Assessments to Guide River Restoration Project Design

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Bren School of Environmental Science & Management
UC Santa Barbara

The themes of this presentation:

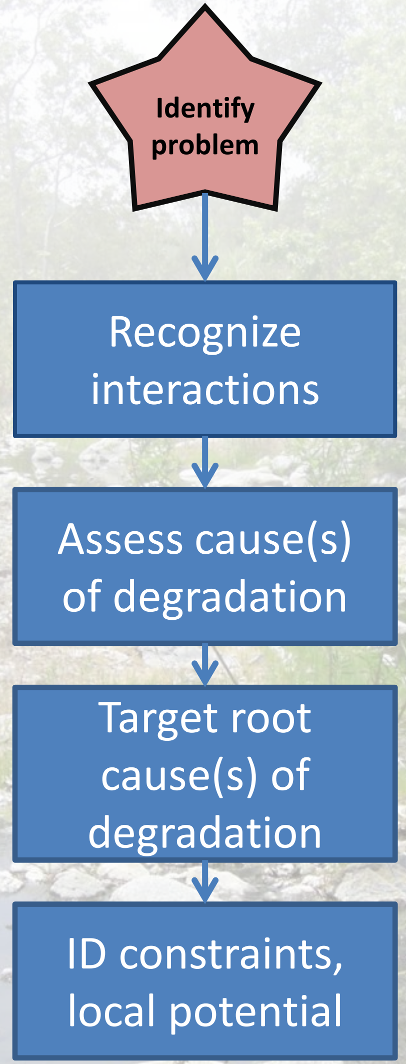
1. Begin with the end in mind. Our “beginning” = assessments; our “ending” = restoration. So you can’t assess without knowing what you’re going to restore.
2. “Process-based restoration” should be our focus. Thus, assessments *also* must focus on processes, not form.
3. Processes occur across multiple scales (both spatial and temporal). Thus, assessment must be multi-scalar as well.

Correcting the *causes* of stream degradation: "process-based restoration"

Processes are typically measured as rates, and they involve the movement of or changes to ecosystem parts and features…Process-based restoration, then, focuses on correcting anthropogenic disruptions to these processes, such that the river-floodplain ecosystem progresses along a recovery trajectory with minimal corrective intervention…"

