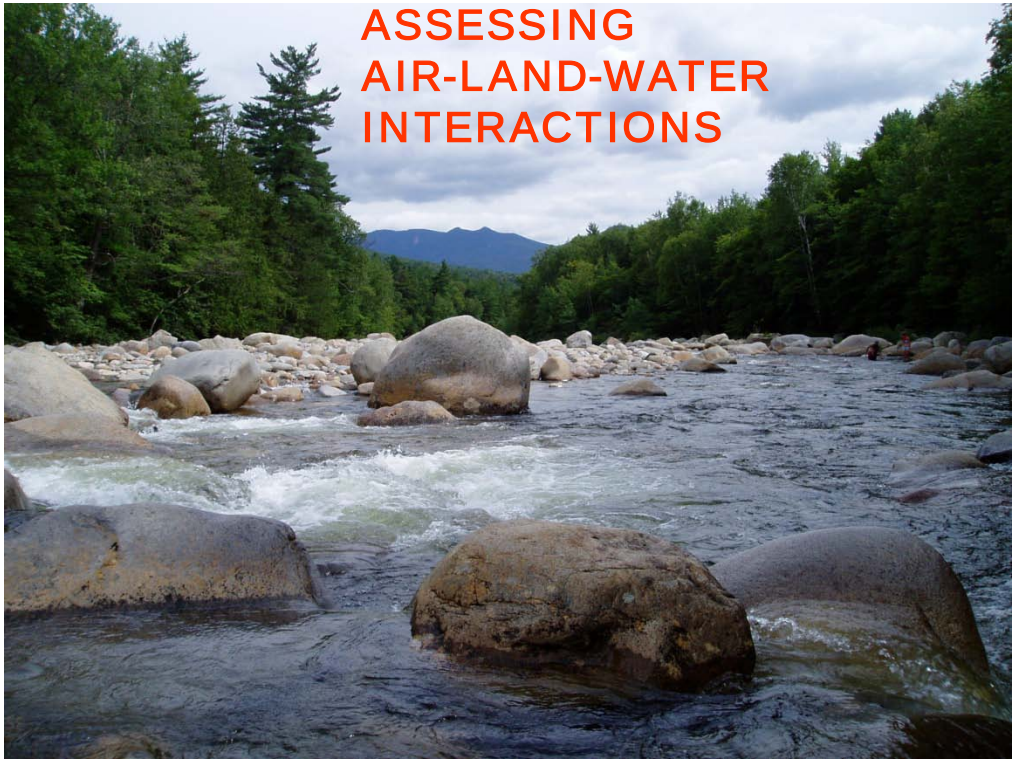
Integrated Research, Monitoring and Management at the Catchment Scale

(from rainwater to the sea, and everything in between)



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Need for greater communication and integration among scientists, policy makers, managers and the public remains one of the key challenges for the intelligent monitoring, management and use of catchments

The call for a transparent, inclusive and adaptive decision-making process that is flexible to changing circumstances, and embraces a diversity of stakeholders and perspectives is a consistent theme in the recent international literature for integrated management and monitoring of catchments

(e.g., Rogers 2006; Koehler and Koontz 2008; Macleod *et al.* 2008; Reed 2008; Eberhard *et al*. 2009; Lindenmayer and Likens 2009).

Integrated knowledge and management

(Integrated Catchment Management)

- **Fractionation of science (ecology)**
- **Fractionation of management**
- **Fractionation of policy**

