Adaptive Management for Large-Scale Water Infrastructure: An Overview of AM

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ESSA

Why is there a need for more effective approaches to environmental management?


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WHY?

Some Pressing Challenges in Environmental Management

- Increasing complexity and uncertainty;
  difficulty in establishing cause and effect
- Increasing intensity of dueling science;
  disagreement about **how** to get what people want
- Increasing conflict among competing interests and objectives;
  disagreement about **what** people want
- Increasing overlap in mandates and responsibilities
- Increasing scrutiny of decisions and needs for transparency
- Decreasing resources and capacity to support science and decision making
- Others?

Some Pressing Challenges in Environmental Management

1 **UNCERTAINTY & COMPLEXITY**

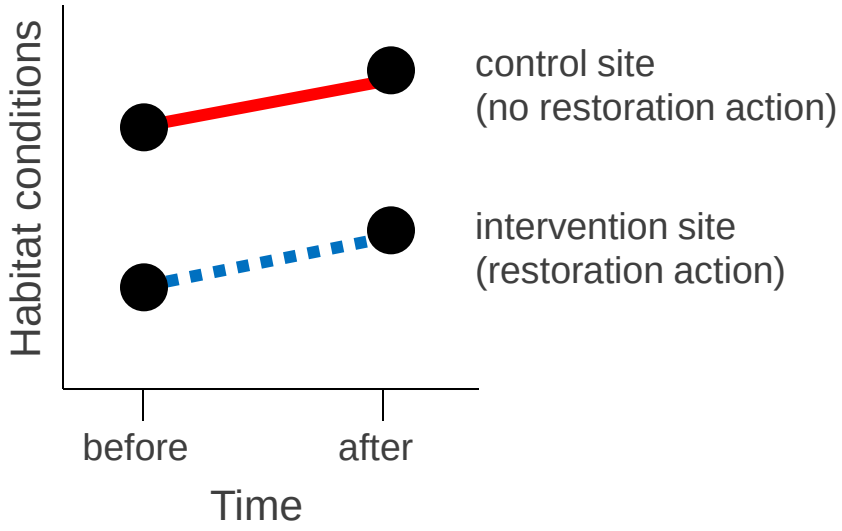
- Increasing complexity and uncertainty;
  difficulty in establishing cause and effect
- Increasing intensity of dueling science;
  disagreement about **how** to get what people want

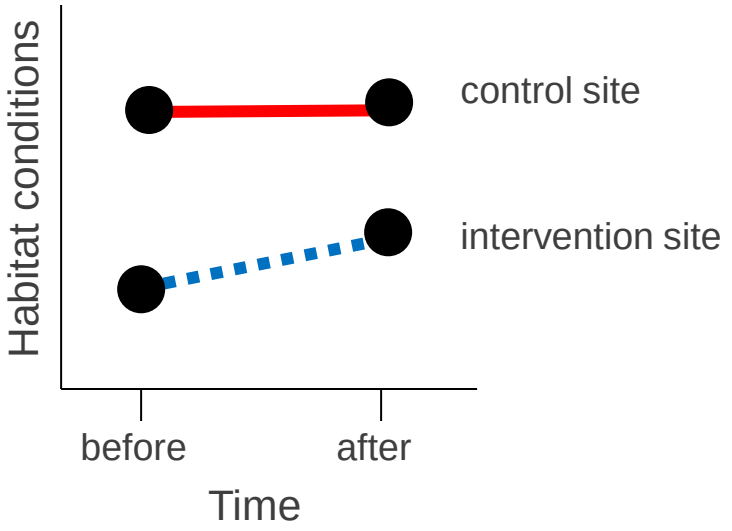
2 **PARTICIPATION & COORDINATION**

- Increasing conflict among competing interests and objectives;
  disagreement about **what** people want
- Increasing overlap in mandates and responsibilities
- Increasing scrutiny of decisions and needs for transparency
- Decreasing resources and capacity to support science and decision making

- Others?

Establishing Cause and Effect





Conclusion?

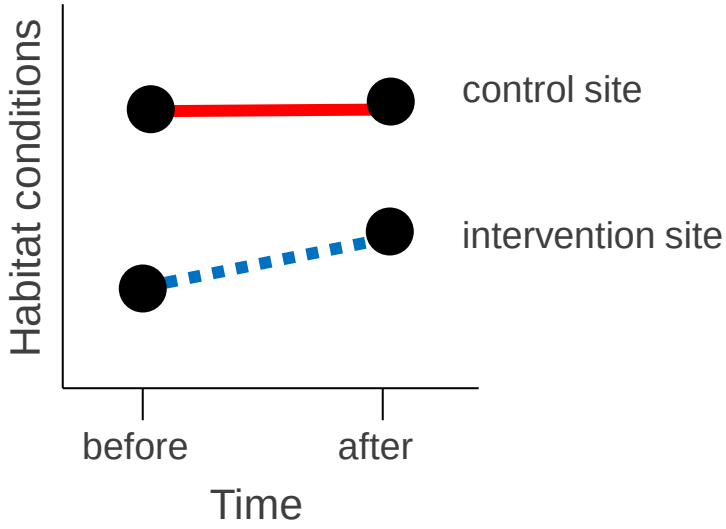
- No evidence of effect
- Both sites experience same temporal trend
- Control vs. intervention reflects site differences

Conclusion?

- Change over time differs between sites
- Action appears to have had an effect

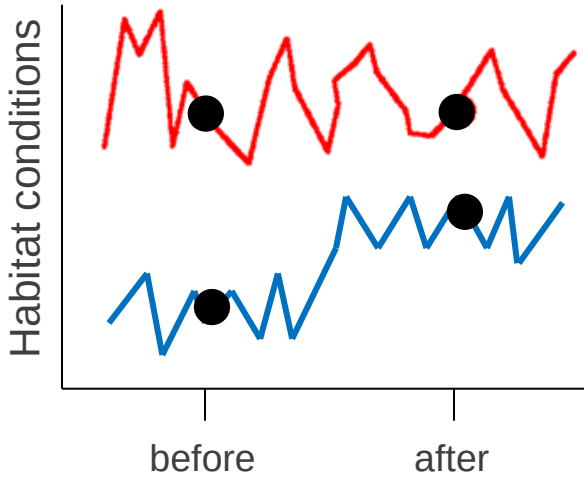
Adapted from Schwarz 1998

But was this conclusion correct?

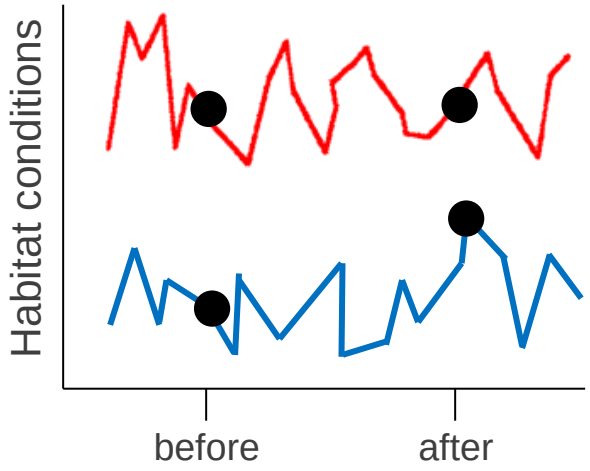


Natural variation can mask the signal amongst the noise

*…**yes**, if*



*…but **no**, if*



Competing Interests and Objectives


You can’t
always get
what you want!

What is Adaptive Management?

Adaptive Management is….

a rigorous approach for designing and implementing management actions

to

maximize learning about critical uncertainties that affect recurrent decisions

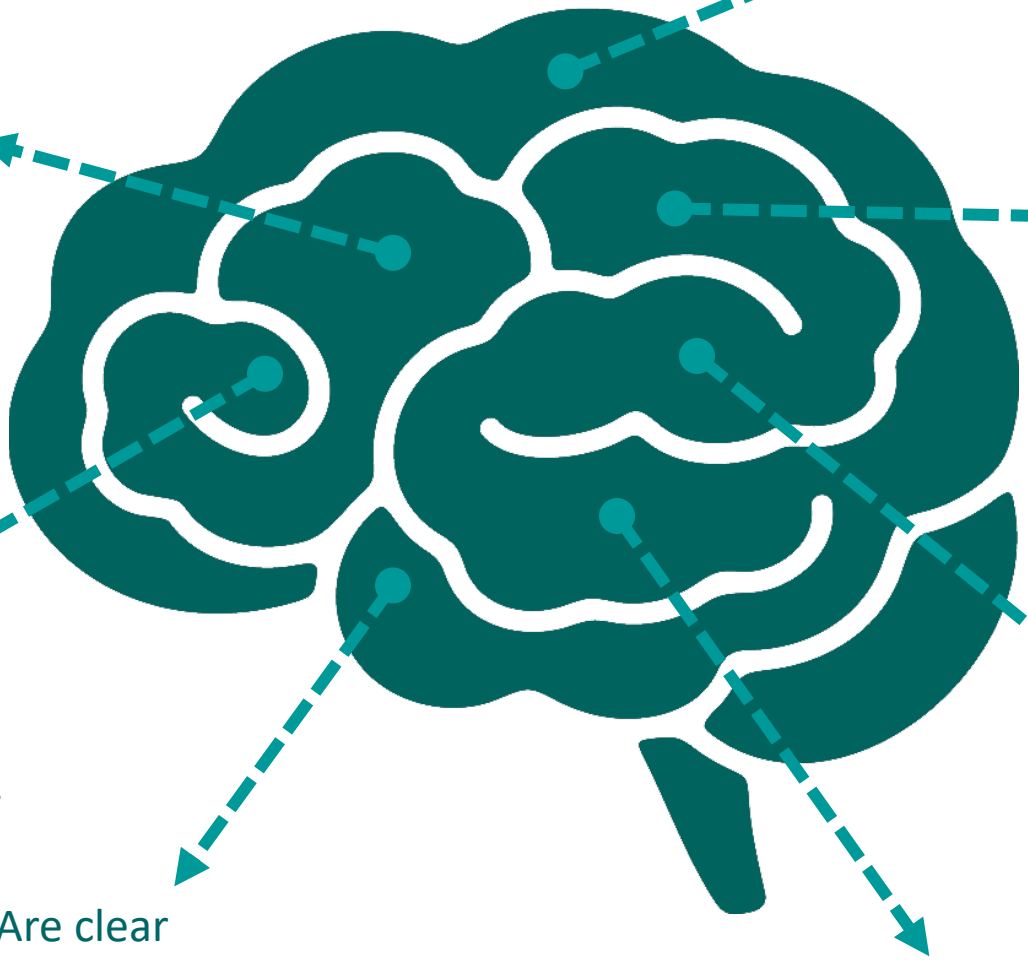
while simultaneously

striving to meet multiple management objectives.

