



*Ecological Restoration: Maintaining
biological diversity in a changing
world*

James G. Hallett

Executive committee, SER

Professor, Eastern Washington University, USA



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SOCIETY FOR
ECOLOGICAL
RESTORATION



*Restauration écologique: Maintien de
la diversité biologique dans un monde
en mutation*

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RESTORATION



To promote ecological restoration...

*...as a means of sustaining the diversity of life
on earth...*

*Afin de promouvoir la restauration
écologique...*

*...comme un moyen de maintenir la diversité
de la vie sur terre...*

*...& reestablishing an ecologically
healthy relationship between nature and
culture*

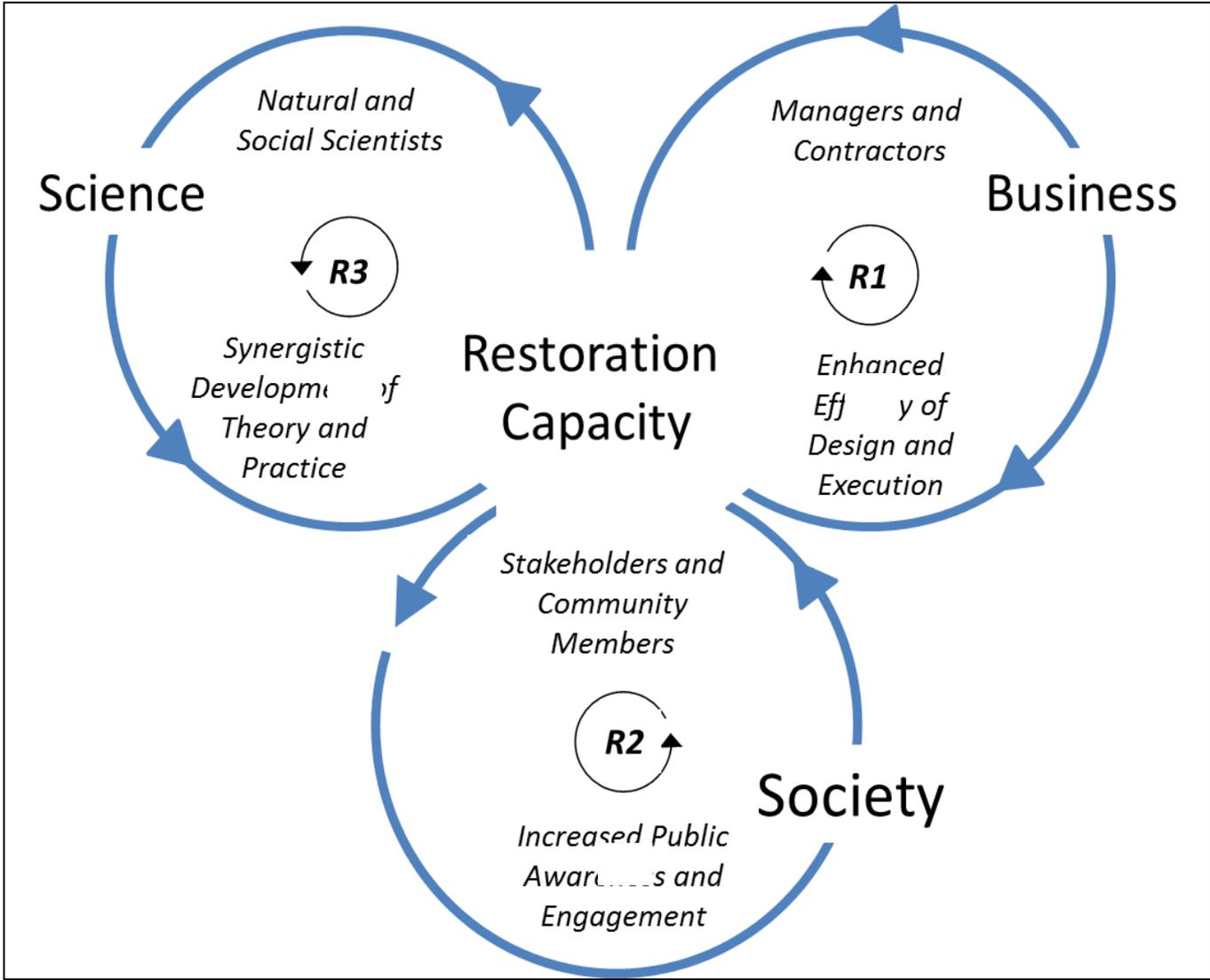
*et de rétablir une relation saine
écologiquement entre nature et culture*



