



**BLM-USGS ECOSYSTEM SERVICES  
VALUATION PILOT**

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**Assessing Ecosystem Services in the San Pedro  
Watershed**

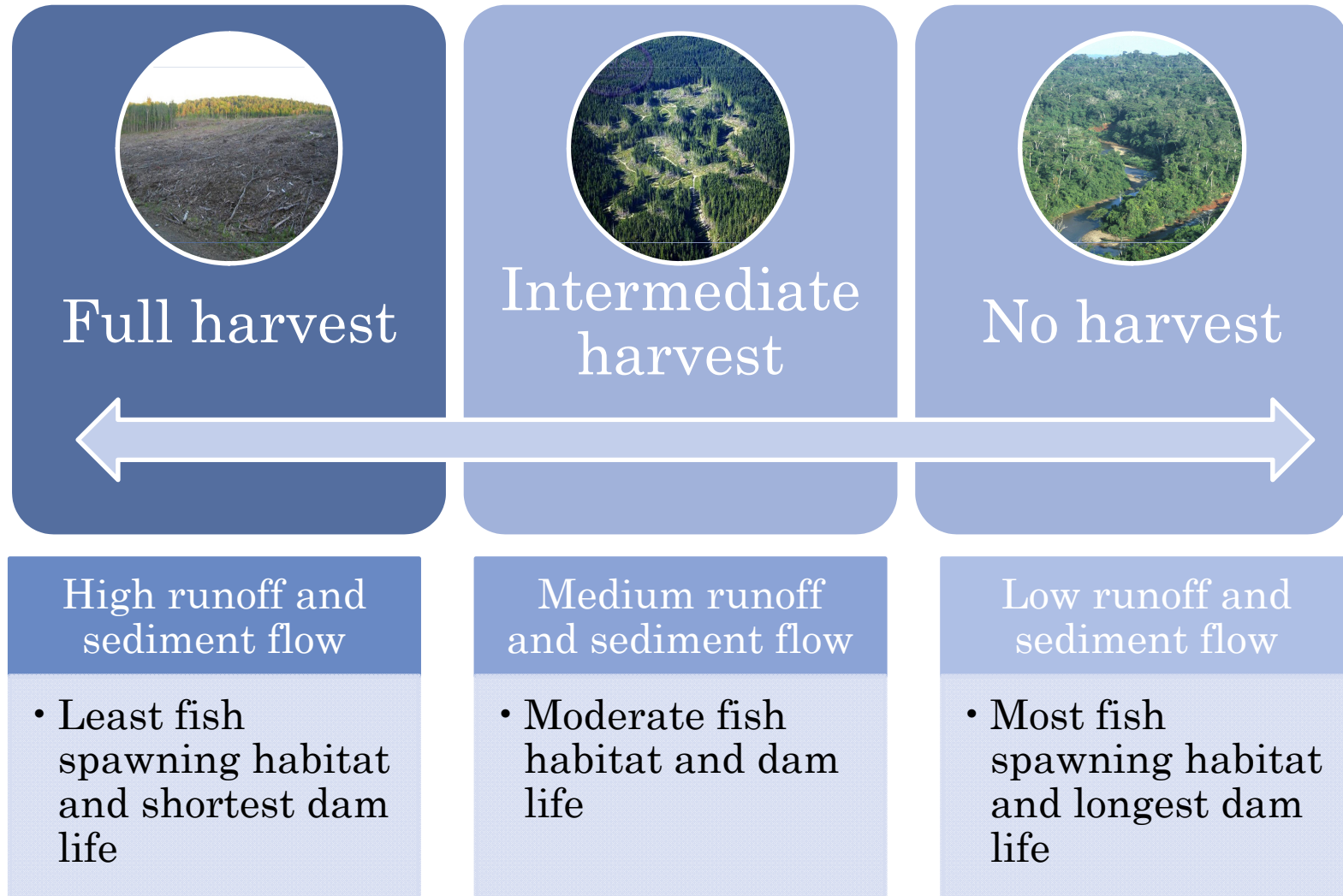
**December 10, 2012**

# WHAT ARE ECOSYSTEM SERVICES?

- “Components of nature, directly enjoyed, consumed, or used to yield human well-being” (Boyd and Banzhaf 2006)
- Millennium Ecosystem Assessment (MEA) identified four categories of ecosystem services
  - Provisioning services (e.g., timber and water)
  - Regulating services (e.g., carbon sequestration)
  - Cultural services (e.g., recreation and spiritual uses)
  - Supporting services (e.g., nutrient cycling)
- Ecological “endpoints”
  - Common measurement objectives
  - Outcomes translated into human terms



