A Road Map for Designing and Implementing a Biological Monitoring Program

Ken Newman, Joel Reynolds, Melinda Knutson,
Emily Silverman, Bill Thompson
US Fish and Wildlife Service

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3 Main Points

#1 Biological Monitoring Programs are ubiquitous

Google Scholar:

“biological monitoring” => 111,000 hits

“status and trends” + monitoring => 40,000 hits

3 Main Points

#2 But the Data collected “often fail to deliver useful information for a variety of reasons”

Administrative reasons– inadequate staffing, documentation, funding

Technical reasons– inadequate sampling design and data analysis

3 Main Points

#3 So to address these problems we developed a Road Map for developing and implementing a Biological Monitoring Program

…a 10 step program

Motivation

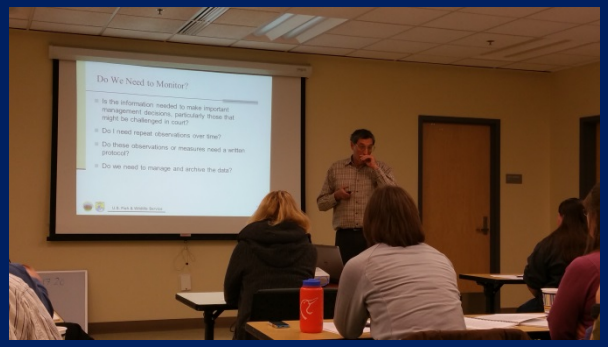
There are some serious problems with many long-term monitoring programs.

Resulting data often

- Improperly or infrequently analyzed
- Not influencing management decisions
- Biased or Imprecise
- No metadata
- Not being used because the reasons for the monitoring were unclear or unknown.

Recognition of these problems led to

Week long class for USFWS biologists



And Road Map for Biological Monitoring

The Road Map

Tool for designing and implementing a Monitoring program

=>

statistically valid and impactful data for improving Biological resource management.

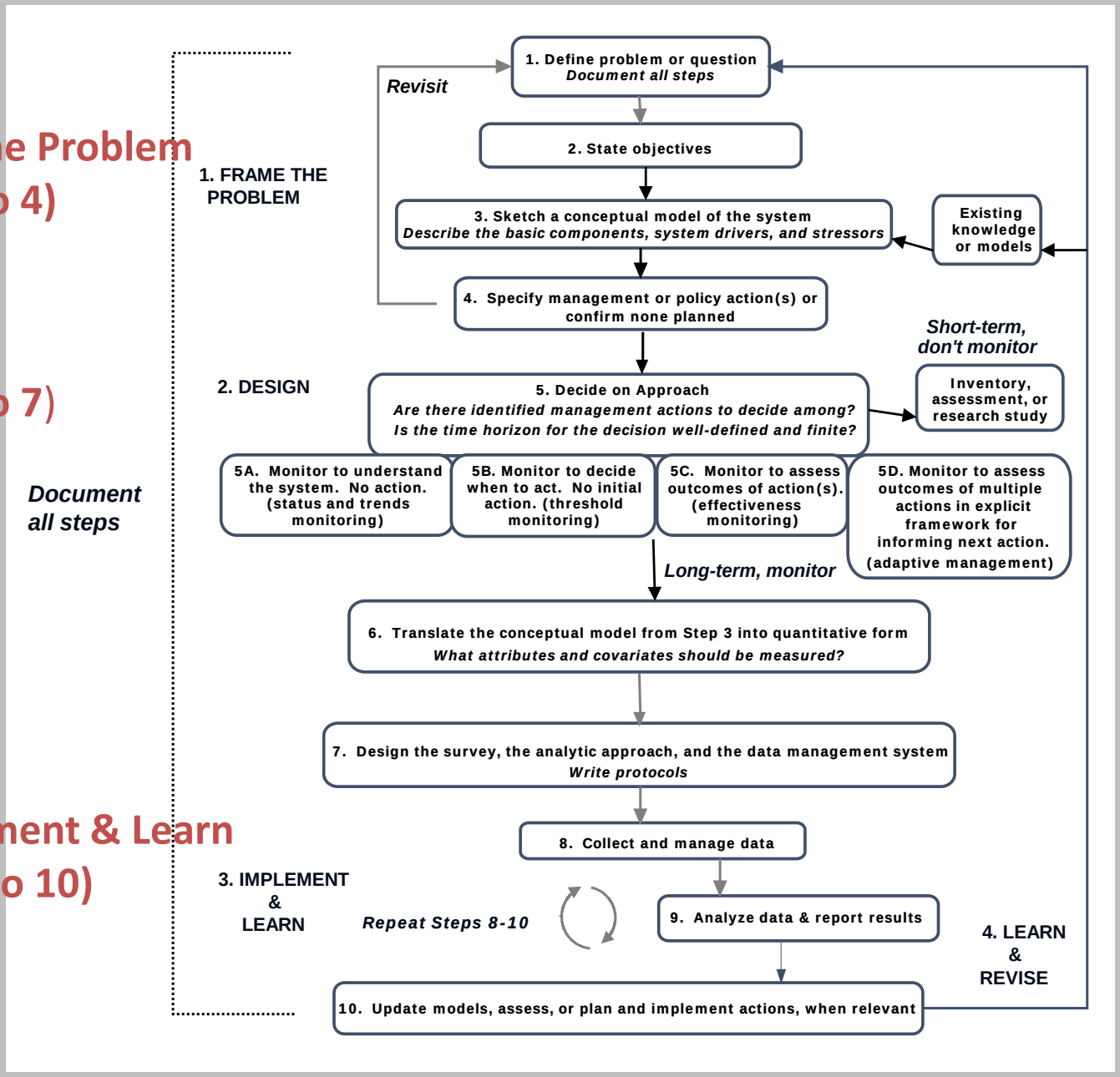
First framework integrating **all** components of designing and implementing a monitoring program.

