What does monitoring look like? A VSP Primer

Washington State Conservation Commission

Washington Department of FISH and WILDLIFE

Monitoring - HRCD and other methods

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VSP Regional Information Session on VSP Implementation

Veterans Memorial Museum, Chehalis

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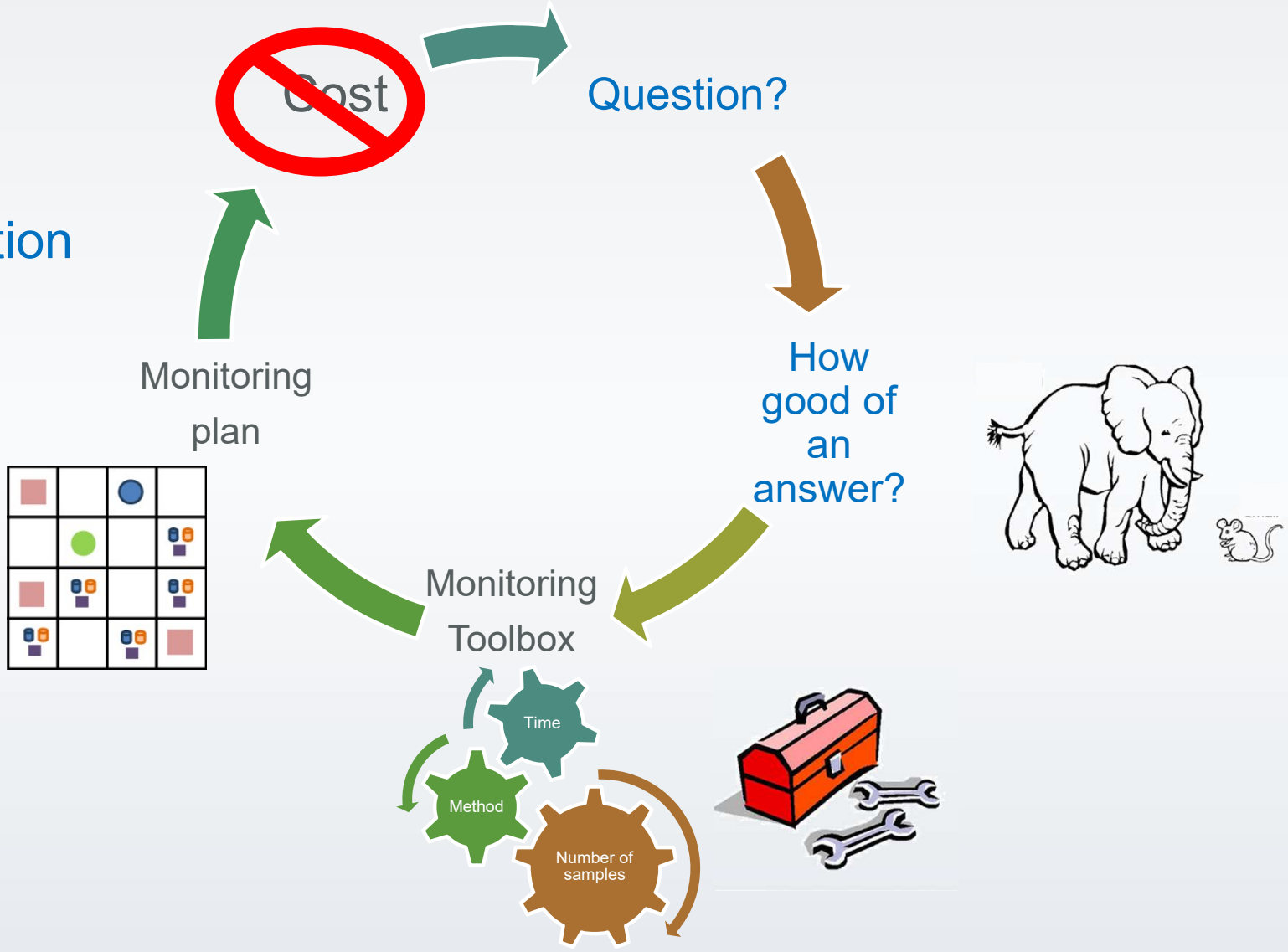
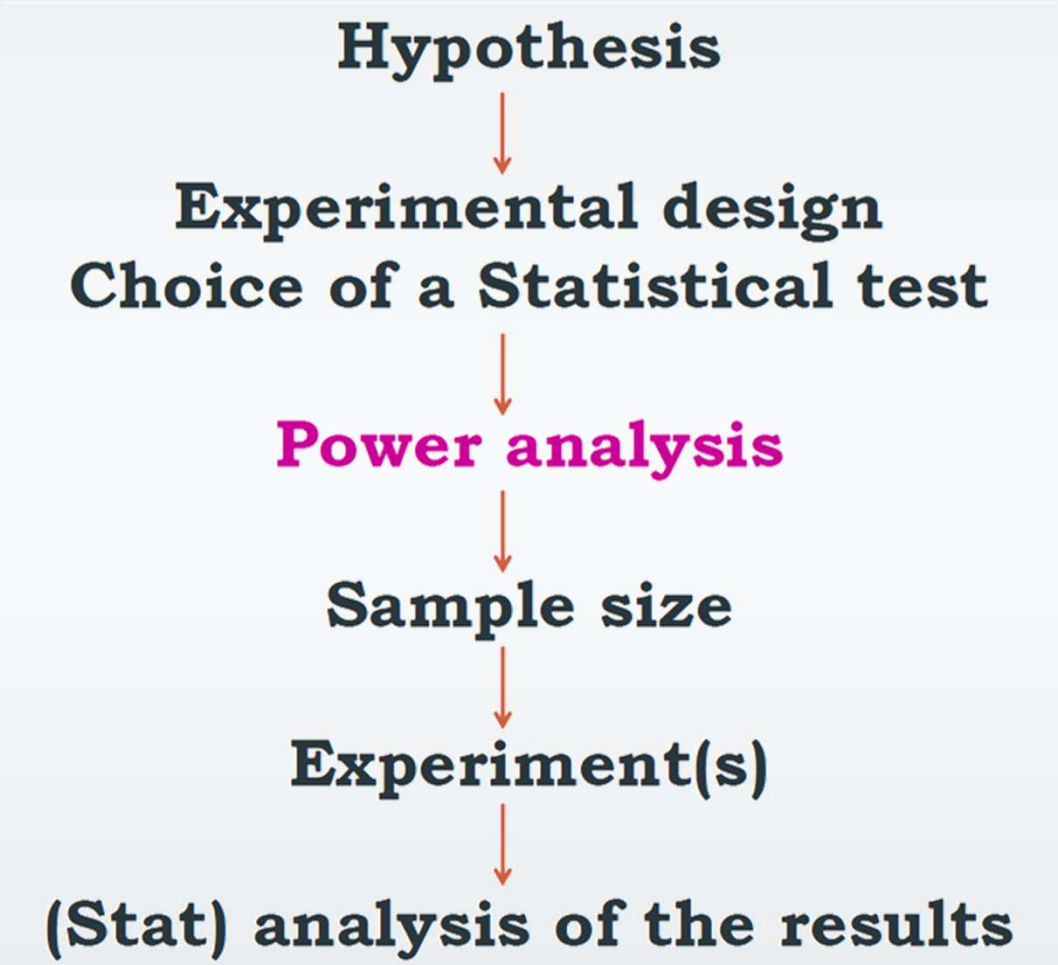
Monitoring basics:

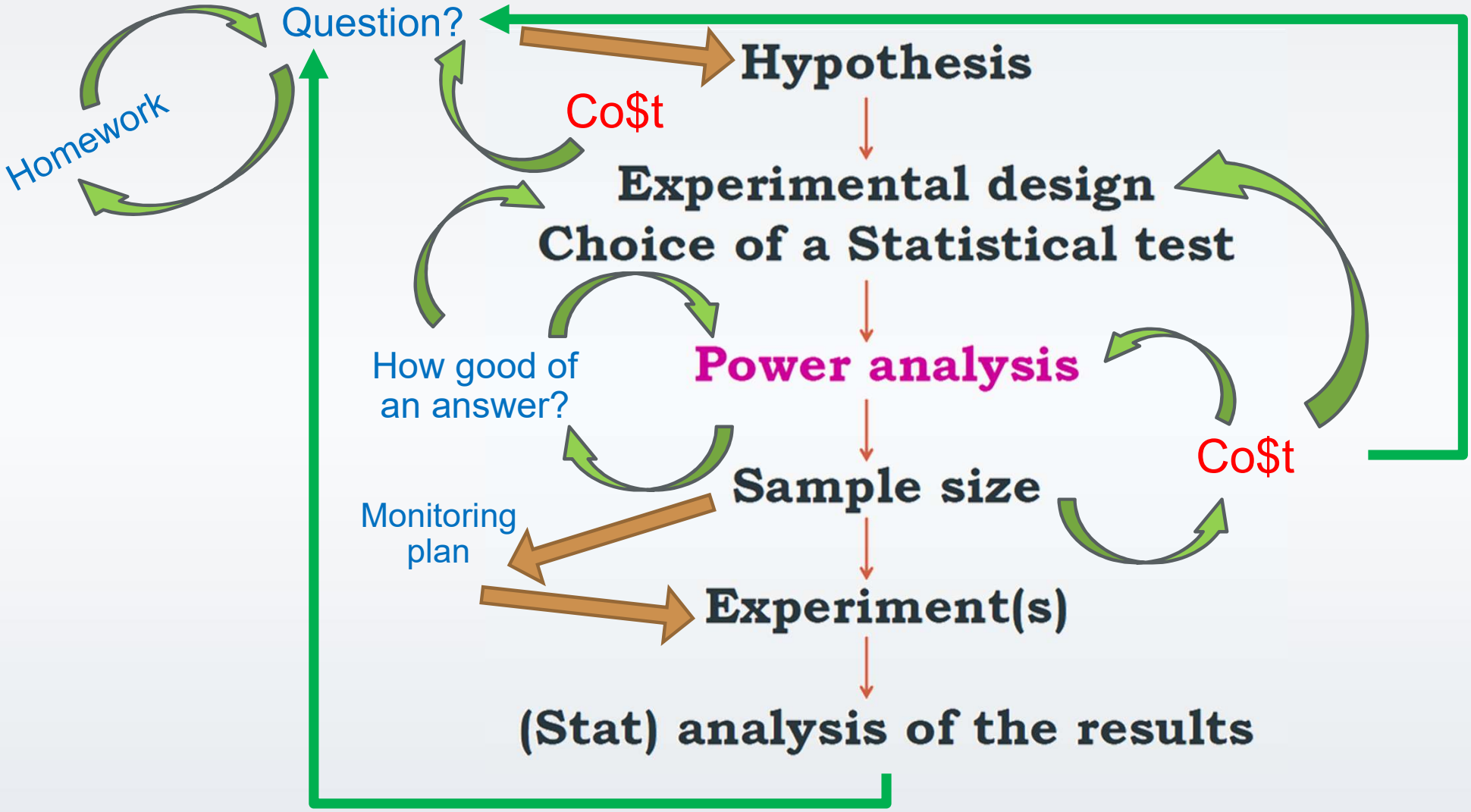
- Hypothesis formulation …
- Sampling
- Types of error
- How good does your data need to be?
- What to measure?
- Sampling for rare events …
- Validating models …
- HRCD as an example.

Lets start with the a conversation …



Another way of looking at it…




Question?
Homework
Hypothesis
Co$t
Experimental design
Choice of a Statistical test
How good of an answer?
Power analysis
Co$t
Sample size
Monitoring plan
Experiment(s)
(Stat) analysis of the results

- Hypothesis formulation …

"If [variable], then [result], (due to [rationale])."

- The question comes first.
- A hypothesis is a statement, not a question. The hypothesis is an educated, testable prediction about what will happen.
- Make it clear.
- Keep the variables in mind.
- Make sure your hypothesis is "testable."
- Do your homework.
- Don't bite off more than you can chew!

H_0: x indicator of critical area function is the same in 2016 compared to 2011.

H_a: x indicator of critical area function is different in 2016 compared to 2011.