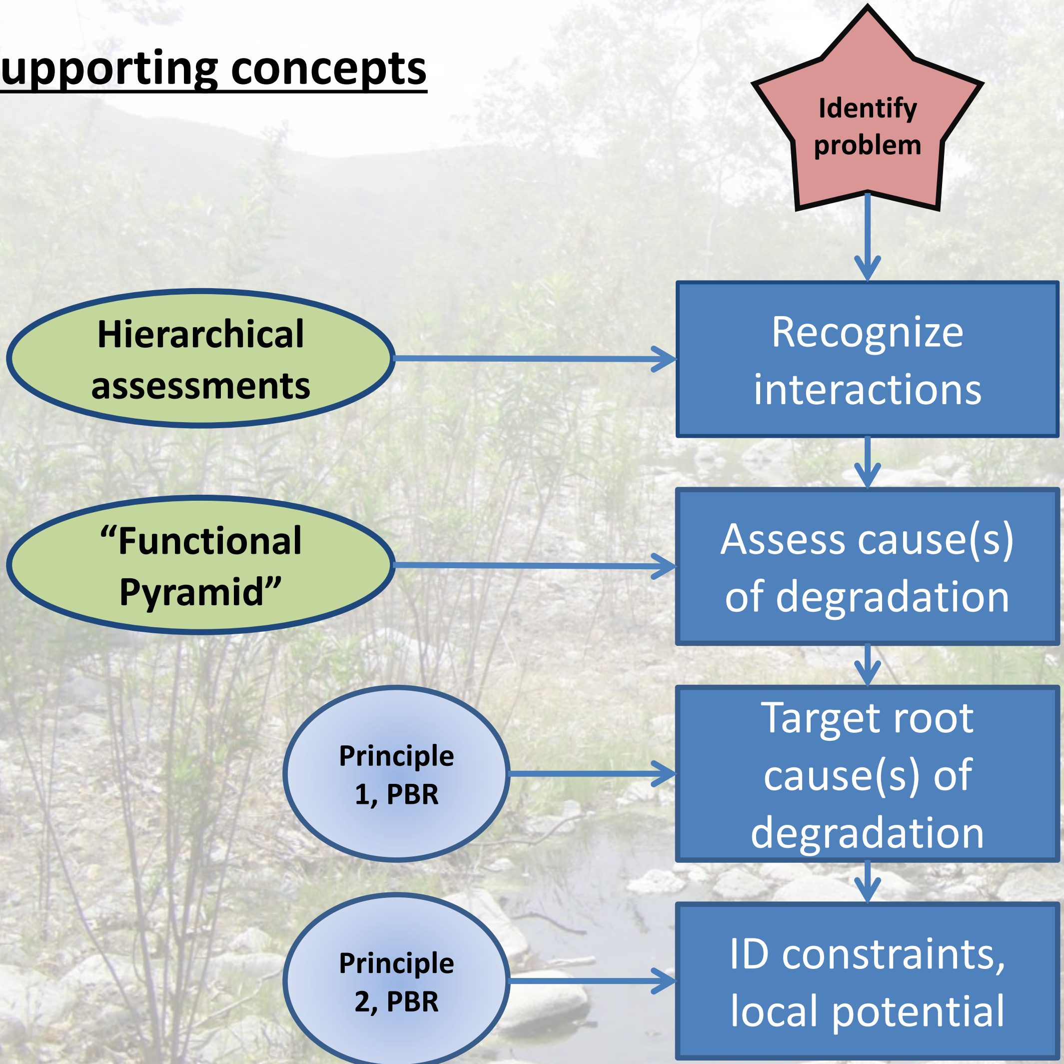
Beechie et al. 2010

Major assessment steps

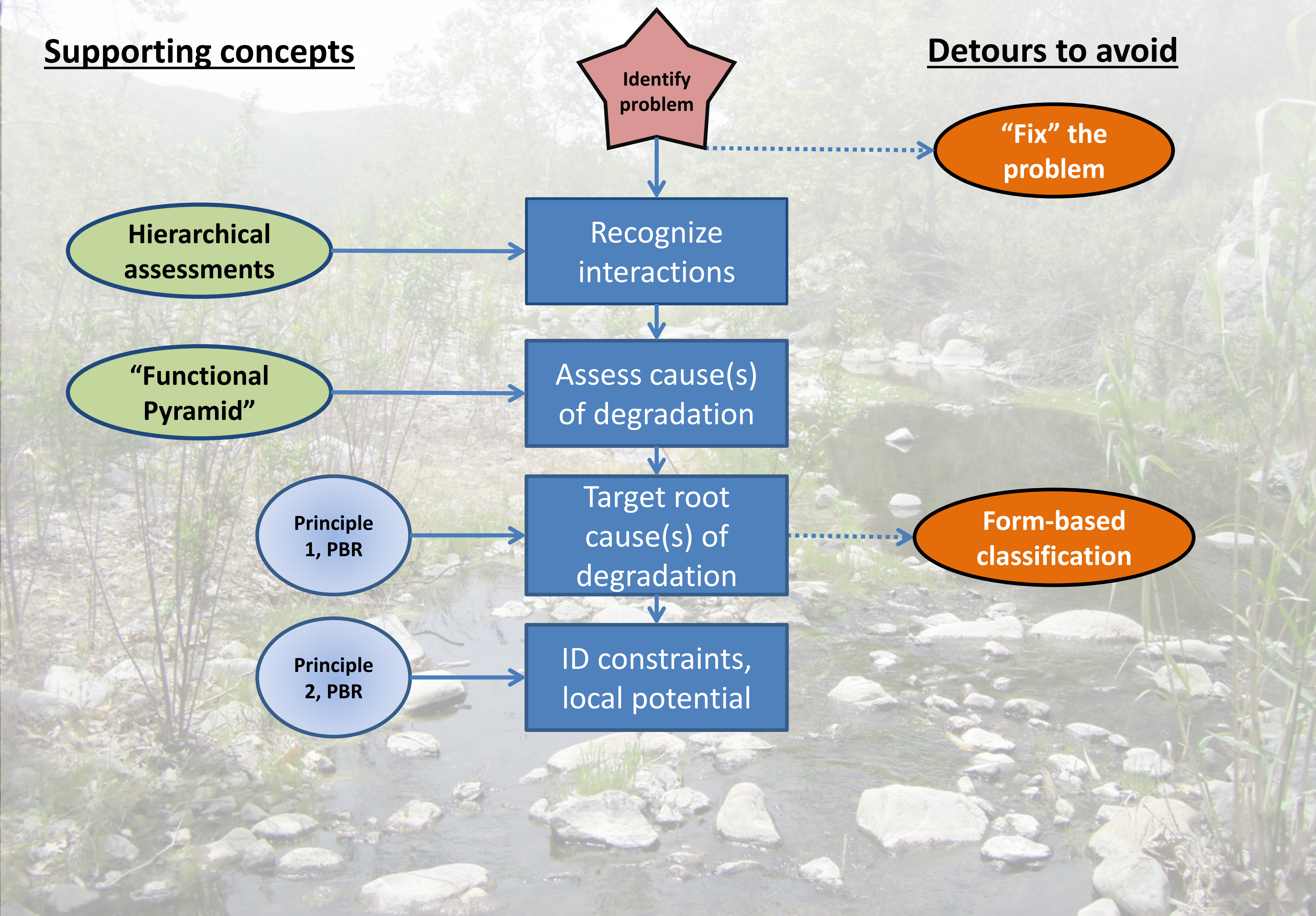


Major assessment steps

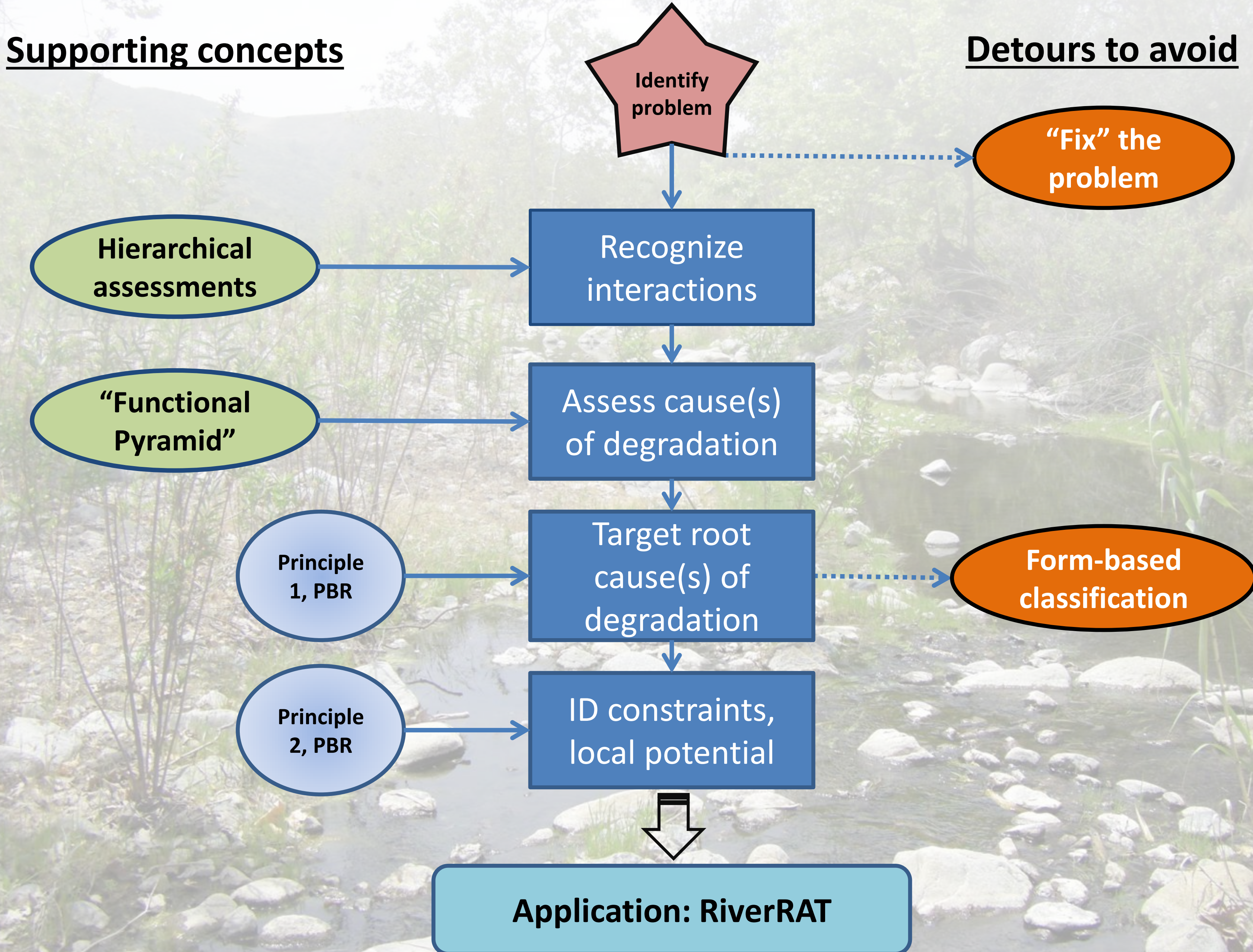
Supporting concepts



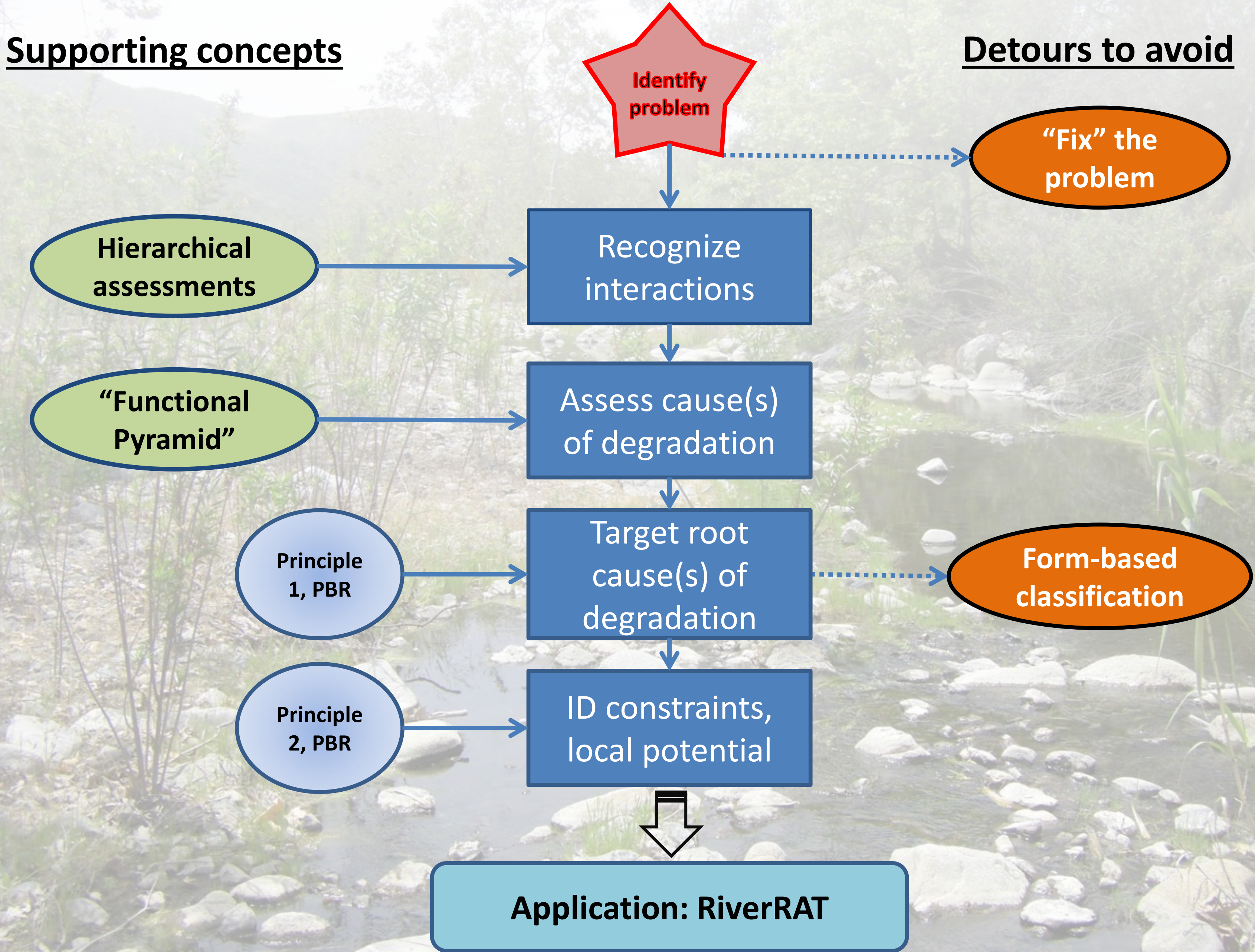
Major assessment steps



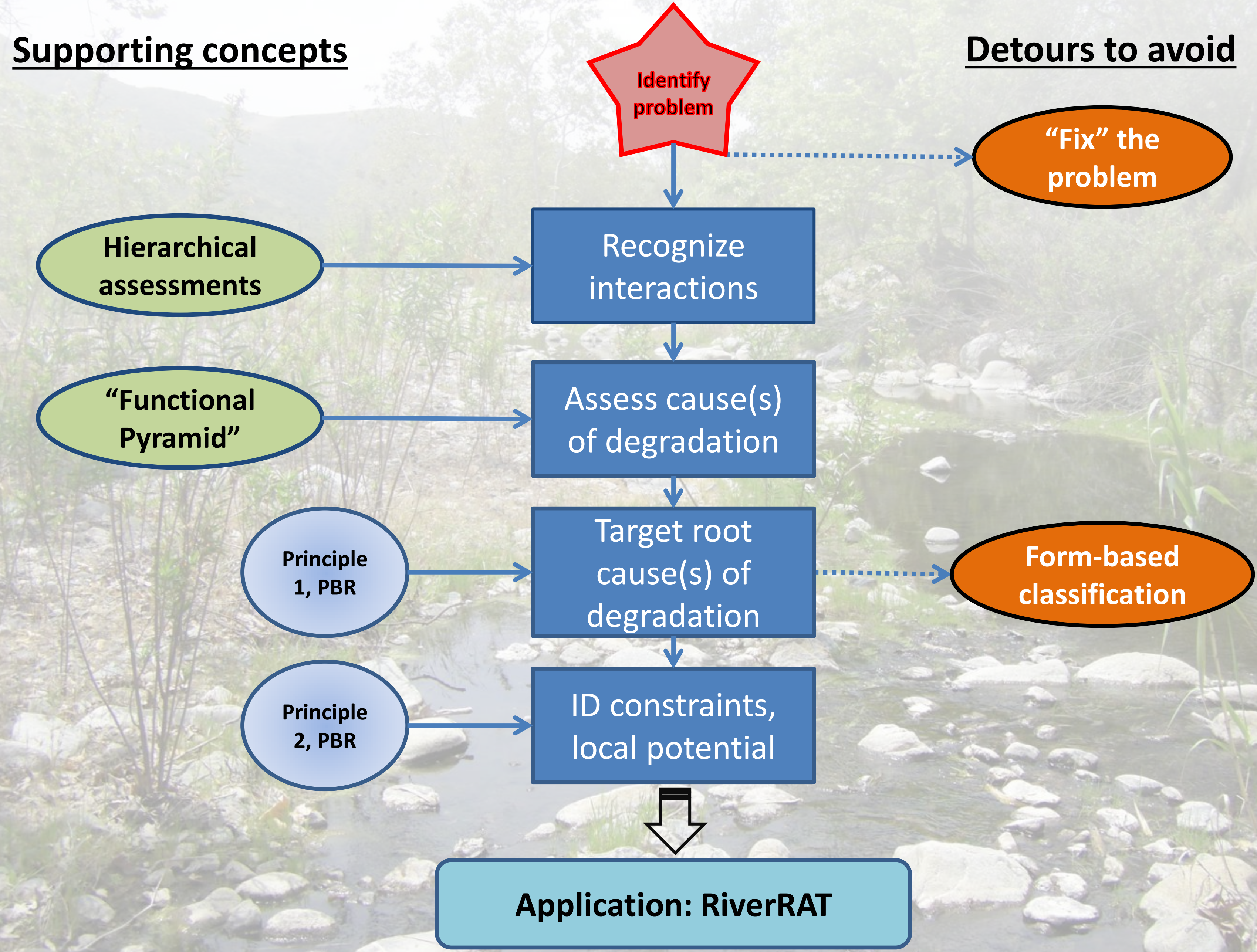
Major assessment steps



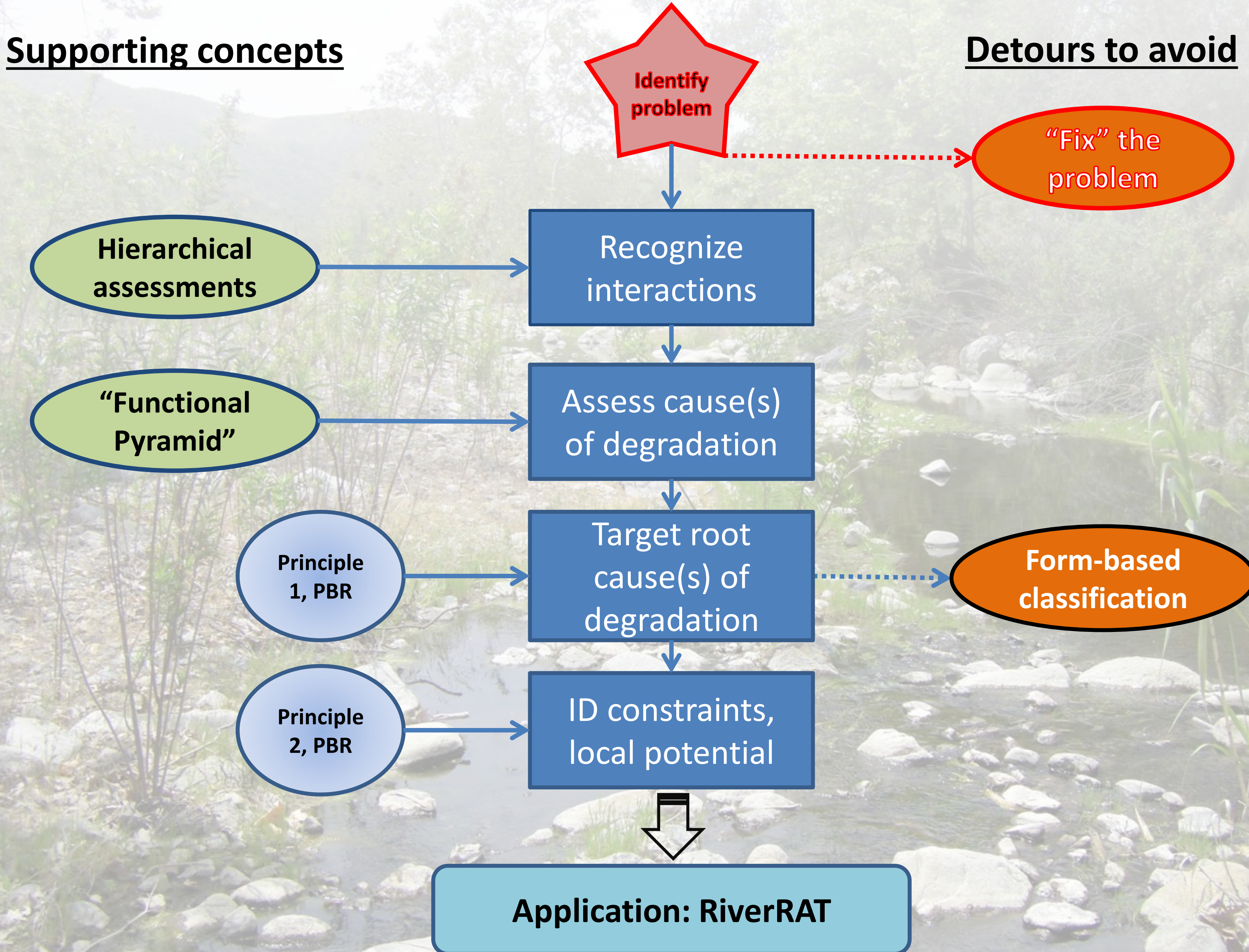
Major assessment steps

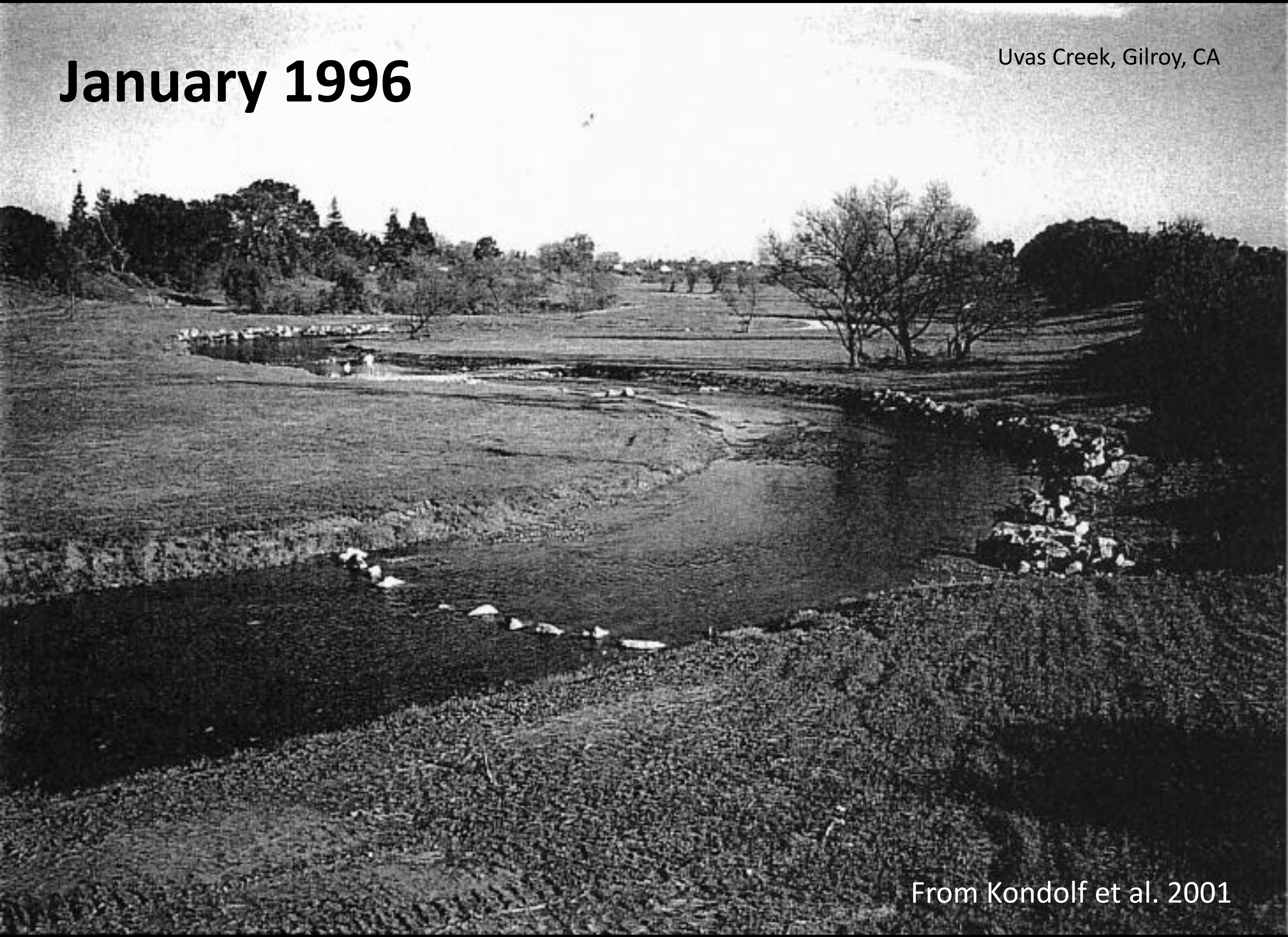


Major assessment steps



Major assessment steps

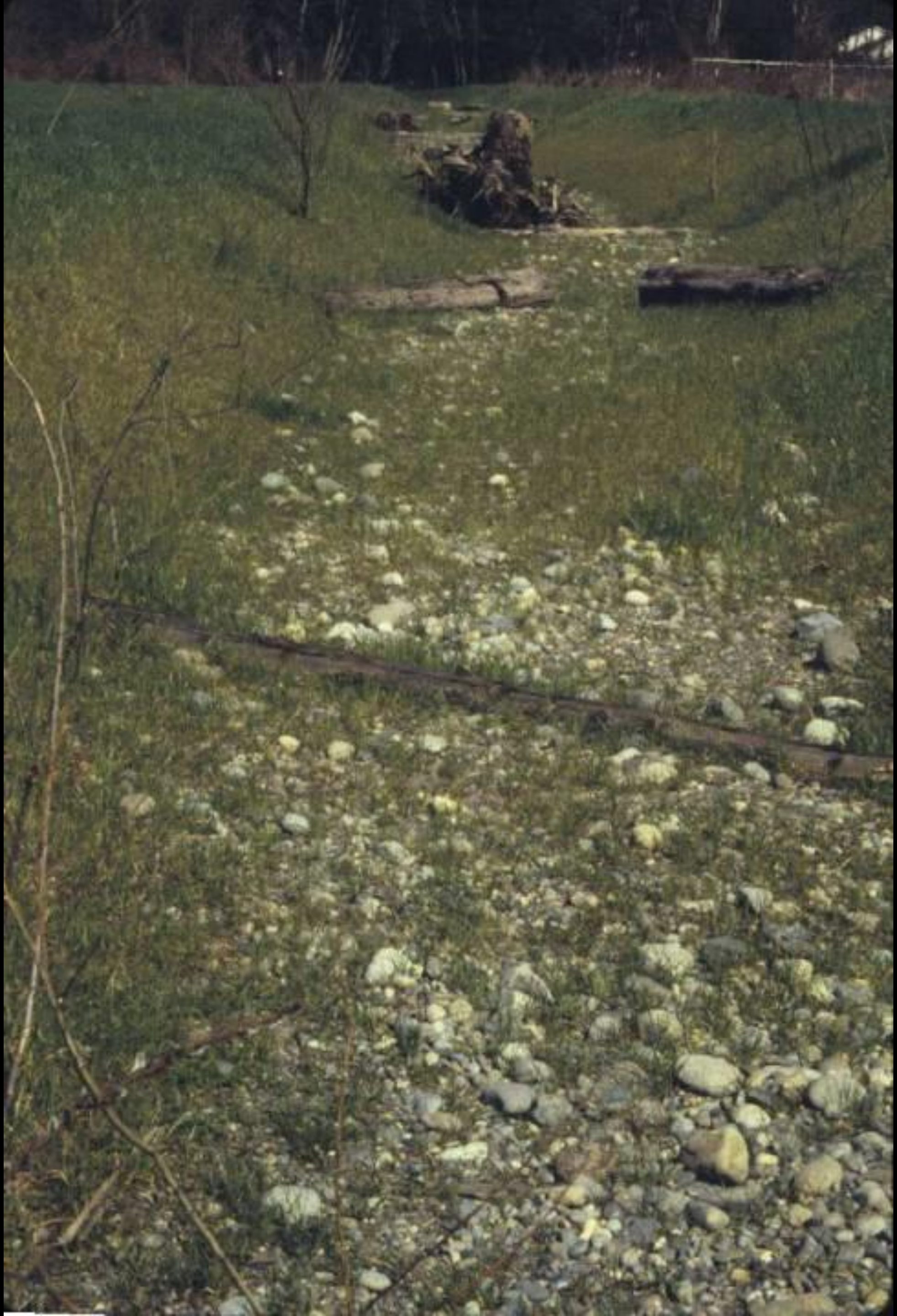