Structure for discussion between Statisticians, Biologists, and Managers.

I .Frame the Problem (Steps 1 to 4)

II. Design (Steps 5 to 7)

III. Implement & Learn (Steps 8 to 10)

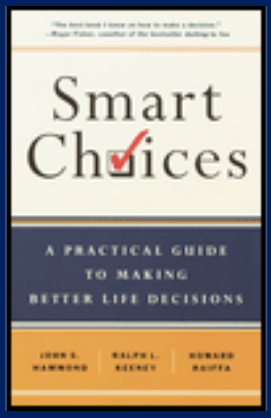


IV. Learn & Revise (meta-step)

Env. Monitoring & Assessment: http://link.springer.com/article/10.1007/s10661-016-5397-x

Steps 1 to 4 ≡ Structured Decision Making

From “Smart Choices”, **PrOACT**.



#1. Problem: State what the problem is

#2. Objectives: Define what is wanted

#3. Alternatives: Identify different actions to take

#4. Consequences: Imagine effects of actions (**C**onceptual Model)

Tradeoffs: compare actions

Step 1. Define the Problem

e.g., Delta Smelt are an endangered species and they are in danger of extinction

Temporal or spatial scope?

Decision makers?

Stakeholders?

Information Needs?

Step 2. State Objectives

"Start with the end in mind", Stephen Covey

Fundamental: **WHY?**

---should reflect Values….

