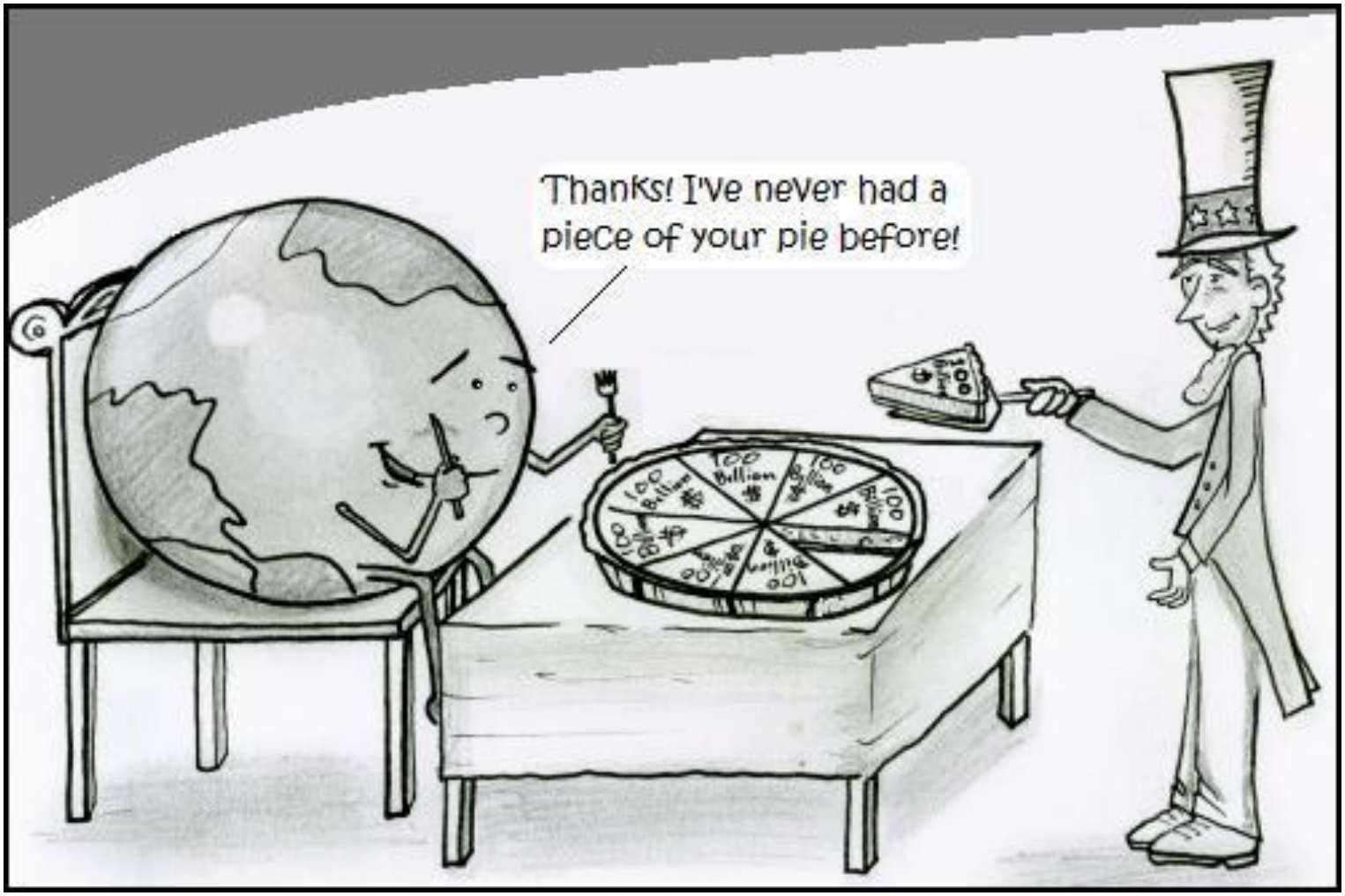
Restoration Ecology

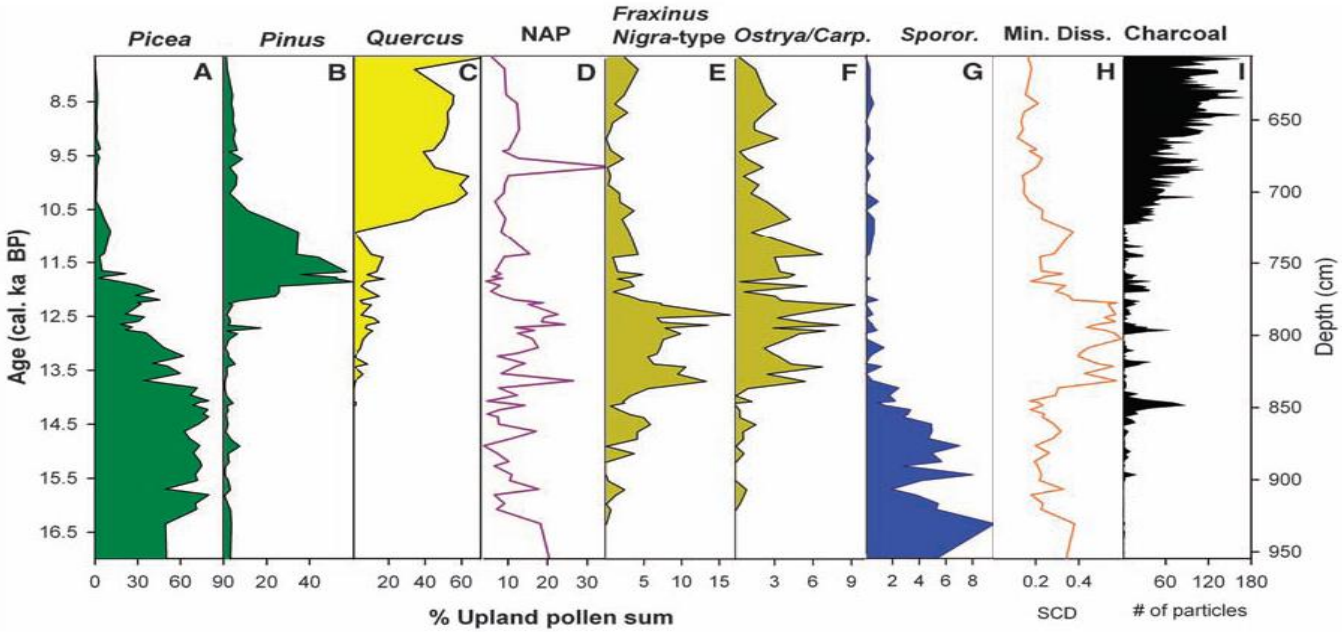


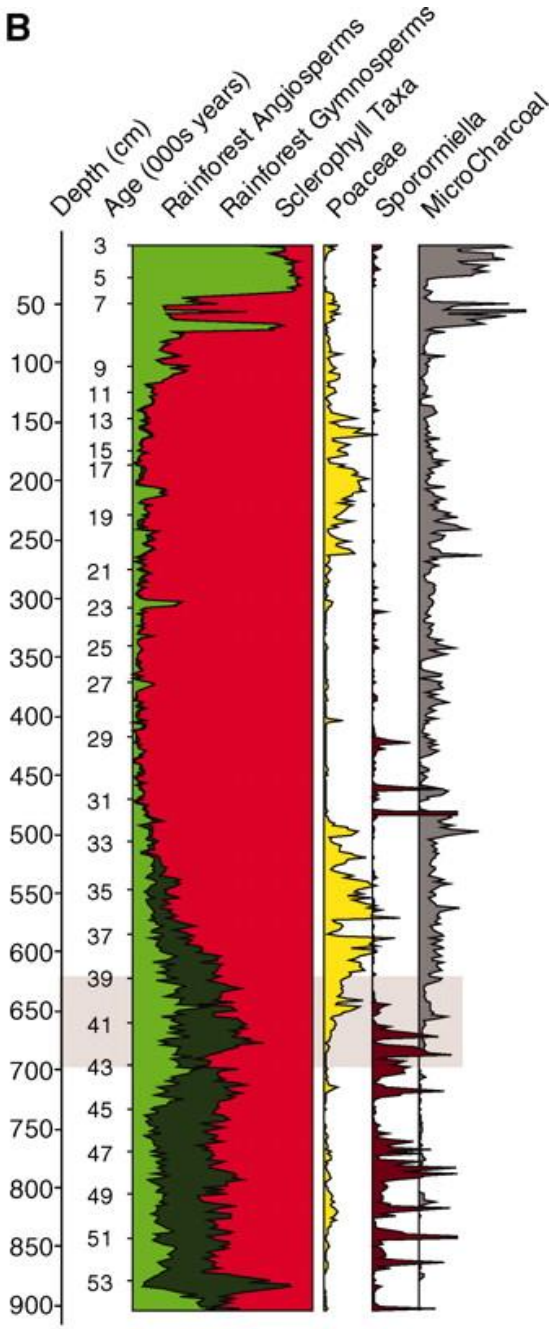
Quiz: Harris et al., 2006

3. Harris highlights a potential challenge for ecological restoration