January 1996
Uvas Creek, Gilroy, CA
From Kondolf et al. 2001

June 1997

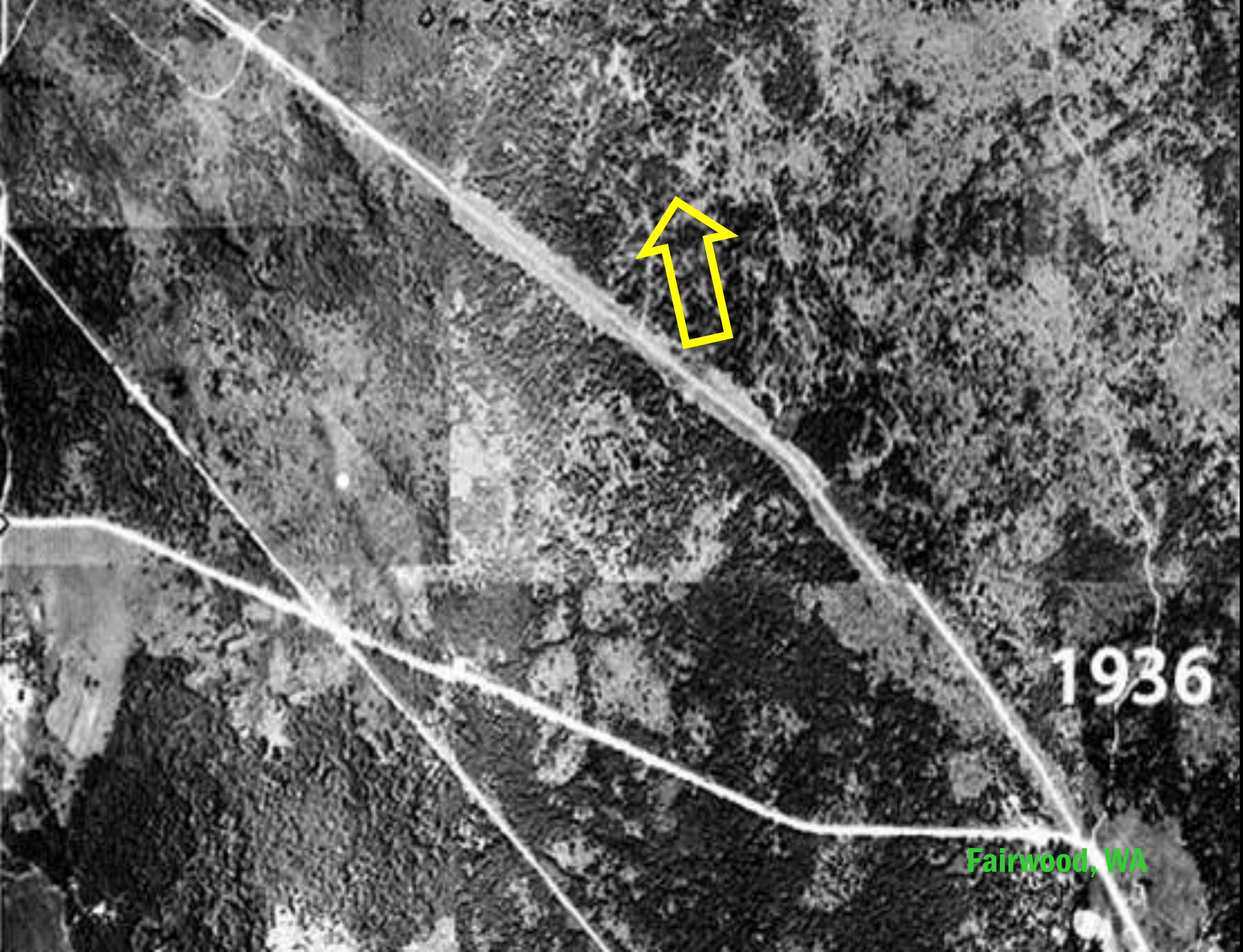
Uvas Creek, Gilroy, CA

From Kondolf et al. 2001



Autumn
1989

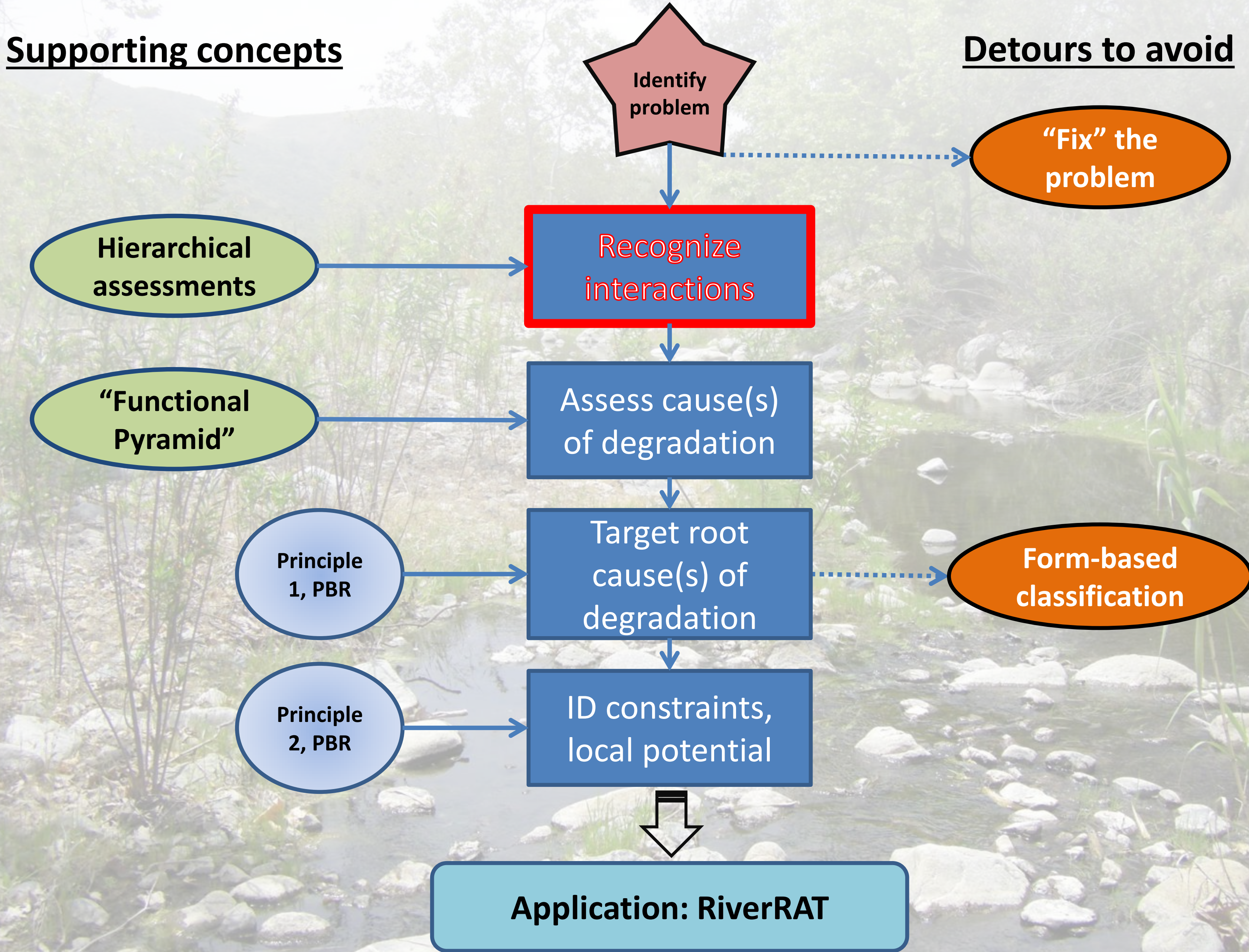
Winter
1990


1936
Fairwood, WA

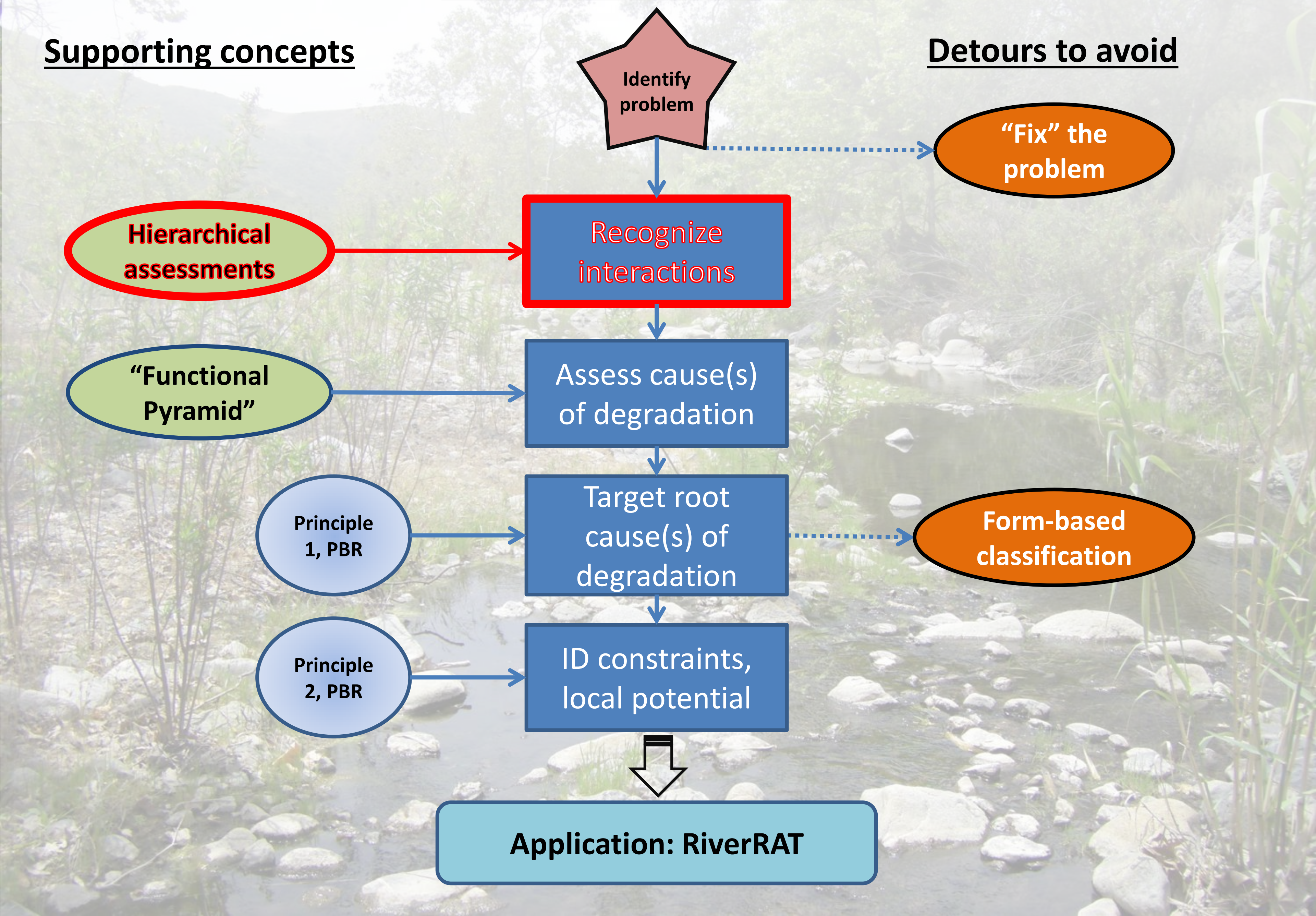

1970

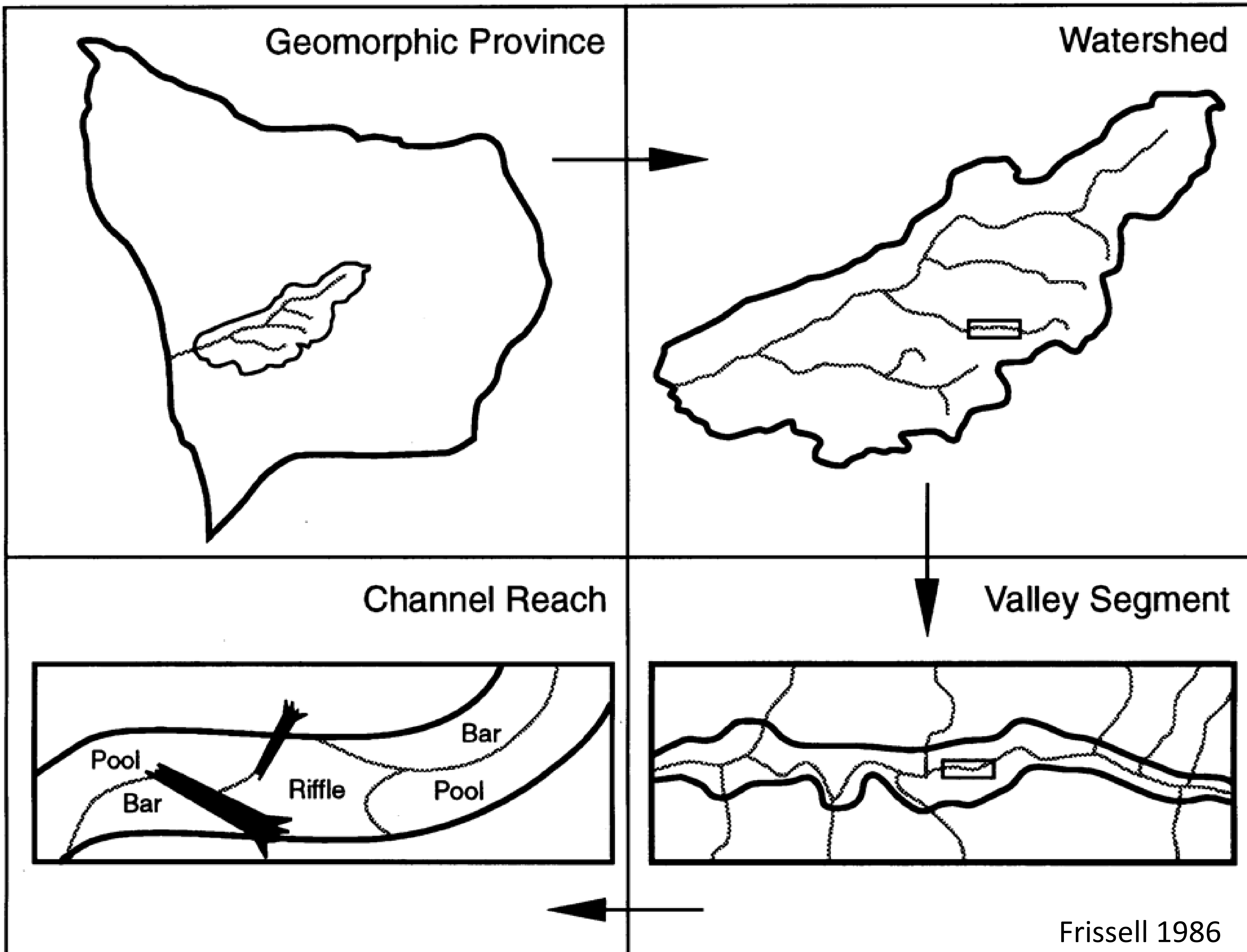

1996

Major assessment steps



Major assessment steps

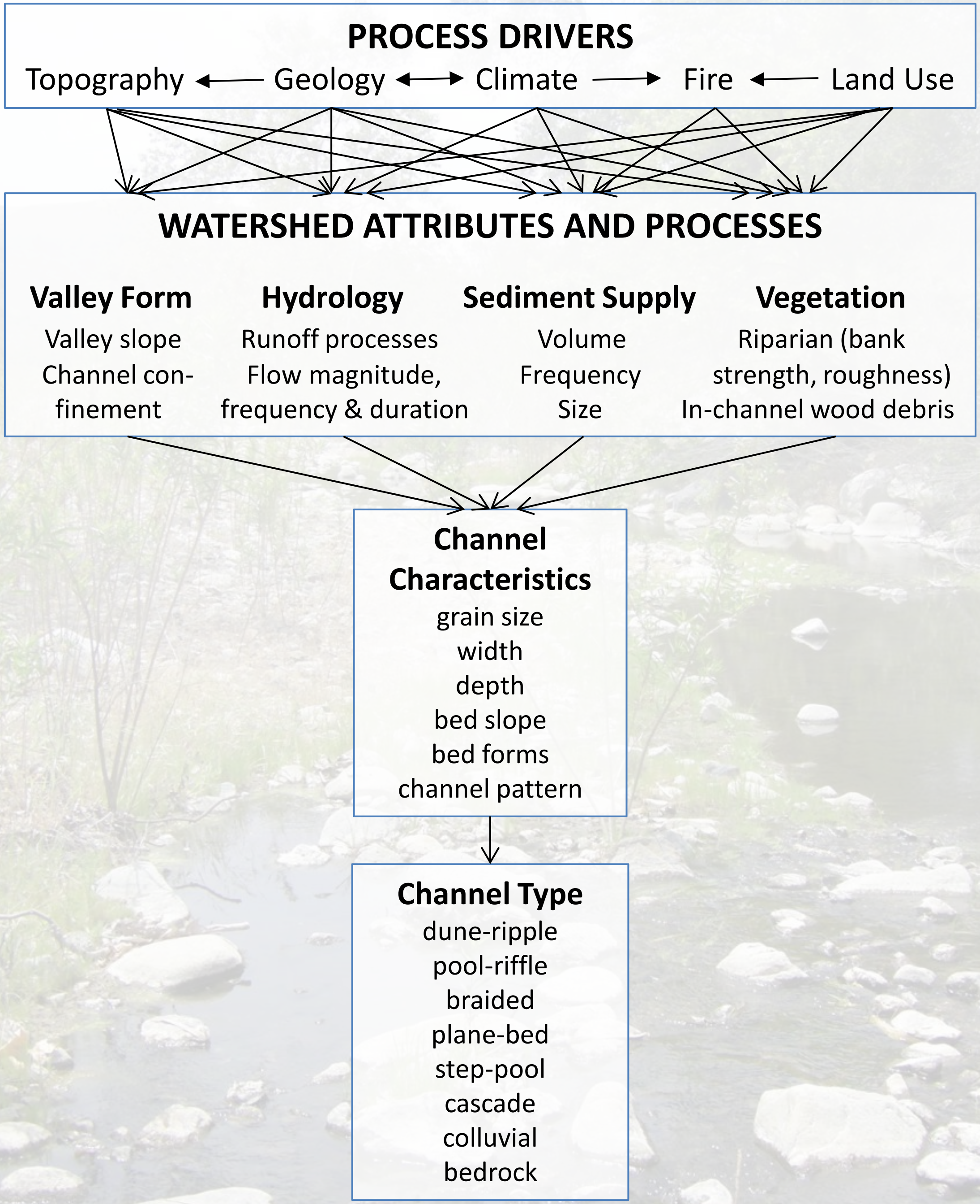




Geomorphic Province
Watershed
Channel Reach
Valley Segment
Pool
Bar
Bar
Riffle
