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!**

Lateral pool with LWD & root wad

Angler: **Snag!**

Water Strider: **Shade!**

Geomorphologist: **Scour!**

Restoration Designer: **Opportunity!**

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

Perennial **vs** Intermittent streams

500 **vs** 220 micron net

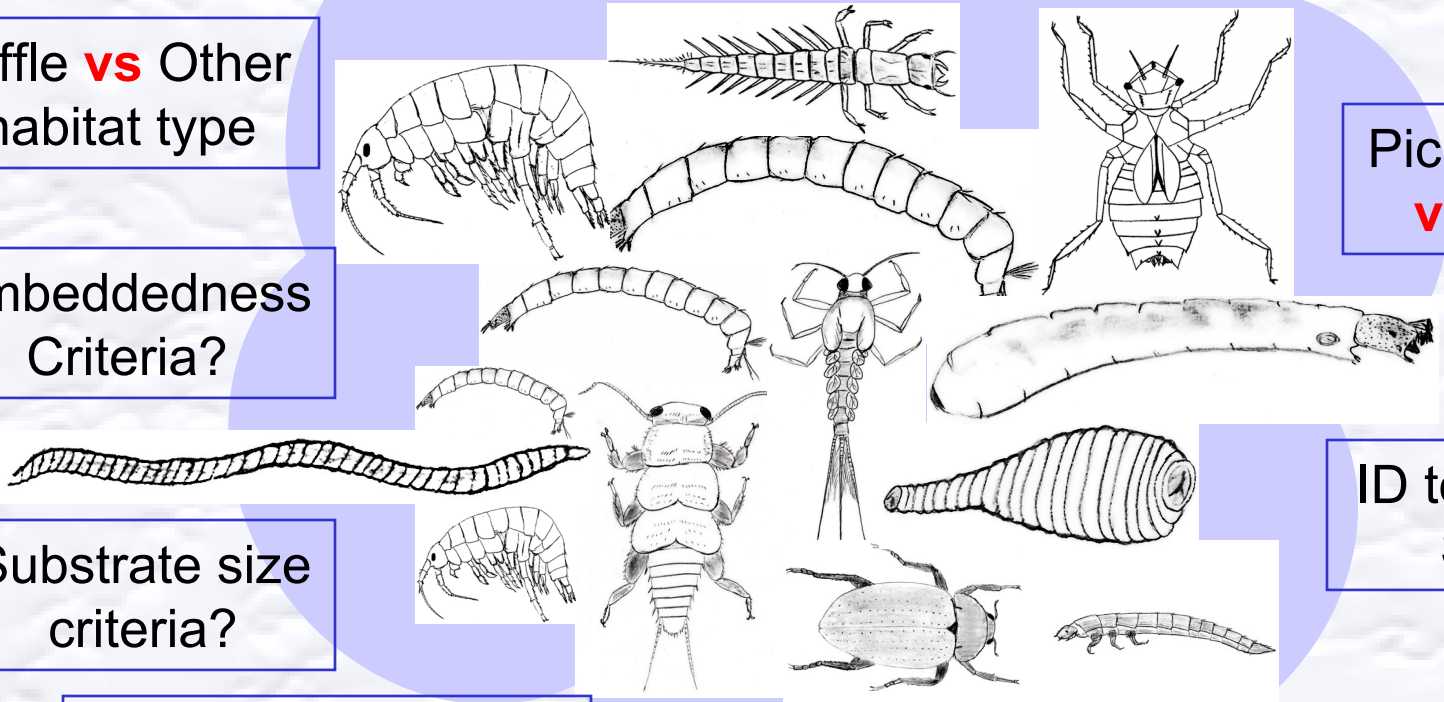
High **vs** Low gradient

3 ‘replicates’ **vs** pool entire Reach

Riffle **vs** Other habitat type

Pickle in alcohol **vs** aldehyde

Embeddedness Criteria?



ID to Family **vs** Species

Substrate size criteria?

