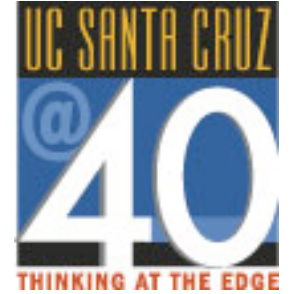




Sebastes aleutianus (rougheye rockfish), possibly born the same year as Darwin (maximum age of *S. aleutianus* ~205 yrs)



Ecology, Conservation and Public Policy: A Vision for the 21st Century

Marc Mangel

Astor Lecture, University of Oxford
April 2007

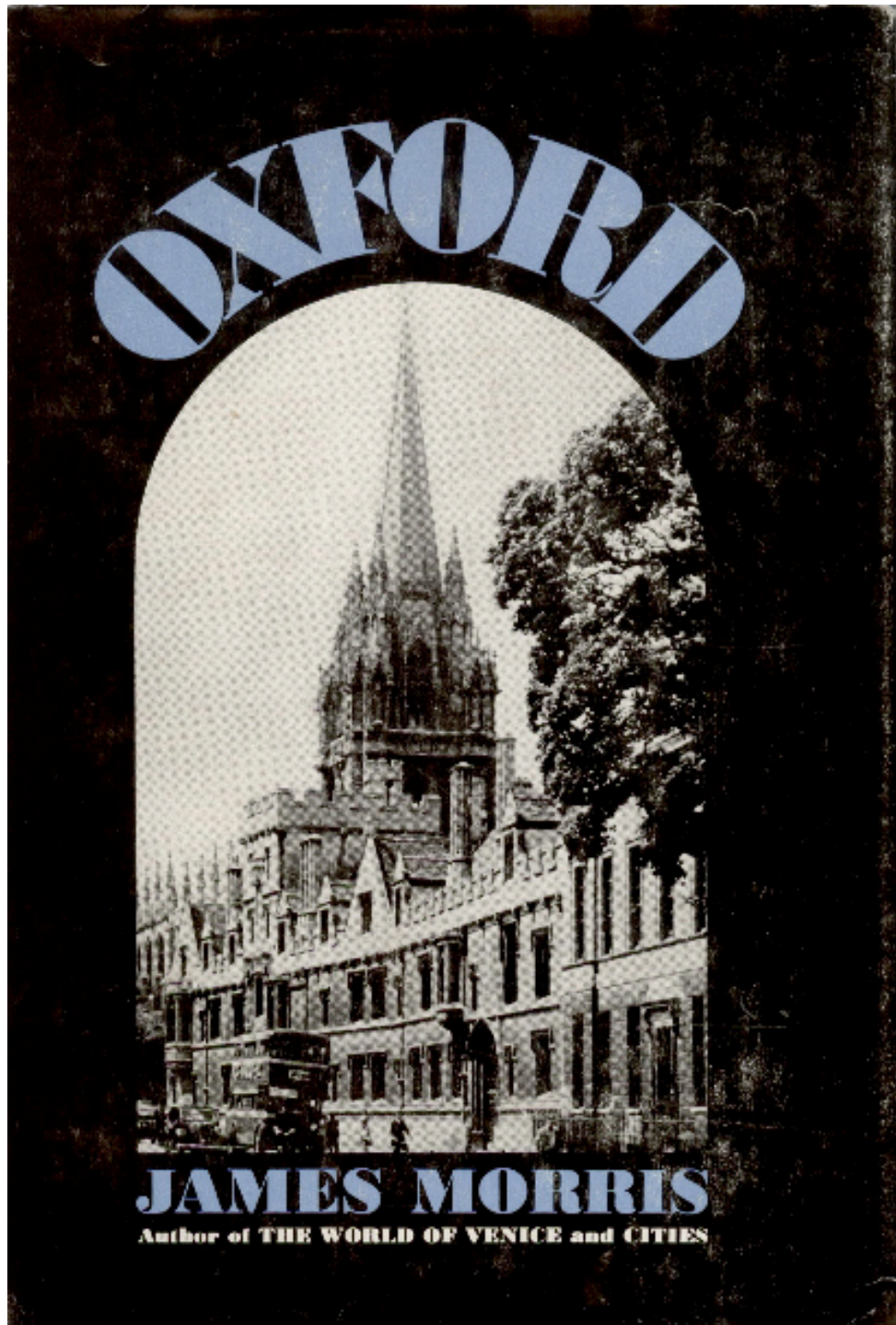
JACK BASKIN SCHOOL OF ENGINEERING
BIOTECHNOLOGY, INFORMATION TECHNOLOGY, NANOTECHNOLOGY

