Zen and the Art of Ecosystem Restoration: Assessing Precision and Accuracy in the Lab and Field

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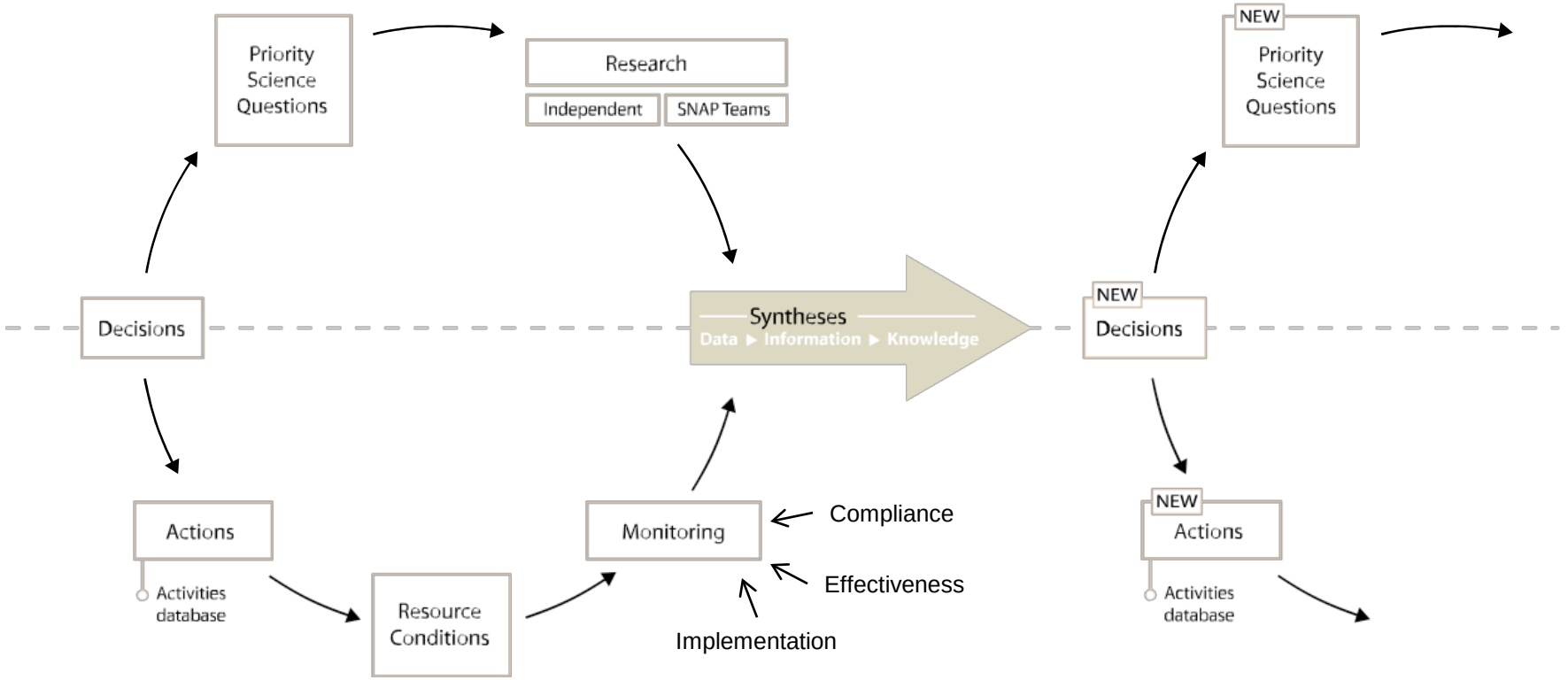
Adaptive Management