Pool
Frissell 1986

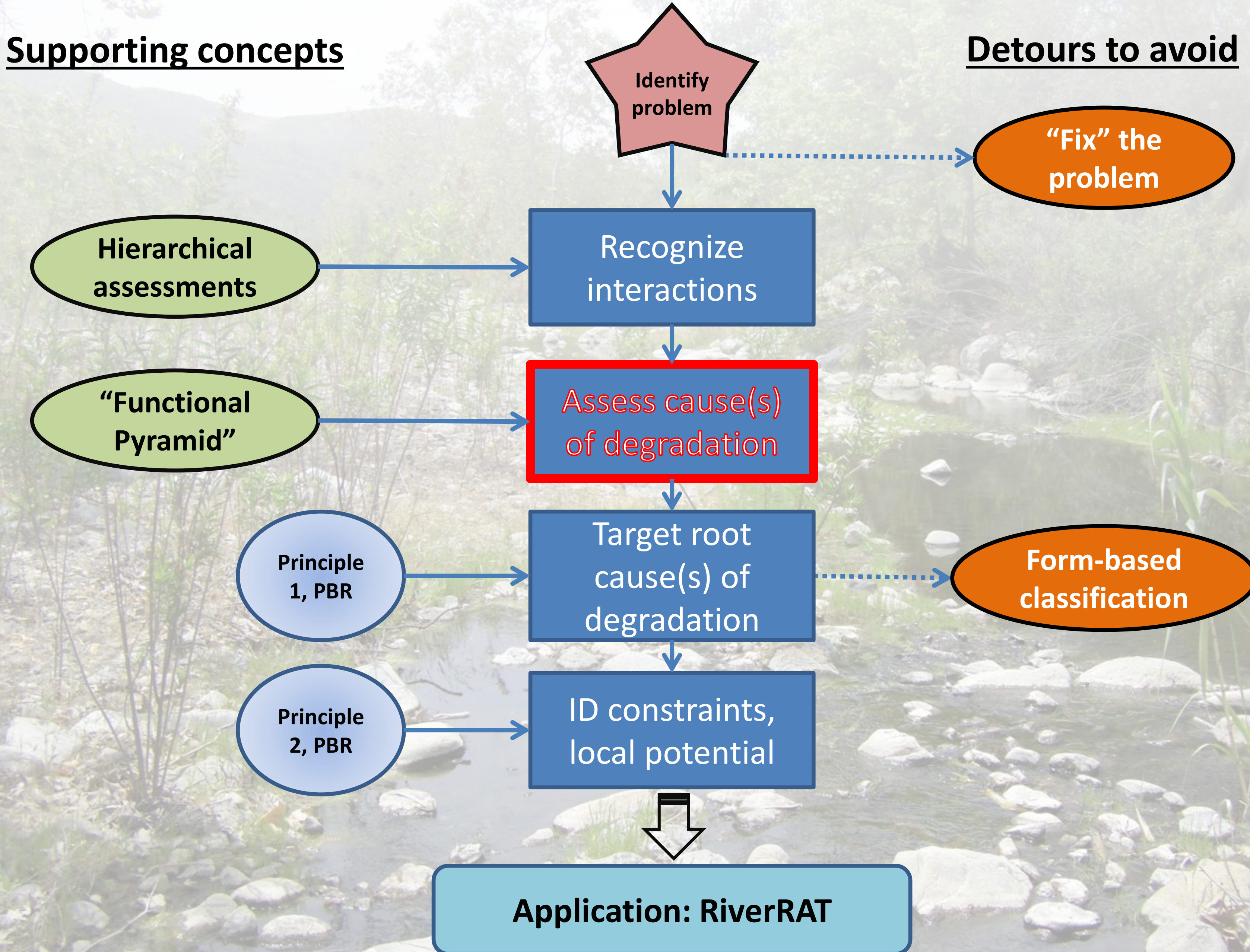
Classification Level	Spatial Scale
Geomorphic Province	1000 km^2
Watershed	50-500 km^2
Valley Segment	10^2 - 10^4 m
Colluvial Valleys	
Bedrock Valleys	
Alluvial Valleys	
Channel Reaches	10^1 - 10^3 m
Colluvial Reaches	
Bedrock Reaches	
Free-formed Alluvial Reaches	
Cascade Reaches	
Step-Pool Reaches	
Plane-Bed Reaches	
Pool-Riffle Reaches	
Dune-Ripple Reaches	
Forced Alluvial Reaches	
Forced Step-Pool	
Forced Pool-Riffle	
Channel Units	10^0 - 10^1 m
Pools	
Bars	
Shallows	

