One Scientist's ~~An Industry~~ Perspective on Adaptive Management

What is Adaptive Management and why hasn't it worked?

Adaptive Management

- Application of scientific method to resource management (salmon recovery)
- Management actions are applied as experiments and monitored
- Learning becomes a part of the management process
- Management actions evolve through time

Adaptive Management in Industry

- Essentially the process used to evaluate and direct business decisions
  - Project profitability closely followed
  - Results compared with a performance level
  - Actions continually modified to improve performance
- Application to environmental issues
  - Forest industry support
  - Must be conducted collaboratively
  - Complicated - not many examples of successful implementation

TFW/CMER

- Evaluation of Forest Practice Rules
  - Rules established 1987
  - Collaborative evaluation process established: CMER
  - Work conducted late 80s to early 90s
- Forests and Fish Negotiations
  - New rules developed 1997 - 1999
  - EIS completed 2001
- Was CMER work used to formulate the new rules?
  - Forests and Fish EIS listed 366 references
  - 11 CMER Reports: 6 research, 5 literature reviews

Adaptive Management

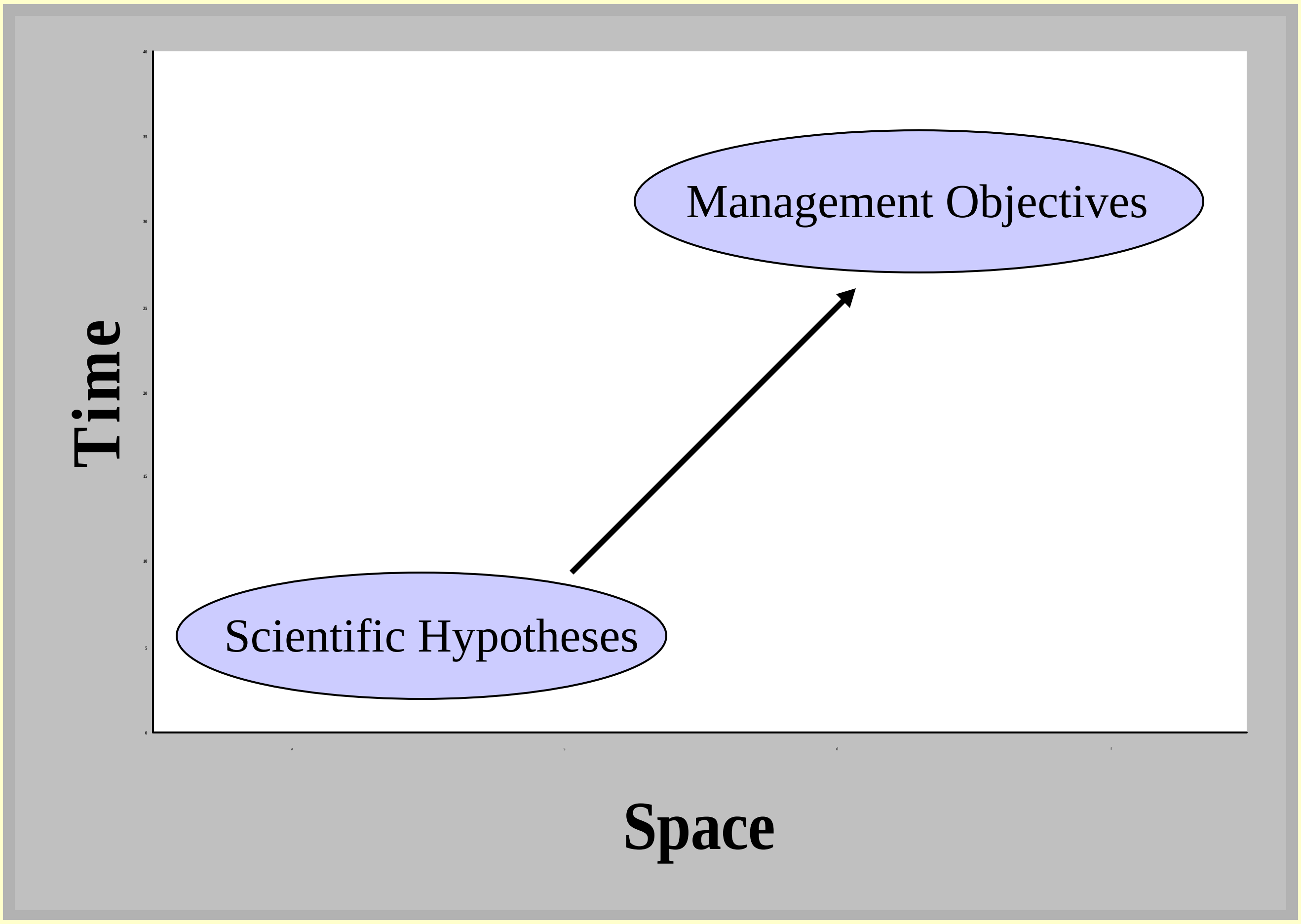
6 Fundamental Steps

1) Determine objectives
2) Experimental design
3) Apply management actions
4) Measure key variables
5) Compare response with objectives
6) Repeat 1-5; Monitoring and adaptation become components of management

Objectives

- Often not relevant to the action being evaluated and the resource being managed
  - Proximate attribute influenced
  - Effect of the change in that attribute on the key resource (salmon)
- Not articulated as testable hypotheses
- How will measured responses be compared with the objectives -When?
- Inappropriate scale

Scale of Objectives



Management Actions

Management as an Experiment

- Actions must be applied in a manner compatible with scientific principles
  - Sufficient baseline information and references to evaluate response
  - Statistically valid experimental design
- Evaluation of multiple management strategies
  - Active versus passive adaptive management
  - Application of a range of management actions informs type and magnitude of change required to meet objectives

Example

Chinook Restoration on the Tuolumne River

- Special Run Pools
  - Issue: Bass predation on smolts
  - Treatment: Fill in pools with gravel
- Pre-Treatment Measure of Survival
  - Tagged smolts
  - Bass stomach samples
  - Bass population census
- Failed to get sufficient information to evaluate effect of the treatment
- Did not evaluate other possible options to reduce predation
  - Netting spawning bass
  - Temperature manipulation

What to Measure?