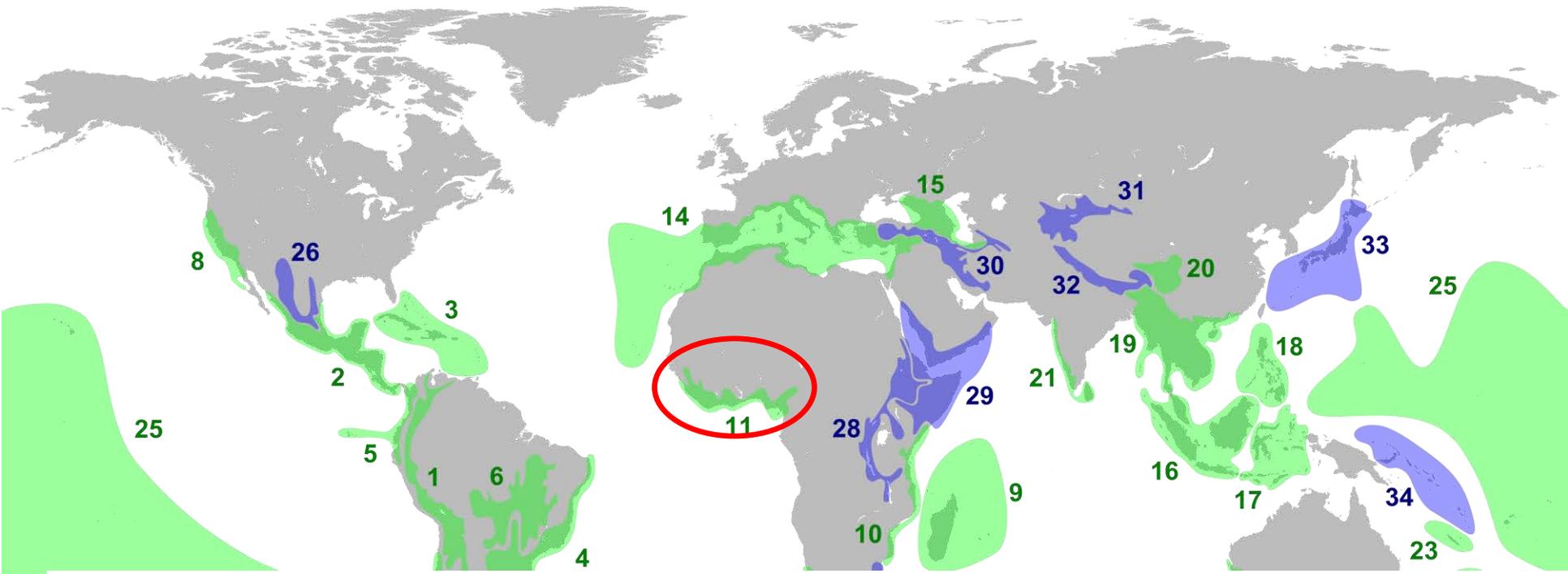


Why scientists
must work
together to save
the world

*Pourquoi les
scientifiques
doivent
travailler
ensemble pour
sauver le monde*



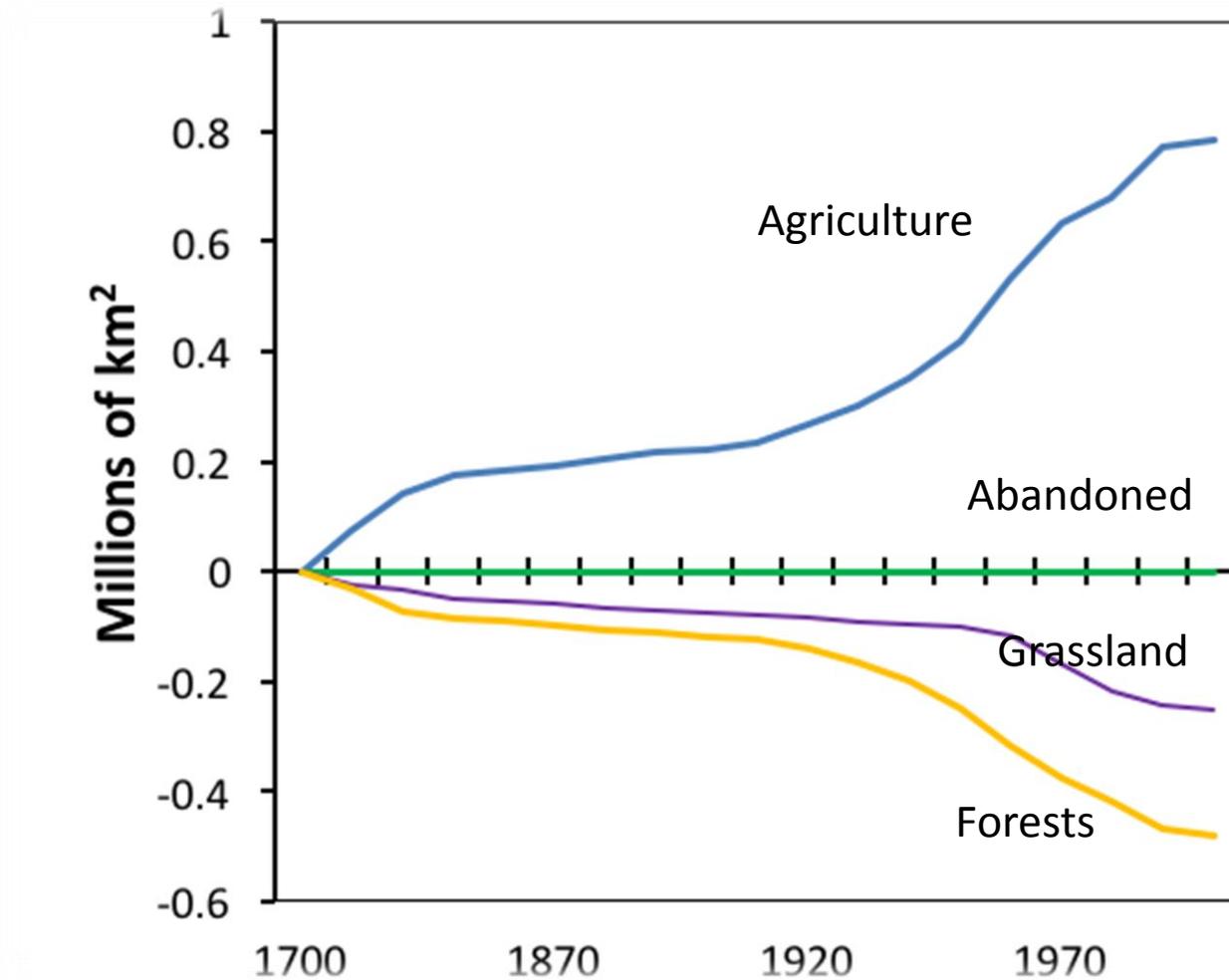
Biodiversity hotspots / Hotspots de la biodiversité



High rates of endemism / Taux élevés d'endémisme

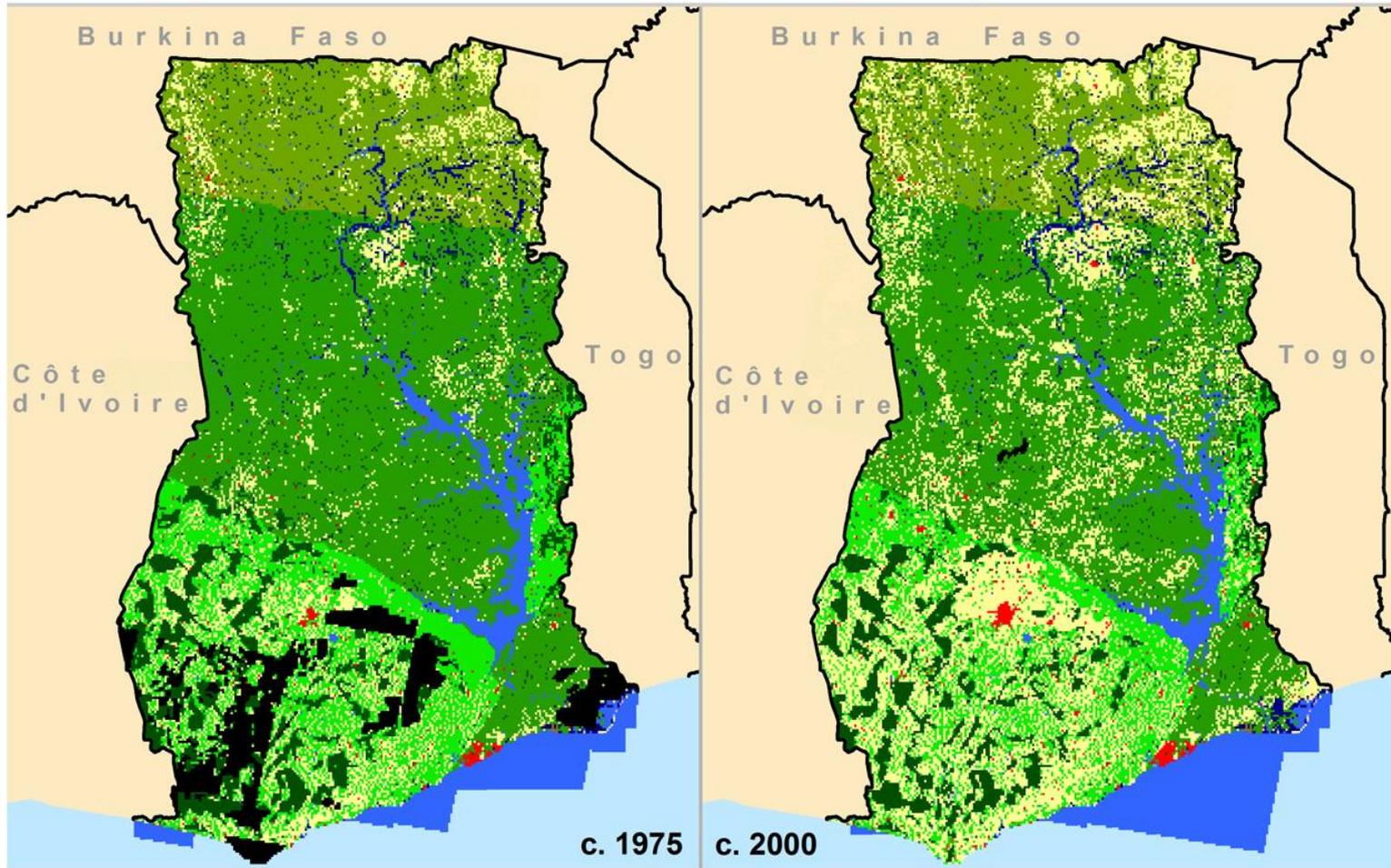
<30% of original native vegetation /
30% de la végétation pré-existante

Land conversion in Tropical Africa



After Ramankutty and Foley. 1999. Global Biogeochem Cycles

Ghana Land Use / Land Cover Change



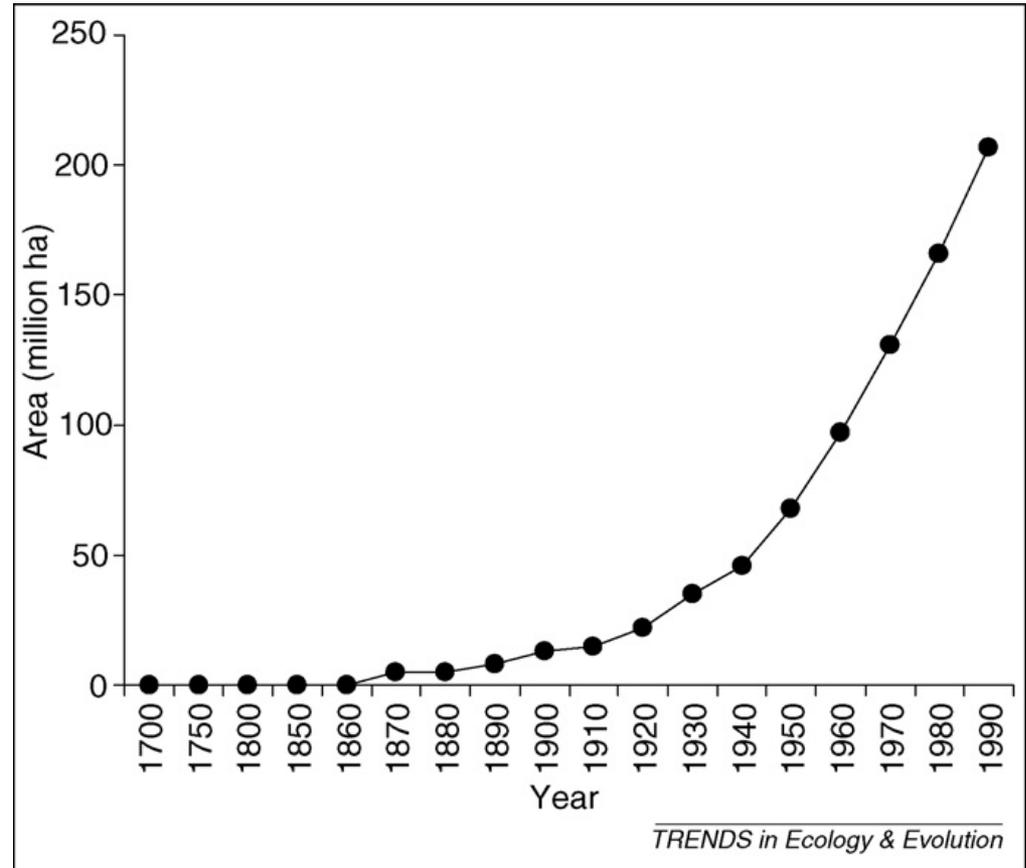
Land Use/Land Cover Classes

 Forest (1)	 Wetland - floodplain (3)	 Open Mine (78)	 Wooded savannas (17)
 Degraded Forest (21)	 Water Bodies (9)	 Bare Soil (12)	 Wooded savannas and woodlands (20)
 Gallery Forest (15)	 Agriculture (8)	 Sandy Area (10)	 Plantation (6)
 Settlements (13)	 Irrigated Agriculture (14)	 Rocky Land (11)	 Mangrove (7)
			 Cloud / Cloud Shadow



