Learning from Restoration Research:

Maximizing Likelihood of Successful Outcomes

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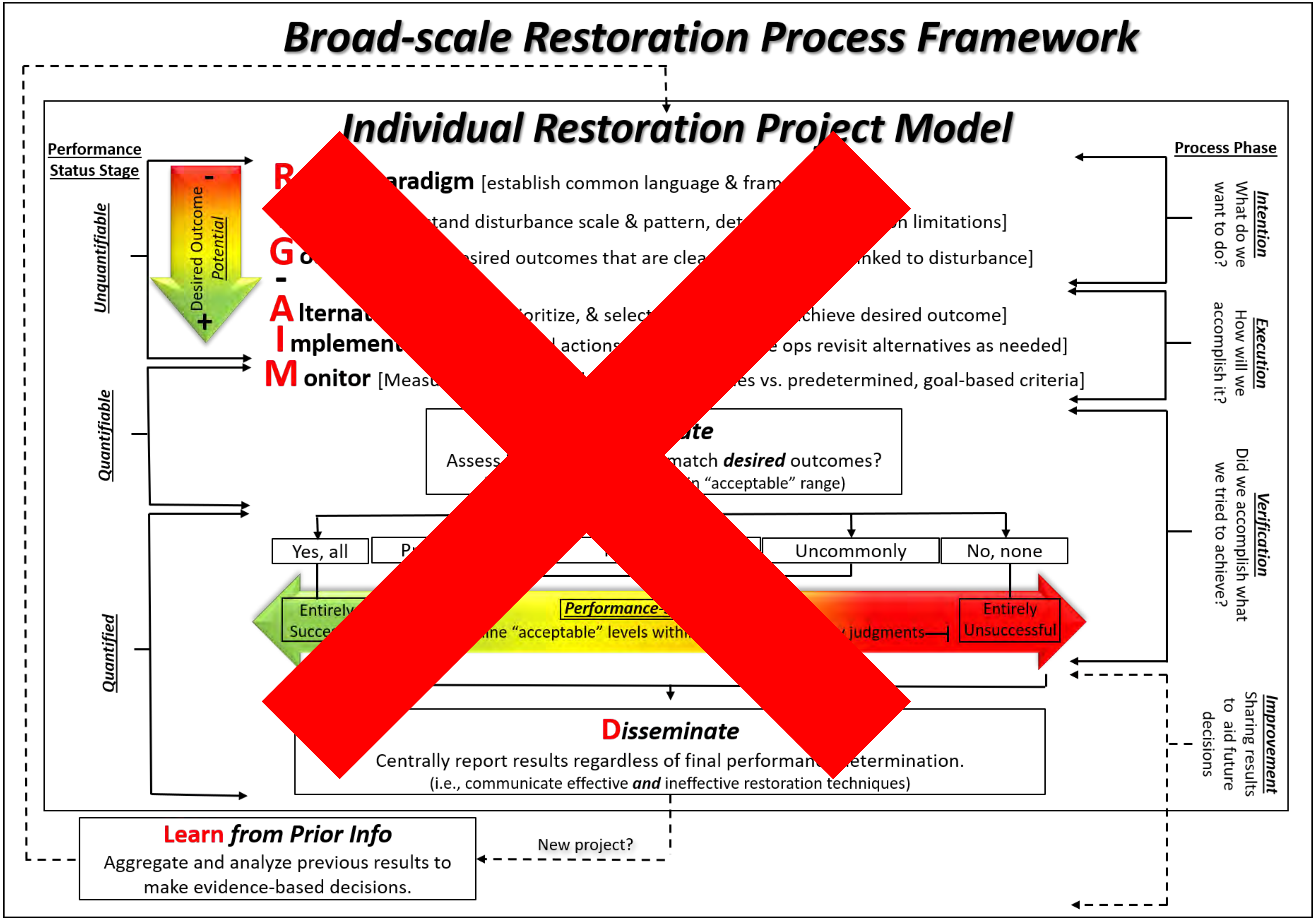
Restoration Support Unit