OXFORD

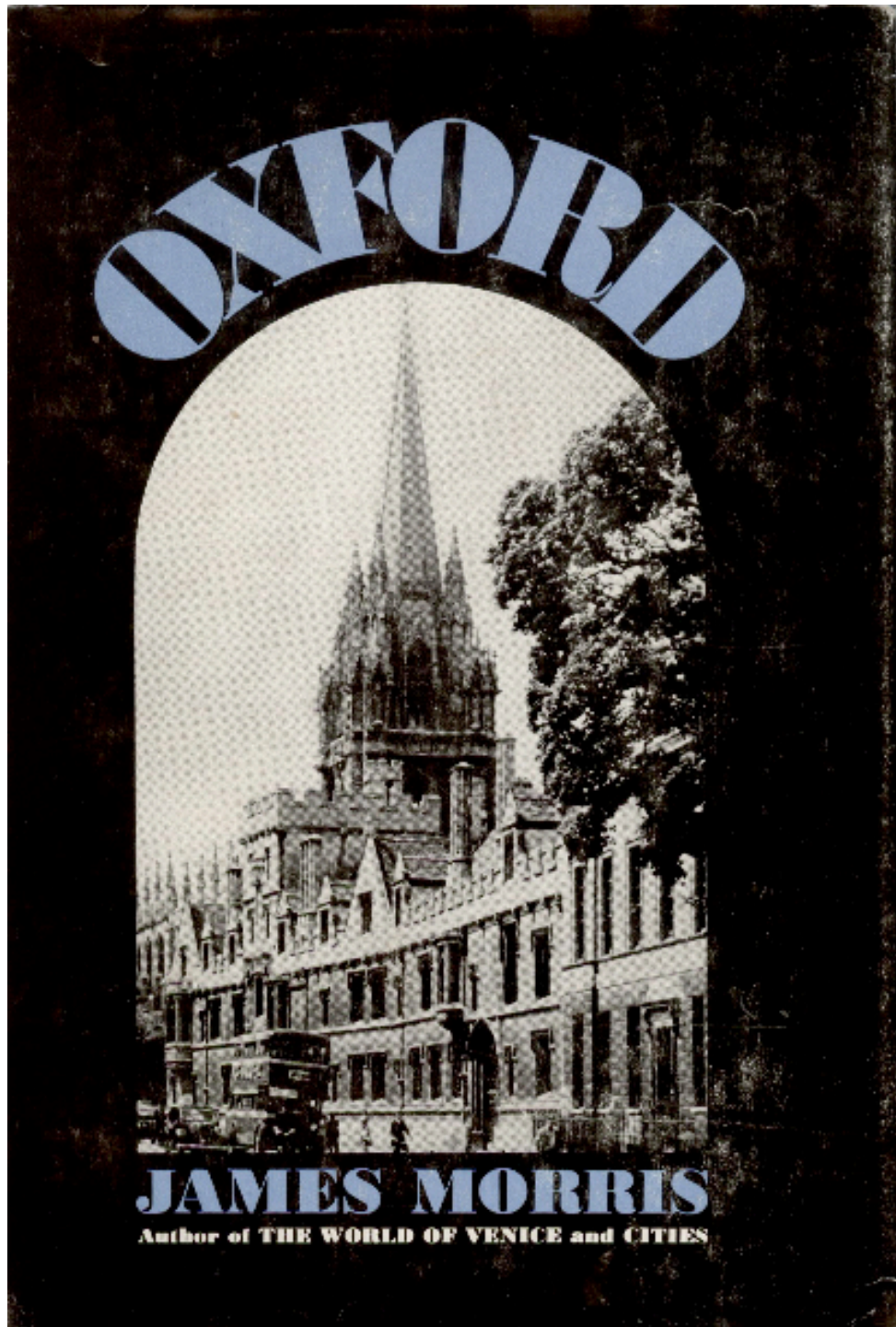


JAMES MORRIS

Author of **THE WORLD OF VENICE** and **CITIES**

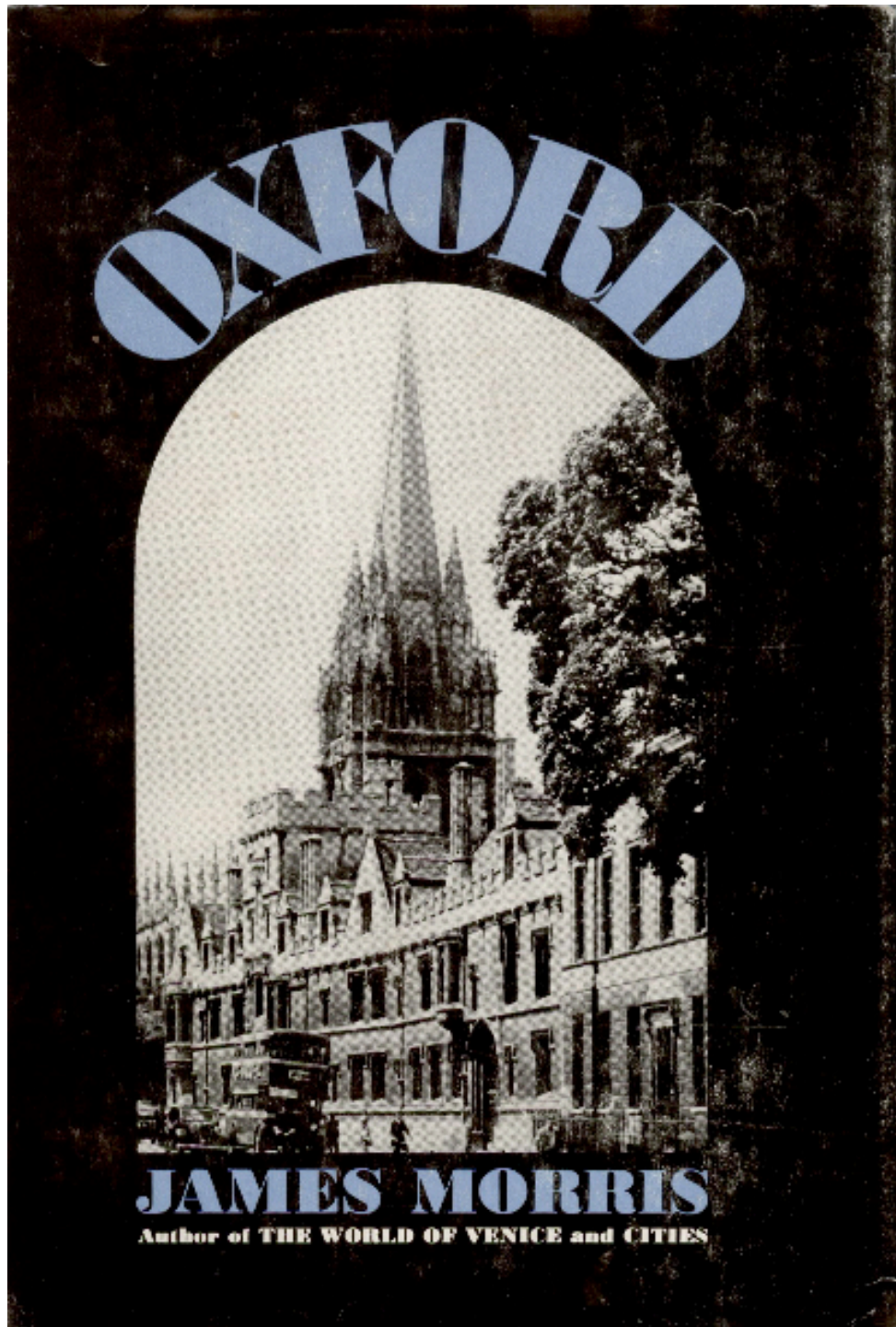


In the spring you really feel you have the hang of things in Oxford



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The college systems, which has survived in Europe only at Oxford and Cambridge, was at first discarded by the Americans: but in the 1920s both Harvard and Yale adopted it after all, and now even the vast University of California, alarmed by its own scale and scope, is dividing one of its new campuses into college units



In the spring you really feel you have the hang of things in Oxford

The college systems, which has survived in Europe only at Oxford and Cambridge, was at first discarded by the Americans: but in the 1920s both Harvard and Yale adopted it after all, and now even the vast University of California, alarmed by its own scale and scope, is dividing one of its new campuses into college units

The worst thing that could happen to this city would be a withdrawal into national pride or self-sufficiency, reducing it to the level of a Salamanca – once among the great intellectual centres of Europe, now merely an historical spectacle. Oxford is not only the Welshmen's, but the world's right of way

Question: How to we bring first class basic science to bear on important applied questions?

Question: How to we bring first class basic science to bear on important applied questions?

One Answer: “Why bother? Let’s just do good science.”

Another Answer:



“*Silent Spring* (1962) is the most important book written by an American”

John McNeil. 2000.
Something New Under the Sun.

The path is not at all clear, but some parts of it are becoming clear

The path is not at all clear, but some parts of it are becoming clear

The path is the focus of this talk, with applications to conservation and resource management but the ideas are general

Answering a question with a series of questions

- How does the nature of environmental problems differ from other kinds of problems?
- How do we deal with uncertainty, data and models?
- How can science support policy making?
- How and what should the next generation of ecologists learn and do?

Environmental Problems are Wicked

- No definitive formulation
- No stopping rule
- No final resolution
- Solutions are “good or bad” not “right or wrong”
- Plurality of legitimate perspectives

“The best environmental policy depends on how you frame the question”

---John Maddox

Wicked problems are not dealt with by

-- Optimizing

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-- Optimizing

-- Managing

Nobody “manages” climate change, El Nino, or the economy for that matter (although we might be able to do something about them)

Banish ‘ecosystem management’ from the lexicon

Wicked problems are not dealt with by

-- Optimizing

-- Managing

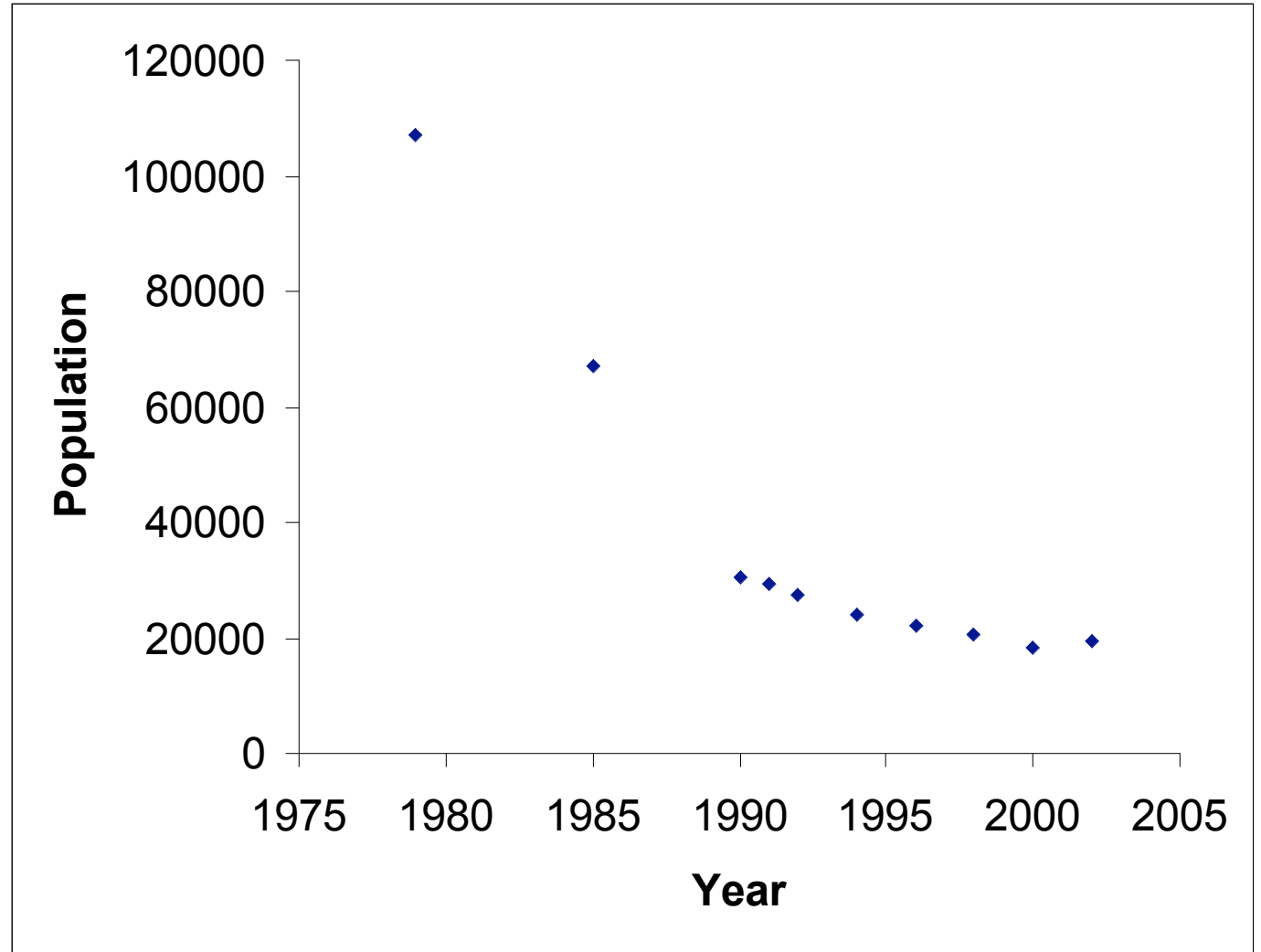
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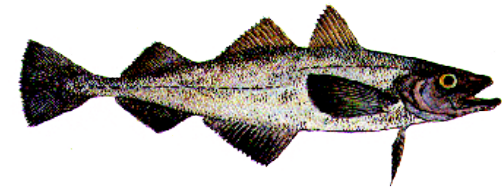
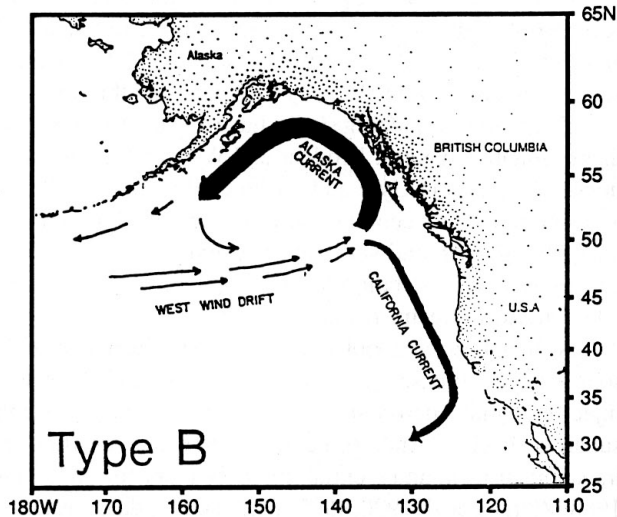
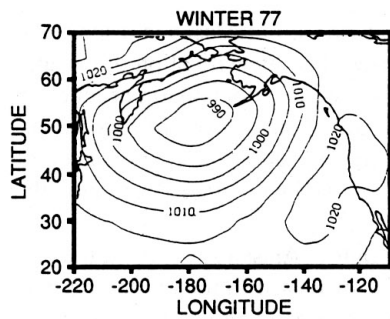
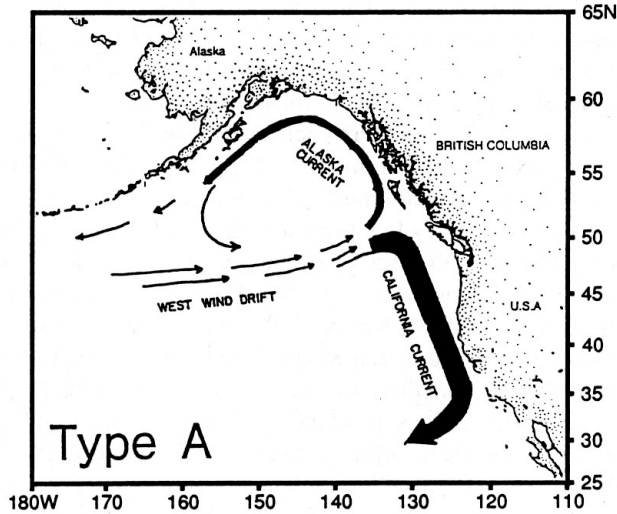
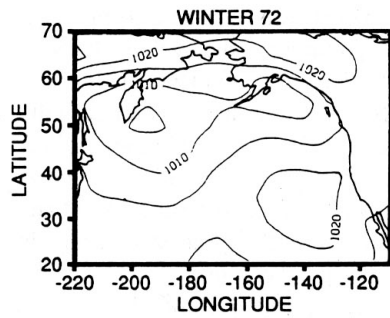
Banish ‘ecosystem management’ from the lexicon

And often lack clear stopping rules

--There is no easy scientific answer to the question “when is a recovery complete?”