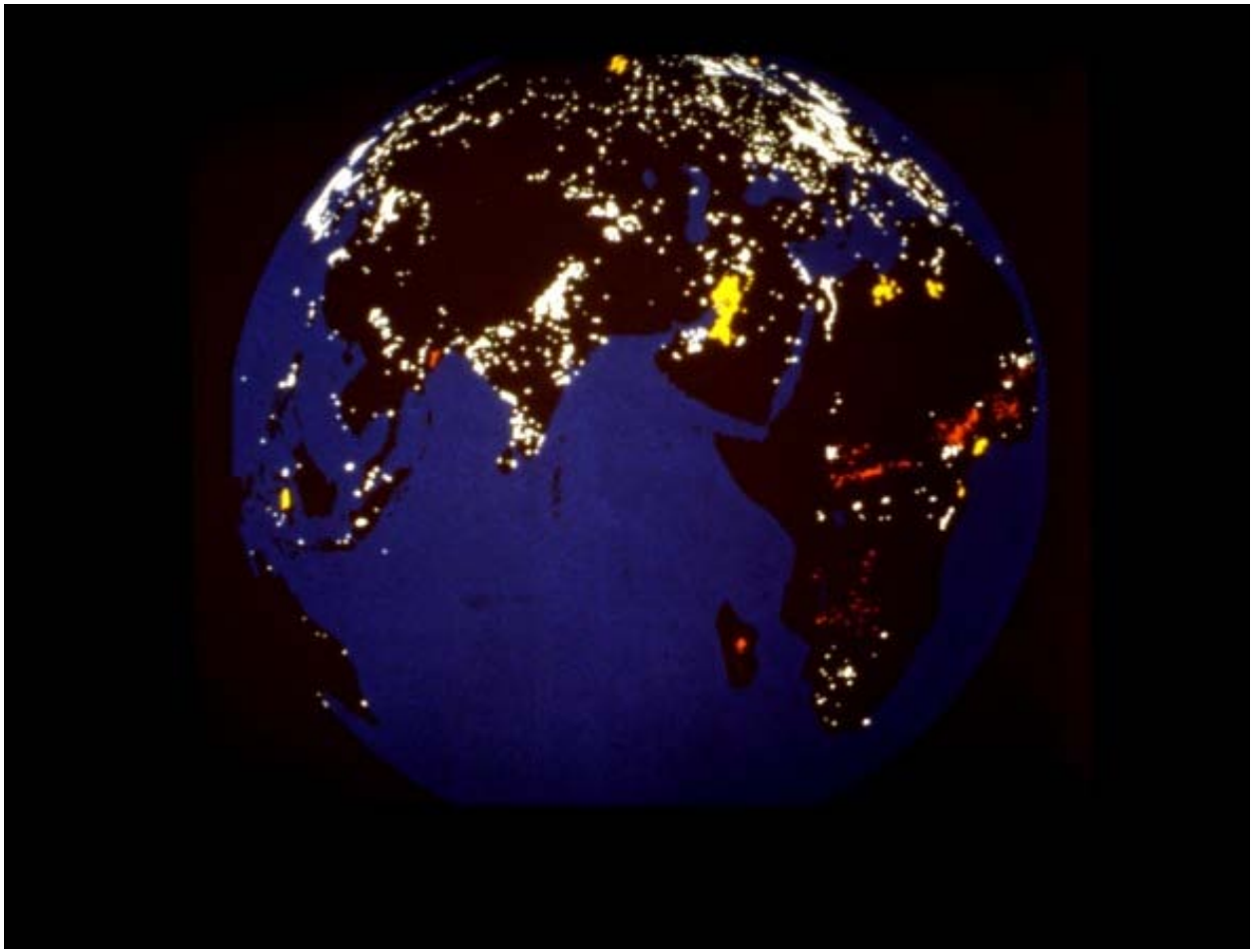
A. Pearce, 2000

International Examples of Integrated Catchment Efforts

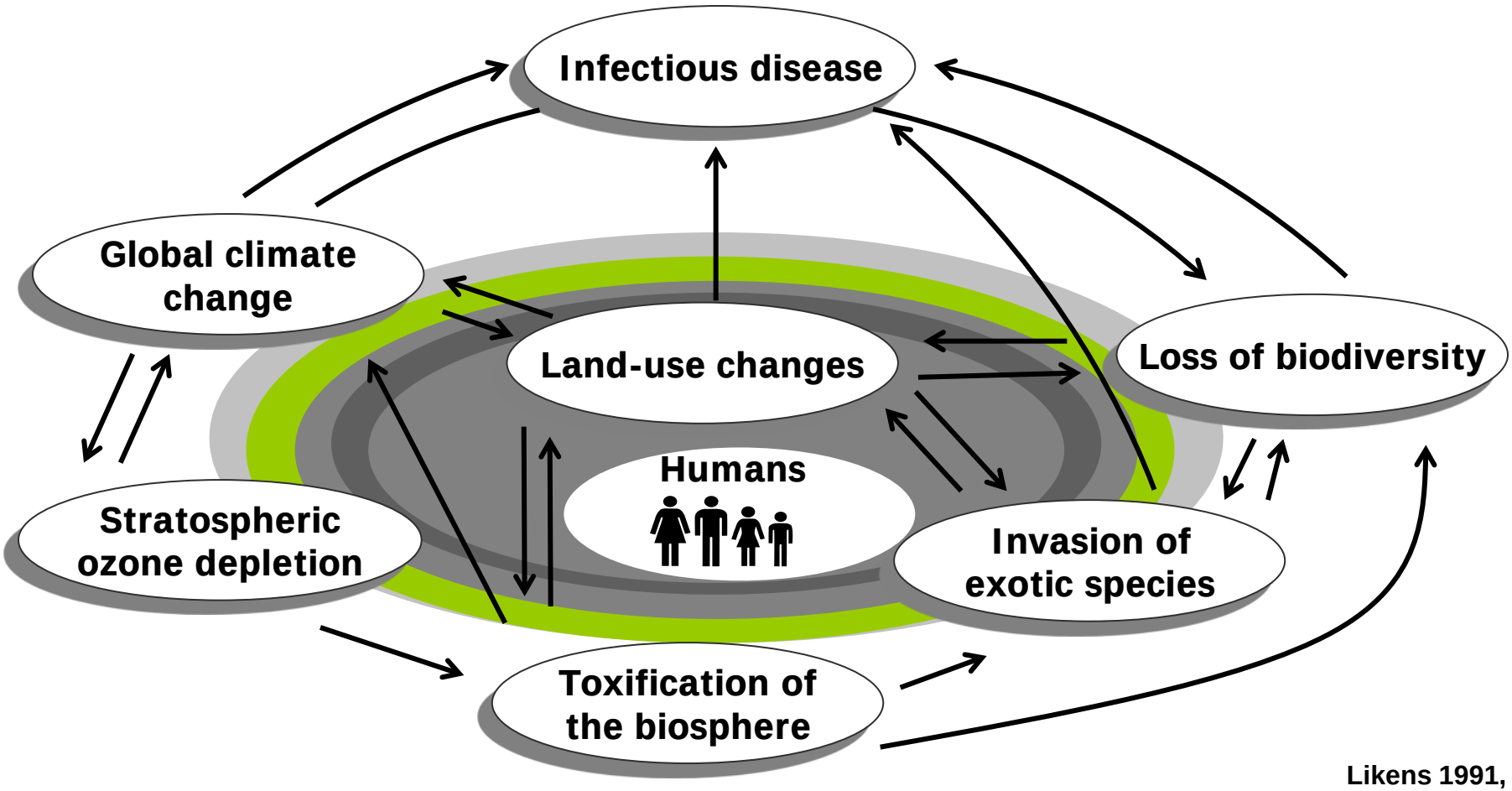
- Motueka Basin
- Danube Basin
- Murray-Darling Basin
- Chesapeake Basin
- Moreton Bay Basin
- Yangtze Basin ??? (NOT!)

