Capturing the Human Dimension of Ecosystem Restoration:

Using GIS and Multi-Criteria Decision Analysis to Measure Ecosystem Services Affected by Proposed Restoration Plans Along the Middle Rio Grande

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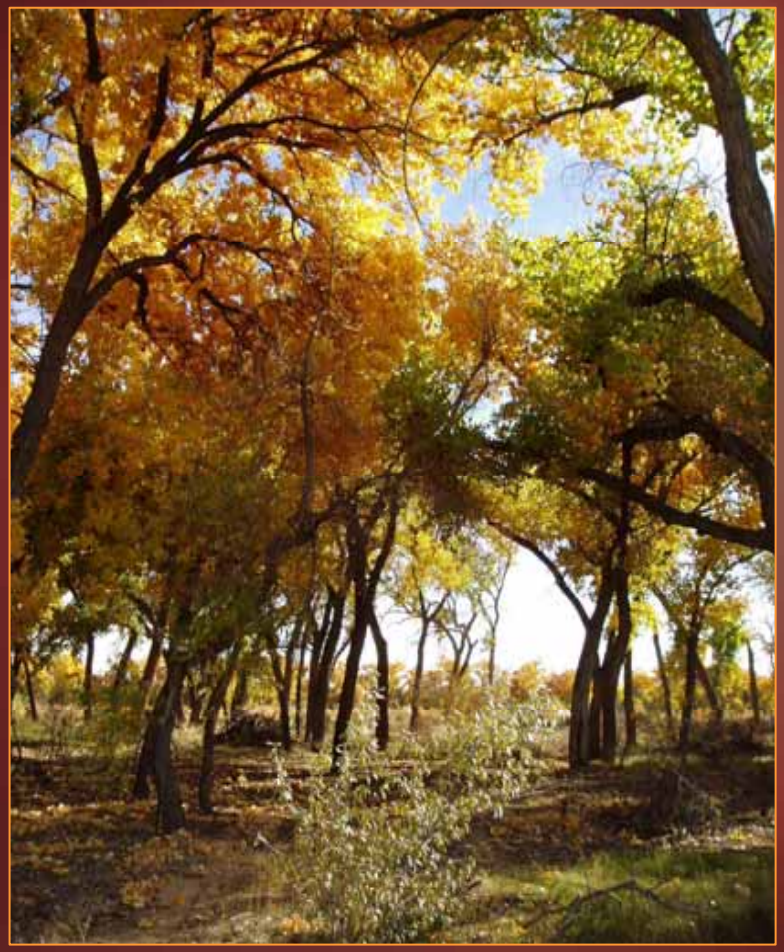
Ongoing Corps Efforts

- "The conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life" Dailey 1997

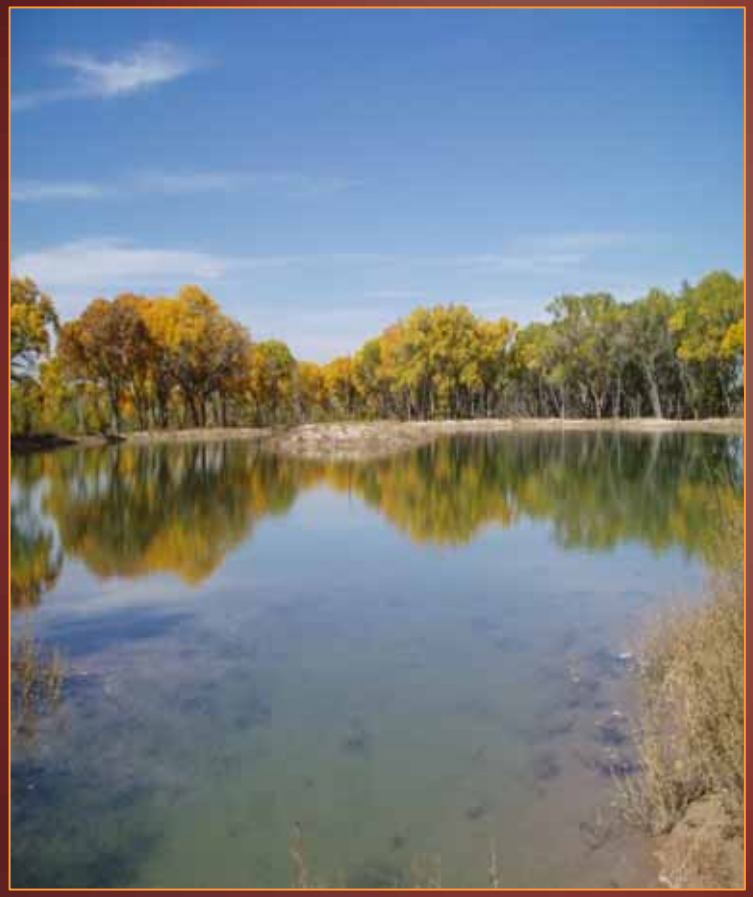
- Ecosystem services can be viewed as the link between the natural properties of ecosystems and human benefits.

- The service concept connects the ecological focus of "what ecosystems do" with a focus on "how ecosystems contribute" to the satisfaction of human preferences (Cole et al. 2003, adapted)