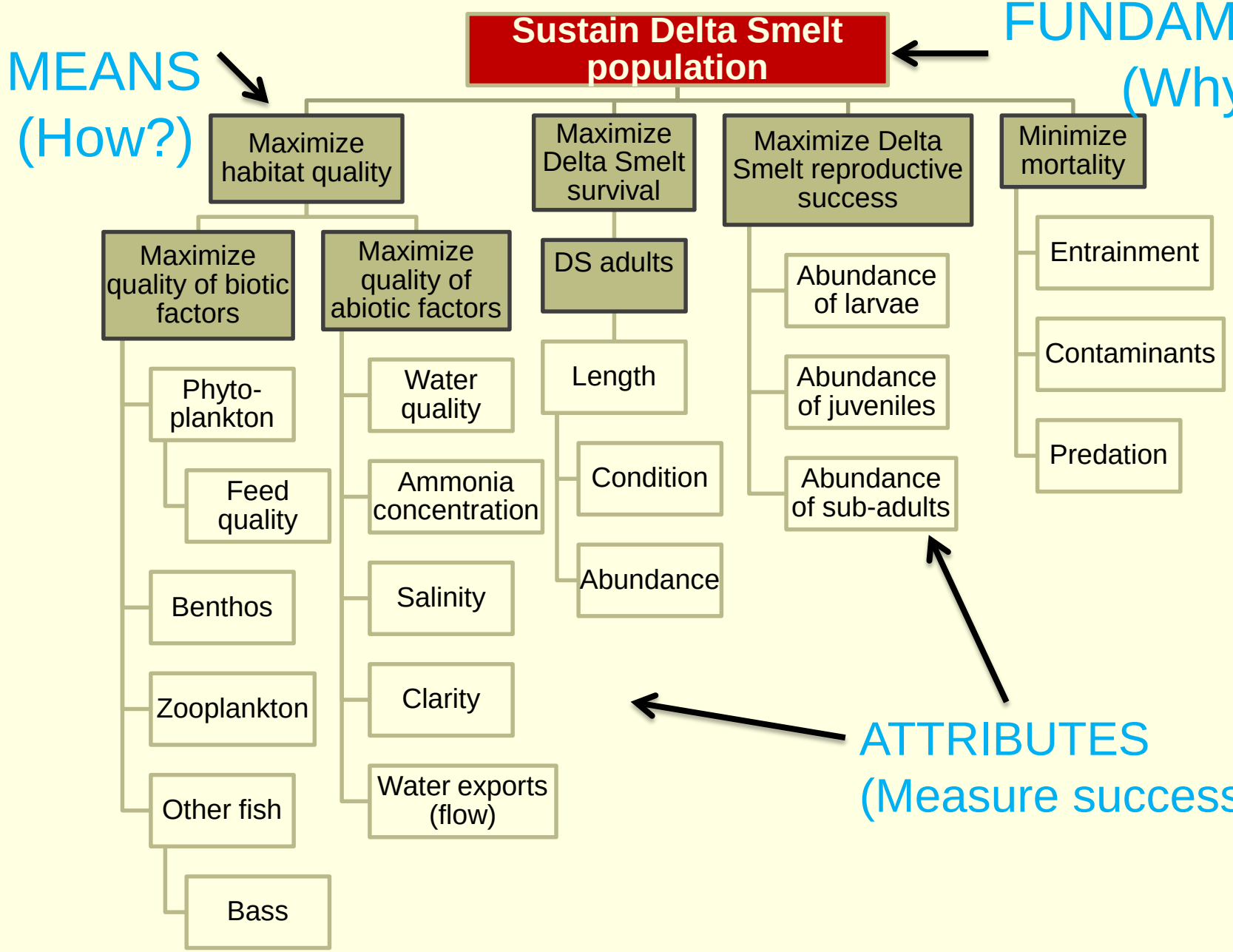
"Protect and restore Delta Smelt"

Means: **HOW?**

---the way to achieve a fundamental objective

e.g., increase survival. Increase reproductive success. Increase habitat quantity

