



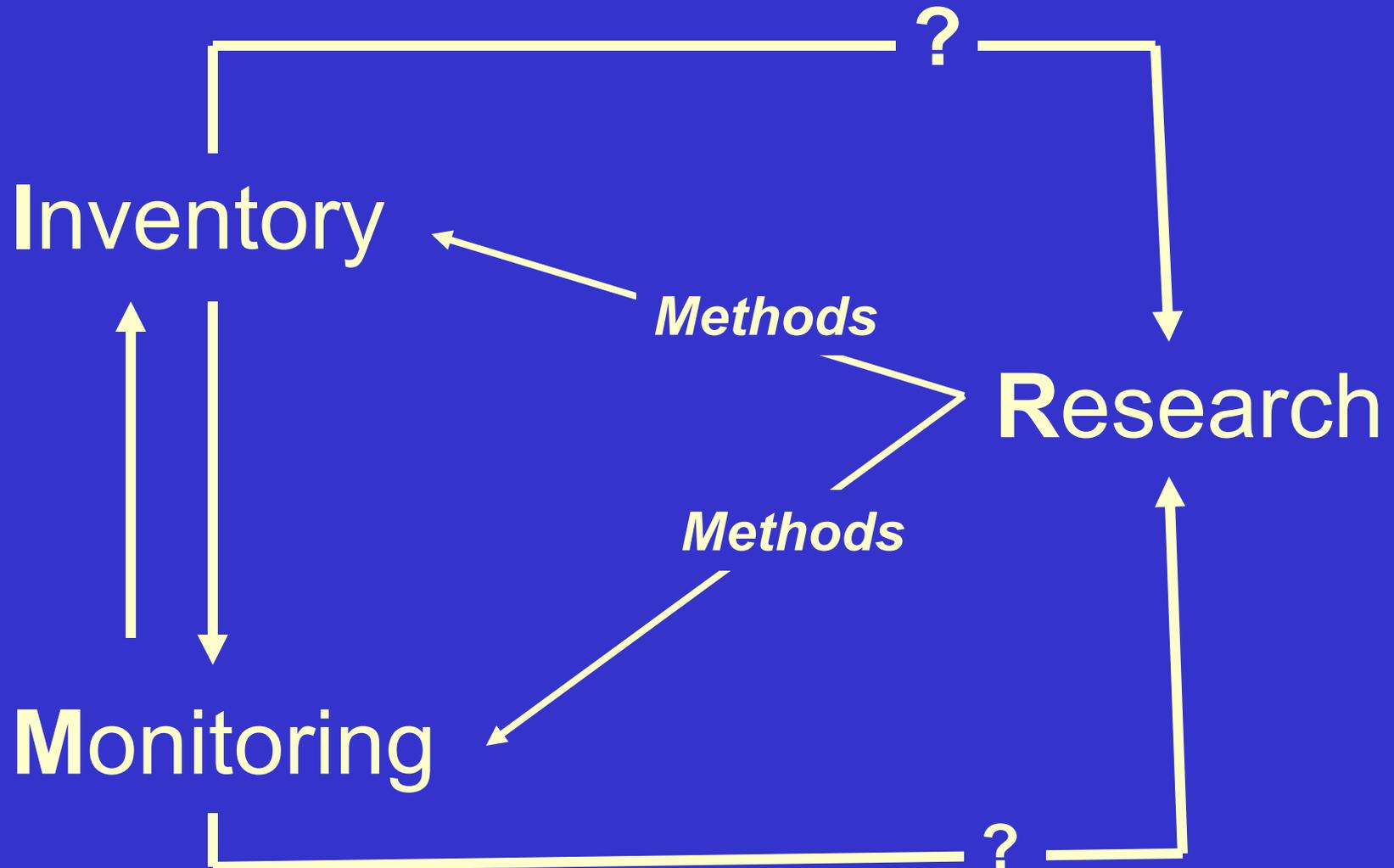
# Monitoring Heuristics:

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**Rules of thumb for  
developing  
successful long-  
term monitoring  
programs**