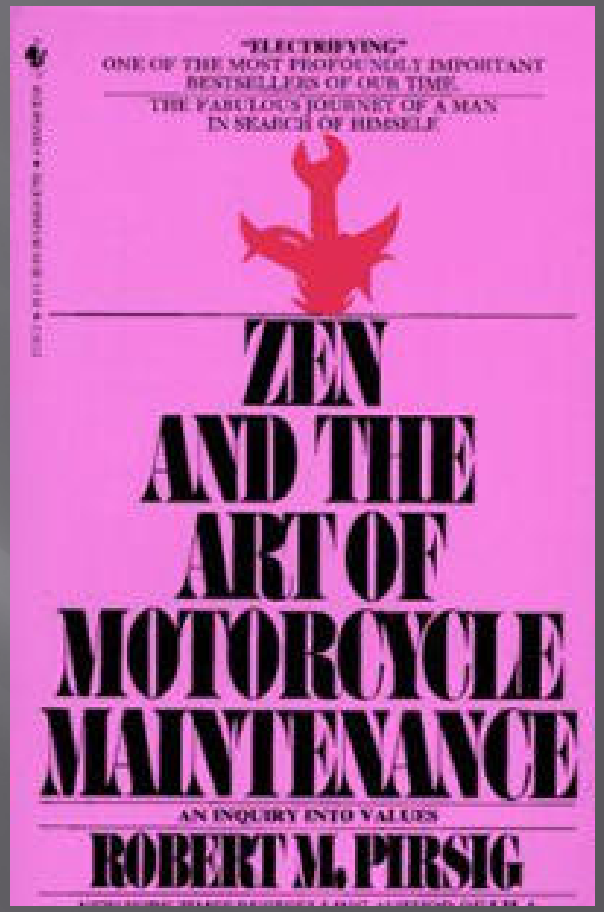
Why do we need to be concerned about quality?

In other words, who gives a hoot?

What is Quality?

Two types of quality

- Classical
- Romantic



FAILURE

When Your Best Just Isn't Good Enough.

Field realities require different QA/QC approaches…

… than might be applicable in the Laboratory

Measurement Errors in the Field

The process of collecting, transporting, and analyzing ecological attributes generates errors that can obscure the ability of an indicator to discern the effectiveness of restoration activities

Sources of Variability

$$\sigma^2_{total} = \sum\left(\sigma^2_{bc} + \sigma^2_{wc} + \sigma^2_{ip} + \sigma^2_{yy} + \sigma^2_{error}\right)$$

where:

σ^2_{total} = **total variability**

σ^2_{bc} = **between-crew variability**

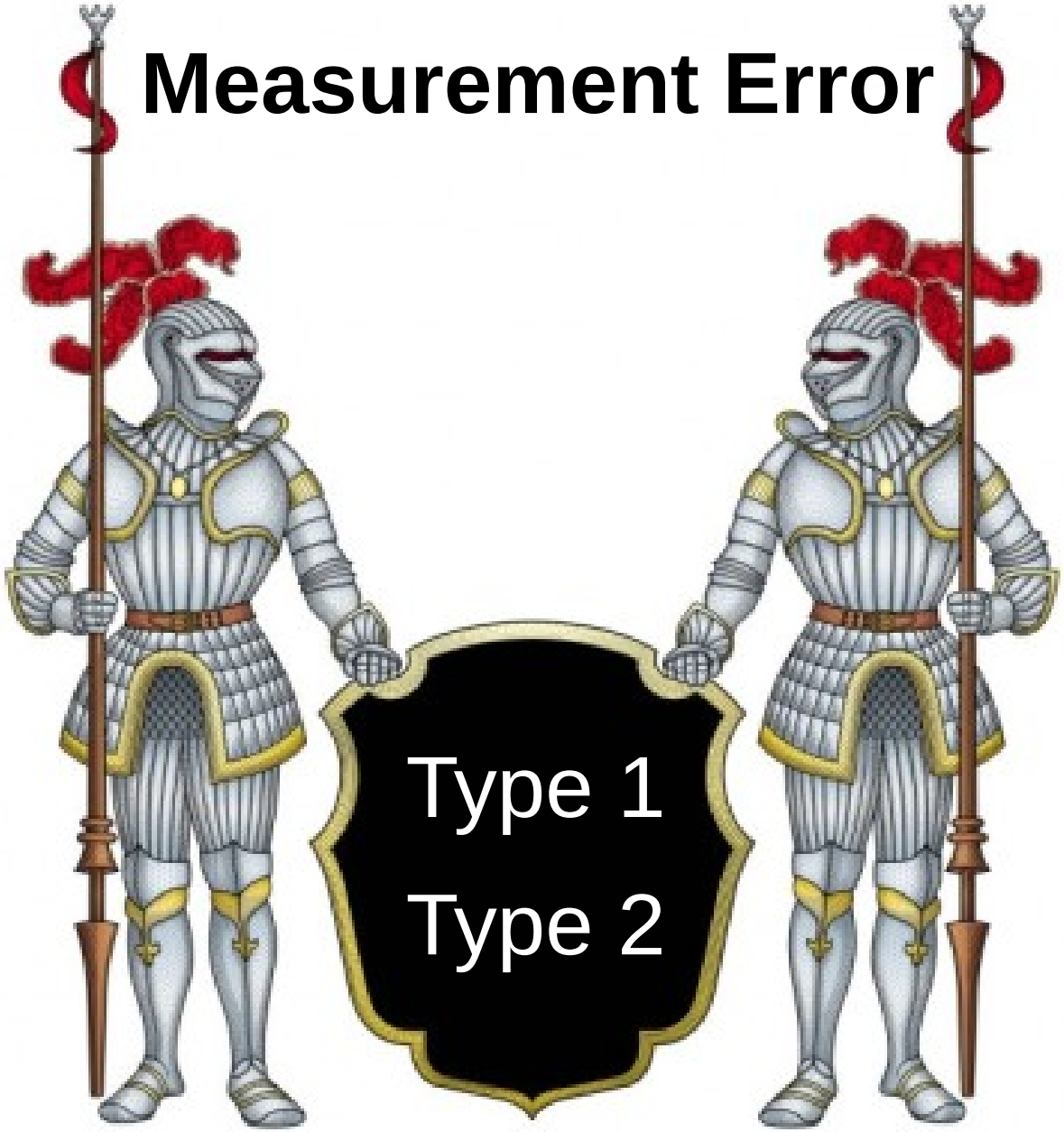
σ^2_{wc} = **within-crew variability**

σ^2_{ip} = **index-period variability**

σ^2_{yy} = **year-to-year variability**

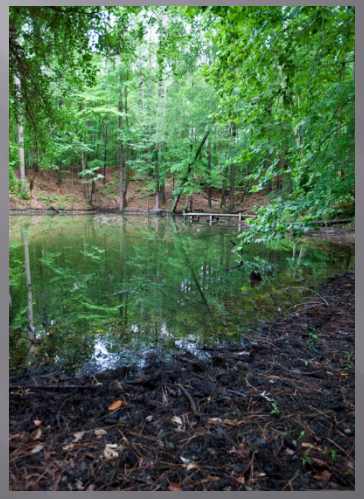
σ^2_{error} = **error term (unaccounted)**

