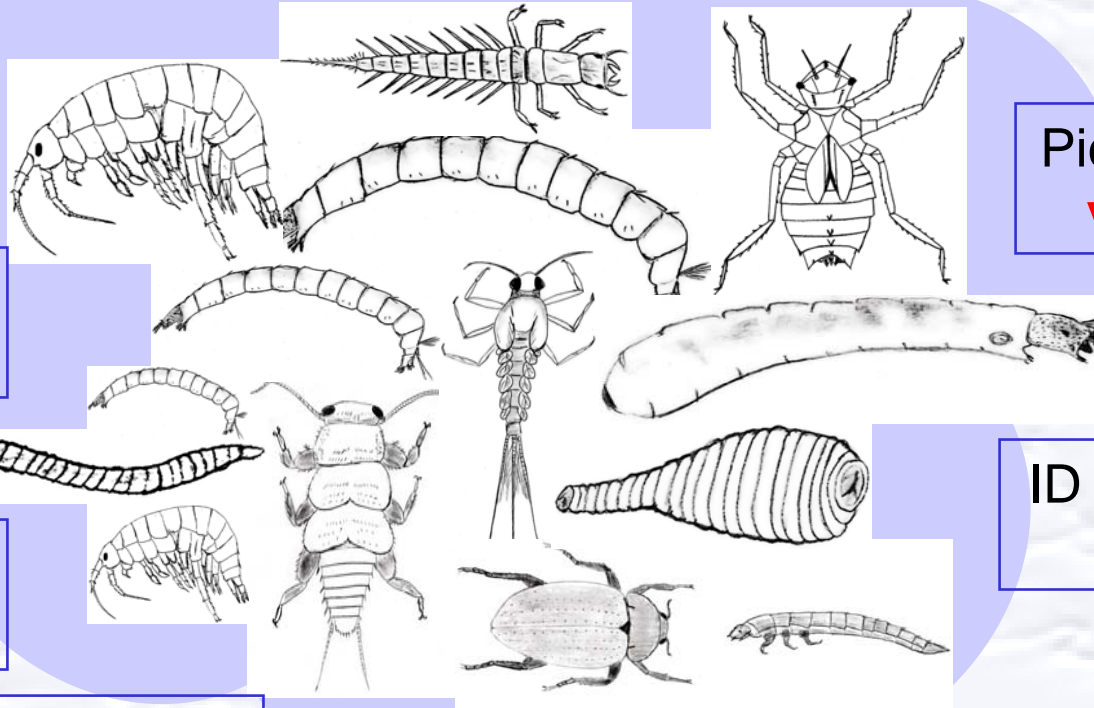
Pickle in alcohol
vs aldehyde

Substrate size
criteria?