Office of Restoration and Damage Assessment

Natural Resource Damage Assessment & Restoration Program

Restoration Program



Broad-scale Restoration Process Framework
Individual Restoration Project Model
Performance Status Stage
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Quantifiable
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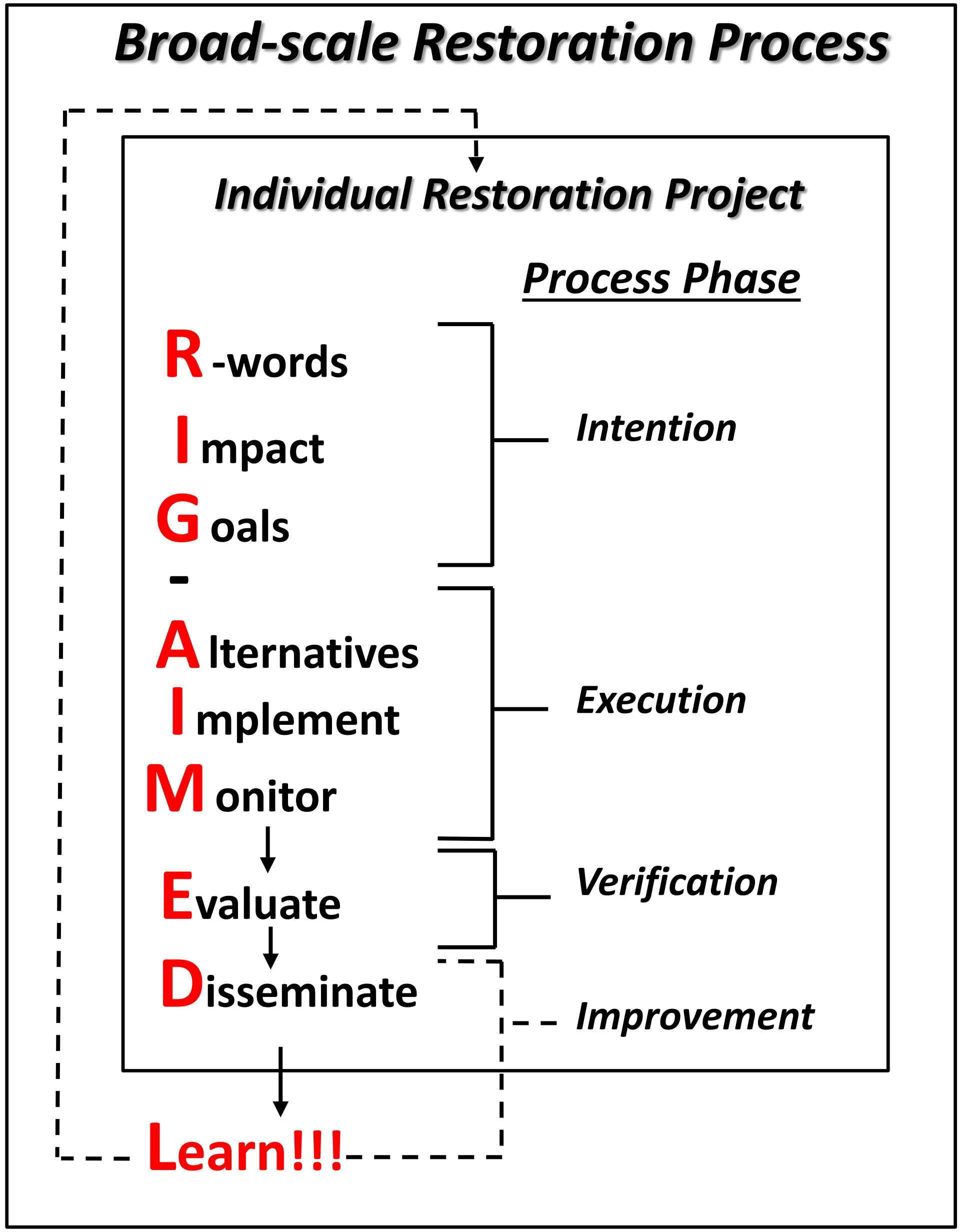
Did we accomplish what we tried to achieve?
Improvement
Sharing results to aid future decisions
Learn from Prior Info
Aggregate and analyze previous results to make evidence-based decisions.
New project?


Broad-scale Restoration Process
Individual Restoration Project
Process Phase
R -words
I mpact
G oals
-
A lternatives
I mplement
M onitor
Evaluate
Disseminate
Intention
Execution
Verification
Improvement
Learn!!!

R-words—Define language & expectations

	Major Foci			Implied Target End-state	
Activity	***Contaminant Management***	***Ecosystem Recovery***	***Stabilization***	***Pre-existing***	***Alternate***
Remediation	**X** (*removal, treatment*)			------------------------**X**------------------------	
Reclamation	**X** (*treatment, containment*)		**X**		-------------------------------------**X**----------
Rehabilitation		**X** (*function, services*)		------------**X**------------------------------------	
Restoration (ecological)		**X** (*structure + function*)		**X** (*min. disturbance*)	
Restoration (common-use)		--**X**------------------------------------		------------**X**------------------------------------	

Terminology consistent with:

Restoration of Impaired Ecosystems: An Ounce of Prevention or a Pound of Cure? Introduction, Overview, and Key Messages from a SETAC-SER Workshop

&

Reclamation of Drastically Disturbed Lands
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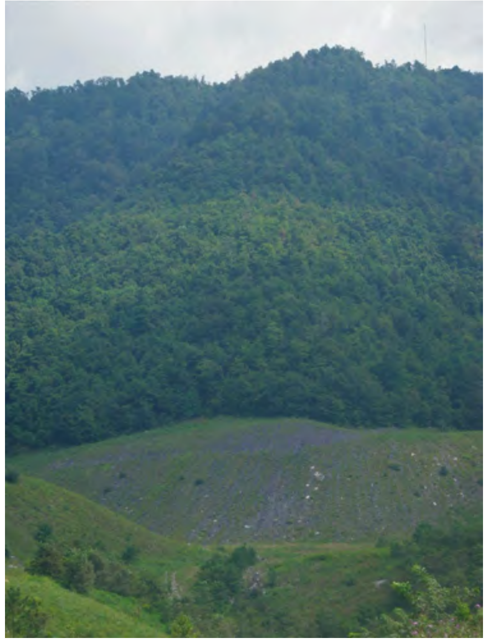
Editorial Committee
Richard I. Barnhisel
Robert G. Darmody
W. Lee Daniels

R-words—Define language & expectations

Remediation

Photo: CA Dept of Fish and Wildlife

Reclamation



Rehabilitation

Ecological Restoration

R-words—Quiz time!

Reclamation, Restoration, or Rehabilitation?

Other? None of the above?

15 Year-old Hardwood Stand

(Planting)

~2 Year-old American Chestnut

(Planting)

50 Year-old Hardwood Forest

(Succession)


Photo: Vic Davis

~55 Year-old Black Walnut

(Planting)


Photo: R. Rathfon

Fuzzy definitions with **LOTS of overlap**!!!