**Karen Oakley  
USGS Alaska Science Center  
January 14, 2003**

# Relationships among Inventory, Monitoring & Research

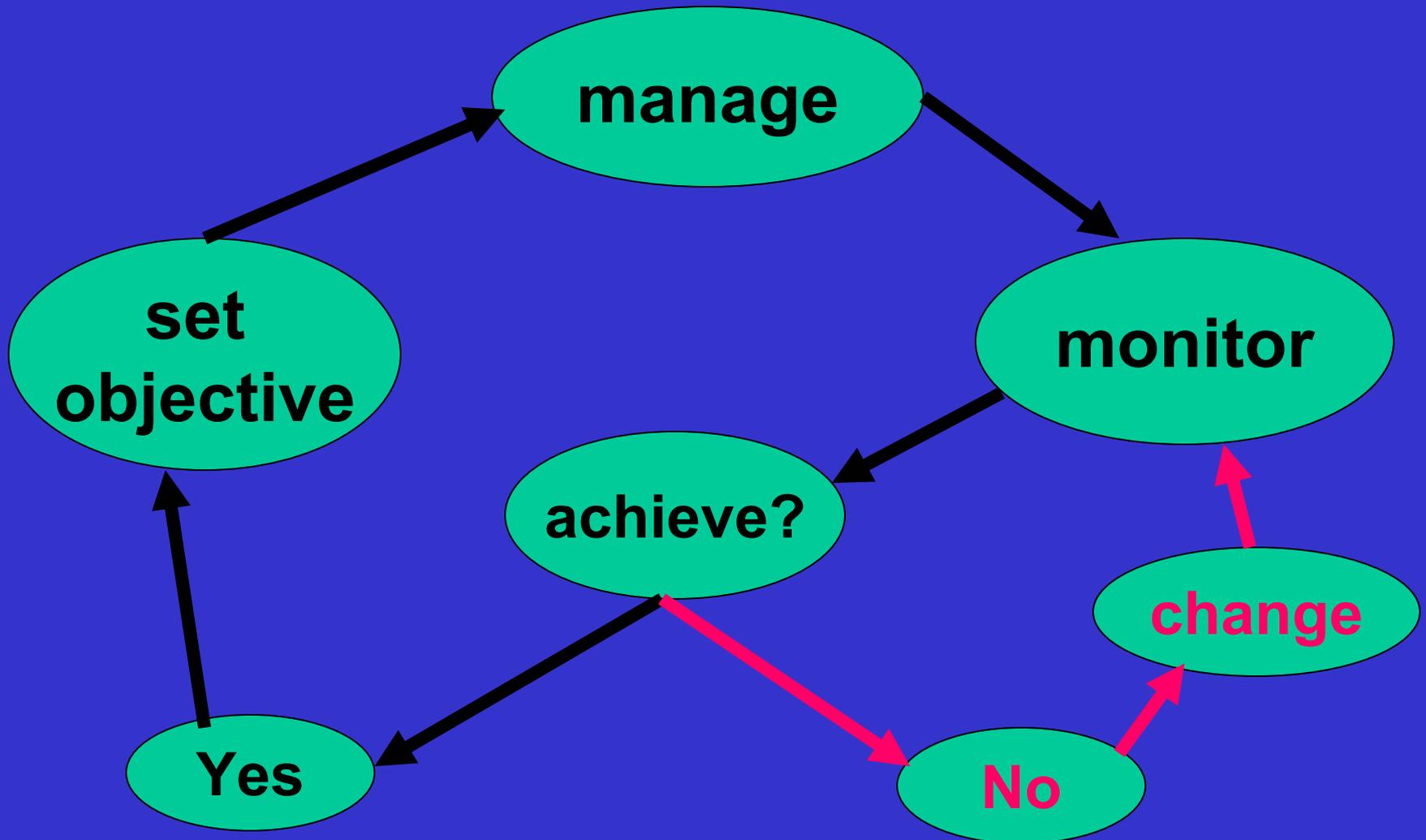


# Two Types of Monitoring

- **Monitoring in the context of an adaptive management program**
- **General ecological monitoring**

