Statistical Framework for Ambient Monitoring Program
Scope of Phase I

Variables	Total P TN, TKN, NH3N Secchi Chl-a
Stations	Lake Epil, Lake Hypol Tributaries
Criteria	Precision of Yearly Means Precision of Long-Term Means Power for Trend Detection
Design Features	Sampling Frequency (# / year) Replication Sampling & Analytical Methods

Preliminary Review of Biological Monitoring Program

Refinement of Statistical Methods

Monitoring Program Design for Trend Detection

Null Hypothesis (H_o): No Trend

Outcome of Hypothesis Test:

		Reality
Test Outcome	**No Trend**	**Trend**
H_o Accepted	Correct	Type II Error max prob. = β
H_o Rejected	Type I Error max prob. = α	Correct

"Significance Level" = α, Pre-Selected

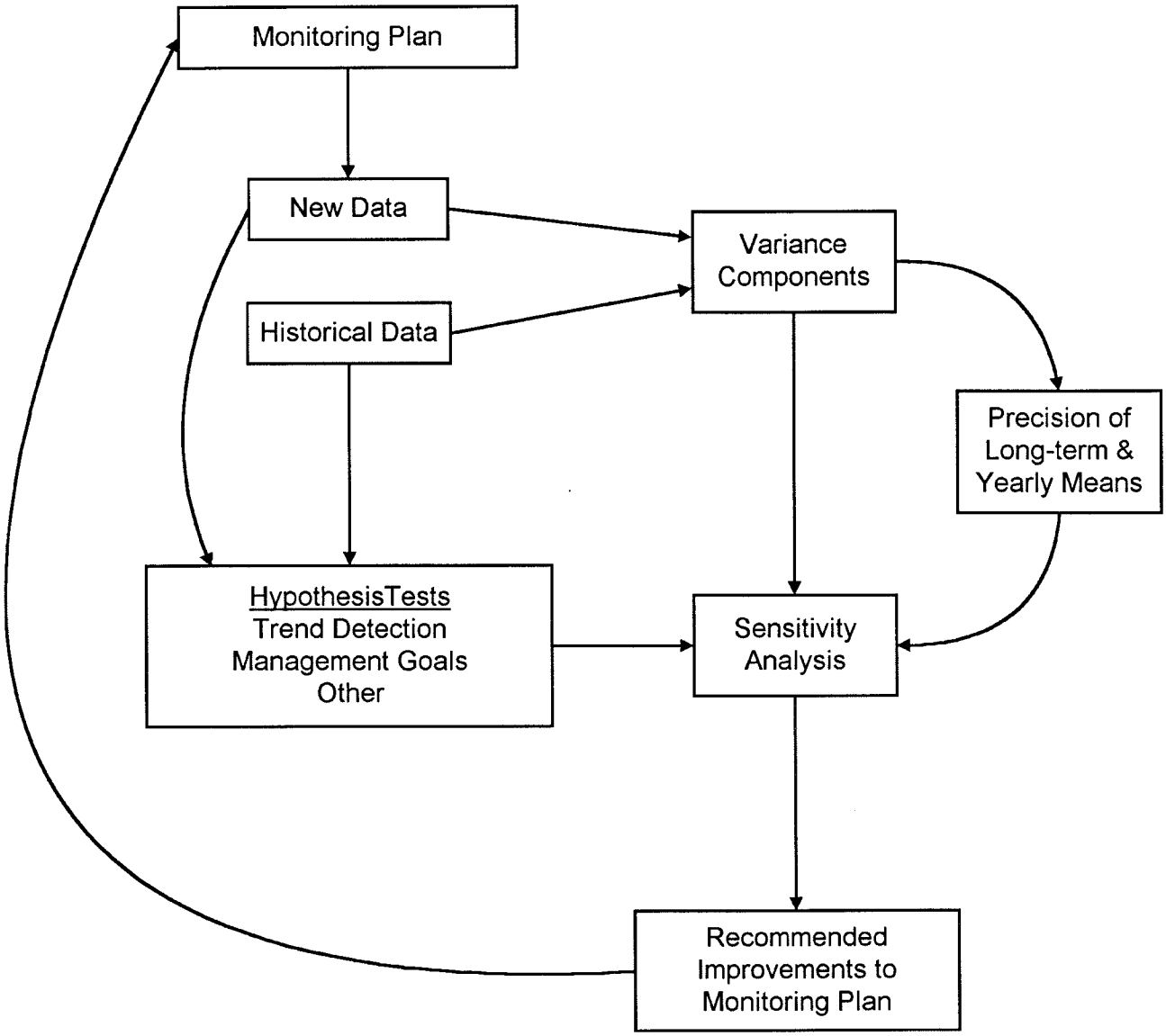
Maximum (β) = 1 - α

Power = Probability of Detecting Trend = 1 - β

= Function ("Trend Number" , α)

$$\text{Trend Number} \sim \frac{\text{Magnitude of Trend} \times (\text{Years of Monitoring})^{1.5}}{\text{Standard Deviation of Yearly Means}}$$

Statistical Framework for Ambient Monitoring Plan



Sampling Design Parameters:

n_y = number of years

n_d = number of sampling dates/year

n_z = number of depths / replicates per date

Variance Component Model:

$$S^2_{total} = S^2_{year} + S^2_{date} + S^2_{depth}$$

Variance of Mean for Individual Year: --> Precision of Yearly Mean

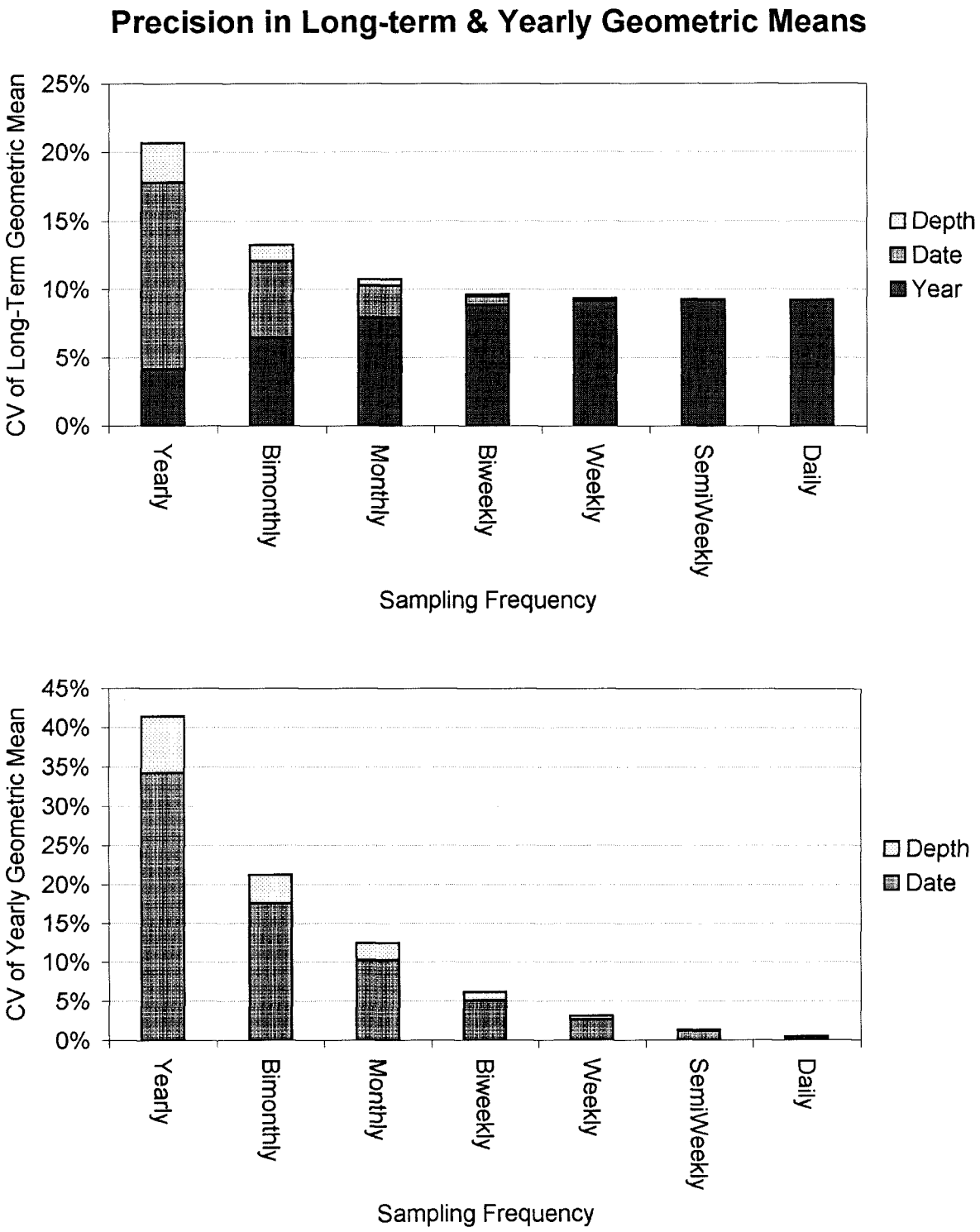
$$E_y^2 \sim S^2_{date} / n_d + S^2_{depth} / (n_d \times n_z)$$