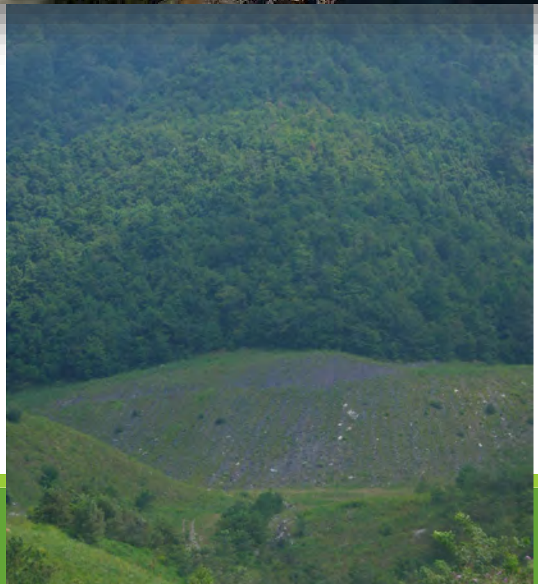
R-__words__—Conflict ± confusion = consequences

Impact—Understand disturbance

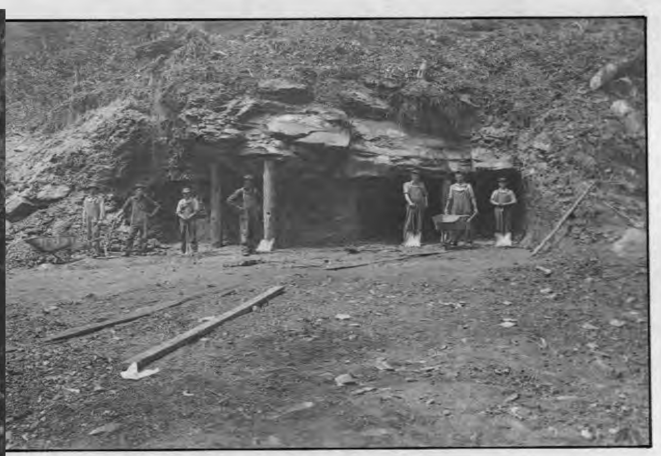
We must understand nature of the disturbance to effectively restore!

Impact—Scale(s)

Spatial Scale



Temporal Scale

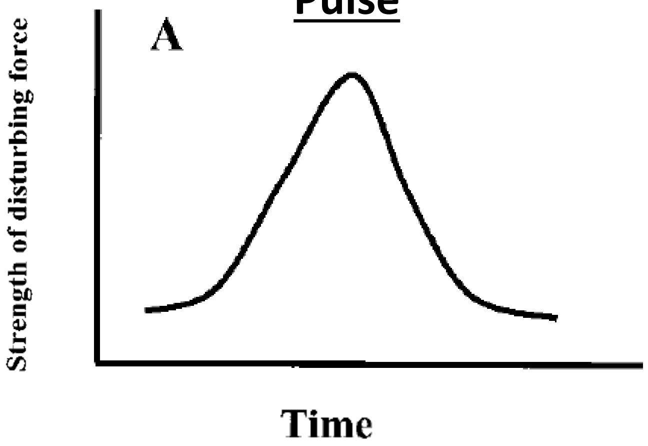


Colliery: Main haulage openings, Taggart Seam.

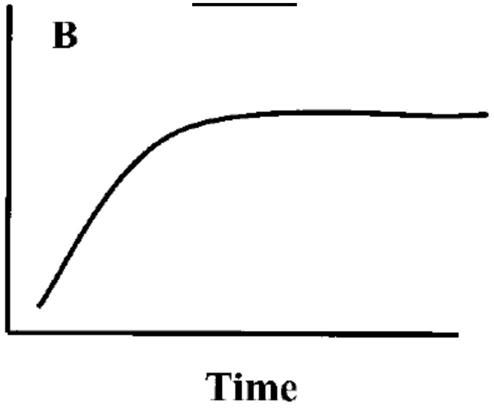
Stonega, Va. about 1919.

Impact—Pattern(s)

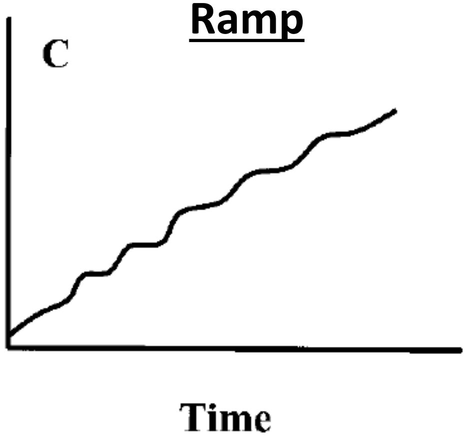
Pulse



Press



Ramp



Disturbance, patchiness, and diversity in stream
P. S. LAKE[1] J. N. Am. Benthol. Soc., 2000, 19(4):573–592
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Impact—Pattern(s)

Could one impact exhibit multiple disturbance patterns?


Pulse disturbances

Nitrogen fluxes

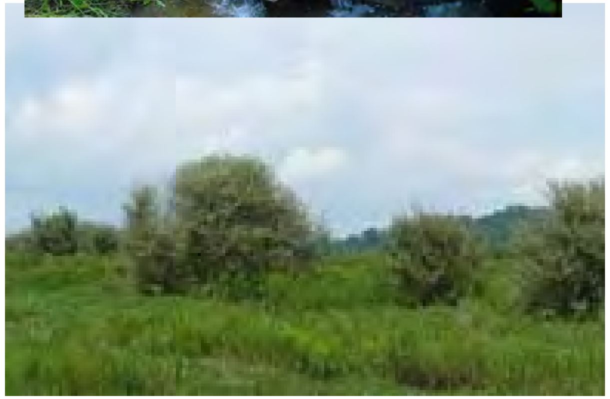
Hydrologic flashiness


Press disturbances

Blasting

Imperviousness/compaction

Streambed precipitates

Ramp disturbances

Invasive vegetation

(Cumulative & Compounding)