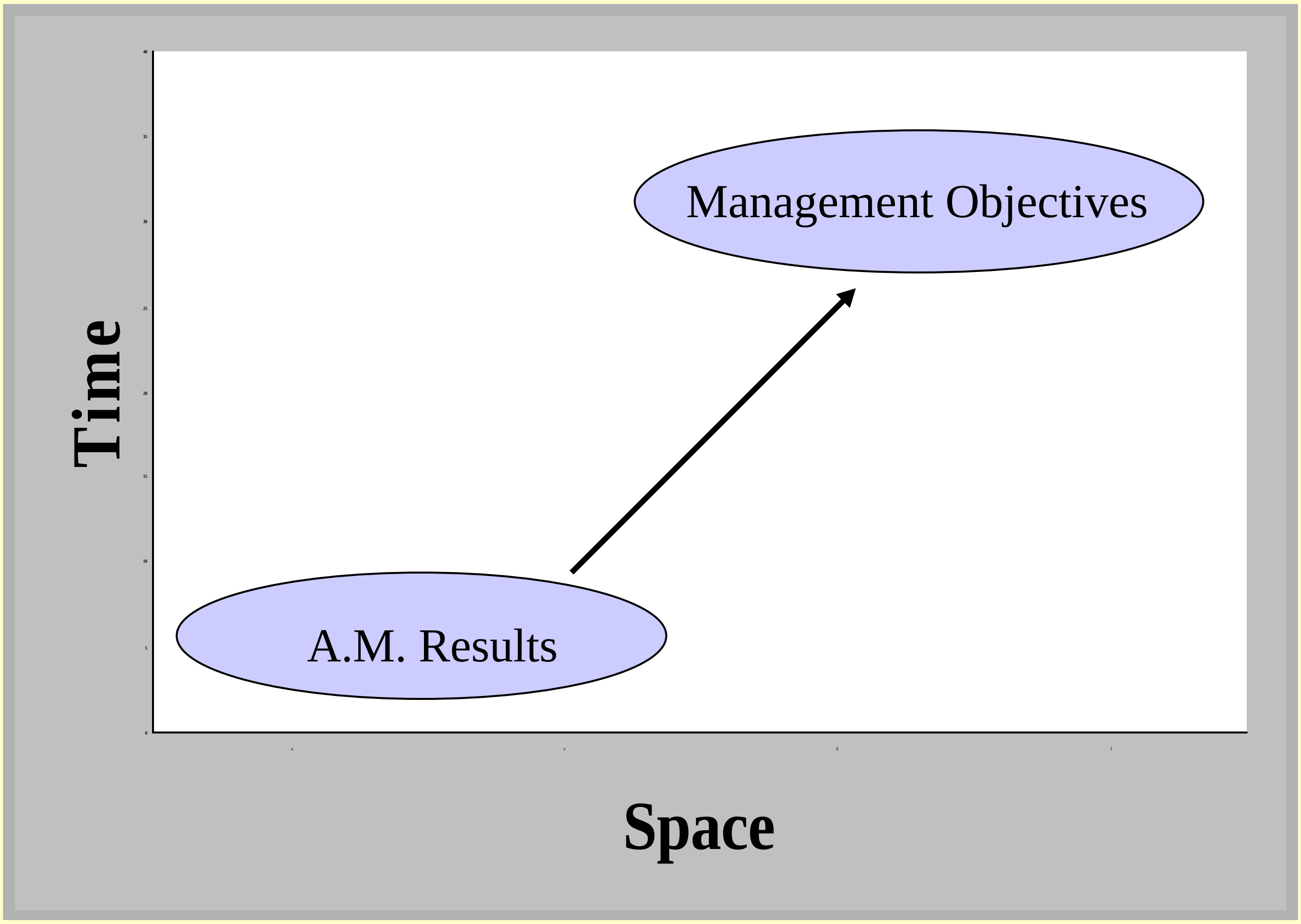
- Selection of Variables
  - Sensitivity to the management actions
  - Type of baseline data available
  - Feasibility and expense of measurement
  - Temporal and spatial scale over which a response is expected
  - Effects on biological resources (salmon)

Failure to connect proximate and ultimate responses

Interpretation of Results

- Compare monitoring data with original objectives
  - If objectives met, no change required
  - If objectives not met, implement change
  - Continue monitoring
- Not so simple
  - What constitutes "meeting the objectives"?
  - If objectives are not met, what types of changes will be implemented?
  - Do results address the fundamental objectives (more salmon)
  - Response over large area/long time

Interpretation of Results



Interpretation of Results

- Empirical Models
  - Use data and established relationships to predict consequences of management action
  - Provides quantified output and degree of uncertainty
  - Knowledge gaps may necessitate the use of many assumptions
  - Large wood input models

Interpretation of Results

- Expert Opinion
  - Often used for complex issues and where data is insufficient for development of an empirical model
  - Suffers from a lack of consistent process for combining and interpreting opinions
  - Acceptance of the outcome often dependent on the reputation of the scientists involved
  - Science review panels

Interpretation of Results

- Expert Systems
  - System for organizing and applying expert opinion
  - Makes rationale for the expert opinion more apparent; outcomes may be easier to understand and justify
  - Some systems provide an indication of the degree of uncertainty associated with an outcome
  - ICBEMP Bayesian Belief Model; Ecosystem Diagnosis and Treatment (EDT)

"All models are wrong but some are useful"