Who manages climate change...



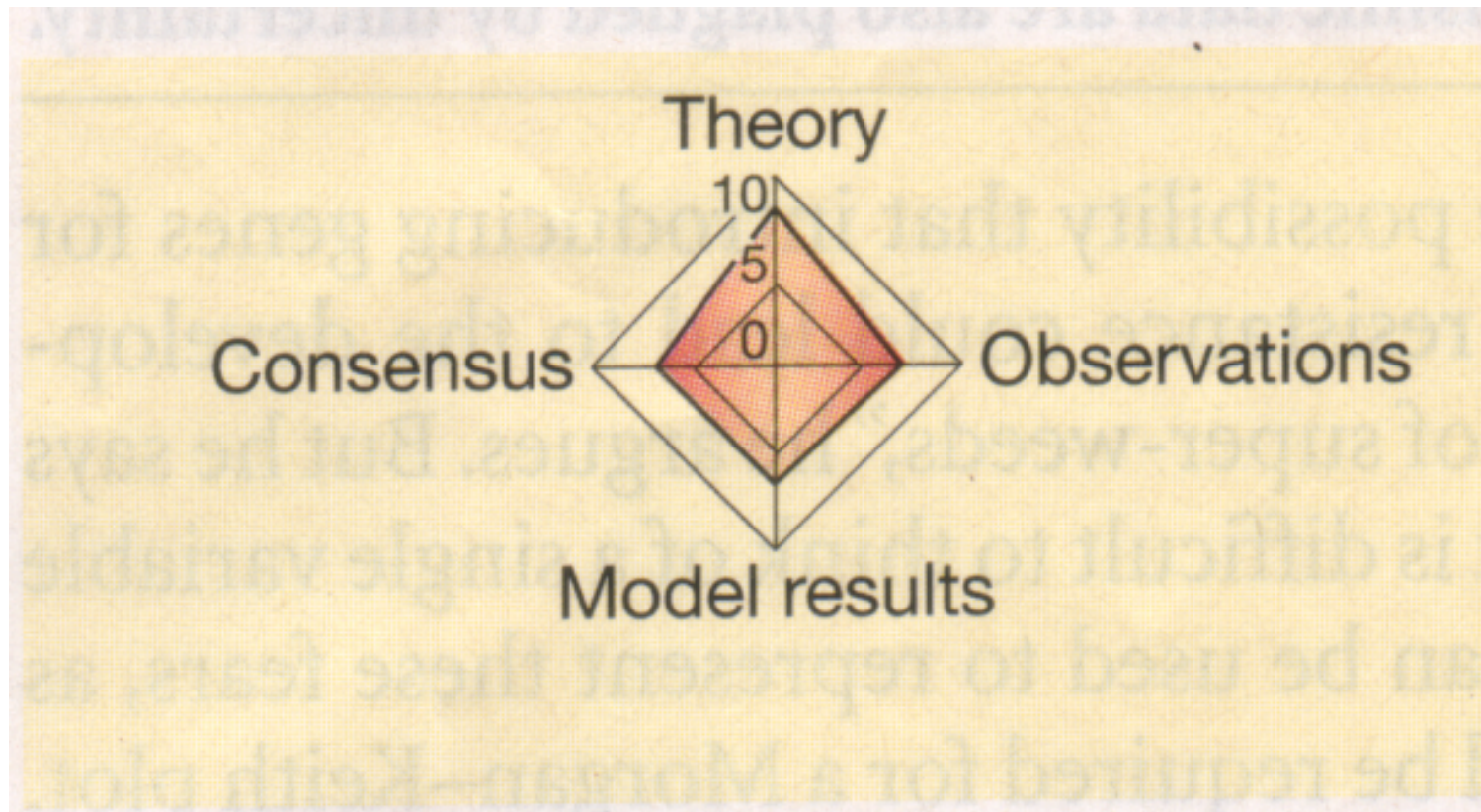


A result that neither Environmentalists nor the National Marine Fishery Service likes

OUCE Board Room
1 pm, Wed 9 May

Wicked problems are swathed in uncertainty

- Principle of irreducible uncertainty: No matter how much science we do, there will always be remaining a level of uncertainty.



We need to think about data and their interpretation

The classical/frequentist approach to dealing with data: The Earth is Round ($p < 0.05$)

“I argue herein that NHST (null hypothesis significance testing has not only failed to support the advance of psychology as a science but also has seriously impeded it” (J. Cohen. 1994. American Psychologist. 49:997-1003)



What is a null hypothesis?

Null hypotheses entertain the possibility that nothing has happened, that a process has not occurred, or that change has not been produced by a cause of interest. They are reference points against which alternatives should be contrasted.

However, since it is often impossible to prove that something has occurred, we construct a null hypothesis that is the complement of the hypothesis of interest and use the accumulated data to assess the probability that the null hypothesis is true.

Examples of Environmental Null Hypotheses That Were Rejected

- The occurrence of sheep remains in coyote scats does not vary across season (p=0.03)
- Duckling body mass does not vary across years (p<0.0001)
- The density of large trees is not greater in unlogged than logged forests (p=0.02)

All from D.H. Johnson. 1999. The insignificance of statistical significance testing. *Journal of Wildlife Management* 63:763-772

- Driving cessation [in the elderly] leads to a decline in out-of-home activity (p<0.001)

RA Marottoli et al. 2000. Consequences of driving cessation: decreased out-of-home activity levels. *Journal of Gerontology: SOCIAL SCIENCES* 55B:S334-340

What's wrong with NHST?

“Well, among many other things, it does not tell us what we want to know, and we so much want to know what we want to know that, out of desperation, we nevertheless believe that it does.

What we want to know is

Given these data, what is the probability that the null hypothesis is true?

But, as most of us know, what it tells us is

Given that the null hypothesis is true, what is the probability of these (or more extreme) data”

(Cohen pg 997)

You Can't Always Get What You Want (Jagger, M. and Richards, K. 1969. ABKCO, London UK)

What we want
for scientific understanding

What we get from NHST

$$\Pr\{H|D\} \neq \Pr\{D|H\}$$

NHST has “caused scientific research workers to pay undue attention to the results of the tests of significance they perform on their data..and too little to the estimates of the magnitude of the effects they are estimating”

(F. Yates. 1951. Journal of the American Statistical Association 46:19-34)

But Sometimes You Might (Jagger and Richards, op. cit.)

Likelihood and Bayesian Methods Show the Way to Get What You Want

“...the discipline of statistics has neglected a key question for which it is responsible: when does a given set of observations support one statistical hypothesis over another?”

The principle fundamental to providing this answer is the law of likelihood, which “provides the explicit objective quantitative concept of evidence that is missing”

Law of Likelihood: If hypothesis A implies that the probability that a random variable X takes the value x is $p_A(x)$, while hypothesis B implies that the probability is $p_B(x)$, then the observation $X=x$ is evidence supporting A over B only if $p_A(x) > p_B(x)$, and the likelihood ratio, $p_A(x)/p_B(x)$, measures the strength of that evidence.

R. Royall. 1997. *Statistical Evidence. A likelihood paradigm*. Chapman and Hall, New York

Ecological Detection in Environmental Problem Solving

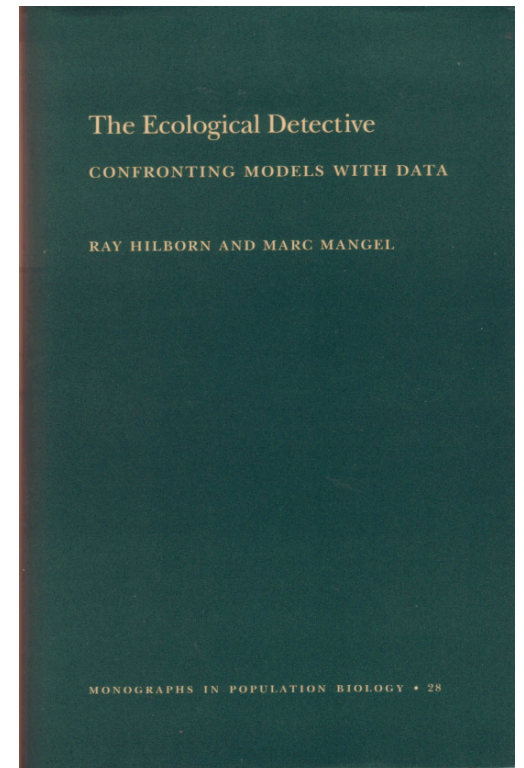
”Method of multiple working hypotheses”

--T.C. Chamberlain (1890)

The three questions we need to ask

Given two (or more) hypotheses/models and an observation (data)
we can ask

- What do I believe, now that I have this observation?
- What should I do, now that I have this observation?
- How should I interpret this observation as evidence regarding the different models/hypotheses?



Simple example

H is the hypothesis of interest, with prior probability p ; H_0 is the alternative hypothesis, with prior probability $1-p$.