←Results from other disturbance types

Impact—Lessons from examples

Goals—Establish desired outcomes

Desired outcome ≠ Desirable outcome

Establishing Appropriate Goals:

3 Key Elements

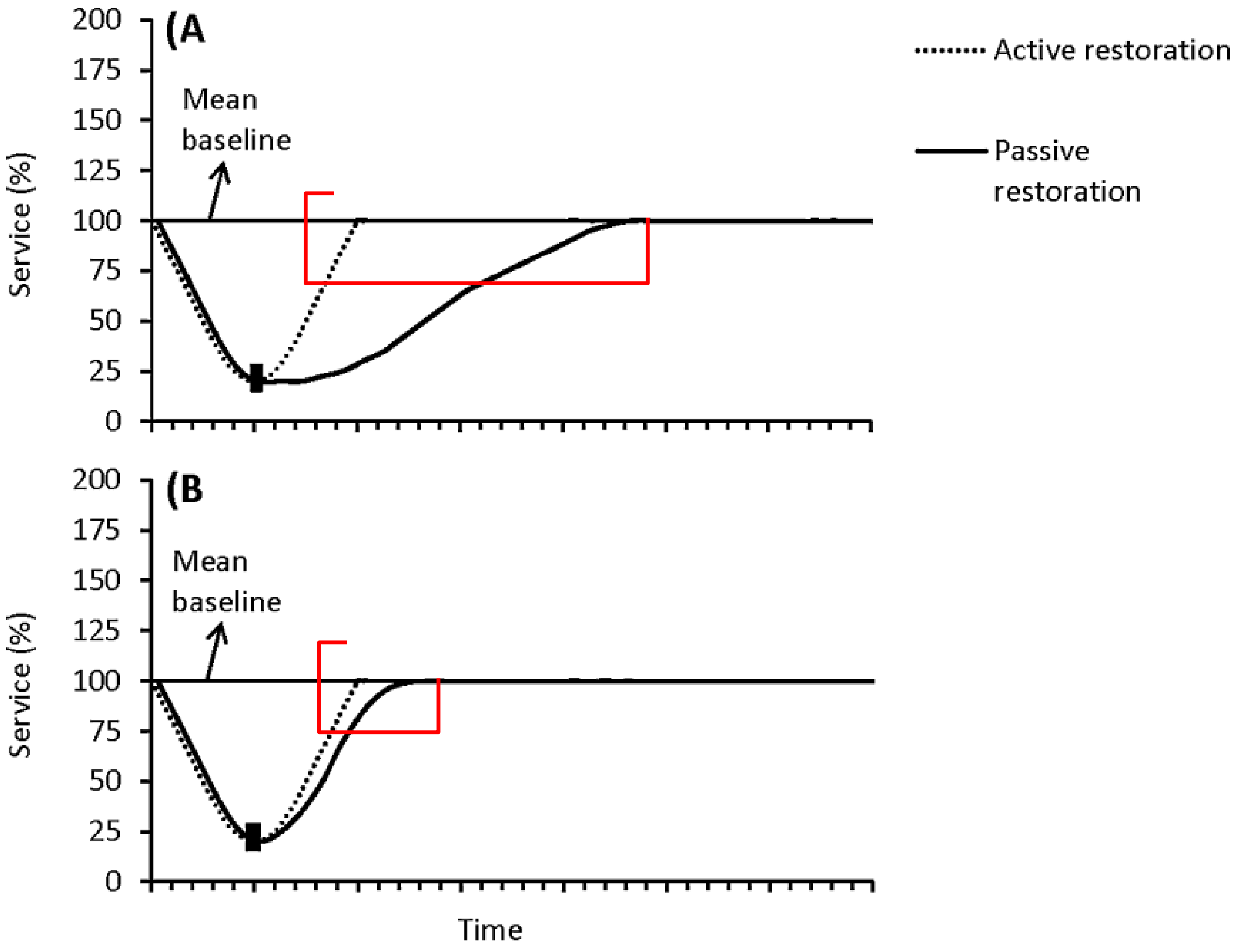
1. **Clearly Delineated**
    - Linked impact to injury to outcome
    - Foster meaningful future assessment
2. **Congruent with scale/pattern of disturbance**
    - Can goals be achieved at scale of restoration
3. **Agreed upon**
    - All parties have input
    - Trustee opinion paramount