Delta Smelt Objectives Hierarchy



Step 3: Conceptual Model of the System

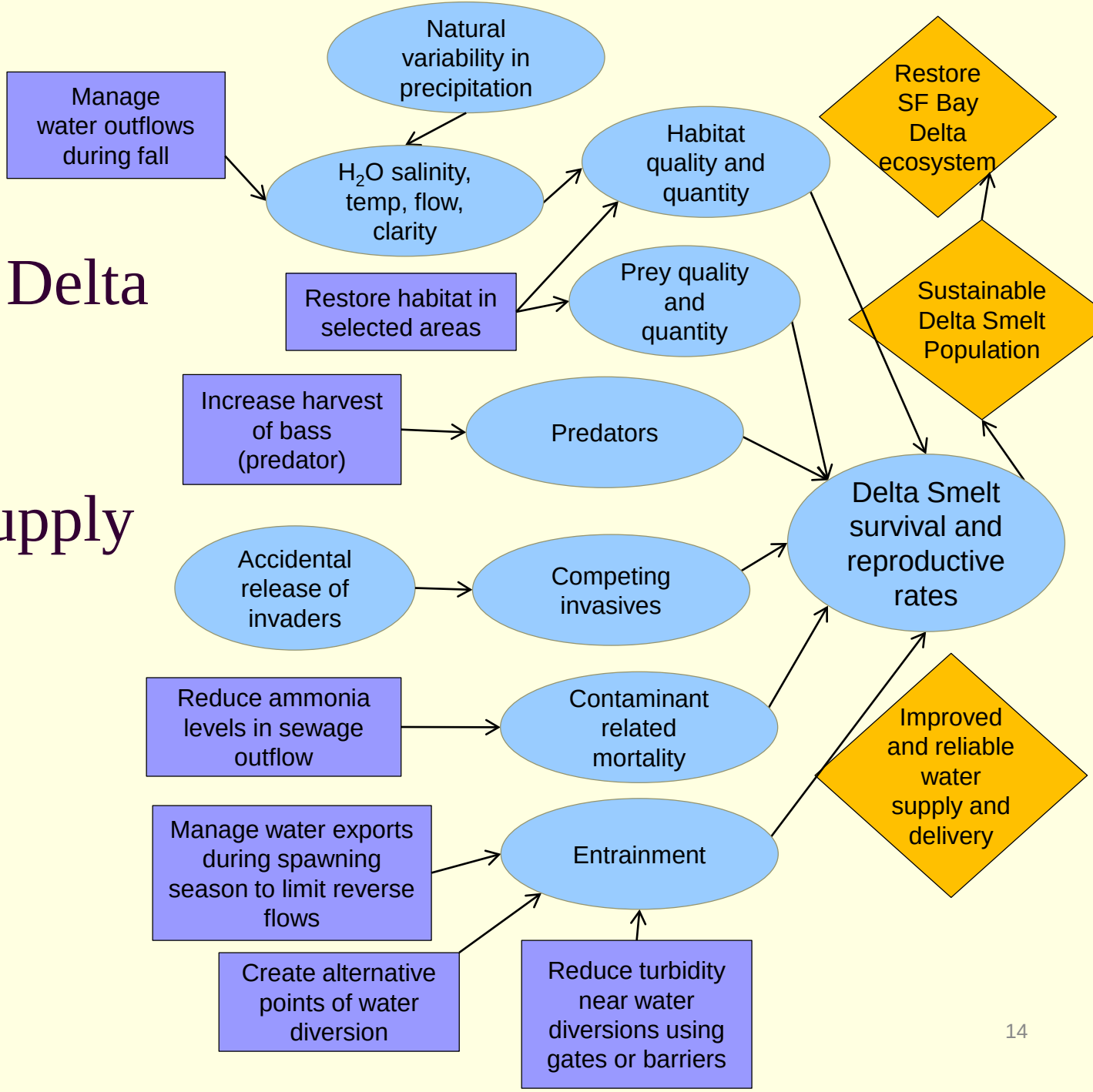
"the intellectual foundation upon which the monitoring program rests."