# ECOSYSTEM SERVICES AND MANAGEMENT DECISIONS



# WHY VALUE ECOSYSTEM SERVICES?

- Ecosystem service valuation improves BLM's ability to provide a comprehensive account of the costs and benefits of our programs and activities
- Better accounting of costs and benefits improves our ability to make informed decisions
- Changing public expectations and environmental attitudes have led to increased demand for environmental valuation

# POLICY MANDATES FOR ANALYZING ECOSYSTEM SERVICES

- Departmental direction: “The absence of a consistent method for assessing [environmental] amenity values across BLM lands prevents decision makers from understanding the scope and magnitude of the full set of values associated with these lands.” -- DOI’s Office of Policy Analysis, 2009
- The Council on Environmental Quality’s new ***Principles and Guidelines for Water Resources Implementation*** emphasizes the need to characterize ecosystem services in assessing water-related plans and projects

# POLICY MANDATES FOR ANALYZING ECOSYSTEM SERVICES

- President's Council of Advisors on Science and Technology recently recommended that the Department of the Interior, as well as other agencies with environmental responsibilities,

***“should be tasked with improving their capabilities to develop valuations for the ecosystem services affected by their decision-making and factoring the results into analyses that inform their major planning and management decisions. . . .”***

President's Council of Advisors on Science and Technology, *Sustaining Environmental Capital: Protecting Society and the Economy*, July 2011, iii.

## PROJECT GOALS

- Determine usefulness of ecosystem service valuation for the BLM
- Determine the feasibility of valuation tools and methods given BLM's capabilities
- Provide relevant information for plans and projects in the Gila District