Integration

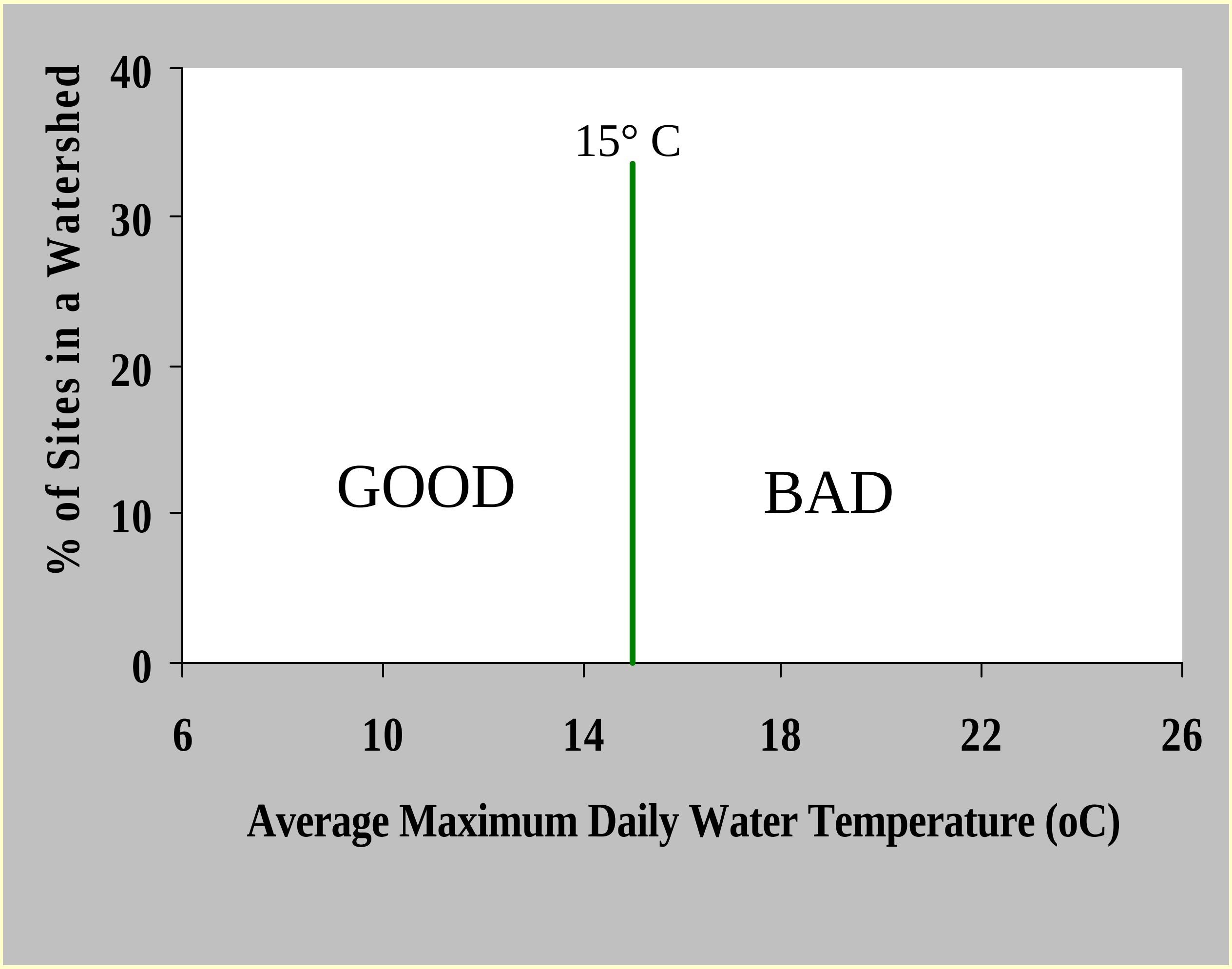
Monitoring Elements

- Site level evaluation of individual actions
- Extensive trend monitoring of easy-to-measure attributes to determine general trends in condition
- Intensive monitoring at a few locations to establish the integration from site level to whole watershed and from physical effect to biological response

