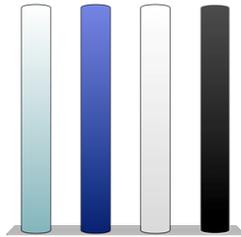


You're hiking in the woods with a friend, having an intense conversation. Suddenly, you realize it's an hour till dark and you have no idea where you are. You have no map, and there's no cell phone reception. What do you do?

What is the most likely response at your office when key data gaps are encountered during a decision-making process?

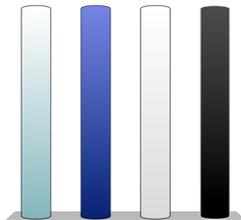
- A. We don't move forward; we don't want to compromise outcomes with inadequate data.
- B. We find substitute data—it isn't ideal, but it's better than nothing.
- C. We make acquiring the missing data a higher priority.
- D. Other



Your pet is sick. 9 of 10 vets say it will die without treatment. The treatment is established, effective, has few side effects and is affordable.

Do you opt for:

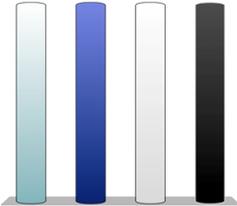
- A. Giving it the drug
- B. Not giving it the drug
- C. Trying an herbal remedy that worked for a friend's pet.



Your pet is sick.
4 of 10 vets say it will die without treatment
The treatment is established, effective, has few side effects and is affordable.

Do you opt for:

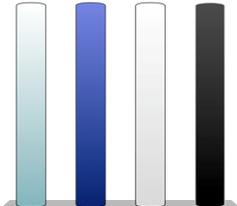
- A. Giving it the drug
- B. Not giving it the drug
- C. Trying an herbal remedy that worked for a friend's pet.



Your pet is sick
9 of 10 vets say it will die without treatment
There is no proven treatment, but there's an expensive experimental drug with uncertain risks and effectiveness.

Do you opt for:

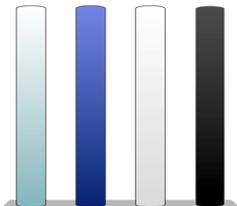
- A. Giving it the drug
- B. Not giving it the drug
- C. Trying an herbal remedy that worked for a friend's pet.



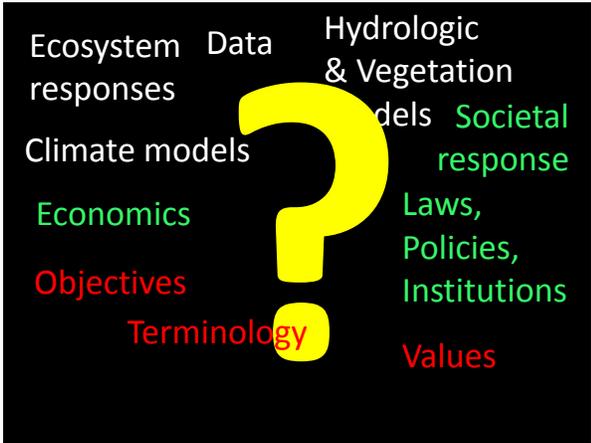
Your pet is sick
4 of 10 vets say it will die without treatment.
There is no proven treatment, but there's an expensive experimental drug with uncertain risks and effectiveness.

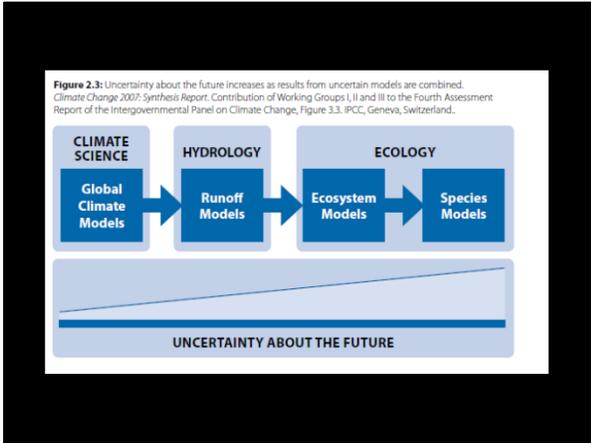
Do you opt for:

- A. Giving it the drug
- B. Not giving it the drug
- C. Trying an herbal remedy that worked for a friend's pet.