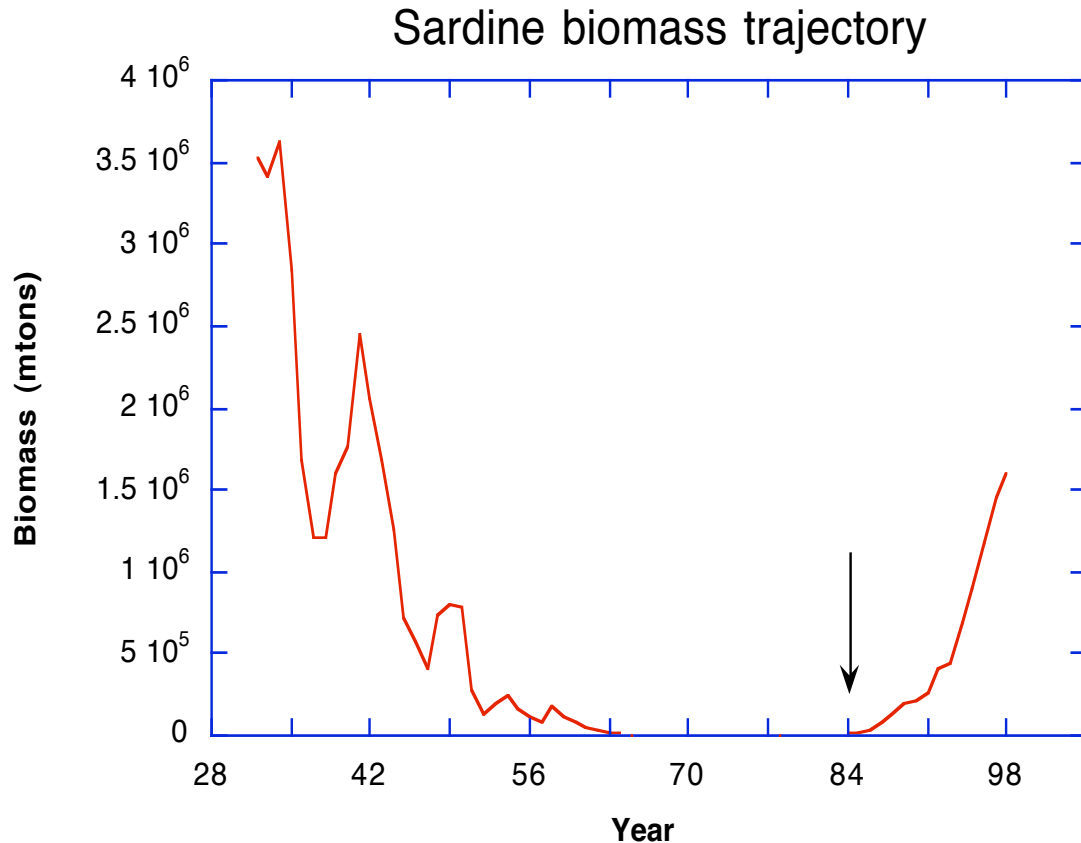
We collect data. Then

$$\Pr\{H|\text{data}\} = \frac{p\Pr\{\text{data}|H\}}{p\Pr\{\text{data}|H\} + (1-p)\Pr\{\text{data}|H_0\}}$$

Bayesian and likelihood methods allow us to deal with uncertainty and information in a consistent framework

Science in support of policy making: Conservation biology provides the context for understanding policy decisions

We have had successes



Some other successes in fishery management

THE BEST AT A GLANCE

Fishery	No. of participants	Season	Gear	Management body	Record revenue	Record harvest
ALASKA SALMON	17,000 permit holders	Late May to late September	Gillnets (set and drift), seines and fishwheels	Alaska Department of Fish and Game	\$781.4 million (1988)	994.1 million pounds (1995)
CALIFORNIA HERRING	416 in San Francisco Bay	November to March	Gillnet	California Fish and Game Commission	\$18.5 million ('95-96)	13,543 tons ('96-97)
MAINE LOBSTER	6,600 permits	Year round, with some daily closures	Traps	Maine Division of Marine Resources	\$138 million (1997)	47 million pounds (1998)
NEW ENGLAND SHRIMP	Open access; 260 vessels in 1998	December to May	Trawl equipped with Nordmore grate to reduce bycatch	The Atlantic States Marine Fisheries Commission	\$15.1 million (1996)	9,166 metric tons (1996)



Science is not always needed to understand consequences
Before bottom trawling



From PK Dayton. Reversal of the burden of proof in fisheries management. *Science* 279:821

After bottom trawling



To remain credible, we must separate environmental science and environmentalism



Science by
Assertion

- Marine stock enhancement,
- Marine reserves

To remain credible, we must separate environmental science and environmentalism



Science by Assertion

- Marine stock enhancement
- Marine reserves

Openers



Success!
It's a Failure

Snatching victory from the ever-snapping jaws of defeat, we've suddenly got lots of big redfish in Miami. Yes, indeed. Unnoticed by most folks, the hatchery-born reds have now grown into catchable adults, living in big schools.

The plump red drum are prospering in many areas of lower Biscayne Bay, leaving some biologist/bureaucrats chagrined and embarrassed, while stocking enthusiasts are plainly delighted but trying not to shout I told you so. It was just a couple years ago, you may recall, that state scientists and managers decreed that stocking efforts in Biscayne Bay were a wasteful bust. One of them pontificated that the bay was a "subtropical lagoon" and not suitable habitat for reds. Others called the fish plantings barracuda chum. Lacking proof to the contrary, officials dropped the Biscayne effort except for some cleanup research and release of leftover brood stock. Instead, they launched the current Tampa Bay program, which is off to a solid start.

What happened next: In the past year, after the Miami abandonment, scientist Carole Neidig implanted sonic transmitters in no-longer-needed large East Coast reds and released them into South Biscayne Bay. She followed their pinging over the months. Lo and behold, the pinging fish not only did well, they joined up with big schools of other hatchery-origin reds that hadn't even been seen.

"We've tracked at least 15 schools," Carole told us, "and I feel that there are a half-dozen more, with more than 50 fish in each one. We had no idea."

One of the big sonic fish was caught north of its release.

The really exciting news, though, is that Carole has spotted schools of eight-inchers that don't match past release growth projections. "I think it's far-fetched to think they came from some outside area; they're most likely new generations from stocked fish," she said. Milt and roe, to be sure, have been found in Miami's new brood-size reds.

The new fishery for reds has at least five fishing guides targeting them regularly and another 15 who include reds in their flats explorations. October's fishing tournament for reds (see floridasportsman.com) adds to the socio-economic value for South Florida.

All this has come from a minimal, under-financed program that is a drop in the fish bucket compared to five million little reds put into Galveston Bay, Texas, every single year.

There's just no excuse for South Florida leaders and state officials to drag their feet on a potential so obviously beneficial.

So let's drop that failure refrain. There's success swimming out there.

Carl Wickstrom

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Top Dog Jr.® 84UR67 4 3/4" 30 Oz.

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behind the lines



By David Taylor



Fishing for the Truth

You won't find it in the misrepresentations and cynicism of the fishing lobby.

DRY TORTUGAS



The fishing lobby was successful in banning divers from one area of the new Dry Tortugas marine sanctuary.



Commercial and sport fishing interests recently battled 500 in the Gulf of Mexico (see "Tortugas Reserve Approved," pg. 20) in their ongoing attempts to ban scuba diving in no-take zones. Next battle: the Florida Keys National Marine Sanctuary's tiny no-fishing areas.

You can bet the fishing lobby's battle cry will be heard throughout the Keys: "If we can't fish there, you can't dive there." Not only is their argument cynical and childish ("If I can't have it, nobody can!"), its logic and science are laughable:

⇒ No social, economic or scientific principle suggests that fishing should be the only benefit of marine resources or that all areas should be

The Myth of Diver Damage

Coral reefs are usually portrayed as sensitive ecosystems vulnerable to sedimentation, excess nutrients, disturbances from fishing, groundings and excessive contact. Not only are corals very resilient to moderate physical damage, some corals actually require physical damage to propagate.

Were it not for physical damage, fast growing branching corals like elkhorn and staghorn would overgrow and kill boulder corals. Periodic storms are the major force that break limbs of branching corals. Broken branches that live start new colonies; branches that die provide substrate for new reef. Indeed, most reef structure is based on dead branching coral, as shown in work by Eugene Shinn in Key Largo from the 1960's.

Moreover, incidental damage to branching corals by diver contact is undetectable compared to other natural stresses. In fact, one storm can produce far more damage than hordes of divers, even at our most heavily used sites. Studies by Jim Tilmant in Biscayne National Park found that diver damage could not be detected because of the extent of natural storm damage.

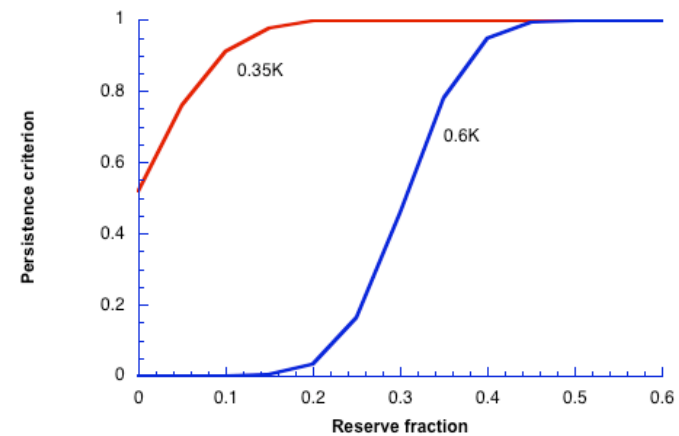
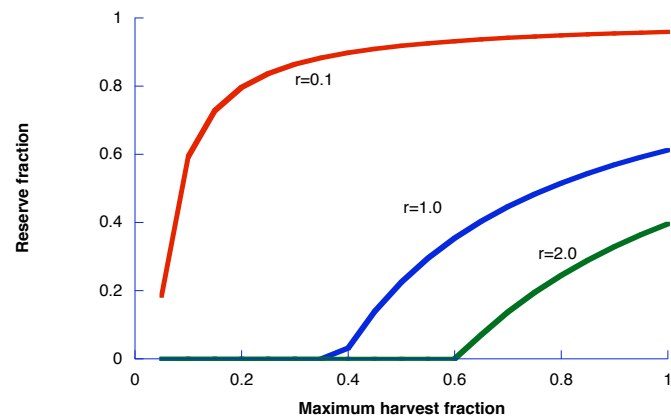
Boulder corals are essentially impervious to inciden-

It can happen to anyone

20% by 2020 !