Rate of abandonment of farmland

Losses have accelerated since 1950 worldwide



Land degradation consequences

- Loss of biodiversity
- Increase in non-native invasive species
- Reduction or loss of ecosystem services necessary for human health, food and water security, and culture
- Strong relationship between poverty and degree of land degradation

Biodiversity loss and its impact on humanity

Bradley J. Cardinale¹, J. Emmett Duffy², Andrew Gonzalez³, David U. Hooper⁴, Charles Perrings⁵, Patrick Venail¹, Anita Narwani¹, Georgina M. Mace⁶, David Tilman⁷, David A. Wardle⁸, Ann P. Kinzig⁵, Gretchen C. Daily⁹, Michel Loreau¹⁰, James B. Grace¹¹, Anne Larigauderie¹², Diane S. Srivastava¹³ & Shahid Naeem¹⁴

Biodiversity loss reduces the efficiency of ecological communities to capture biologically essential resources, produce biomass, decompose and recycle biologically essential nutrients

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Impact of biodiversity on any single ecosystem process is nonlinear and saturating, such that change accelerates as biodiversity loss increases

Biodiversity loss and its impact on humanity

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Loss of diversity across trophic levels has the potential to influence ecosystem functions even more strongly than diversity loss within trophic levels



Biodiversity loss and emerging infectious disease:
An example from the rodent-borne hemorrhagic fevers

James N. Mills

Biodiversity. 2006.

Articles

**Biodiversity Loss Affects
Global Disease Ecology**

MONTIRA J. PONGSIRI, JOE ROMAN, VANESSA O. EZENWA, TONY L. GOLDBERG, HILLEL S. KOREN,
STEPHEN C. NEWBOLD, RICHARD S. OSTFELD, SUBHRENDU K. PATTANAYAK, AND DANIEL J. SALKELD

Bioscience. 2009.



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Ecosystem Services

journal homepage: www.elsevier.com/locate/ecoser

Exploring connections among nature, biodiversity, ecosystem services, and human health and well-being: Opportunities to enhance health and biodiversity conservation [☆]

Paul A. Sandifer ^{a,*}, Ariana E. Sutton-Grier ^{b,1}, Bethney P. Ward ^c

^a National Ocean Service, National Oceanic and Atmospheric Administration, Hollings Marine Laboratory, 331 Fort Johnson Road, Charleston, SC 29412, USA

^b Cooperative Institute for Climate and Satellites, Earth System Science Interdisciplinary Center, University of Maryland and National Ocean Service, National Oceanic and Atmospheric Administration, 1305 East-West Highway, Rm 13614, Silver Spring, MD 20910, USA

^c Coastal Services Center, National Ocean Service, National Oceanic and Atmospheric Administration, 2234 South Hobson Avenue, Charleston, SC 29405-2413, USA

Ecosystem Services 12 (2015) 1-15

Linkage between human health and biodiversity operates at many scales /

Des liens entre la santé humaine et la biodiversité opèrent à plusieurs échelles.

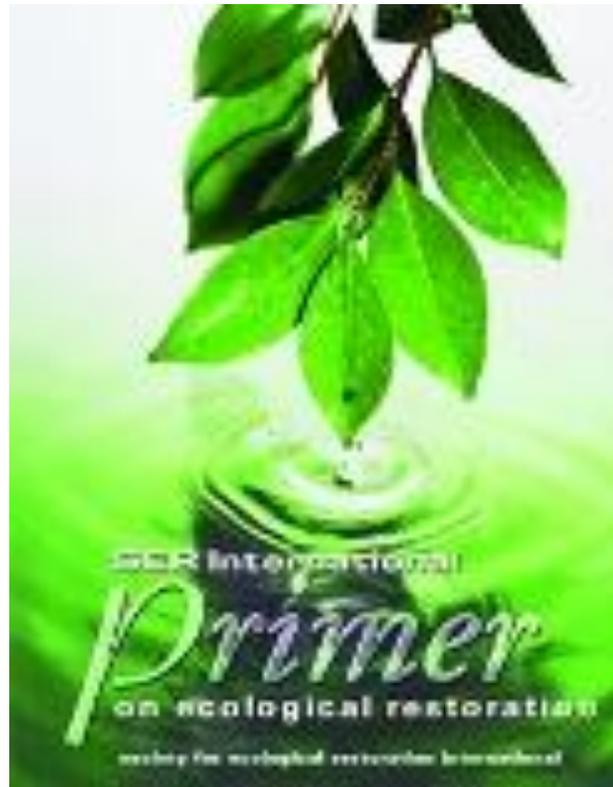
- Genetic (gene frequencies)
 - Changes in host resistance or pathogen virulence
- L'échelle génétique (fréquences des gènes)
 - Changements de la résistance de l'hôte, ou de la virulence des pathogènes

Linkage between human health and biodiversity operates at many scales /

Des liens entre la santé humaine et la biodiversité opèrent à plusieurs échelles.

- Microbial (internal and external)
 - Host immune response change; range expansion
- Vector species
 - Contact rates; range expansion
- L'échelle microbienne (interne et externe)
 - Changement de réponse immunitaire de l'hôte; expansion de l'aire de distribution
- L'échelle espèces hôtes
 - Taux de contact; expansion de l'aire de distribution

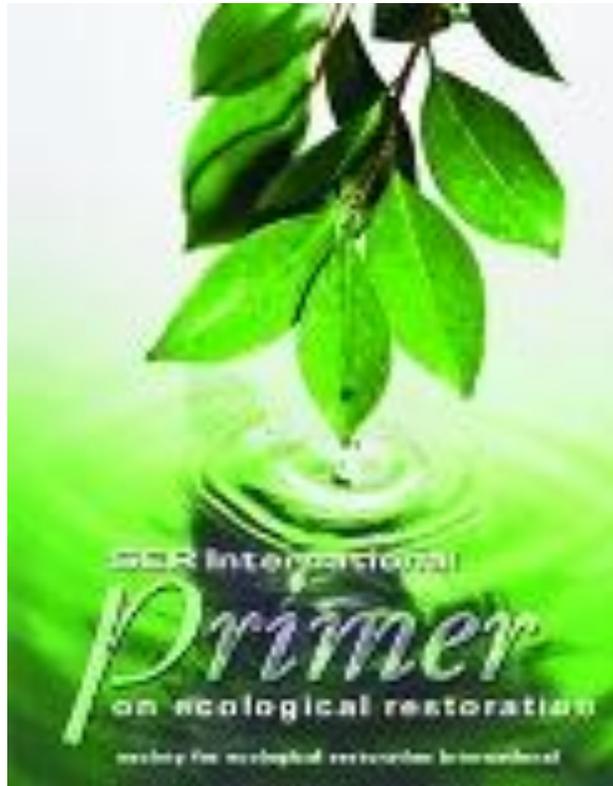
Ecological restoration defined:



*Ecological restoration is the process of **assisting** the recovery of an ecosystem that has been degraded, damaged, or destroyed.*

Society for Ecological Restoration Primer (2004)