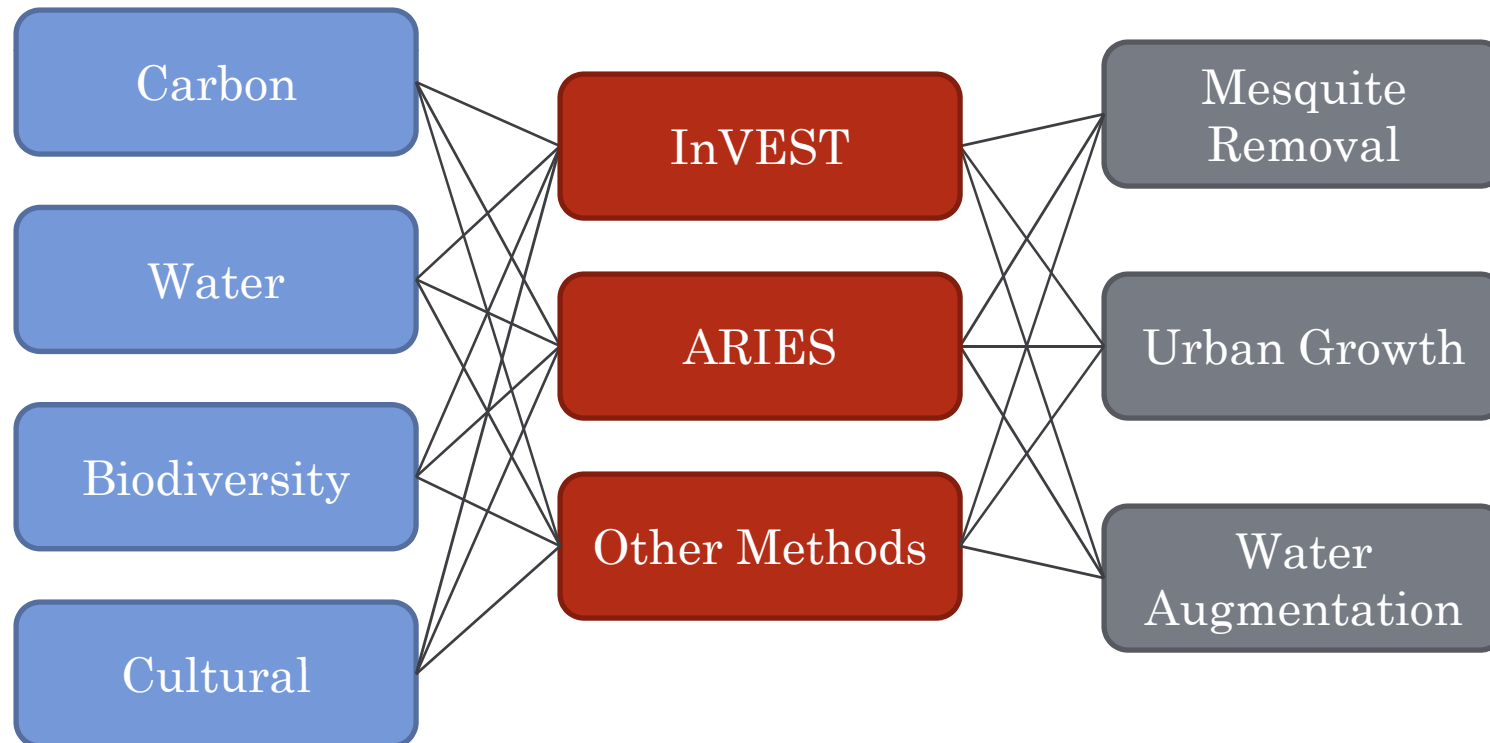


# PROJECT DESIGN

Services

Tools

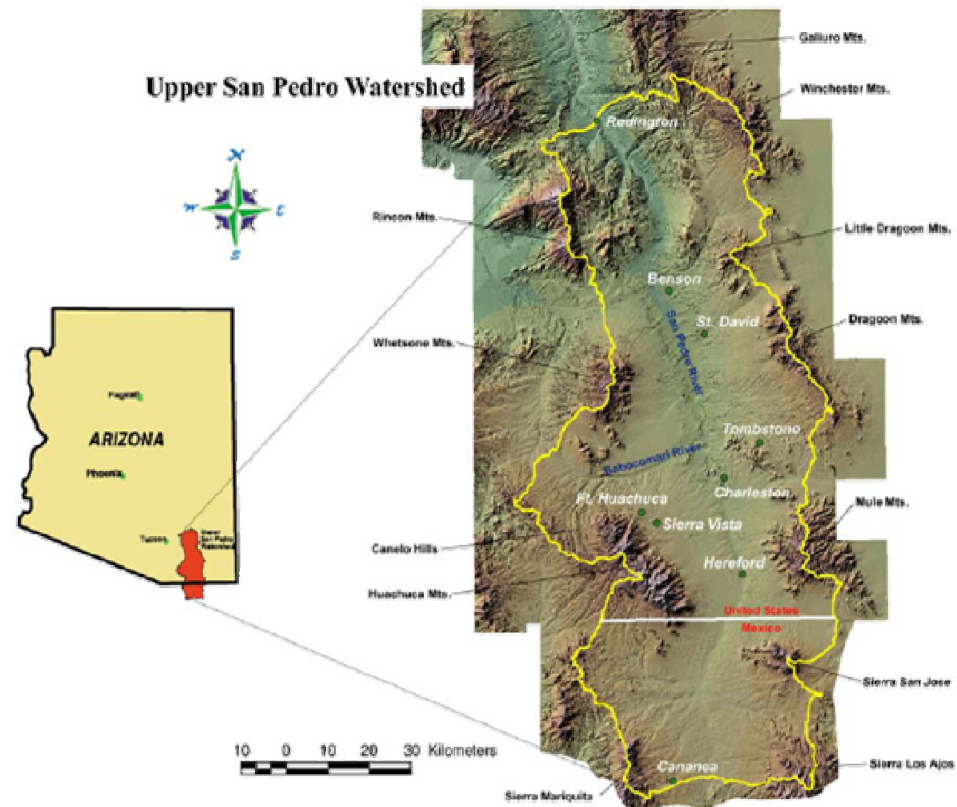
Scenarios





# SAN PEDRO STUDY AREA

- 2,800 sq mi headwater of Lower Colorado River Basin
  - Undammed
  - Perennial flow
- Substantial body of previous research
- Ecologically important
- Service-dependent local economy
- Active & organized stakeholders
- Pressing environmental concerns
- History of ecosystem-based management decisions