Variance of Yearly Mean Time Series: --> Power for Trend Detection

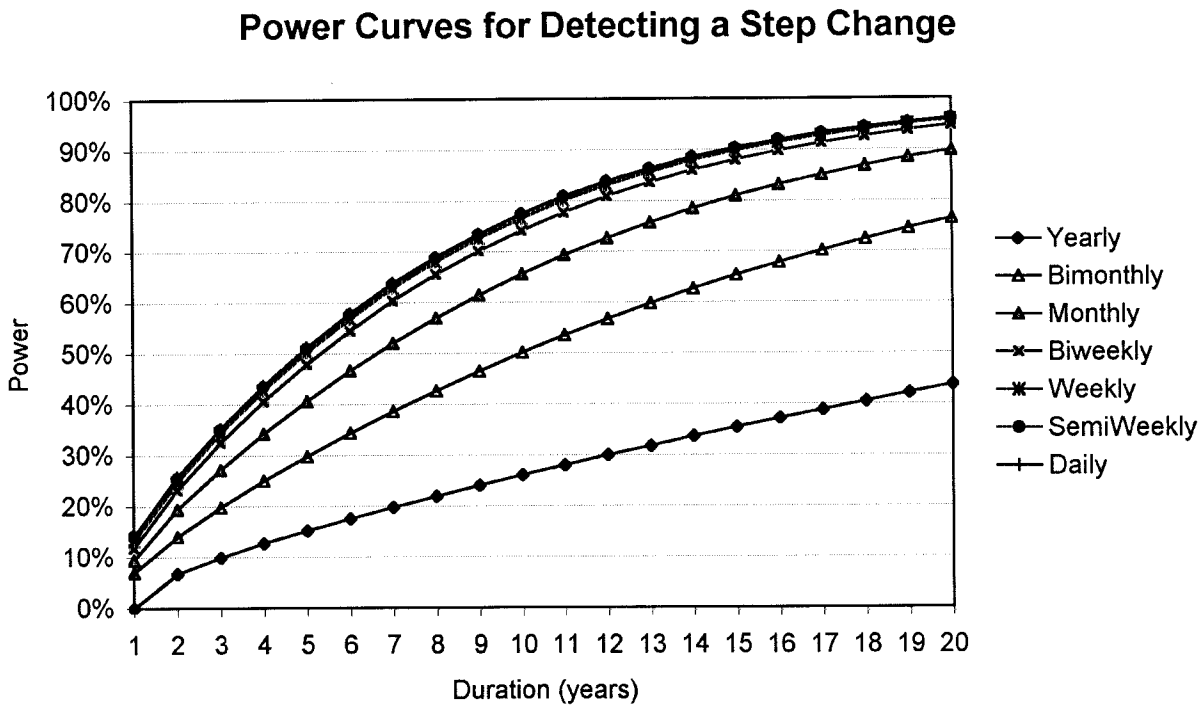
$$E_t^2 \sim S^2_{year} + S^2_{date} / n_d + S^2_{depth} / (n_d \times n_z)$$