Goals—Lessons from examples

Alternatives—Identify, evaluate, & select

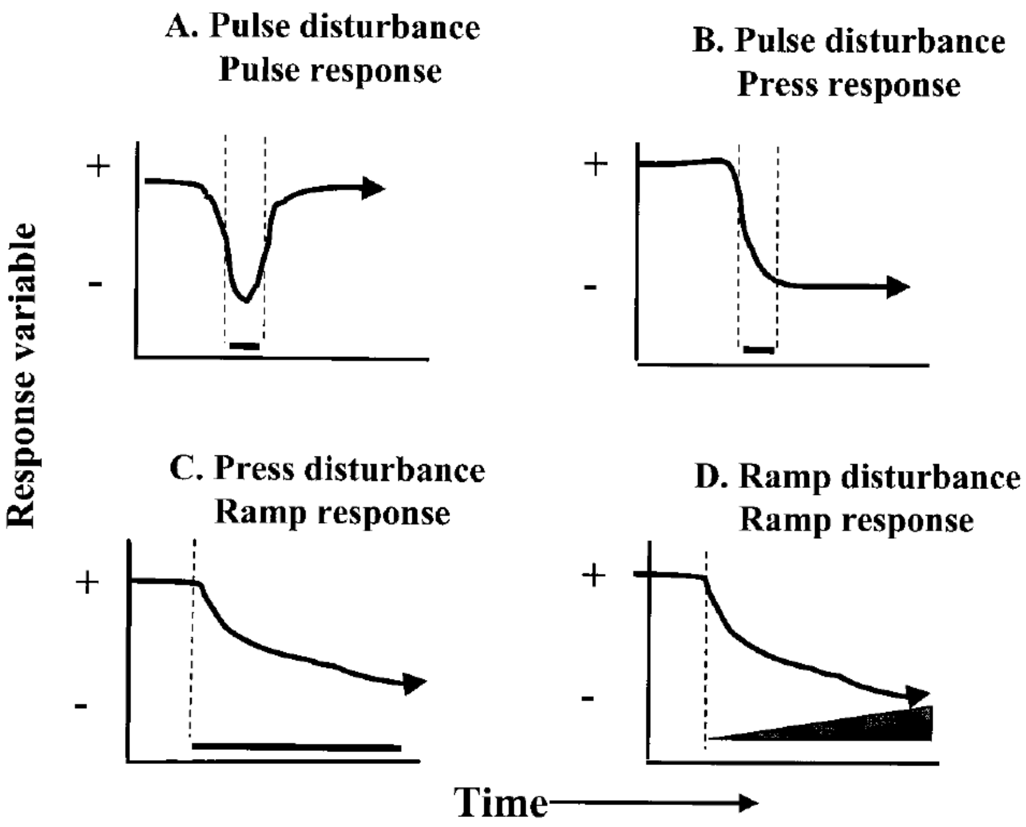
NRDAR Criteria
for Selecting CERCLA Alternatives

1. Technical feasibility
2. Expected cost-benefit evaluation
3. Cost effectiveness relative to other options
4. Results/impacts of actual or planned response
5. Potential for additional Injury
6. Natural recovery period (no-action vs. alt.)
7. Ability for recovery (no-action vs. alt.)
8. Adverse public health and safety
9. Consistency: federal, state, tribal
10. Compliance: federal, state, tribal



Transforming Ecosystems: When, Where, and How to

Alternatives—Doing nothing (Any NEPA fans, out there?)



Selective Logging

Disturbance, patchiness, and diversity in streams
P. S. Lake[1] J. N. Am. Benthol. Soc., 2000, 19(4):573–592
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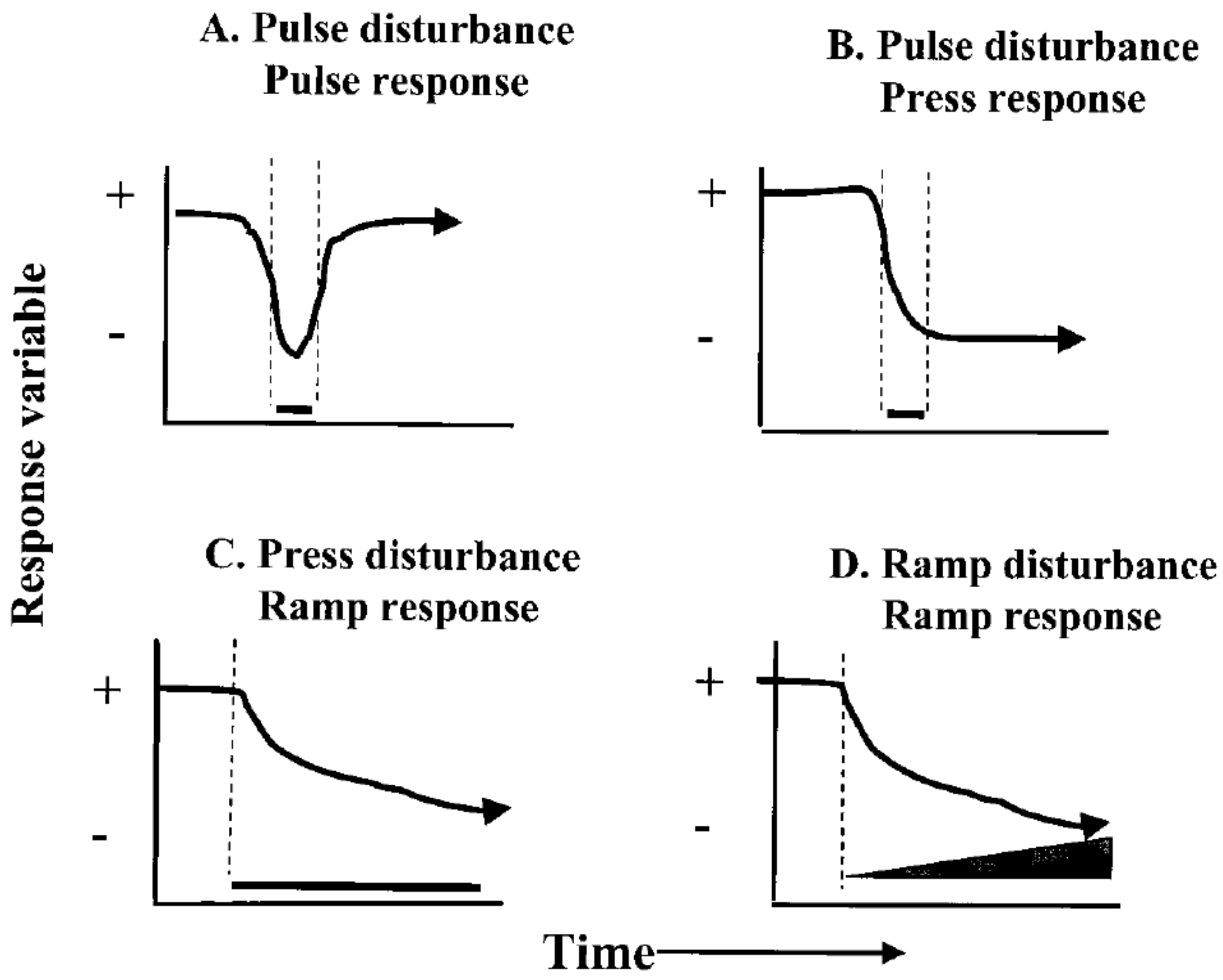
Alternatives—Doing something



