

Watershed Science, Policy, and Uncertainty

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Traditional Western Science

- **method** of obtaining reliable - though not infallible – knowledge of world around us
- descriptions of **what** happens and explanations of **why** it happens
- naturalistic: about natural processes and natural events



- **Linear**: world operates through cause and effect
- **Bounded**: eliminate as much “noise” as possible
- **Divisible**: whole can be divided into parts without damage to parts
- **Limited**: sum of the parts is equal to the whole



**Strongly
Disagree**

**Mildly
Disagree**

Neutral

Mildly Agree

**Strongly
Agree**

a. Use of the scientific method is the only certain way to determine what is true and false about the world.

b. The advance of knowledge is a linear process driven by key experiments.

c. Equally valid, but different, scientific interpretations can be made using the same data.

d. Scientific methods are inherently biased to support existing social power structures.

e. Science provides objective knowledge about the world.

f. It is possible to eliminate values from the interpretation of scientific data.

g. Science provides universal laws or theories that can be verified.

h. Scientists are generally more objective than others involved in natural resource management.

i. Nonscientists can make valid judgments about the same phenomena studied by scientists using different forms of rationality (e.g., experience).

	Strongly Disagree	Mildly Disagree	Neutral	Mildly Agree	Strongly Agree
a. Use of the scientific method is the only certain way to determine what is true and false about the world.	18%	23%	12%	33%	14%
b. The advance of knowledge is a linear process driven by key experiments.	21%	40%	16%	24%	5%
c. Equally valid, but different, scientific interpretations can be made using the same data.	2%	7%	10%	55%	26%
d. Scientific methods are inherently biased to support existing social power structures.	33%	37%	18%	10%	1%
e. Science provides objective knowledge about the world.	1%	9%	7%	50%	33%
f. It is possible to eliminate values from the interpretation of scientific data.	11%	37%	12%	30%	10%
g. Science provides universal laws or theories that can be verified.	8%	10%	13%	38%	30%
h. Scientists are generally more objective than others involved in natural resource management.	2%	14%	23%	45%	16%
i. Nonscientists can make valid judgments about the same phenomena studied by scientists using different forms of rationality (e.g., experience).	9%	22%	18%	40%	10%

Role of Scientists

Scientists' Role	Scientists	Mgrs	Interest Groups	Atten. Public
Only <i>report</i> results*	2.86	3.18	2.45	2.72
<i>Interpret</i> for others	4.18	3.92	3.99	3.88
Help to <i>integrate</i> *	4.09	4.30	4.20	4.28
Actively <i>advocate</i> *	2.20	2.19	3.21	2.95
<i>Make decisions</i> *	1.66	1.79	2.65	2.47

