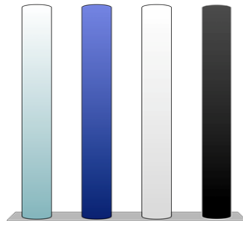


Your pet is sick.  
9 of 10 vets say it will die without treatment  
The treatment is established, effective, has few side effects and is affordable.

**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.



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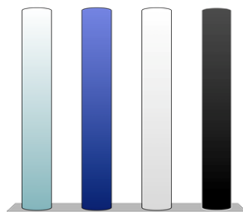
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Your pet is sick.  
4 of 10 vets say it will die without treatment  
The treatment is established, effective, has few side effects and is affordable.

**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.



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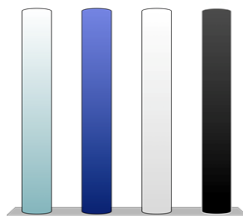
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Your pet is sick  
9 of 10 vets say it will die without treatment  
There is no proven treatment, but there's an expensive experimental drug with uncertain risks and effectiveness.

**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.



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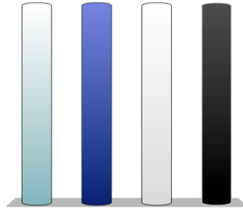
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## Putting Uncertainty in Context

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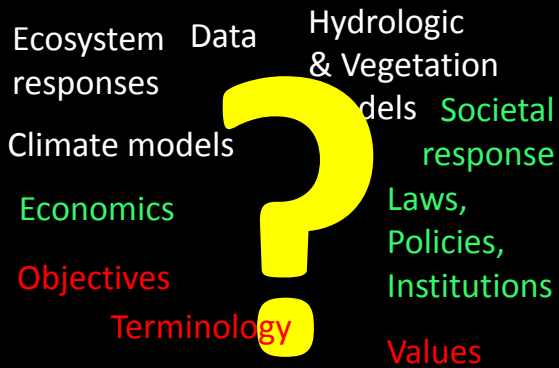
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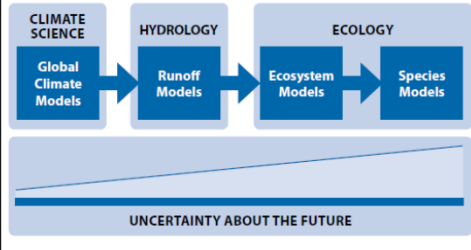
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Figure 2.3: Uncertainty about the future increases as results from uncertain models are combined. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on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



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## Responses to uncertainty

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## Responses to uncertainty

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

*Beware spurious precision!*

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## Responses to uncertainty

- Frame the problem as one of uncertainty

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## Responses to uncertainty

- Focus on better-understood problems where uncertainty seems manageable

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## Responses to uncertainty

- Understand and work with it

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## Uncertainty as information

Being uncertain is not the same as knowing nothing

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## Characteristics:

- Reducibility



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## Characteristics:

- Reducibility
- Directionality vs. magnitude



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### Characteristics:

- Reducibility
- Directionality vs. magnitude
- Controllability



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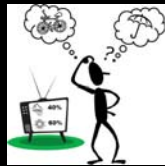
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### Characteristics:

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



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### Risk Attitude:

- Risk-averse vs. risk-seeking



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## Risk Attitude:

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

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## Surf the wave!

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



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## 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



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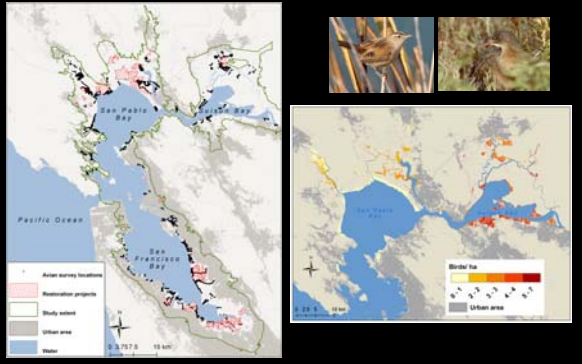
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**Example: Tidal marsh restoration SF Bay with sea level rise**




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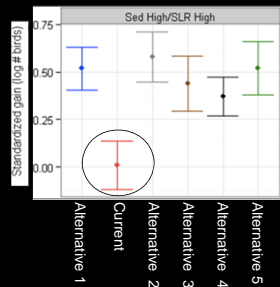
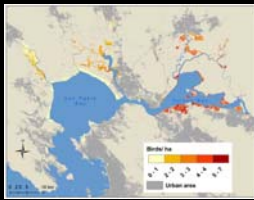
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**Example: SF Bay/SLR**

Metric: # of birds added  
 Aspiration: Maximize  
 Alternatives: Marsh restoration sites



Veloz et al. 2013. Ecosphere

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**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

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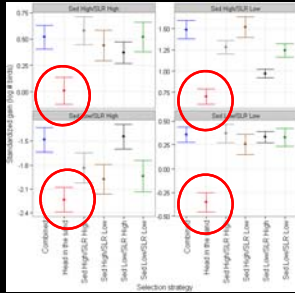
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## SF Bay: Assessing outcome across four scenarios

### Restoration Prioritization Strategies:

- Current
- 4 strategies optimized for each scenario
- Combination



Veloz et al. 2013. Ecosphere 28

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## Take-home message

*Dealing with uncertainty in management can be hard;*

*Not dealing with it can be much harder*

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**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*

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