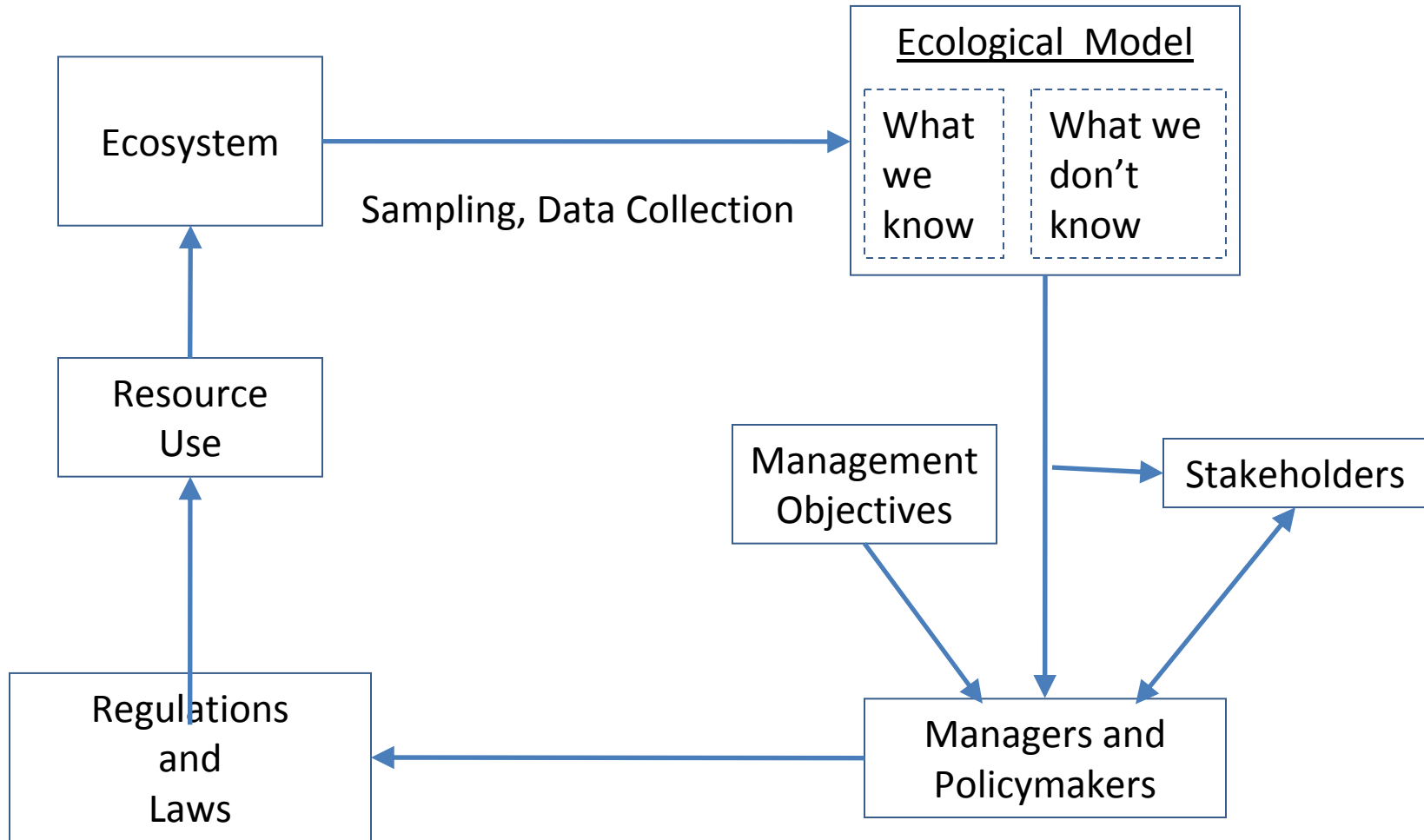


# Understanding Uncertainty in Modeling for Resource Management

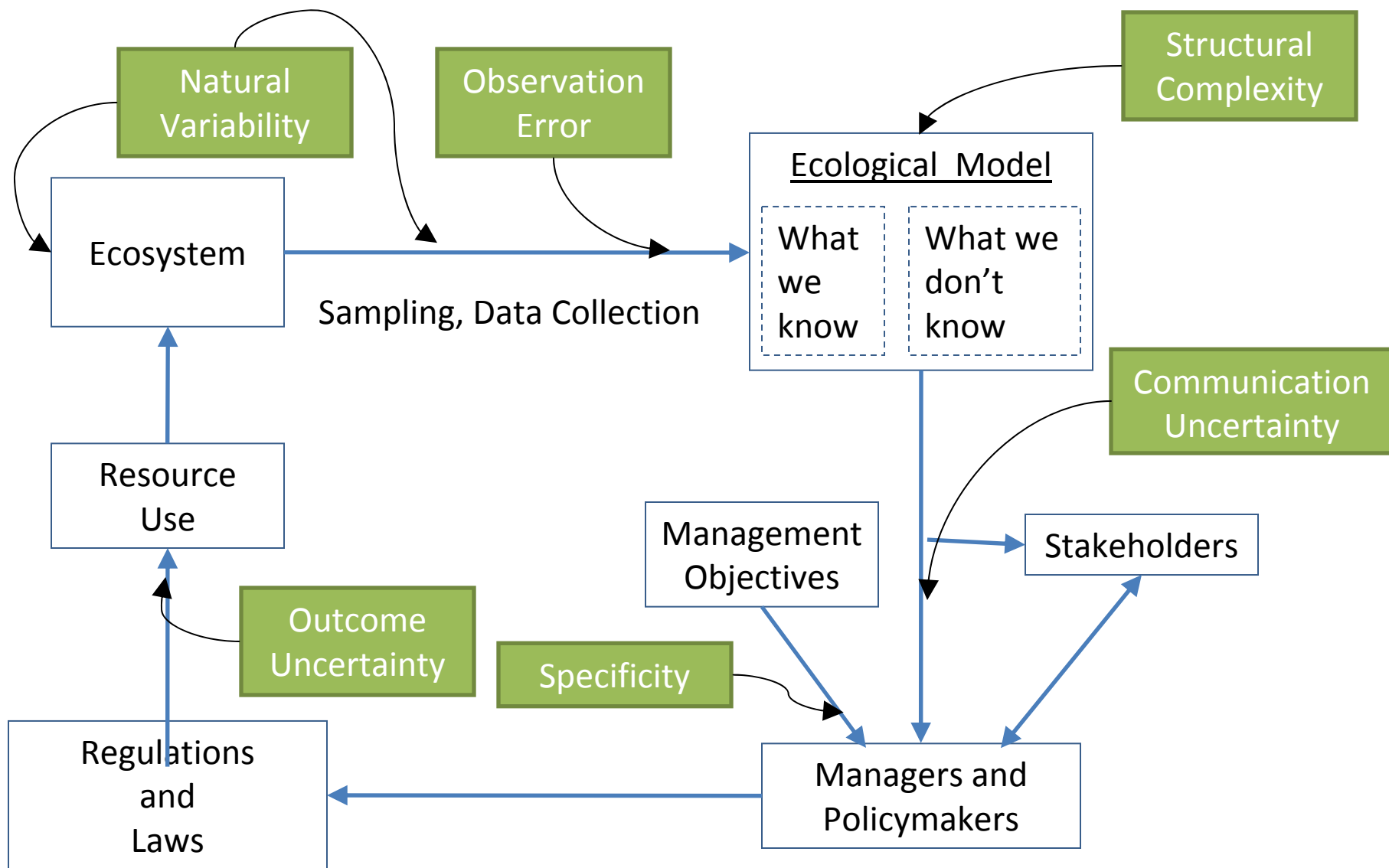
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# Resource Management Cycle



# Uncertainty in Resource Management



# Uncertainty in Resource Management

- Natural Variability, Observation Error and Structural Complexity lead to parameter uncertainty
- Outcome Uncertainty leads to imperfect forecasts
- Unclear Objectives and Communication Uncertainty lead to poorly informed decisions

# Natural Variability

## Source/Cause

- variability in a state variable that is observed in nature but not necessarily well captured in a model
- also known as process error
- e.g., climate

## How to Handle

- Use additional parameters to capture as much variability as possible
  - Too few → bias
  - Too many → over-parameterization
- Solution
  - Sensitivity analysis to weed out parameters
  - ...

# Observation Error

## Source/Cause

- error as a result of imperfect methods of observing and quantifying natural phenomenon and human activities
- includes sampling error

## How to Handle

- Gear efficiency studies
- Improving catch reporting and surveys
- Increasing sample size (and spatiotemporal coverage) (reduces sampling error)
- ...

# Model Structural Complexity

## Source/Cause

- The extent to which natural phenomena are implicitly described in a model
- Includes the spatial and temporal resolution

## How to Handle

- More phenomena requires more parameters and more uncertainty with each (because of previous sources)
- However, more complex can also reduce bias