Variance of Long-Term Mean: --> Precision of Long-Term Mean

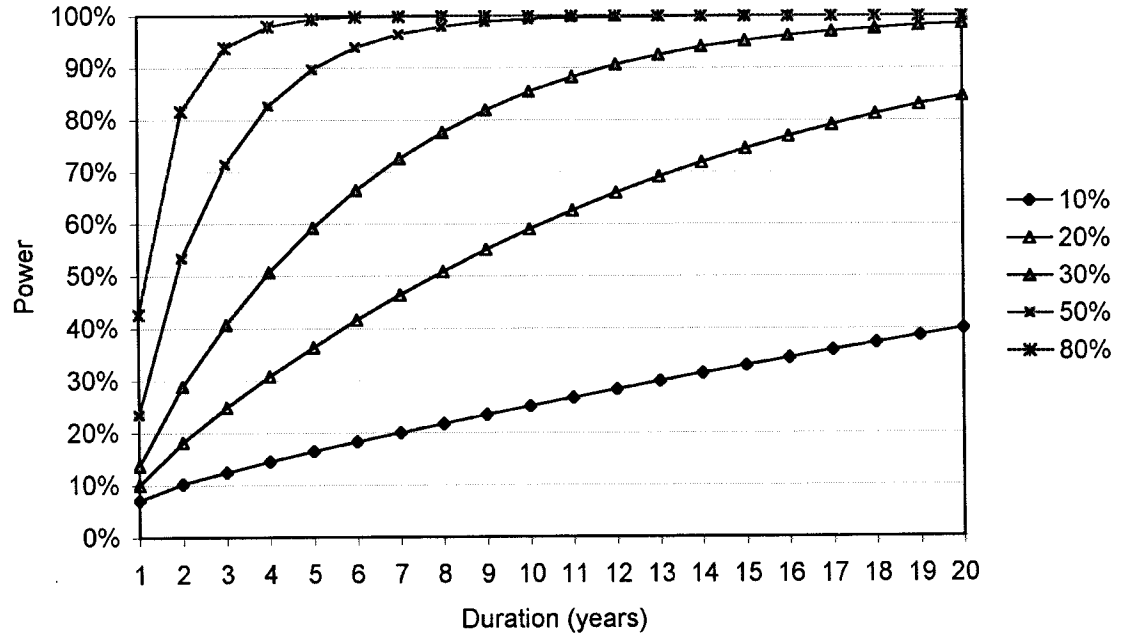
$$E_\mu^2 \sim S^2_{year} / n_y + S^2_{date} / (n_d \times n_y) + S^2_{depth} / (n_y \times n_d \times n_z)$$



Shaded areas in each bar reflect percent of variance attributed to yearly, daily, or depth variation
Variable: Total Inorganic P
Duration = 5 years

