Making Effective Use of Conceptual Site Models for Management Decision Making

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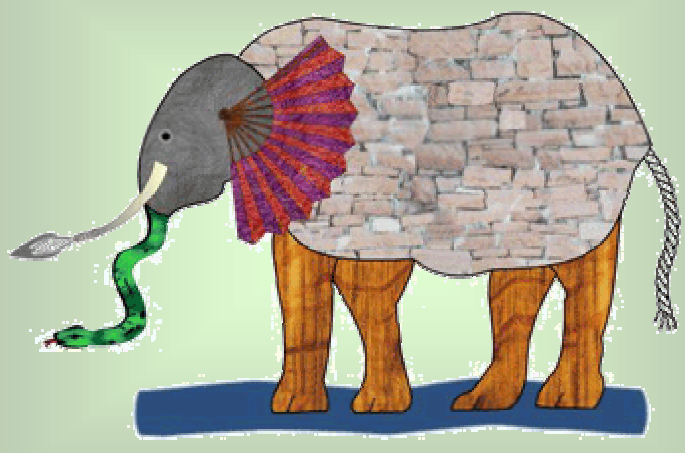
The Blind Men and the Elephant
By Godfrey Saxe



Acknowledgement to Joel Hedgepeth

It was six men of Indostan
To learning much inclined,
Who went to see the Elephant
(Though all of them were blind),
That each by observation
Might satisfy his mind

The First approached the Elephant,
And happening to fall
Against his broad and sturdy side,
At once began to bawl:
"God bless me! but the Elephant
Is very like a wall!"

The Second, feeling of the tusk,
Cried, "Ho! what have we here
So very round and smooth and sharp?
To me 'tis mighty clear
This wonder of an Elephant
Is very like a spear!"

The Third approached the animal,
And happening to take
The squirming trunk within his hands,
Thus boldly up and spake:
"I see," quoth he, "the Elephant
Is very like a snake!"

The Fourth reached out an eager hand,
And felt about the knee.
"What most this wondrous beast is like
Is mighty plain," quoth he;
" 'Tis clear enough the Elephant
Is very like a tree!"

The Fifth, who chanced to touch the ear,
Said: "E'en the blindest man
Can tell what this resembles most;
Deny the fact who can
This marvel of an Elephant
Is very like a fan!"

The Sixth no sooner had begun
About the beast to grope,
Than, seizing on the swinging tail
That fell within his scope,
"I see," quoth he, "the Elephant
Is very like a rope!"

And so these men of Indostan
Disputed loud and long,
Each in his own opinion
Exceeding stiff and strong,
Though each was partly in the right,
And all were in the wrong!

Conceptual Models Help us Achieve a Shared Understanding

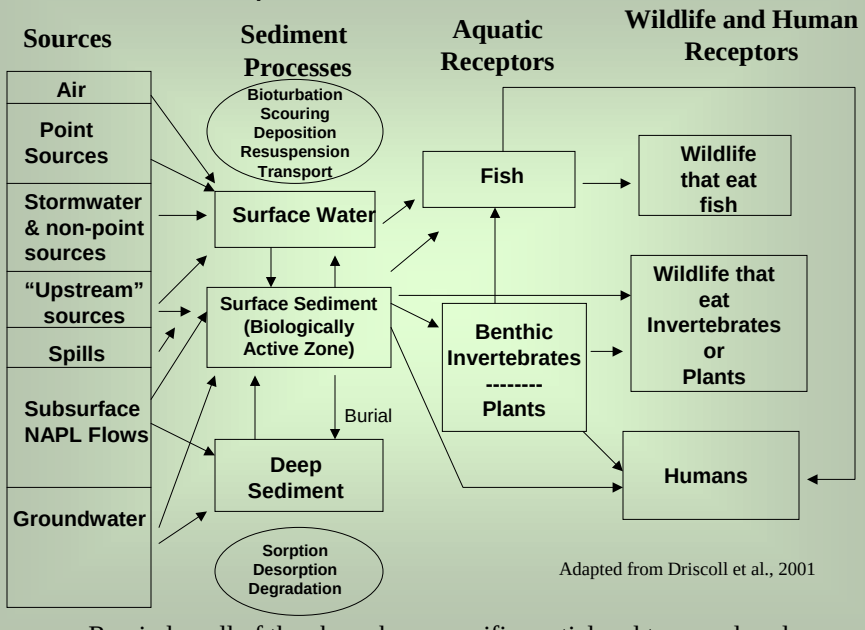
- Defining management objectives
- Guiding problem formulation
- Identifying potential sources and extent
- Identifying potential exposure pathways
- Analyzing exposure and effects
- Communication
- Guiding remedial planning and alternative analyses
- Identifying sources of uncertainties

