A few thoughts on riparian ecosystem restoration.....

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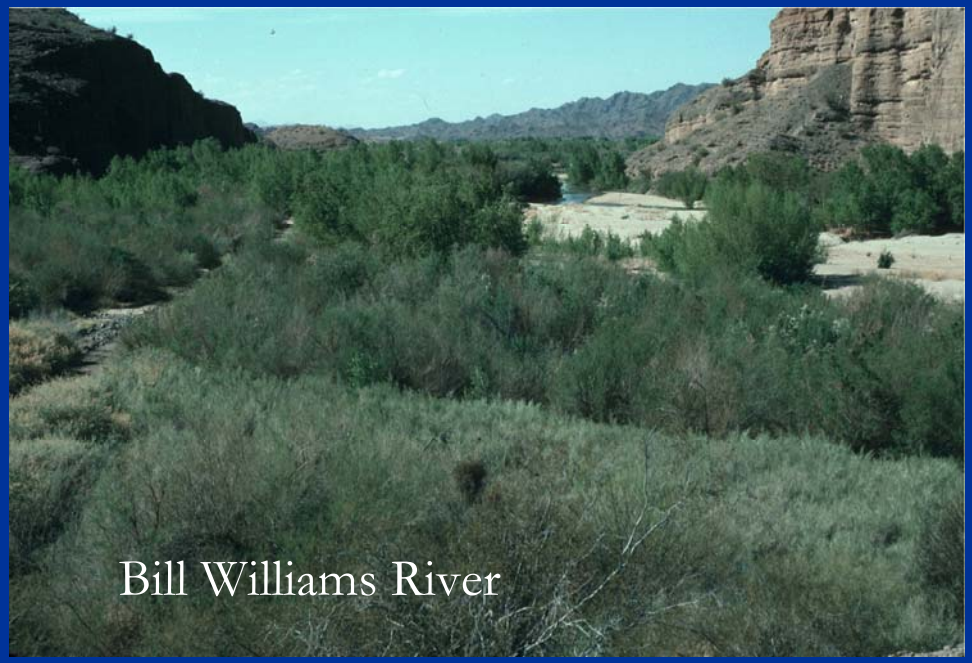
Salt River-Phoenix


Santa Cruz River
Photo from Tucson Audubon


Bill Williams River


San Pedro River

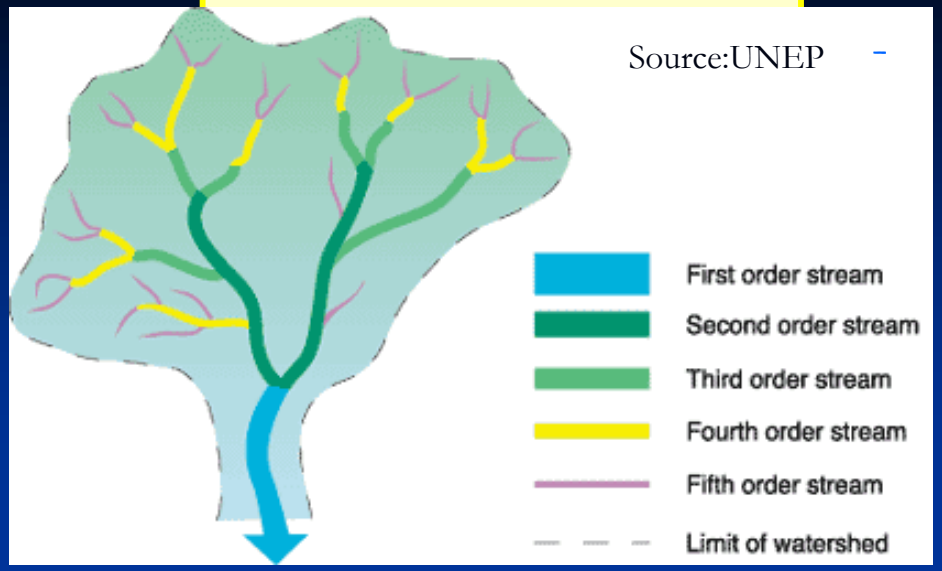
How do we measure success?