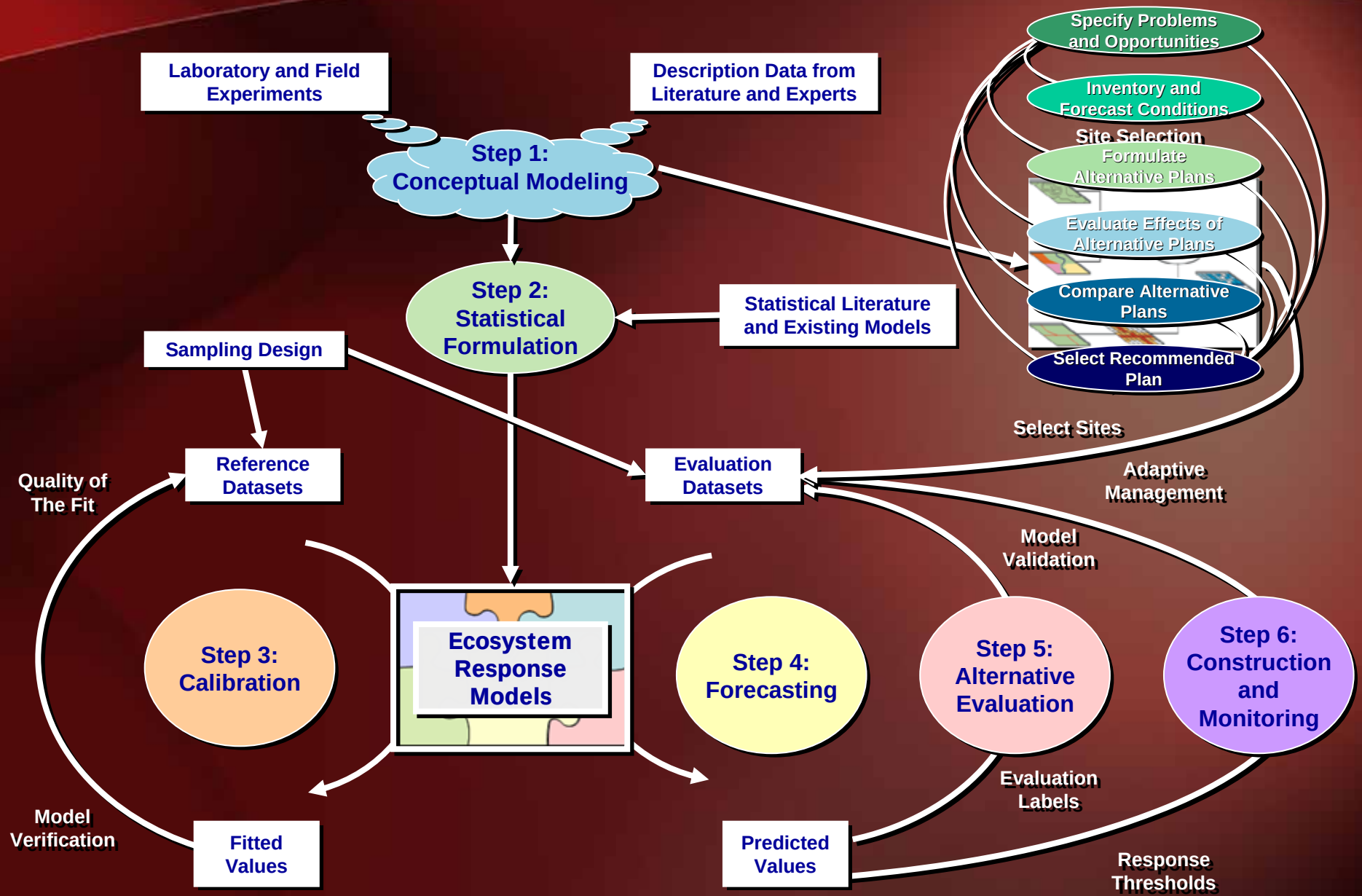
Ongoing Corps Efforts

- **Recon and other initial analyses often mention ecosystem services and benefits, but these are rarely carried forward into evaluation of alternatives**
- ER 1105-2-100 (22 Apr 2000) "Planning Guidance Notebook" (page 2-2)
  - **". . . ecosystem restoration plans shall be formulated and evaluated in terms of their net contributions to increases in ecosystem value [National Ecosystem Restoration (NER) outputs], expressed in non-monetary units"**
- **Environmental Benefit Indicators (EBI) (Boyd and Wainger 2002) offer a reasonable alternative to benefits analysis, making use of data accumulated in the normal study process.**



http://www.usace.army.mil/publications/eng-regs/er1105-2-100/

Ecosystem Assessment Approach



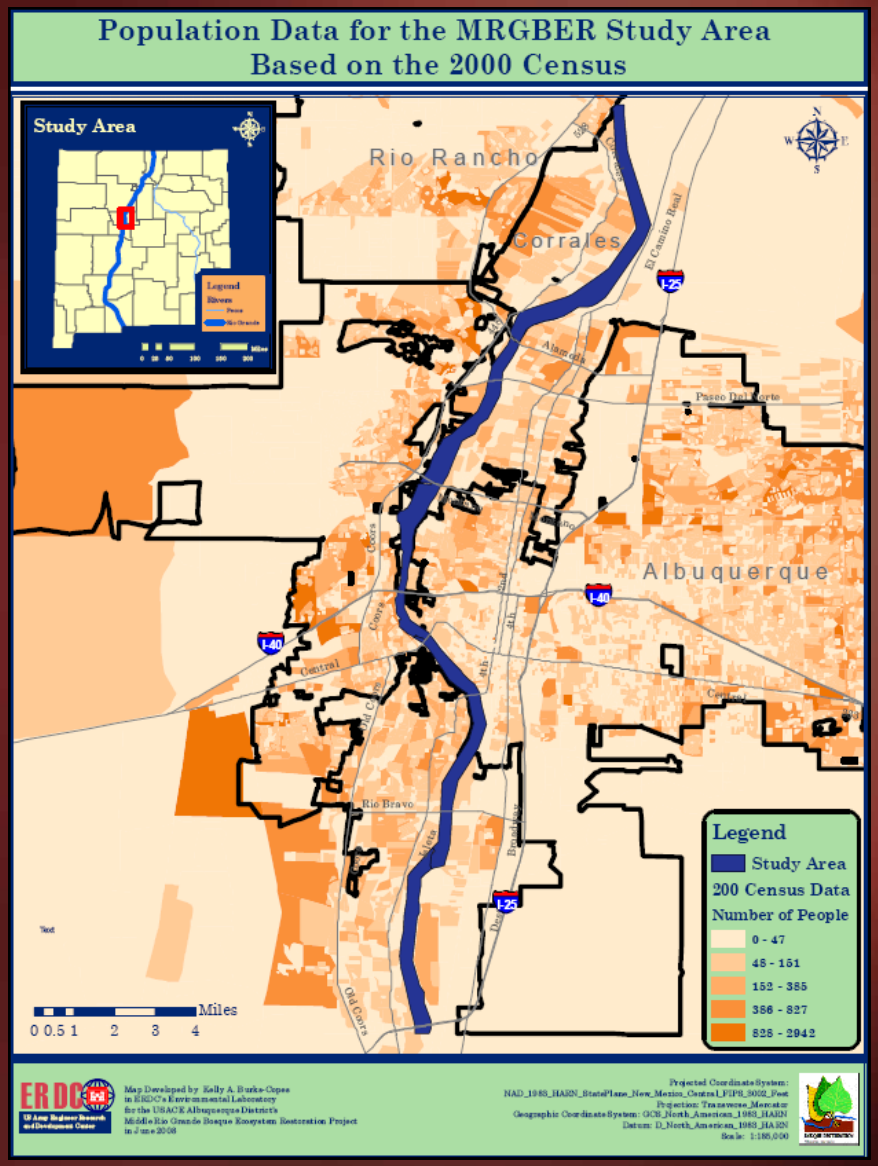
Middle Rio Grande Bosque Ecosystem Restoration Study

Environmental Benefit Indicators (EBI)
(Boyd and Wainger 2002)

- **Definition: EBI's are a quantitative, <u>but not monetary</u>, approach to the assessment of habitat and land uses.**

Use GIS and other existing data

- **Develop indicators (index, ratio quantity) of existing and future benefits using expert elicitation and reference-based data**



The Middle Rio Grande Bosque Ecosystem Restoration Study

Traditional Goals and Objectives

1. Increase mature cottonwood riparian forest
2. Increase early successional riparian forest
3. Increase acreage and diversity of quality aquatic habitat in existing wetlands
4. Increase critical T&E habitat