Null:

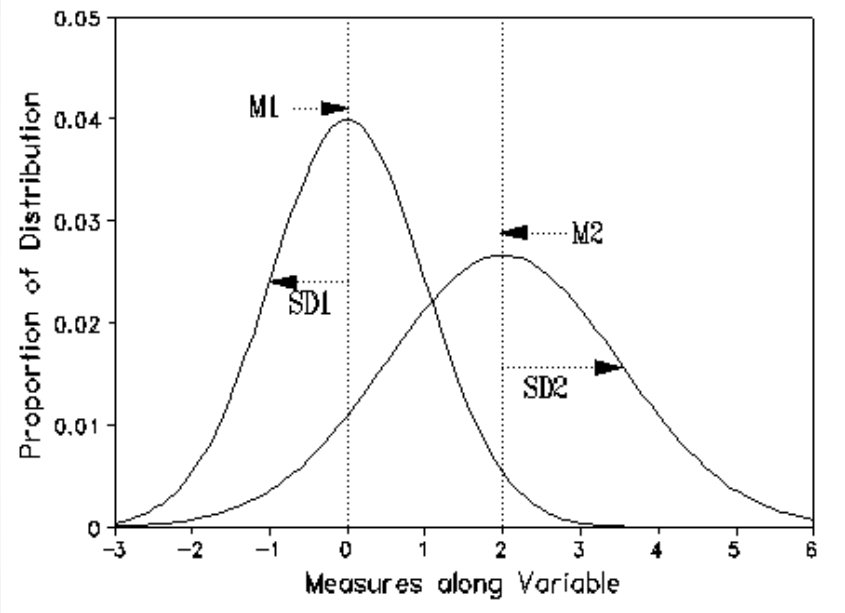
- a statement about the value of a population parameter that is assumed to be true for the purpose of testing.
- always includes an equals sign (2016 = 2011)

Alternative:

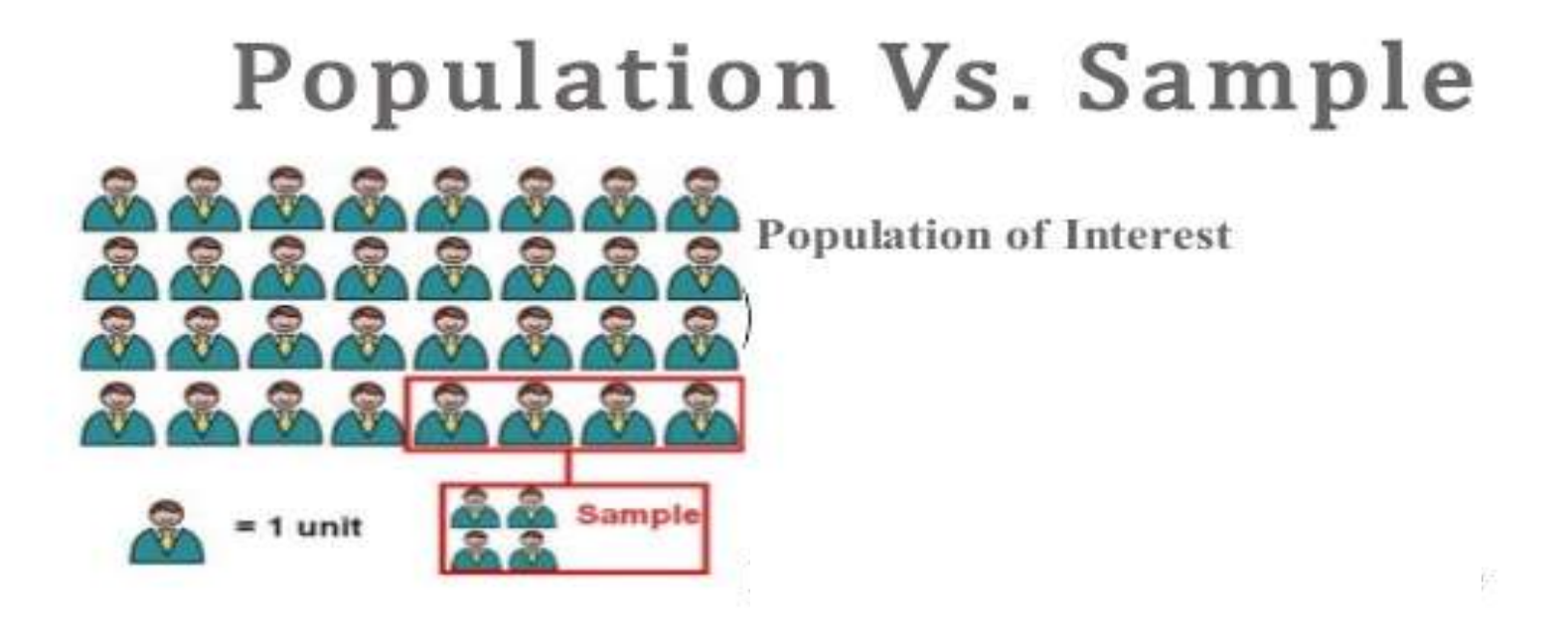
- a statement about the value of a population parameter that is assumed to be true if the null hypothesis is rejected during testing.
- always the opposite of the null hypothesis.

H_0: the sample of x variable in 2016 is drawn from the same population in as observed in 2011.

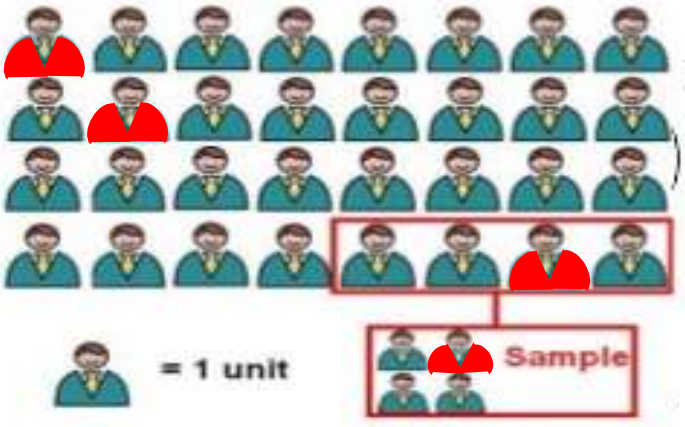
H_a: the sample of x variable in 2016 is from a different population as observed in 2011.