Disturbance, patchiness, and diversity in streams

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Alternatives—Select in good faith

Professional Judgment

Pet Projects

NRDAR Criteria
for Selecting CERCLA Alternatives

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Alternatives—Lessons from examples

Chosen Alternative
<u>Incongruent with Impact's Scale & Pattern</u>

Chosen Alternative
<u>Not Tied to Goals</u>

Implementation—Apply & adapt actions

Monitoring—Measure, record, & report

Integrated Risk and Recovery Monitoring of Ecosystem Restorations on Contaminated Sites

Michael J Hooper,† Stephen J Glomb,‡ David D Harper,§ Timothy B Hoelzle,‖ Lisa M McIntosh,# and David R Mulligan††*

Integrated Environmental Assessment and Management © 2015

1. Monitoring as part of restoration plan
2. Trajectory of recovery
3. Biotic, chemical, physical
4. Structural and functional linkages
5. Expected cost-benefit evaluation

Monitoring—A major weakness

Meta-analyses

Terrestrial

Evaluating Ecological Restoration Success: A Review of the Literature 2013 *Restoration Ecology Vol. 21*

Liana Wortley,[1,2] Jean-Marc Hero,[3] and Michael Howes[1]

- **301 scientific articles*, through 2012***
  - Global, U.S. & Australia-centric
  - Total # projects not indicated
  - Active, ecological restoration focus
- **Post-implementation monitoring**
  - ***Structural (pattern) metrics* = *94%***
    - Diversity & abundance
    - Vegetation structure
  - ***Functional (process) metrics* = *42%****
    - Soil-structure corrected = ***32%***
  - ***Socioeconomic evaluation*= *3.5%***
    - Community-involvement & project cost dominated
    - Economic benefits of ecosystem services unquantified

Aquatic

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. Sudduth[13]

- **37,099 projects*, through mid-2004***
  - National River Restoration Science Synthesis database
  - Pacific NW, Chesapeake Bay, California-centric (***88%***)
  - "Restoration", common-usage
- **Post-implementation monitoring**
  - ***Linkages to goals***
    - No goals listed for ***20%***
    - Restoration or just alteration?
  - ***Dearth of monitoring & assessment***
    - ***Only 10%*** completed any monitoring
    - Majority of those didn't link action & outcome
    - Majority didn't provide for dissemination

Monitoring—An essential restoration action

Structural and functional characteristics of natural and constructed channels draining a reclaimed mountaintop removal and valley fill coal mine
Ken M. Fritz[1,6], Stephanie Fulton[2,7], Brent R. Johnson[1,8], Chris D. Barton[3,9], Jeff D. Jack[4,10], David A. Word[4,11], AND Roger A. Burke[5,12] J. N. Am. Benthol. Soc., 2010

Ecological function of constructed perennial stream channels on reclaimed surface coal mines
J. Todd Petty · Gretchen Gingerich · James T. Anderson · Paul F. Ziemkiewicz Hydrobiologia 2013

Riparian subsidies and hierarchical effects of ecosystem structure on leaf breakdown in Appalachian coalfield constructed streams
Robert J. Krenz III[a,d], Stephen H. Schoenholtz[a,b], Carl E. Zipper[c]
Ecological Engineering 97 (2016)

Periphyton structure and function in constructed headwater streams of the Appalachian coalfield
Robert J. Krenz III[1,4], Carl E. Zipper[2,5], and Stephen H. Schoenholtz
Freshwater Science. 2018

Coordinating Ecological Restoration Options Analysis and Risk Assessment to Improve Environmental Outcomes
Lawrence A Kapustka,† Keith Bowers,‡ John Isanhart,§ Cristina Martinez-Garza,‖ Susan Finger, Ralph G Stahl Jr,†† and Jenny Stauber* Integrated Environmental Assessment and Management 2015 SETAC

Meaningful Monitoring: 3 Key Elements

1. Goal-based criteria

- Predetermined
- Congruent w/disturbance
- Linked to injury

2. Quantifiable

- Objective
- Physical, chemical, biotic structure
- Functional & services

3. **Sufficient length & frequency**

- Ideal, until achievement of goals
- Realistic, until likely trajectory established

Integrated Risk and Recovery Monitoring of Ecosystem Restorations on Contaminated Sites
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A CASE FOR USING LITTER BREAKDOWN TO ASSESS FUNCTIONAL STREAM INTEGRITY
MARK O. GESSNER[1] AND ERIC CHAUVET *Ecological Applications*, 2002

Organic matter breakdown and ecosystem metabolism: functional indicators for assessing river ecosystem health
Roger G. Young[1] Christoph D. Matthaei[2] AND Colin R. Townsend
J. N. Am. Benthol. Soc., 2008,

July 30, 2010

MEMORANDUM FOR U.S. Army Corps of Engineers Headquarters, Directorate of Civil Works, Districts and Divisions, and U.S. Environmental Protection Agency Regional Offices

SUBJECT: Assessment of Stream Ecosystem Structure and Function under Clean Water Act Section 404 Associated with Review of Permits for Appalachian Surface Coal Mining[1]

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUL 21 2011

MEMORANDUM

SUBJECT: Improving EPA Review of Appalachian Surface Coal Mining Operations Under the Clean Water Act, National Environmental Policy Act, and the Environmental Justice Executive Order

A Function-Based Framework
for Stream Assessment & Restoration Projects
a.k.a., (Harman et al., 2012)* EPA 843-K-12-006 » May 2012