in an economy-driven society if baselines are no longer employed. Explain.

Vocab: Harris et al., 2006

Evidence from *sporormiella* dung fungus in the US and Australia suggests that humans, not climate, caused the megafauna extinction. Explain why.





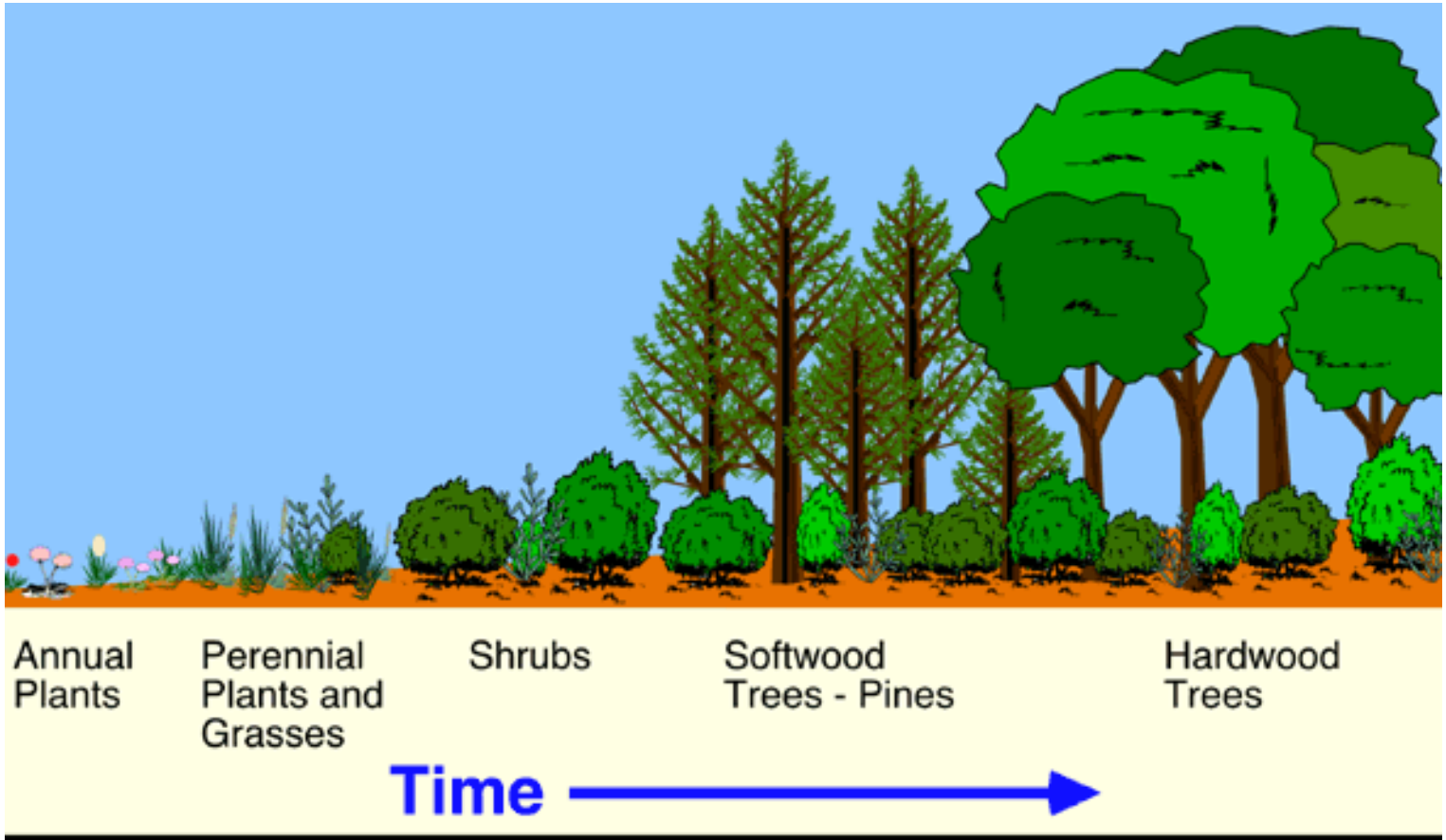
Parmesan & Yohe's Table 2 refers to 'changed as predicted' and 'changed opposite to prediction'. What are the predictions for distribution and for abundance that these terms refer to?