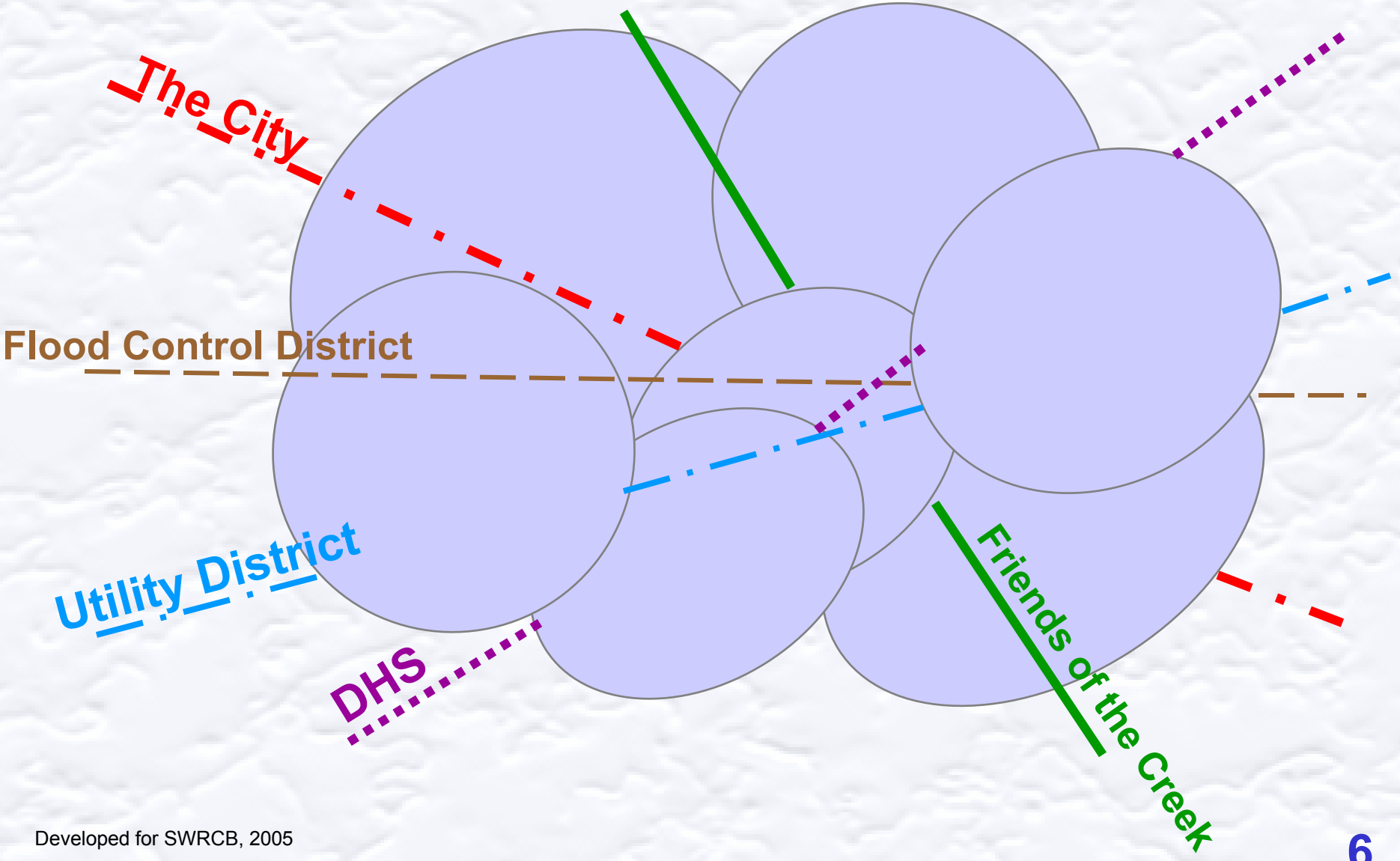
Current Velocity criteria?

ID for West Coast **vs** East Coast

Developed for SWRCB, 2005

Bug pictures source: CA Streamside Biosurvey 2001

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



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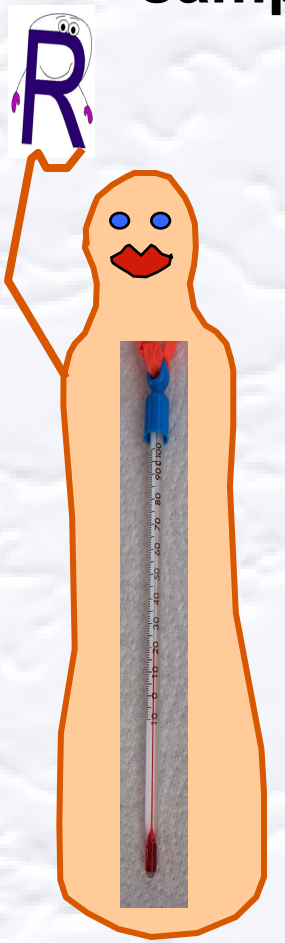
…or get their lat/long coordinates in **their** preferred format and on the Datum **they** like…