- Sampling



Population Vs. Sample



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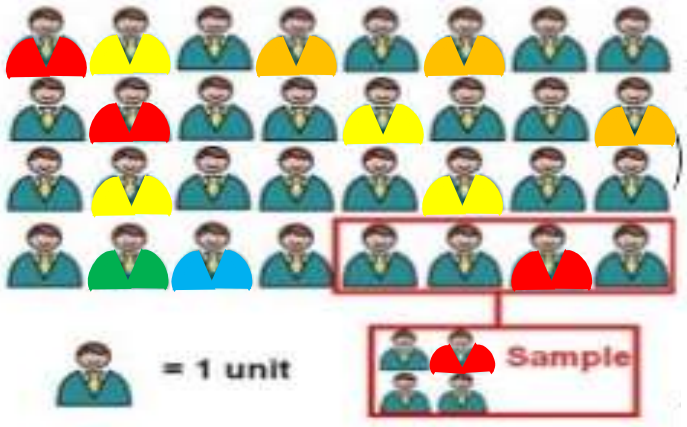
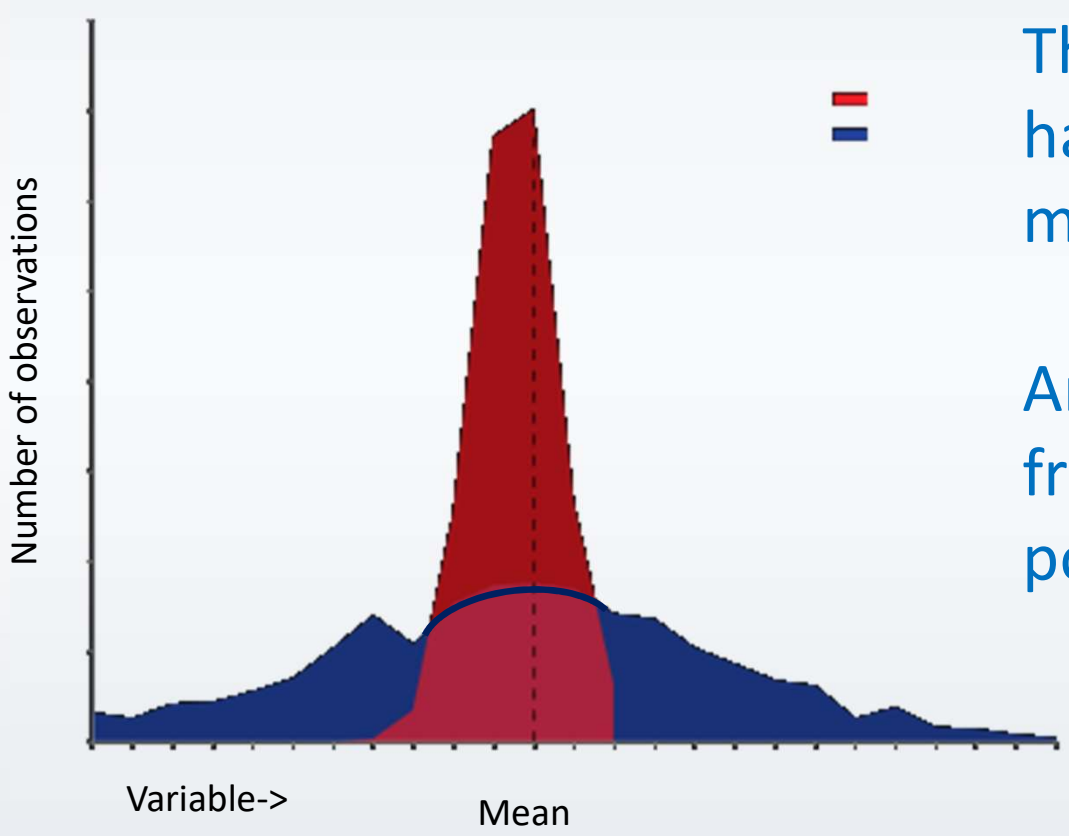




These two samples have the same mean.

Are they drawn from the same population?

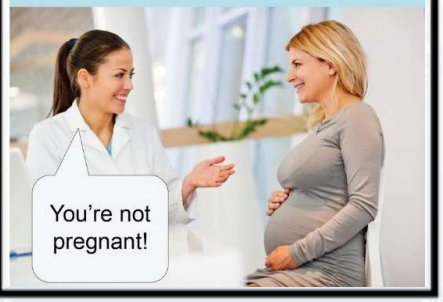
Types of error as told by the story of the boy who cried wolf:

H_0: there is no wolf
H_a: there is a wolf

Villagers believe the boy when there is no wolf – type 1 error
Villagers don't believe the boy when there actually is a wolf – type 2 error

KUOW.org

Types of error

Test result	Actual condition: H_0 true	Actual condition: H_0 false
Reject H_0	Type I Error 	True positive (TP)
Failure to reject H_0	True negative (TN)	Type II Error 

- How good does your data need to be?

Answer = POWER!

- Statistical power is the likelihood that a study will detect an effect when there is an effect there to be detected.
- Power is the probability that the test correctly rejects a false null hypothesis (H_0).
- It avoids Type I error.

- How good does your data need to be?