1. Ecosystem improvement, as indicated by
   a) Improved water quality, b) increased riparian vegetation abundance, c) increased population viabillity of target species, d) increase in bioassessment indices

2. Increased resilience: System should have the capacity to recover from natural disturbances such as fire, floods, drought, as indicated by
   a) Few interventions needed to maintain the site

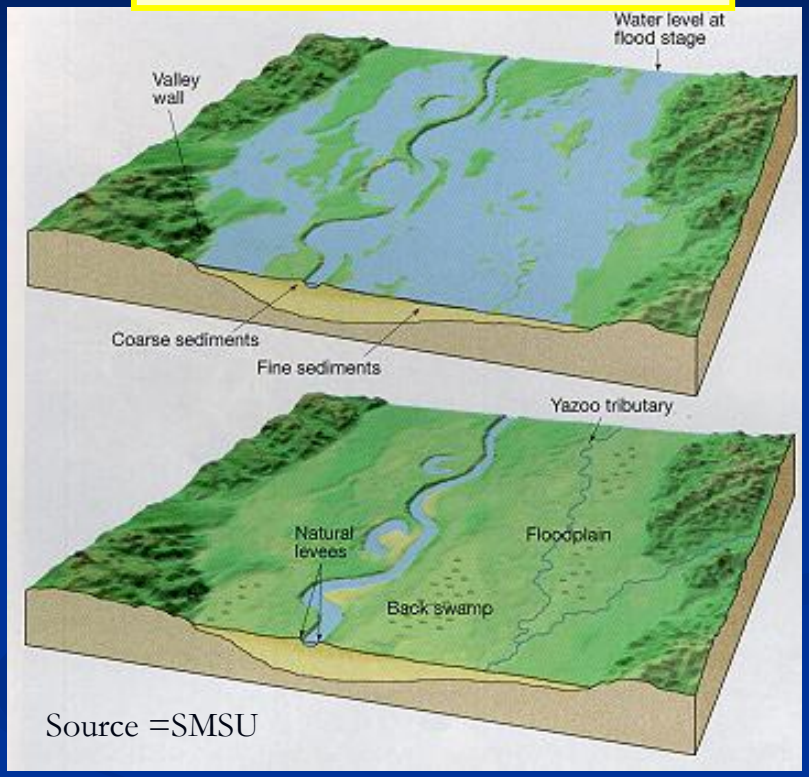
Palmer MA et al. 2005. Standards for ecologically successful river restoration. Journal of Applied Ecology.

Longitudinal connectivity:



Source:UNEP

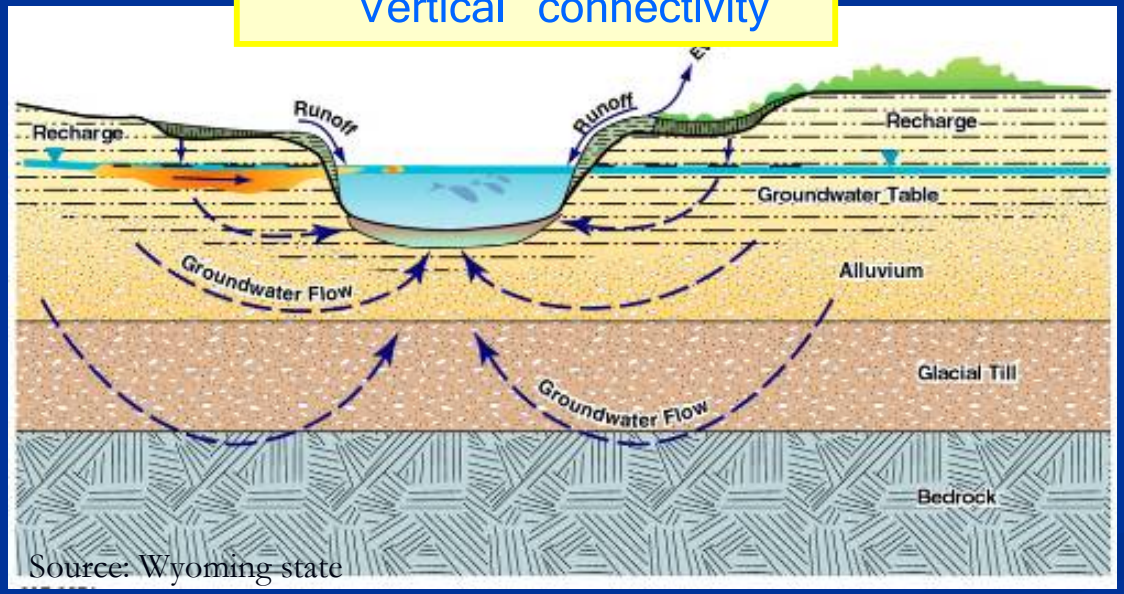
Lateral connectivity



Source =SMSU

Source=USEPA

Vertical connectivity



Source: Wyoming state

Boon PJ. 1998. River restoration in five dimensions. Aquatic Conservation- Marine and Freshwater Ecosystems 8 (1): 257-264.

We need to pay attention to the landscape in which a restoration site is embedded and ask,

Is restoration success feasible given the landscape setting?

Where and how can we re-establish connectivity within and between river sites?

What on-going interventions will be necessary, if connectivity can’t be restored?

We need to increase awareness of the connection between ecosystem function and structure; and between ecosystem process and pattern, and ask,

Where and how can we restore the fundamental processes that shape riparian ecosystems?

Small floods to wet floodplain soils, disperse seeds, trigger seedling germination, stimulate organic matter decomposition

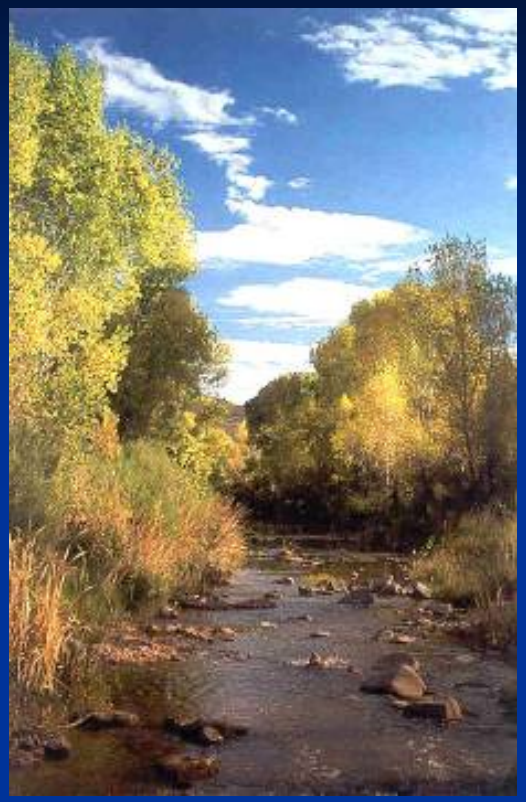
Large floods to move sediment, scour vegetation, drive patch dynamics and successional change

Surface and groundwater flows to sustain growth of channel-side plants and floodplain phreatophytes

Ward J.V., Tockner K., Uehlinger U., & Malard F. 2001 Understanding natural patterns and processes in river corridors as the basis for effective river restoration Regulated Rivers- Research and Management **17:** 311-323.

Watt, A.S. 1947. Pattern and process in the plant community. Journal of Ecology 35: 1-22.

Upstream site



San Pedro River re-watering restoration project:

The Nature Conservancy/U.S.Bureau Reclamation; purchase of ranch (6 river miles) and retirement of agriculture pumping on free-flowing river.
Restoration cost: $2.8 million, 0.2 million per mile