Putting Uncertainty in Context





Responses to uncertainty

Responses to uncertainty

- Ignore it/pretend you can get rid of it/wait and hope it goes away

Beware spurious precision!

The allure of downscaling

Beware spurious precision!

Certain: death and taxes
Uncertain: everything else



Responses to uncertainty

- Frame the problem as one of uncertainty

Responses to uncertainty

- Focus on better-understood problems where uncertainty seems manageable

Responses to uncertainty

- Understand and work with it

Uncertainty as information

Being uncertain is not the same as knowing nothing

Characteristics:

- Reducibility



Characteristics:

- Reducibility
- Directionality vs. magnitude



Characteristics:

- Reducibility
- Directionality vs. magnitude
- Controllability



Characteristics:

- Reducibility
- Directionality vs. magnitude
- Controllability
- Decision relevance



Risk Attitude:

- Risk-averse vs. risk-seeking



Risk Attitude:

- Risk-averse vs. risk-seeking
- Risk preference
 - Regret, robustness, expected payoff, loss and gain

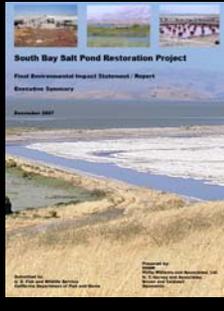
Surf the wave!

- Adaptive management
- Expert elicitation
- Scenario assessment
- Decision sensitivity analysis
- Value of information analysis



Adaptive Management Plan for South Bay Salt Pond Restoration Project

- Specified key uncertainties and research to address them
- Specified triggers for action
- Specified necessary science and institutional structure for adaptive management to work



Really cool table!

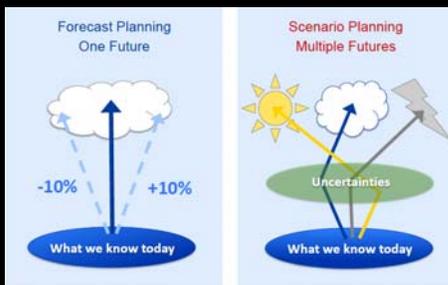
For each goal/target:

- What they' ll monitor, why and where
- When they' ll make decisions
- What observations would trigger a re-examination of their plans
- Action options once a trigger is tripped
- Key knowledge gaps and how they' re filling them

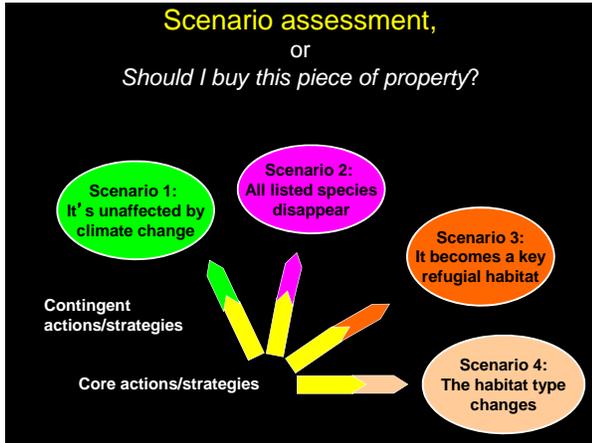
MANAGEMENT TRIGGER	APPLIED STUDIES
<ul style="list-style-type: none"> • Outboard mudflat decreases greater than the range of natural variability = observational variability/error. 	<ul style="list-style-type: none"> • Will sediment movement into restored tidal areas significantly reduce habitat area and/or ecological functioning (such as plankton, benthos, fish or bird diversity or abundance) in the South Bay? • Development of a 2- and 3-D South Bay tidal habitats evolution model.
POTENTIAL MANAGEMENT ACTION	
<ul style="list-style-type: none"> • Conduct study sessions to review and interpret findings to assess if observed changes are due to restoration actions or system-wide changes in the sediment budget (e.g. effects of sea level rise). • Study biological effects of loss of mudflat, subtidal shallows, and/or subtidal channel habitats. • Adjust restoration phasing and design to reduce net loss of tidal mudflats. Potential actions include remove bayfront levees to increase wind fetch and restrain tidal mudflat, phase berthing to match demand and supply, and/or breach only high-elevation ponds to limit sediment demand. • Reconsider movement up structure. 	