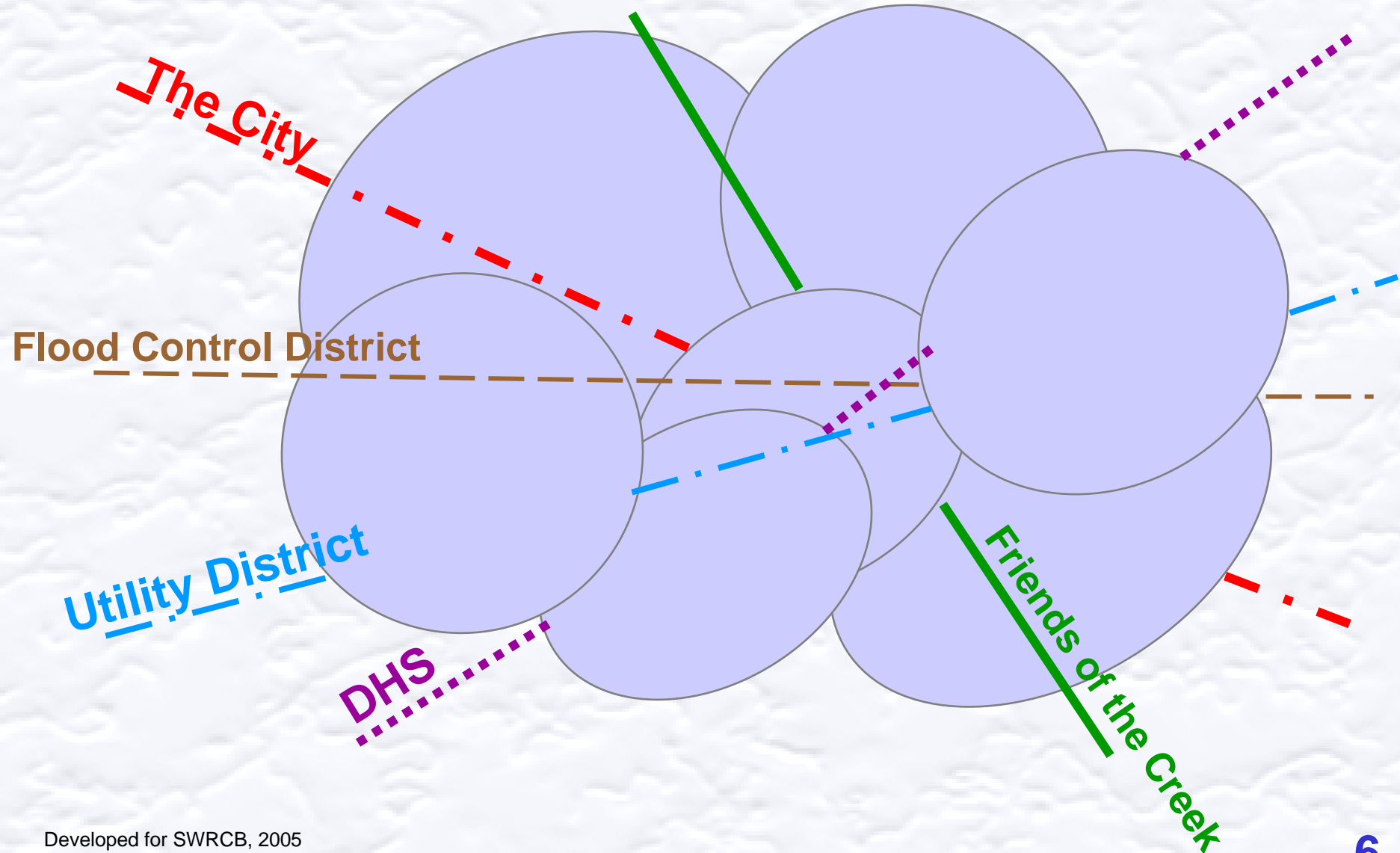
Current Velocity
criteria?

ID to Family **vs**
Species

ID for West Coast
vs East Coast



...or likes to slice the watershed **their way**



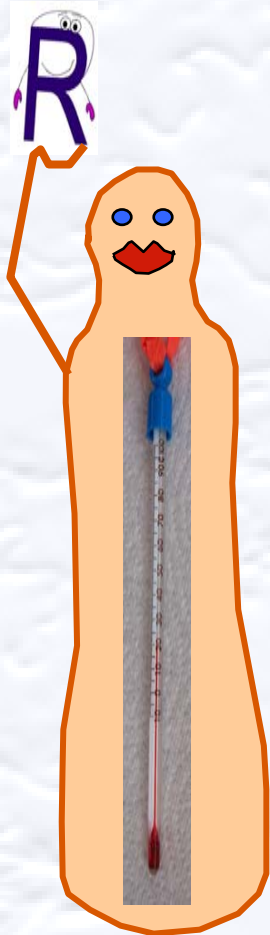
...or get their lat/long coordinates in **their** preferred format and on the Datum **they** like...

But we ARE able to put all our stations on the same Grid!

In fact, ALL of us environmental monitoring folks devise Measurement Systems, and run Quality Checks, and apply Sampling Design Principles, and obtain Monitoring Results - in all our disciplines and Areas of Inquiry.

Most folks define “Measurement Systems” as

Devices and/or procedures used for quantitation of environmental characteristics, including instruments used for field measurements and sampling & analysis processes.



Some have
one simple
step,
others
have many
steps



But they also include physical habitat assessments



(Also think about:

Densiometer;
Stadia rod;
Level;
Field data sheet for observations;
and more)



Every Measurement System needs Quality Checks

Matrix Spike/Matrix Spike Duplicate,
sample arrival temperature,
repeated categorical observations, or
a survey loop closure

are very different from each other but all of them
are Quality Checks.