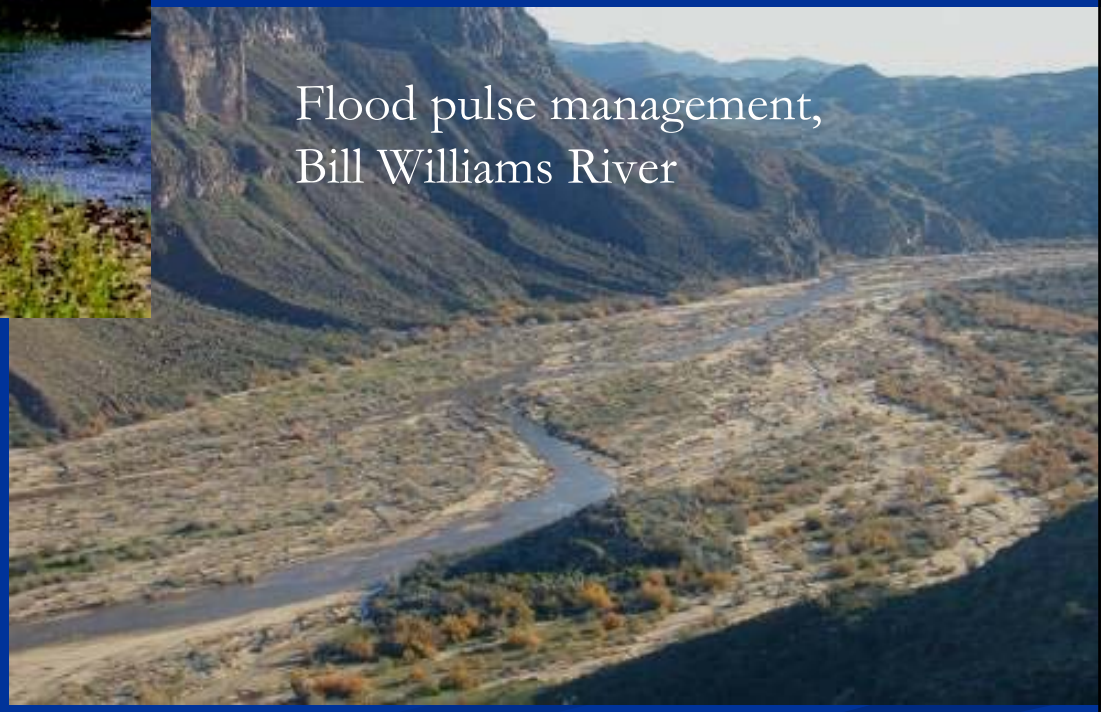
Downstream restoration site

Upstream perennial reaches will provide seed sources for revegetation, following stream rewatering. Tamarisk shrublands will give way to cottonwood-willow, following flooding.

Haney J.A. 2002. Groundwater modeling and biodiversity conservation on the Lower San Pedro River. *Southwest Hydrology* **1:**8.

Flood pulse restoration projects, on dammed rivers

[a]Managed flood release, Truckee River Nevada



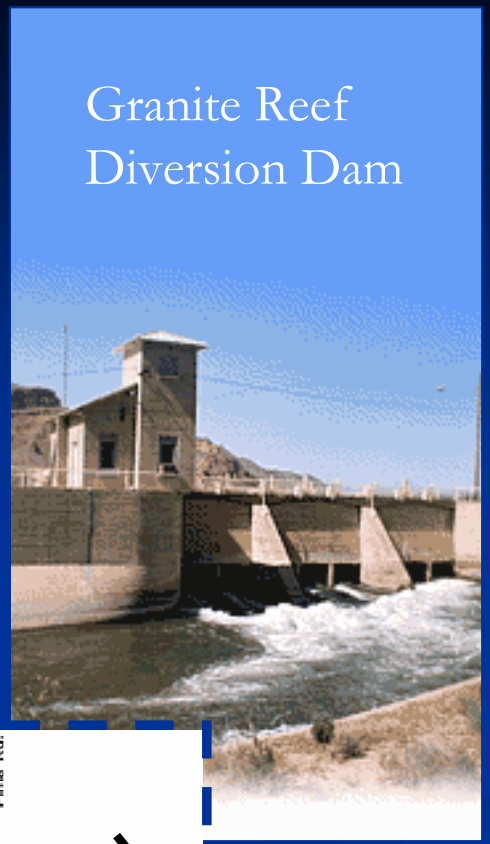
Flood pulse management,
Bill Williams River