Ecosystem Service Objectives

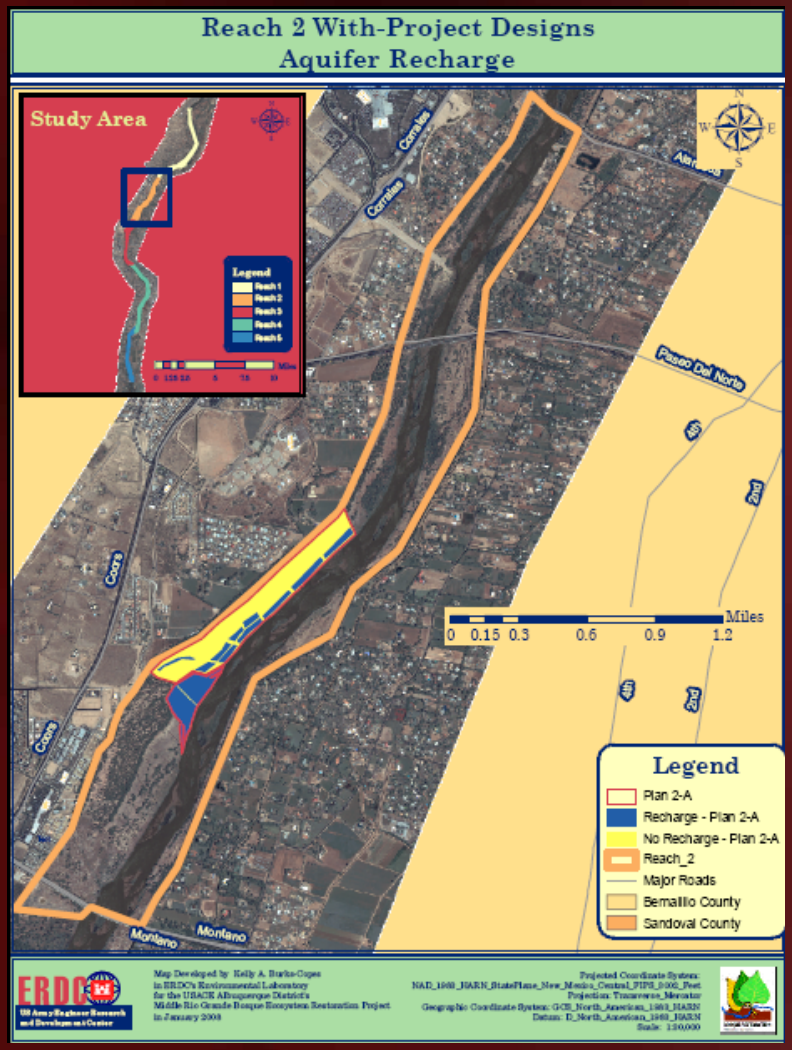
1. Improve Aesthetics (Viewsheds)
2. Provide Storm water filtration
3. Improve Carbon sequestration
4. Increase recreational access and opportunities
5. Increase educational benefits
6. Increase value of adjacent lands
7. Increase downtown economic development and ecotourism

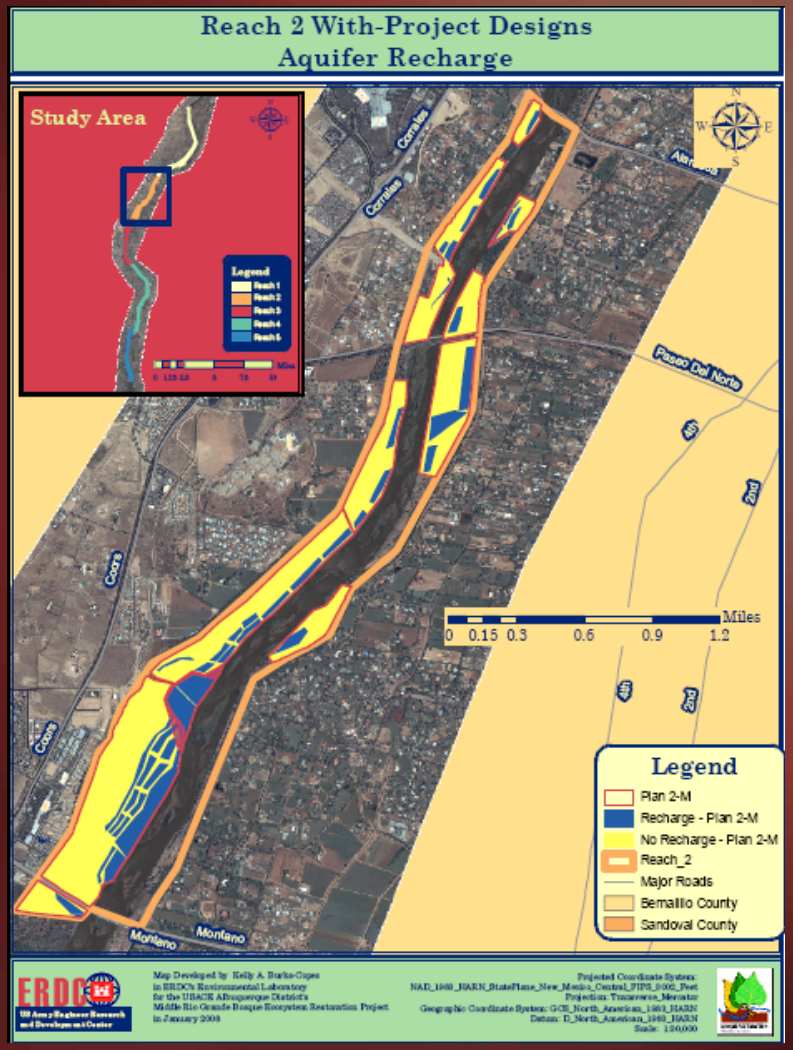
Final Services Selected

- **Riparian Aquifer Recharge and Infiltration**
  - Through the creation of hydrologic connections between the Rio Grande and the bosque, riparian aquifer recharge and infiltration will be increased.
- **Access**
  - The bosque provides recreation and aesthetic opportunities via access roads and parking areas; trails, interpretive areas, parks, boat ramps.
- **Public Education and Awareness Provide**
  - Educational opportunities to promote understanding of ecological and cultural resources in the bosque.
- **Natural and Cultural Integrity**
  - Provide a visual connection between the urban and natural environment. Natural and cultural integrity is evidenced visually and by physical access.
- **Catastrophic Fire Risk Reduction**
  - Reduce the risk of catastrophic fire damage by removing the excess and non-native vegetation and increasing hydrologic connections where possible.

Service #1: Riparian Aquifer Recharge

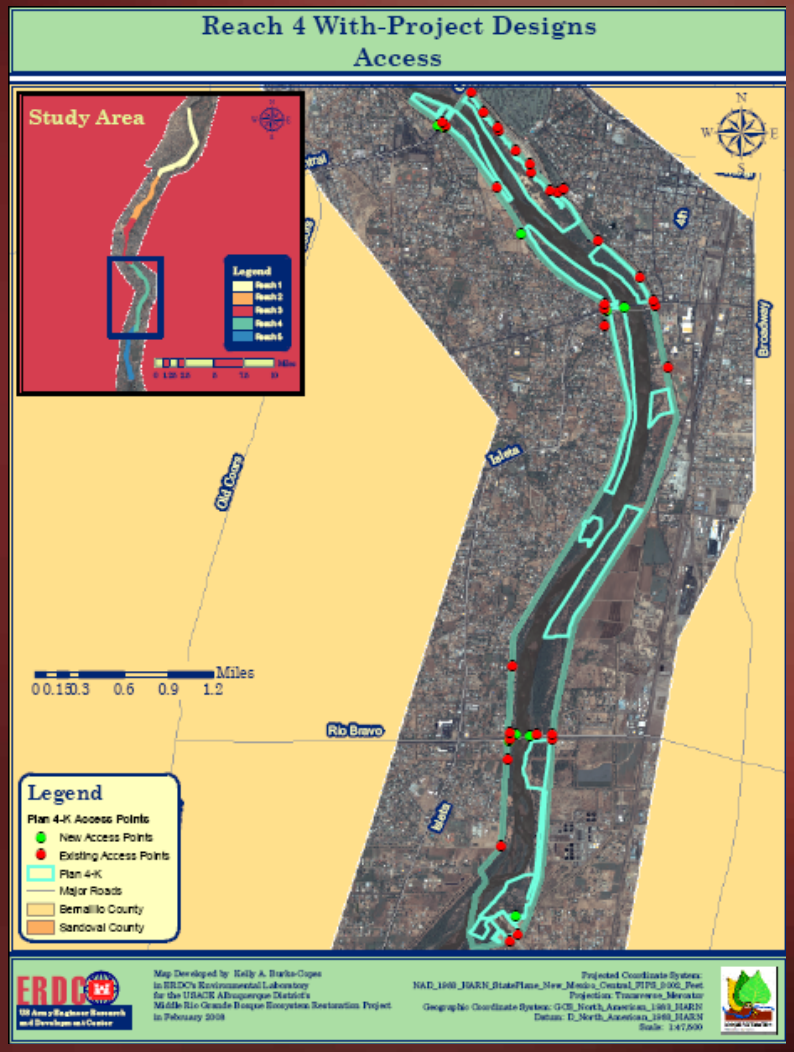
$$= \frac{\text{Pervious area}}{\text{Total area}}$$