1:strongly disagree...5:strongly agree

Watershed Science and Policy

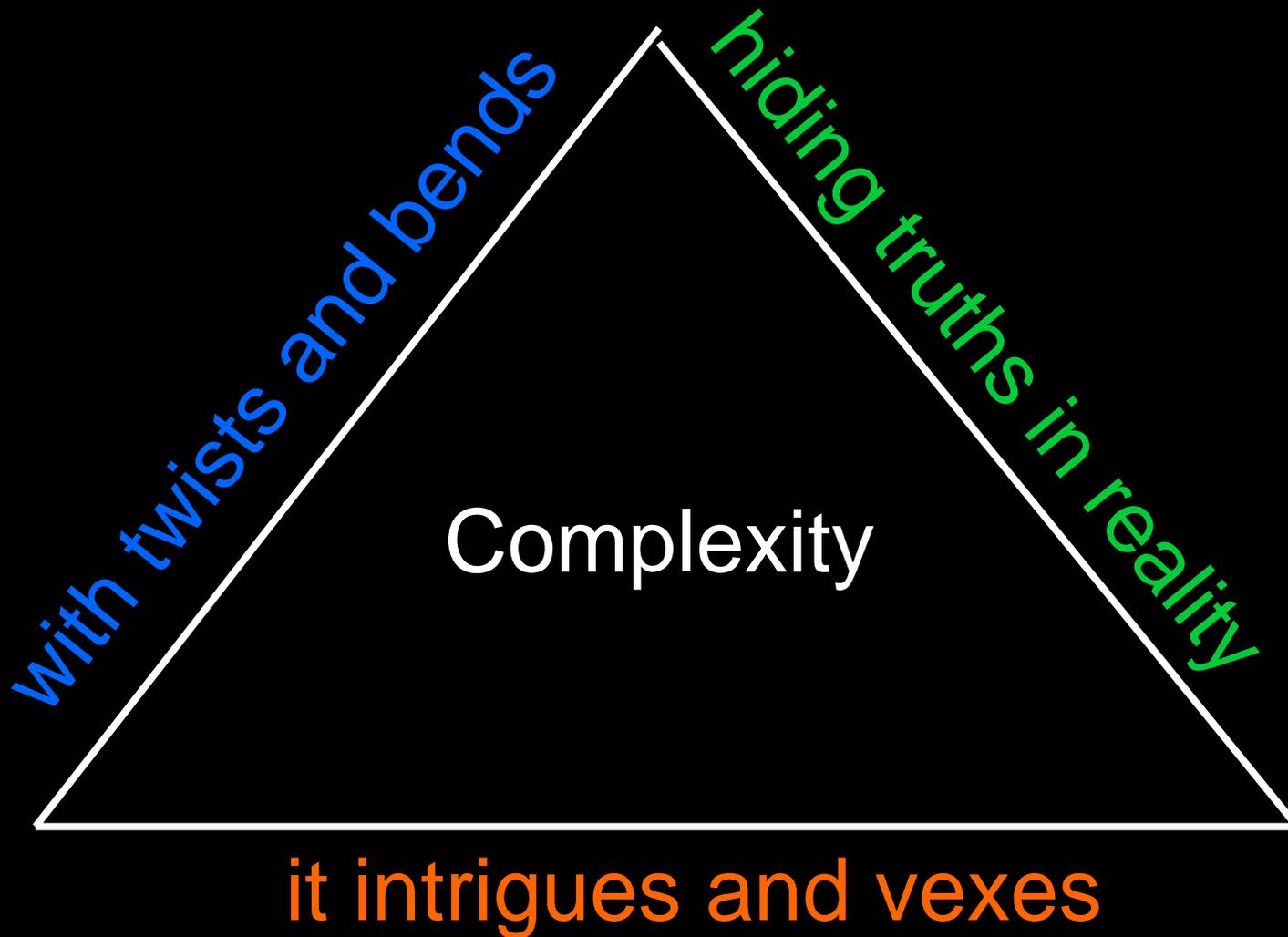
- Masses of details about many issues
- Issues are mutually implicated
- Problems extend across many scales of time and space
- Uncertainties and value-loadings of all sorts





New Ways to Think about Ecosystems

- **Complexity**: a system made up of a collection of elements and subsystems, defined by their relationships
- **Hierarchies**: relationships based on inclusion, scale, function
- **Reflexivity**: elements have purposes of their own and learn from experience

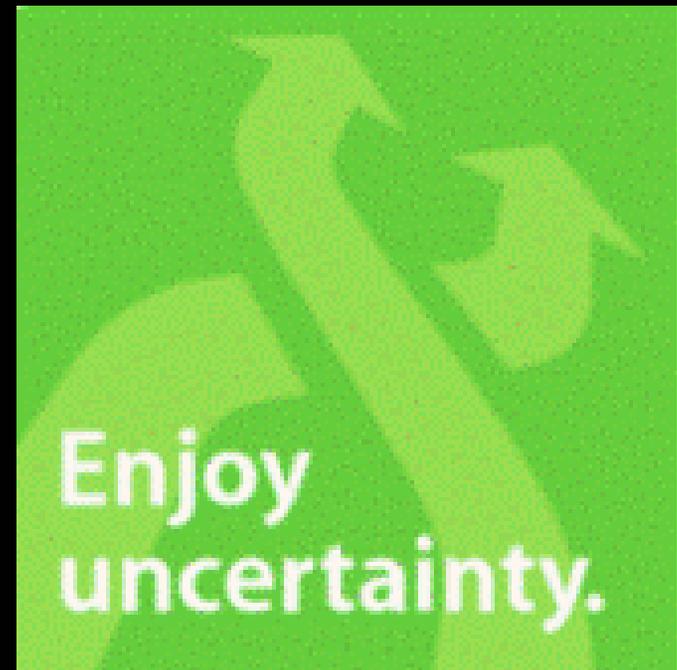


Complex Systems

- Presence of significant and irreducible **uncertainties** of various sorts
- **Self organizing** with multiple operating states that can radically shift
- **Emergent** properties that are more than the sum of the parts
- **Multiple legitimate perspectives**: choices are driven by values embedded in the social systems in which science is being done

Uncertainties

- Uncertainty in empirical quantities
- Uncertainty in models
- Temporal uncertainty
- Structural uncertainty
- Measurement uncertainty
- Statistical uncertainty
- Theoretic uncertainty
- Ignorance
- Inexactness
- Unreliability