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

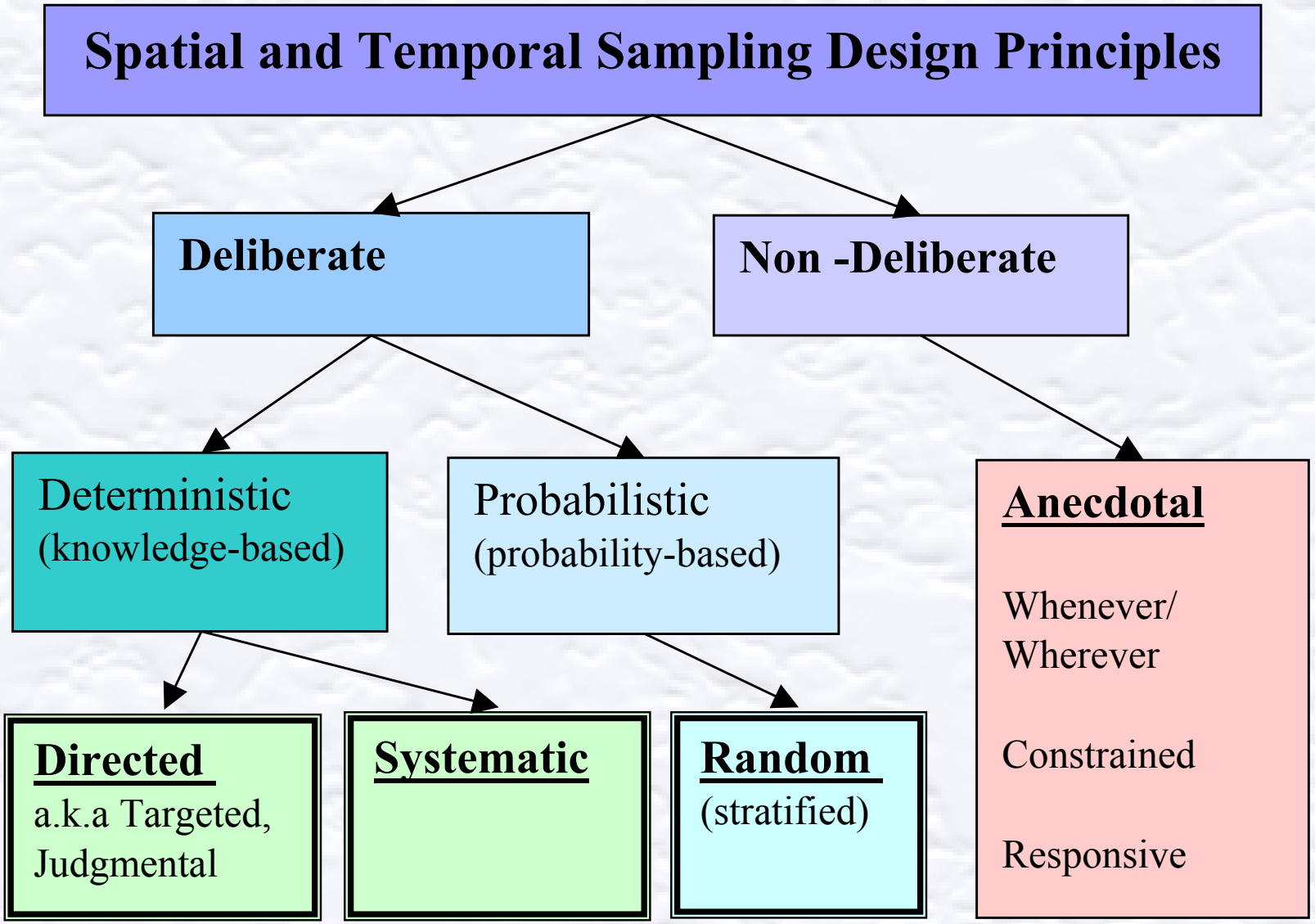
Matrix Spike/Matrix Spike Duplicate,
sample arrival temperature,
repeated categorical observations, or
a survey loop closure