People with an AM Mindset....

Communicate in a clear and transparent way.

Focus on uncertainties that have the most influence on decisions.



Use collaborative processes for resolving uncertainties.

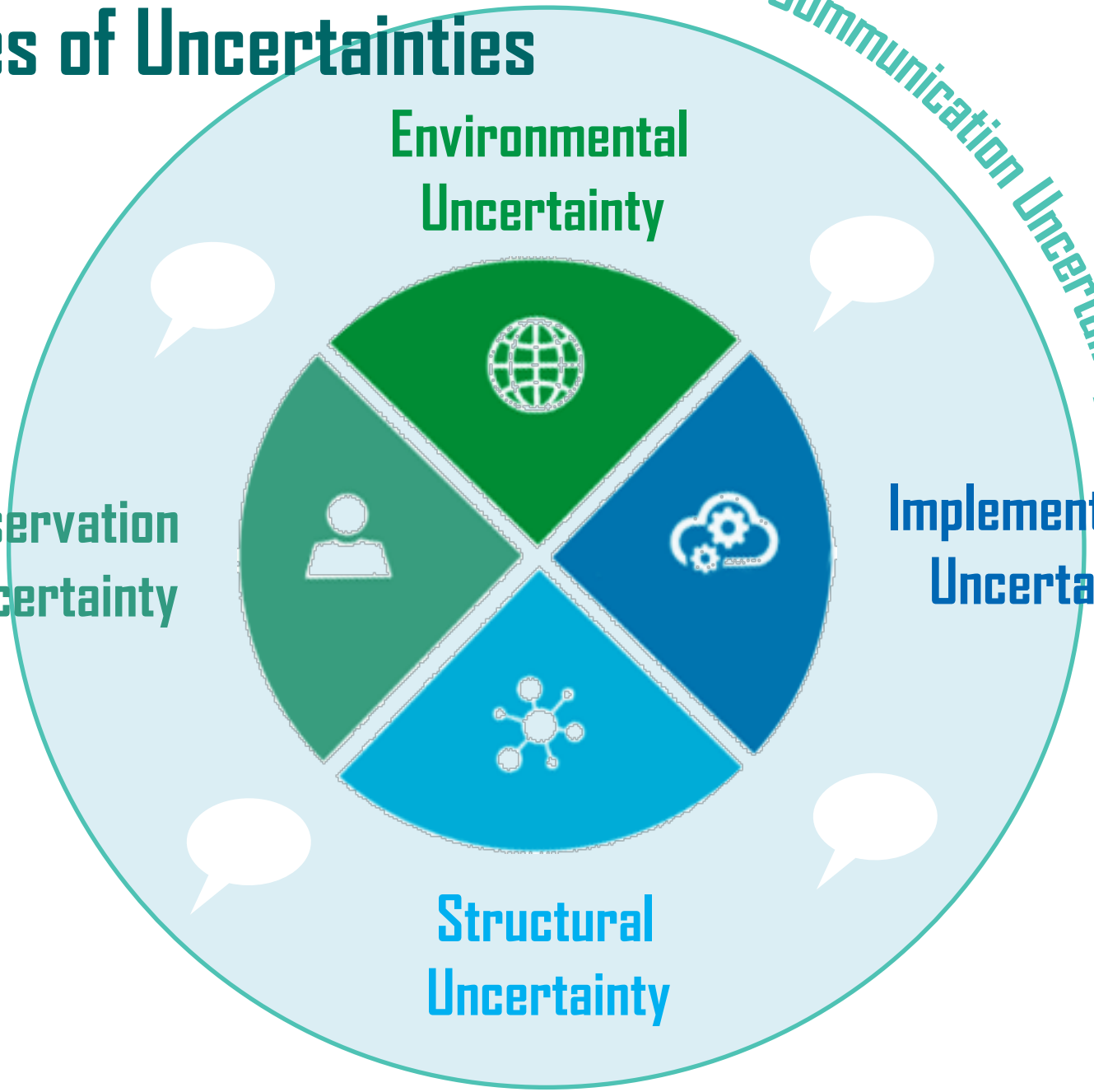
Isolate complex issues and use 'systems thinking' to analyze them.

Commit to monitoring, learning, and adjusting actions; backed by organizational culture.

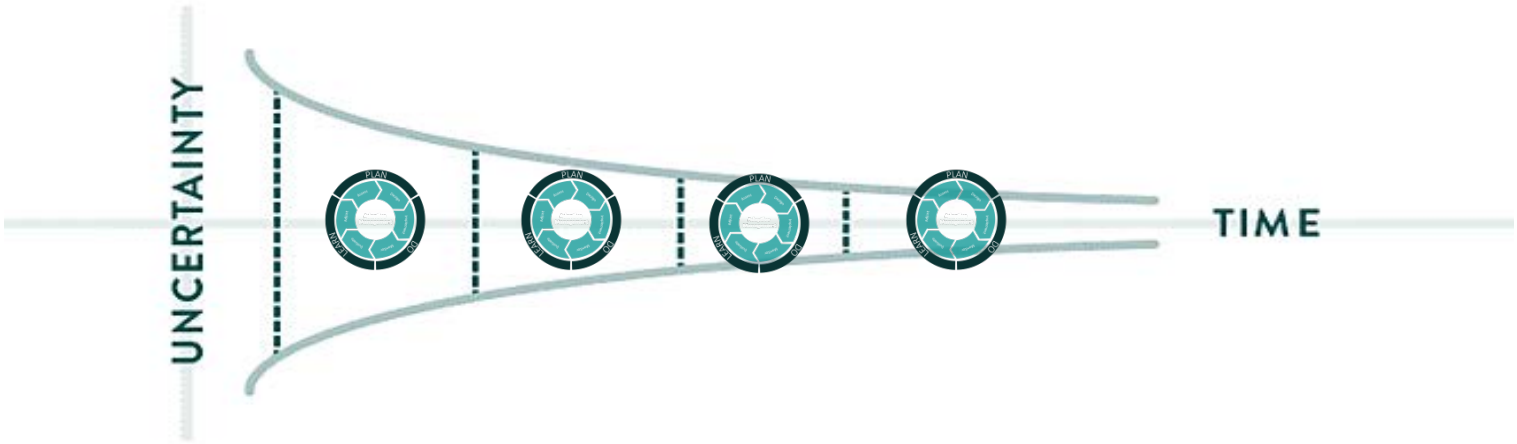
Are clear about objectives.

Implement contrasting interventions to test hypotheses and hasten learning.

Types of Uncertainties



Types of Uncertainties



Reducing a **scientific uncertainty** leads to better knowledge and fewer erroneous results/inferences.

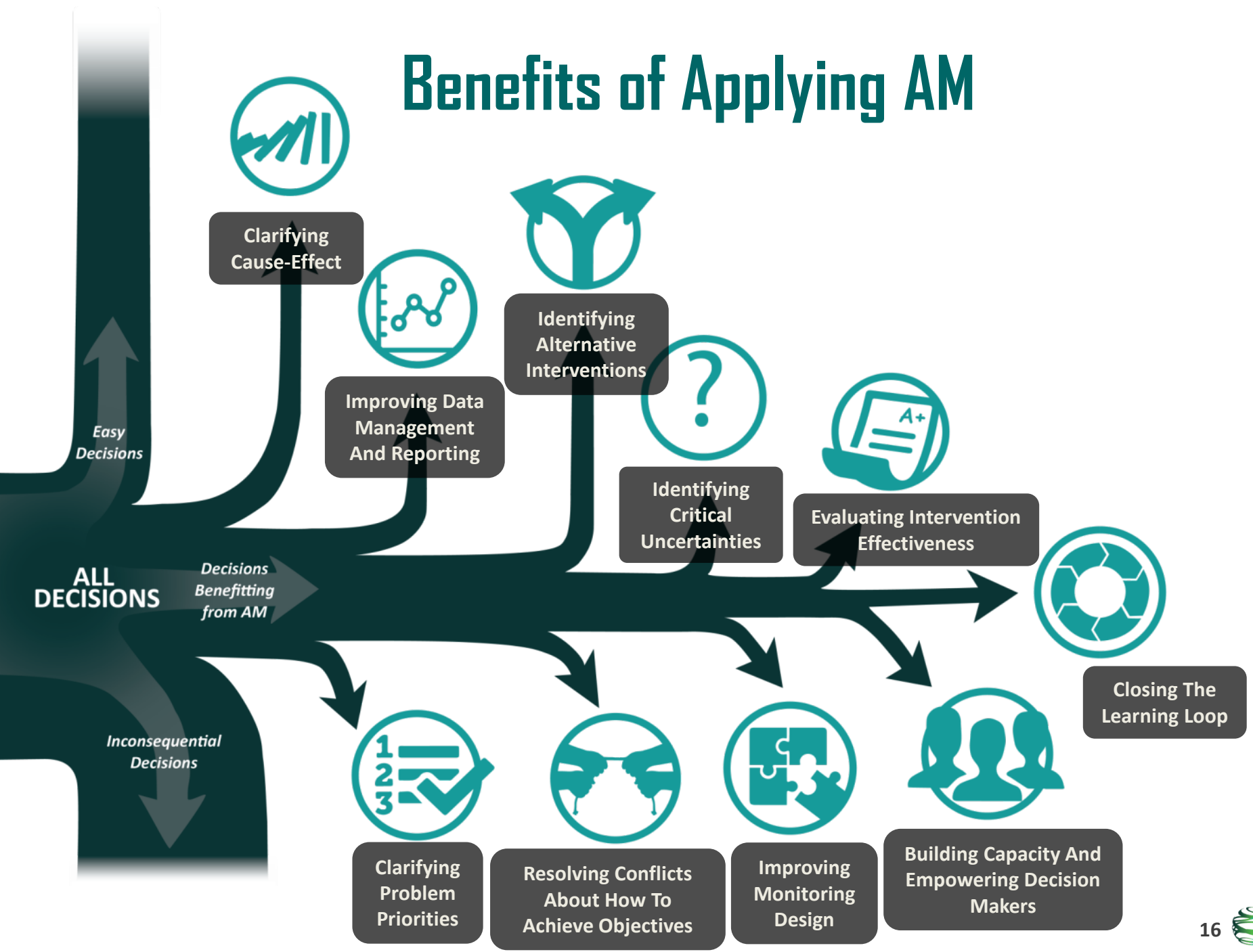
Reducing a **management (or critical) uncertainty** leads to either:

- rigorously **confirming current management actions** are appropriate,

OR

- a **choice of different management actions** that better satisfy one or more objectives.

Benefits of Applying AM



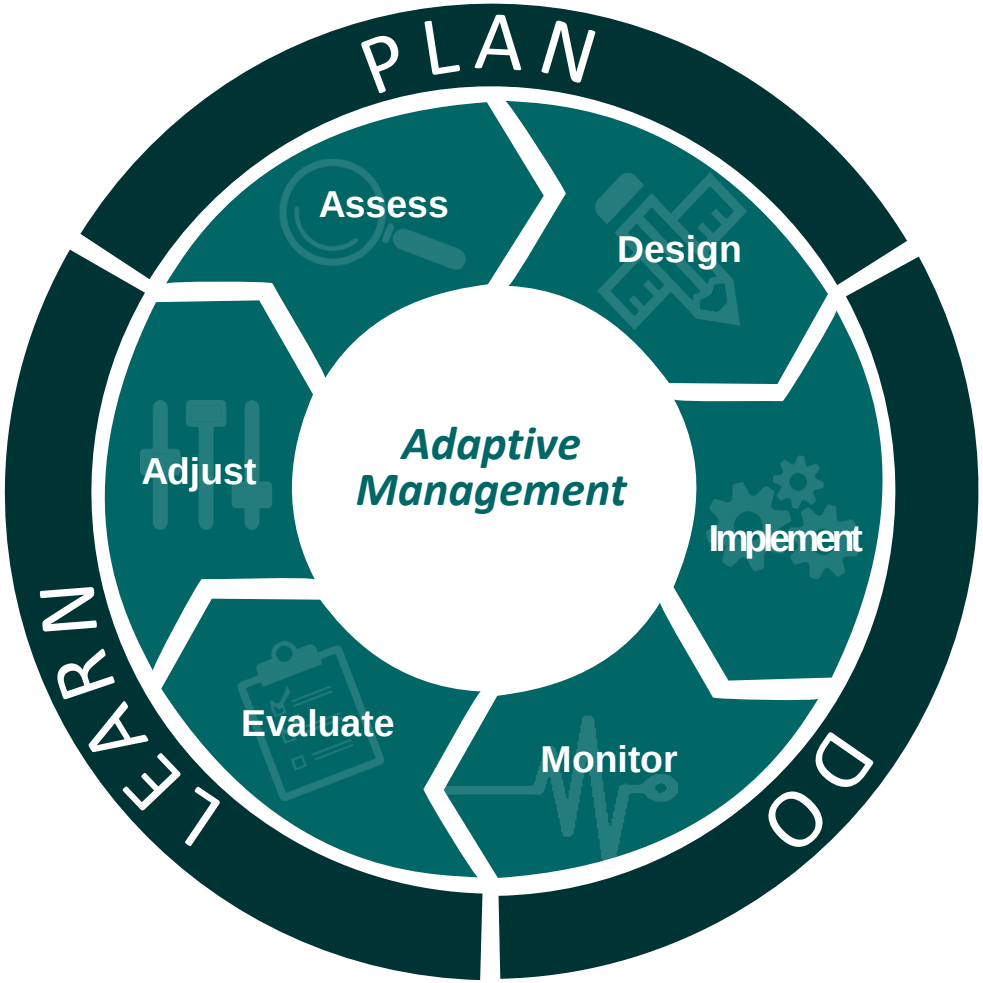
AM Light vs. AM Stout

- **Problem context** does not require AM (low stakes / uncertainty)
- **Organizational structure** does not support AM
- Only some steps and elements of **AM practice** are applied

- **Problem context** well suited to AM (high stakes, high uncertainty)
- Robust **organizational structure** to support AM
- Full commitment to steps and elements of **AM practice**

Adapted from David Galat, University of Missouri and Murray et al. 2015

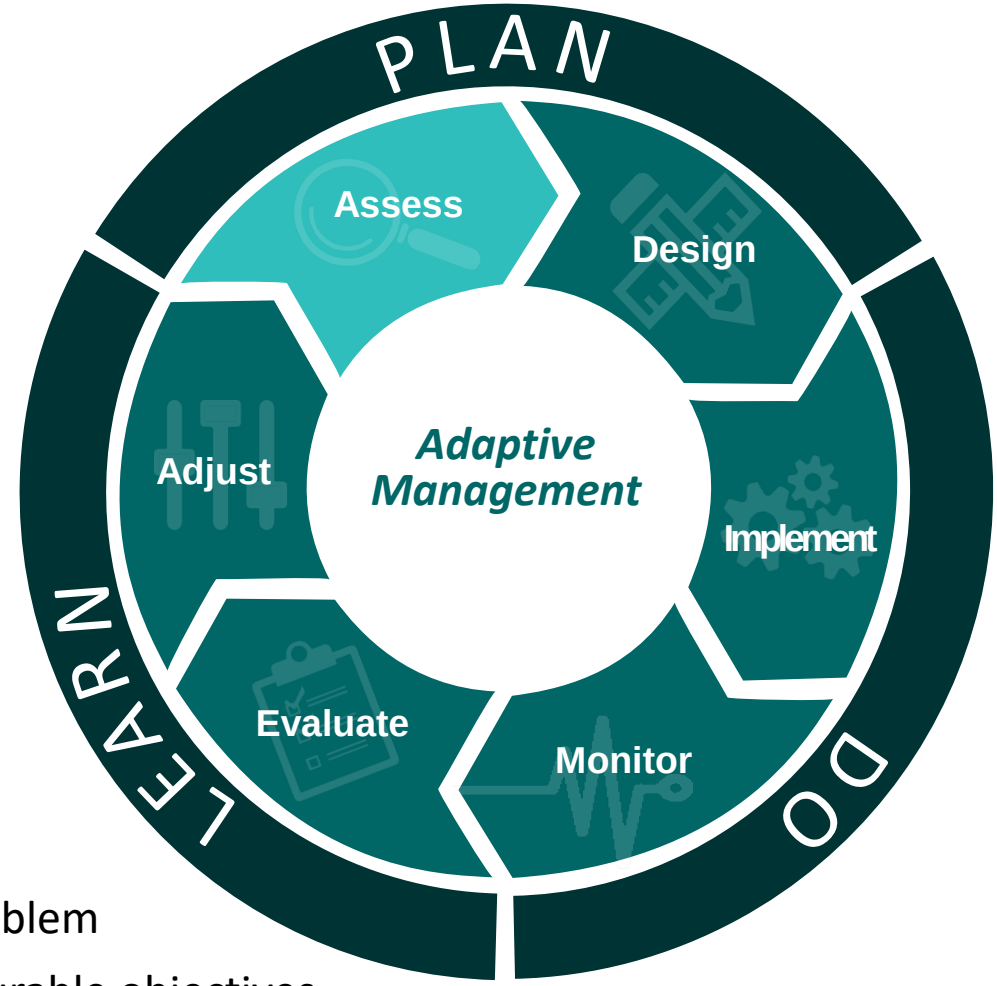
How is Adaptive Management conducted?



PLAN: Frame problem, assess, and design actions from view of management uncertainties