“... a professor who is bitten by the political bug ceases to be effective as a scholar”

Stephen L Carter (2002)



Understanding the policy process

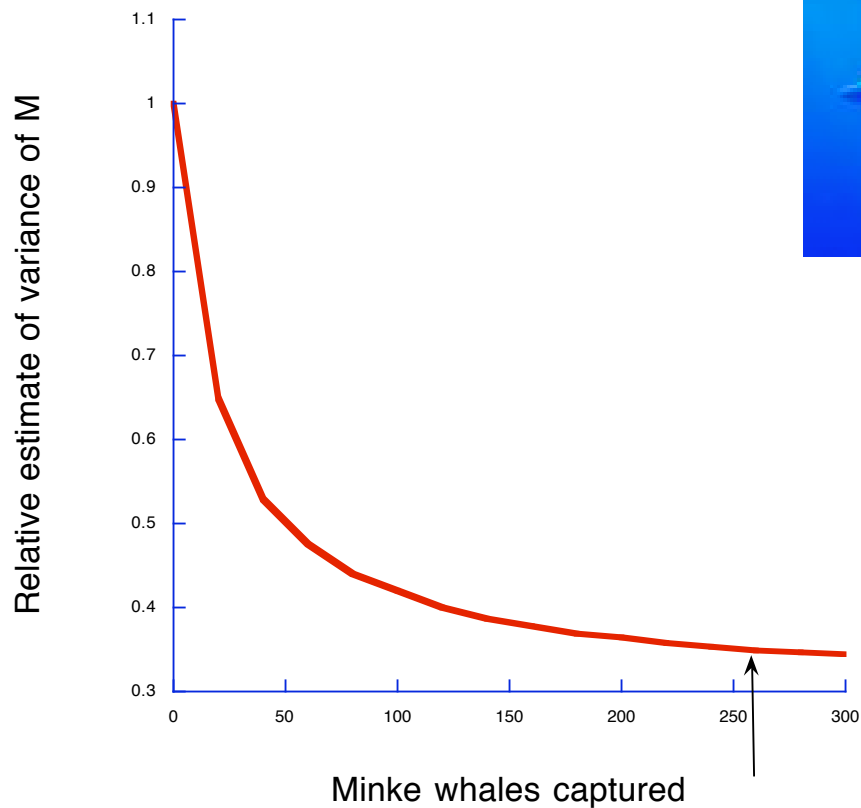
Policies expressed by

- Goals articulated by political leaders
- Points of view expressed by staff of government agencies
- Formal statutes, rules, or regulations
- Practices of administrative agencies or courts charged with implementing or overseeing programs

Policy can occur anywhere in the executive, judicial or legislative branches

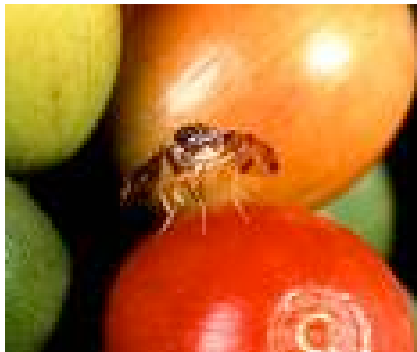
When science and policy interact, they both may become distorted

- The closer an issue is to human interests, goals or aspirations, the more difficult it is to separate scientific conclusions from other influences

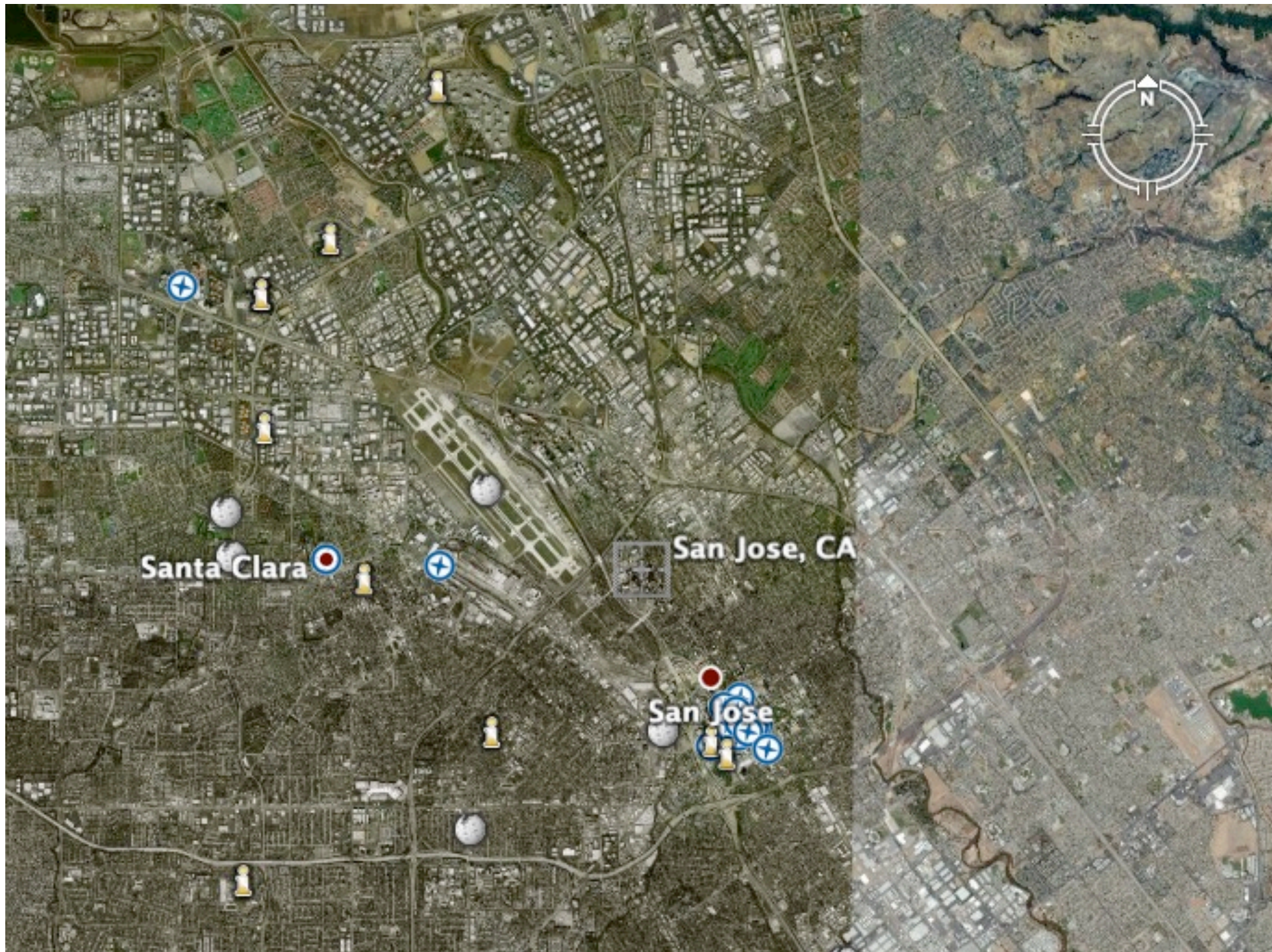


Mediterranean Fruit Fly in California: 1970s and 1980s

“Just do something!”