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

Another example of a unifying concept: Sampling design principle



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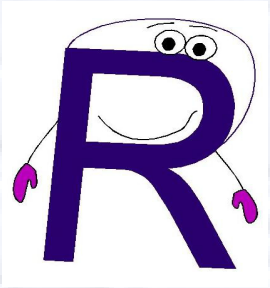
‘Activity’ is a thing!

(-) 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***)

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



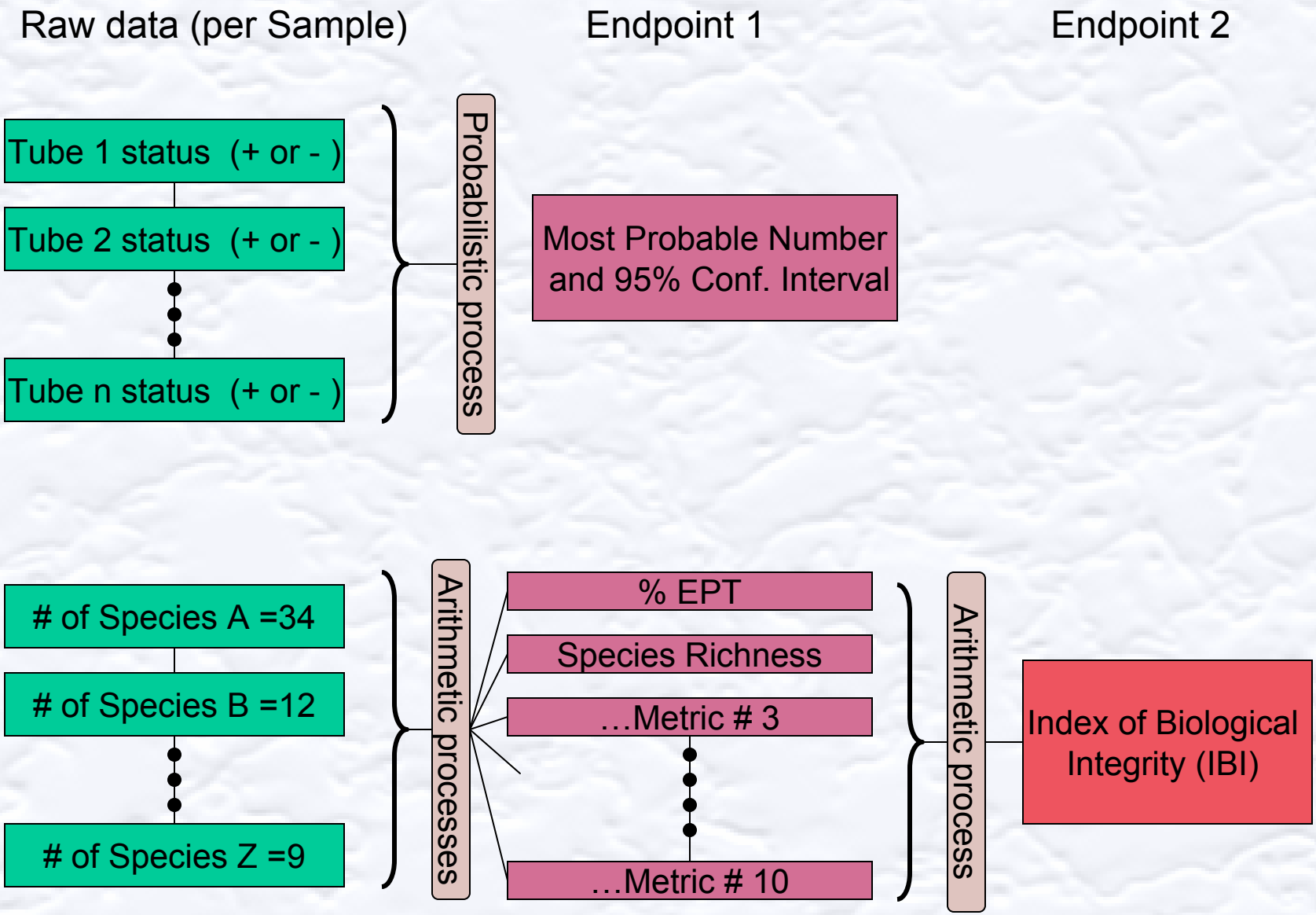
R is the monitoring Result: the outcome of a measurement, analysis, or categorical observation.