# Adaptive Management

monitoring is an integral, inseparable part



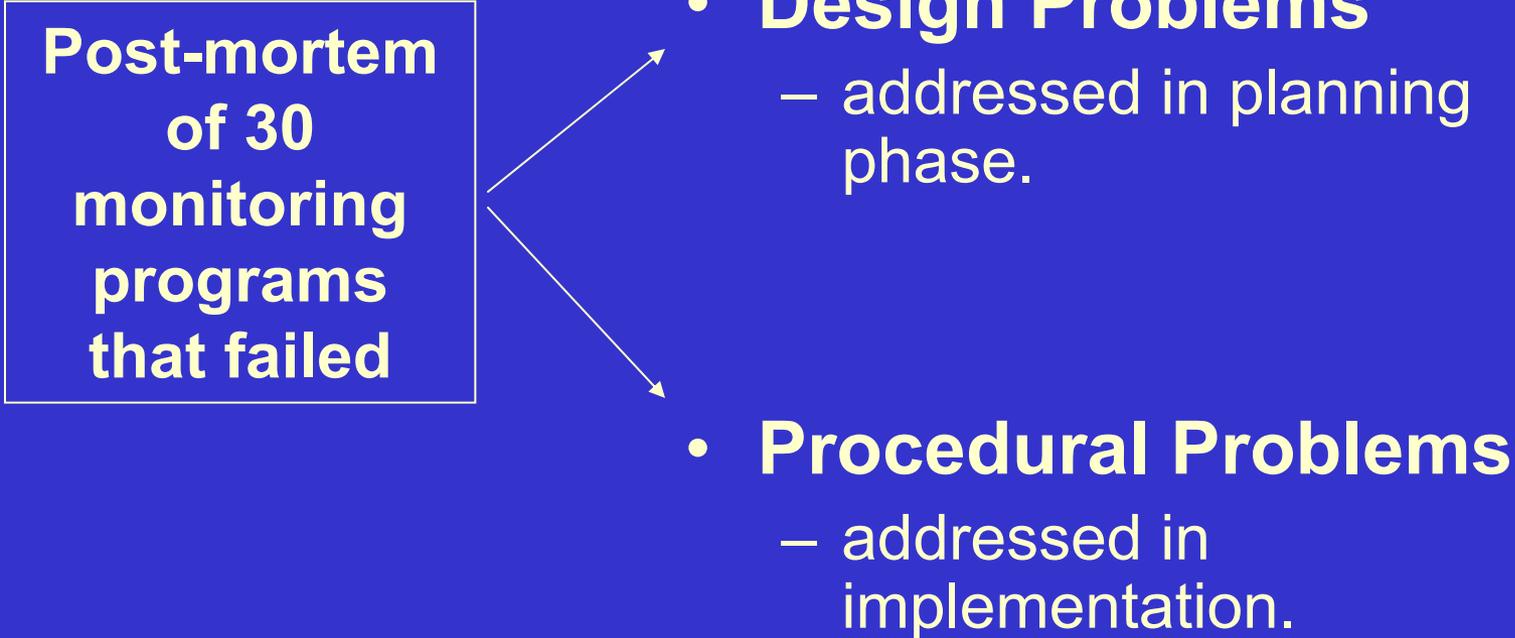
# General Ecological Monitoring

- Relationship to management generalized
- Wider variety of attributes
- Often, broad spatial scales
- Developing a database that can be queried to answer unanticipated questions

# “Epidemiology” of Monitoring

Reid (2001)