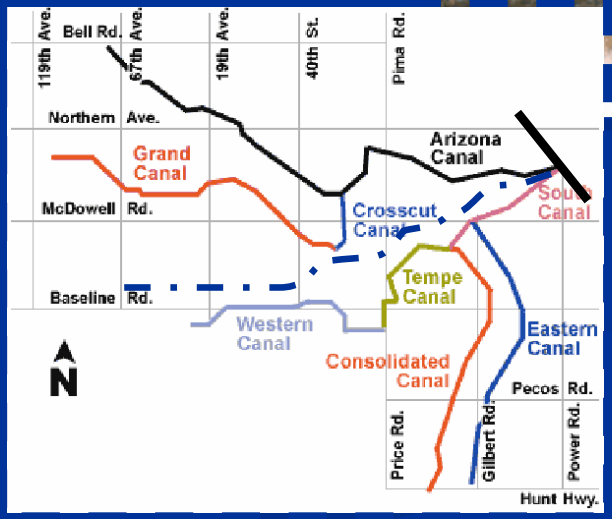
Rood SB, et al. 2003. Flows for floodplain forests: A successful riparian restoration. BioScience 53: 647-656.
Shafroth, P. B., G. T. Auble, J. C. Stromberg & D. T. Patten. 1998. Establishment of woody riparian vegetation in relation to annual patterns of streamflow, Bill Williams River, Arizona. Wetlands 18: 577-590.

Restoration of heavily modified urban rivers

Rio Salado Ecosystem Restoration project on Salt River-Phoenix. U.S.Army Corps of Engineers/City of Phoenix; Federal Water Resources Development Act. Approximate restoration cost = $85 million; $17 million per mile

Connectivity reduced due to upstream diversion dam, adjacent urbanization, and stream channelization





If key fluvial processes can not be restored, and if connectivity remains low, on-going intervention will be required and restoration success will be reduced

Structural actions- such as riparian plantings and landform sculpting- should be viewed as a sometimes necessary, but insufficient, step in the restoration process

" One begins to get a whiff of 'disneyfication' in the whole idea…
… come see a genuine replica of a forest"

Holland N. Undated. The integrity of nature over time.

How do we measure success?

3. Allowing for Ecosystem Dynamism, as indicated by
   a) Design plan not centered around a single, fixed, invariant endpoint

4. Cause No Lasting Harm: Restoration intervention itself should not damage the ecosystem, as indicated by
   a) Little vegetation removed or damaged in restoration implementation

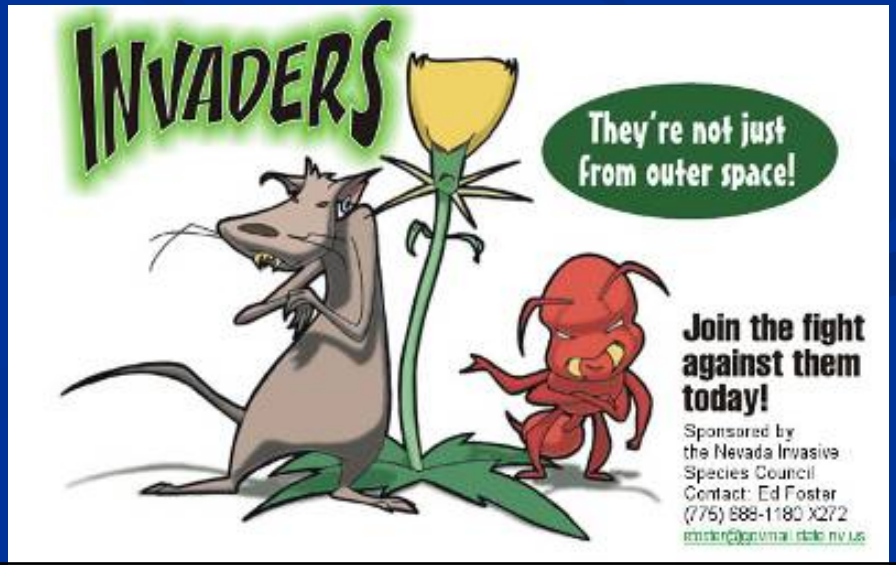
Palmer MA et al. 2005. Standards for ecologically successful river restoration. Journal of Applied Ecology.