Frissell 1986



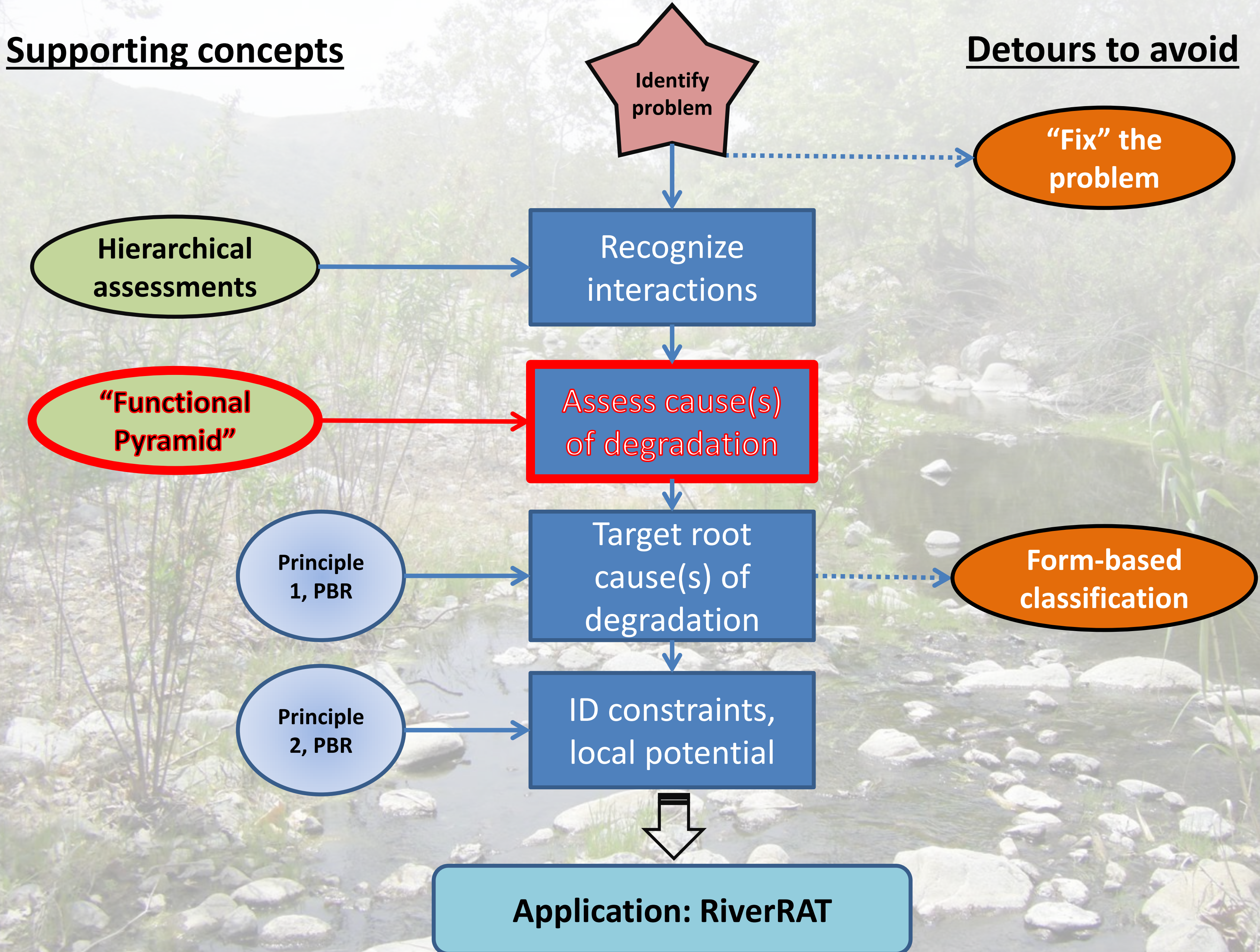
Modified from Buffington et al. 2003

Major assessment steps




Juanita Creek Watershed
Juanita Creek

Major assessment steps



Stream Functions Pyramid

A Guide for Assessing & Restoring Stream Functions » OVERVIEW

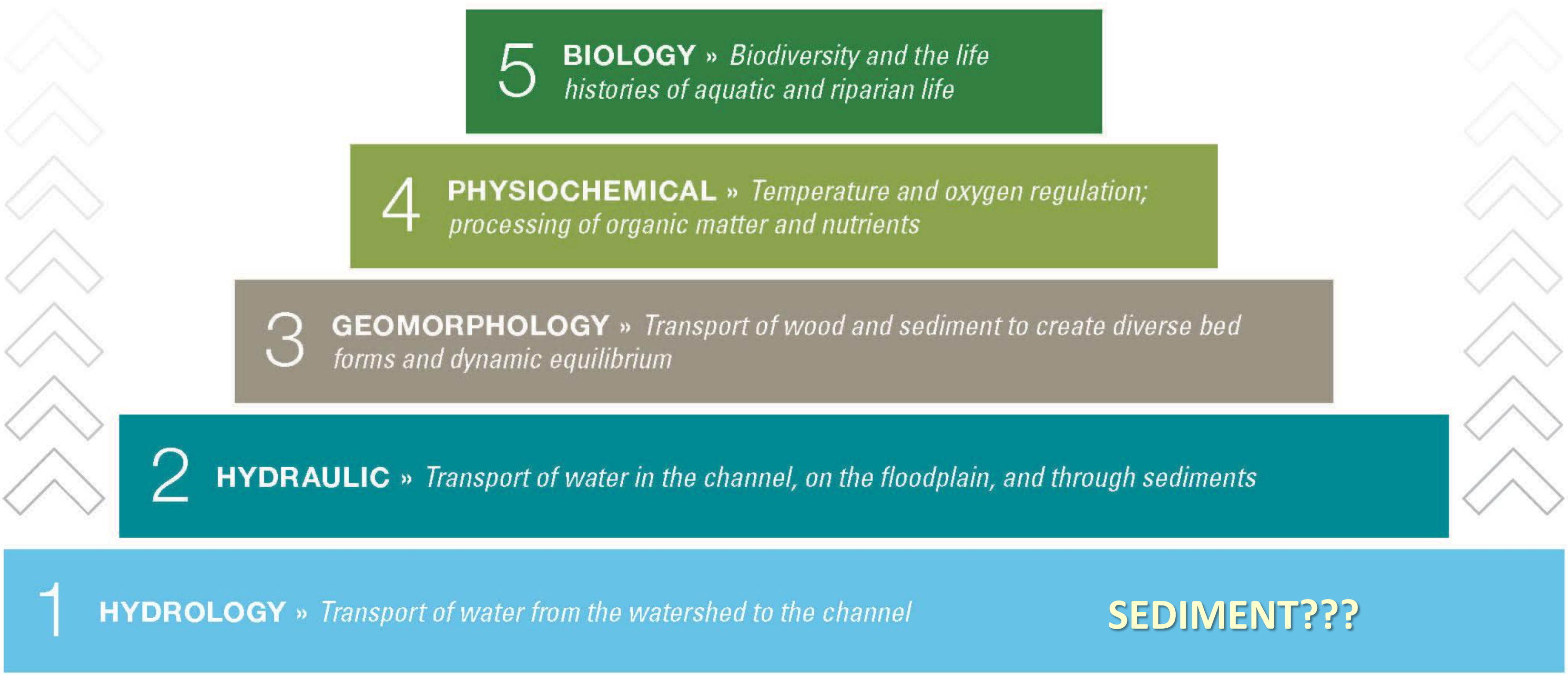


FIGURE 1

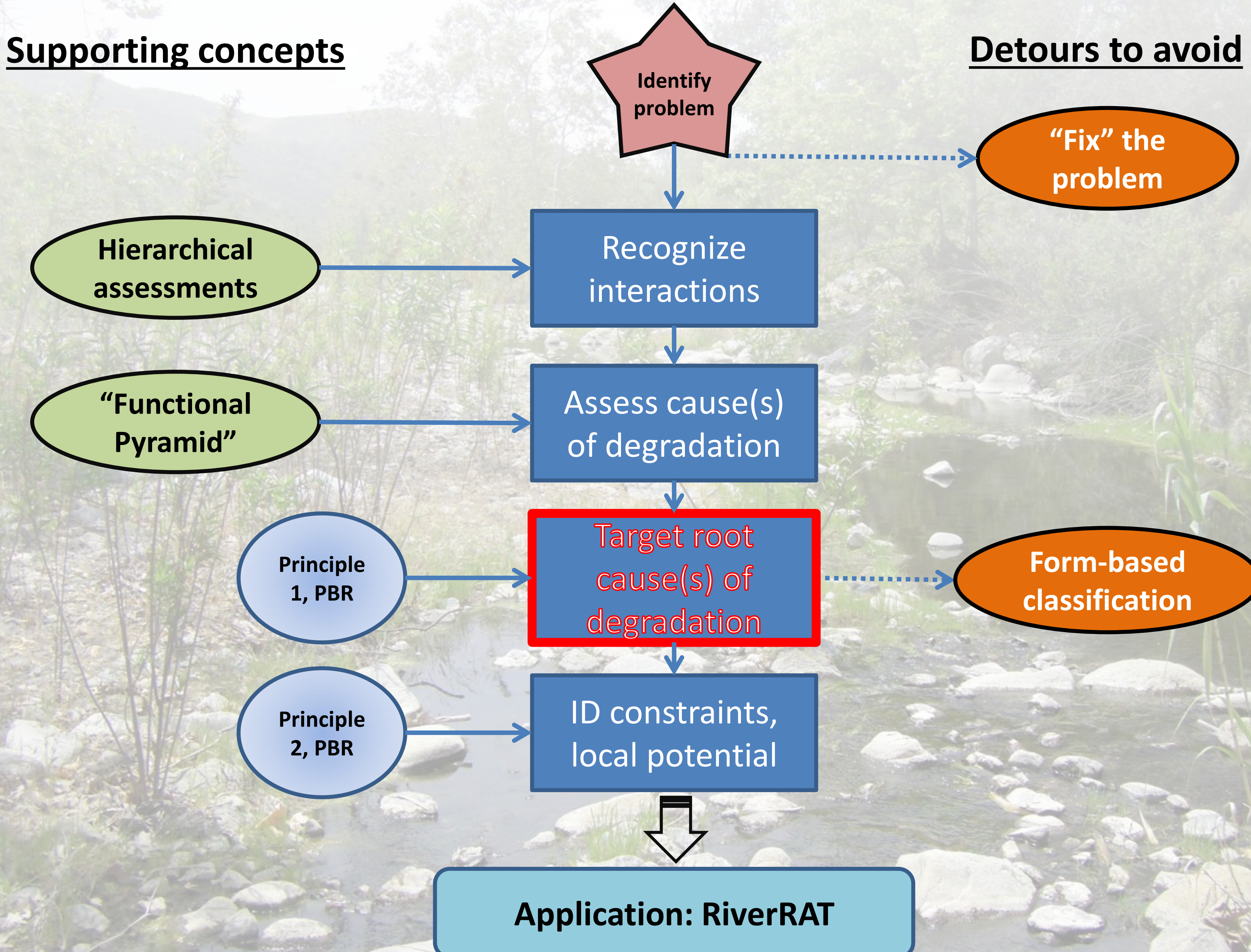
http://water.epa.gov/lawsregs/guidance/wetlands/upload/A_Function-Based_Framework-2.pdf

A Function-Based Framework

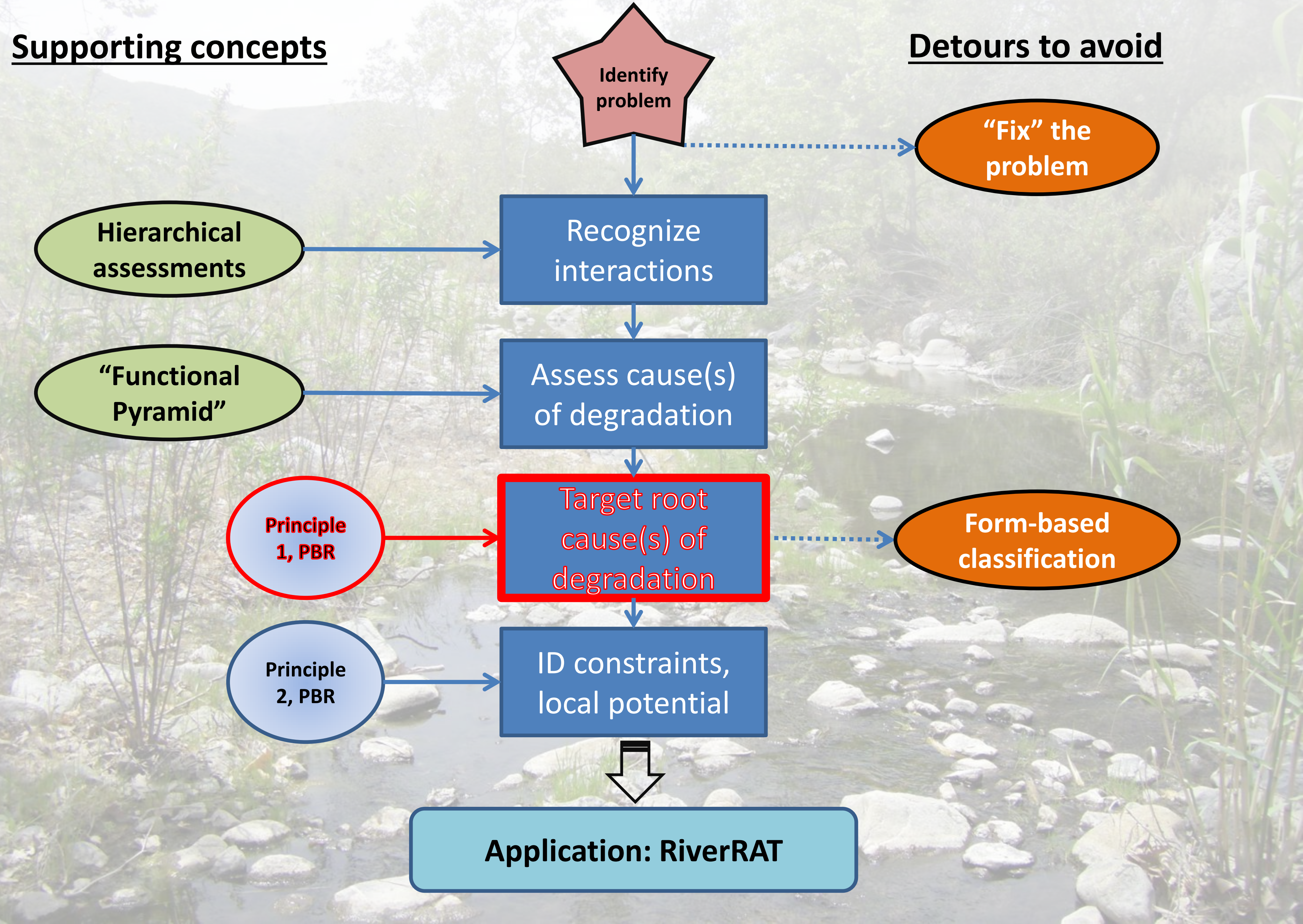
for Stream Assessment & Restoration Projects

EPA 843-K-12-006 » **May 2012**

Major assessment steps



Major assessment steps



Beechie et al. 2010, Process-Based Restoration

Principle 1: Target the root causes of habitat and ecosystem change.

For example….

SYMPTOM → RESPONSE (*not* "process-based restoration")

Few pools → build LWD structures

Eroding banks → armor the bank

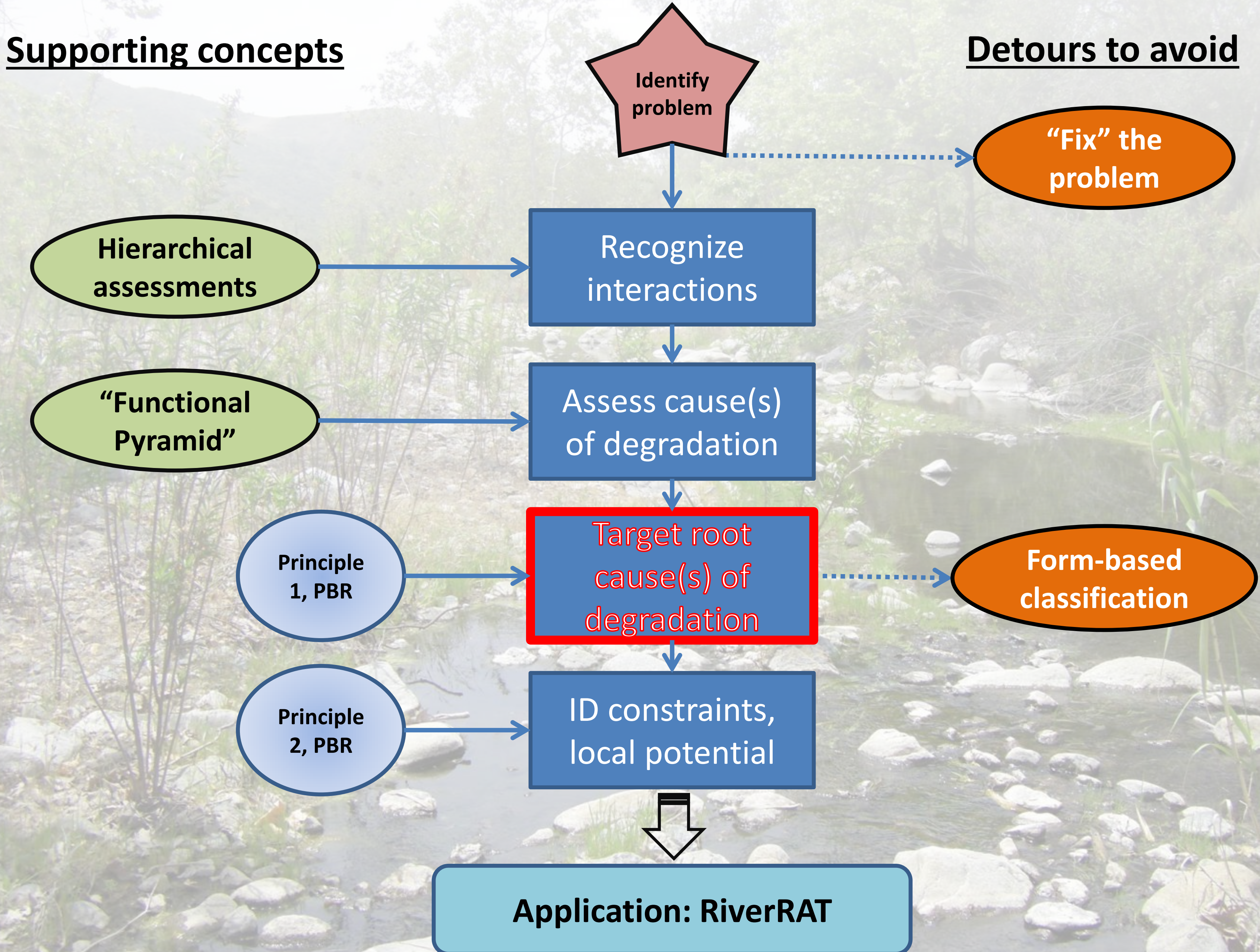
Instead, consider:

CAUSE → SYMPTOM → RESPONSE

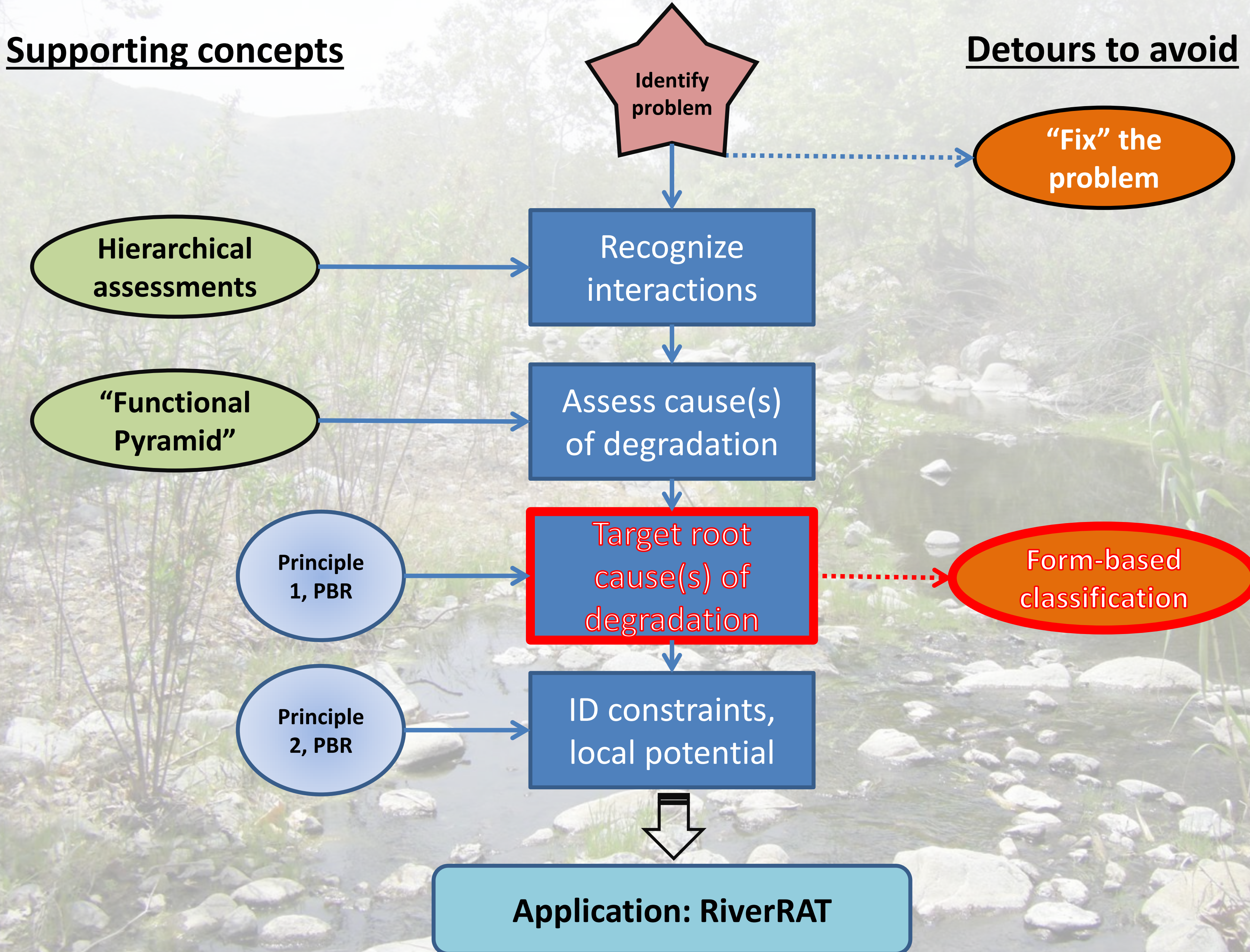
High sediment loads → few pools → reduce sediment inputs

Levee confinement → eroding banks → setbacks, riparian zone

Major assessment steps



Major assessment steps



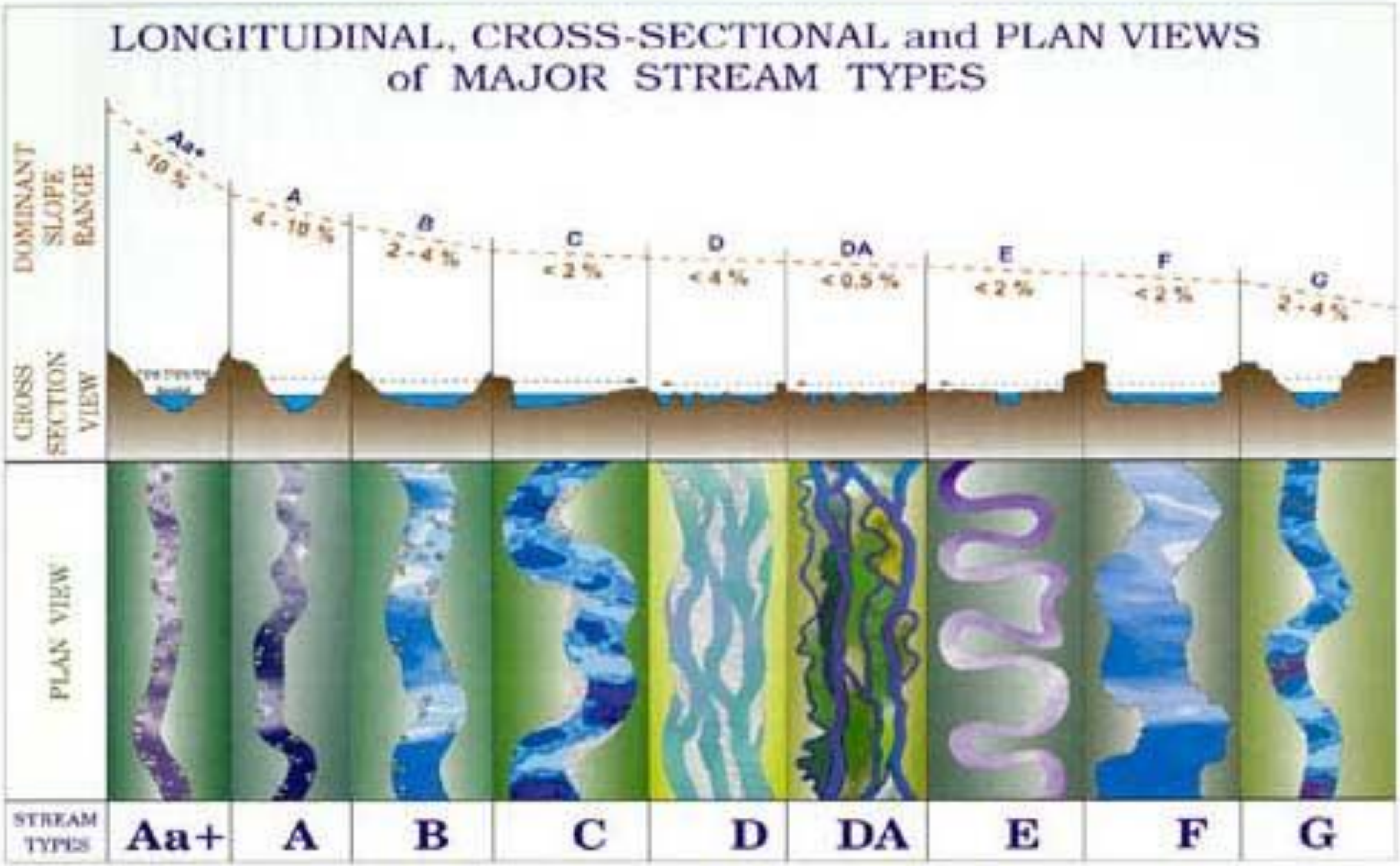
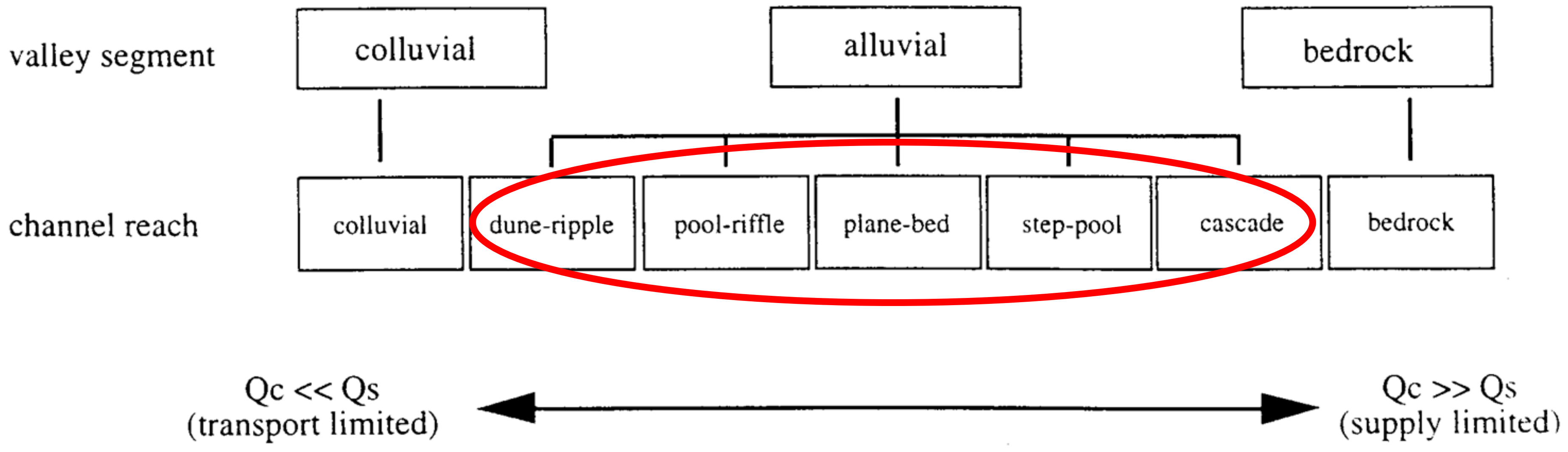
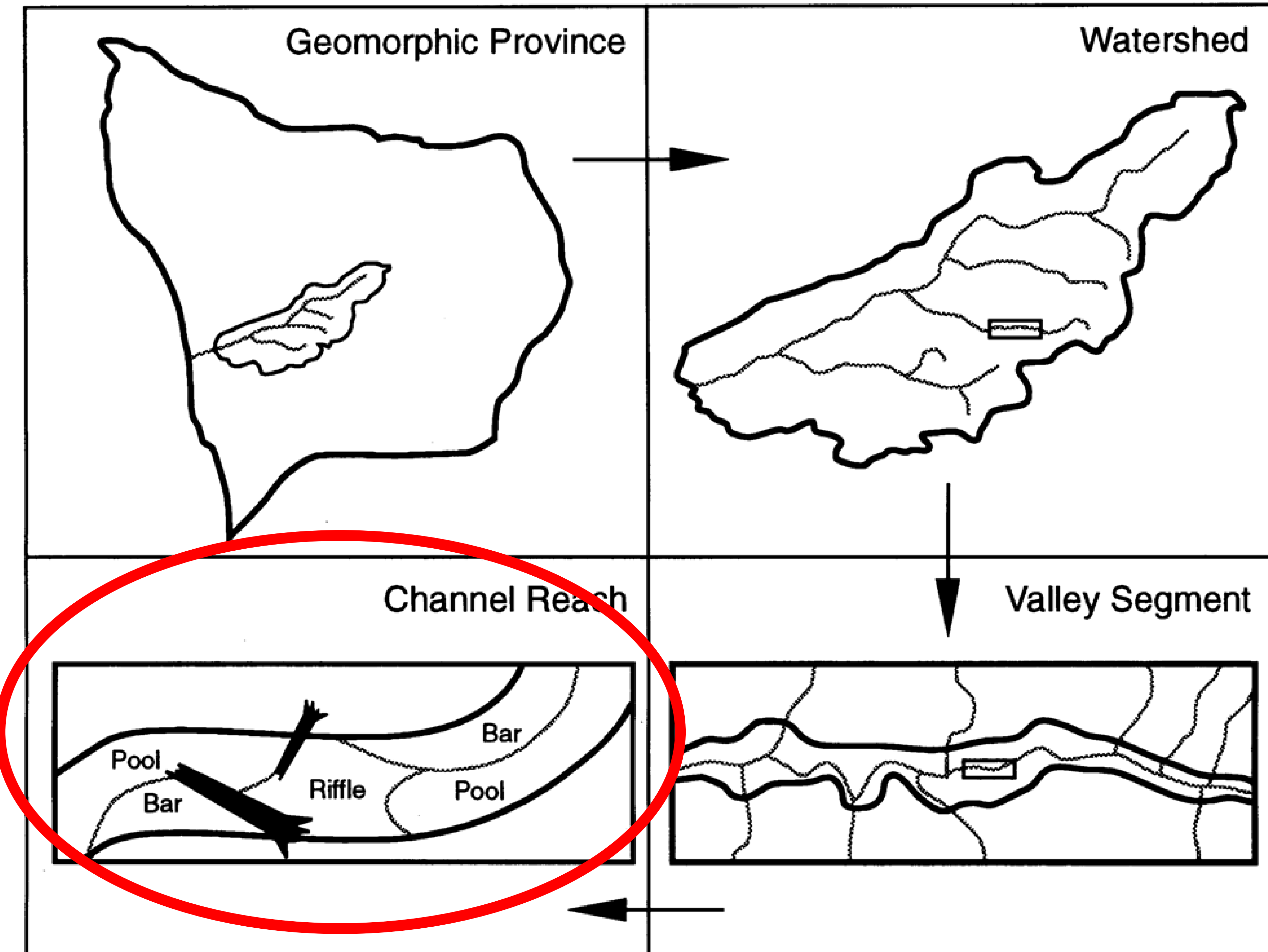
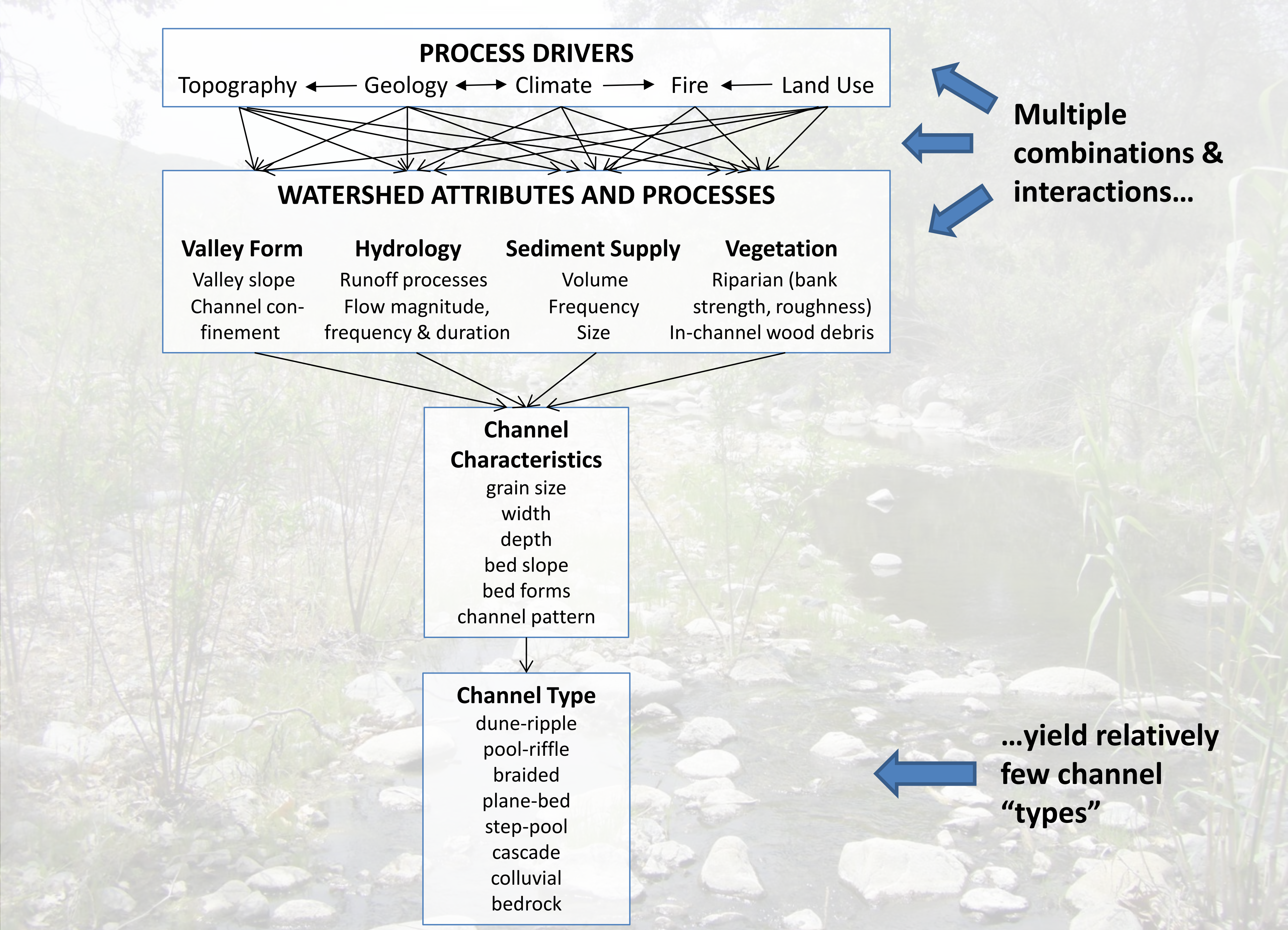