We Have a Serious Problem!

Catchments Are Changing!



HUMAN-ACCELERATED ENVIRONMENTAL CHANGE

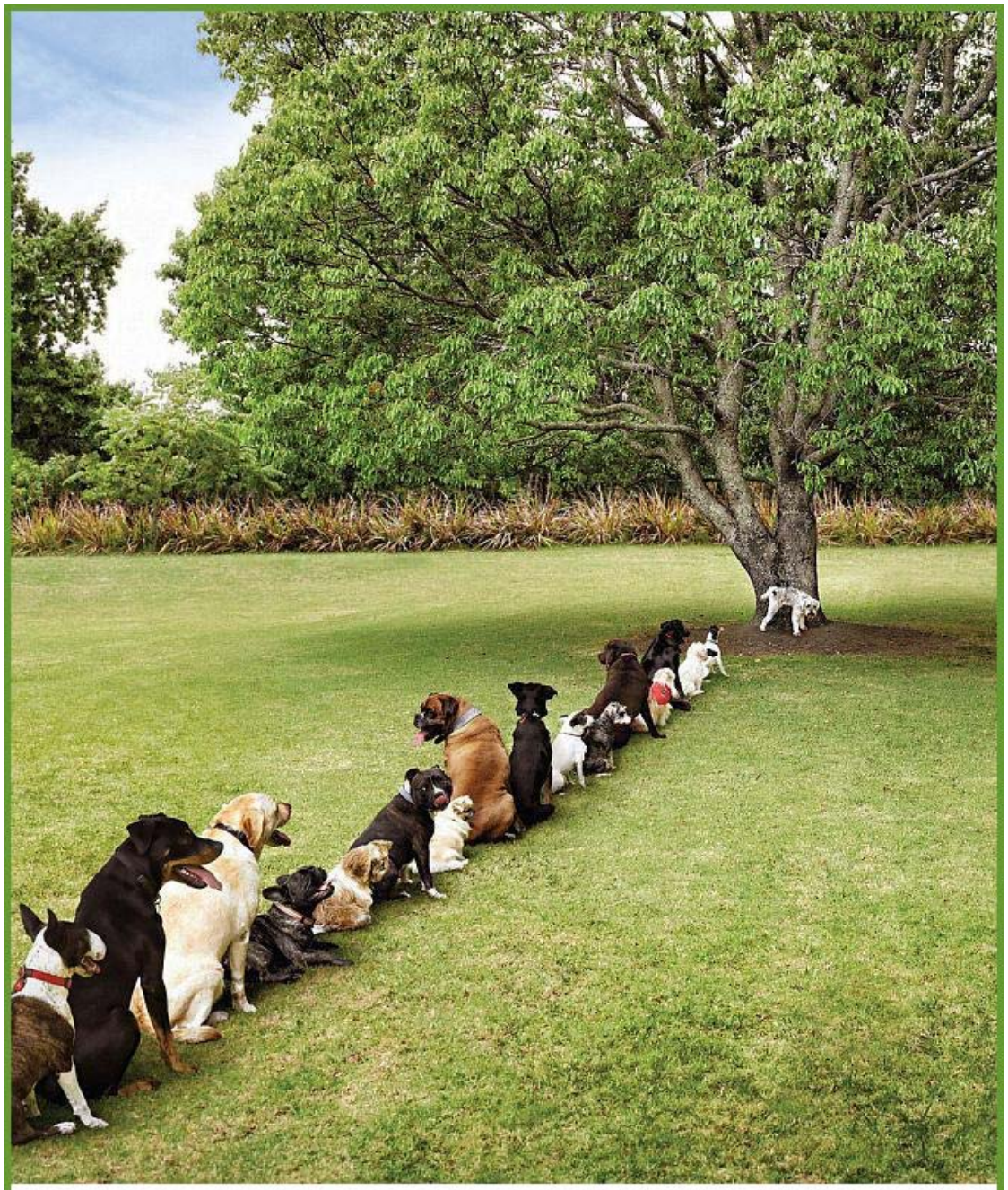


Likens 1991,
Updated 2004

Land and Water Disturbance

Average sediment load in rivers — past 540 million yr	5 *Gt/yr*
Current sediment load in rivers	21 *Gt/yr*
Current human movement of soil and rock	75 *Gt/yr*

Wilkinson and McElroy (2007)
Geol. Soc. Amer. Bull.



Another problem caused by deforestation

We Have a Serious Problem!