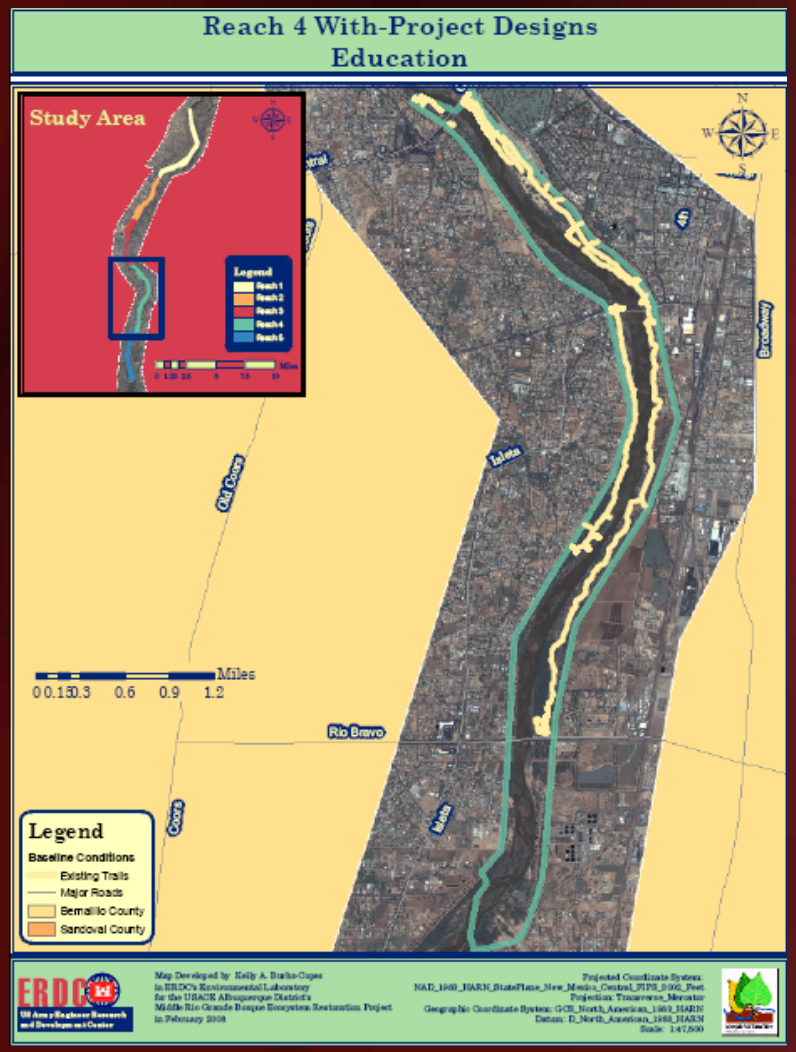
Service #2: Access

$$= \frac{\text{Distance Btw Points}}{\text{Baseline Distance}}$$



Service #3: Education

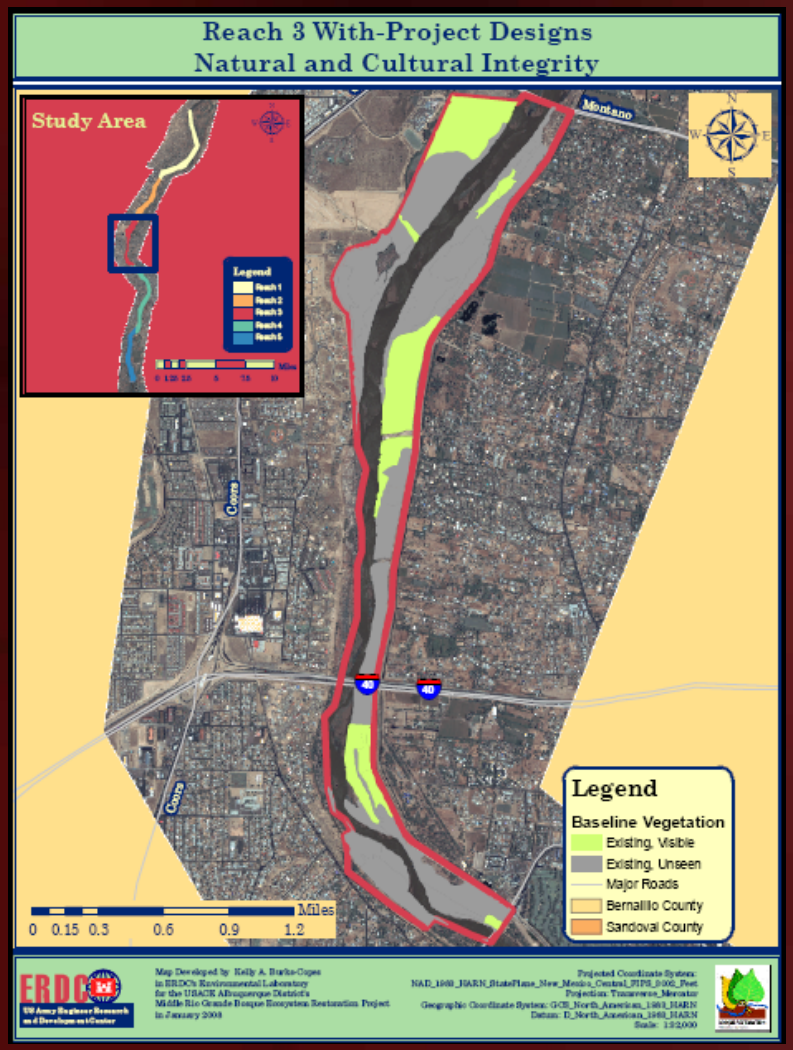
$$= \frac{\text{Feet of New + Old Trails}}{\text{Baseline Trails}}$$