FIGURE 2. Broad level stream classification delineation showing longitudinal, cross-sectional and plan views of major stream types. (from Rosgen, 1994)



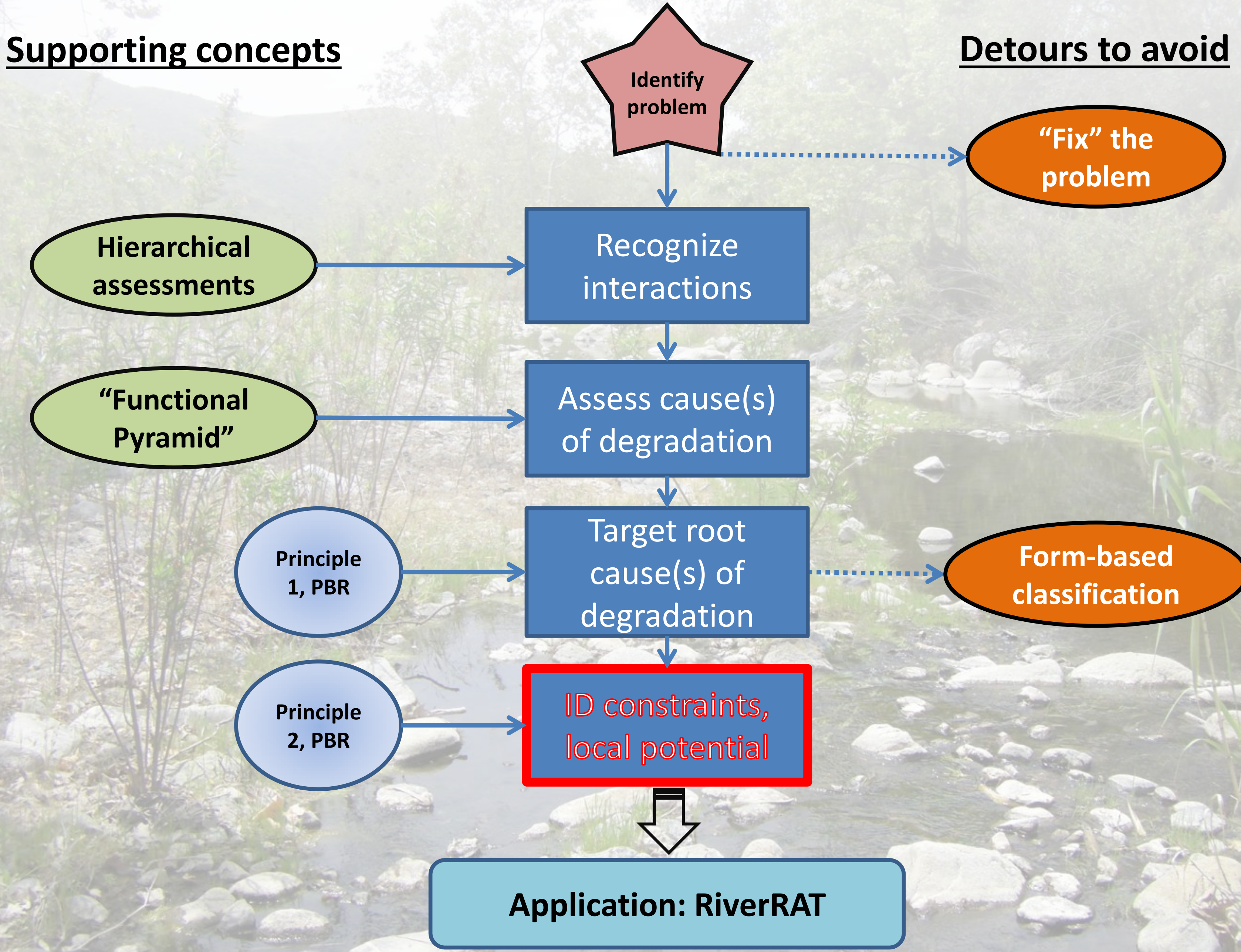
Montgomery and Buffington 1997


Geomorphic Province
Watershed
Channel Reach
Valley Segment
Pool
Bar
Riffle
Bar
Pool

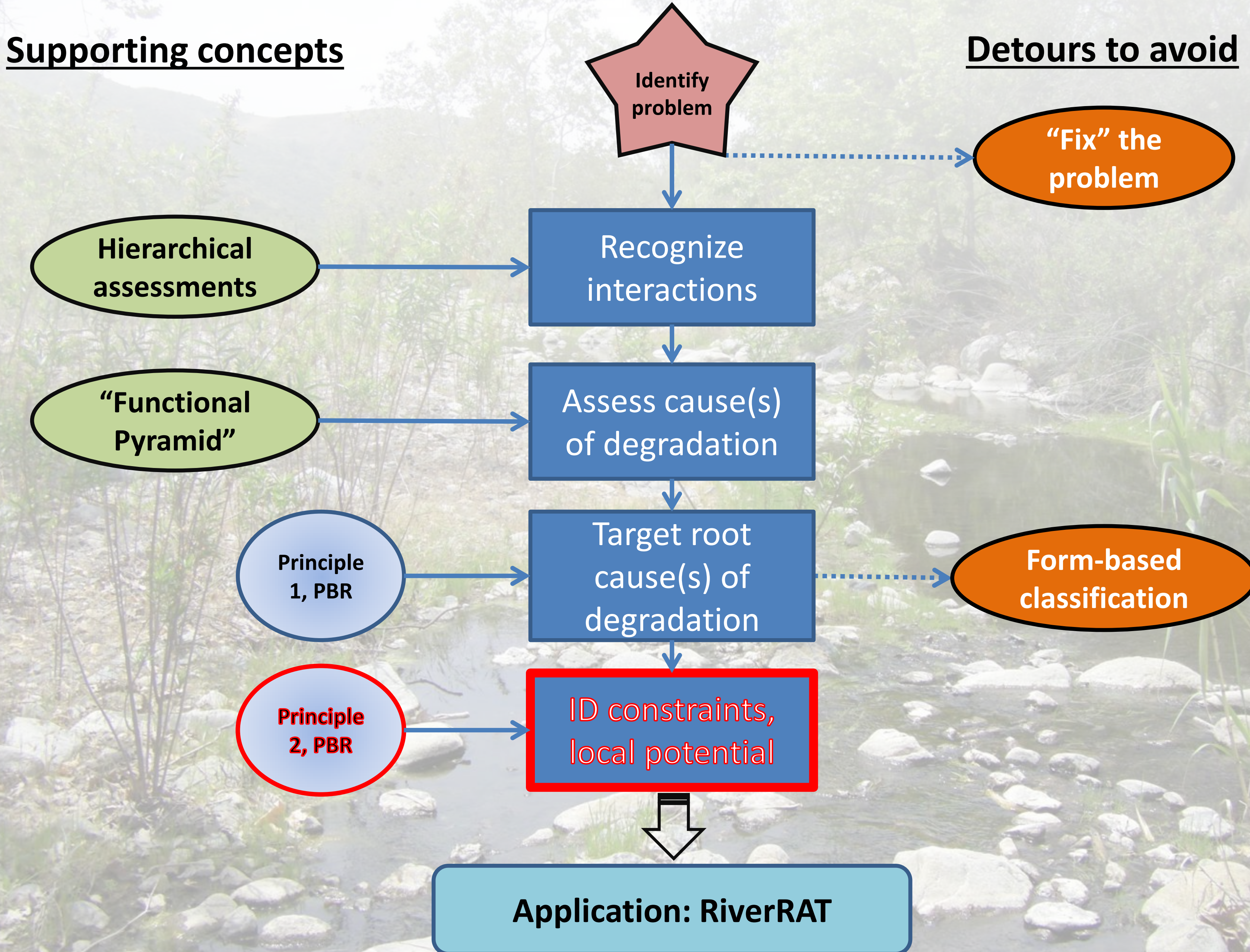


Modified from Buffington et al. 2003

Major assessment steps



Major assessment steps



Beechie et al. 2010, Process-Based Restoration

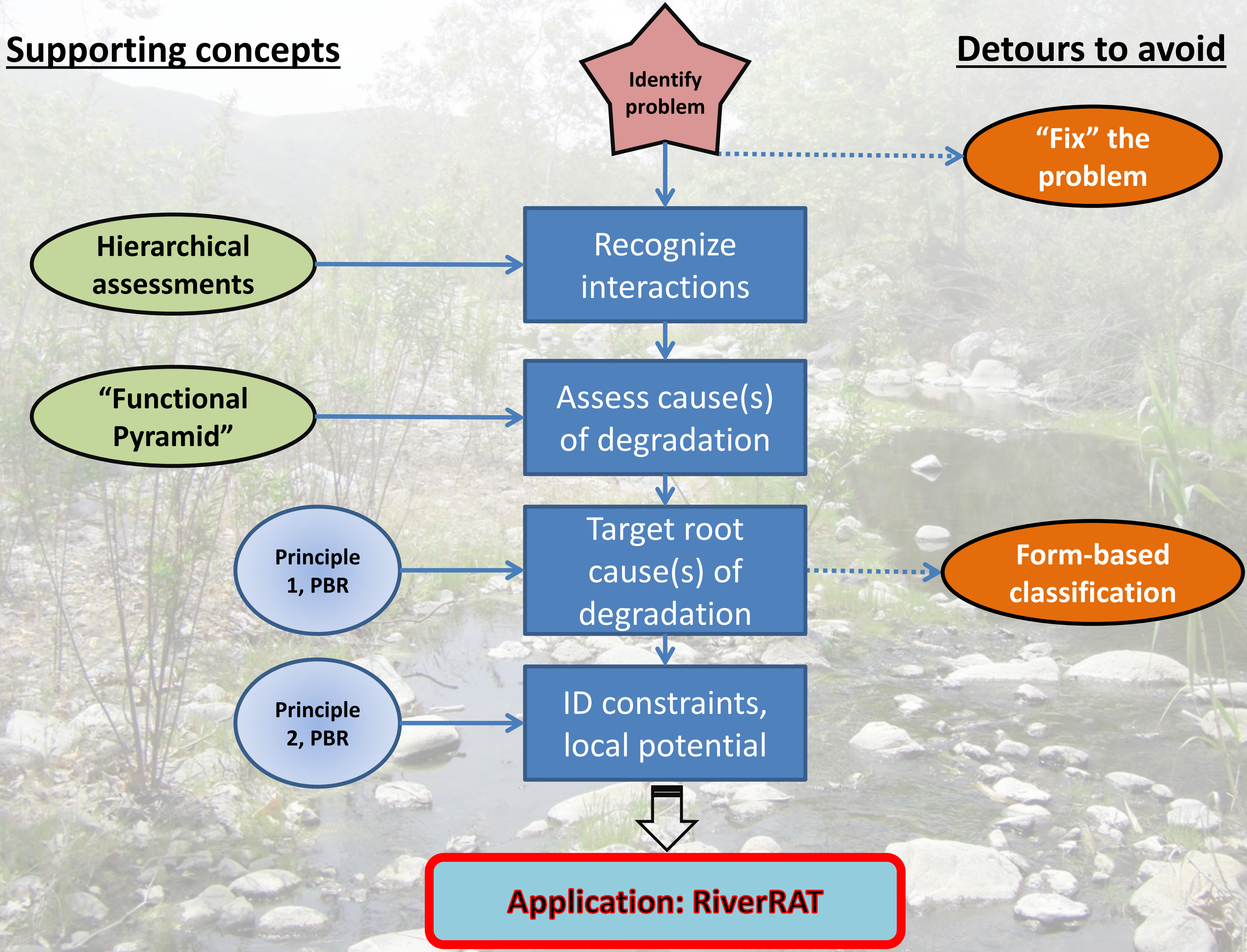
Principle 2: Tailor restoration actions to local potential.

“Restoration designs and techniques should be tailored to local physical and biological potential, which are controlled by processes operating at regional, watershed, reach, and site scales…Restoration targets consistent with natural potential can be identified through historical analysis and by **assessing disruptions to the primary driving processes**.”

So—assessments to support restoration need to address:

- Processes at multiple scales
- Historical conditions
- Disruptors of processes

Major assessment steps



RiverRAT

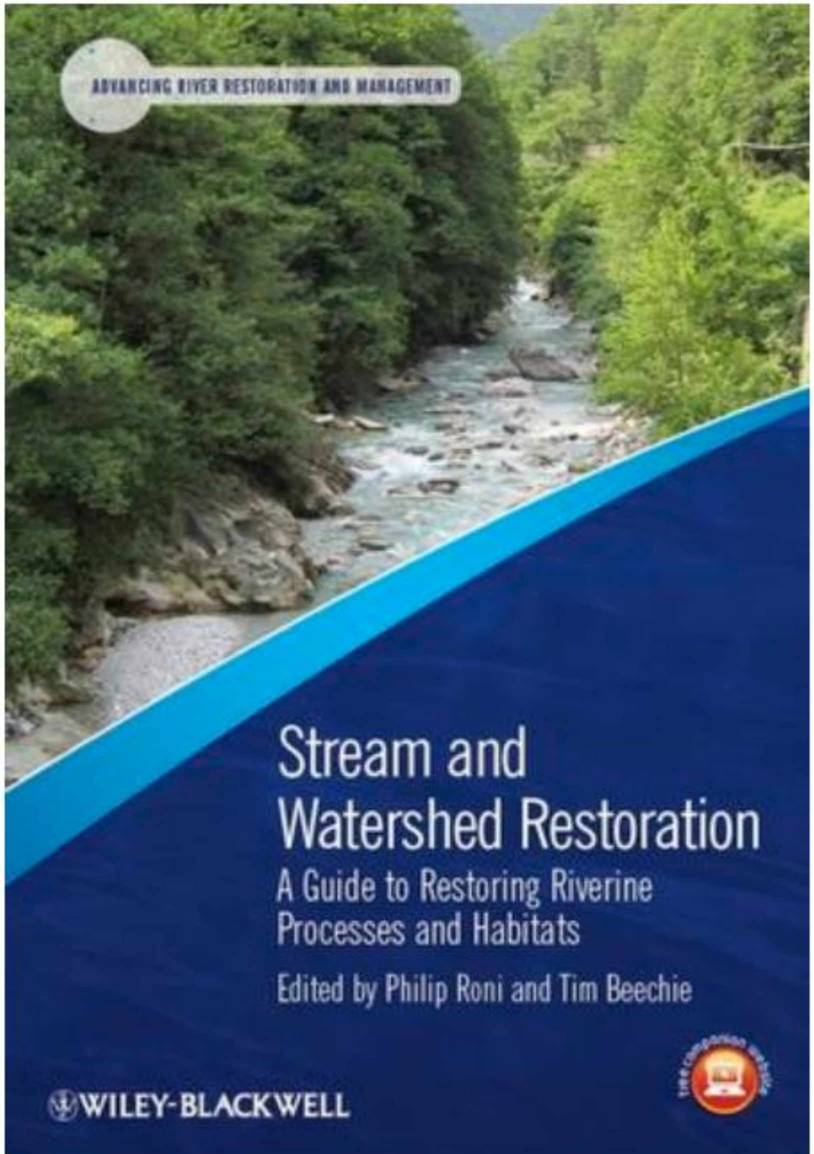
www.restorationreview.com

NMFS-SWR
Habitat Conservation Division

NOAA Fisheries
National Marine Fisheries Service
Northwest Fisheries Science Center

U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

OTHER RESOURCES:



Stream and Watershed Restoration: A Guide to Restoring Riverine Processes and Habitats

OTHER RESOURCES:

PIBO-EMP

PACFISH INFISH BIOLOGICAL OPINION EFFECTIVENESS MONITORING PROGRAM for STREAMS and RIPARIAN AREAS

2011 SAMPLING PROTOCOL for STREAM CHANNEL ATTRIBUTES

2011 SAMPLING PROTOCOL FOR STREAM CHANNEL ATTRIBUTES

By

PACFISH/INFISH Biological Opinion Effectiveness Monitoring Program (PIBO-EMP) Staff
Multi-federal Agency Monitoring Program;
Logan, UT

Heitke, Jeremiah D.; Archer, Eric K.; Leary, Ryan J.; and Roper, Brett B. 2011. Effectiveness monitoring for streams and riparian areas: sampling protocol for stream channel attributes. Unpublished paper on file at: http://www.fs.fed.us/biology/fishecology/emp.