- **Aldo Leopold**

“It is inconceivable to me that an ethical relation to land can exist without love, respect, and admiration for land, and a high regard for its value; I mean value in the philosophical sense."
Aldo Leopold, 1949

“*… the oldest task in human history:* ***to live on a piece of land without spoiling it****.”*
Aldo Leopold, 1938

Effective Ecological Monitoring

"Repeated field-based empirical measurements collected continuously and then analyzed for at least 10 years"

- Types of Monitoring
  - Curiosity Driven or Passive Monitoring
  - Mandated Monitoring
  - Question-driven Monitoring

D. B. Lindenmayer and G. E. Likens
(CSIRO Publishing and Earthscan, 2010)

Effective Monitoring should be good science, and just like good science, should be driven by good questions

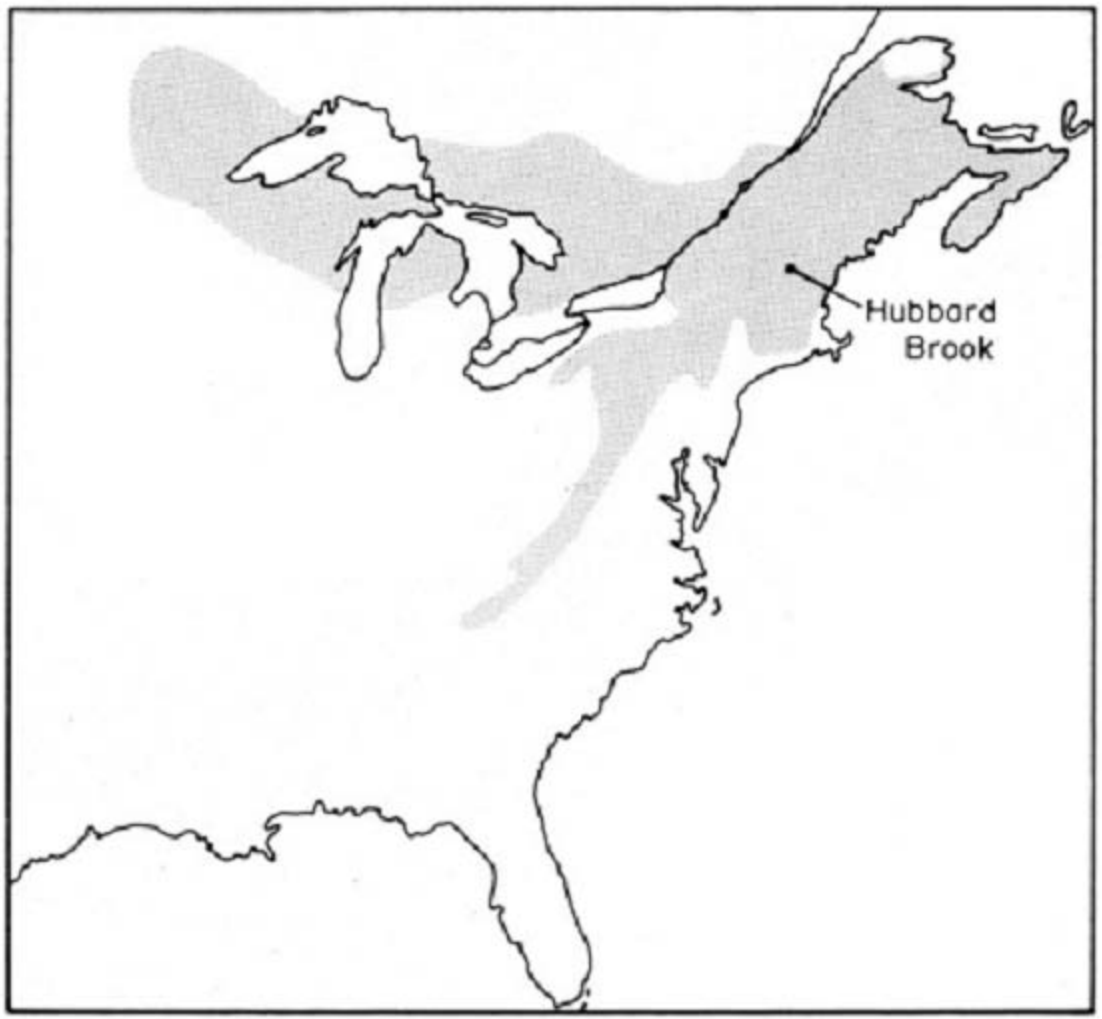
Components of Effective Ecological Monitoring

- Underpinned by Good Questions
- Use of a Conceptual Model
- Statistical Design at the Outset
- Strong and Dedicated Leadership
- Well-developed Partnerships
- Frequent Use of Data Collected
- Ongoing Funding
- High Scientific Productivity
- Maintenance of Data Integrity and Field Techniques

David B. Lindenmayer and Gene E. Likens (2010)