Power Analysis

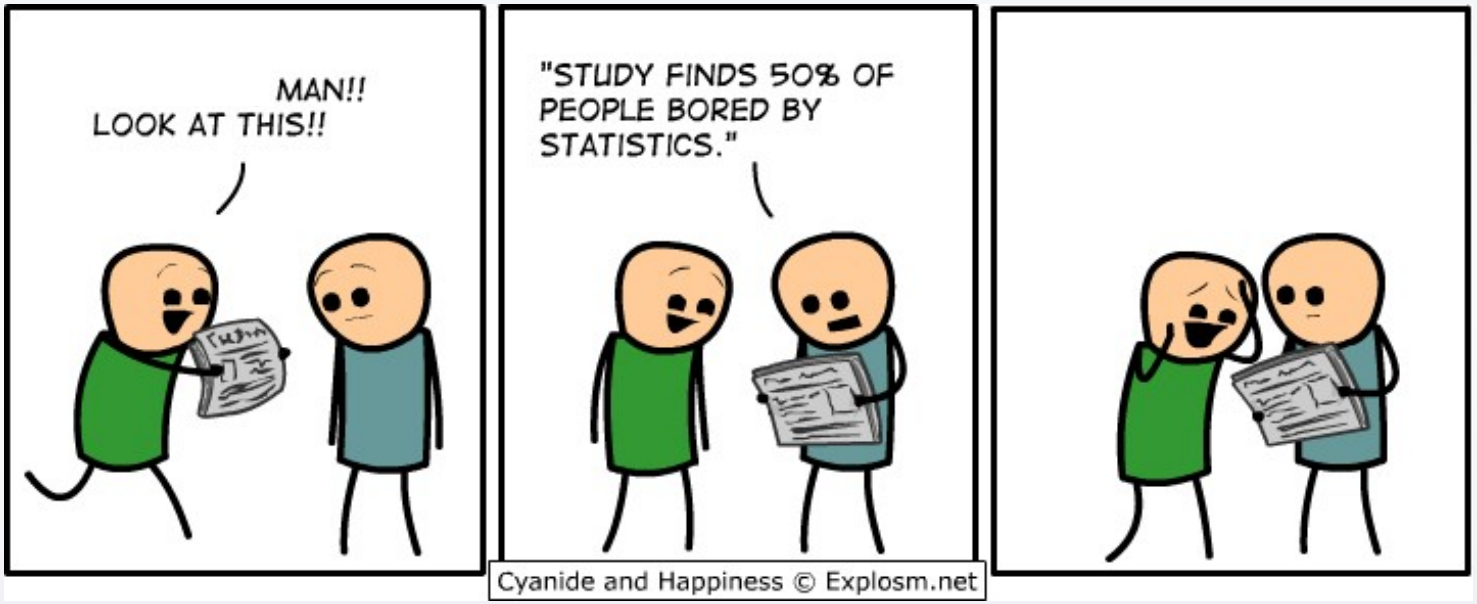
The power analysis depends on the relationship between 6 variables:

- the **difference** of biological interest
- the **standard deviation**

} **Effect size**

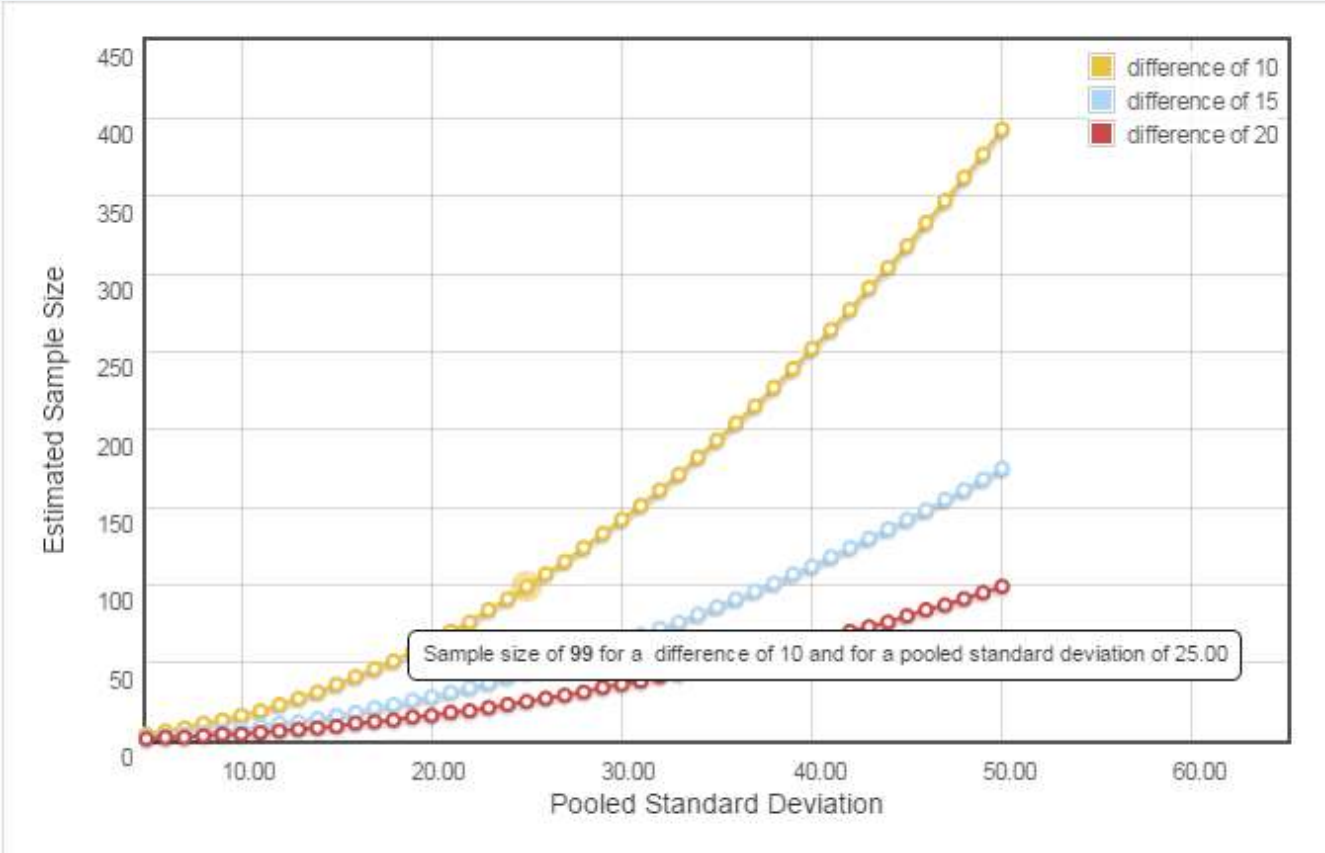
- the significance level (5%)
- the desired power of the experiment (80%)
- the **sample size**
- the alternative hypothesis (ie one or two-sided test)