Location of the Upper San Pedro River Basin, Arizona/Sonora

# PROJECT OVERVIEW

## ○ Why the San Pedro?

- Strong interest from District, State Office, and external agencies
- Opportunities to benefit from collaboration with other agencies/researchers pursuing similar projects
- Strong foundation of ecological research in the San Pedro watershed gives the project team a defensible scientific foundation to build on

## ○ Timeline

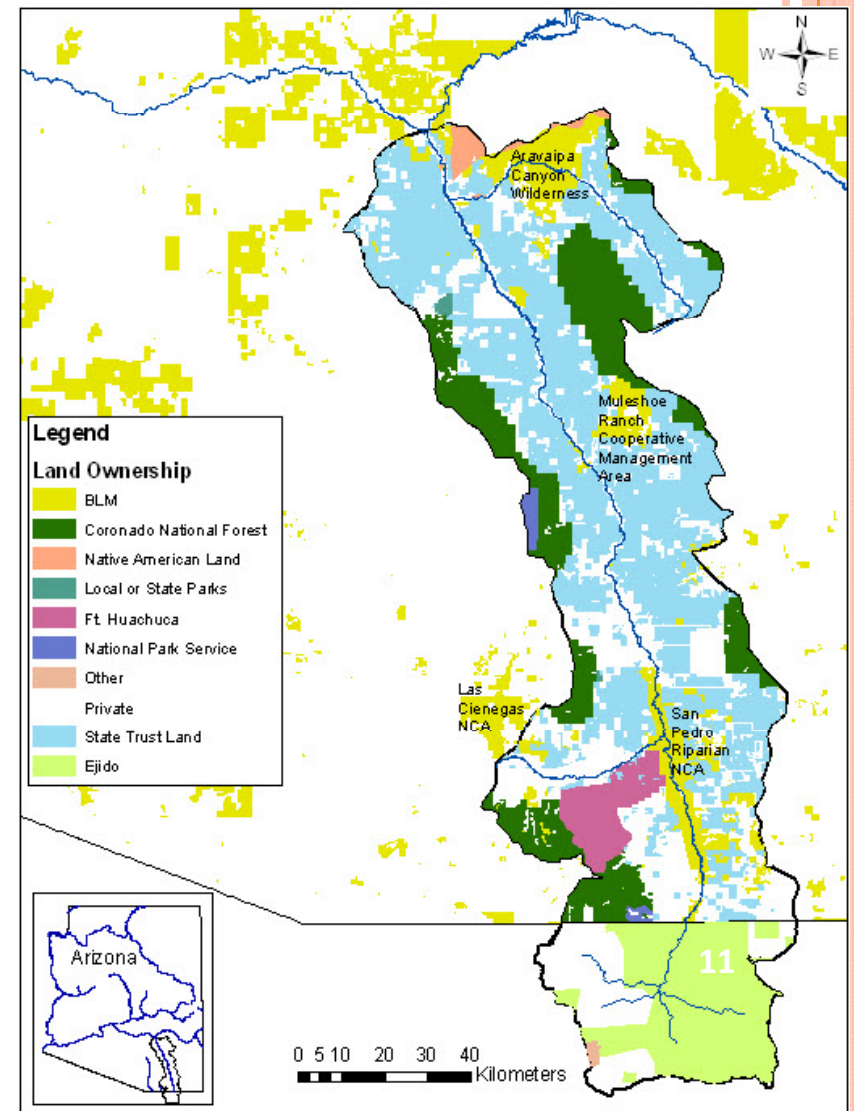
- Project kick-off meeting held in Jan 2010
- Final report in review; briefings & documents Jul-Aug 2011

## ○ Outcomes

- White paper on feasibility and usefulness of ecosystem service valuation for the BLM
- Technical report on valuation findings