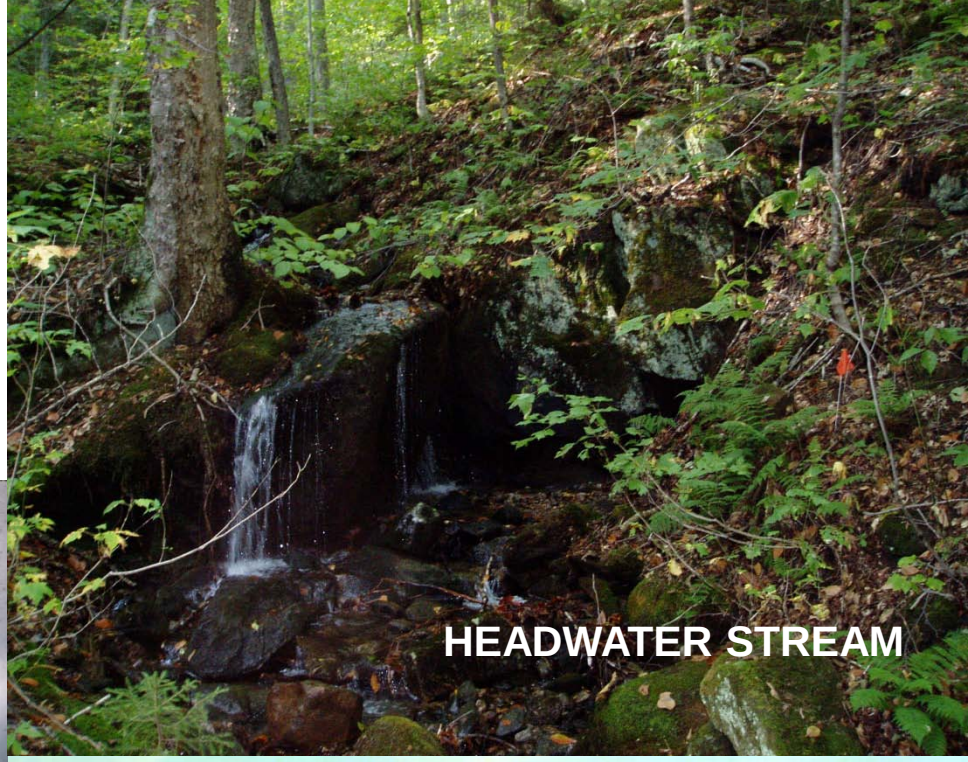
Why monitoring programs can fail

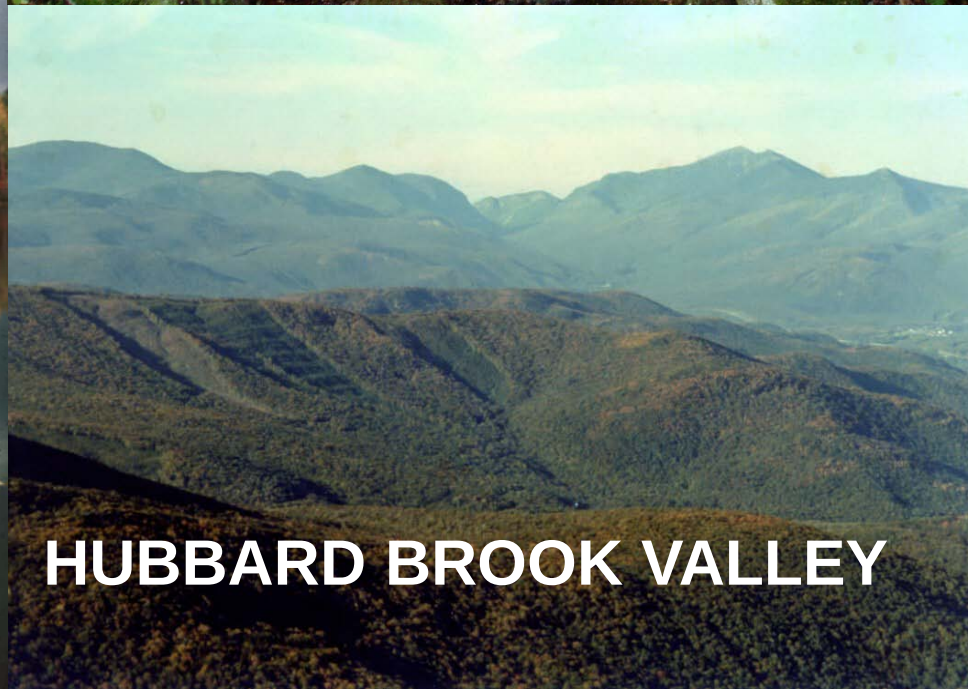
- Passive, mindless, lacking questions
- Poor study design
- Laundry list of items to be monitored
- Snowed by blizzard of ecological details
- Squabbles about what to measure
- Assumption that one size fits all
- Not adaptive (Lindenmayer and Likens 2009)