Examples of quality check categories

Quality Check Category	Examples	Data quality aspect addressed
Comparison to a 'Standard'	Accuracy Check (a.k.a post calibration check)	accuracy
Survey Loop	Survey loop closure	accuracy
Repeats	repeated field measurement, field rdups, lab reps, etc.	precision
	repeated categorical observations	% match
Inspections or verifications	sample custody seal, arrival temperature, preservative concentration, field spike, etc.	sample integrity - lack of tempering or deterioration
Blanks	bottle blank, equipment rinsate, field blank, method blank, etc.	sample integrity - lack of contamination
Spikes	LCS, CRM, Surrogate, Matrix Spike, Internal Standard	Percent recovery
Positive and negative controls	reference toxicant test, bacterial cultures, etc.	validity

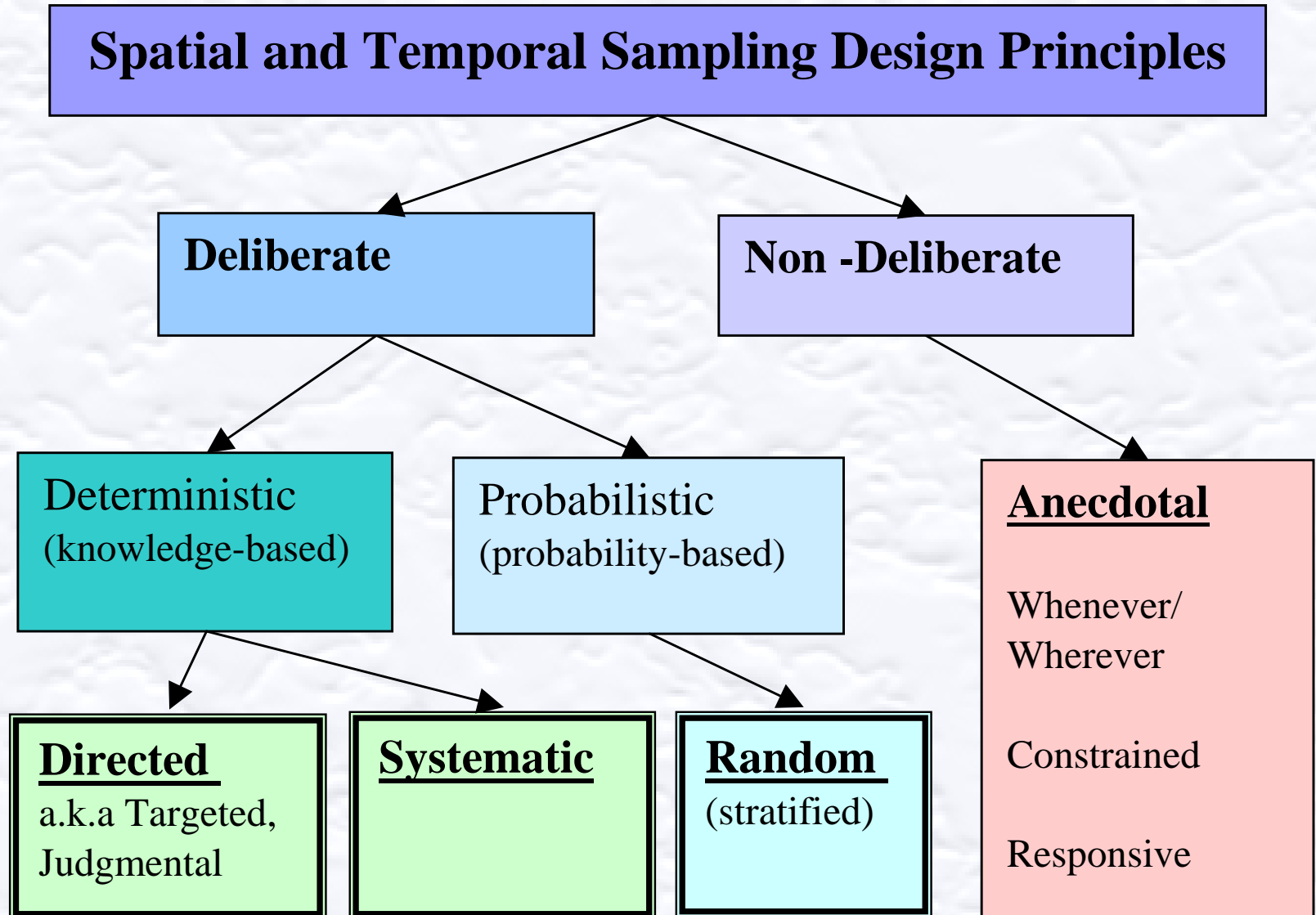
‘Activity’ is a thing!