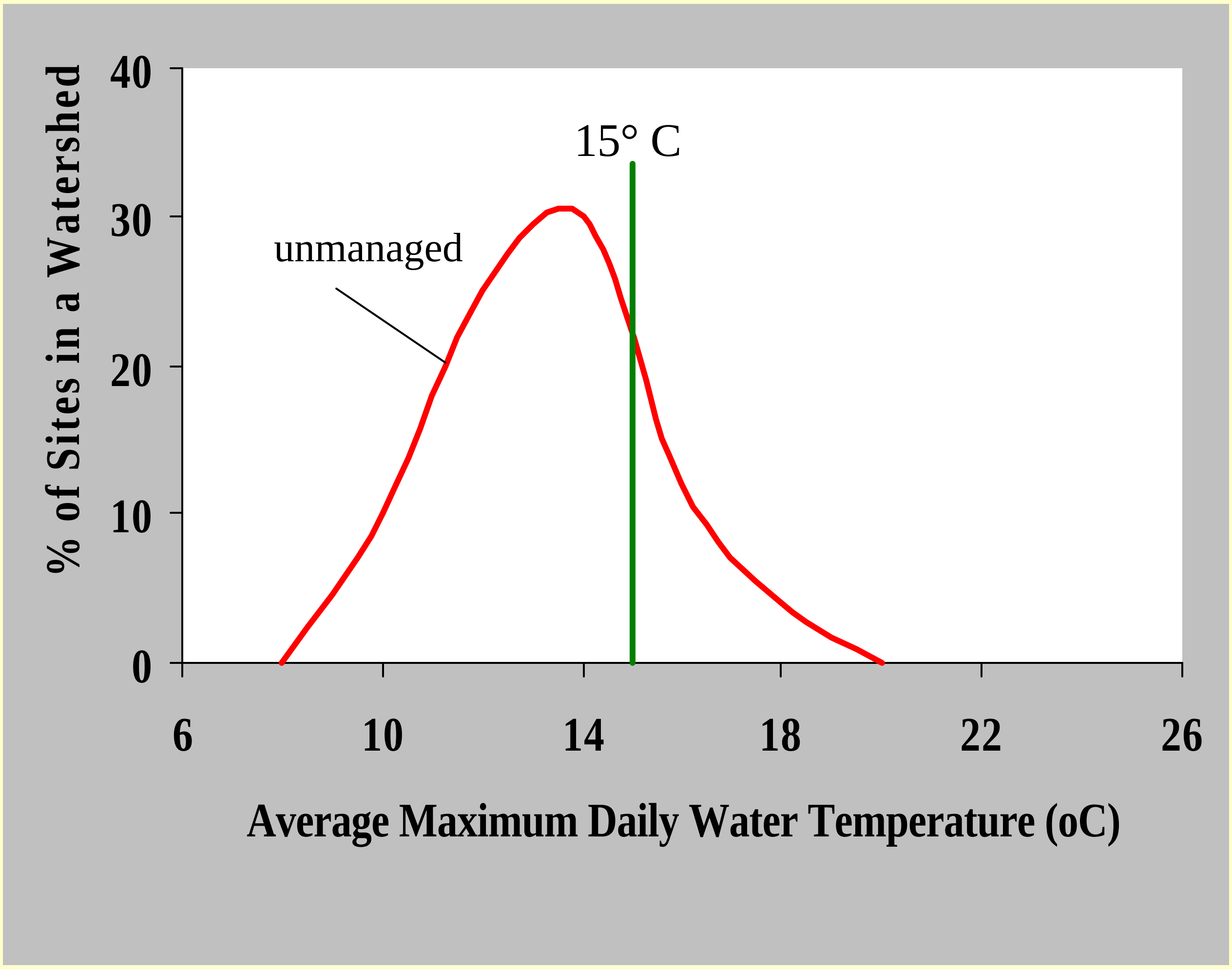
Performance Standards

- Several methods of establishing desired outcomes
  - Legal standards
  - Requirements of a species of interest
  - Conditions at unimpacted sites
  - Trend through time
- First two most frequently utilized
- Last two most ecologically meaningful
- Using trend as a desired outcome enables more rapid interpretation of results