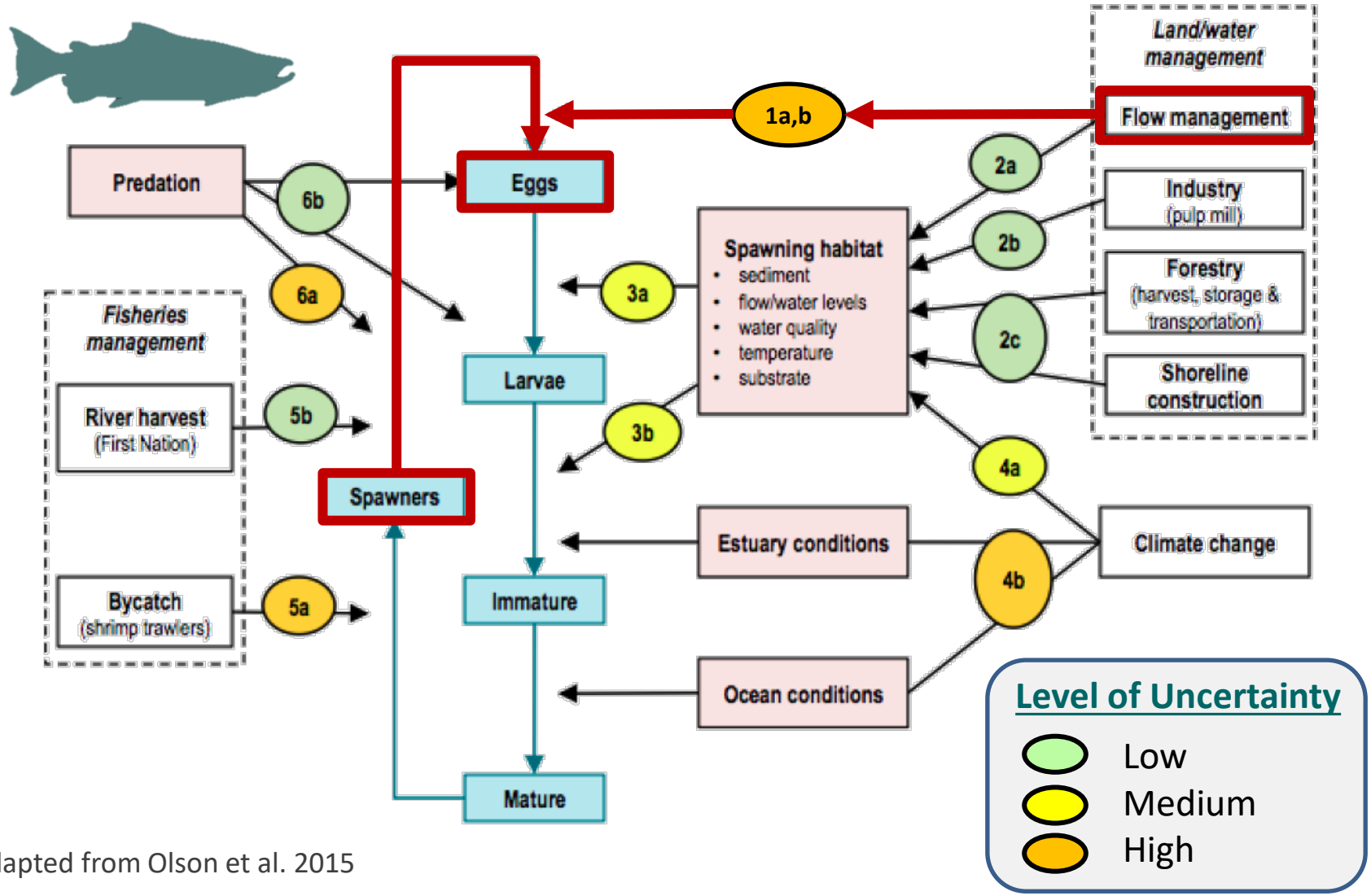
DO: Implement and monitor actions using principles of experimental design

LEARN: Evaluate data to learn about effectiveness of actions and adjust management



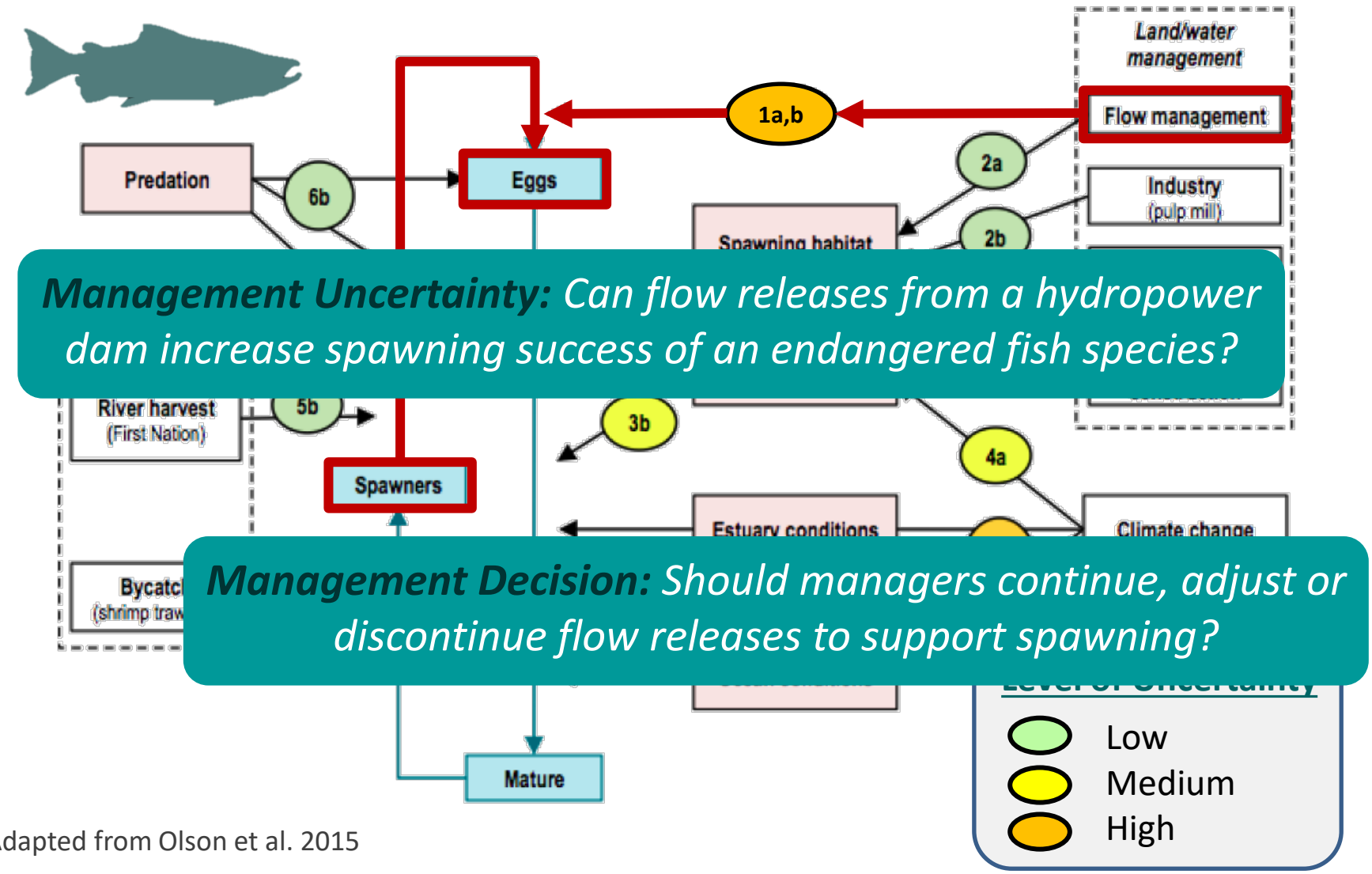
- Define the problem
- Identify measurable objectives
  (what are you trying to achieve and how will you know when you get there?)
- Identify management uncertainties (what do you want to learn about?)
- Build conceptual and/or quantitative models; explore hypotheses, alternative actions
- Predict outcomes / responses

Assess: Use 'systems thinking'



Adapted from Olson et al. 2015

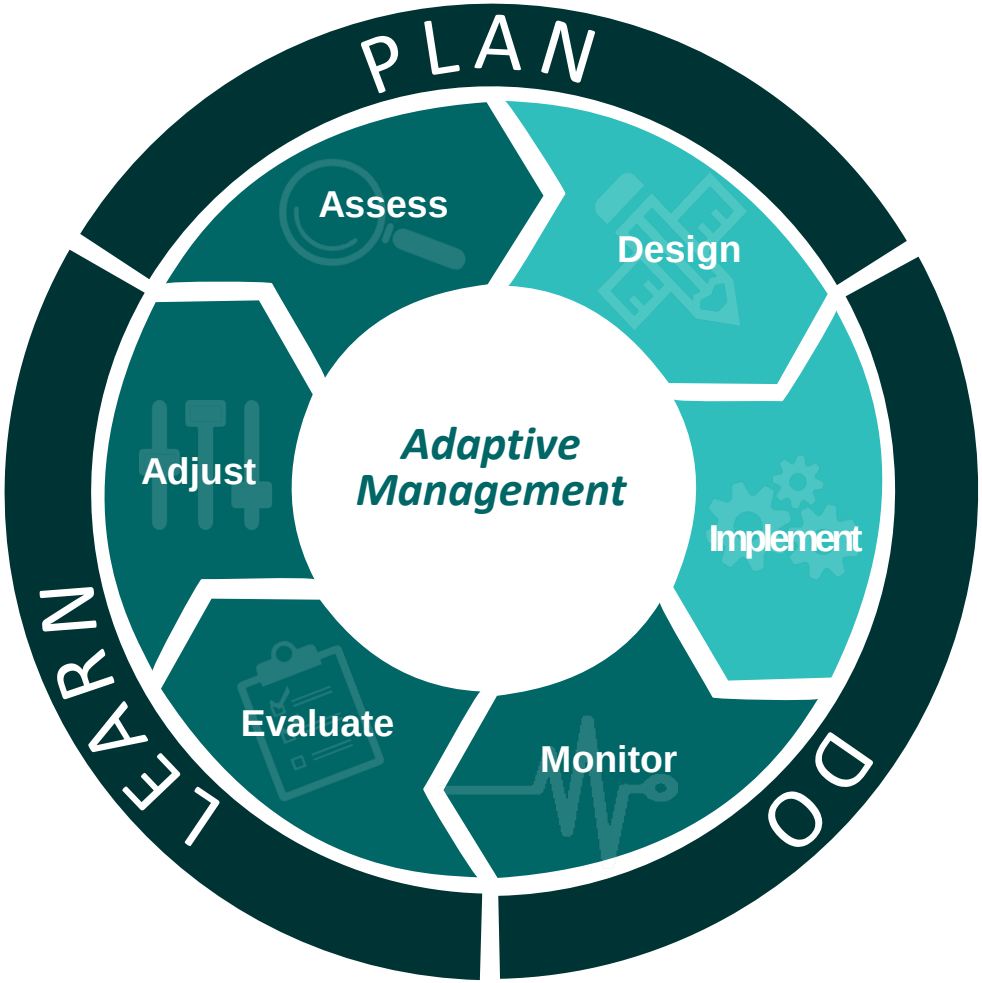
Assess: Use 'systems thinking'