(-) Pete Ruhl

Activity – a.k.a. S/M/O – is what we do in the field to generate data or start a data generation process. It can be an action or an object.

- **Evaluative**, using eyes/brain/experience (e.g., categorical observation, estimate, score)
- **Measured**, using an instrument *in situ* or counting (e.g., discrete/time series field measurement, elevation survey, count, etc.)
- **Collected**, by transferring medium into containers for processing elsewhere, or capturing biota (Sample *sensu strictu*)

Another example of a unifying concept: Sampling design principle



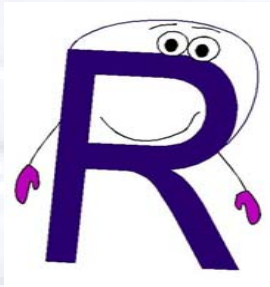
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But **R** is the first unifying concept in all the monitoring activities we do!



R is the monitoring Result: the outcome of a measurement, analysis, or categorical observation.

Result Type examples

Verbal Category (e.g., 'murky')

Individual Value (e.g., 18 C)

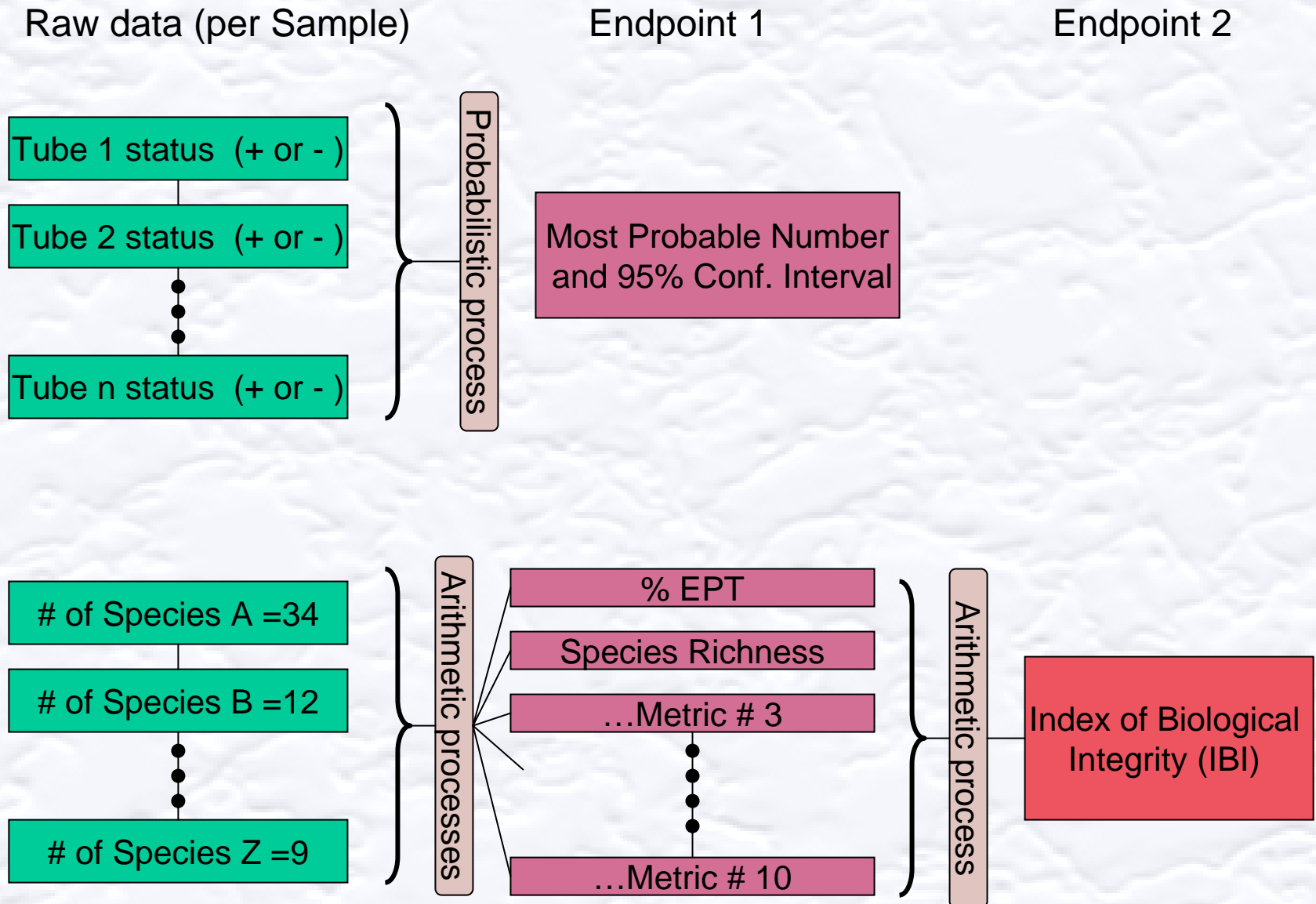
Estimated number or numeric range (e.g., 20-50% embeddedness)