Establishing Objectives



Establishing Objectives



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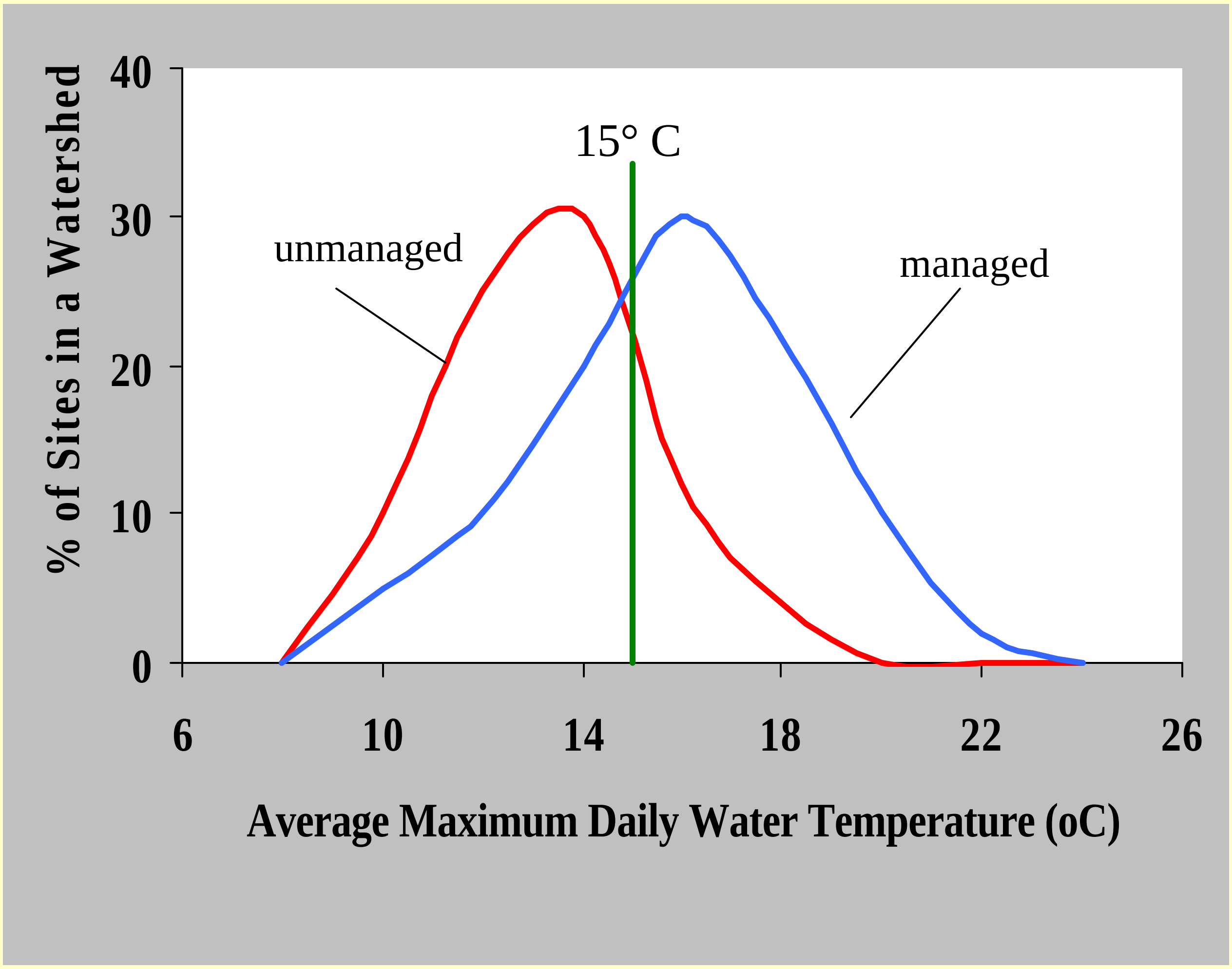