Evaluation—Compare actual vs. desired outcomes

Non-binary evaluation is key!!! (vs. success/failure)

Dissemination—Communicate data & results

Restoration of Impaired Ecosystems: An Ounce of Prevention or a Pound of Cure? Introduction, Overview, and Key Messages from a SETAC-SER Workshop

Aïda M Farag,† Ruth N Hull,‡ Will H Clements,§ Steve Glomb,|| Diane L Larson,# Ralph Stahl,†† and Jenny Stauber‡‡*
Integrated Environmental Assessment and Management 2015 SETAC

Call for:

A Function-Based Framework
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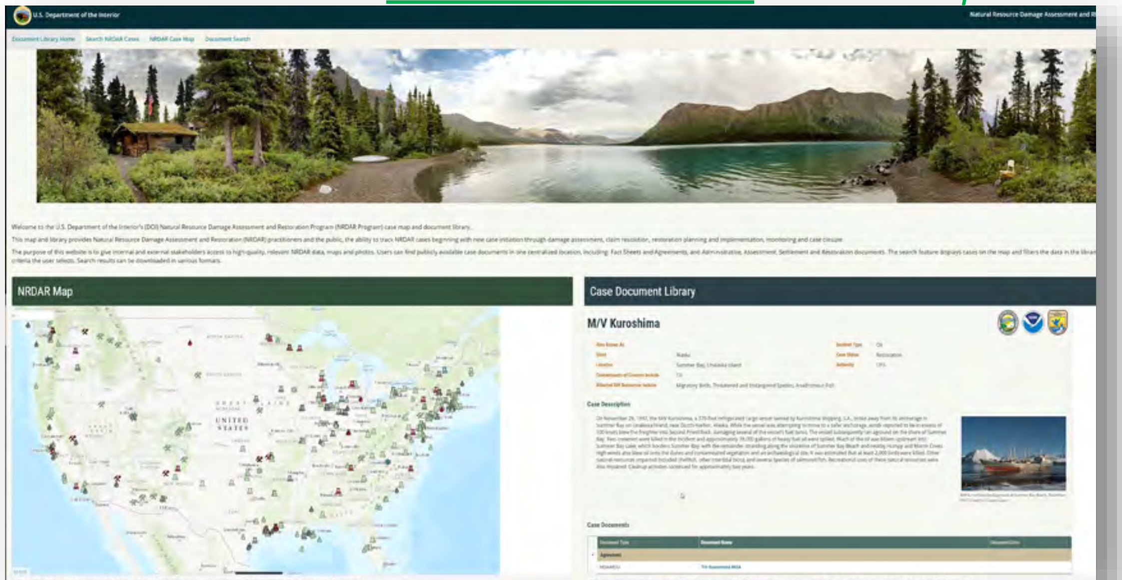
EPA 843-K-12-006 » May 2012

Reciprocal Transfer of
Multi-disciplinary Knowledge
Practitioners ←→ Theorists ←→ Stakeholders

Disseminate

DARTS Database **in development**



LEARN!!!—Aggregate & analyze for new projects

Multi-disciplinary Knowledge

Practitioners ←→ Theorists ←→ Stakeholders

Disseminate

DARTS Database **in development**

New project planning:

Aggregate & Analyze

Planning & Design Team

(Practitioners, Trustees, Stakeholders)

Learn from

& apply to:

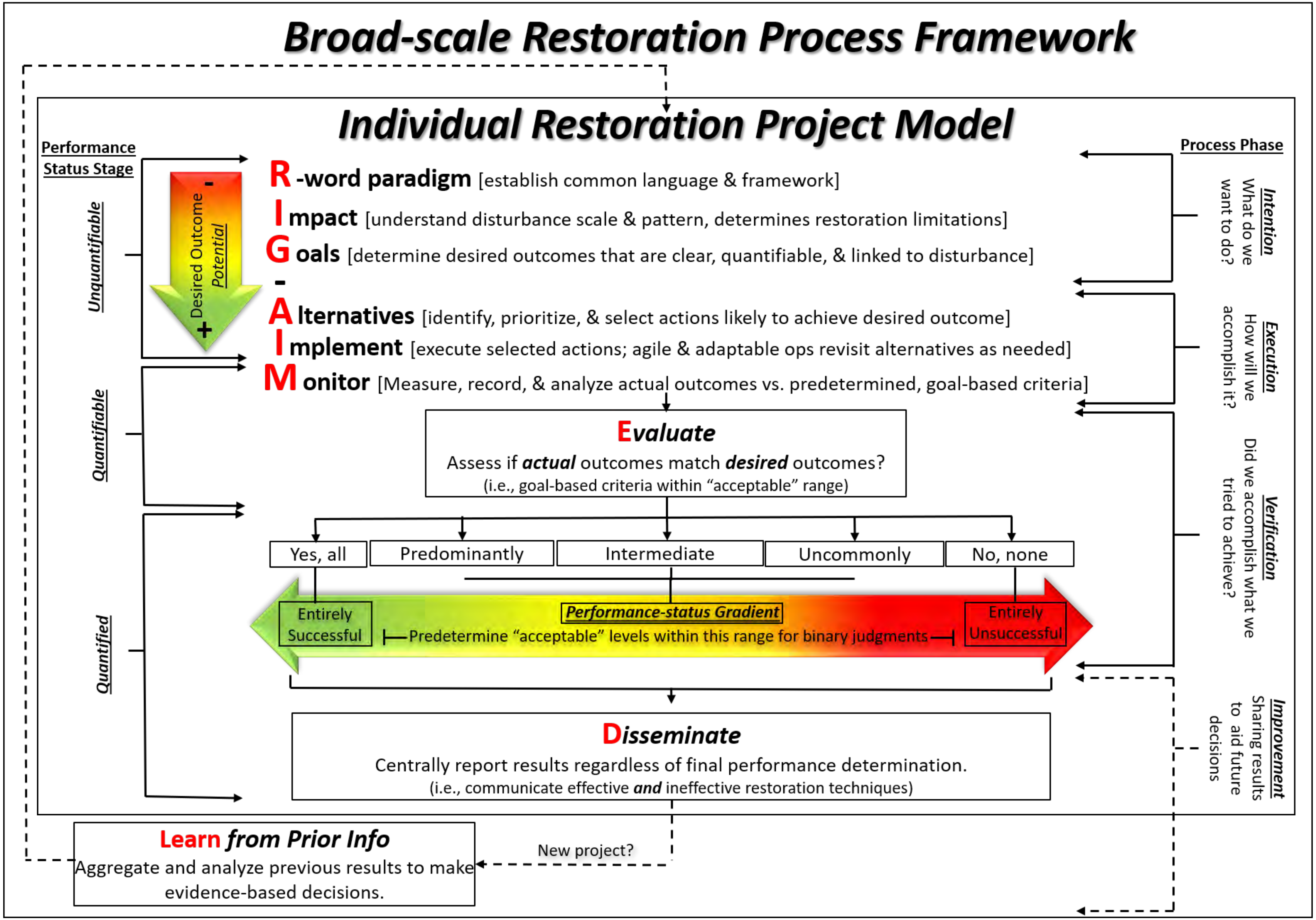
New Project!!!