**Post-mortem  
of 30  
monitoring  
programs  
that failed**



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graph LR; A[Post-mortem of 30 monitoring programs that failed] --> B[Design Problems]; A --> C[Procedural Problems];
```

- **Design Problems**

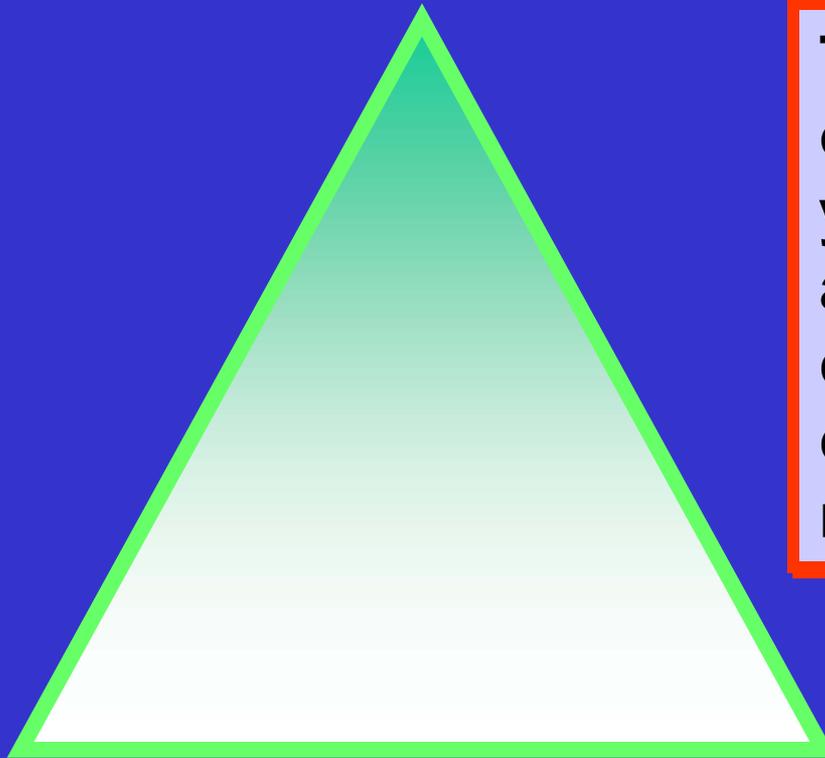
- addressed in planning phase.

- **Procedural Problems**

- addressed in implementation.

# Hinds (1984): Tripartite requirement for success in long-term monitoring

**Statistics**



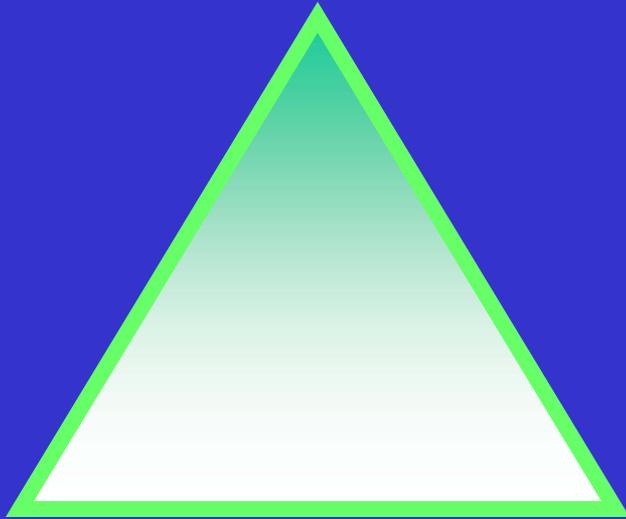
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**To be successful over the long-haul, you must address all three of these considerations: cost, statistics, and relevancy.**

**Relevancy**

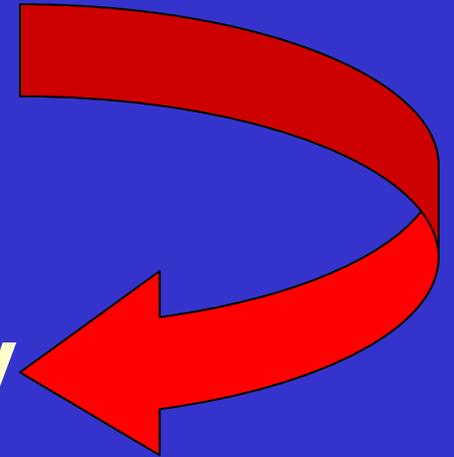
# Relevancy: What It's All About

Statistics



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Relevancy



# Lots to Think About When Considering Relevancy

- Management relevancy:
  - Why bother at all?
- Ecological relevancy:
  - have you picked the right things to look at?

# Management Relevancy

1. Thoroughly understand enabling legislation.
2. What are the “issues”—current and the future?
3. Understand distinctions among types of “monitoring” so expectations are realistic.
4. Need something immediate to sell the program, but do not tie to the issues of today.

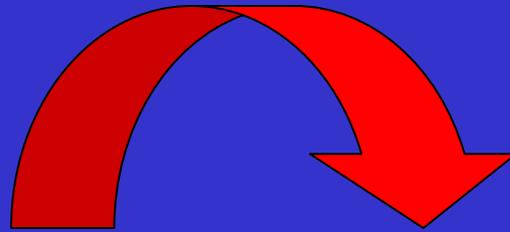