Types of Conceptual Models

- Narrative descriptions
- Flow diagrams (sources, fate & transport, food-chain diagrams)
- Hierarchical models
- Watershed conceptual models
- Vertical and spatial models

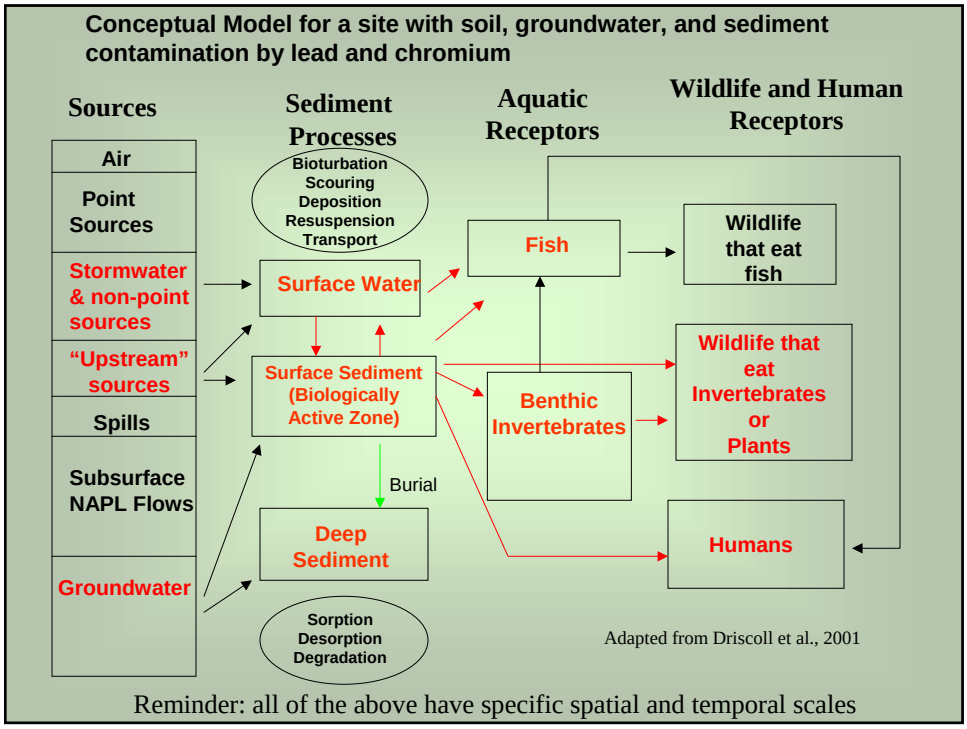
Exposure assessment should incorporate spatial scales where that is appropriate for reducing uncertainties confronting decision makers

Basic Conceptual Model for Sediment Risk Assessment



Adapted from Driscoll et al., 2001

Reminder: all of the above have specific spatial and temporal scales



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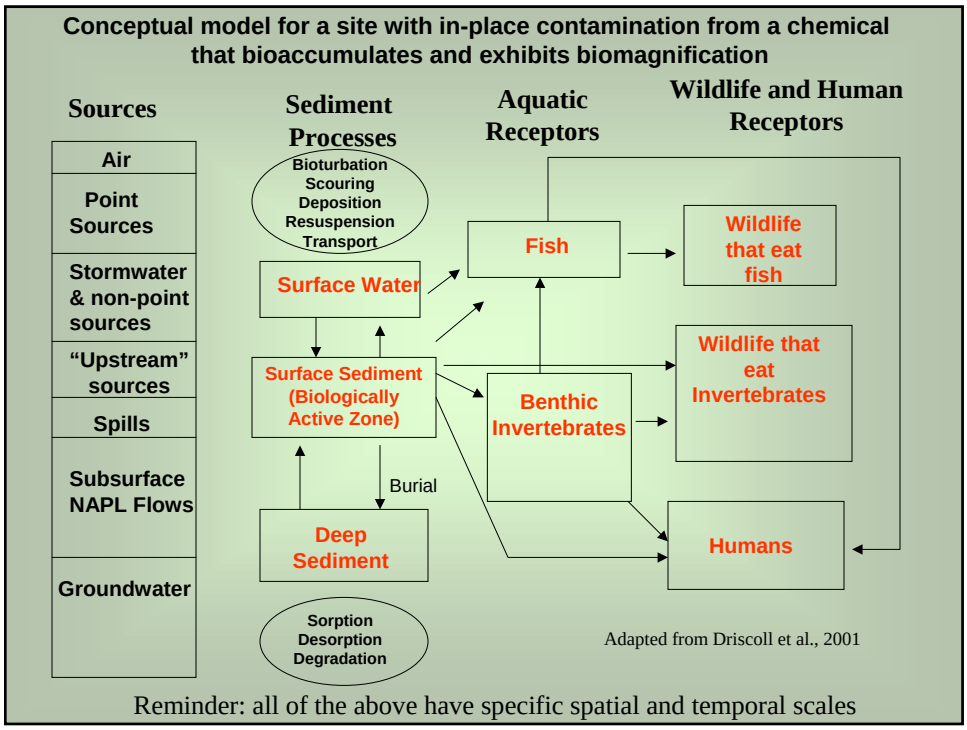