We need to be cognizant of the fact that ecosystems are “open” and dynamic, and change over time

We need to have frank discussions about whether lists of “target species” and of “uninvited guests” are compatible with the notion of a “non-fixed, variable endpoint”

“ ..the use of exotic versus native species in designed landscapes is an issue that seems to bring out the worst in people, not unlike the debate on abortion or gun control” (Tredici 2004)

Tredici, PD. 2004. Neocreationism and the illusion of ecological restoration. Harvard Design Magazine 20:1-3.



The plant community in a restored reach may differ from some idealized target for many reasons:

1. Environmental conditions in the river have been fundamentally altered, with historic conditions not restorable, thereby favoring a new suite of species

2. The landscape in which the riparian site is embedded has been altered, as have landscape processes such as seed dispersal, thereby adding a new suite of species to the site

Brown, R. L., and R. K. Peet. 2003. Diversity and invasibility of southern Appalachian plant communities. *Ecology* 84: 32-39.

Davis, M. A., J. P. Grime, and K. Thompson. 2000. Fluctuating resources in plant communities: a general theory of invasibility. *Journal of Ecology* 88 (3): 528-534.

.....if groundwater levels can not be raised at the restoration site, conditions will favor deep-rooted phreatophytes over shallower-rooted phreatophytes

....if urban rivers no longer flood frequently, site conditions will favor species adapted to more stable conditions, many of which dispersed from landscape plantings

Middle Gila River

Salt River-Phoenix area

Lite, S. J. & J. C. Stromberg. In press. Surface water and ground-water thresholds for maintaining *Populus* - *Salix* forests, San Pedro River, Arizona. Biological Conservation

Functional comparisons:

There is no *a priori* reason to assume that a recent immigrant has lower functional value than a long-term resident.

Aesthetic functions

"Beauty is in the eye of the beholder"

Hydrologic or geomorphic functions

Influenced more by plant growth form than by phylogenetic heritage
Influenced by community-level properties (i.e., species diversity)

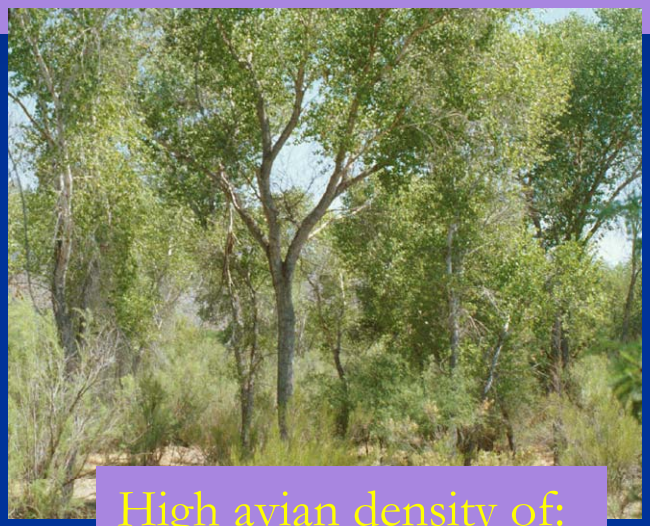
Animal habitat:

Influenced by both vegetation structure and floristics, as well as by community and landscape level traits.

Riparian functions: maintaining bird habitat

Riparian corridors are composed of a mosaic of landscape patches

Cottonwood-willow forest patch



High avian density of:
Common yellowthroat
Yellow-billed cuckoo
Song sparrow

High diversity of patch types can increase avian diversity in the landscape

Tamarisk shrublands:

High avian density of:
Mourning dove
Verdin

Brand LA, BR Noon. In prep. Abundance of breeding birds on the San Pedro River as a function of habitat and hydrologic regime.

Taylor, RV. 2003. Factors influencing expansion of the breeding distribution of Bewick's wren into riparian forests of the rio grande in central New Mexico. Southwestern Naturalist 48: 373-382.

If we maintain a 'purity' or static viewpoint with respect to biota, and remove non-native species, it follows that we also should remove non-native physical structures and processes

"What's striking about this restoration process is that it looks an awful lot like gardening, with its ongoing need for planting and weeding....