# Ecological Relevancy

- What is your conceptual model of how things work?
- Are you asking the right questions? Are the attributes meaningful? Will they answer the question?

# So, Relevancy:

- **Take your blinders off: Know where this fits into the BIG PICTURE.**
- **Be explicit about your assumptions (conceptual model).**
- **This is the foundation—make it strong!**

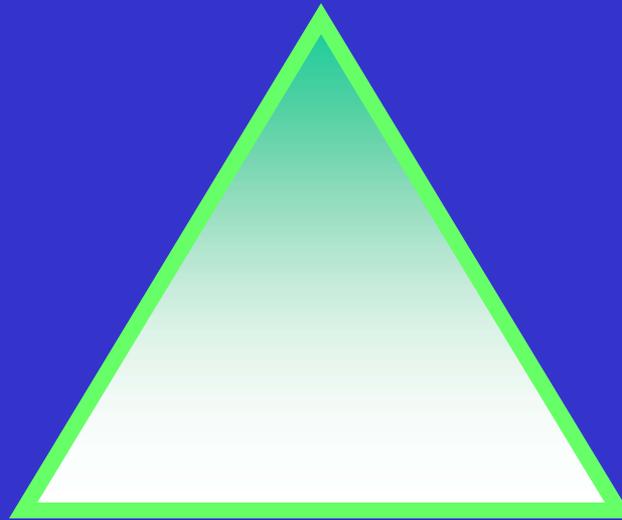
# Statistics: Getting Real



**Statistics**

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Relevancy



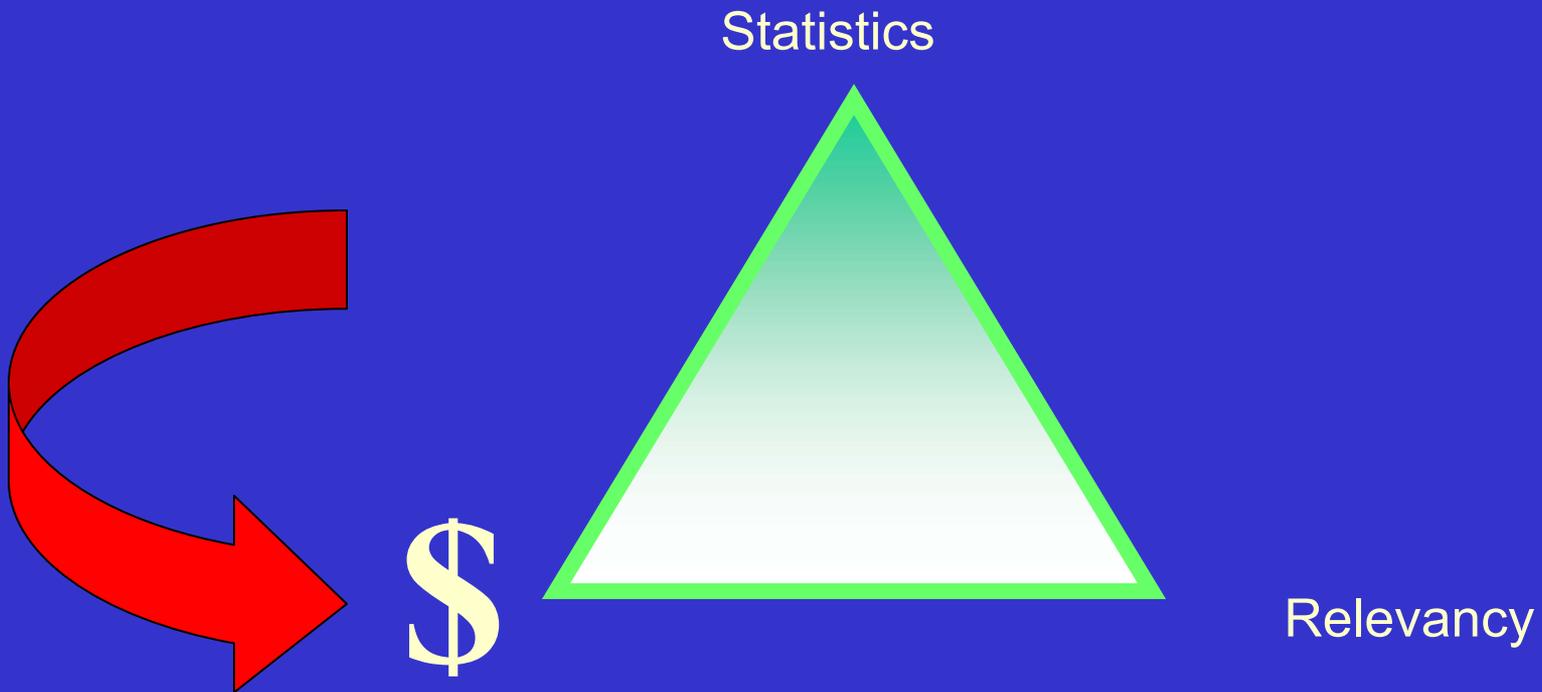
# Statistical Considerations

- **Studies over time have their own statistical issues.**
- **Measurement error is a big deal.**
- **Use a probability-based design.**
- **Be careful with stratification.**
- **Use pilot studies and modeling to optimize your design (cost).**

**“Sampling over space and time is a problem . . . “**

Trent McDonald, WEST, Inc. 8/14/2001

# Cost Considerations



# Recognize the True Costs

- Budgetary: How is money spent?
- Economic: What monitoring really costs?

# Budgetary Costs: How is money spent?

- Consider all costs:
  - scientific oversight
  - data collection
  - data management
  - quality assurance
  - data analysis
  - reporting
  - program management and support
  - costs of development