A visual depiction of the current understanding of a system's dynamics

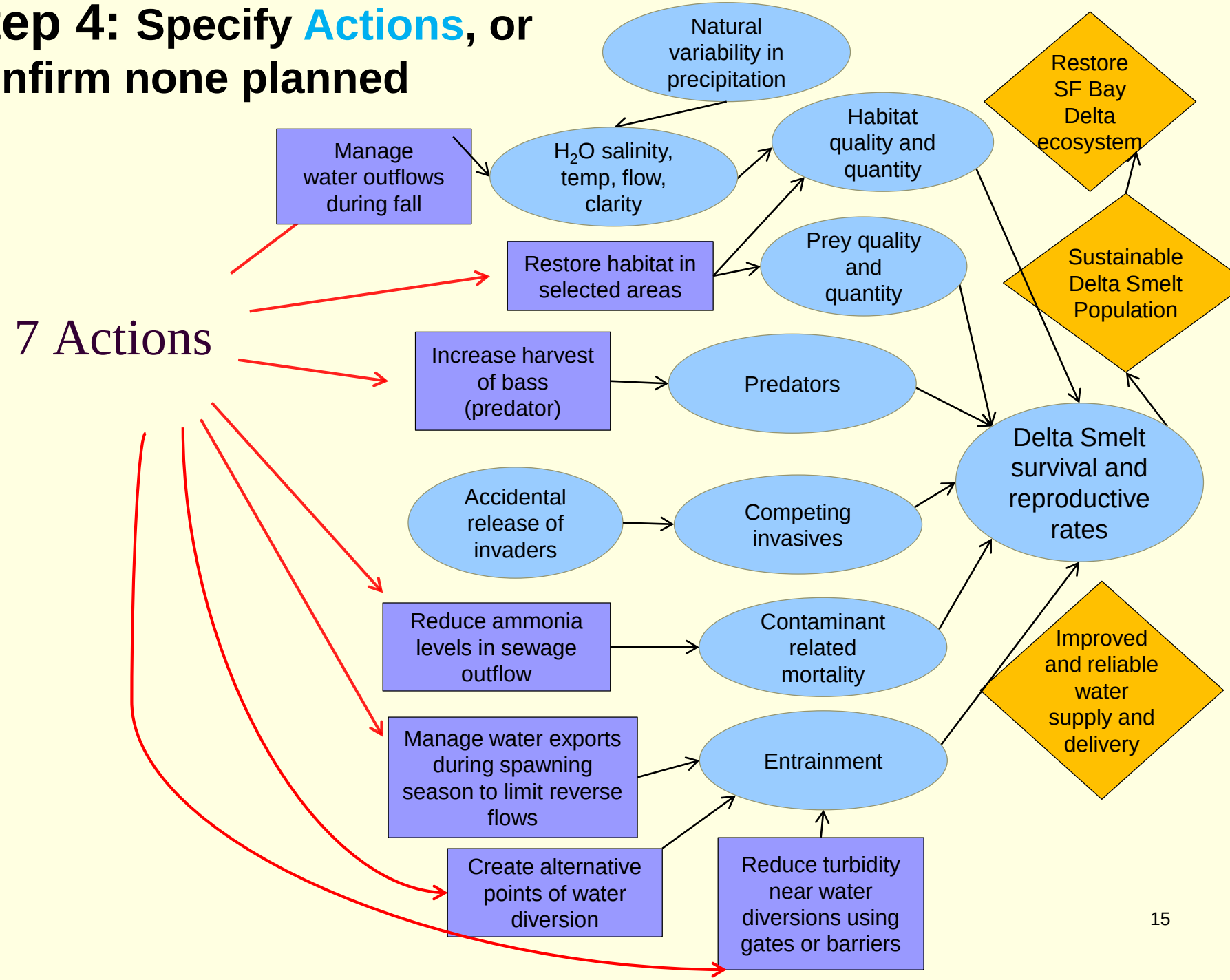
Includes system drivers and management actions **(A**lternatives) and the connection with fundamental and means objectives.