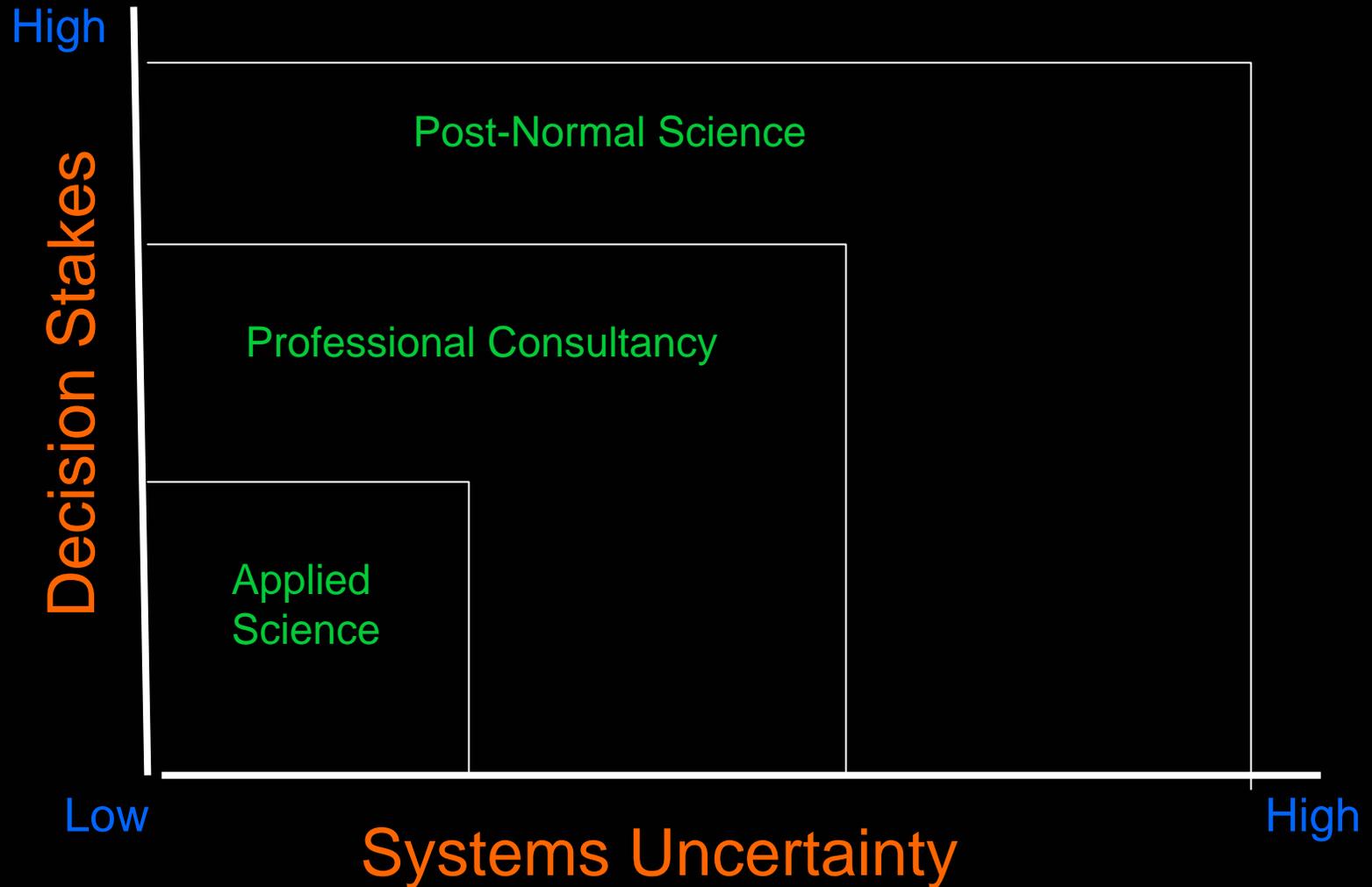


Environmental Policy under Conditions of Uncertainty

- Normality challenged: can routine science provide adequate knowledge base for policy decisions?
- Environmental issues: uncertain facts, values in dispute, stakes high, and decisions urgent



“Post Normal” Science: A Bridge to Environmental Policy?



Decision Quality under Uncertainty

- Extended peer communities: all who have desire to participate in resolution of problem
- Citizens juries, focus groups, consensus conferences, watershed councils
- Assess quality of proposals, including scientific elements, during preparation stages
- Verdicts have moral force and political influence



Example: UK Royal Commission on Environmental Pollution

- When environmental standards are set or other judgments made about environmental issues, decisions must be informed by understanding of peoples' values...
- Traditional forms of consultation, while they have provided useful insights, are not an adequate method of articulating values...
- More rigorous and wide-ranging exploration of people's values requires discussion and debate to allow a range of viewpoints and perspectives.