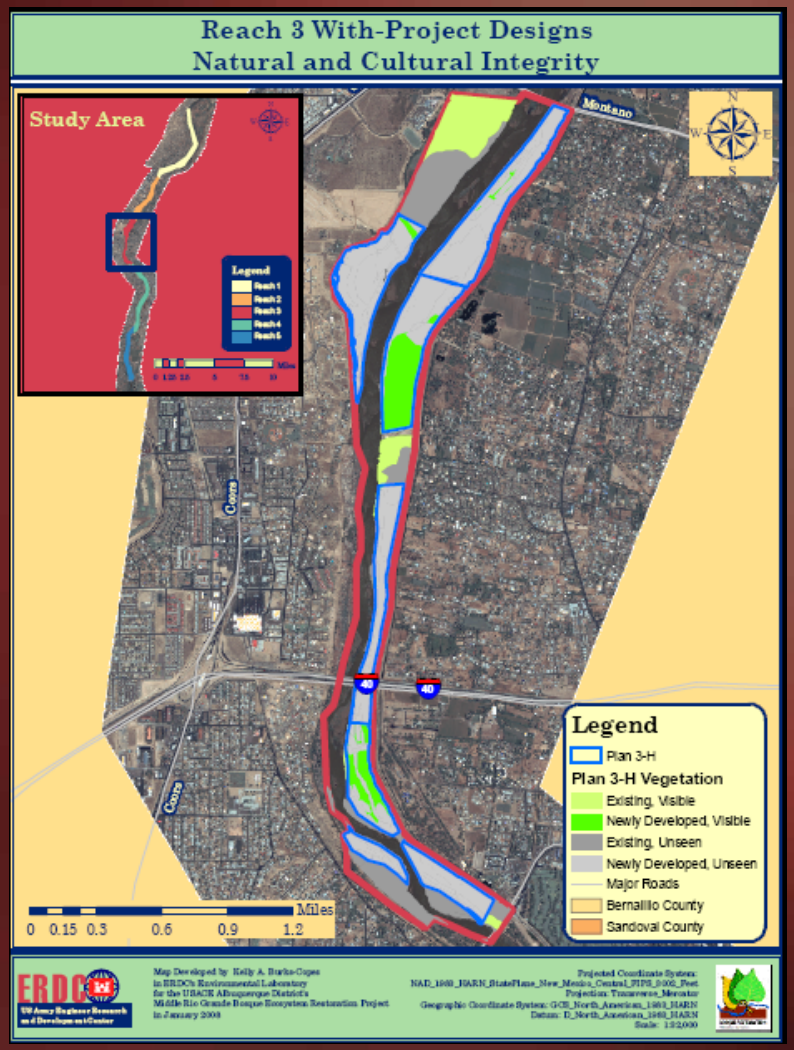


Service #4: Natural and Cultural Integrity

= Area of Viewable Bosque

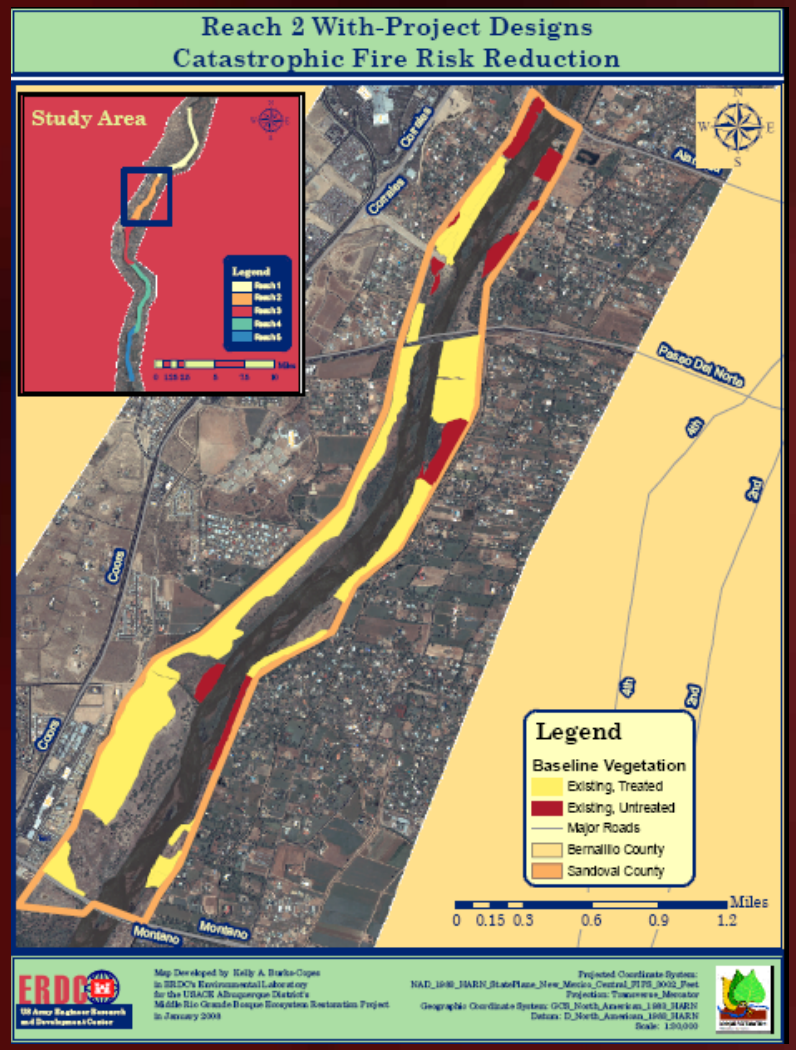
Baseline View

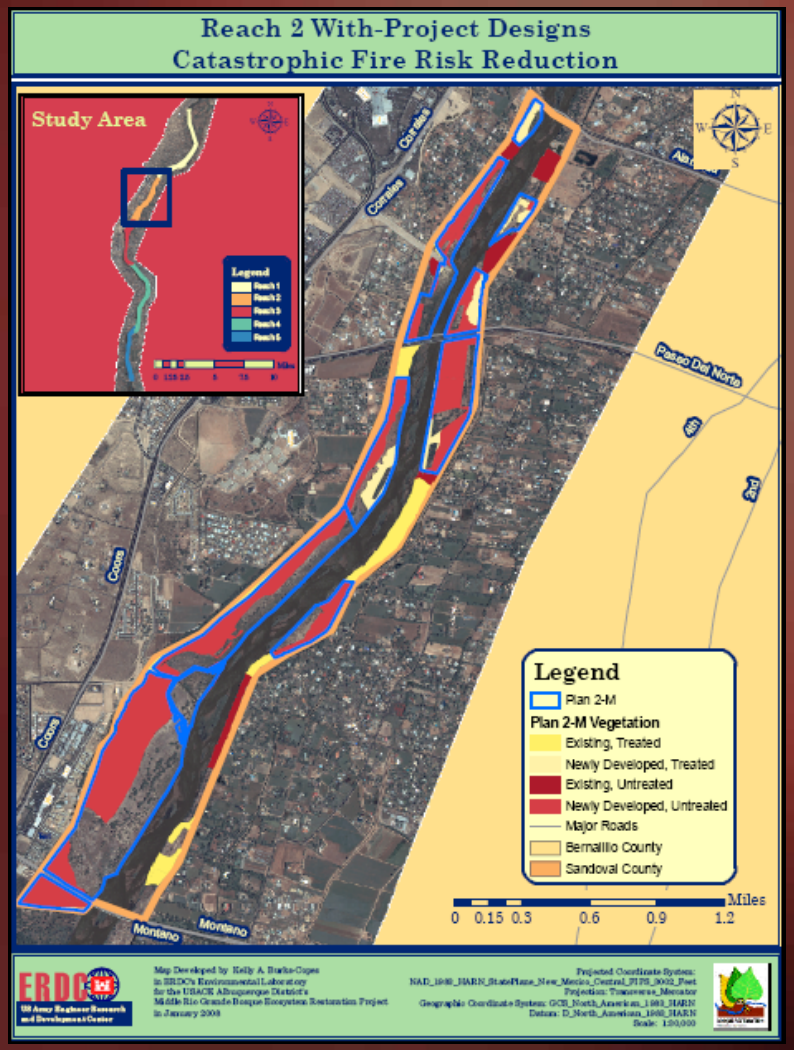




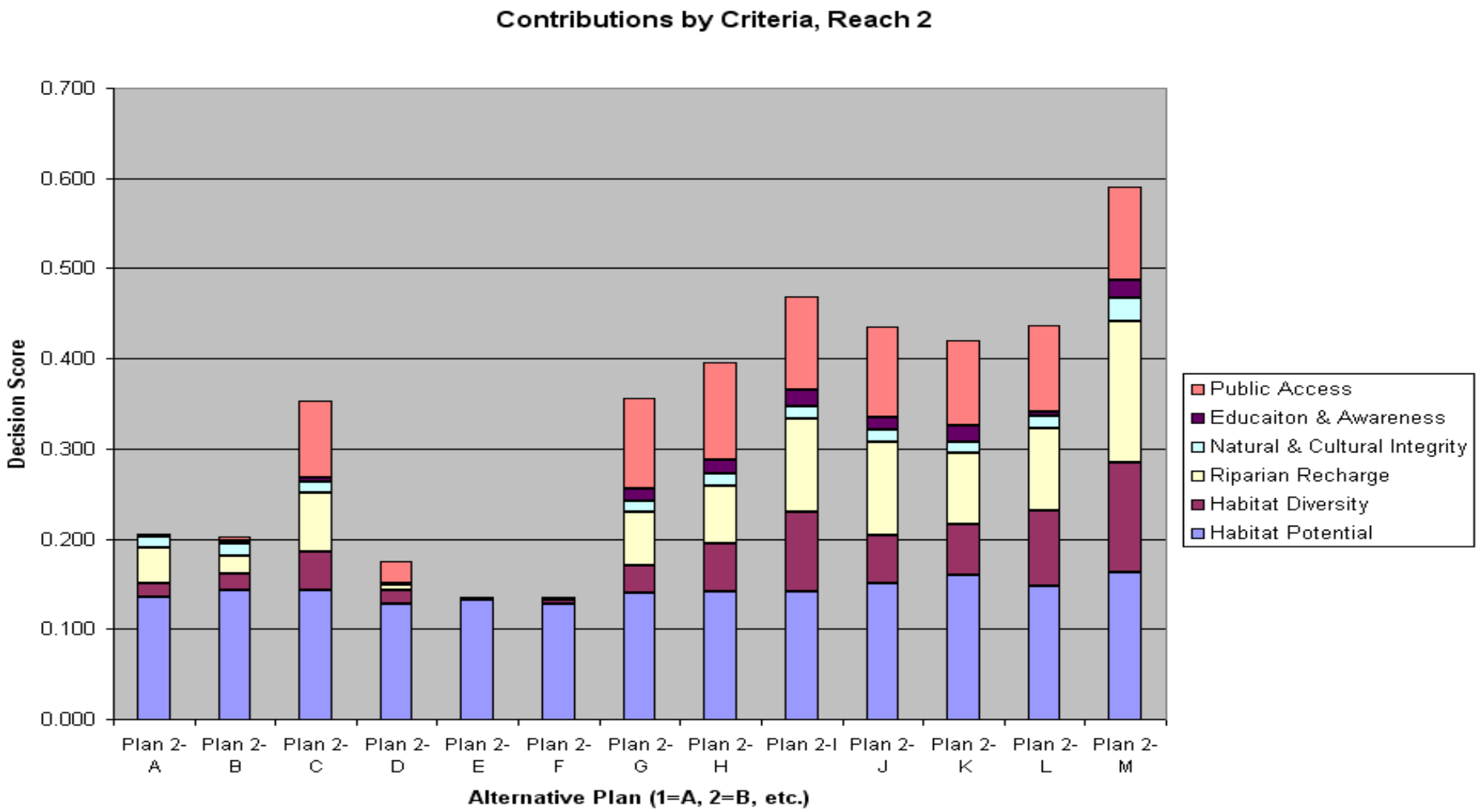
Service #5: Catastrophic Fire Risk Reduction

$$= \frac{\text{New Fuel Load}}{\text{Baseline Fuel Load}}$$