R I G - A I M

Evaluate

Review & Summary—Avoiding pitfalls & improving process

…let's take a look back at our conceptual model…



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Performance-status Gradient
Predetermine "acceptable" levels within this range for binary judgments
Entirely Unsuccessful
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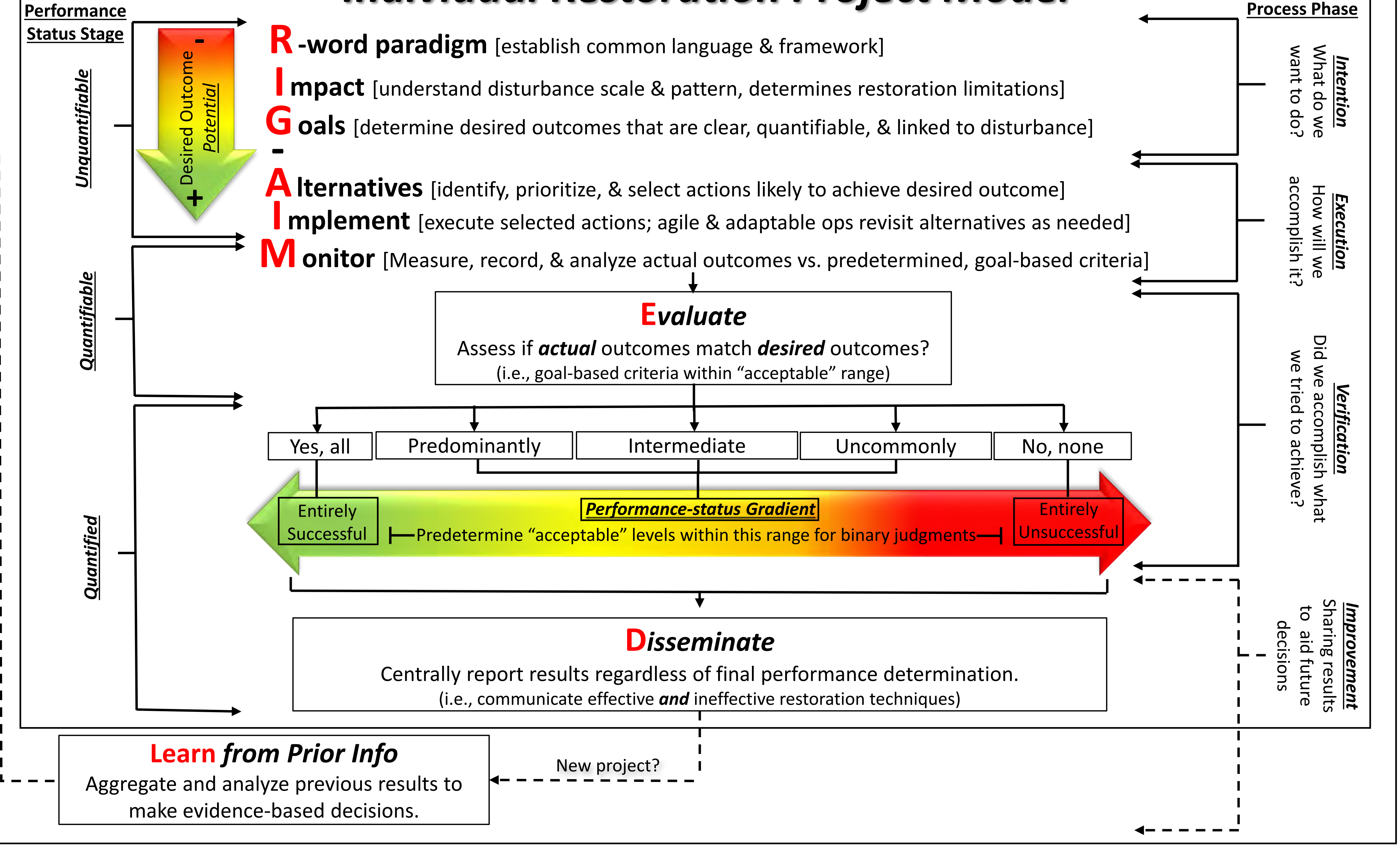
New project?

Questions?



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