Result Type examples

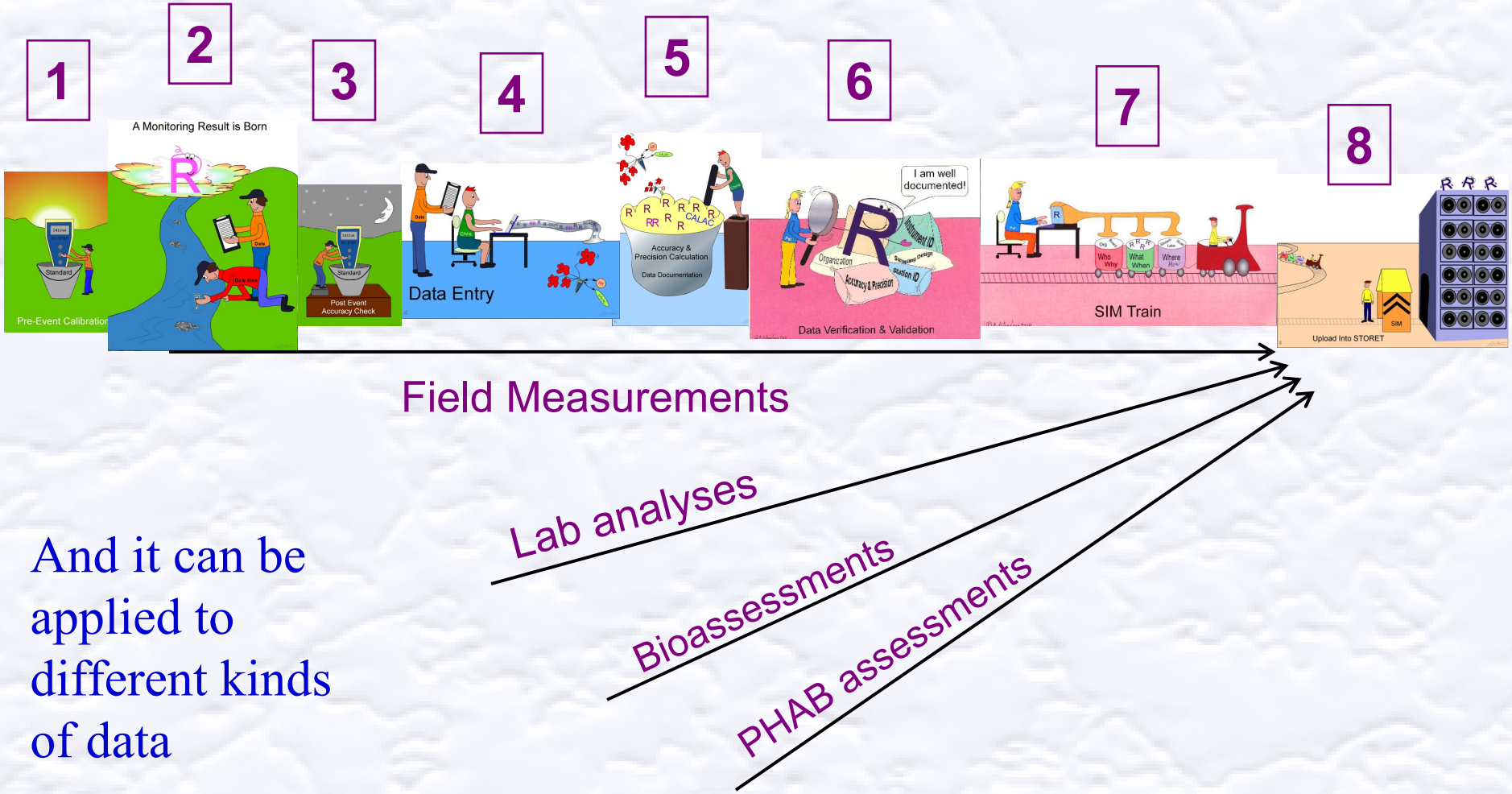
Verbal Category (e.g., 'murky')
Individual Value (e.g., 18 C)
Estimated number or numeric range (e.g., 20-50% embeddedness)
Count
Score

- **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**!