MCDA Used to Perform Trade-offs



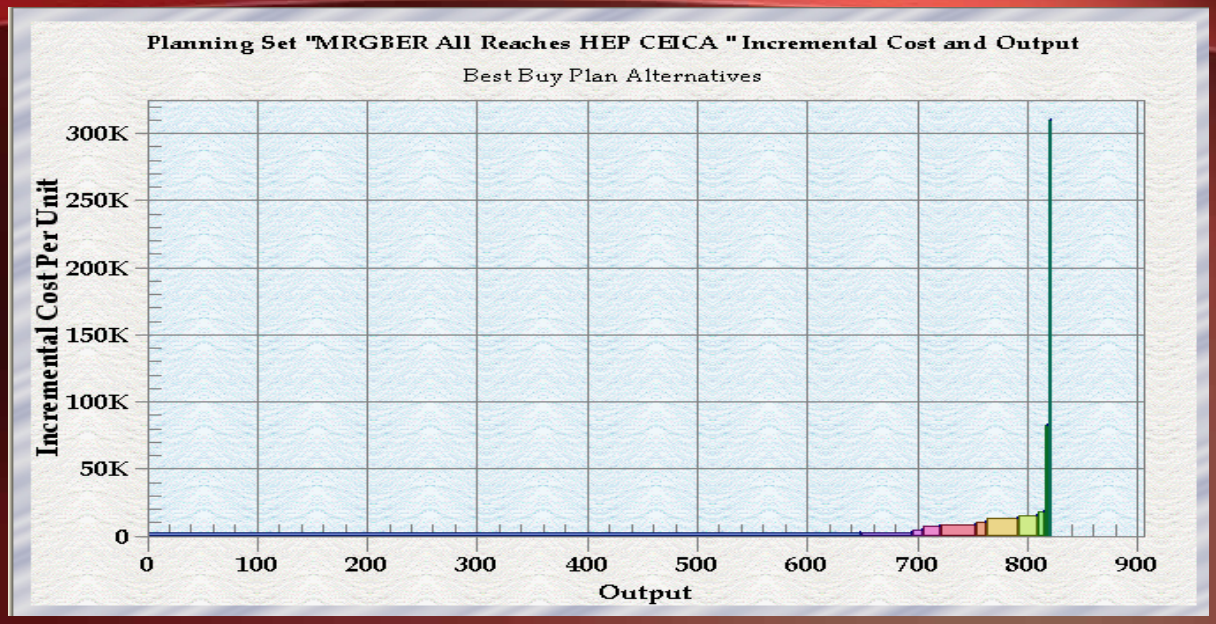
Cost Effectiveness and Incremental Effectiveness

- ER 1105-2-100:
  - "For ecosystem restoration projects, a plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective, shall be selected. The selected plan must be shown to be cost effective and justified to achieve the desired level of output." (pg 2-7)