**Being realistic about the costs of monitoring will undoubtedly mean doing less, but it will also mean doing a better job of whatever you do.**

# Economic Costs: What monitoring really costs?

- **Opportunity Cost**
  - don't worry, if you don't think about it, your Boss will (!)
- **Cost-Benefit**
  - Difficult (comparing apples and oranges)
  - “Costs” occur before “Benefits”
  - What is the cost of a Type II error? (=benefit)

**If the monitoring program seems “expensive”, then the economic cost is too high.**

# Plan for fluctuating budgets (this year, for example!)

- **Tier 1: rock bottom budget—core measurements that can be made “no matter what”**
- **Tier 2: the “normal” expected budget**
- **Tier 3: What is the first thing you would do with a windfall?**

**To be robust over the long-haul, recognize and plan for the realities of government budgeting and politics.**

# Design Phase: Putting it all together . . .

## Statistics

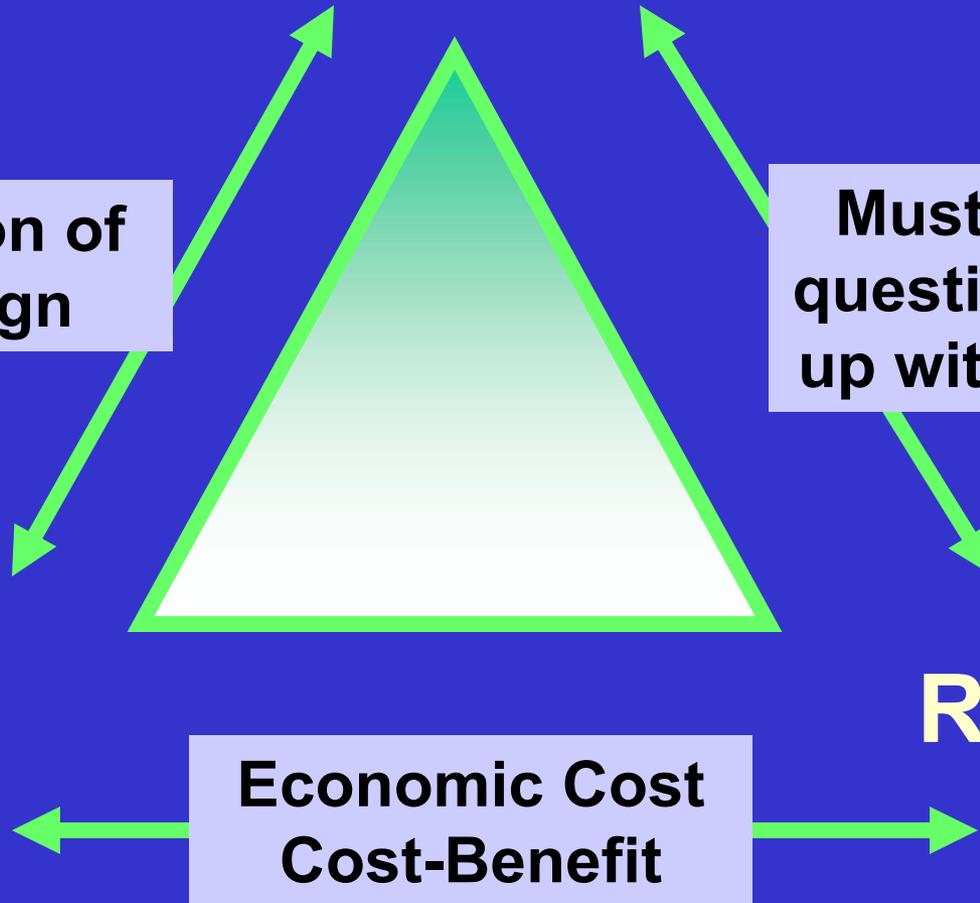
**Optimization of  
your design**

**Must know the  
question to come  
up with a design.**

**\$**

**Economic Cost  
Cost-Benefit**

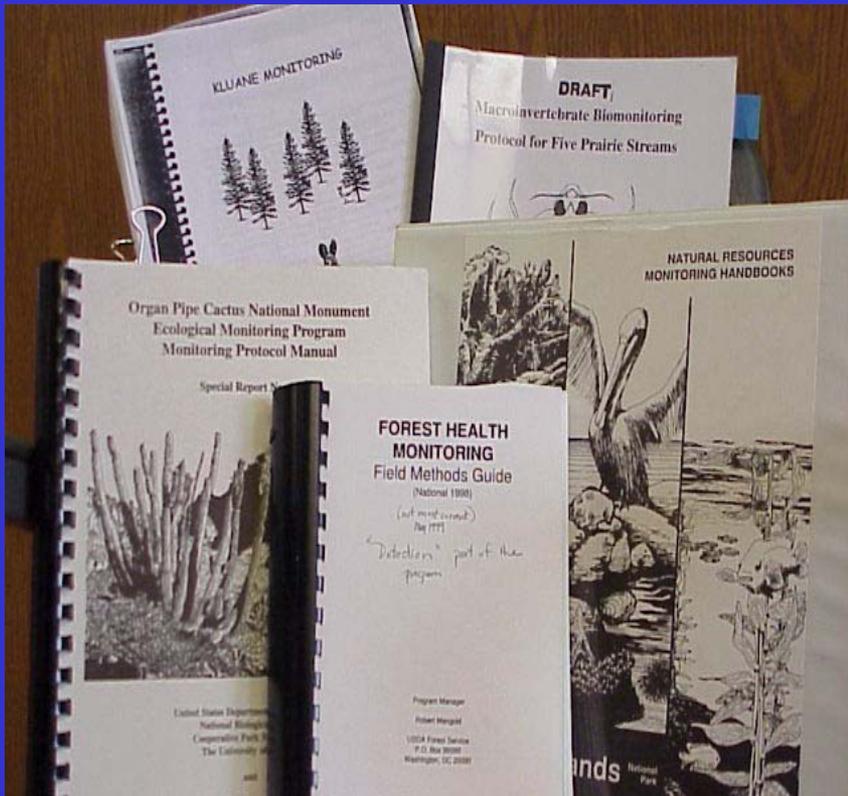
**Relevancy**



# Avoiding Problems in the Implementation Phase

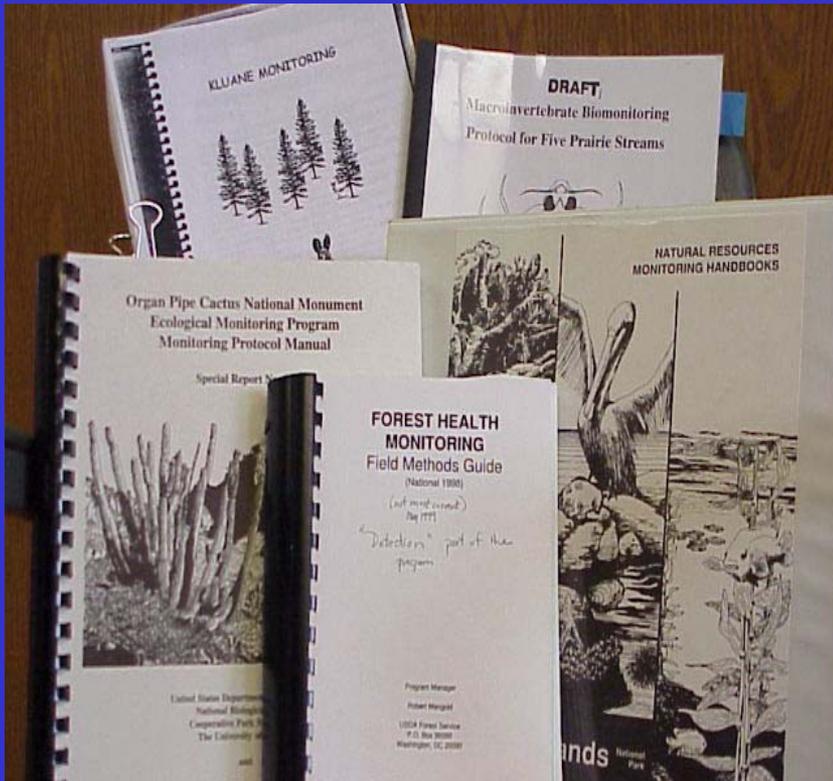
1. **Having done a good job in the Design Phase!**
2. **Institutionalization, i.e., systems that provide continuity:**