Problem:

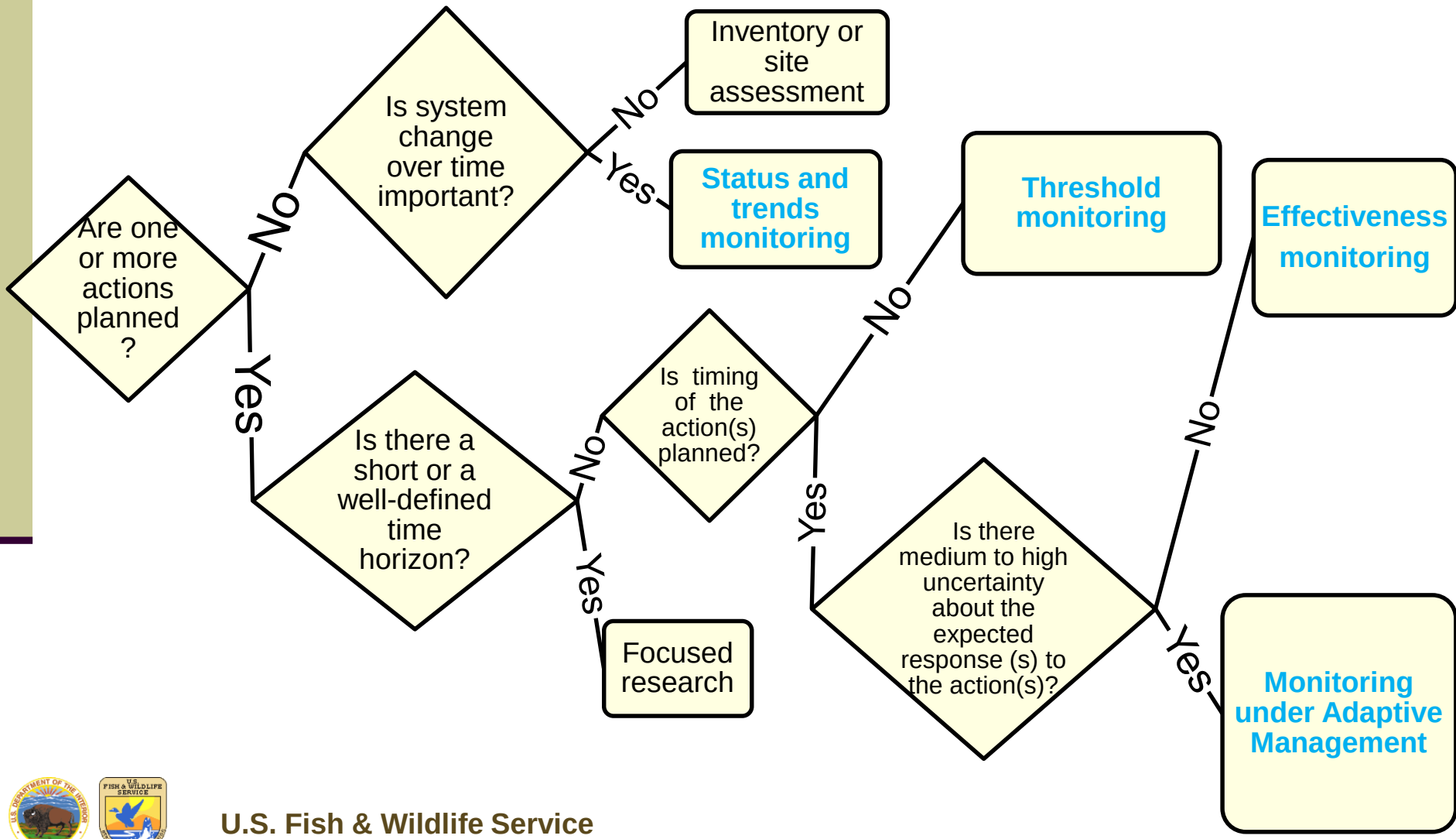
- Recover Delta Smelt
- Improve Water Supply