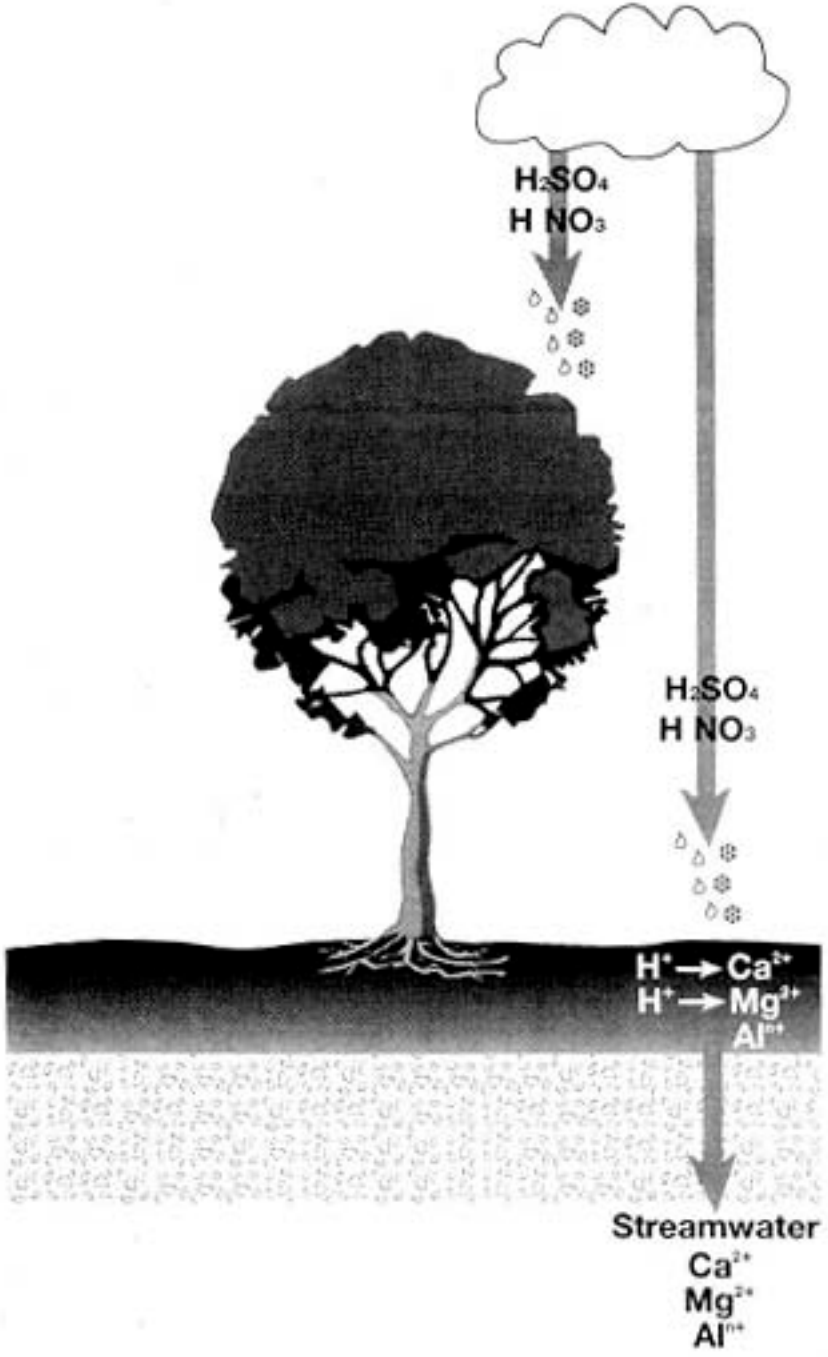

Hubbard
Brook

THE HUBBARD BROOK ECOSYSTEM STUDY

1963 - 2010



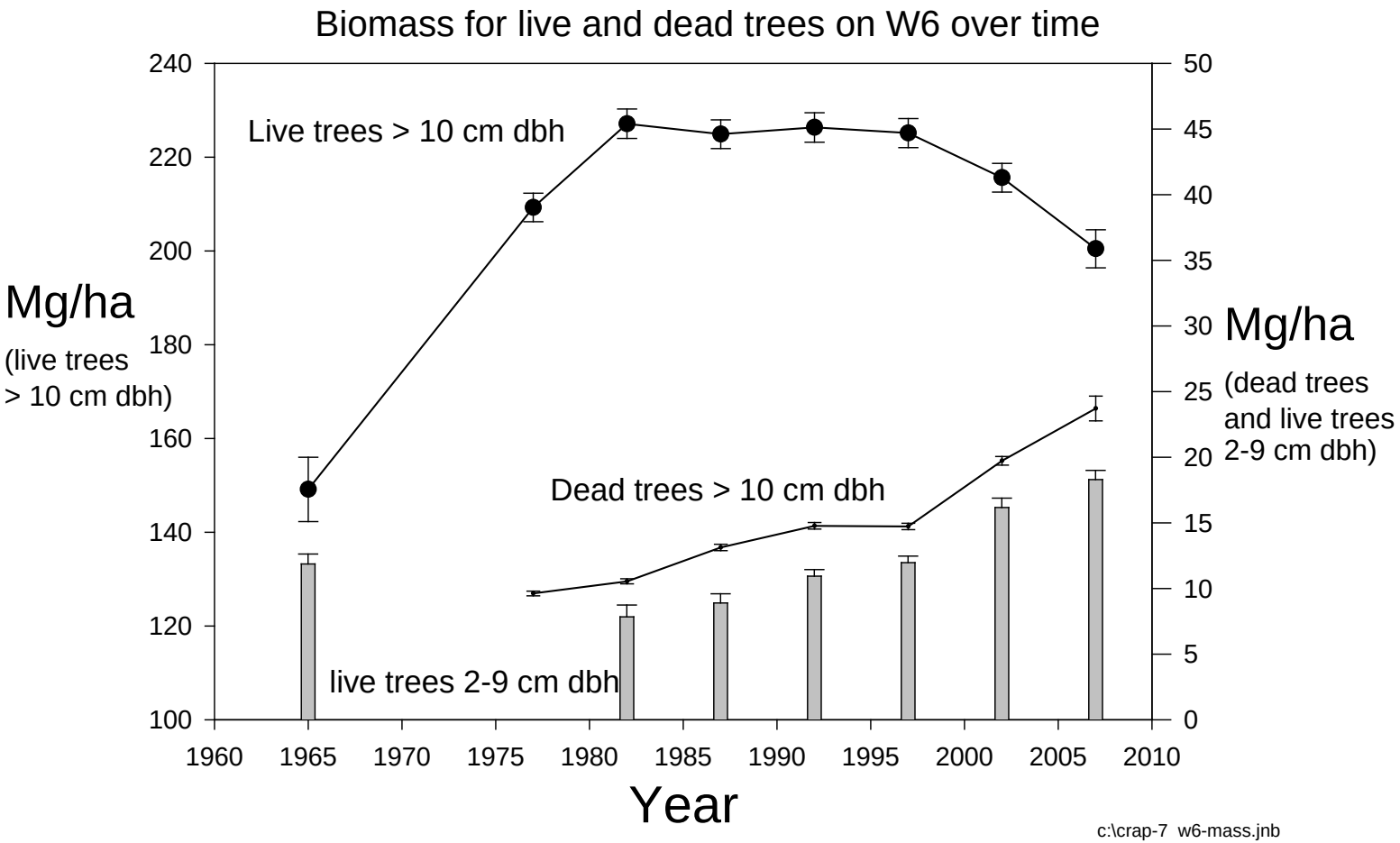



H_2SO_4
$H\ NO_3$
H_2SO_4
$H\ NO_3$
$H^+ \rightarrow Ca^{2+}$