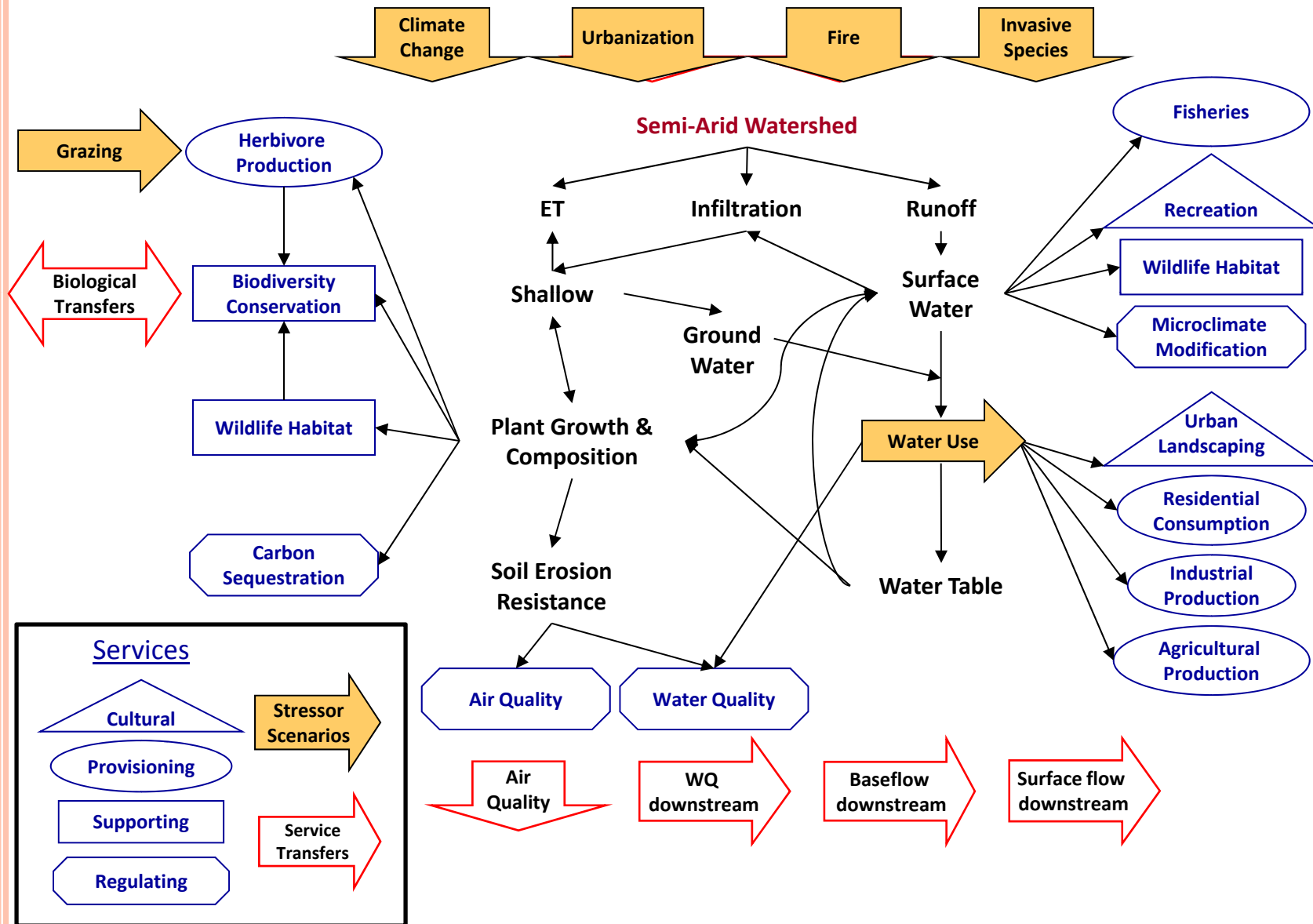
# ECOSYSTEM SERVICES EVALUATED

- Water
  - Ground water for drinking and irrigation
  - Surface water for recreation and aesthetics
- Biodiversity
  - Biodiversity for birding
  - Biodiversity for hunting
- Carbon sequestration and storage
- Cultural services
  - Recreation
  - Aesthetic