Table 2 **Summary statistics and synthetic analyses derived from Table 1**

Type of change	Changed as predicted	Changed opposite to prediction	*P*-value
Phenological ($N = 484/(678)$)	87% ($n = 423$)	13% ($n = 61$)	$<0.1 \times 10^{-12}$
Distributional changes			
At poleward/upper range boundaries	81%	19%	–
At equatorial/lower range boundaries	75%	25%	–
Community (abundance) changes			
Cold-adapted species	74%	26%	–
Warm-adapted species	91%	9%	–
$N = 460/(920)$	81% ($n = 372$)	19% ($n = 88$)	$<0.1 \times 10^{-12}$
Meta-analyses			
Range-boundaries ($N = 99$)	6.1 km m^{-1} per decade northward/upward shift*		0.013
Phenologies ($N = 172$)	2.3 days per decade advancement*		<0.05

Why restoration?

- Classic succession in ecology suggests if we just leave it alone, ecosystems will recover



Restoration targets in tropical forests

1. Restore cleared lands (farms or pasture)
2. Restore secondary forest regrowth

Lamb et al., 2005

Biodiversity doesn't recover on its own

Species	Family	< 10 cm dbh			>10 cm dbh		
		52 yr	77 yr	>80yr	52 yr	77 yr	>80 yr
Ocotea leucoxylon	Lauraceae	4	4	4			
Cordia borinquensis	Boraginaceae	4	3	4			
Myrcia deflexa	Myrtaceae	3	4	3			
Syzygium jambos	Myrtaceae	0	3	3			
Guarea glabra	Meliaceae	0	2	3			
Dacryodes excelsa	Burseraceae	1	0	4	1	0	4
Miconia tetandra	Melastomataceae	1	0	4	0	0	4
Drypetes glabra	Euphorbiaceae	0	1	4	0	0	4
Micropholis guyanensis	Sapotaceae	0	1	3	0	1	4
Sloanea berteriana	Eleocarpaceae	0	1	3	0	1	4
Prestoea montana	Arecaceae				4	4	4
Alchornea latifolia	Euphorbiaceae				4	3	2
Schefflera morototoni	Araliaceae				3	3	4
Casearia arborea	Flacourtiaceae				3	3	4
Homalium racemosum	Flacourtiaceae				0	2	4
	# of species in at least 50% of the sites	3	5	10	4	5	10