Management Uncertainty: *Can flow releases from a hydropower dam increase spawning success of an endangered fish species?*

Management Decision: *Should managers continue, adjust or discontinue flow releases to support spawning?*

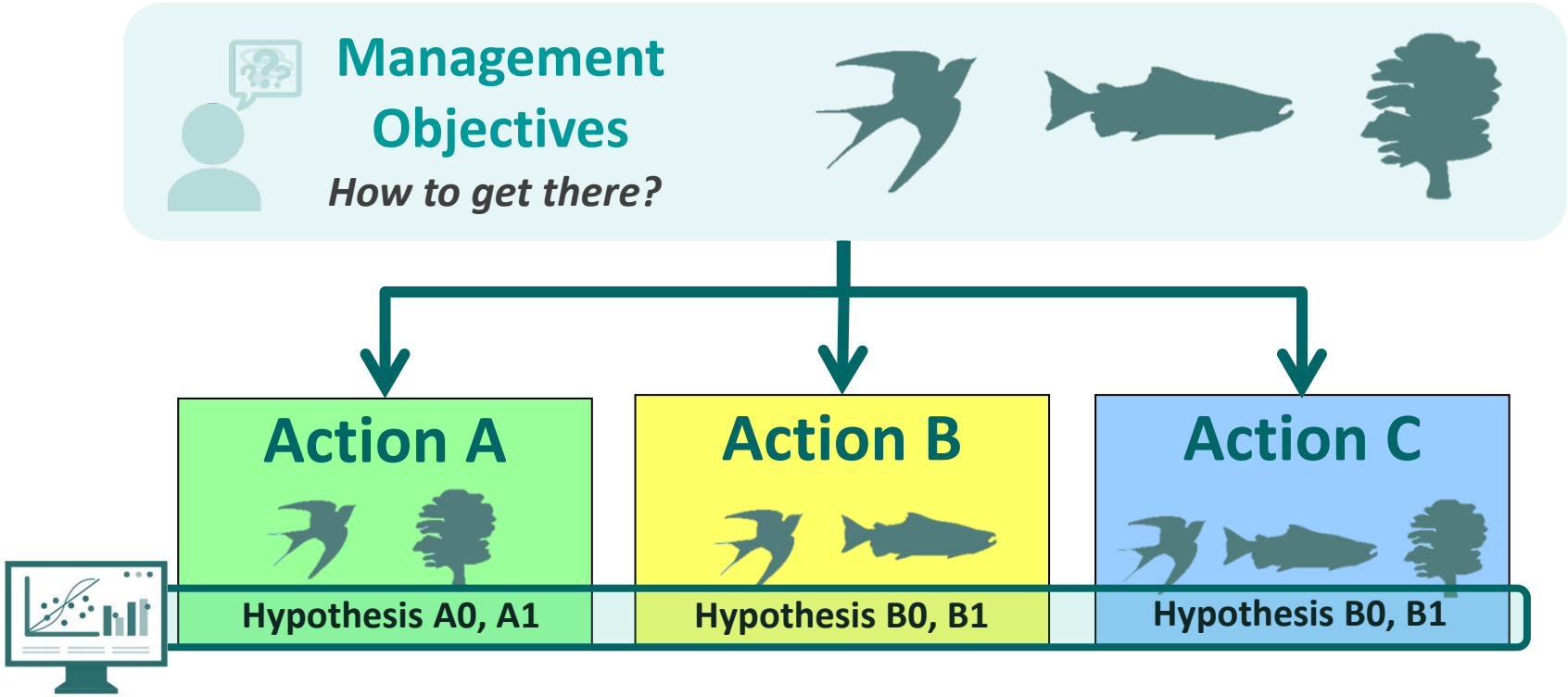
Adapted from Olson et al. 2015



- Design management treatments; contrasts, replicates, controls… (power analysis,)
- Design plans for next steps (identify relevant metrics, statistical monitoring design, identify field sampling protocols, data analysis plans)
- Implement actions / treatments as designed

Implement: Test hypotheses with contrasting interventions

Identify management objectives, assess and implement management action(s), and monitor; evaluate; adjust



__Several actions__ available emphasizing different objectives.

__Hypotheses__ about outcomes can be generated by modelling.

And they can be __tested with two learning strategies__…

Passive AM

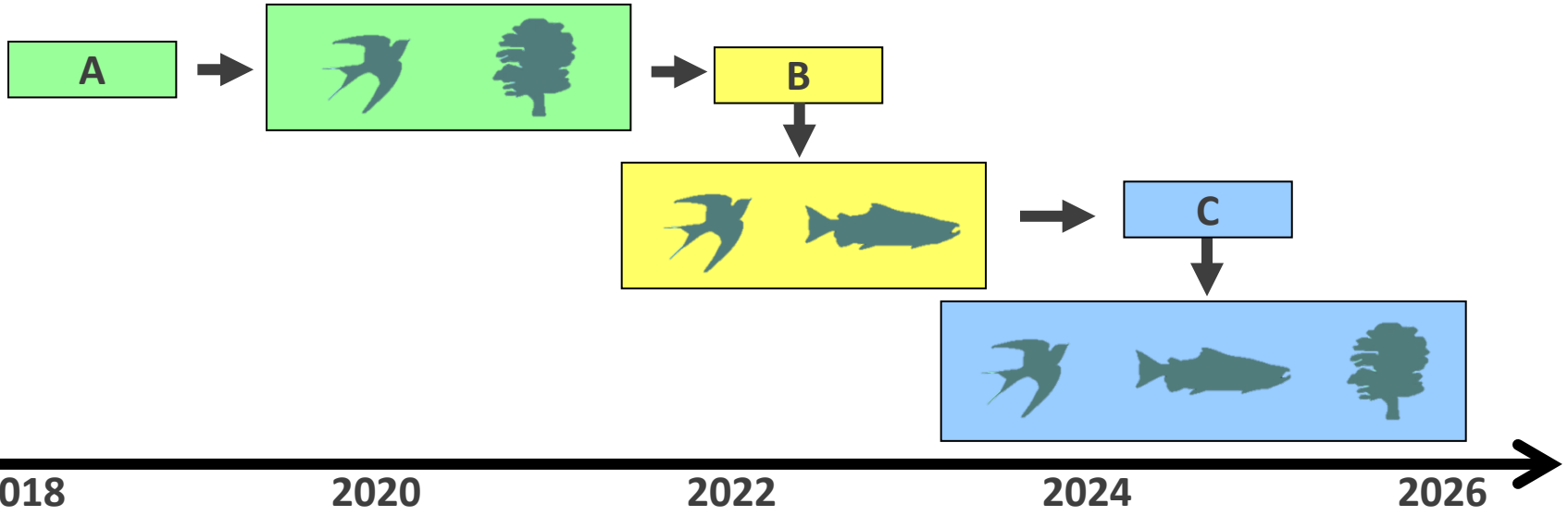
Assess and implement ‘best’ management action; monitor; evaluate; adjust

Management Objectives

How to get there?