- How good does your data need to be?
- the **difference** of biological interest



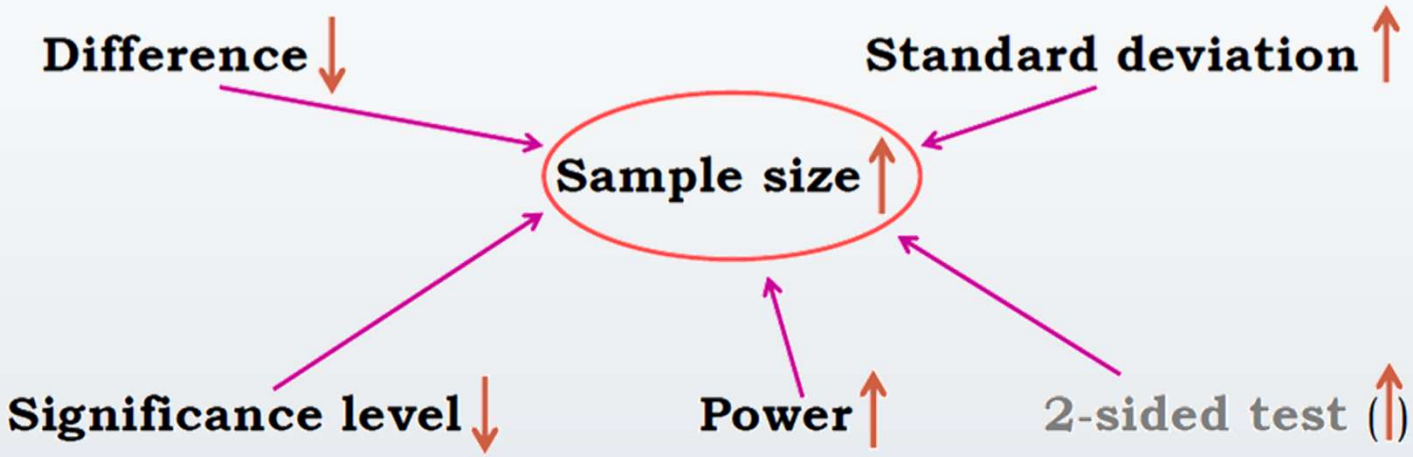
A statistically significant difference indicates only that the difference is unlikely to have occurred by chance.

- How good does your data need to be?
  - the **standard deviation**
  - the **sample size**



- How good does your data need to be?
  - **Fix any five of the variables and a mathematical relationship can be used to estimate the sixth.**

e.g. What sample size do I need to have a 80% probability (**power**) to detect this particular effect (**difference** and **standard deviation**) at a 5% **significance level** using a **2-sided test**?



What to measure?

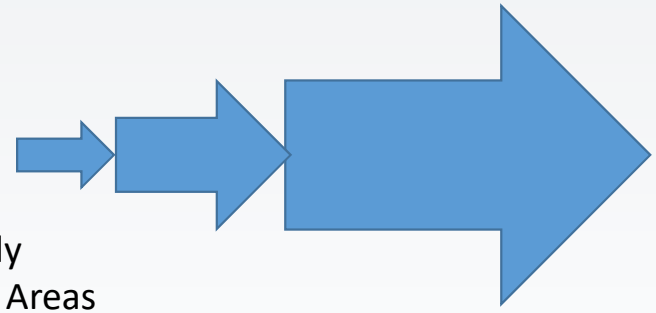
- Keep the variables in mind.
- Make sure your hypothesis is "testable."

Ask yourself:

- What are the functions of x critical area?
- Which of these are of greatest interest (biologically?, economically?, politically?)
- Which of these are measurable at the scale and time frame of interest?
- Can I use surrogates?

What are the functions?

- Wetlands
- CARAs
- Geologically Hazardous Areas
- Frequently Flooded Areas
- Fish and Wildlife Habitat Conservation Areas



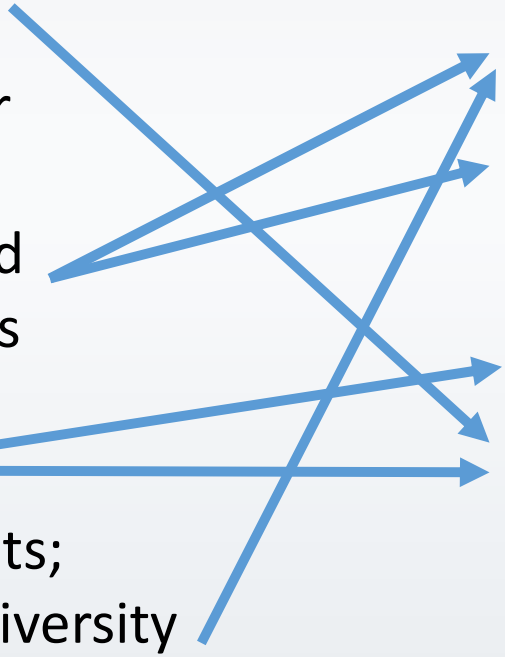
- Assist in the reduction of erosion, siltation, flooding;
- Ground and surface water pollution;
- Provide wildlife, plant, and fisheries habitats (perhaps seasonally);
- Storage of water
- Transformation of nutrients
- Growth of living matter, diversity of wetland and/or rare plants

Which of these are of greatest interest?

Which of these are measurable at the scale and time frame of interest?

Some Wetland Functions

- Assist in the reduction of erosion, siltation, flooding;
- Ground and surface water pollution;
- Provide wildlife, plant, and fisheries habitats (perhaps seasonally);
- Storage of water;
- Transformation of nutrients;
- Growth of living matter, diversity of wetland and/or rare plants.



Ideas for Measurement

- Diversity of plant species
- Number and types of species of large invertebrates
- Range of water-level fluctuation
- Sedimentation rates

Can I use surrogates?