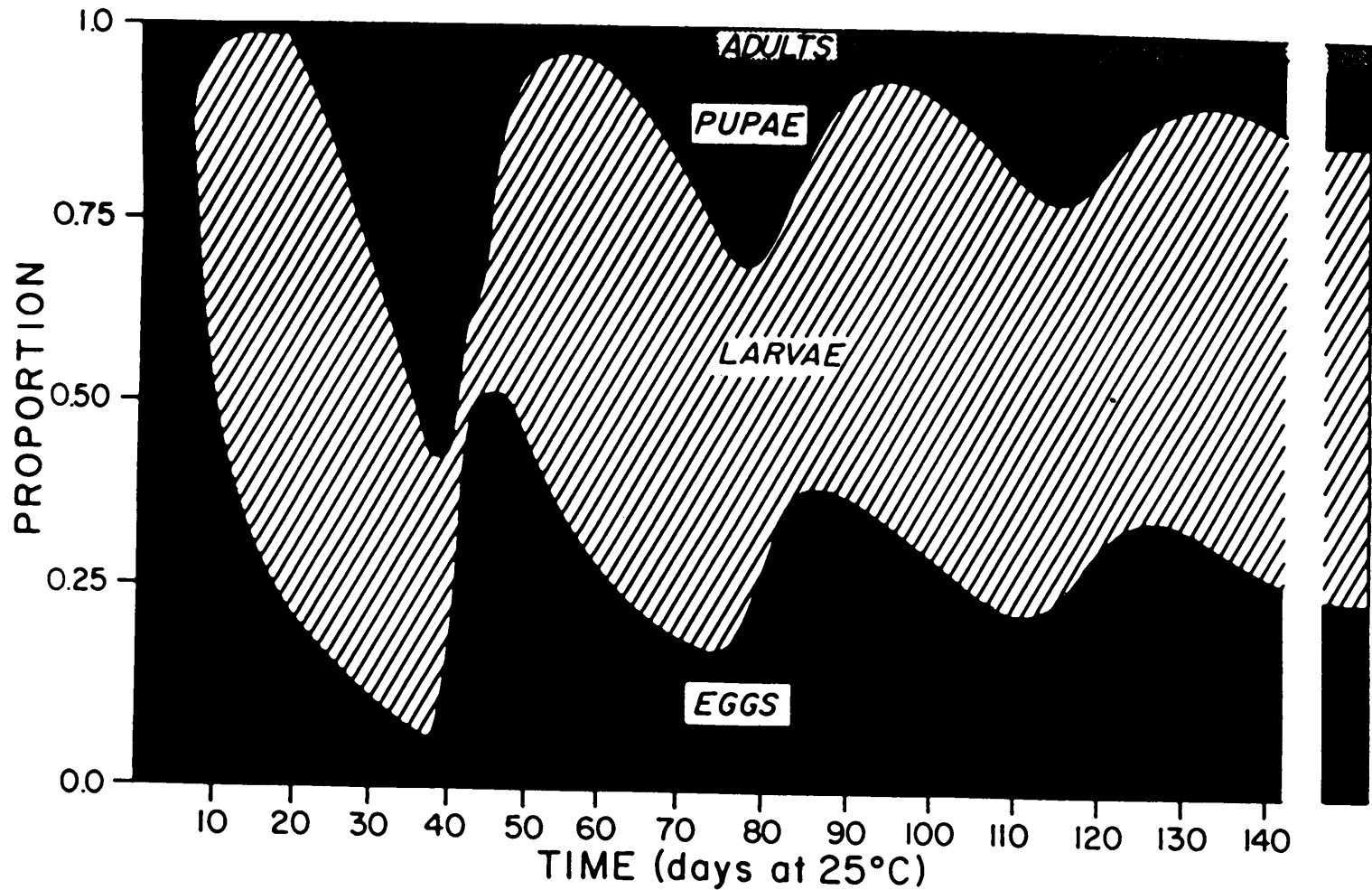


Mediterranean Fruit Fly in California: 1970s and 1980s

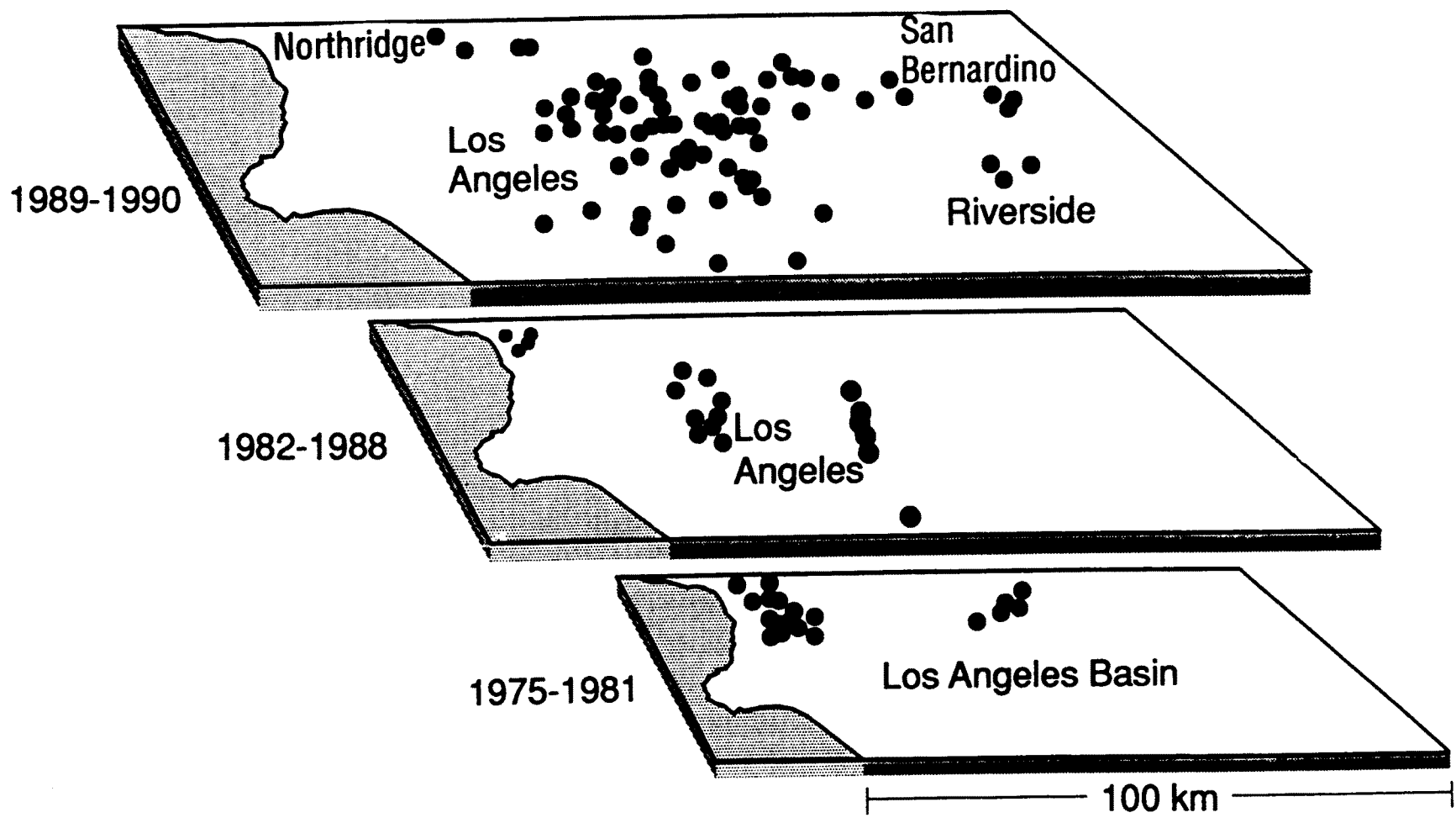
Just doing something to do something in the absence of thinking is usually useless

Mediterranean Fruit Fly in California: 1970s and 1980s

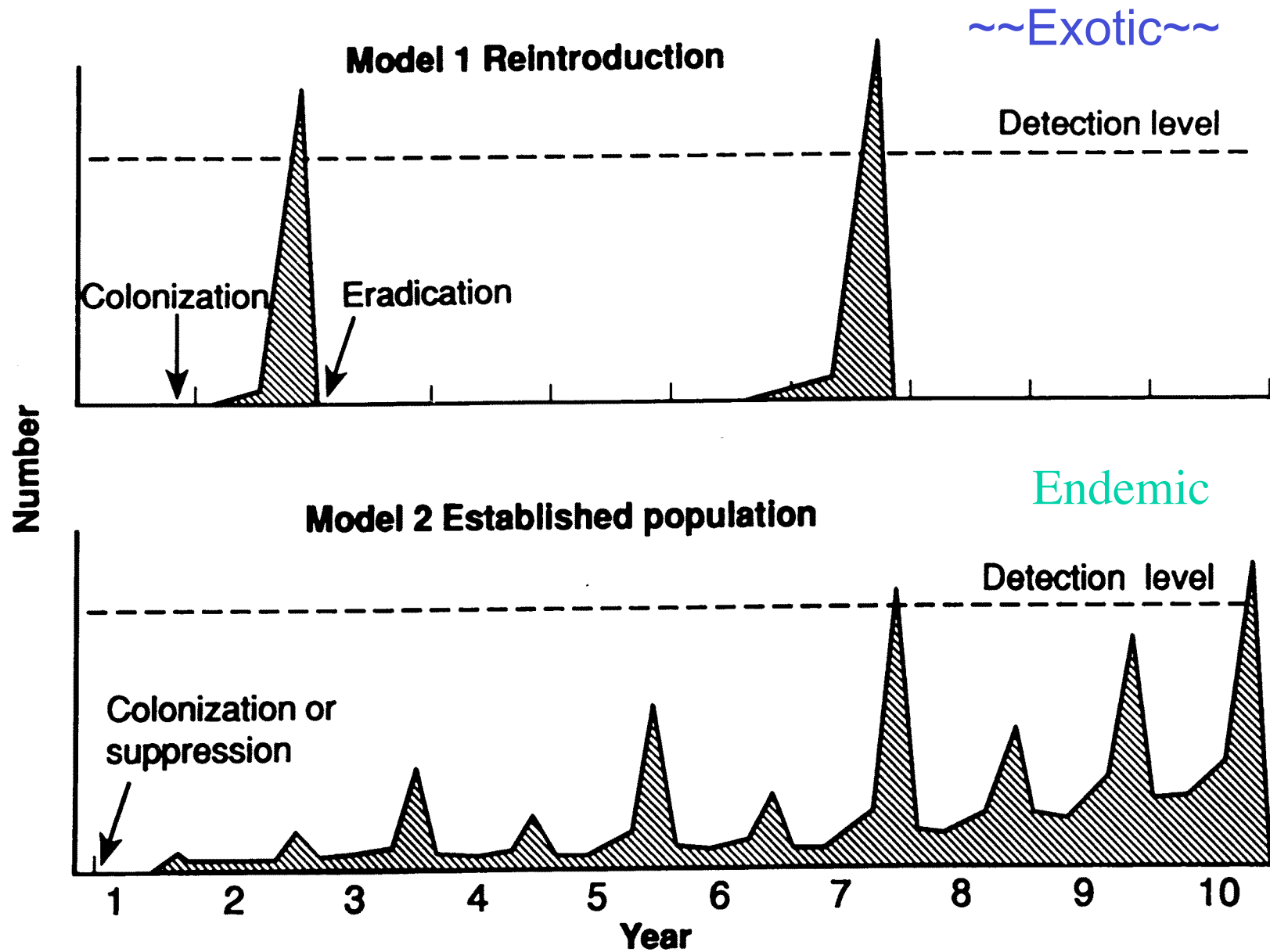
Just doing something to do something in the absence of thinking is usually useless



1990s and Beyond: Spatial distribution of trap catch



Two models of medfly infestation



Advice for the next generation of ecologists

- Keep your eyes on the prize --- Avoid goal displacement



• Remember that nature IS variable and complex...and that much of the complexity and variability can be understood

• The highest function of ecology is understanding consequences
(Frank Herbert)



• The simpler the mathematical tool, the more likely it is to deliver the goods
(John Hammersley)



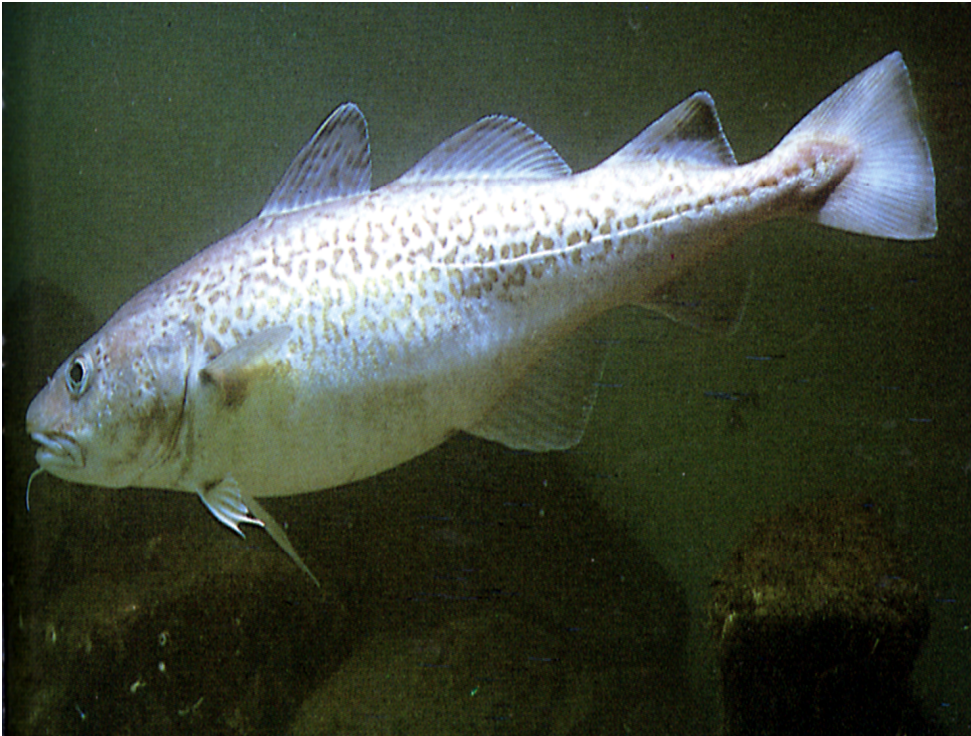
• I would not give a fig for simplicity this side of complexity, but I would give my life for simplicity on the other side of complexity
(Oliver Wendell Holmes)



- Recognize the diversity of stakeholders and their different values



- Recognize that scientists have values

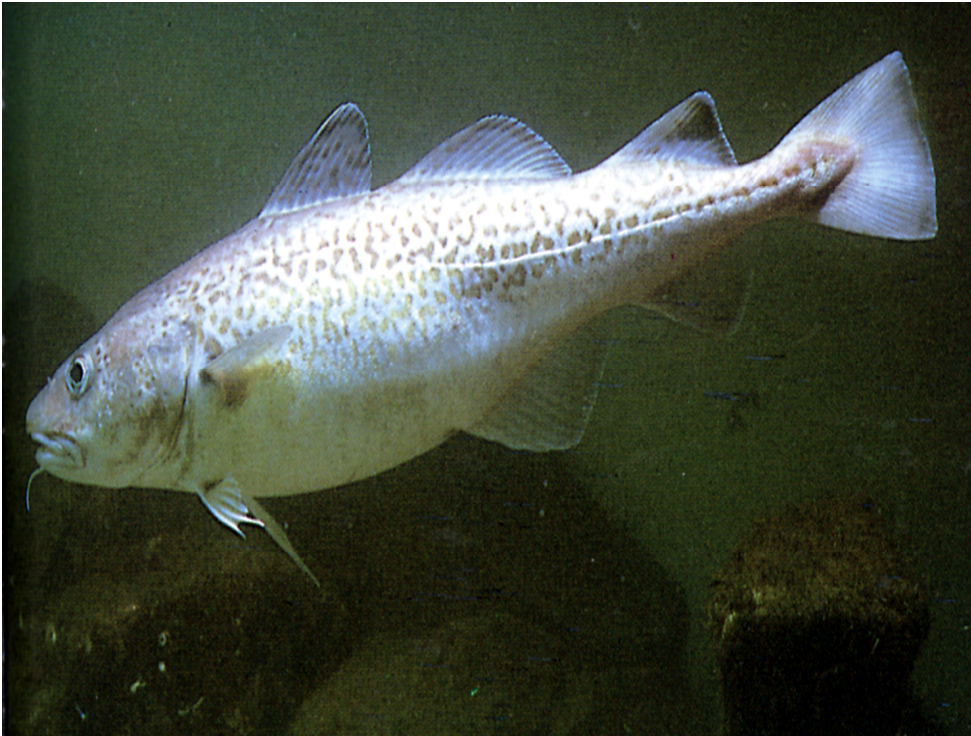


The conservation paradigm: the purpose of management is to conserve fish stocks.