And it can be applied to different kinds of data

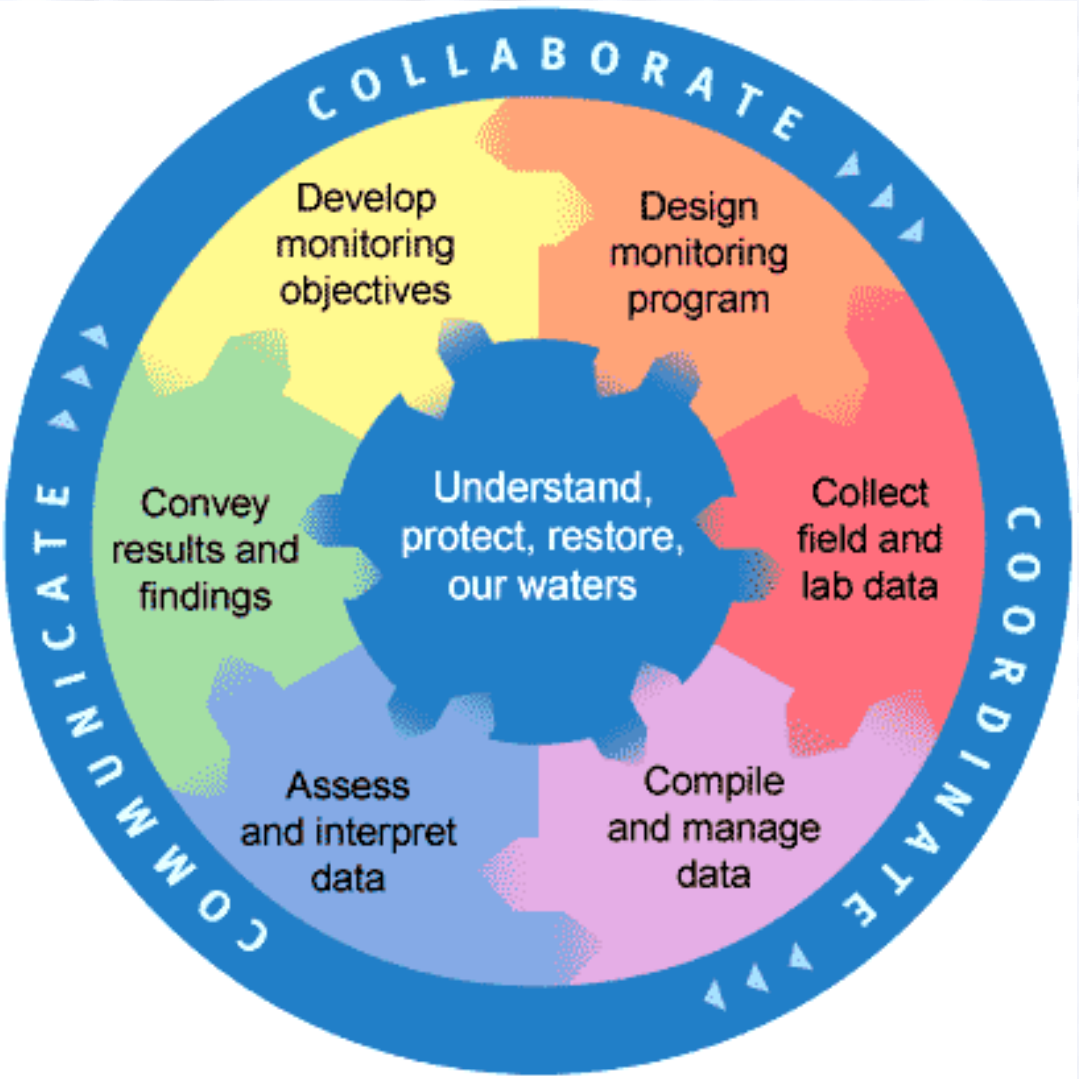
Summary: some unifying concepts that are relevant to environmental monitoring

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?