  - **People: Good Leaders and good crews**
  - **Protocols**
  - **Frequent Reporting for Multiple Audiences**

# Protocol Problems



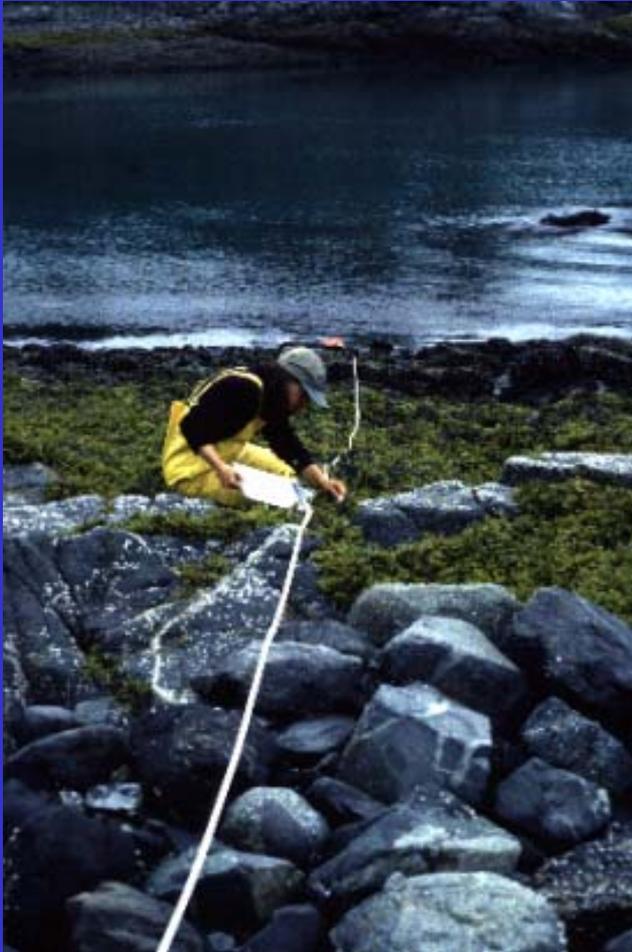
- Great variation in what is called a protocol.
- Monitoring methods cost a lot to develop.
- Wasted effort if end result not clearly identified at the outset.

# Protocol Problems



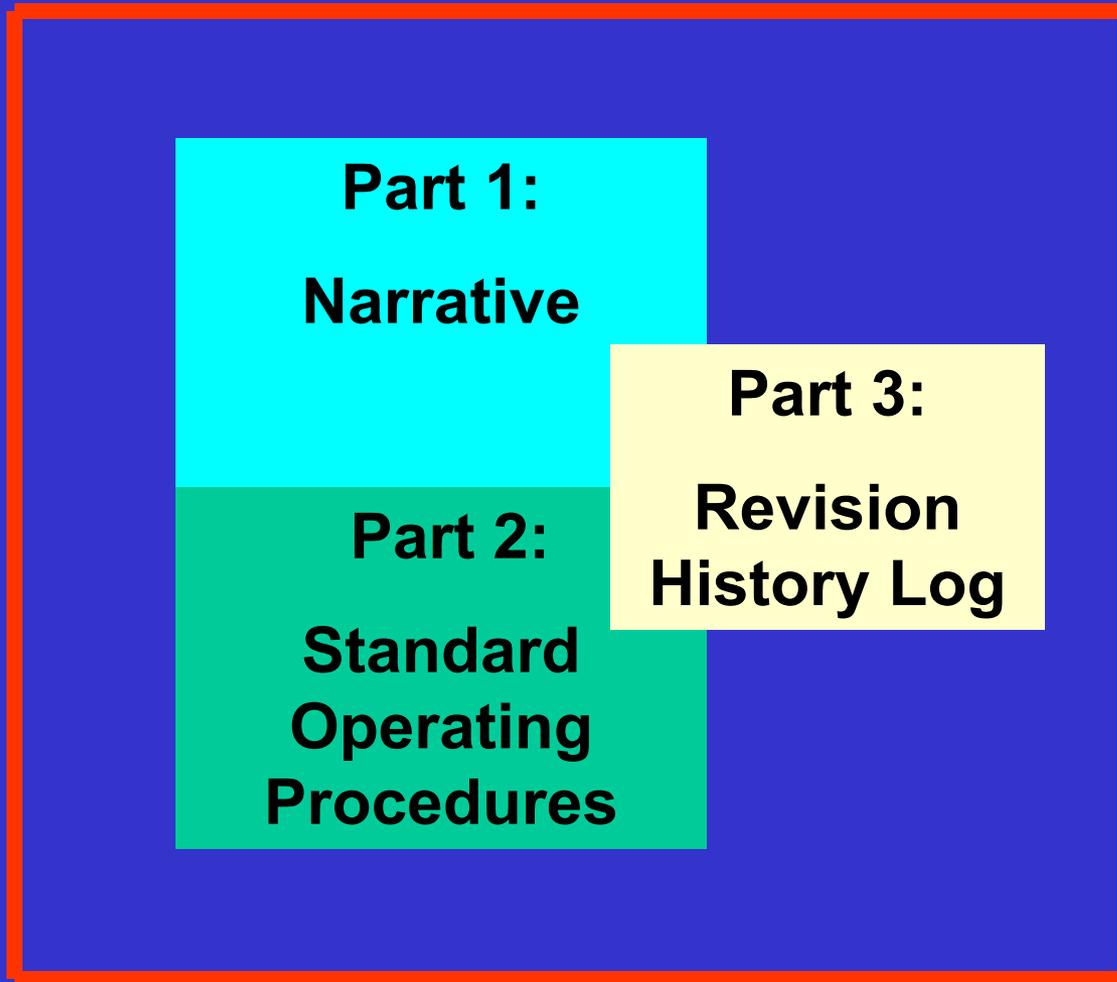
- Typically, not enough detail is provided.
- Important topics often not addressed.
- Mix explanation and justification with instructions.
- Collect dust on the shelf.

# What is a Protocol?



- A protocol is a full **STUDY PLAN**, not just a description of field methods.
- A **STUDY PLAN** demonstrates that the proposed monitoring has worthwhile objectives achievable for the ecosystem within the limits of time, money and personnel available for the project.

# The “Good Protocol” has 3 distinct parts:



# Part 1: The Narrative

## The Narrative Explains

Are the objectives worthwhile and achievable within the constraints?

- Provides context--why is this important? How does this help meet programmatic goals? (RELEVANCY)
- History of protocol development
- Measurable Objectives (RELEVANCY)
- Sampling Design (STATISTICS)
- Field Methods Overview

# Part 1: The Narrative

## The Narrative Explains

**Are the objectives worthwhile and achievable within the constraints?**

- **Data Management, Analysis, Interpretation, and Reporting**