$H^+ \rightarrow Mg^{3+}$
Al^{n+}
Streamwater
Ca^{2+}
Mg^{2+}
Al^{n+}

About 842 Kg of calcium/ha depleted from soil pools during 1940 to 1995.

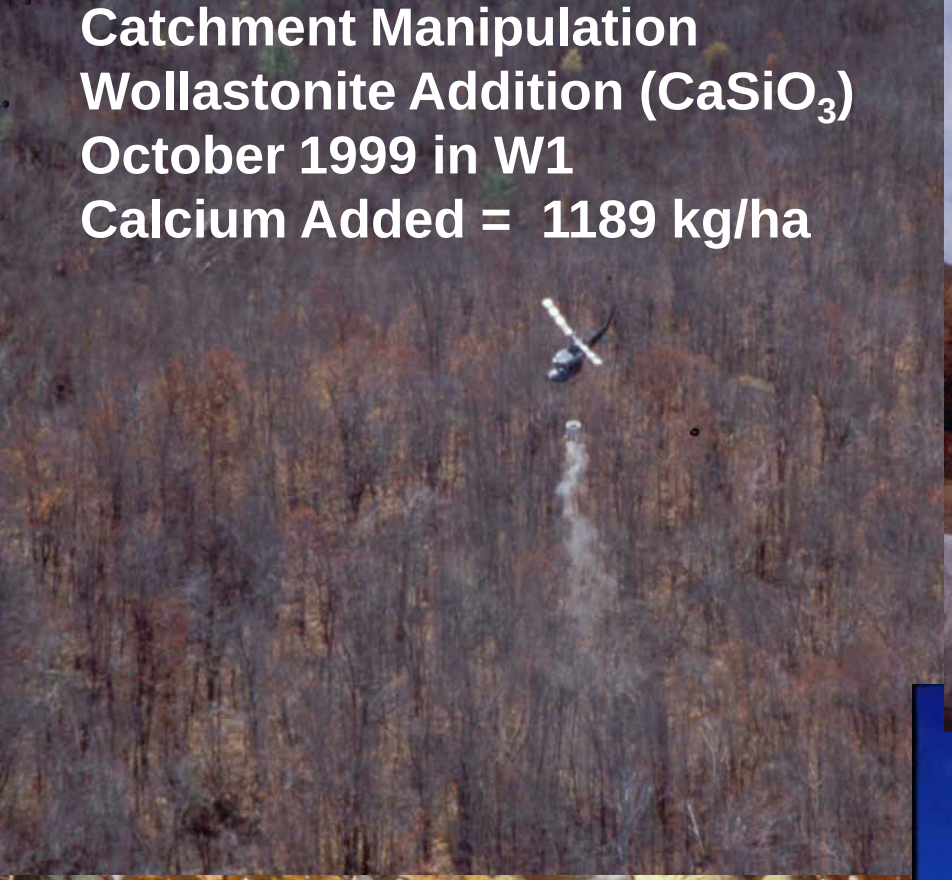
(***Likens et al. Science 1996***)