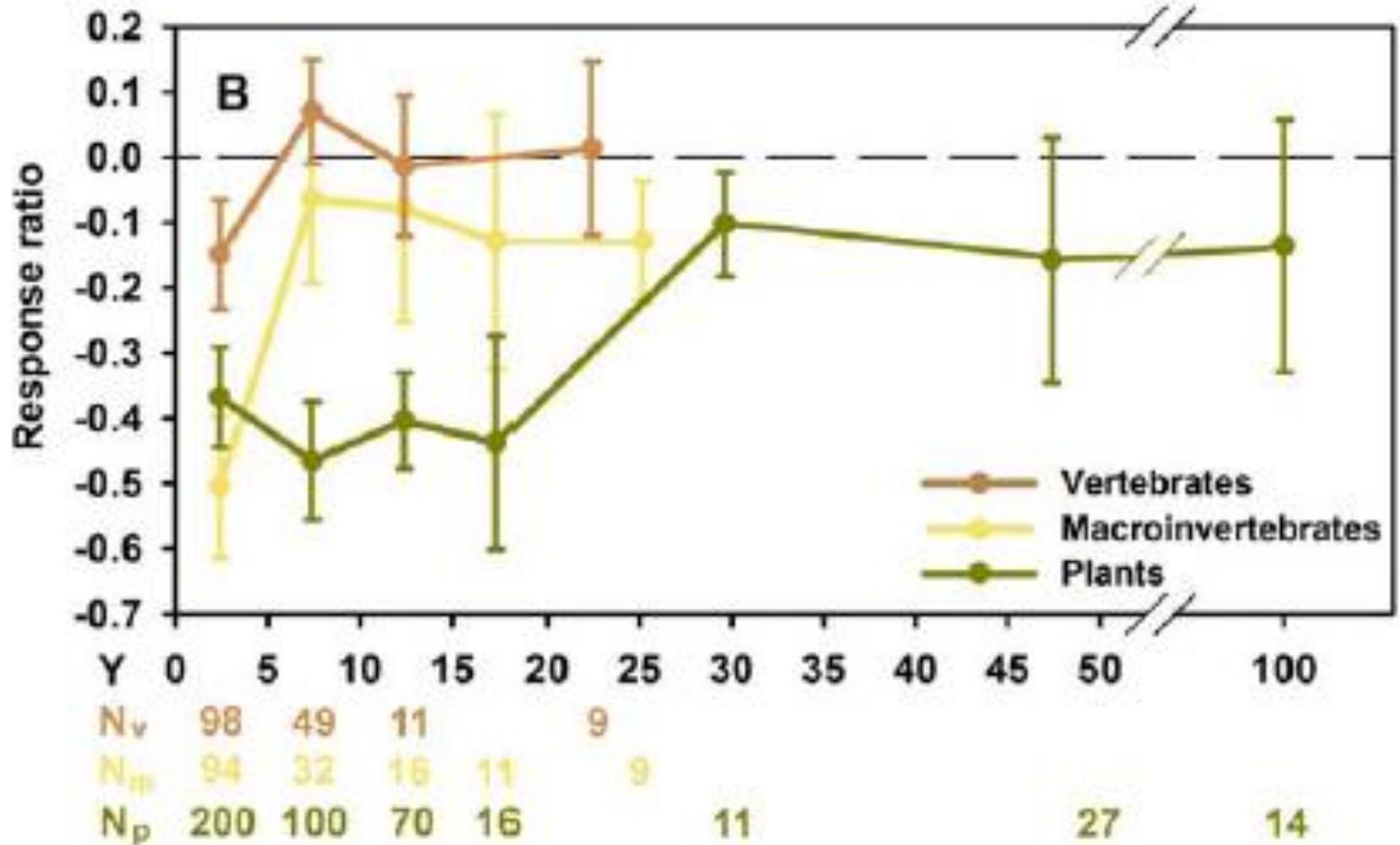
What is the restoration target?



*Ecosystem resumes a trajectory that follows the **historic** continuity for that ecosystem as guided by a **reference model**.*

Society for Ecological Restoration Primer (2004)

Restoration is rarely 100% successful



Success of restoration

Meta-analysis of 89 projects in different ecosystems world-wide

- Ecological restoration increased provision of biodiversity (44%) and ecosystem services (25%)
- Lower relative to intact systems
- Timescales may be quite long