- **Quality Controls**
- **Personnel Requirements and Training**
- **Detailed Budget (COST)**
- **Schedule**
- **Compliance**

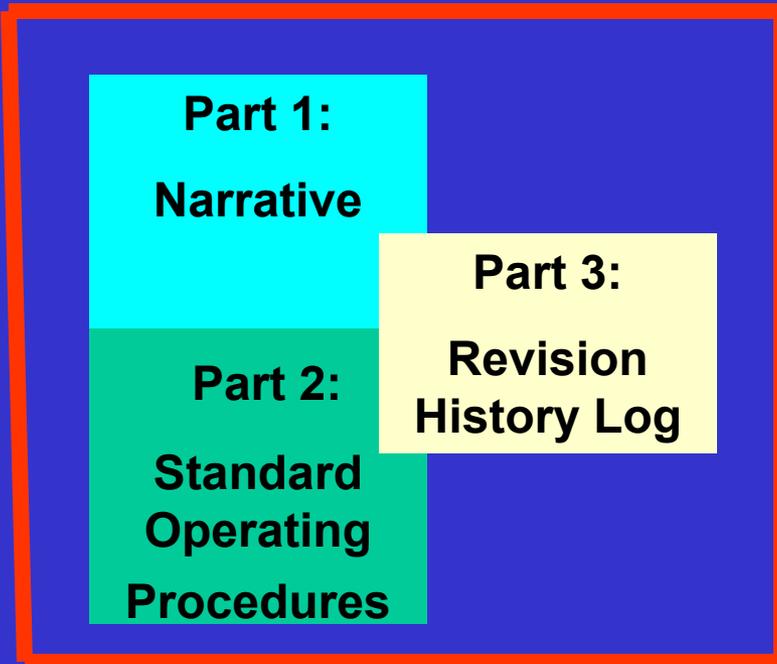
# Part 2: The Procedures

- **Instructions written for the people actually doing the work.**
- **Best written as steps.**
- **Procedure writing is different than most writing we do.**

**D. Wieringa, C. Moore, and V. Barnes.  
1998. Battelle Press**



# Why are Protocols so Important?



- Narrative demonstrates that the work is meaningful and achievable.
- Procedures help prevent measurement error and promote consistency over time.
- Revision Log builds confidence in the data over the long-haul.

# The Purpose of it All: Reporting

- **Think about it up front: address in the protocol**
  - Annual reporting
  - Synthesis reports
- **Don't Wait!**
- **Use the Internet**

**What's  
important?**

**Reporting,  
Reporting,  
Reporting**

# Reporting, cont'd

- **Consider multiple audiences**
  - Scientists
  - Managers
  - Public
- **Work at it**—we have a long way to go in improving the effectiveness of our reporting

**What's  
important?**

**Reporting,  
Reporting,  
Reporting**

# Putting it **ALL** Together

- **Design Phase**
  - Cost
  - Statistics
  - Relevancy
- **Implementation**
  - Protocols
  - Reporting