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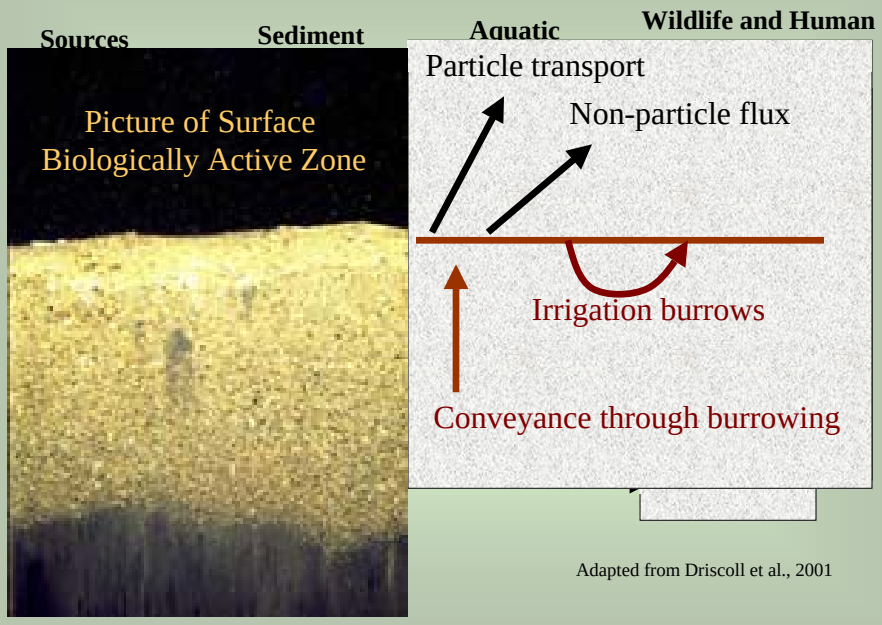
Example of Hierarchical Model



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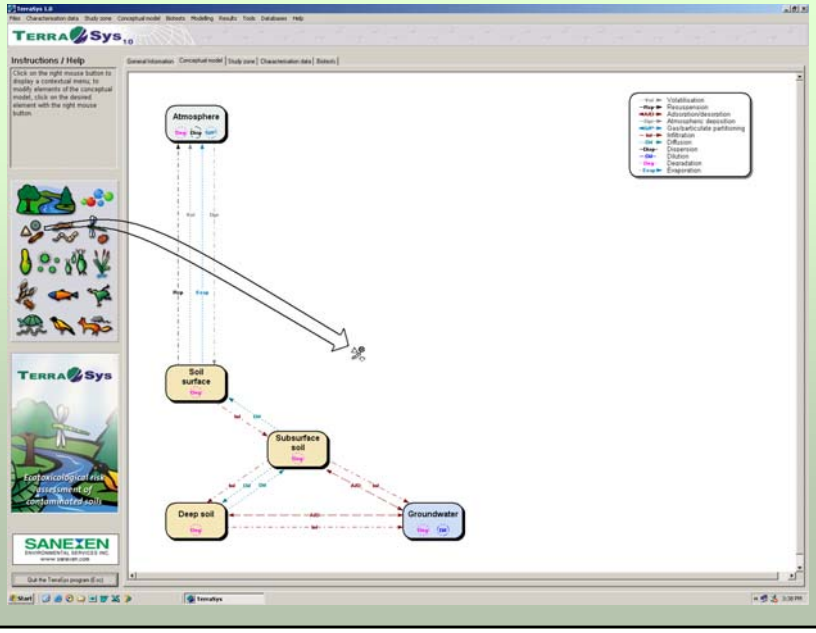
Building a conceptual model with TerraSys:
Adding components by « *drag and drop* »