Secondary forest (fewer species)

Old growth

Aide et al., 2000

Restoration targets in tropical forests

Limited seed bank

No seed bank

Need restoration to point recovery in the direction we want it to go

Lamb et al., 2005

Mount St. Helens insights on succession

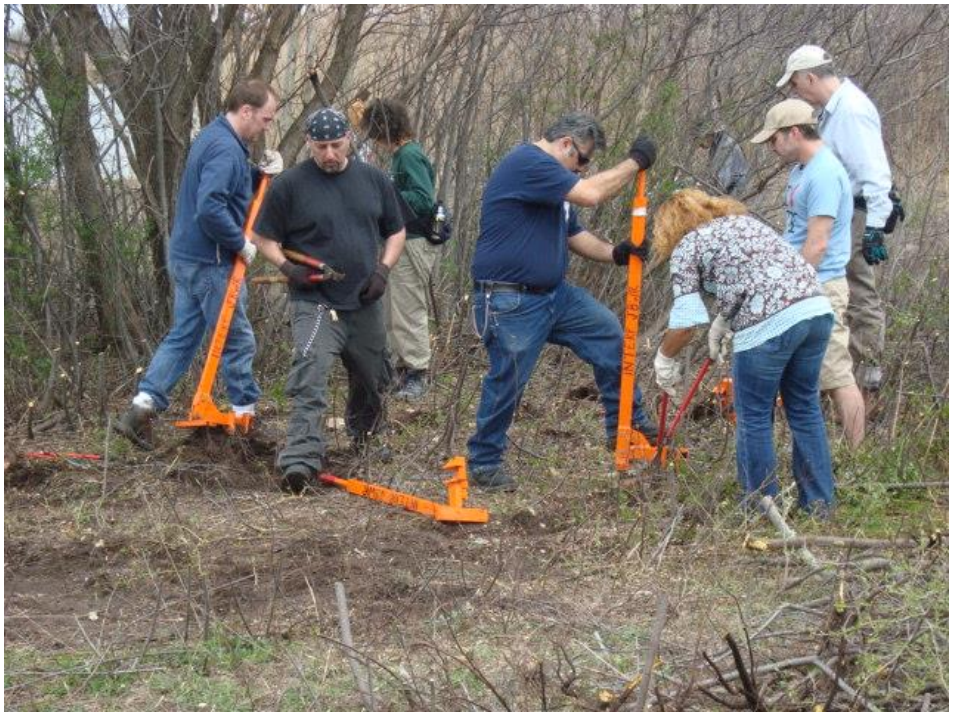
Short-term succession can be rapid

But, species assemblages depend *hugely* on local populations