SEQUENTIAL TREATMENTS

Management Action → **Examine Outcomes** → **Adjust** → **Adjust Again**



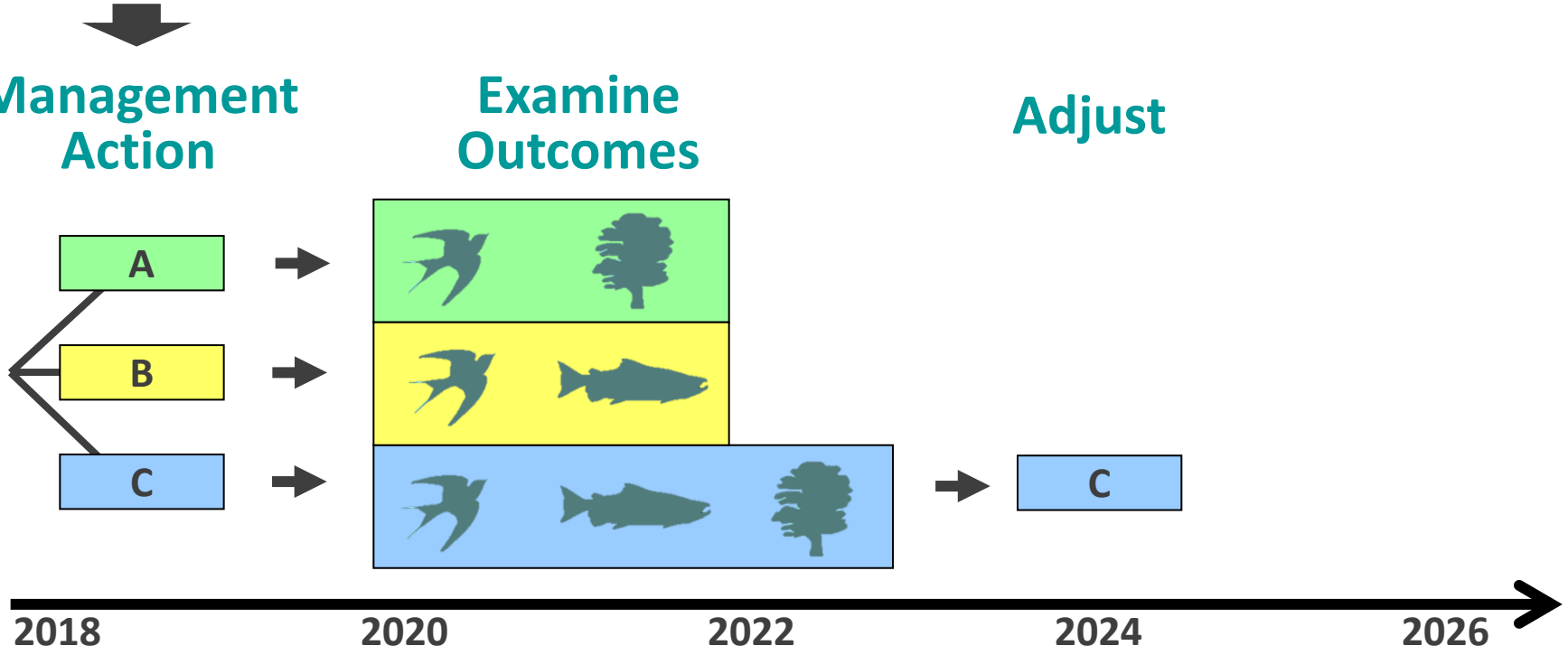
Active AM

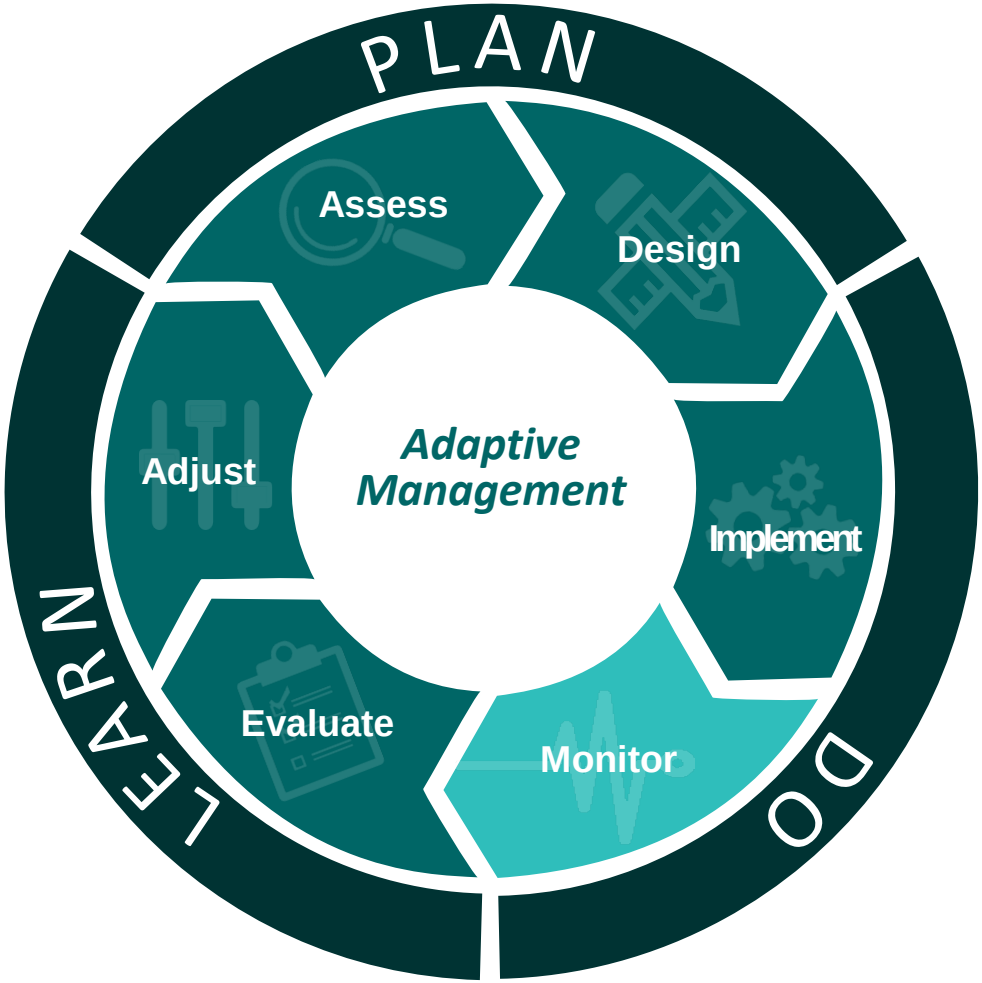
Deliberate probing, using different management actions; monitor; evaluate; adjust

Management Objectives

How to get there?

CONCURRENT TREATMENTS



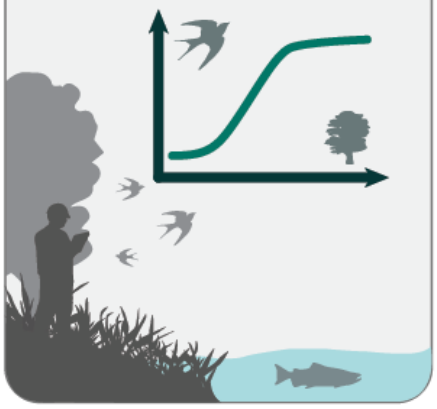


- Make observations / gather data about system

Monitor: Commit to monitoring to track progress

Validation & Research

Do we understand the system, its components & relationships?

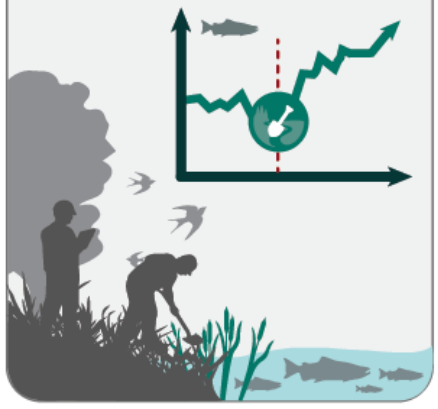


Implementation & Compliance

Was a management action implemented as intended?

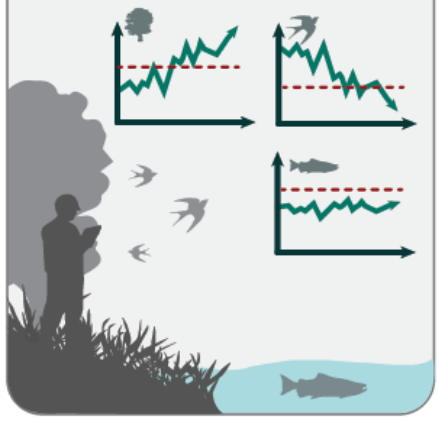
Effectiveness

Is there a response to the management action? How effective is it?



Status & Trend

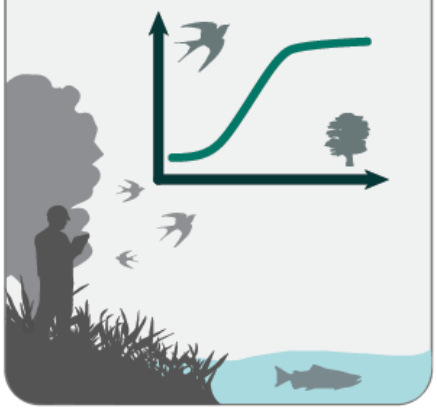
How are valued components changing? Are targets being achieved?



Monitor: Commit to monitoring to track progress

Validation & Research

Do we unders… the syste… compon… relationships?

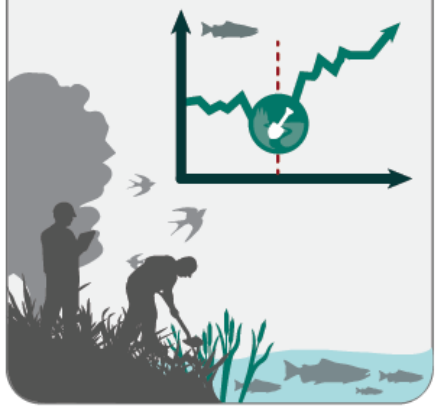


Implementation & Compliance

Was a… intended?

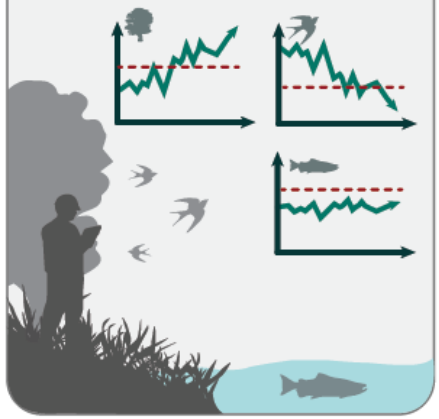
Effectiveness

Is there a… effective is it?

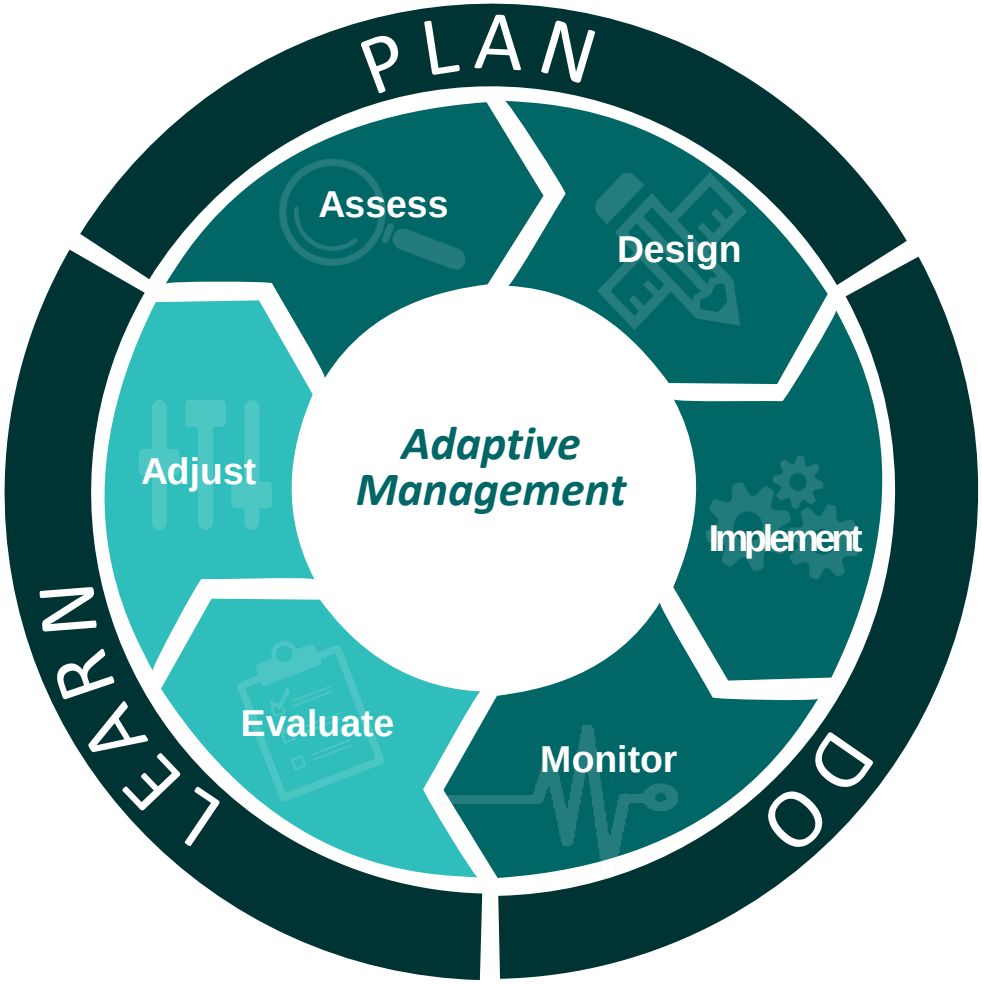


Status & Trend

How are valued …onents …ng? Are …s being achieved?