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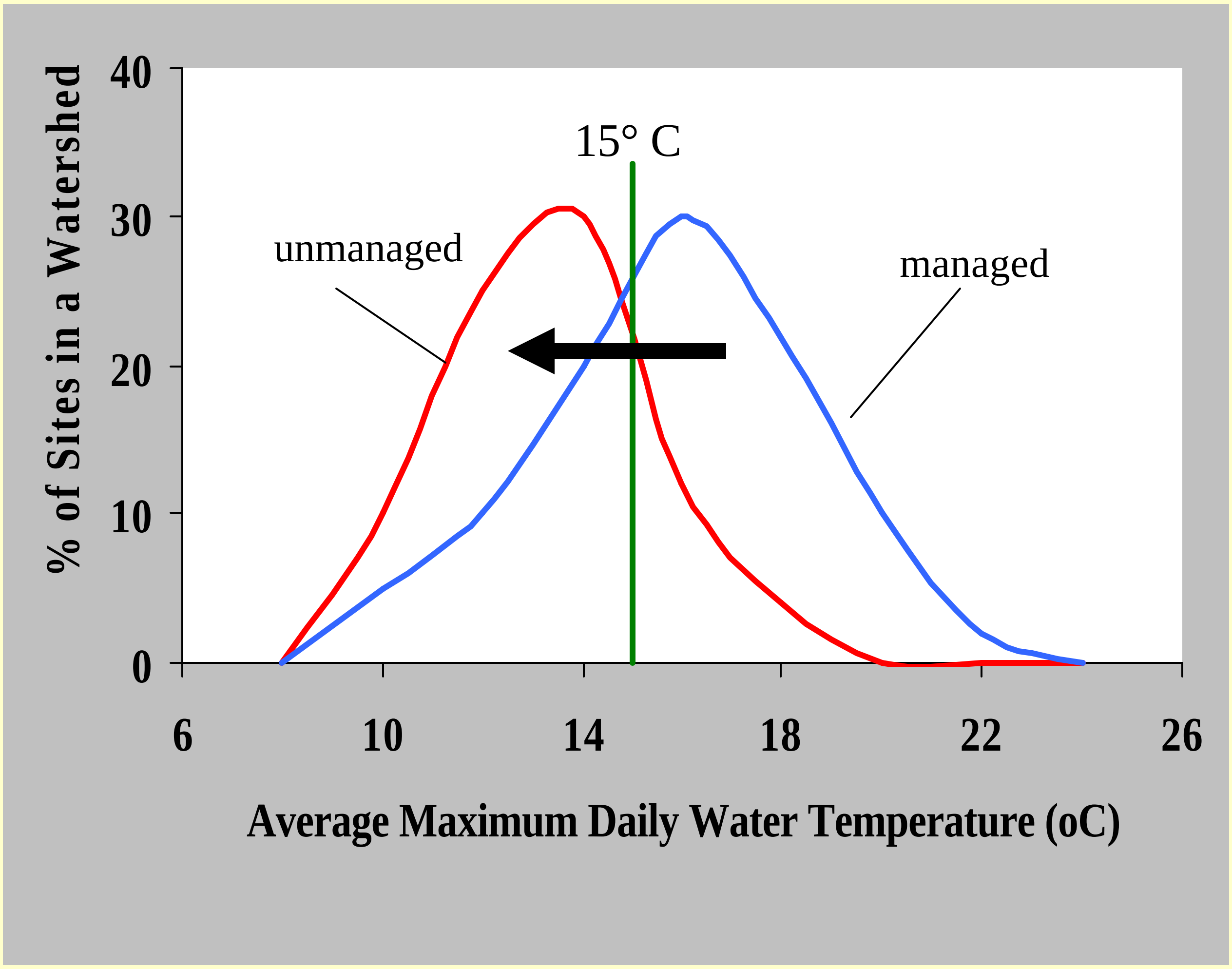


Desired outcome expressed as a direction and rate of change in the attribute

Evaluating Fish Response

- Life stage-specific response can be related to individual management actions
- Overall population performance influenced by all actions affecting habitats required to complete freshwater rearing (entire watershed)
- Changes in abundance over time requires long record to determine response
- More sensitive variables may be available
  - fish condition, growth rate
  - smolts/female
  - spatial distribution of fish abundance