Short-term patterns are very hard to predict

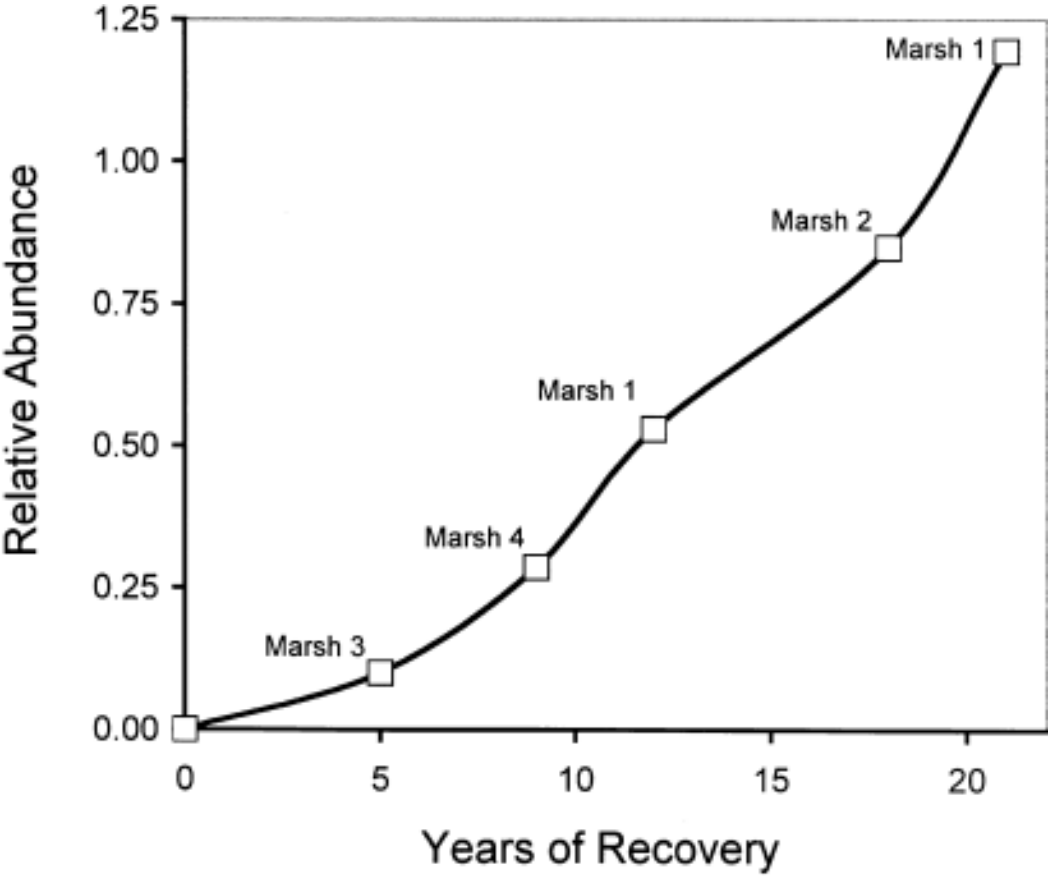
Another need for restoration: Filling the 'weed-shaped hole'

- Invasive plant removal often leaves a vacuum – available resources with no plants using them
- Without restoration, invasive plants come right back



Volunteer to help remove invasive plants

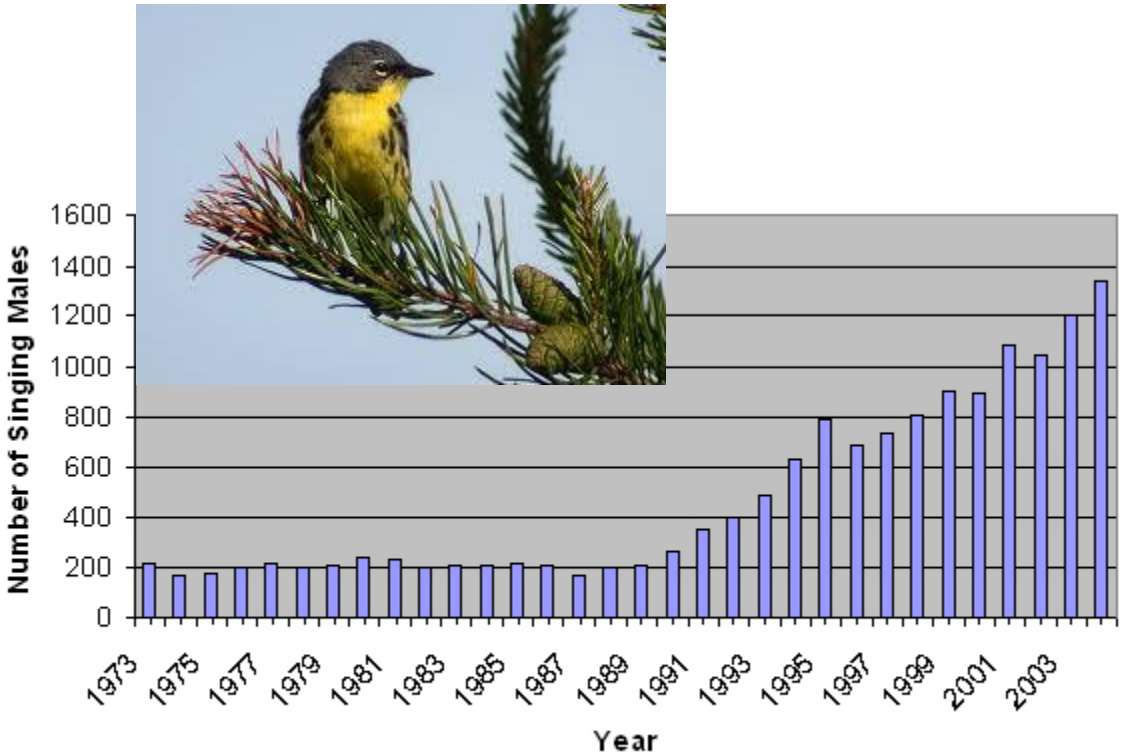
Challenge: Long recovery times with short $$



