Putting Uncertainty in Context

Climatic change is affecting all ecosystems, and will continue to do so for centuries, so…

- **We need to *incorporate climatic change into long-term planning***
  - **Minimize risk of wasting time, money, and effort**
  - **Maximize likelihood of success**

Ecosystem responses

Data

Climate models

Hydrologic & Vegetation Models

?

Ecosystem responses

Data

Societal response

Climate models

Laws, Policies, Institutions

Hydrologic & Vegetation Models

Economics

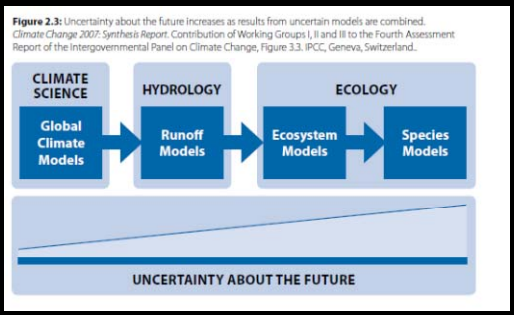


Figure 2.3: Uncertainty about the future increases as results from uncertain models are combined. *Climate Change 2007: Synthesis Report*. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Figure 3.3. IPCC, Geneva, Switzerland..

Responses to uncertainty

- Ignore it/wait until it disappears

Certain: death and taxes

Uncertain: everything else

Responses to uncertainty

- Ignore it/wait until it disappears
- Pretend you can get rid of it

Reducible vs. irreducible uncertainty

- Future greenhouse gas emissions

vs

- How global temperatures respond to increases in GHG concentration

vs

- How global precipitation regimes respond to increases in GHG concentration

The allure of downscaling

Beware spurious precision!

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

Responses to uncertainty

- Ignore it/wait until it disappears
- Pretend you can get rid of it
- **Understand it**

Known unknowns vs. Unknown unknowns

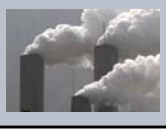
- Lake level changes, temperature change
- Land use changes, boss's mood
- New technologies, ecosystem tipping points, political revolution

Directionality vs. magnitude

- All climate models say things will get warmer; they disagree on just how much warmer
- Models disagree on whether things get wetter or drier overall

Controllability

- Whether or not to buy a car
- Greenhouse gas emissions
- Massive methane belch from the deep sea


Uncertainty as information

Being uncertain is not the same as knowing nothing

Responses to uncertainty

- Ignore it/wait until it disappears
- Pretend you can get rid of it
- Understand it
- **Surf the wave!**
  - **Adaptive management**
  - **Scenario planning**
  - **Risk management**

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

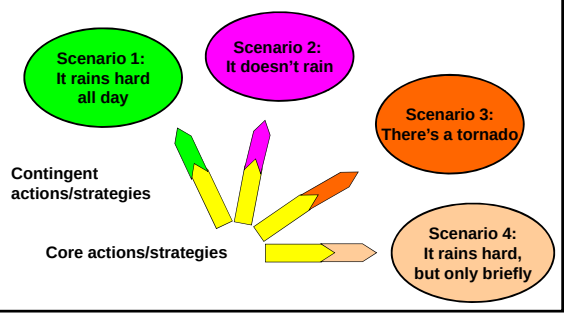
Really cool table!

For each goal/target:

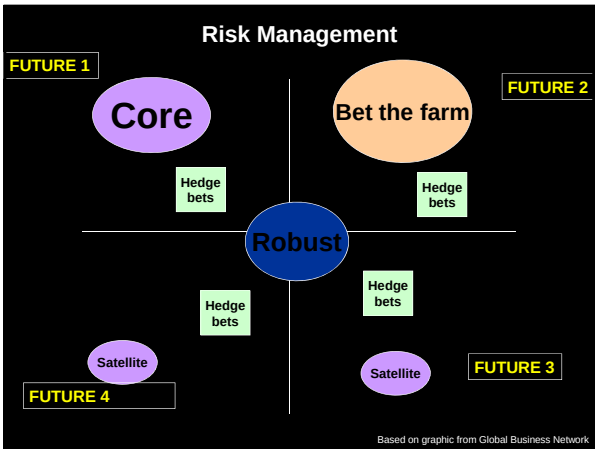
- What they'll monitor and where
- When they'll make decisions
- What observations would trigger a re-examination of their plans
- Action options once a trigger is tripped
- Key knowledge gaps and how they're filling them

MANAGEMENT TRIGGER	APPLIED STUDIES
• Outboard mudflat decreases greater than the range of natural variability + observational variability/error.	• Will sediment movement into restored tidal areas significantly reduce habitat area and/or ecological functioning (such as plankton, benthic, 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	
• Convene study session 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 habitat. • Adjust restoration phasing and design to reduce net loss of tidal mudflats. Potential actions include remove bayfront levees to increase wind fetch and sustain tidal mudflat; phase breaching to match demand and supply, and/or breach only high-elevation ponds to limit sediment demand. • Reconsider movement up staircase	

Scenario planning and robust decision-making, or *Should I bring my umbrella?*



Risk Management



How much Uncertainty am I Willing to Accept?

- Depends on the environmental endpoint and decisions to be made
- Important to clearly define environmental endpoints and the types of decisions that will be made using the results of the vulnerability assessment
  - Prioritization and targeting vs. prediction and forecasting
  - Structured Decision Making