The economic rationalization paradigm: the purpose of management is to maximize economic return to society.

The social/community paradigm: the purpose of management is to maintain communities, social structure, and ways of life.

- Recognize that scientists have values



And that science is not
'just another stakeholder
position'

The conservation paradigm:
the purpose of management
is to conserve fish stocks.

*The economic rationalization
paradigm:* the purpose of
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economic return to society.

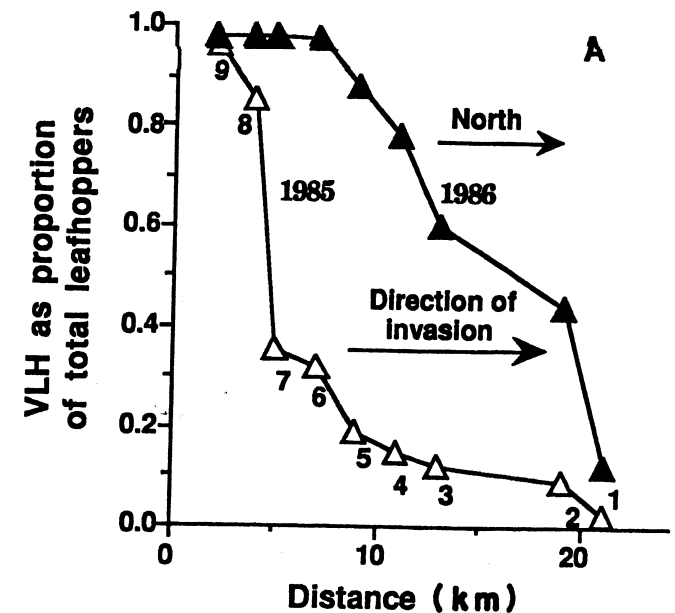
*The social/community
paradigm:* the purpose of
management is to maintain
communities, social
structure, and ways of life.

- Avoid dealing with uncertainty and values by averaging positions
-- do the risk analysis



- Recognize that disciplines are essential but disciplinary boundaries are an impediment since they tell us what are the “right” questions and the “right” way to approach them

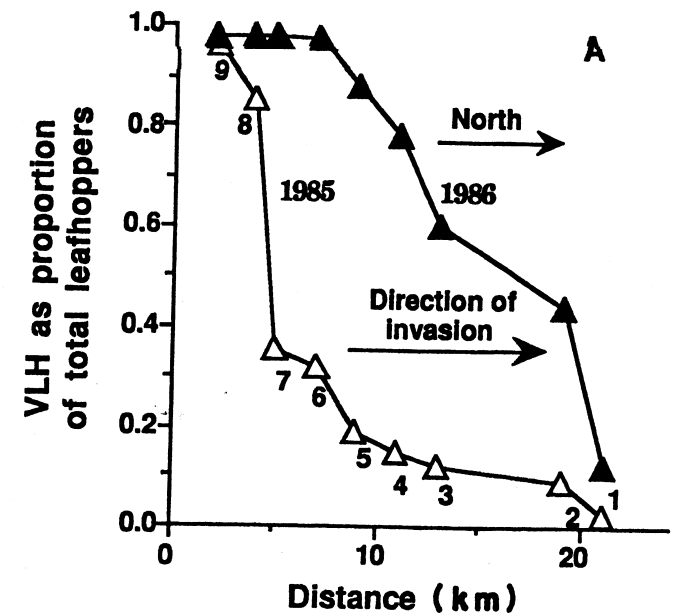
$$\frac{\partial N}{\partial t} = \sigma^2 \frac{\partial^2 N}{\partial x^2} + rN \left(1 - \frac{N}{K} \right)$$



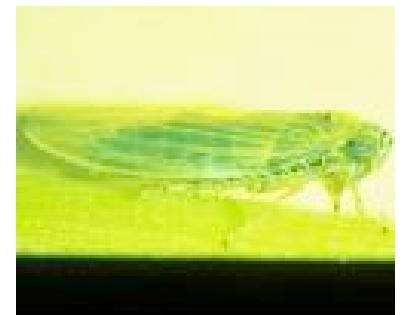
Leafhopper
[Photo by S. J. Hall]

•Recognize that disciplines are essential but disciplinary boundaries are an impediment since they tell us what are the “right” questions and the “right” way to approach them

$$\frac{\partial N}{\partial t} = \sigma^2 \frac{\partial^2 N}{\partial x^2} + rN \left(1 - \frac{N}{K} \right)$$



To do true interdisciplinary work, master the core skills in multiple disciplines



[Author: [unreadable]]
[Reprinted by: [unreadable]]

- Seek insights from geography, history and anthropology (read widely and think deeply)

- Many regional problems require a geographic perspective

- Doing a Population Viability Analysis may be less meaningful than understanding the rate and direction of spread of a city

- Seek insights from economics



Understand the four horsemen of conservation

Density-dependence (what is excess production in a community context)

Common property (belonging to everyone \neq belonging to no one)

Open access (driving towards the bionomic equilibrium)

Discounting (the future is less valuable than the present)

- Seek insights from political science

Recognize the gulf between environmentalism and liberalism (indeed, all moderate politics)

“...[environmentalism] is a political movement that seeks to *impose* upon the natural sciences and engineering restraints based upon the findings and judgments of the social sciences”

Paehlke (1989)

- Seek insights from philosophy, ethics, and religion

--Read *A Sand County Almanac*

-- Don't be sophomoric when dealing with religion

10 March 1967, Volume 155, Number 3767

SCIENCE

**The Historical Roots of
Our Ecologic Crisis**

Lynn White, Jr.

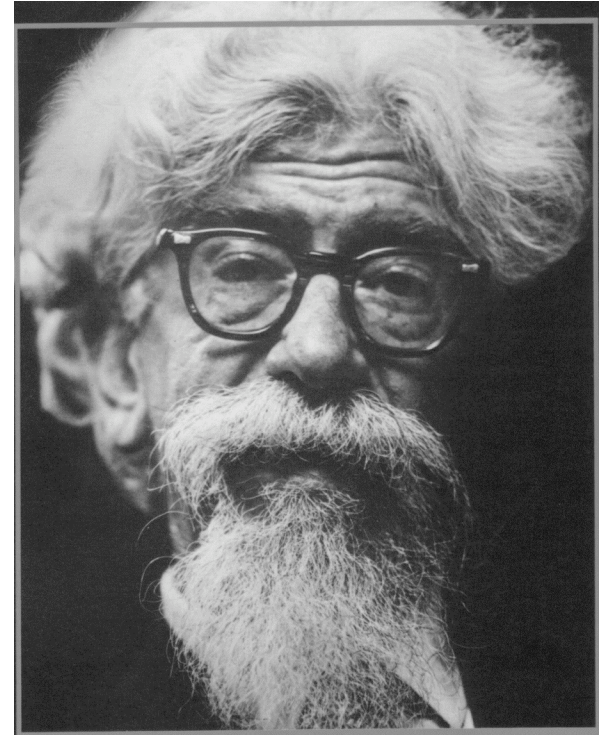
...Religion is an answer to man's ultimate questions. The moment we become oblivious to ultimate questions, religion becomes irrelevant, and its crisis sets in.

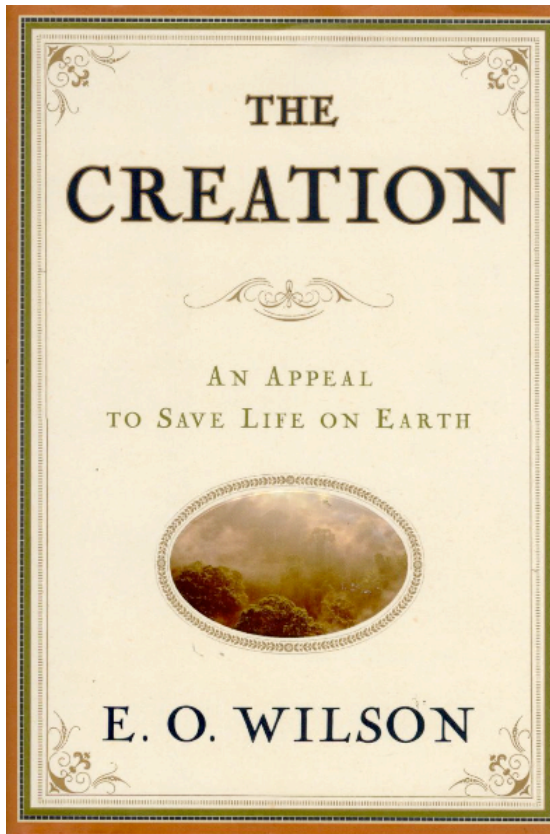
[italics in the original] -- AJ Heschel.

1955. *God in Search of Man*.