Count

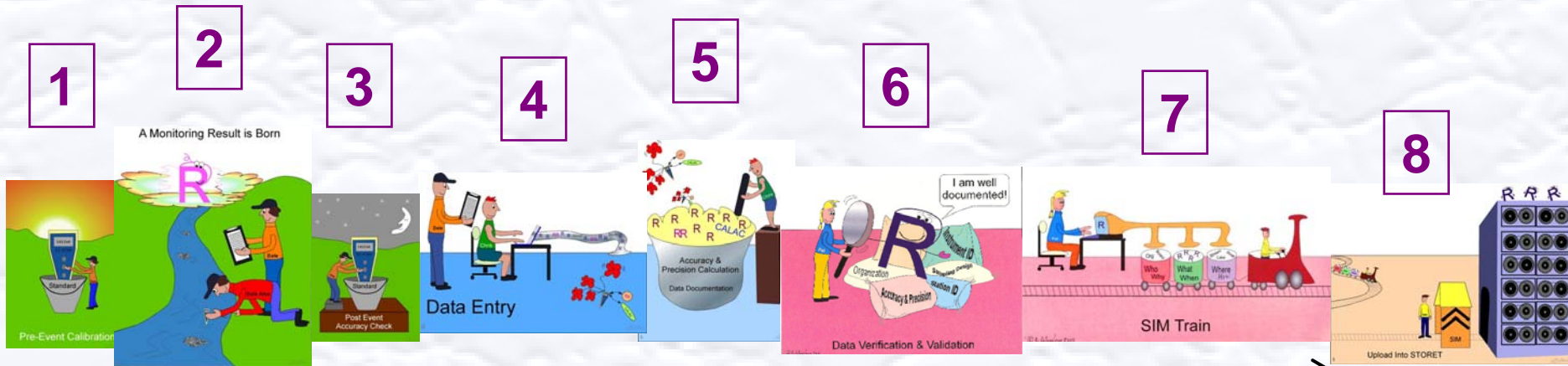
Score

-
- **Derived Endpoint** for **one data point or Sample** (e.g., Q=5cfs; LC50=0.4ug/L; E. coli=126 MPN/100mL; % tolerant taxa=24)
 - **Aggregated Endpoint** or **Statistic** for **one data point, or Sample, or spatial entity** (e.g., PEC toxicity quotient, Average stream width, median particle size, Index of Biological Integrity, etc.)
 - **Descriptive Statistic** for **many data points** (Endpoint types: moving weekly average, 5-wk geometric mean, max, MWAT, etc)
 - **Rank** for **many data points**

Results and Endpoint possibilities



Sequence is a unifying concept too... and so is **Data Flow!**



Field Measurements

Lab analyses

Bioassessments

PHAB assessments

And it can be
applied to
different kinds
of data

Summary: some unifying concepts that are relevant to environmental monitoring

Monitoring Results

Result types and Endpoint types;

Activity (Sample/Measurement/Observation)

Measurement systems and Quality Checks;

Performance / acceptance criteria;

Selection criteria;

Quality objectives (e.g., accuracy, confidence level);

Sampling design principles (e.g., directed, random);

Units of Representativeness (e.g., Station Visit, transect);

Spatial Sampling Frames

Spatial Components;

Tracking and linking entities (e.g., Station ID, Sample ID);

(more.....)

...and you will recognize many unifying concepts here...

The NWQMC 2002 Monitoring Framework:

Our central
goal, and the
ways to get
there



Source: NWQMC <http://acwi.gov/monitoring/ppt/index.html>

Some unifying concepts in action

Monitoring Framework;
Tiered approach;
Systematic planning process;

The challenge: Can we apply these unifying concepts to all areas of inquiry, i.e. ‘types’ or ‘disciplines’, of environmental monitoring?

Can we use them to communicate information?