- use  $> 1$  modeling framework, with different assumptions and levels of complexity, multiple scenarios
- ...

# Communication Uncertainty

## Source/Cause

- “the difficulties associated with communication among scientists, managers, and stakeholders about technical scientific information and its associated uncertainties;” (Peterman 2004).
- We all speak different jargons and have different “cultures”

## How to Handle

- Complex and technical subject matter
- Requires “iterative two-way flow” (Peterman 2004).
- Requires Socratic vs Vatican method (Degnbol -ICES ASC 2009)
- Requires new ways of visualizing complex information (Peterman presentation)
- ...

# Specificity

## Source/Cause

- Objectives that are poorly conceived, vaguely expressed, or difficult to quantify
- Leads to ambiguous targets, performance measures and decision rules, and inability to properly characterize important tradeoffs

## How to Handle

- early and ongoing engagement of scientists, managers and stakeholders, where objectives are carefully scoped and prioritized
- Multiple preliminary model runs to explore options in objectives
- ...

# Outcome Uncertainty

## Source/Cause

- Deviation of a realized value from a target value (actual vs. expected)
- the difference between a scientific recommendation and an implemented management level
- May result from non-compliance, inadequate reporting, lags in communication assessment/forecast and implementation

## How to Handle

- Explicitly account for it by probabilistic forecast models
- Develop information systems to expedite model development and communication of model output
- ...

# Uncertainty in Resource Management