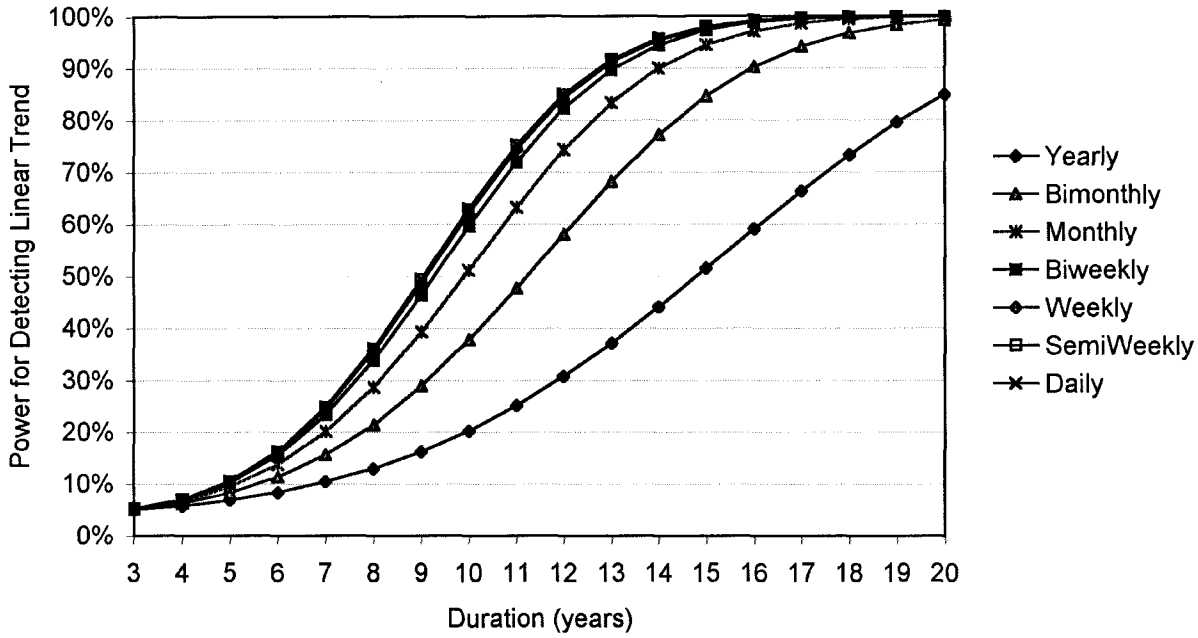


Sensitivity to Sampling Frequency
Step Change Magnitude = 25%
Duration = Number of Years of Monitoring Before & After Step Change

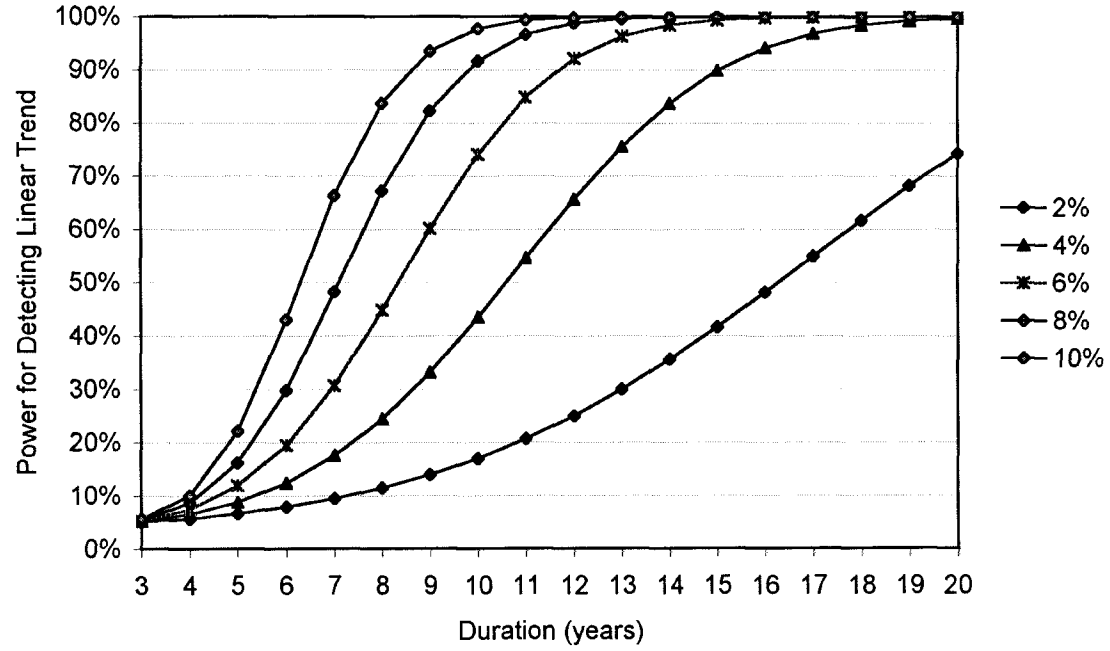


Sensitivity to Step Change Magnitude
Sampling frequency = Biweekly

Power Curves for Detecting a Linear Trend



Sensitivity to Sampling Frequency
Trend Magnitude = 5% /yr



Sensitivity to Trend Magnitude
Sampling Frequency = Biweekly

Statistical Framework for Ambient Monitoring Program Development of Phase II Scope

Additional Variables Likely to Influence Management Decisions

- Bacteria
- Free Ammonia
- Turbidity
- TOC, BOD
- Dissolved Oxygen
- Biological Measurements ?
  - Phytoplankton
  - Zooplankton
  - Macroinvertebrates
  - Fish
- Other ?

Additional Monitoring Locations

- Lake Nearshore
- River

Additional Criteria

- Frequency WQ Standards Exceeded
- Other ?