Step 4: Specify Actions, or confirm none planned



Step 5. Decide on an Approach

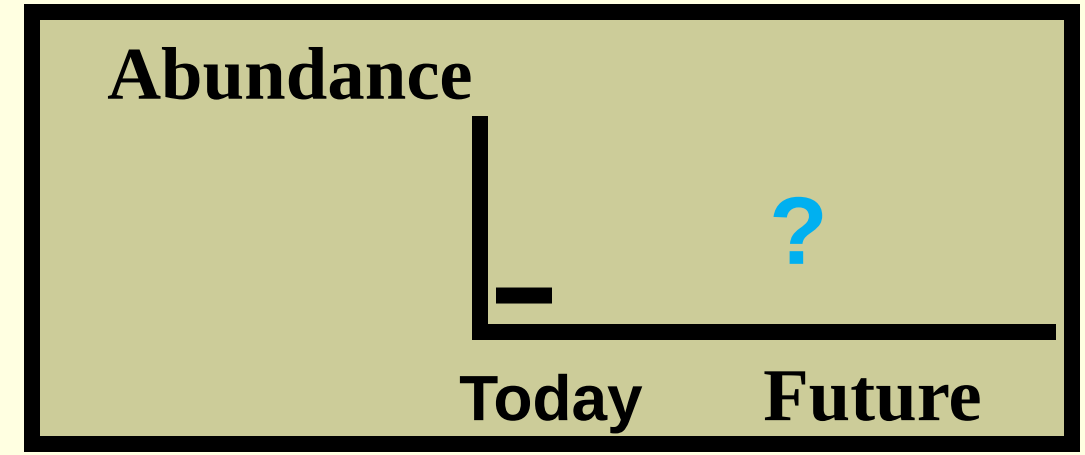


Step 6. Translate Conceptual Model into a Quantitative Model

Objectives => Actions => Consequences

Double Pintail Duck Abundance

Remove cattails



Objectives => Actions => Consequences

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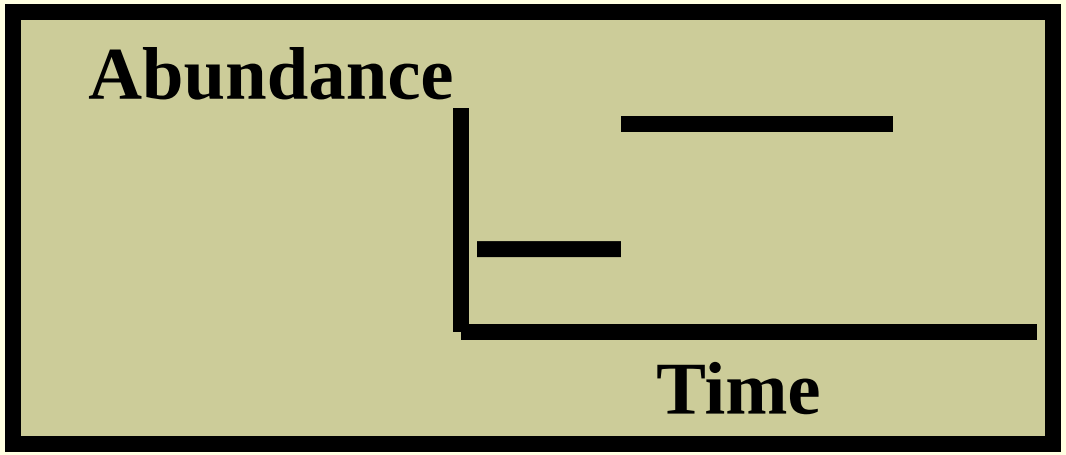


Step Change

Step 7. Survey Design

(1) Attributes versus Measurements

identify the Sampling Unit

(2) Snapshots: Plot samples, distance sampling, M/R

and

Movies: Cross-sectional, Longitudinal, Rotating Panel, ..