Different purposes of monitoring, each with different roles in AM; ensure "fit for purpose".



- Analyze data as related to management questions / hypotheses
- Compare results with earlier predictions
- Draw conclusions (what was learned?), share insights with others
- Modify actions, practices, and/or policies based on what was learned

Evaluate / Adjust:

Commit to learning and adjusting actions

Management Uncertainty: *Can flow releases from a hydropower dam increase spawning success of an endangered fish species?*

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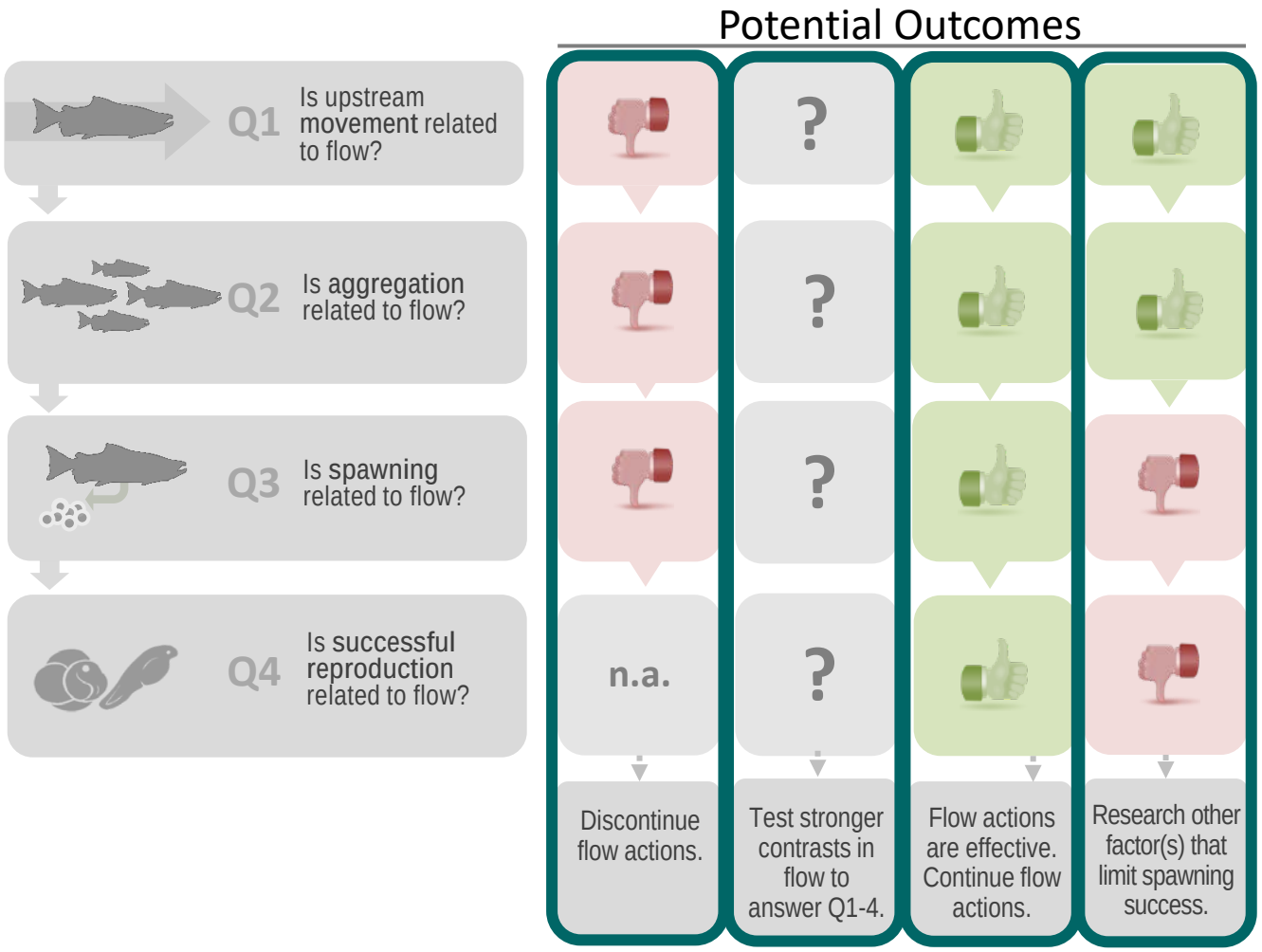
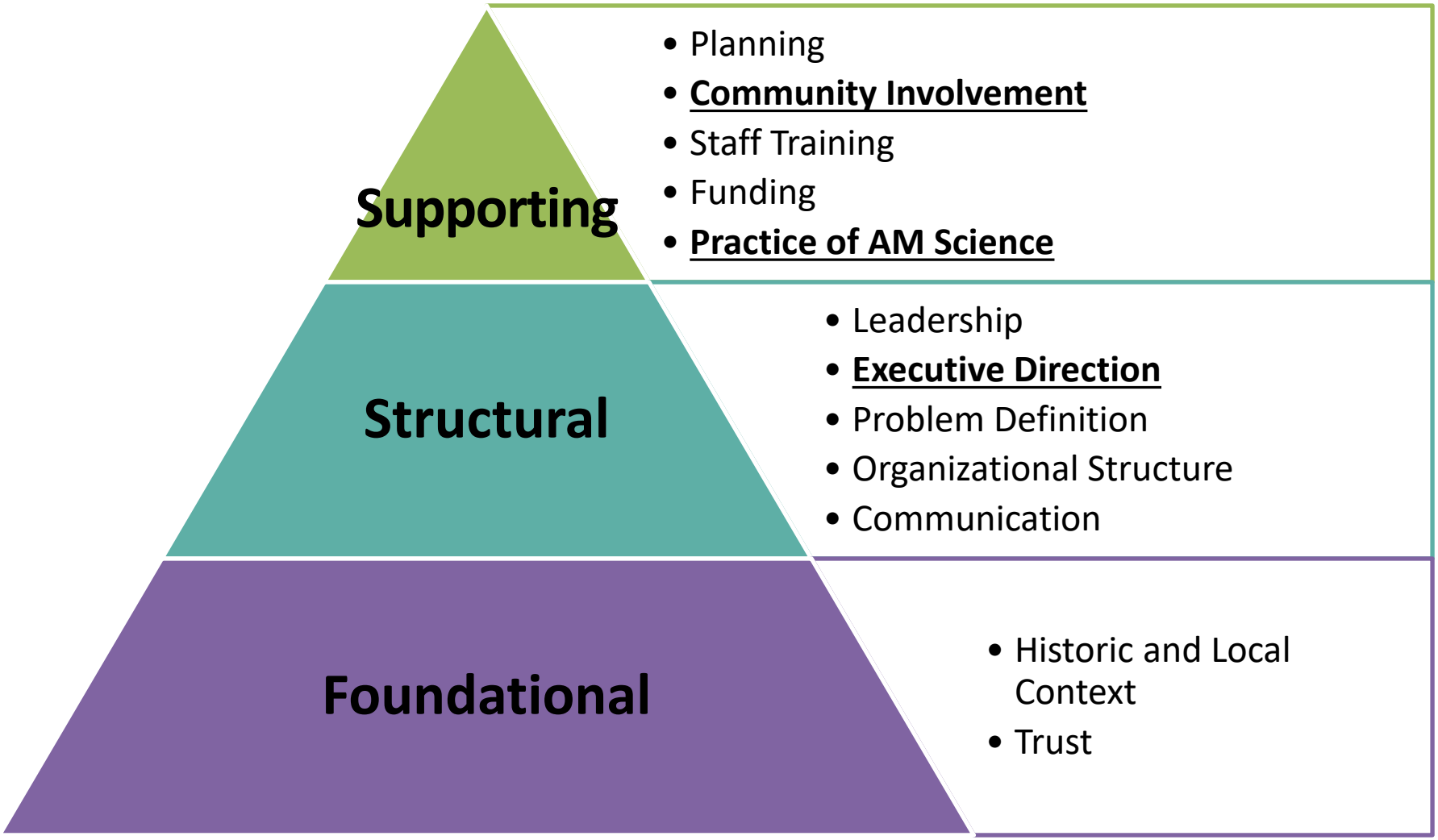
Evaluate / Adjust:

Commit to learning and adjusting actions



What are some of the factors that influence success of AM?