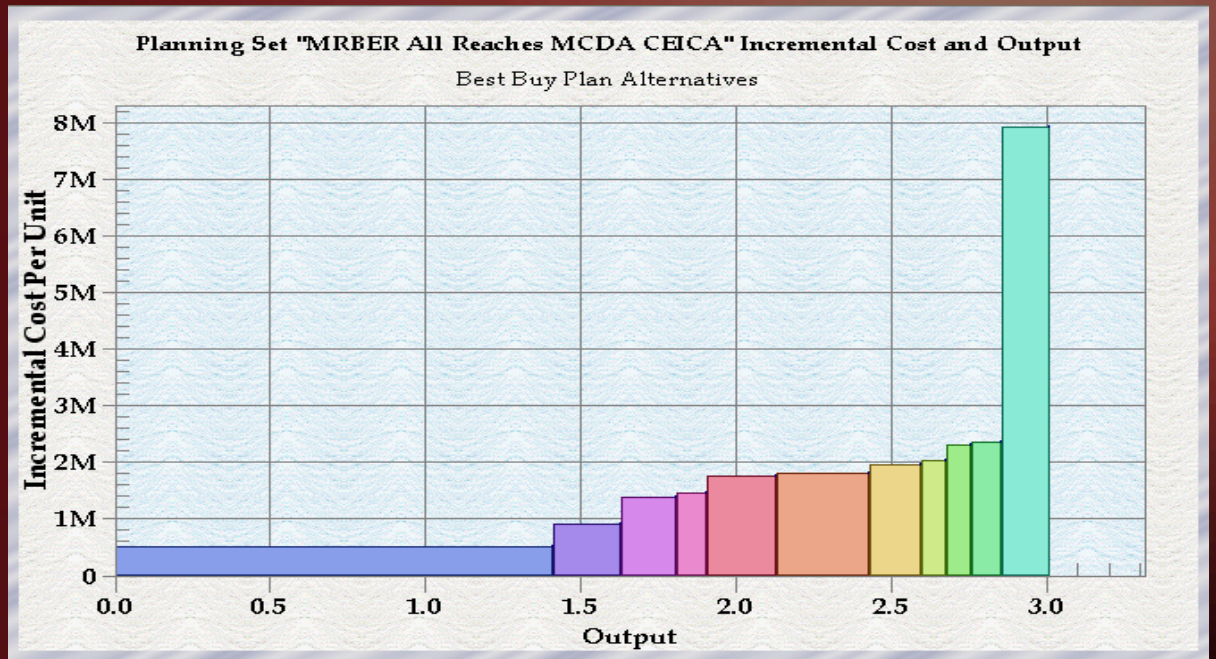
- Incremental analysis is the mandated process used in the Corps plan formulation process to help identify plans that deserve further consideration in an efficient manner.

Traditional vs. ES Supplementation

Traditional (HEP) Outputs Compared to Incremental Costs



Supplemented Outputs (with Ecosystem Services) Compared to Incremental Costs



Institutional Barriers

Some clauses in ER 1105-2-100 support the concept of Ecosystem Services . . . .

"The environmental quality account displays non-monetary effects on ecological, cultural, and aesthetic resources including the positive and adverse effects of ecosystem restoration plans." **(pg 2-6)**

"The social, cultural, scientific, and educational values should be considered within the framework of the ecosystem restoration project purpose" **(pg 3-29)**

Institutional Barriers

However . . . . (ER 1105-2-100)

"The objective of ecosystem restoration is to restore degraded ecosystem structure, function, and dynamic processes to a less degraded, more natural condition. Restored ecosystems should mimic, as closely as possible, conditions which would occur in the area in the absence of human changes to the landscape and hydrology. Indicators of success would include the presence of a large variety of native plants and animals, the ability of the area to sustain larger numbers of certain indicator species or more biologically desirable species, and the ability of the restored area to continue to function and produce the desired outputs with a minimum of continuing human intervention." **(Pg 3-20)**

Institutional Barriers

And . . . . (ER 1105-2-100)

"*Measurement of National Ecosystem Restoration (NER) is based on changes in ecological resource quality as a function of improvement in habitat quality and/or quantity and expressed quantitatively in physical units or indexes (but not monetary units).*" (Pg 2-1)

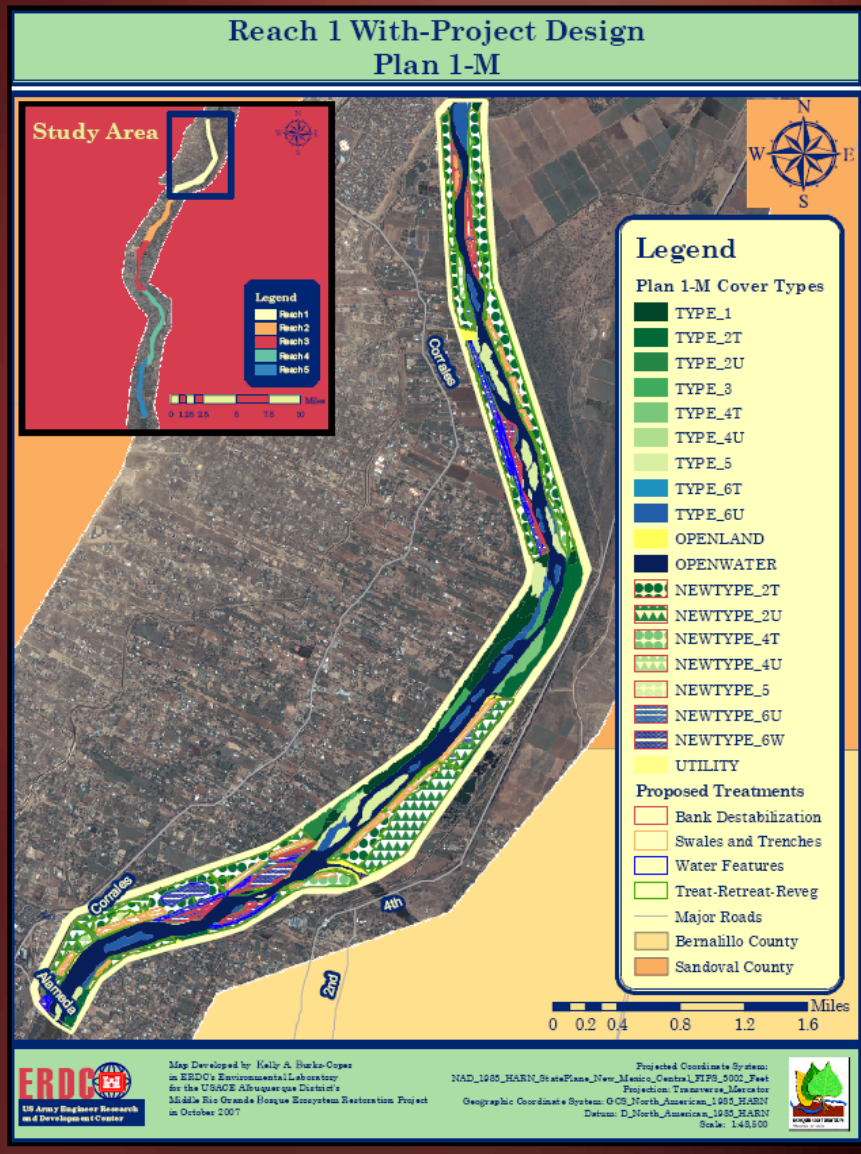
"*Budget Policy generally precludes using Civil Works resources to implement recreation oriented projects in the Civil Works program.*" (pg 3-30)

"*Recreation development at an ecosystem restoration project shall be totally ancillary to the primary purpose, appropriate in scope and scale, and shall not diminish the ecosystem restoration outputs used to justify the project.*" (pg 3-30)