(3) Dual sample size problem:

within time period sampling intensity

number of times (revisits, etc)

III. Implement and Learn: Steps 8-10

Step 8. Collect & Manage Data:

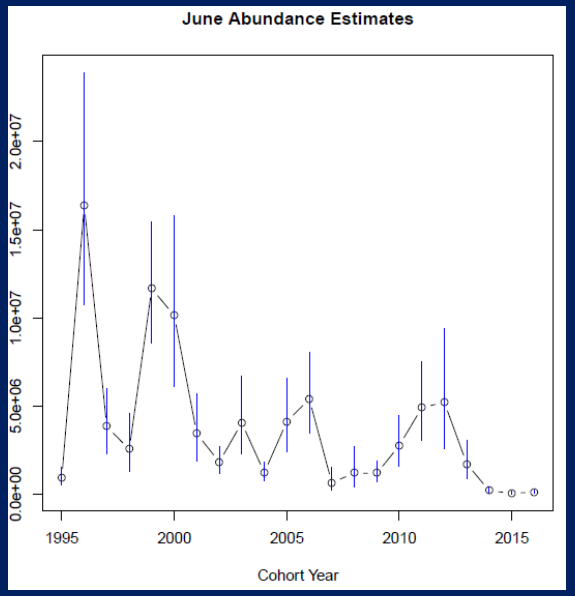
Field data collection- Sampling Protocol

Getting “raw” data into databases

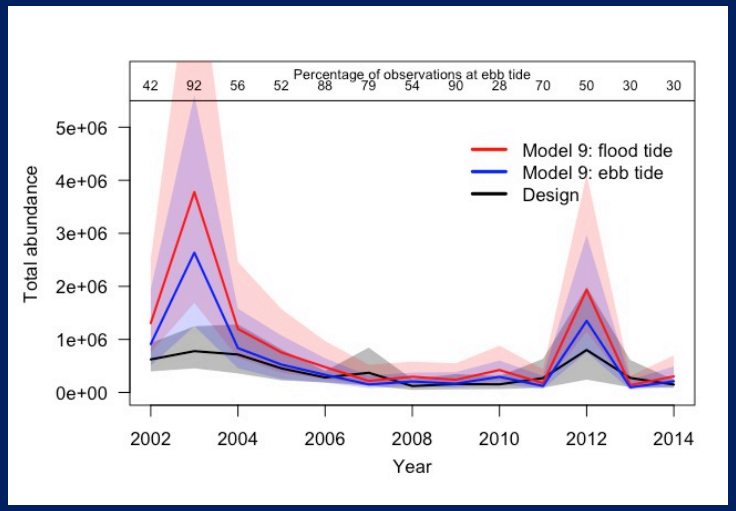
Year	Month	Week	SampleDate	Time	TowNum	SiteNum	Latitude	Longitude
2014	December	1	12/1/2014	7:00	1	TBD	38.17674	-122.287
2014	December	1	12/1/2014	7:10	2	TBD	38.17674	-122.287
2014	December	1	12/1/2014	7:20	3	TBD	38.17674	-122.287
2014	December	1	12/1/2014	7:30	4	TBD	38.17674	-122.287

Step 9. Analyze Data and Report Results

```
# function for calculating confidence intervals given point estimates and
#  standard errors assuming a lognormal distribution for estimates
logn.ci.alt <- function(theta,se.theta,alpha=0.05) {
  logn.sigma <- se.theta/theta
  z <- qnorm(1-alpha/2)
  LB <- theta*exp(-z*logn.sigma)
  UB <- theta*exp(z*logn.sigma)
```



Step 10. Update models, Assess Actions, Plan new Actions



Only 1 of the 10 steps is actual data collection!

Concluding Remarks

"I am using the roadmap in my everyday work. I recently had a biometric request that was extremely broad/unfocused, had multiple collaborators, a large spatial scale, and a 10-year time frame for the proposed study. I sent the PIs a copy of the draft Roadmap manuscript and asked them to consider this approach so we could get on the same page. It worked! ….. The PIs seem **relieved to be working towards a more focused goal** and I have gotten only supportive feedback about the roadmap. The roadmap is a great tool to pull people together so I can more effectively focus my efforts."

Anna-Marie Benson, Biometrician, USFWS

Thank you!