Recovery of salt marsh snails in Connecticut salt marshes relative to reference marsh (reference = 1)

Warren et al., 2002

Long recovery - Kirtland's Warbler



Habitat requirements: Patchy Jack pine forest with open grassy areas

Forests restored in mid-1970s

Restoration projects have a variety of possible goals

Table 1. Ecosystem functions with examples of processes, goods, and services (adapted from de Groot et al. 2002).

Ecosystem Function	*Ecosystem Process and Components*	*Goods and Services*
Regulation functions	Maintenance of essential ecological processes and life support processes	
Gas regulation	Biogeochemical cycling	UVb protection by ozone
Climate regulation	Influence of land-cover vegetation type	Maintenance of a favorable climate
Water supply	Filtering, retention, and storage of water	Provision of water for consumption
Habitat functions	Providing habitat for plant and animal species	
Refugium function	Niche availability	Maintenance of biological and genetic diversity (and hence most other functions)
Production functions	Provision of food and fiber	
Raw materials	Conversion of solar energy into edible plants and animals	Fuel, structural materials
Information functions	Providing opportunities for cognitive development	
	Cultural and artistic information	Use of nature as motive in books, film, and painting

Harris et al., 2006

Ecosystem restoration often focuses on restoring what was there before the disturbance/change

- ‘Baseline’ = what was there before
- How do we choose a baseline?

Preconceptions about what ecosystems should be restored to

Baseline is often assumed to be a state of ecological ‘health’ – can’t be sure that’s true

Preconceptions about what ecosystems should be restored to

What was there before ≠ what will be there in the future!

Baselines don’t make a lot of sense in a changing world

Preconceptions about what ecosystems should be restored to

Explicit restoration goals needed instead of baselines?

But, who gets to pick the goals?

How do we know we achieved our goal? (quantify ecological outcomes)

1. Diversity
   - Plants, bugs, birds, other easy-to-count species
2. Vegetation structure
   - Cover, density, biomass, height
3. Ecological processes
   - Soil nutrients, soil carbon, biotic interactions (pollination, herbivory, seed dispersal)

Lots of monitoring needed to measure outcomes!!

Turns out we're not so great at measuring outcomes …

Only 68 of 468 articles published in the journal *Restoration Ecology* between 1993-2003 evaluated restoration outcomes

Ruiz-Jaen & Aide, 2005

How well set up are existing policies for dealing with shifting baselines?