A Compromise For Now

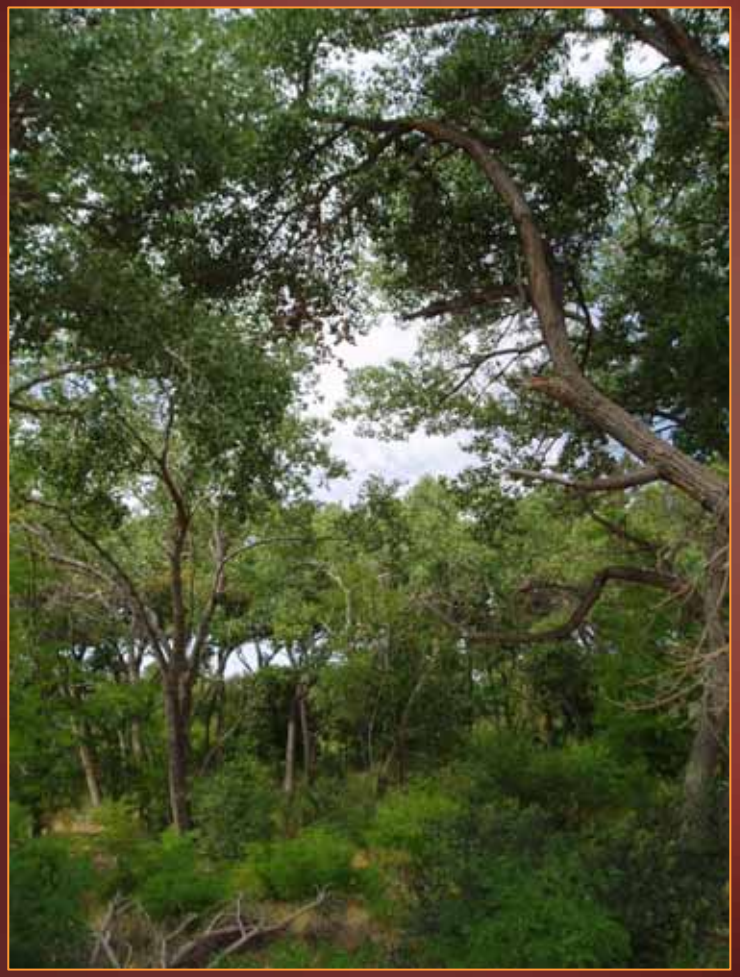
No. - Alternative	HEP Outputs (AAHUs)	Spatial Habitat Diversity	Shallow Aquifer Recharge	Maintenance of Natural and Cultural Integrity	Public Education and Awareness	Access	Final Score[1]
1 - No Action Plan	0	Low	Low	Low	Low	Low	0
2 - Plans --, 2-F, --, --, --,	139	Low	Low	Low	Low	Low	0
3 - Plans --, 2-F, --, --, 5-G	294	Low	Low	Low	Low	Low	4
4 - Plans --, 2-F, 3-A, --, 5-G	394	Low	Low	Low	Low	Low	4
5 - Plans --, 2-F, 3-A, 4-F, 5-G	428	Low	Low	Low	Low	Low	8
6 - Plans --, 2-F, 3-A, 4-H, 5-G	474	Low	Low	Low	Low	Medium	14
7 - Plans 1-J, 2-F, 3-A, 4-H, 5-G	696	Low	Medium	Medium	Low	Medium	25
8 - Plans 1-K, 2-F, 3-A, 4-H, 5-G	705	Low	Medium	Medium	Low	Medium	24
9 - Plans 1-K, 2-B, 3-A, 4-H, 5-G	721	Medium	Medium	Medium	Low	Medium	26
10 - Plans 1-M, 2-B, 3-A, 4-H, 5-G	754	Medium	Medium	Medium	Low	Medium	28
11 - Plans 1-M, 2-B, 3-B, 4-H, 5-G	764	Medium	Medium	Medium	Low	Medium	29
12 - Plans 1-M, 2-B, 3-B, 4-K, 5-G	792	High	Medium	Medium	Medium	Medium	35
13 - Plans 1-M, 2-K, 3-B, 4-K, 5-G	809	High	High	Medium	Medium	High	42
14 - Plans 1-M, 2-K, 3-H, 4-K, 5-G	817	High	High	High	High	High	52
15 - Plans 1-M, 2-K, 3-H, 4-K, 5-H	819	High	High	High	High	High	53
16 - Plans 1-M, 2-M, 3-H, 4-K, 5-H	823	High	High	High	High	High	57

[1] Final scores were calculated based upon contribution of individual alternatives per plan and relative area was used to capture the contribution of each reach to the overall value. The individual MCDA values were initially normalized using a "percent of total" approach suggested in Yoe 2002. High, Medium and Low scores were developed on a metric-by-metric basis where the range of scores was divided as evenly as possible into the three categories (Final Decision Matrix).



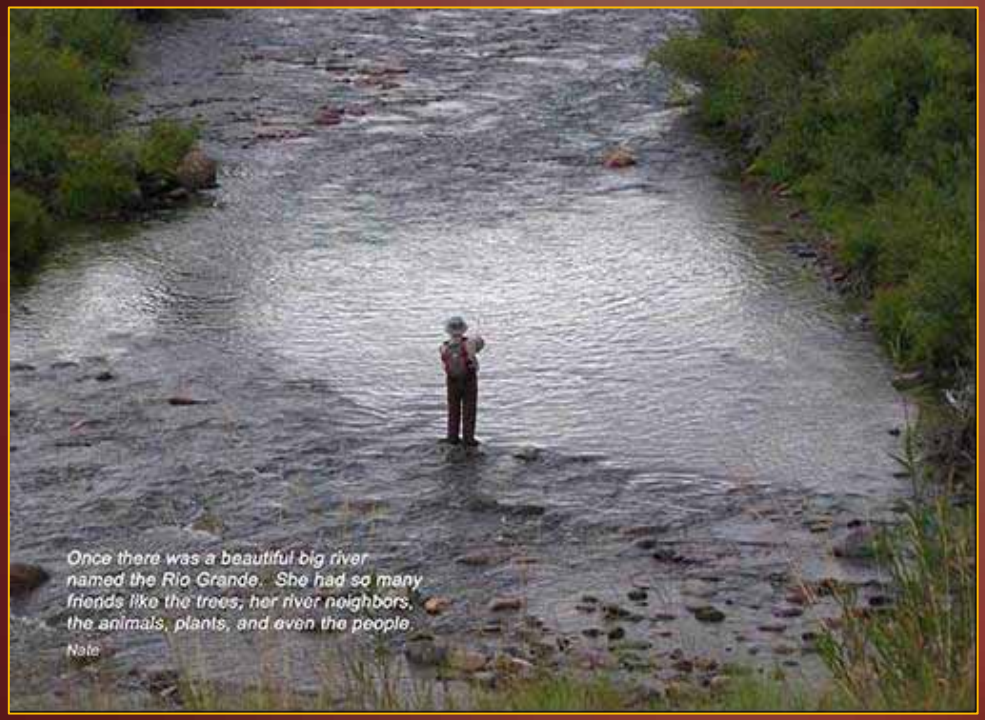
Conclusions

- Radical transformation is required to move the Corps from conceptual frameworks and theory to practical integration of ecosystem services into decision-making in a manner that is credible, replicable, scalable, and sustainable.
- There remain highly nuanced scientific challenges for ecologists, economists, and other social scientists to understand how human actions affect ecosystems, the provision of ecosystem services, and the value of those services
- The approach described here augments the traditional Corps ecosystem analysis approach (HEP) in a useful manner
- It provides support for the Locally Preferred Plan, offers stakeholders with a range of benefits and generates non-monetary benefits, without:
  - Questions on economic benefit transfers
  - Extensive new study effort



Conclusions

- There are new efforts in the Corps to address Ecosystem Service Valuation
  - In 2008 an Environmental Benefits Analysis (EBA) Work Unit focused on Ecosystem Services (joint effort with EPA) – and use this as a case study
    (ERDC POC = Jim Henderson)
  - In 2009 there is a new EBA Work Unit that will review TNC's efforts to incorporate Ecosystem Services into their site selection protocol
    (ERDC POC = Barry Payne)



Questions?