Externally imposed
restrictions on choice

+

The Fatalist
It doesn't matter

The Hierarchist
A place for everything...

Individual

Group

-

+

The Individualist
The bottom line for me...

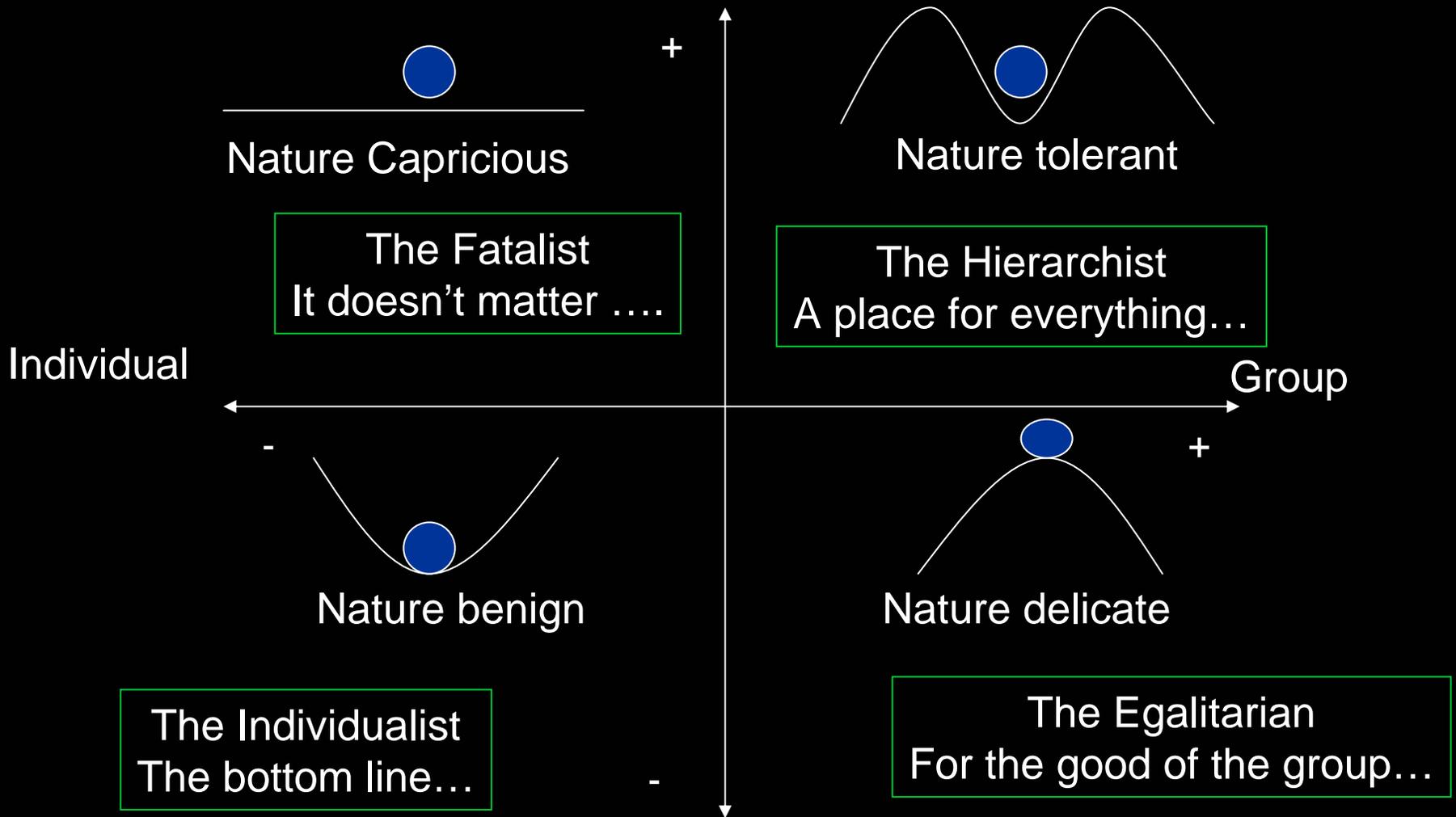
The Egalitarian
For the good of the group...

-

No externally imposed
restrictions on choice



Externally imposed
restrictions on choice



No externally imposed
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“Clumsy” Solutions

- Otay Water District, City of San Juan Capistrano Water District, and Irvine Ranch Water District
- Conservation rate structure: funds all current operations by a base rate, sectors are allocated conservation use targets
- Those using more than the target are assessed sharply escalating fees for water