Is "landscape restoration" really just gardening dressed up with jargon to simulate ecology, or is it based on scientific theories with testable hypotheses?" (Tredici 2004)

Monitoring is critical to assess these measures of success

Pre-project monitoring:

Adequate pre-project inventory of biotic and abiotic conditions, to allow for assessment of success and to prevent inadvertent biotic impoverishment

Intra-project and post-project monitoring:

Monitoring and adaptive management should continue during project initiation and extend for several years after project completion

"about half the project managers surveyed reported the collection of baseline data and the use of biological, physical, chemical , or other…measures" (Bash and Ryan 2002)

Bash and Ryan. 2002. Stream restoration and enhancement projects: Is anyone monitoring? Environmental Management 29:877-885.

Holl and Cairns, 2002. Monitoring and Appraisal. Pages 411-432 in Perrow and Davy, Handbook of Ecological Restoration, Volume 1, Principles of Restoration. Cambridge Press.

We need to bridge the gap between science and practice, and effectively utilize scientific information in restoration planning

Take advantage of the many data bases and journals devoted to river restoration

Develop conceptual models of ecosystem dynamics to work from

Encourage external peer-review of project design by a wide range of stakeholders and scientists

Stanford JA, Ward JV, Liss WJ, Frissell CA, Williams RN, Lichatowich JA, Coutant CC . 1996. A general protocol for restoration of regulated rivers. Regulated Rivers- Research and Management 12 (4-5): 391-413.
Mitsch WJ, Day JW. 2004. Thinking big with whole-ecosystem studies and ecosystem restoration - a legacy of H.T. Odum. Ecological Modelling 178 (1-2): 133-155.
Shields FD, Cooper CM, Knight SS, Moore MT. 2003. Stream corridor restoration research: a long and winding road. Ecological Engineering 20 (5): 441-454.

Take advantage of rapidly proliferating information

Journals of Professional Societies
River Research and Application
Restoration Ecology
Wetlands

Online journals and Websites
San Francisco Estuary and Watershed journal
Freshwater Life web site

River Restoration Data Bases
Nat'l River Restoration Science Synthesis
Army Corps of Engineers
Bureau of Land Management
Forest Service
Nat'l Park Service
American Society of Civil Engineers
European River Restoration Network

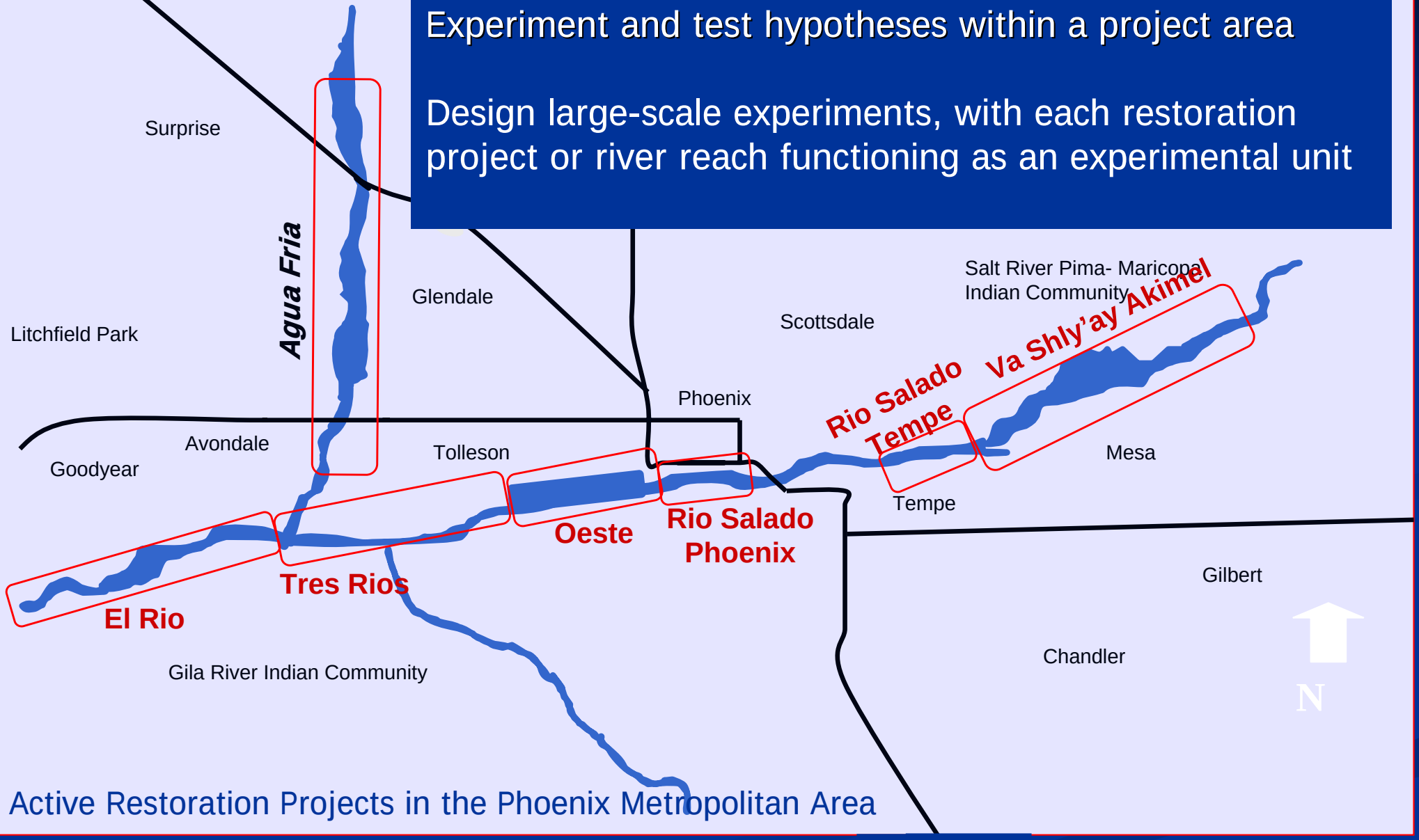
Books
Restoration of Aquatic Ecosystems (NRC)
Handbook of Ecopsystem Restoration (Cairns)