History of species-related legislation

- Lacey Act (1900)

History of species-related legislation

- Lacey Act (1900)
  - Illegal to transport wildlife killed in violation of state law
  - Illegal to kill birds for feather trade
  - Illegal to hunt for commercial markets
  - Illegal to introduce harmful non-native species

History of species-related legislation

- Lacey Act (1900) (Major amendments 1981, 1988, 2008)
  - Illegal to transport wildlife or plants that cannot be harvested based on any state, federal or tribal law
  - The Lacey Act applies to invasive species as well as protected species

History of species-related legislation

- Lacey Act (1900)
- Migratory Bird Treaty Act (1918)
  - All migratory birds are subject to federal regulation
  - Established protective treaties with Canada, Mexico (1936), Japan (1972) & USSR (1976)
  - Establishes hunting seasons for game birds

History of species-related legislation

- Lacey Act (1900)
- Migratory Bird Treaty Act (1918)
- Bald Eagle Protection Act (1940)
  - Concerns that bald eagles were an extinction risk

Endangered Species Act (1973)

Fish, wildlife, and plant species have aesthetic, ecological, educational, historical, recreational, and scientific value to the U.S.; some species have become extinct or are threatened with extinction.

1. *Provide a means to conserve the ecosystems upon which endangered and threatened species depend*
2. *Provide a program for the conservation of such species*
3. *Take steps to achieve purposes of existing treaties and conventions affecting wildlife, fish, and plants.*

Recovery Plan Amendment (1988)

- A description of "site-specific" management actions to make the plan as explicit as possible.
- The "objective, measurable criteria" to serve as a baseline for judging when and how well a species is recovering.
- An estimate of money and resources needed to achieve the goal of recovery and delisting

Success stories (there are a handful)

Kirtland's Warbler:

- Restoration of early successional pine habitat through fire (1970s)
- 210 breeding pairs in 1971, 1415 breeding pairs in 2005

Bald Eagle:

- Bands of DDT in U.S. & Canada in 1970s
- Delisted in 2007

Recovery Plan Amendment (1988)

- A description of "site-specific" management actions to make the plan as explicit as possible.
- The "objective, measurable criteria" to serve as a baseline for judging when and how well a species is recovering.
- An estimate of money and resources needed to achieve the goal of recovery and delisting
- *Not much flexibility for adapting management if a site is changing*

Federal laws/policies protect single species, not ecosystems

Protecting ecosystems is on us

Looking forward – considering climate change in species listing

Paving the way for ESA listings based on climate change threats?

Reasons climate change could increase vulnerability

Criteria	Climate Change might increase risk if:
Species has a restricted range or habitat is highly fragmented	▪ Movement is restricted by soils, topography, or land use ▪ Range is restricted due to unique climatic conditions

American Pika lives near the peaks of the Rocky Mountains

Reasons climate change could increase vulnerability

Criteria	Climate Change might increase risk if:
Species or habitat is directly vulnerable to climate change effects	▪ Life cycle or physiology is directly sensitive to temperature ▪ Life cycle or physiology is directly sensitive to precipitation or hydrology (less certain than temperature)

Salmon sensitive to water temperatures

ESA & Private Lands: Habitat Conservation Plans (HCPs)

- ESA section 10 (1982): Provides private land owners with a process for receiving an incidental take permit
- Incidental take permitted with a habitat conservation plan that mitigates impacts on listed species
- But, only 14 HCPs created 1982-1994 because no assurances of longevity of HCP

ESA & Private Lands: Habitat Conservation Plans (HCPs)

- 1994: “No Surprises” policy
- No additional mitigation in terms of land or money required beyond specified in HCP
- 600+ HCPs approved through 2008
- 18 million ha currently under HCP mgmt
- Management timeline 30-50 years

No Surprises

- *Changed circumstances*: Changes affecting the species or HCP that can be reasonably anticipated
- *Unforseen circumstances*: Changes affecting the species or HCP that could not have been reasonably anticipated
- Is climate change a changed circumstance?