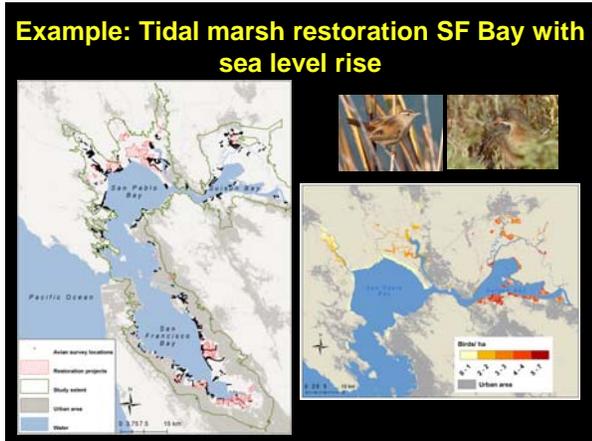
Scenario Planning vs. Forecasting

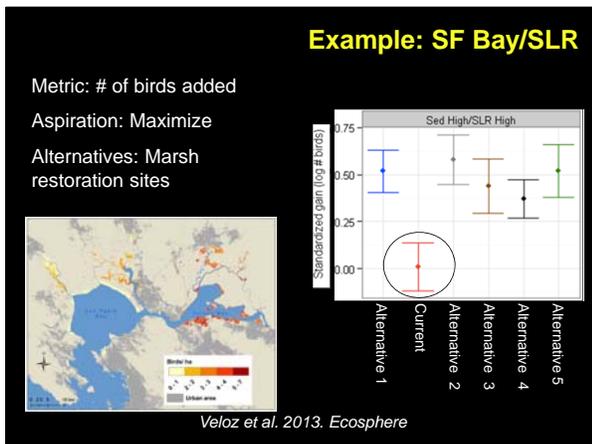
"Never make forecasts, especially about the future." (Samuel Goldwyn)



GBN







Example: SF Bay/SLR

But actually, multiple uncertainties...

- 1. Magnitude of SLR
- 2. Sediment accumulation rates over time



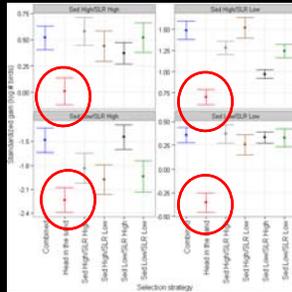
Scenarios approach...

- 1. High SLR/High Sedimentation
- 2. High SLR/Low Sedimentation
- 3. Low SLR/High Sedimentation
- 4. Low SLR/Low Sedimentation

SF Bay: Assessing outcome across four scenarios

Restoration Prioritization Strategies:

- Current
- 4 strategies optimized for each scenario
- Combination



Veloz et al. 2013. Ecosphere 32

Take-home message

Dealing with uncertainty in management can be hard;

Not dealing with it can be much harder

**May I have the ability to reduce the
uncertainties I can, the willingness to
work with the uncertainties I cannot,
and the scientific knowledge to know
the difference.**

*Joe Barsugli, Cheis Anderson, Joel Smith and
Jason Vogel*