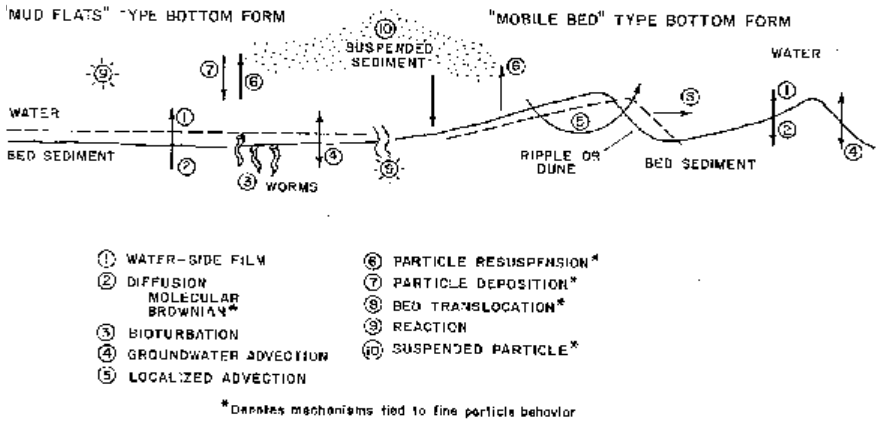
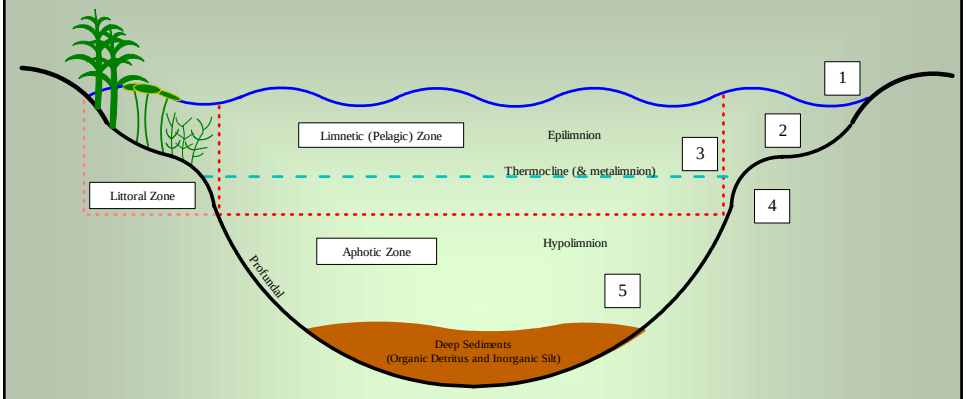