Disturbances of global concern are long-term and large-scale



Land-use change



Climate change



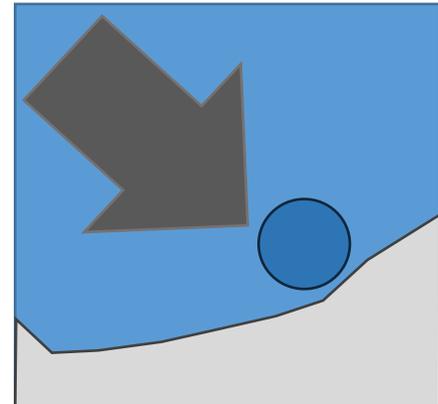
CO₂ enrichment



Nitrogen deposition



Biotic invasion



Synergistic effects

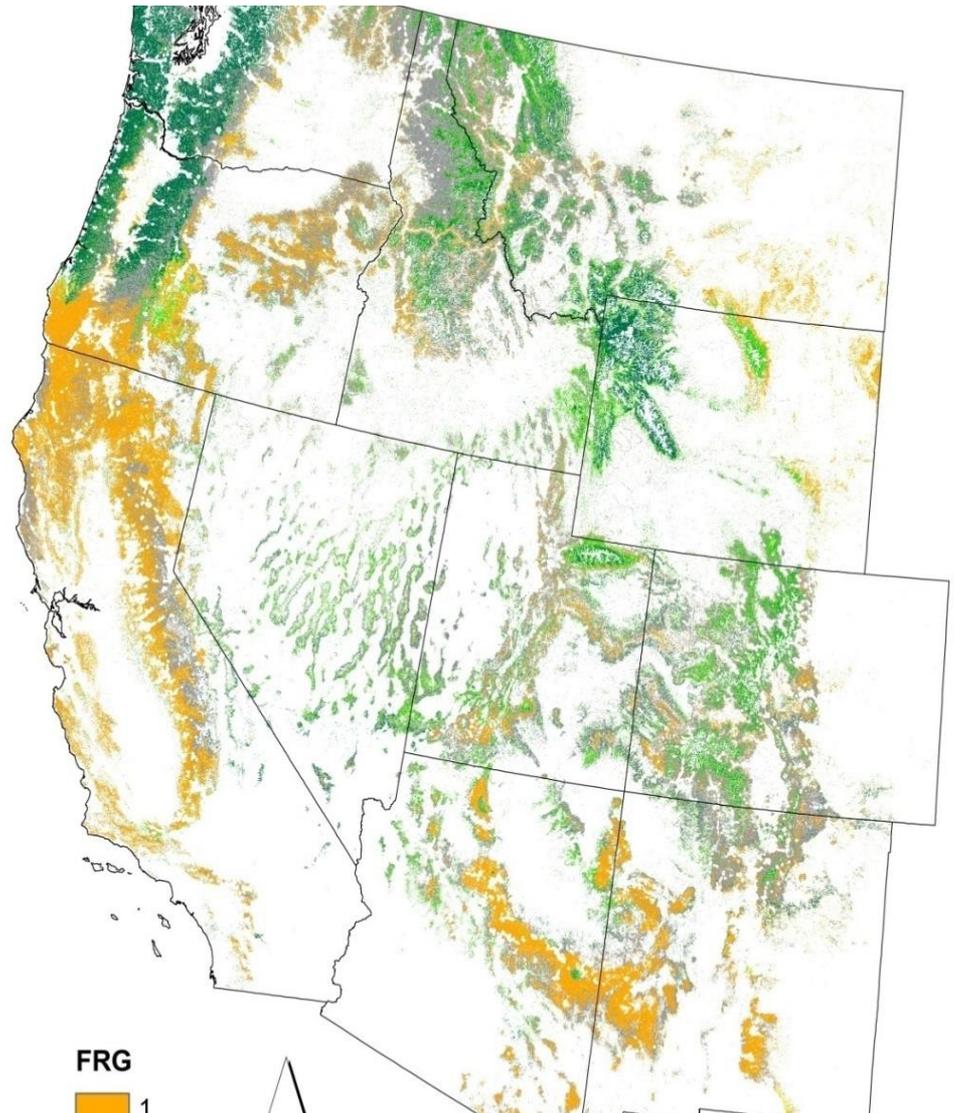
Steps in the restoration process

Assessment

Ecological condition
and context

Stakeholders

Priority Areas for Restoration



FRG

1

2

3

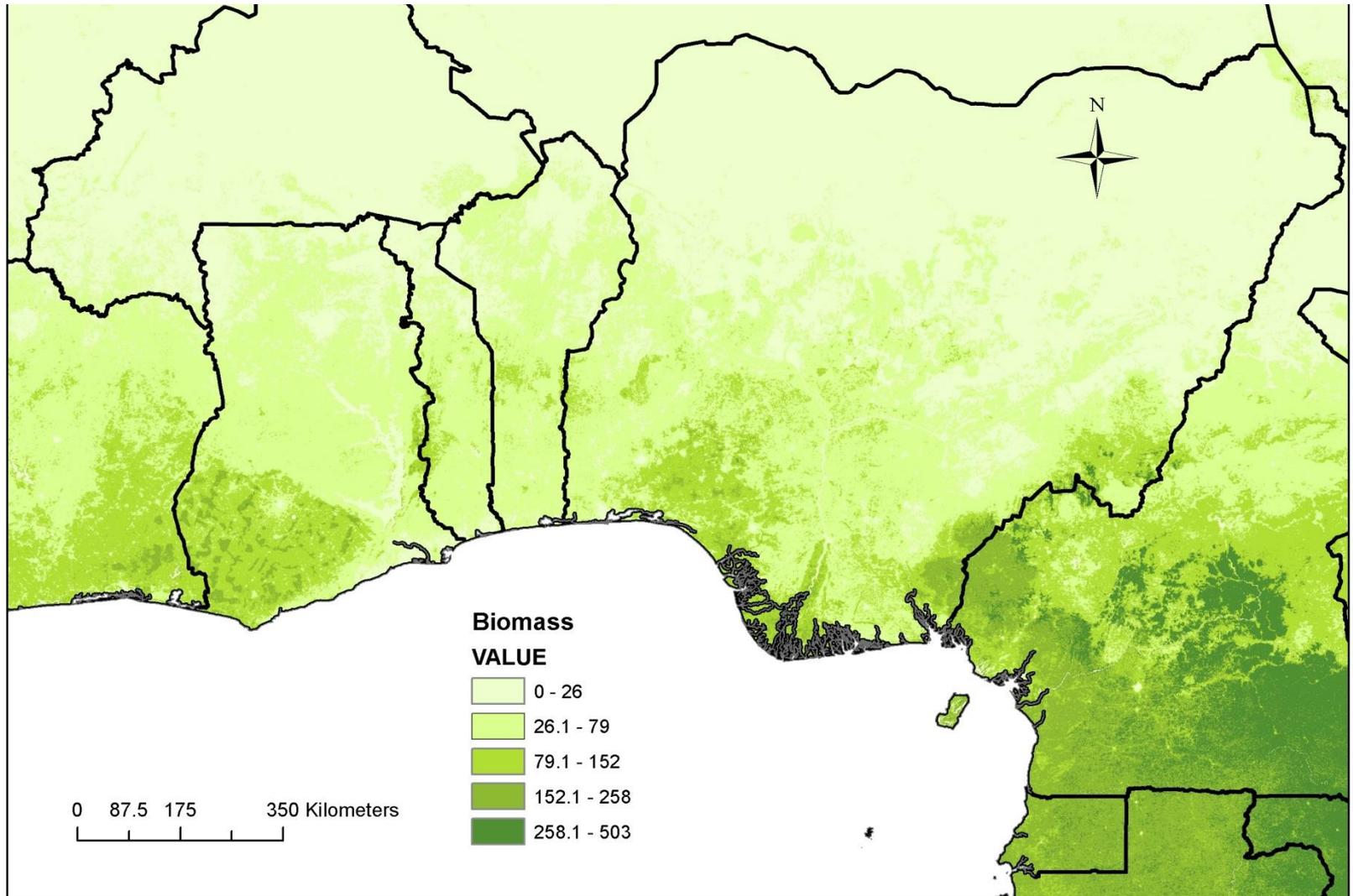
4



Schoennagel and Nelson 2011

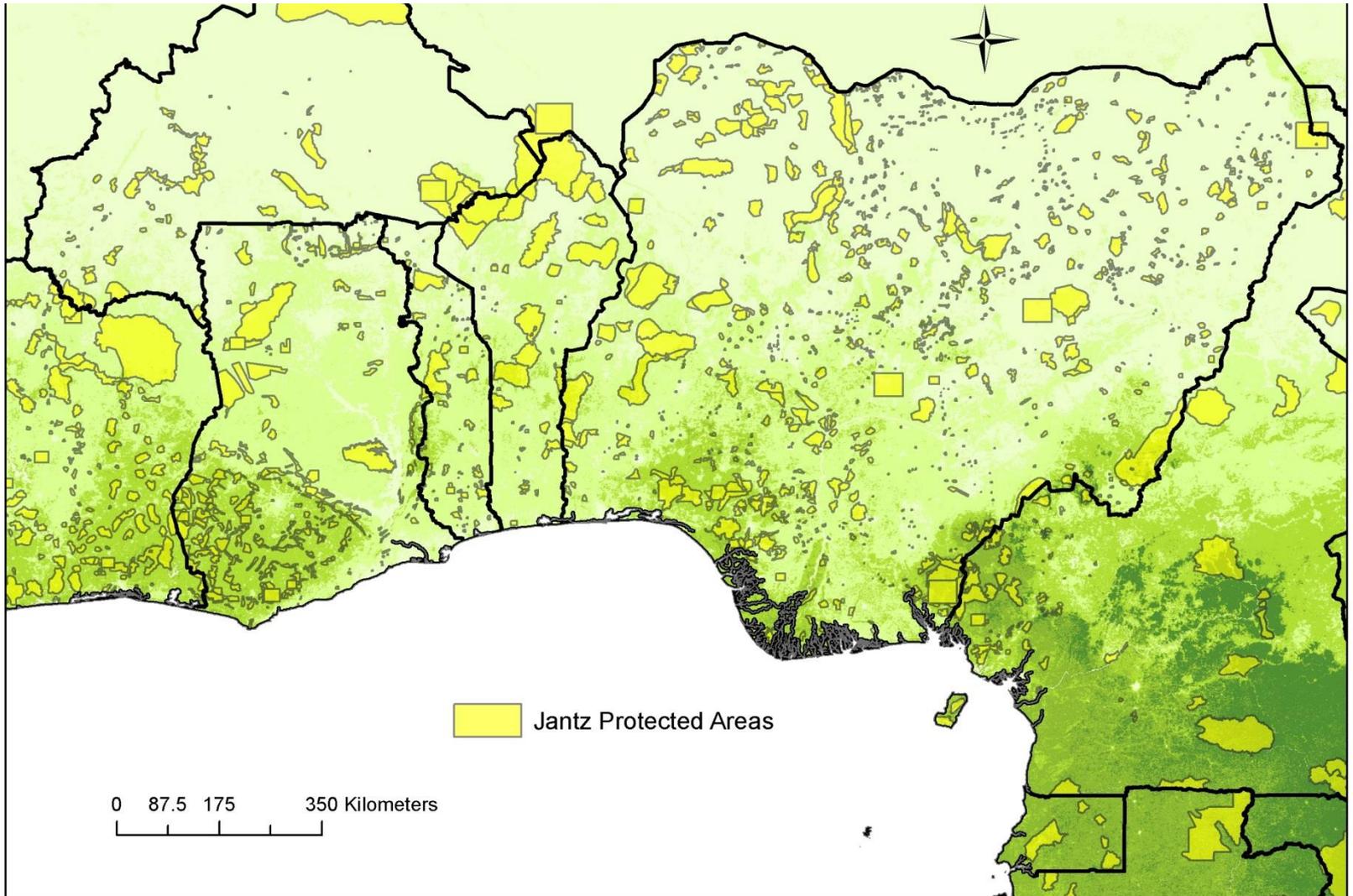
0 125 250 500 Kilometers

Carbon Stocks / Les stocks de carbone



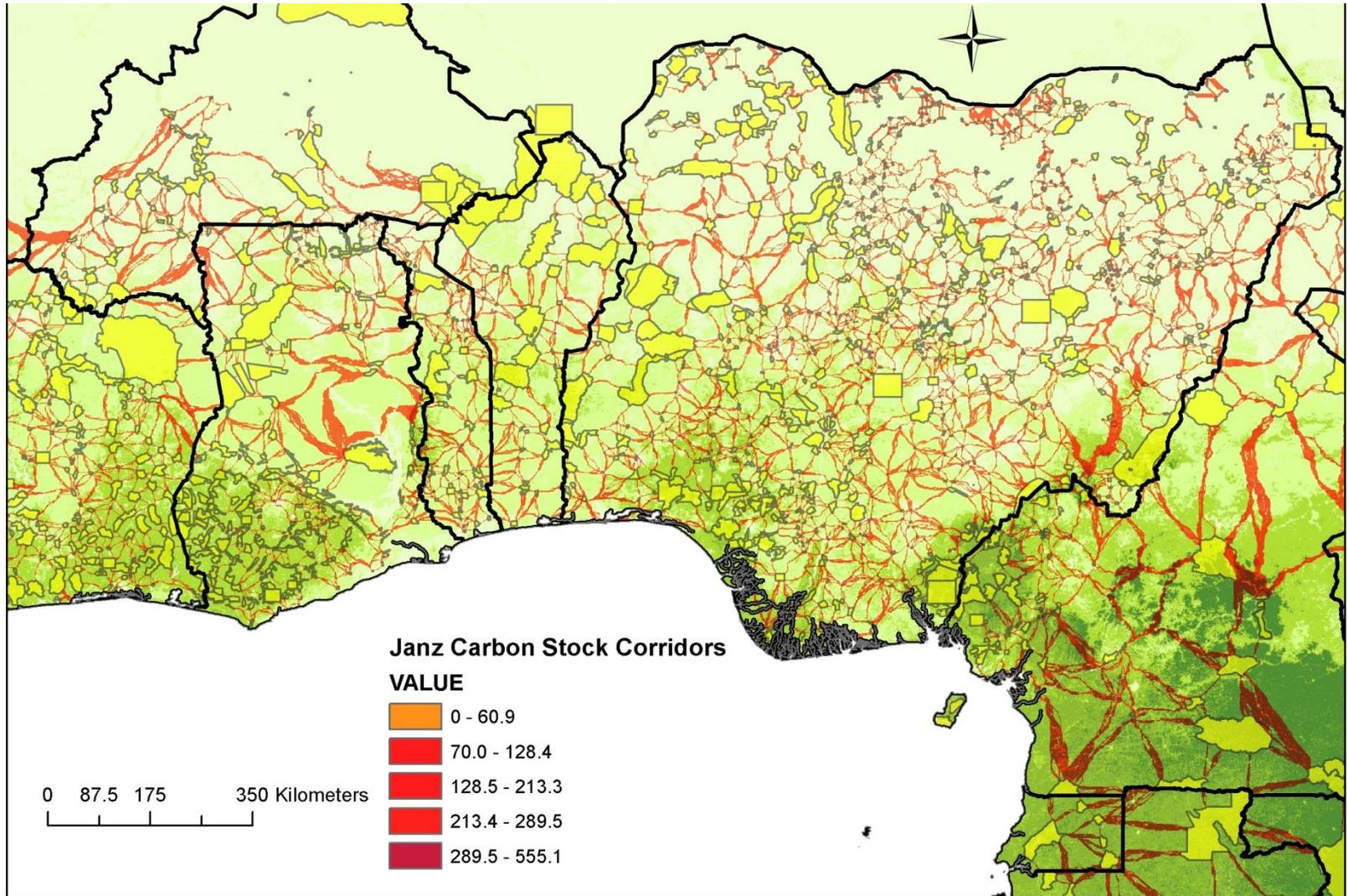
Data from WHRC.org

Reserves/ Réservees



Data from WHRC.org

Corridors / Couloirs



Data from WHRC.org

Steps in the restoration process

Assessment



Restoration planning

Reference system

Definition of objectives

Selection of restoration measures

Implementation plan

Monitoring and evaluation plan

Steps in the restoration process

Assessment

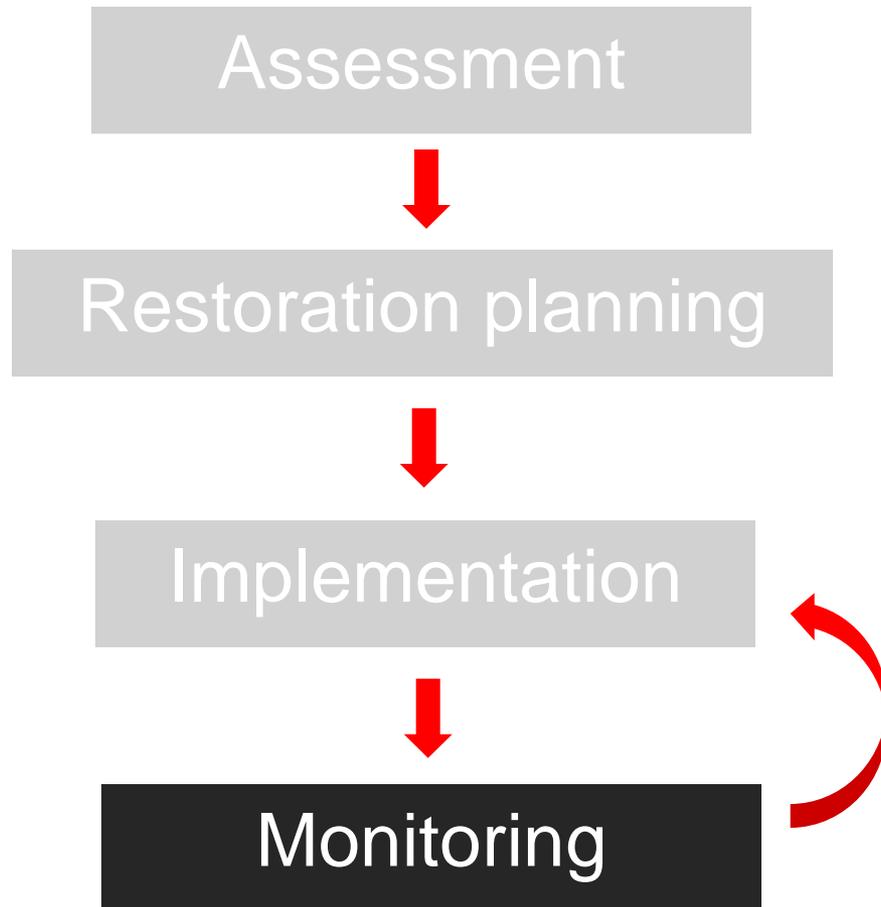


Restoration planning



Implementation

Steps in the restoration process



Evaluation allows modification of implementation plan and depends on comparison to a *reference model*

Steps in the restoration process

Assessment



Restoration planning



Implementation



Monitoring



Utilization

Maintenance

Communication of results

Recommendations for future projects



Synthesizing U.S. River Restoration Efforts

E. S. Bernhardt,^{1*†} M. A. Palmer,¹ J. D. Allan,² G. Alexander,² K. Barnas,³ S. Brooks,⁴
J. Carr,⁵ S. Clayton,⁶ C. Dahm,⁷ J. Follstad-Shah,⁷ D. Galat,^{8,9} S. Gloss,¹⁰ P. Goodwin,⁶