Detecting Fish Response

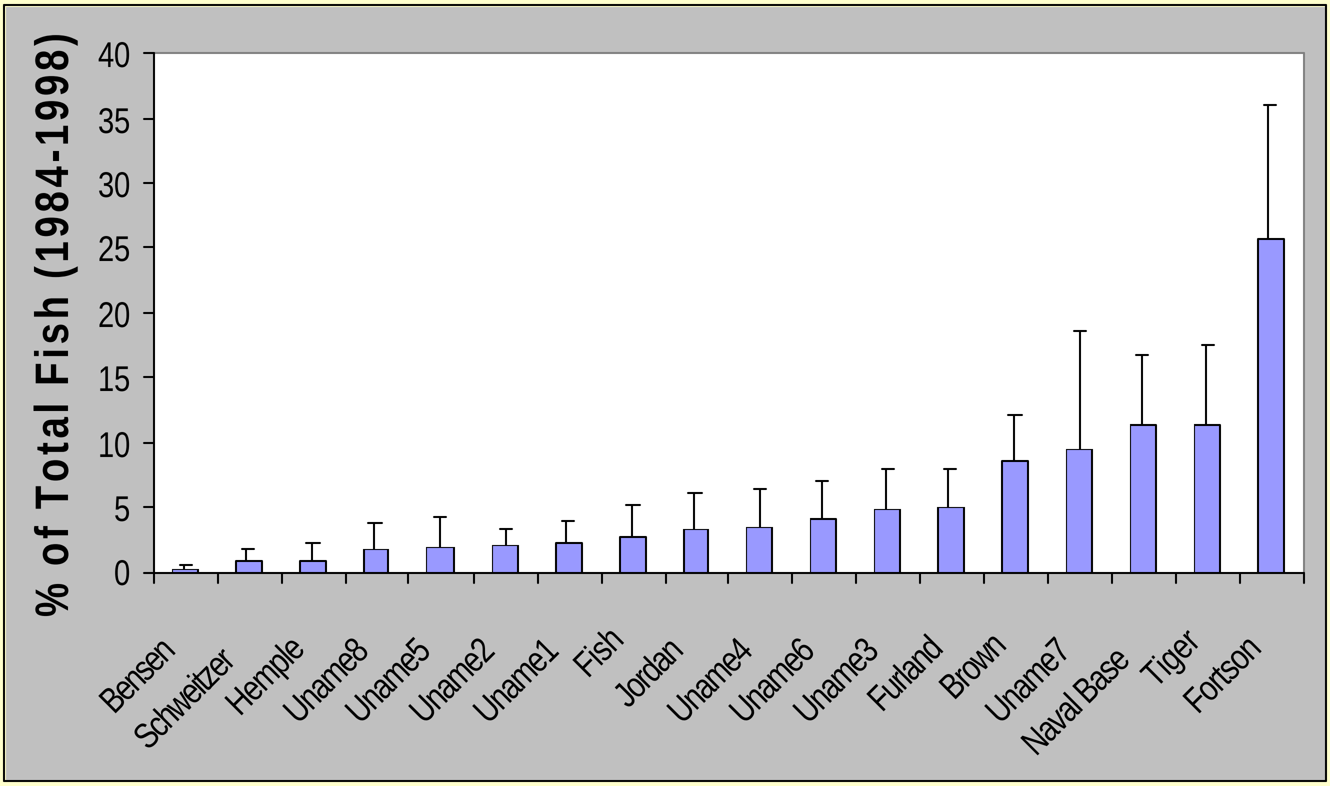
Population decrease required to detect a response to a management action within 5 years for the Yakima River

Stock	Detectable Impact
Bull Trout	76%
Cutthroat Trout	41%
Fall Chinook Salmon	79%
Mountain Whitefish	22%
Rainbow Trout (river)	19%
Rainbow Trout (trib.)	38%
Spring Chinook Salmon	55%
Steelhead	59%

Ham and Pearsons 2000

Coho Salmon Abundance

Stilliguamish River 1984-1998



WDFW data

How to Make Sure the "Right" Science is Collected

- Commitment to integrate monitoring into management
- Evaluate appropriate questions at appropriate scales
- Design program to integrate across disciplines and scales
- Adequate funding
- Clear separation of science and policy roles - science designed and implemented independent of policy considerations
- Adequate scientific expertise - oversight
- Improved communication between decision makers/managers and scientists