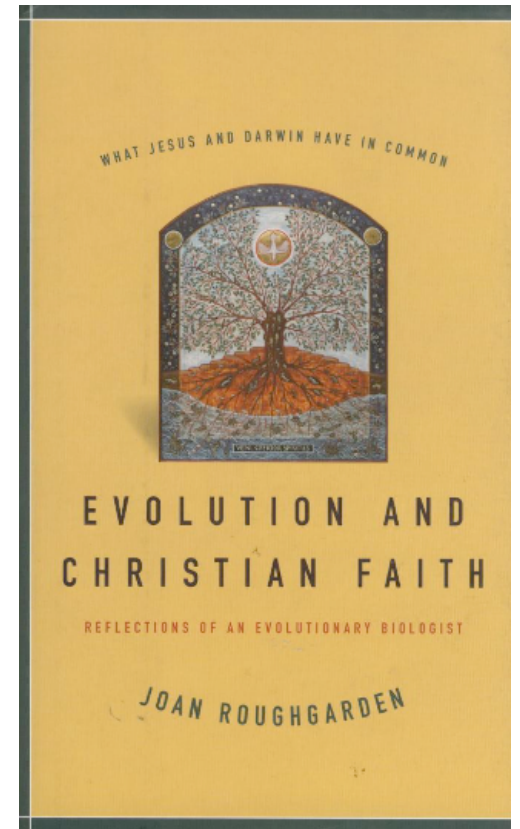
There are strong theological arguments against human-induced extinctions--
We should incorporate them when appropriate

“Nothing that the Lord created in the world was superfluous or in vain; hence, all must be sustained” (Lamm 1986, pg 168).

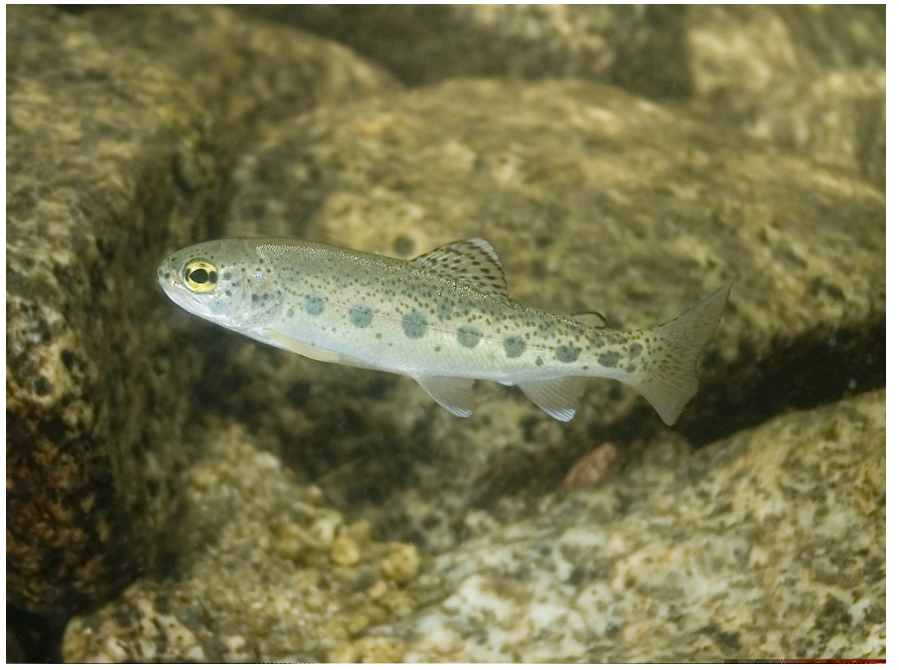
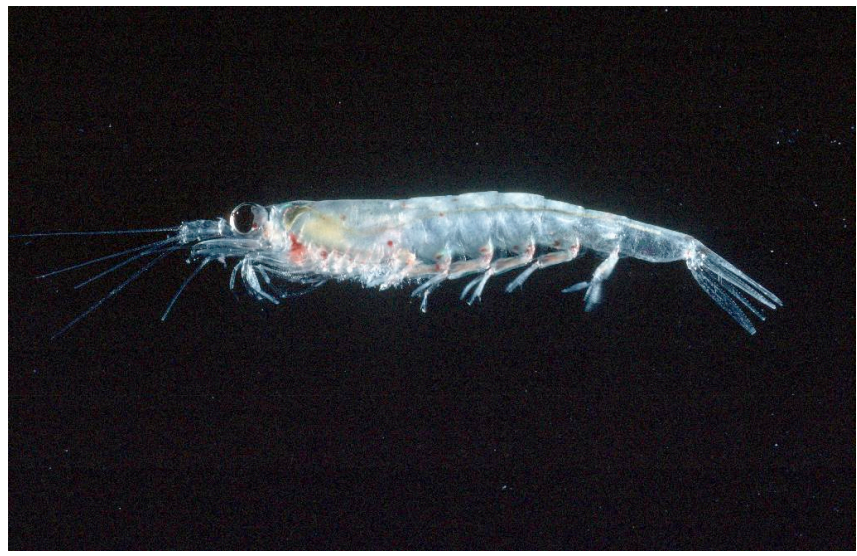




The human being is the jewel of creation, but every single thing in our physical world -- animal, mineral, and vegetable -- has also been charged with divine energy and purpose, and must be treated accordingly. The environment is sacred and no man has a right to destroy it
-- Lubavitcher Rebbe



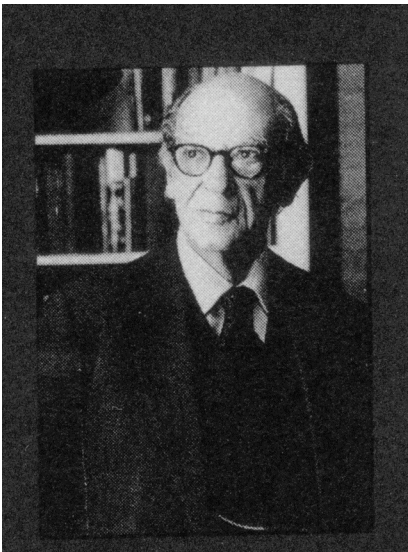
- Pick your study species carefully: the problem is paramount



- Recognize that the world is real and be careful of words about words

“He [Comte] understood the role of natural science and the true reasons for its prestige better than most contemporary thinkers. He saw no depth in mere darkness; he demanded evidence; he exposed shams; he denounced intellectual impressionism ... he provided weapons in the war against the enemies of reason, many of which are far from obsolete today. Above all he grasped the central issue of all philosophy — the distinction between words (or thoughts) that are about words, and words (or thoughts) that are about things, and thereby helped to lay the foundation of what is best and most illuminating in modern empiricism” (pg 42).

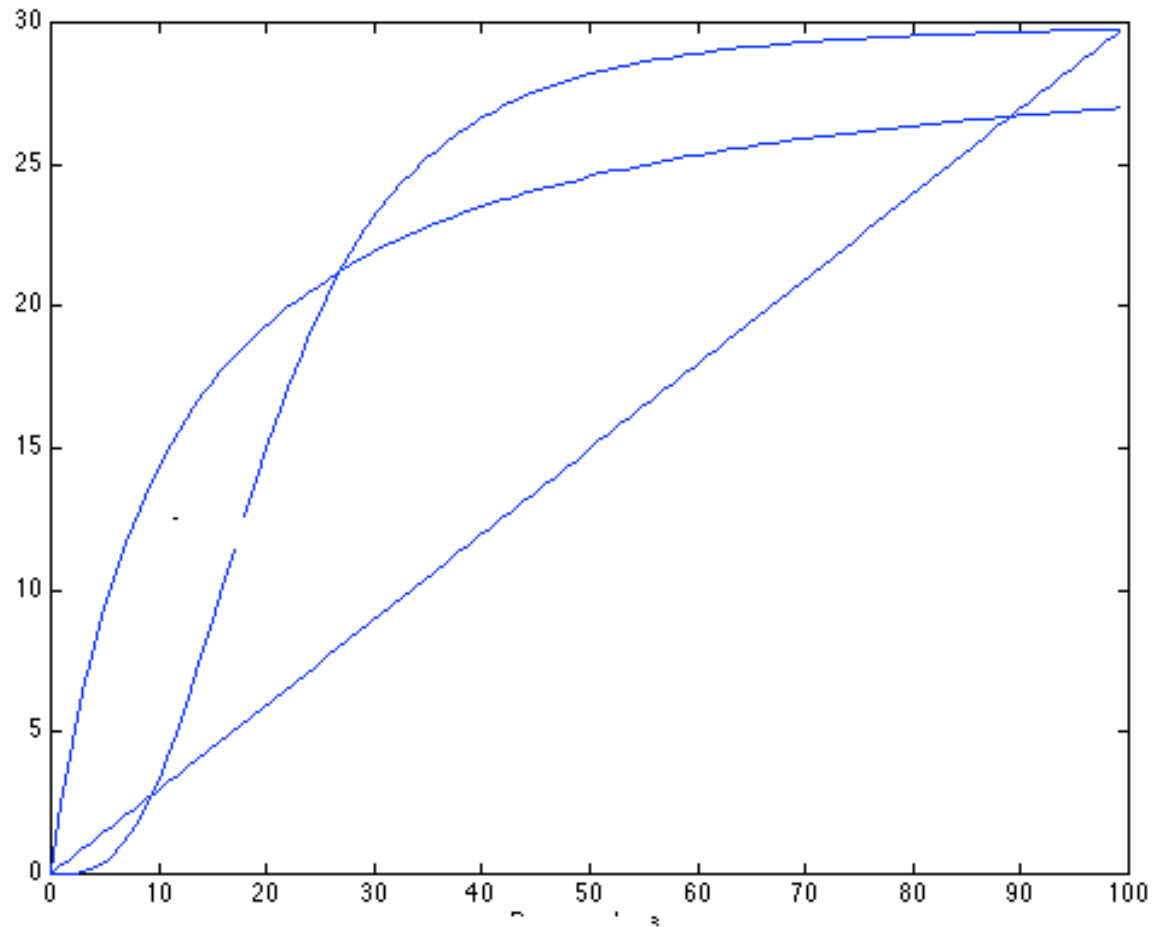
Berlin, I. 1990. *Four Essays on Liberty*. New York: Oxford University Press



- Help resolve the science wars in ways that facilitate discussion across disciplinary divides

Is predation a social construction?

Number of prey consumed



Number of prey present

And at the end, get involved:

It is not the critic who counts, not the man who points out how the strong man stumbled or where the doer of deeds could have done better.

The credit belongs to the man who is actually in the arena; whose face is marred by dust and sweat and blood; who strives valiantly; who errs and comes short again and again...who knows the great enthusiasms, the great devotions, and spends himself in a worthy cause; who at least knows in the end the triumph of high achievement; and who, at the worst, if he fails, at least he fails while doing greatly so that his place shall never be with those cold and timid souls who know neither victory nor defeat.



Theodore Roosevelt, quoted by John Kennedy in *Profiles in Courage* (1956)