D. Hart,⁵ B. Hassett,¹ R. Jenkinson,¹¹ S. Katz,³ G. M. Kondolf,¹² P. S. Lake,⁴ R. Lave,¹²
J. L. Meyer,¹³ T. K. O'Donnell,⁹ L. Pagano,¹² B. Powell,¹⁴ E. Sudduth¹³

CONCLUSIONS

- comprehensive assessment of restoration progress not possible with available information
- < 10% of projects included any type of monitoring.

Steps in the restoration process

Assessment



Restoration planning



Implementation



Utilization

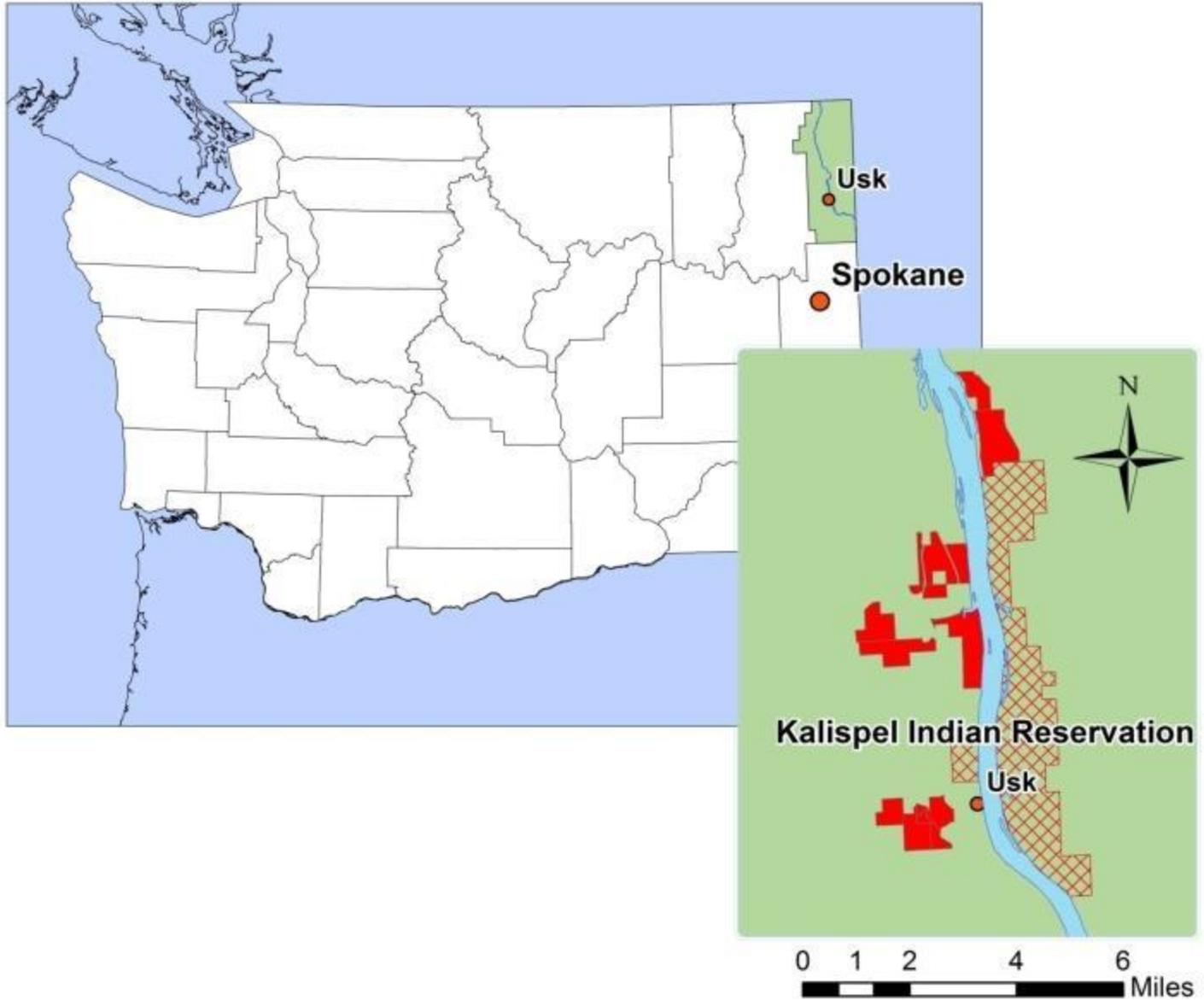
Maintenance

~~Communication of results~~

~~Recommendations for future projects~~



Kalispel Indian Reservation, Pend Oreille County, WA



Albeni Falls dam in Idaho converted 2627 ha of wetlands to open water



Before



After

Wetlands were lost from Morton Slough, Idaho



Assessing change presents several problems



A reference or baseline condition must be determined



Communities must be selected for monitoring



Limited sampling is unlikely to reveal all species in a habitat

Restoration approaches for mitigation lands



1997

Flying Goose Ranch

**Water level
management**



2002

Restoration approaches for mitigation lands



Exclude grazing

Control weeds

**Restore native
vegetation**

Reference sites were the best representatives of extant vegetation types

Riparian forest



Riparian shrub



Multiple reference sites describe spatial variation

Wetland meadow



Emergent wetland



Vegetation monitoring began in 2002



Shrub species and
volume



Cover and diversity of
grasses and herbs



es

Characterize both structure and species composition

Wildlife monitoring began in 2002



Larval amphibians



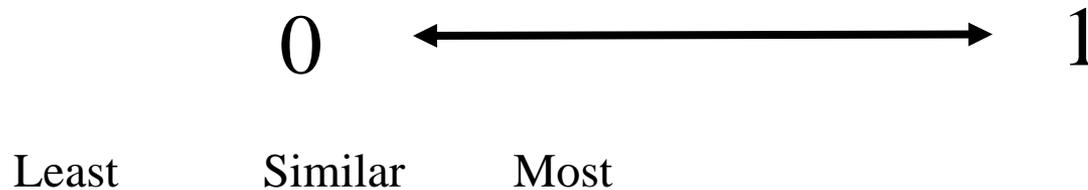
Small mammals



Birds

How can we determine change in restoration?