FIGURE 1. CONTAMINANT TRANSPORT MECHANISMS BETWEEN SEDIMENT/WATER

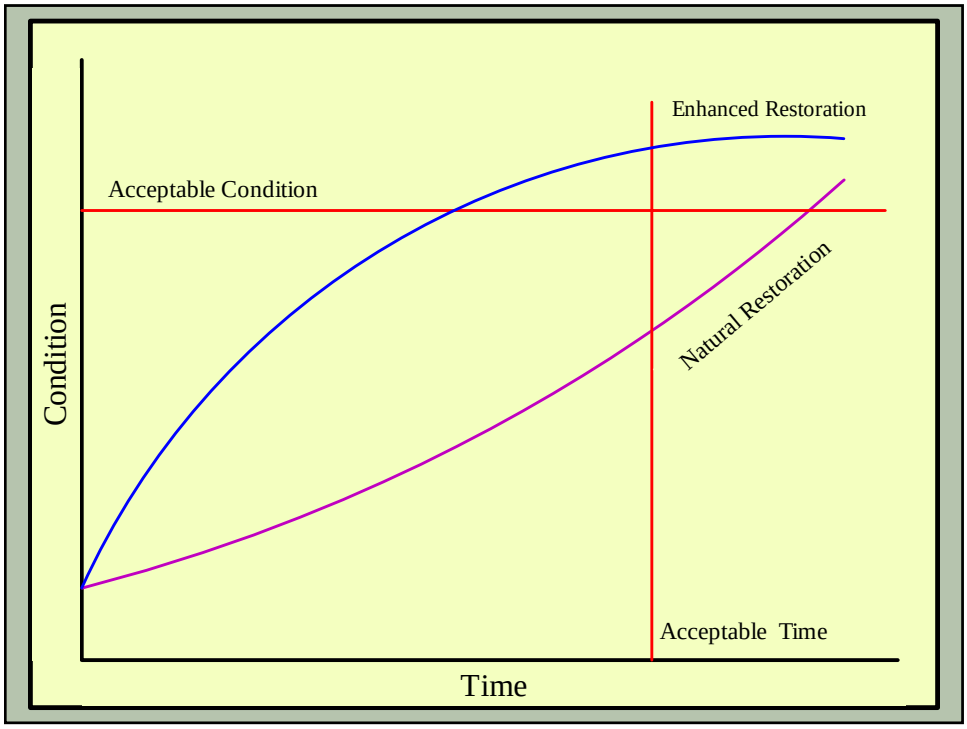
Courtesy of Danny Reible

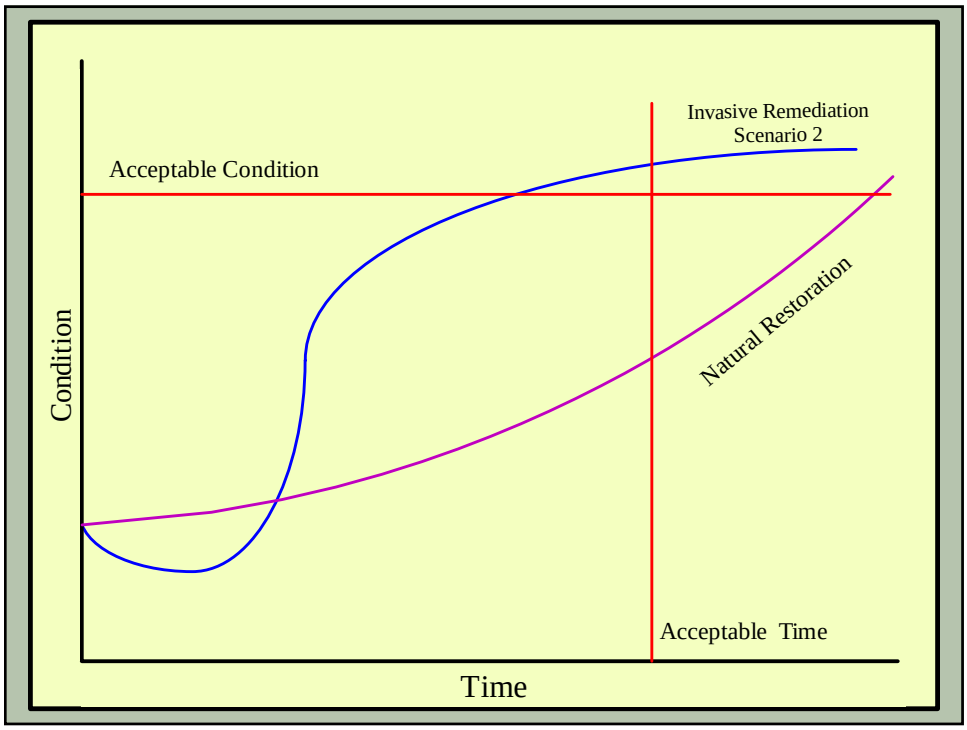
Example of a conceptual model illustrating biological zones



Representative Invertebrates in Five Habitats

1	2	3	4	5
Neuston	Littoral Water Column	Pelagic Zooplankton	Littoral Benthos	Profundal Benthos
Protozoa	Water Mites	Protozoa	Hydra	Gastrotrichs
Springtails	Rotifers	Rotifers	Bryozoans	Flatworms
Water Spiders	Cladocera	Cladocera	Leeches	Nematodes
Water Mites	Water Boatmen	Copepods	Amphipods	Oliogochaetes
Water Striders	Phantom Midges	Phantom Midges	True Midges	True Midges


Enhanced Restoration
Acceptable Condition
Natural Restoration
Condition
Acceptable Time
Time


Invasive Remediation
Scenario 2
Acceptable Condition
Natural Restoration
Condition
Acceptable Time
Time

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Coastal Protection and Restoration Division

All of the Components of the Conceptual Model Present Sources of UncertaintyRelative to Management Decision Making

- Sources
- Sediment Processes/Fate and Transport Processes
- Risk Assessment

Sources

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Sources

- What sources are the focuses of the potential management action?
- What is the magnitude of the release? Is it ongoing? Historic? Both?
- What is the nature and extent of contamination relative to the sources?
- Are there other sources of the contaminants of concern in the area? Attribution possible?
- What effect would controlling a source/sources have relative to the management objectives?