A Hierarchy of Factors

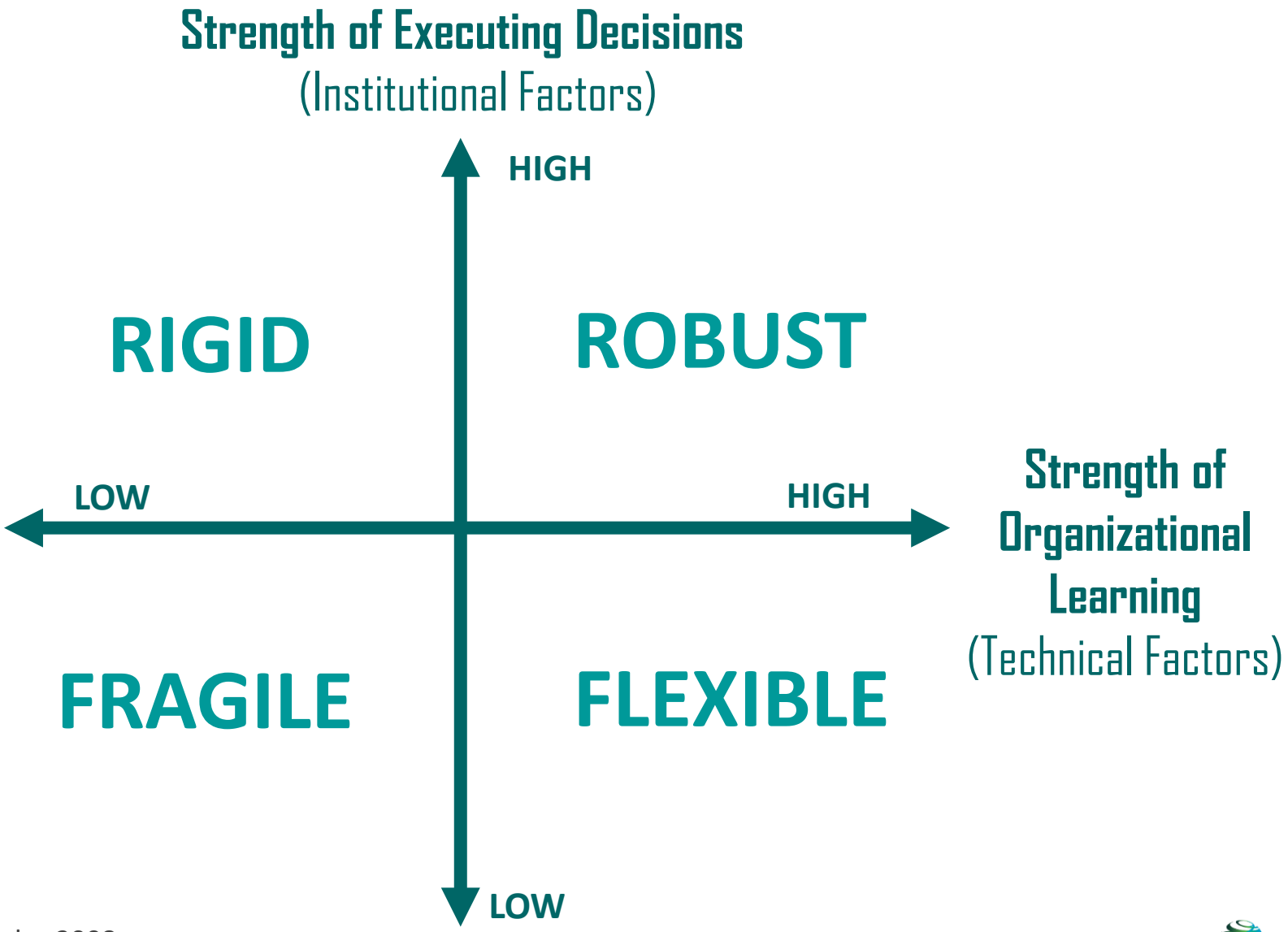


From Greig et al. 2013

Two Wheels, Multiple Gears

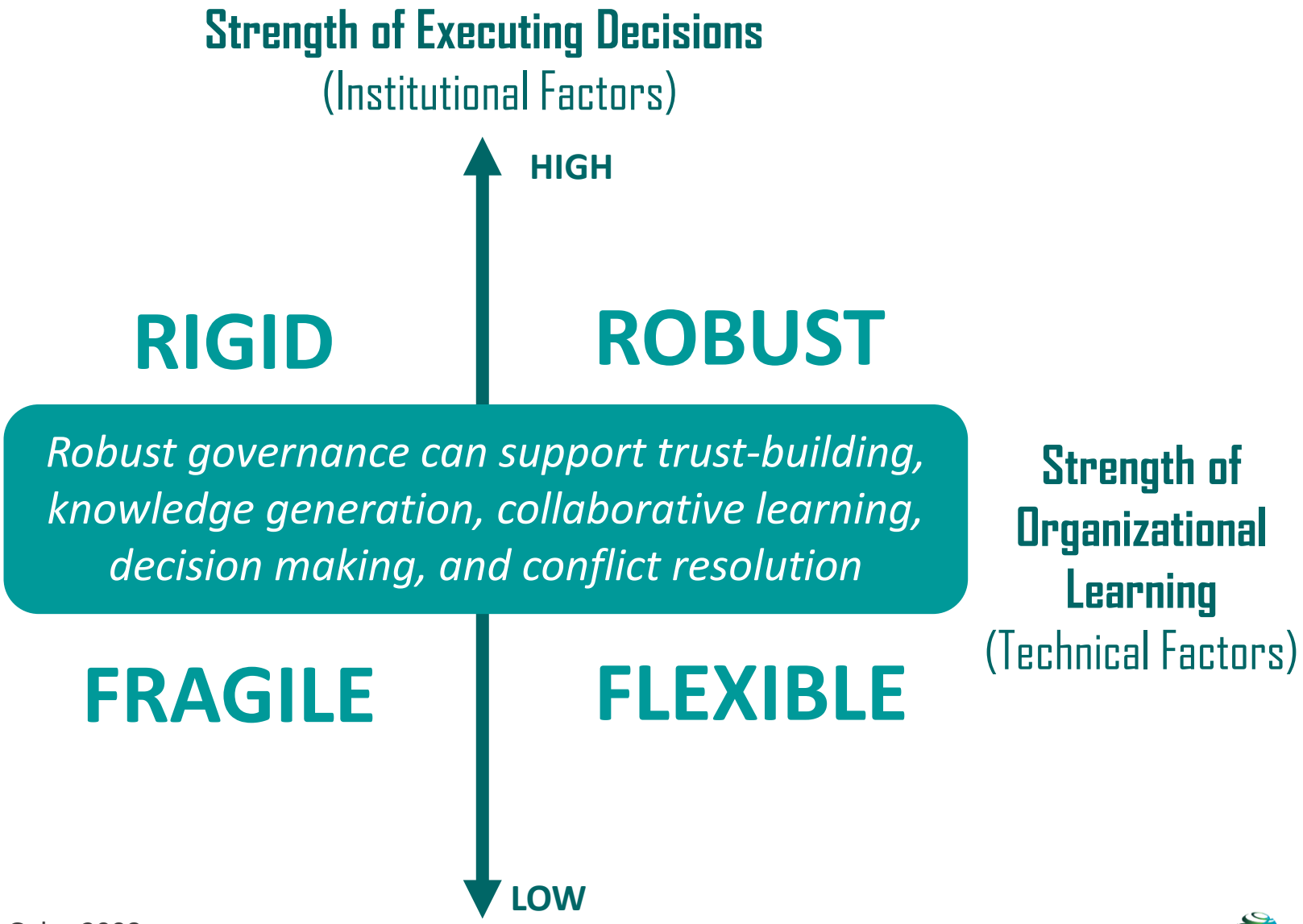
Technical gears to support learning	Institutional gears to support execution
Rigorous practice of AM science	Trust
Thorough hypothesis testing	Leadership
Strong contrasts, replication	Executive direction / authority
Targeted monitoring and rapid evaluation	Strong communication within agencies and stakeholders
Science communication simplified for decision makers	Effective organizational structure (governance)

Effectiveness of Governance



From Duitz and Galaz 2008

Effectiveness of Governance



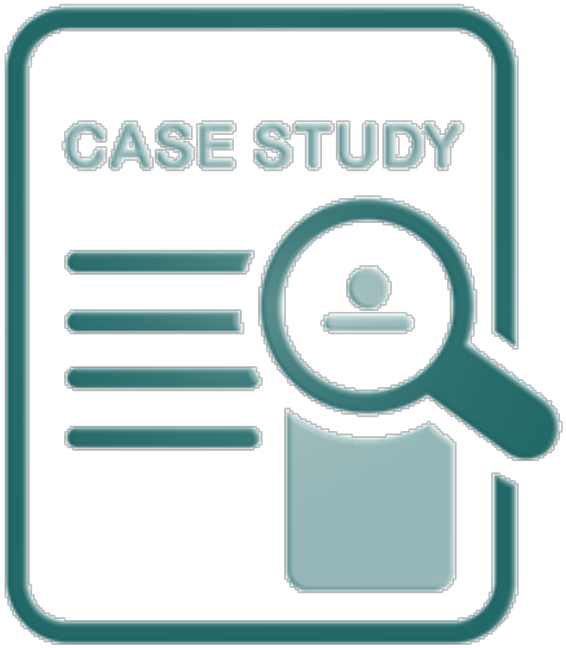
From Duitz and Galaz 2008

What are some take away messages?

Key Messages

- AM is **systematic and rigorous**, not ad-hoc or trial-and-error; it involves specific steps and elements
- AM also requires a unique **mindset**
- AM is grounded in **management uncertainties** facing decision makers (a subset of all unknowns), guided by clear objectives
- Explicit hypothesis testing and implementation of **contrasting actions** in space and/or time can hasten learning
- **Monitoring** can serve different purposes; ensure "fit for purpose"
- Various **factors** can strongly influence success; leverage opportunities and avoid pitfalls

Examples of AM Being Discussed Today



Thank you!

For more information contact:
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