- Comparisons of species richness or diversity
- Comparisons of community similarity



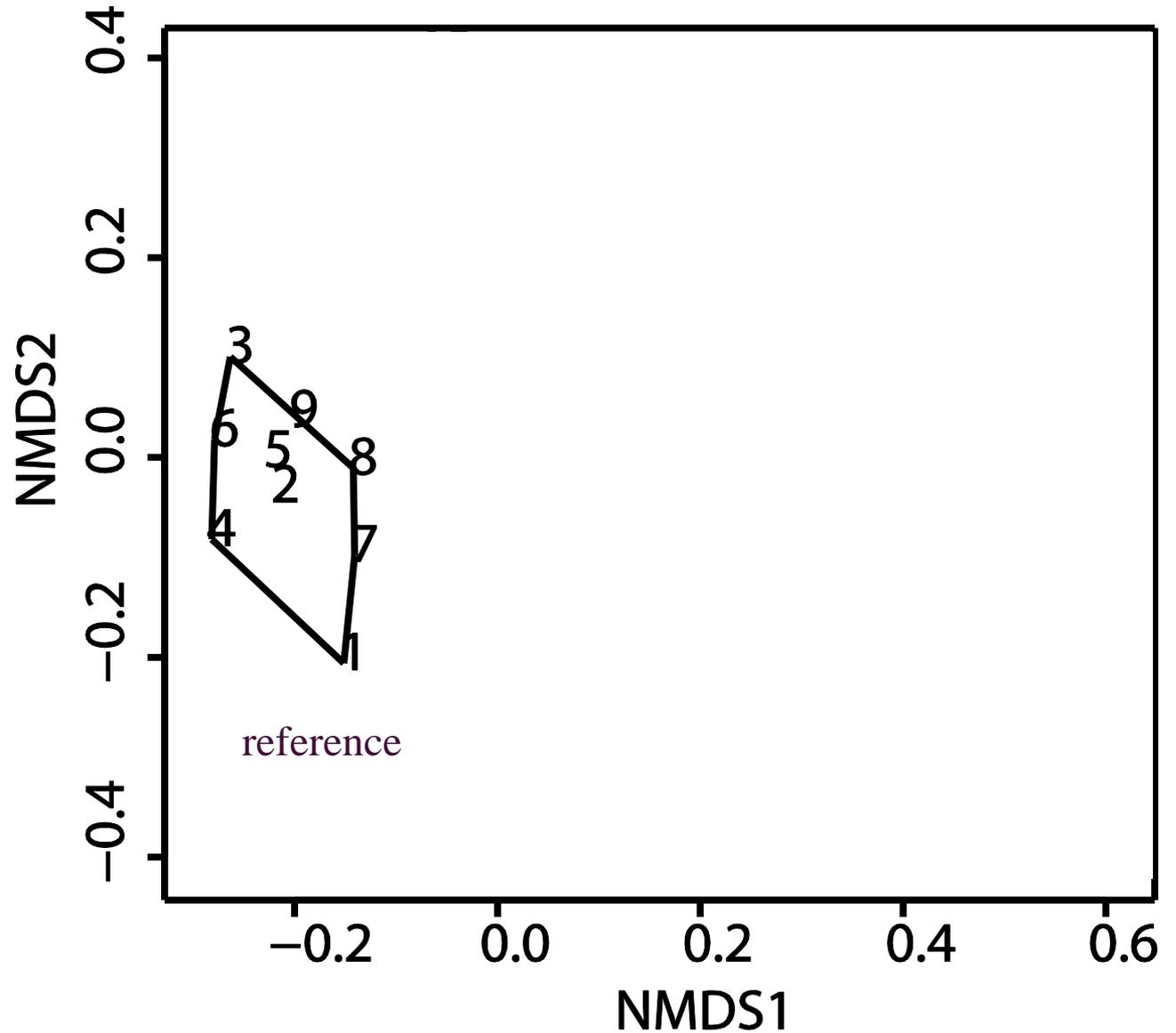
How can we visualize the similarity relationships of different sampling sites?

Plant ecologists have used ordination techniques for many years.

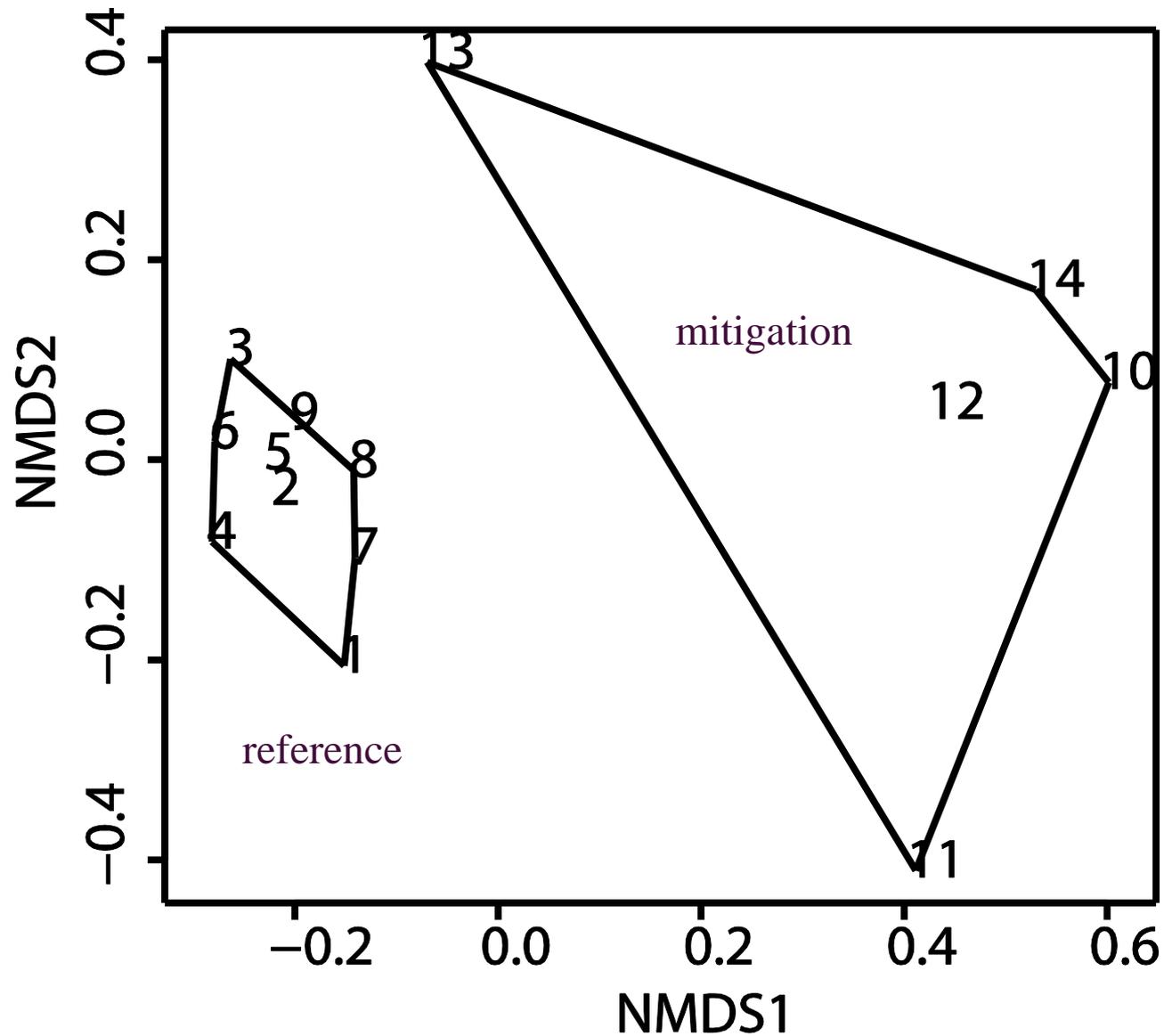
We use non-metric multidimensional scaling because it does not entail assumptions about the distributions of the underlying data

Similarity patterns for plant cover at reference and mitigation (restoration) sites