For Information about PIBO Effectiveness Monitoring, contact Eric Archer, telephone: 435 755-3565.

ACKNOWLEDGEMENTS

The authors wish to thank everyone who helped develop this sampling protocol. We especially appreciate the critical input from hundreds of summer technicians and staff members who were invaluable in refining, clarifying, and evaluating the methods. We thank Ann Carlson, Tim Burton, Charles Hawkins, Phil Kaufman, Kerry Overton, David Peck, John Potyondy, Gordy Reeves, Jack Schmidt, Rick Henderson, Jeff Kershner and many others for their advice and review of the various drafts. We also thank Kate Dircksen, Emily Hall, Deanna Vinson and Jeremiah Heitke for their artistic diagrams. Thanks to the U.S. Forest Service (FS) Regions 1, 4, and 6 and the Idaho and Oregon/Washington State Offices of the Bureau of Land Management (BLM). Finally, we thank the Aquatic and Riparian Effectiveness Monitoring Program (AREMP) who we have cooperated with to standardize a core set of sampling methods.

OTHER RESOURCES:

http://www.stream.fs.fed.us/publications/PDFs/RM245E.PDF

United States Department of Agriculture

Forest Service

Rocky Mountain Research Station

General Technical Report RM-245

Stream Channel Reference Sites:

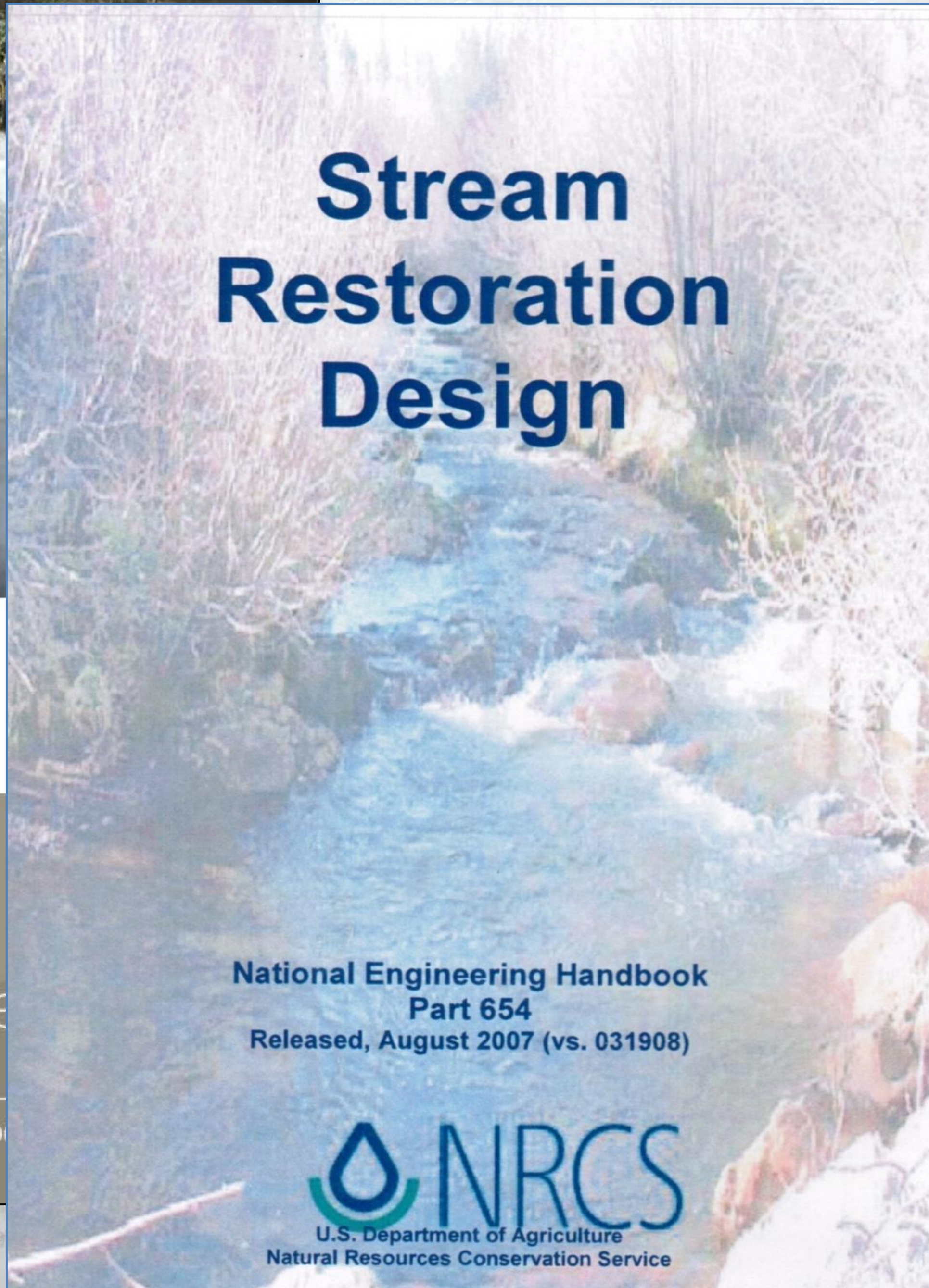
An Illustrated Guide to Field Technique

Cheryl C. Harrelson

C. L. Rawlins

John P. Potyondy

OTHER RESOURCES:



Technical Supplement 3A

Stream Corridor Inventory and Assessment Techniques

Table TS3A–1 Attributes of stream corridor assessment techniques

Column notes listed below >	1	2	3	4	5	6
Technique (to obtain a technique's citation and summary, turn to the page number listed in parentheses)	Primary setting (listed first)	Sampling intensity	Skill level, training, time	Kind, measure type, proximity	Reference site needed	Suitability for monitoring
Applied River Morphology. Wildland Hydrology Consultants. D. Rosgen. 1996. Pagosa Springs, CO (14)	C	D	H–H–H	I/A–N–O	Y	M
Channel-Reach Morphology in Mountain Drainage Basins. Geological Society of America Bulletin.	C	C	M–M–M	I–L–O	O	M/H
D.R. Montgomery and J.M. Buffington. 1997 University of Washington, Seattle, WA (14)	C	C	M–M–L	I–L–O	N	M
Incised Channels–Morphology, Dynamics, and Control. S.A. Schumm, M.D. Harvey, and C.C. Watson. 1984. Littleton,	C, R, A	D	M–M–L	I/A–L/N–O	N	M
CO (16)	C, R, W, A	C	M–M–L	A–L–O	Y	L
Procedures for Using Oregon Stream Habitat Data Sheet. USDA NRCS. 1988. Portland, OR (19)						
Rapid Stream Assessment Protocol (RSAT)	C, R, W	C	L–L–L	A–L–O	N	L
Field Methods–Appendix A. J.Galli, Sr. 1996. Metro. Washington Council of Governments, Washington, DC (21)	C	D	H–H–H	I–N–O	Y	M
Stream*A*Syst. Oregon State University, Extension Service. 2000. Corvallis, OR (30)	C, R, A	C	M–L–L	I/A–L–O	N	L
Stream Channel Reference Sites: An Illustrated Guide to Field Technique. USDA	C, R, A	D	M–M–H	I–N–O	O	H
Forest Service. 1997. Fort Collins, CO (26)	C, R, A, W	D	M–M–M	I/A–L/N–O	Y	M/H
Stream Corridor Assessment Survey. KYetman, MD Dept. of Natural Resources. 2000. Annapolis, MD (26)	C, R, W, A	C	L–L–L	A–L–O	N	L
Stream Inventory Handbook–Level I and II. USDA Forest Service. 1996. Version 9.6. Portland, OR (27)						
Streamkeeper's Field Guide–Watershed Inventory and Stream Monitoring Methods. The Adopt-A-Stream						

Table TS3A–1 Attributes of stream corridor assessment techniques—Continued

Column notes listed below >	1	2	3	4	5	6
Technique (to obtain a technique's citation and summary, turn to the page number listed in parentheses)	Primary setting (listed first)	Sampling intensity	Skill level, training, time	Kind, measure type, proximity	Reference site needed	Suitability for monitoring
Primary setting—Riparian area						
Guidebook for Application of Hydrogeomorphic Assessments to Riverine Wetlands. U.S. Army Corps of Engineers, Waterways Exp. Station. 1995. Washington, DC (15)	R	D	H–H–H	A–L/N–O	Y	M
Integrated Riparian Evaluation Guide. USDA Forest Service. 1992. Ogden, UT (Level I) (Level II) (Level III) (16)	R, C, A R, C, A R, A	C D D	M–M–L H–H–M H–H–H	I–L–R I/A–N–O I/A–N–O	N N	L H
Methods for Evaluating Riparian Habi- tats with Applications to Management. USDA Forest Service. 1987. Ogden, UT (17)	R, C	D	H–H–H	A–N–O		
National Forestry Manual: National Range and Pasture Handbook (Procedures for completing Vegetation Field Forms and Ecological Sites). USDA NRCS. 1997, 1998. Washington, DC (18)	R	D	M–H–H	I–N–O	Y	M
Preliminary Investigation (PI) for Stream Riparian Areas. USDA NRCS, Watershed Science Institute. 1996. Seattle, WA (18)	R, C, A, W	C	M–M–L	I–L/N–O	N	L
Protocols for Classifying, Monitoring Evaluating Stream Riparian Vegetation on Idaho Rangeland Streams. Division of Environmental Quality. 1992. Boise, ID (19)	R and	D	H–H–H	I–N–O	N	H
Rapid Assessment of Riparian Systems (RARS). R.D. Ohmart, et al. 1998. Arizona Game and Fish Department, Phoenix, AZ (20)	R, C	D	M–H–H	A–N–O/R	Y	M
Riparian Area Management: A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas. DOI Bureau of Land Management. 1998. Denver, CO (22)	R, C	C	M–L–L	A–L–O	Y	L
Riparian Area Management—Greenline Riparian—Wetland Monitoring. DOI Bureau of Land Management. 1993. Denver, CO (22)	R	D	M–M–M	I–N–O	N	H

Table TS3A–1 Attributes of stream corridor assessment techniques—Continued

Column notes listed below > Technique (to obtain a technique's citation and summary, turn to the page number listed in parentheses)	1 Primary setting (listed first)	2 Sampling intensity	3 Skill level, training, time	4 Kind, measure type, proximity	5 Reference site needed	6 Suitability for monitoring
Riparian Area Management—Inventory and Monitoring of Riparian Areas. DOI Bureau of Land Management. 1989.	R	D	M/L–H/M/L–H/M/L	I–N–O	N	H
Denver, CO (23)		D	H–H–H	I–N–O	N	H
Riparian Area Management—Procedures R, C for Ecological Site Inventory. DOI Bureau of Land Management. 1992. Denver, CO (23)		C	M–M–L	A–L–R	Y	L
Riparian Reserve Evaluation Techniques R and Synthesis in Ecosystem Analysis at the Watershed Scale—Federal Guide for Watershed Analysis, Section II. Multiagency. 1995. Portland, OR (24)		D	H–M–H	A–L–O/R	N	M
Role of GIS in Selecting Sites for Riparian R Restoration Based on Hydrology and Land Use. Utah State University. 1997. Logan, UT (25)		C	H–M–L	I/A–N–R	Y	M
		C	M–M–L	A–L–O	N	M
RWRP Lotic Health Assessment. University R, C of Montana. 1999. Missoula, MT (25)	R, C	D	H–M–M	I–L/N–O	N	L
Adopt-A-Stream Shoreline Survey. Massachusetts Riverways Programs. 1996. Boston, MA (13)	C	L–M–M	I/A–L–O	N	L	
Agricultural Water Quality Index. Robert B. Annis Water Resources Institute, Grand Valley State University. 1998. Allendale, MI (13)	W,C,R,A	C	M–M–M	A–L–O	N	L
Monitoring Protocols to Evaluate Water Quality Effects of Grazing Management on Western Rangeland Streams. U.S. Environmental Protection Agency. 1993. Seattle, WA (17)	W, A, C, R	D	M–H–H	A–N–O	Y	H

Table TS3A–1 Attributes of stream corridor assessment techniques—Continued

Column notes listed below >	1	2	3	4	5	6
Technique (to obtain a technique's citation and summary, turn to the page number listed in parentheses)	Primary setting (listed first)	Sampling intensity	Skill level, training, time	Kind, measure type, proximity	Reference site needed	Suitability for monitoring
Primary setting—Water quality—Continued						
Stream Temperature Investigations: Field and Analytic Methods (for use with SNTEMP: Stream Network Temperature Model). U.S. Fish and Wildlife Service. 1989. Fort Collins, CO (28)	W (temperature)	D	H–M–M	I–N–O	N	H
Water Quality Indicators Guide—Surface Water (chapter 2 and appendices A and F). Terrene Institute. 1996. Washington, DC (30)	W	C	M–M–M	A–L–O	N	L

Column notes:

1 Primary Setting (listed first); Channel flood plain, Riparian area, Water quality, Aquatic Sampling intensity:
2 Cursory, Detailed
3 Skill level, training, time (each rated as): High, Medium, Low
4 Kind: Inventory, Assessment, Measure type: QuaLitative, QuaNtitative; Proximity; Onsite, Remote Reference site
5 required: Yes, No, Optional
6 Suitability for monitoring: High, Medium, Low

Recall--the themes of this presentation:

1. Begin with the end in mind. Our “beginning” = assessments; our “ending” = restoration. So you can’t assess without knowing what you’re going to restore.

2. “Process-based restoration” should be our focus. Thus, assessments *also* must focus on processes, not form.

3. Processes occur across multiple scales (both spatial and temporal). Thus, assessment must be multi-scalar as well.

Recall--the themes of this presentation:

The specific choice of metrics is far less important than the **framework** that guides the their collection and their analysis.


With particular thanks to
colleagues Peter Skidmore,
Peter Downs, and
Tim Beechie