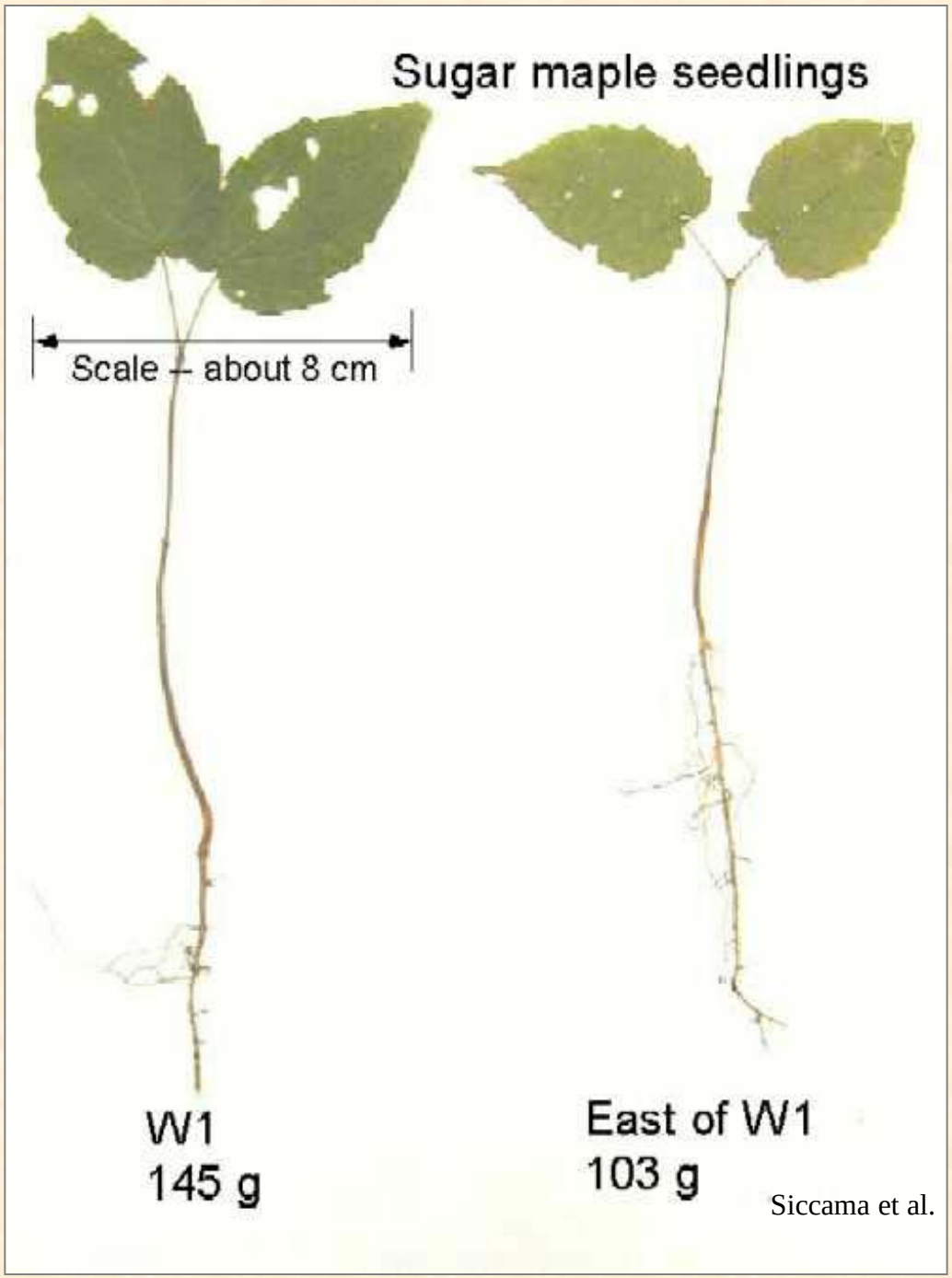
The Hubbard Brook Experimental Forest Has Stopped Growing!!



Whittaker et al.(1974), Siccama et al. (2007),
J. Battles and T. Siccama, pers. comm.

Catchment Manipulation
Wollastonite Addition ($CaSiO_3$)
October 1999 in W1
Calcium Added = 1189 kg/ha




Sugar maple seedlings
Scale – about 8 cm
W1
145 g
East of W1
103 g
Siccama et al.

AIR-LAND-WATER CONNECTIONS

So, coal mined in eastern Kentucky, burned in a power plant in Detroit, releasing SO_2 and NO_x to the atmosphere, forming acid rain, leaching base cations from soil in New Hampshire, causing the forest to stop growing, releasing CO_2 to the atmosphere, contributing to global climate change, which in turn, impacts the forest!!

Aptly described as the “decapitation” of entire mountains, mountaintop removal- mining extracts horizontal seams of coal located within the coal-rich mountainous US states of Kentucky, West Virginia, Tennessee, and Virginia.

MOUNTAIN TOP REMOVAL FOR COAL

Hundreds of km of vital headwaters and streams, and thousands of hectares of adjacent hardwood forests, already have been destroyed.

Between 1992 and 2002, approximately 1,900 km of headwaters were directly impacted by mountaintop mining and valley fills, including coal removal areas, valley fills, roads and ponds. Major human health impacts.

"Clearly, current attempts to regulate MTM/VF practices are inadequate. Mining permits are being issued despite the preponderance of scientific evidence that impacts are pervasive and irreversible and that mitigation cannot compensate for losses. Considering environmental impacts of MTM/VF, in combination with evidence that the health of people living in surface-mining regions of the central Appalachians may be compromised by mining activities, we conclude that MTF/VF permits should not be granted unless new methods can be subjected to rigorous peer-review and shown to remedy these problems. Regulators should no longer ignore rigorous science." Palmer et al. 2010. Science

On 1 April 2010, EPA Administrator, Lisa Jackson announced a “guidance” on water quality, which effectively will end mountaintop mining in the USA!

The Dunne and Likens Challenge (Feb. 2000)

"It will take strong leadership, conceptual models, and unusual cooperation between scientists from various disciplines, and between scientists and members of the management community and the public to achieve a truly integrated "ridge tops to the sea" management approach."