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Sediment Processes/Fate and Transport Processes

- Relative to the extent of contamination, what are the major processes effecting the distribution of contaminants?
- Are the contaminants migrating?
- Are the contaminants buried or not bioavailable? If so are they stable?
- What are the contaminant degradation pathways and rates?
- Are contaminants bioavailable and/or bioaccumulating? What are the processes that control bioavailability? Can they be amended?

Which Receptor?








Risk Assessment

- What are the assessment endpoints? How are the receptors/populations of concern defined?
- What are the exposure profiles to the receptors of concern?
- What are the spatial and temporal considerations?
- How are home range and habitat factors addressed?
- What are the uncertainties in the effects data? Species to species? Acute to chronic? Individual to Population?
- Will the risks be monitored after the management decision is made?

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How are considerations of uncertainty addressed by various technical disciplines involved in developing a conceptual model?

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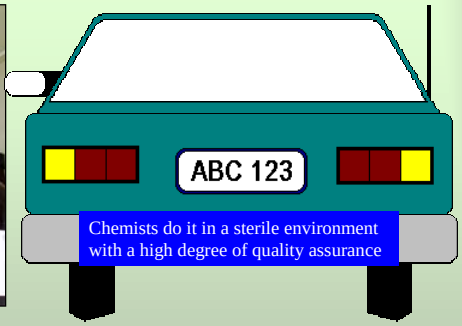
Chemist



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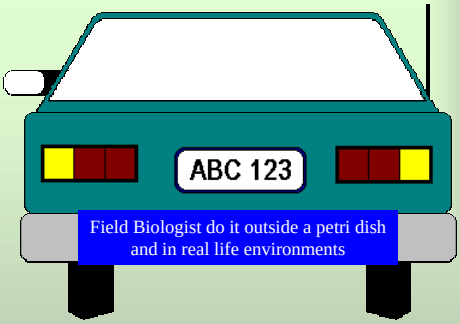
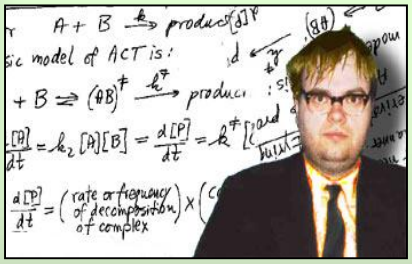
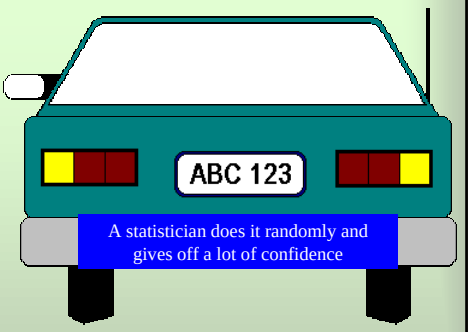
Field biologist



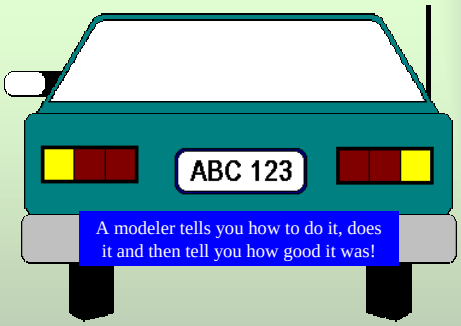
Statistician



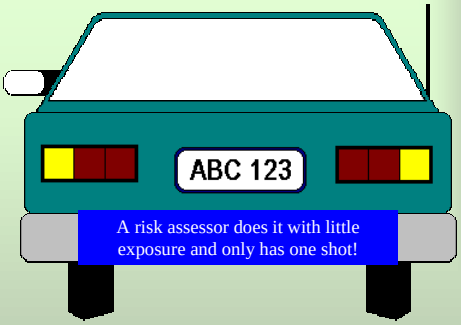


- Statistics means never having to say you're certain.

Modeler



Risk assessor



Project manager/engineer