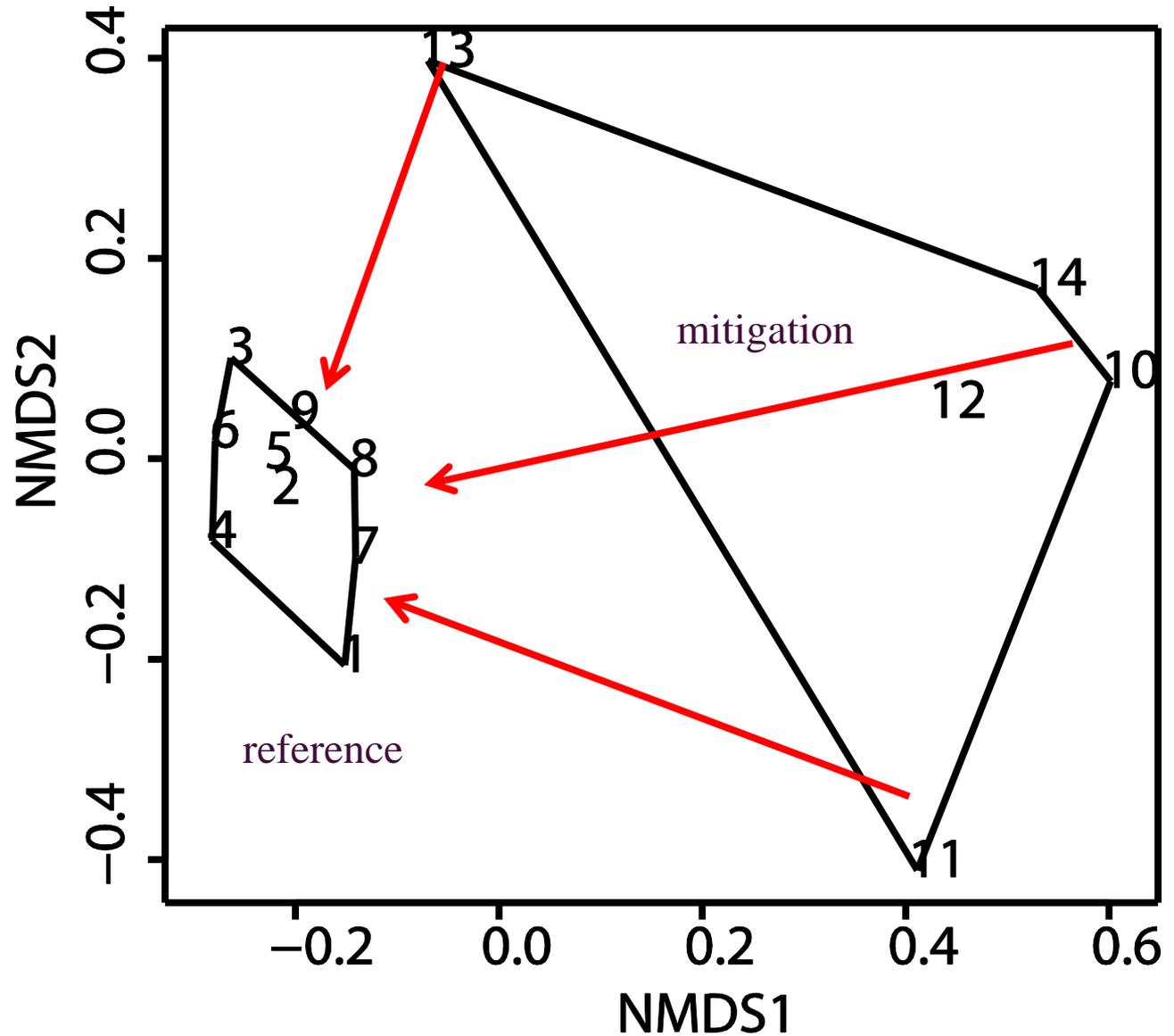
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Similarity patterns for plant cover at reference and mitigation (restoration) sites



Similarity patterns for plant cover at reference and mitigation (restoration) sites



Communication

Stakeholders

Funding agencies

Meeting participants

Restoration Ecology

THE JOURNAL OF THE
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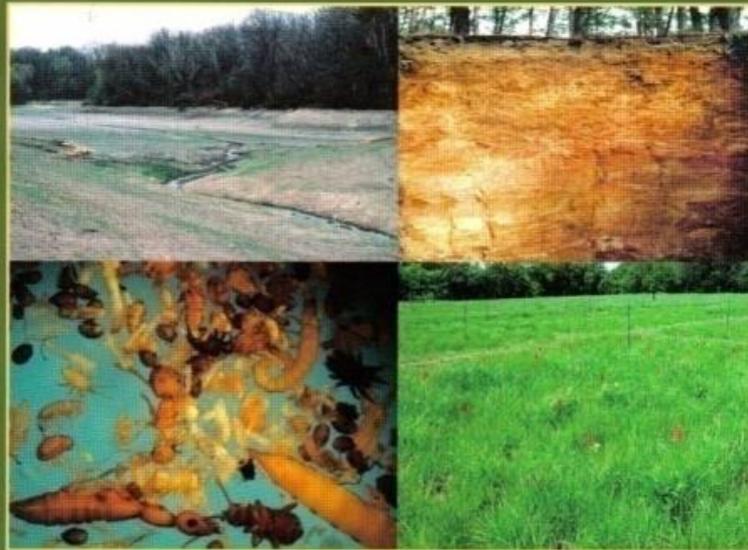
Restoration Ecology

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GUEST EDITORS: MAC A. CALLAHAM, JR., LIAM HENEGHAN, AND CHARLES C. RHOADES



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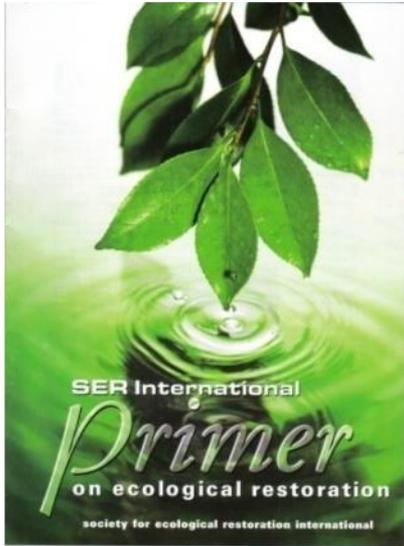


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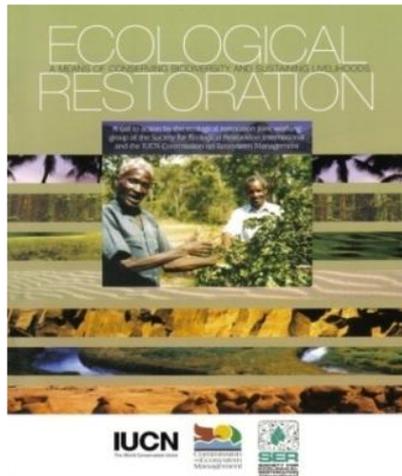
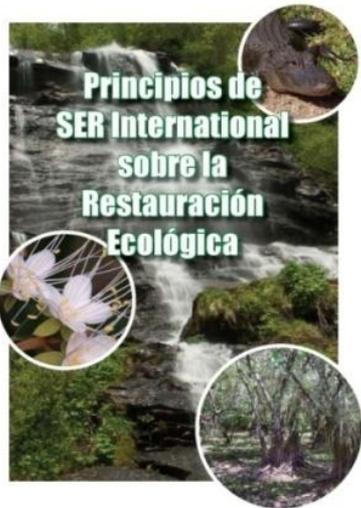
ISSN 1061-2971

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Technical Guidelines



- Primer on Ecological Restoration
- Guidelines for Developing and Managing Ecological Restoration Projects
- Ecological Restoration – A Means of Conserving Biodiversity and Sustaining Livelihoods (SER and IUCN)



The Science and Practice of Restoration

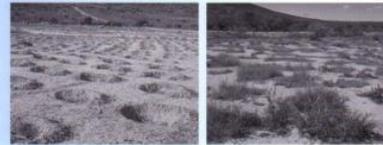
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FOUNDATIONS OF
RESTORATION ECOLOGY



SOCIETY FOR ECOLOGICAL RESTORATION INTERNATIONAL
*Assembly Rules
and Restoration Ecology*
BRIDGING THE GAP BETWEEN THEORY AND PRACTICE



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RESTORING
NATURAL CAPITAL
Science, Business, and Practice

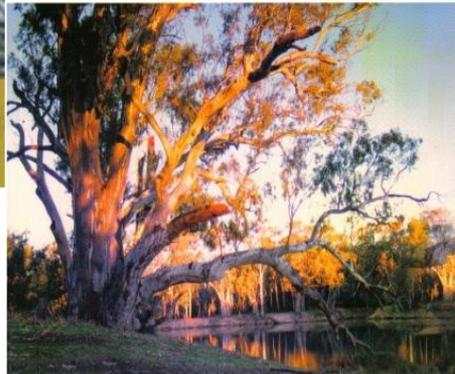


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NEW MODELS FOR
ECOSYSTEM DYNAMICS
AND RESTORATION



Edited by
Richard J. Hobbs and Katharine N. Suding

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River Futures

An Integrative Scientific Approach to River Repair

Edited by Gary J. Brierley and Kirstie A. Fryirs

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Edited by
James Aronson, Suzanne J. Milton, and James N. Blignaut
Foreword by Peter H. Raven



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