Conference Proceedings and On-line technical documents
River Restoration in Europe: Practical Applications

Create opportunities for experimentation

Experiment and test hypotheses within a project area

Design large-scale experiments, with each restoration project or river reach functioning as an experimental unit



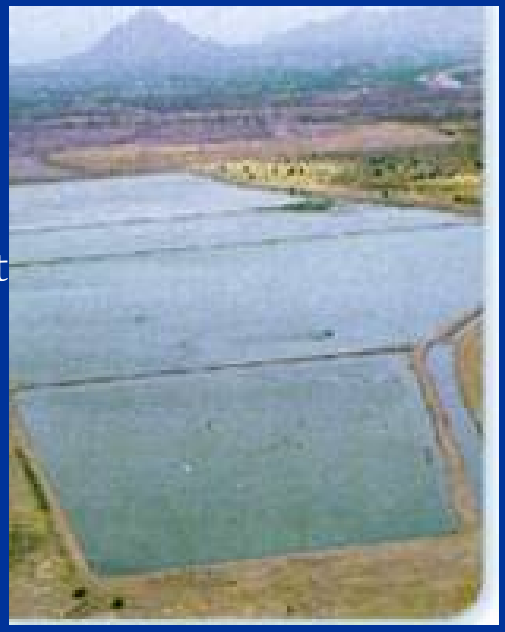
Active Restoration Projects in the Phoenix Metropolitan Area

Poff et al. 2003. River flows and water wars: emerging science for environmental decision making. Frontiers in Ecology and Environment 1:298-306.

‘Multi-task’: Coordinate water and river management efforts among management entities to achieve greater success and avoid being at cross-purposes….

While some river reaches are being rewatered and planted, at great expense, riparian vegetation is cleared or suppressed at others

Granite Reef Underground Storage Project on Salt River. Source: SRP



Pastorok RA, MacDonald A, Sampson JR, Wilber P, Yozzo DJ, Titre JP. 1997. An ecological decision framework for environmental restoration projects. Ecological Engineering 9 (1-2): 89-107.

Focus on conservation / protection of rivers

Degradation gradient

Severe.....Minimal

Restoration success probability

Low.....High

Restoration cost

High.....Low

An ounce of prevention
is
worth a pound of cure