Measurement Error



Sample

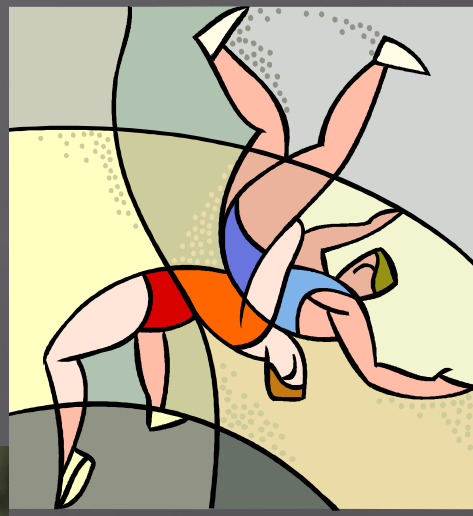
Instrument



Data Quality Indicator	QC Check and QC Sample	Sources of Measurement Error										Purpose To evaluate or determine the source of measurement error arising from:
		Sample Collection				Sample Transport	Laboratory/Field Analytical Method					
		Sampling Equipment	Conditions During Sampling	Preservation Technique	Sampling Matrix	Shipment Process	Sample Storage at Laboratory	Sample Preparation Reagents	Sample Preparation Equipment	Analytical Methods Reagents/ Standards	Analytical Equipment	
Precision	Field Duplicates	2°	2°	2°	1°	2° (VOCs)	2°	2°	2°	2°	2°	Cumulative effects of both field and laboratory precision to measure overall precision.
	Laboratory Duplicates				1°			2°	2°	2°	2°	Laboratory preparatory and analytical precision.
	Matrix Spike Duplicates				1°			2°	2°	2°	2°	Laboratory and analytical bias and precision for specific compounds in specific sample matrices.
	Analytical Replicates										1°	Analytical precision for determinative instrumentation.
	Internal Standards										1°	Instrument precision and stability.
Accuracy/Bias (Positive bias introduced by contamination)	Equipment Blank (Rinsate Blank)	1°		2°		2° (VOCs)	2°	1°	1°	1°	1°	Carryover contamination resulting from successive use of sampling equipment or labware. Includes ambient contaminates introduced by wind or water.
	Volatile Organic or Radiological (Radon) Trip Blank					1°	1°	1°	1°	1°	1°	Contamination introduced during shipment. Usually limited to VOCs and radiological parameters such as radon.
	Volatile Organic Storage Blank (Refrigerator blank)						1°			2°	2°	Cross contamination introduced during sample storage, usually for VOCs. Also may be used for radon, tritium.
	Reagent Blank (one per lot number)			1°				2°	2°	2°	2°	Contamination introduced by reagents used as sample preservatives.
	Preparation Blank							1°	1°	1°	1°	Contamination introduced by preparation process, glassware, analytical reagents, and analytical instrumentation.
	Instrument (System) Blank										1°	Contamination originating with the analytical equipment.
Accuracy/Bias (Bias due to sample matrix or sample preparation/ analytical methodology/ operator error)	Matrix Spike				1°			2°	2°	2°	2°	Preparatory and analytical bias for specific compounds in specific sample matrices.
	Surrogate Spike				1°			2°	2°	2°	2°	Preparatory and analytical bias in specific sample matrices.
	Laboratory Control Samples							1°	1°	1°	1°	Laboratory's ability to accurately identify and quantitate target compounds in a reference matrix at a known concentration.
	Single- (ampule) or Double-Blind Performance Evaluation Material				1°		1°	1°	1°	1°	1°	Laboratory's ability to accurately identify and quantitate target compounds in a reference matrix.
	Initial Calibration									1°	1°	Sets the response to a known concentration to ensure the instrument will produce acceptable quantitative data.
	Continuing Calibration, Verification and Instrument Performance Check									1°	1°	Checks the accuracy and stability of the instrument response and ensures it can accurately identify and quantitate target analytes at specific concentration levels.
Accuracy/Bias (Bias due to methodology)	Field Splits (Homogenized Samples)							1°	1°	1°	1°	Comparability of results between two methods, or laboratories (e.g., field and fixed).
	Field Splits (extracts)							1°	1°	1°	1°	Comparability of results between two methods, or laboratories when sample matrix is known to be extremely heterogenous.

1° = Primary purpose of QC sample

2° = Secondary purpose of QC sample



Training

Precision: Agreement among repeated “measurements”

Accuracy: Agreement with “truth” (e.g., standard) or expert

Data Quality Indicator	Performed by	Location	Purpose
Precision	Single Field Crew	Remeasure:	Within-crew variability
		Training plot	
		Routine plot	
		Calibration plot	
	Multiple Field Crews	Remeasure:	Between-crew variability
		Each other's routine plot	
		Training plot	
		Calibration plot	
Accuracy	Field crew and experts	Remeasure:	Field crew accuracy (hot/cold checks)
		Each other's routine plot	
		Training plot	
		Calibration plot	

Stability:
All sites/variables not equal

Trees / understory
Fish / phytoplankton

Implementation Monitoring

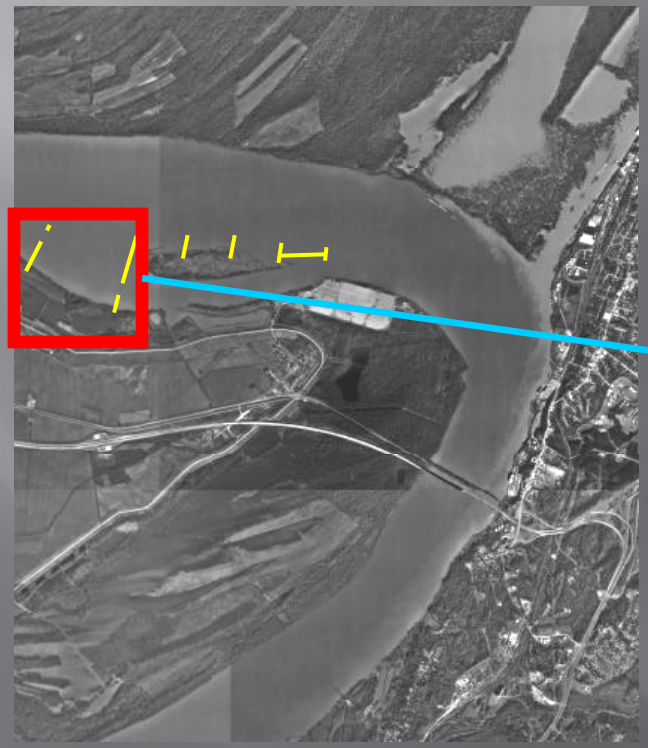
Contracting Officer review

Project done to specs?

Are we looking for a response to something that wasn't done, only partially done, or done incorrectly?

Was the project done in the right place?

Was it done to specs?




Project looks great.
Now if they'd just add
some water!


Thank you !