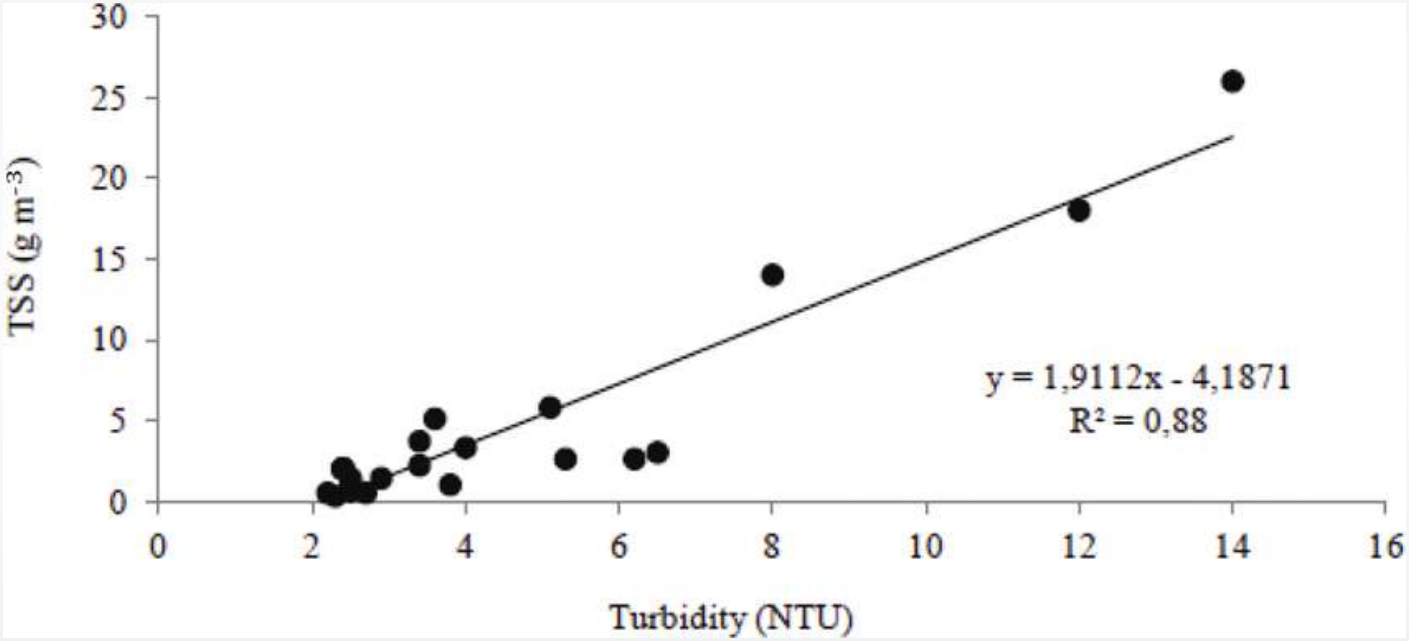
Ideas for Measurement

- Diversity of plant species
- Number and types of species of large invertebrates
- Range of water-level fluctuation
- Sedimentation rates

Surrogate Ideas

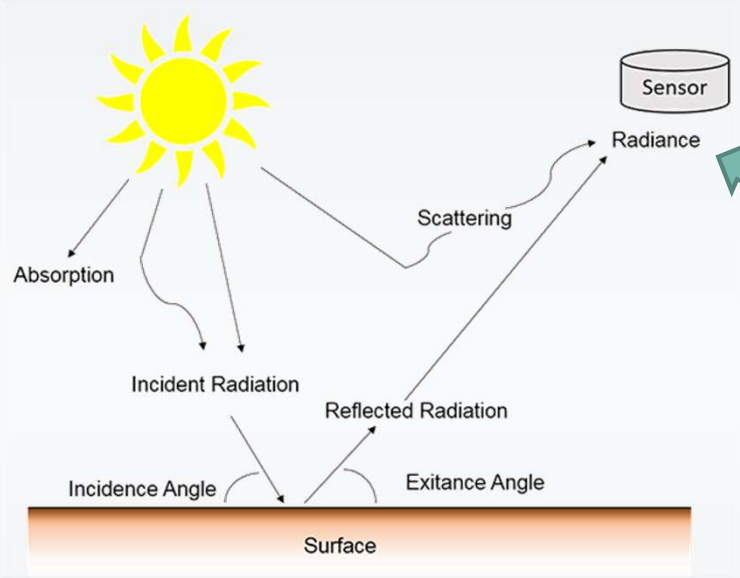
- Total sediment in/out
- Suspended sediment in/out
- Turbidity in/out
- Change in RUSLE in watershed
- Change in open water area due to sediment and emergent plant colonization

Can I use surrogates?



Surrogates assume a relationship between the measurement and the real parameter of interest.

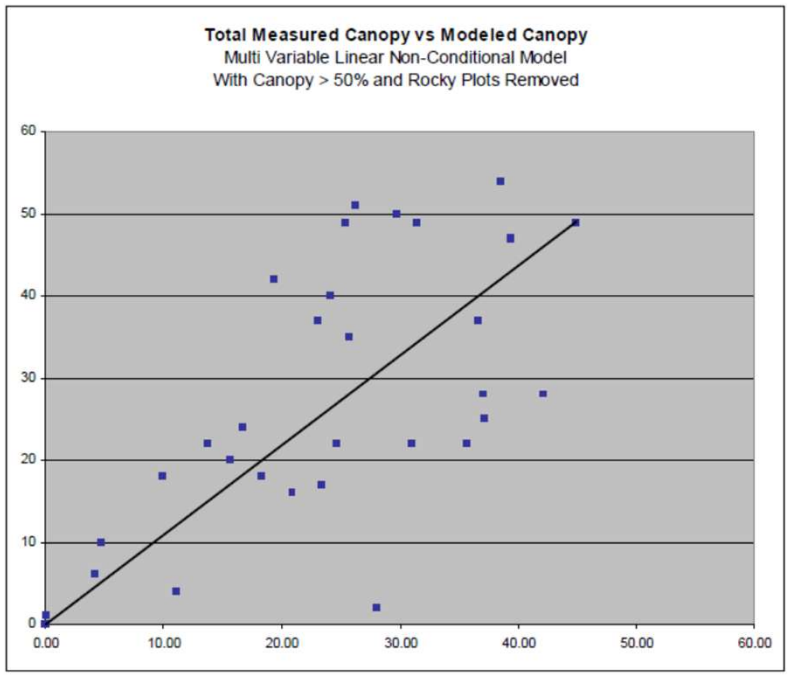
Can I use surrogates?



This number is not the same measurement as this number.

Images are not same thing as the object you are trying to measure!! It's a model.

Can I use surrogates?

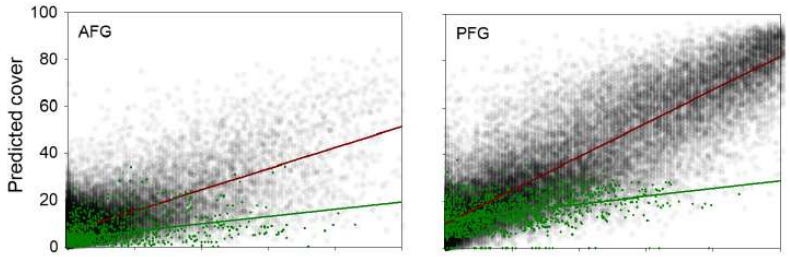


Tagestad, JD, Downs, JL. 2007. Landscape Measures of Rangeland Condition in the Bureau of Land Management Owyhee Pilot Project: Shrub Canopy Mapping, Vegetation Classification, and Detection of Anomalous Land Areas. Prepared for the U.S. Department of Interior, Bureau of Land Management & U.S. Department of Energy, Contract DE-AC05-76RL01830

Table 3. Mean absolute error (MAE) and root mean square error from ranger and Earth Engine (EE) Random Forests out-of-bag (OOB) error estimates, and percent cover between model results and independent plot-level measures from three projects: the Sagebrush Steppe Treatment Evaluation Project (SageSTEP), the Restore New Mexico Collaborative Monitoring Program (RNMCMP) initiative, and a project from the Eastern Oregon Agricultural Research Center (EOARC).

Land Cover	OOB ranger	OOB EE	SageSTEP	RNMCMP	EOARC
Annual Forbs/grasses	8.1|12.0	7.8|11.8	8.2|11.5	7.5|14.8	7.3|10.0
Perennial Forbs/grasses	11.6|15.2	11.2|14.9	13.2|17.7	11.0|14.9	10.8|13.2
Shrubs	7.2|10.1	6.9|9.9	9.2|11.0	5.6|7.1	8.1|10.6
Bare ground	7.0|10.1	7.3|10.6	9.4|12.5		

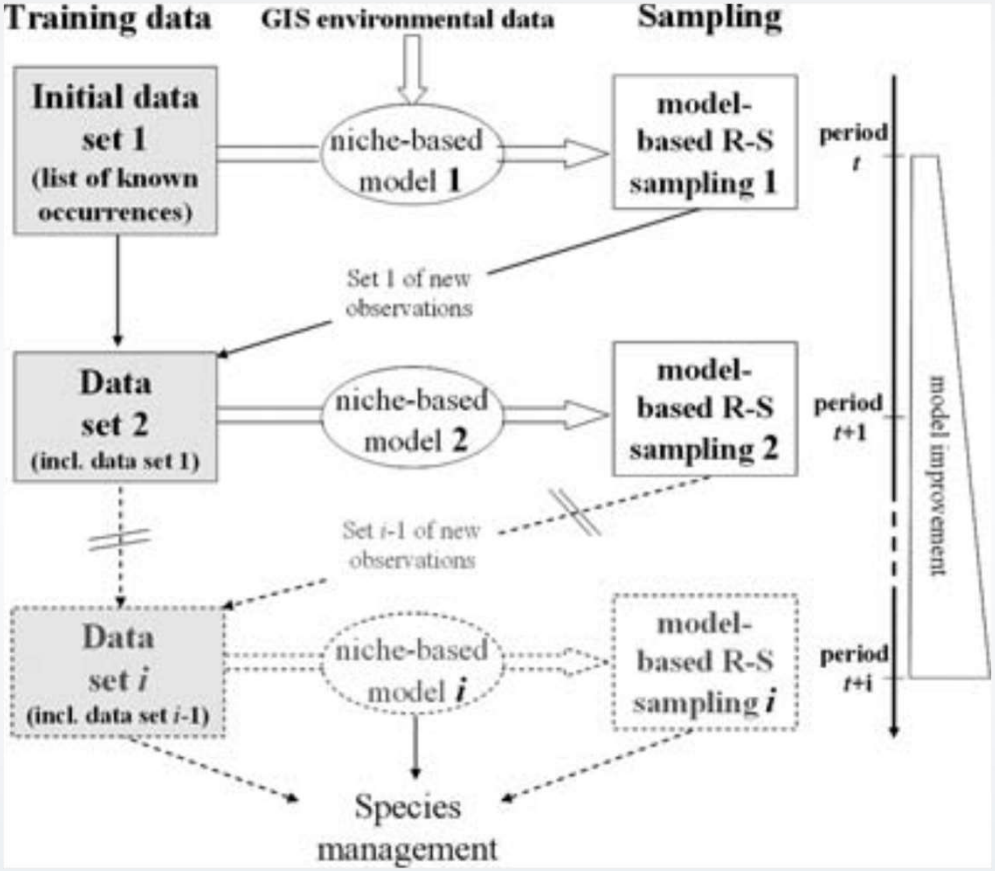
Notes: Error values displayed as MAE|RMSE. Bare ground percent cover values available for SageSTEP only.



Jones, M. O., B. W. Allred, D. E. Naugle, J. D. Maestas, P. Donnelly, L. J. Metz, J. Karl, R. Smith, B. Bestelmeyer, C. Boyd, J. D. Kerby, and J. D. McIver. 2018. Innovation in rangeland monitoring: annual, 30 m, plant functional type percent cover maps for U.S. rangelands, 1984–2017. Ecosphere 9(9):e02430. 10.1002/ecs2.2430

- Sampling for rare events

- Clumped distributions (spatially)
- Rare (uncommon)
- Temporal



Typically use stratified sampling to narrow area of interest or use a model predict where the event will occur, then look in those areas, then refine the model.

Transition from concepts to specific monitoring example using HRCD.

Photo: Dean White, Lincoln CD

Thank you!

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