# SAN PEDRO GENERAL CONCEPTUAL MODEL

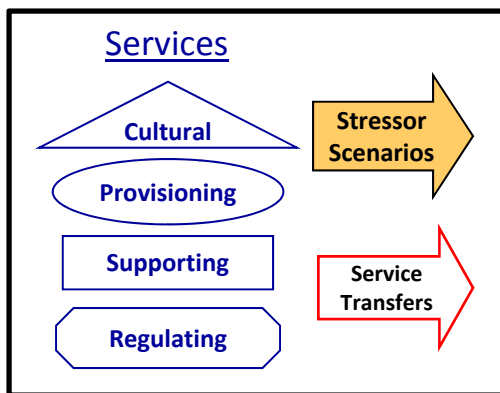
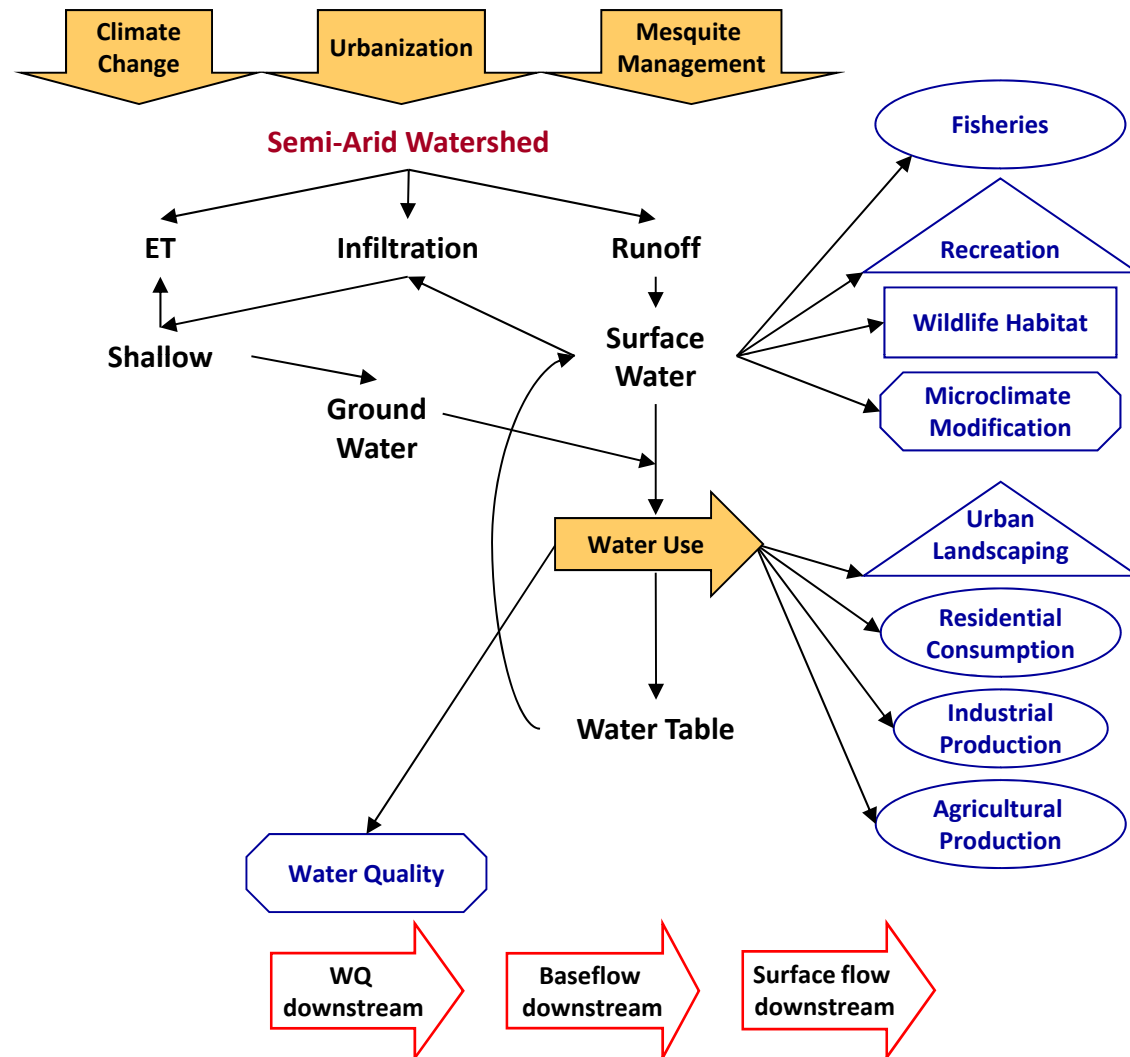
(MODIFIED FROM HAVSTAD ET AL., 2007)





# SAN PEDRO GENERAL CONCEPTUAL MODEL (WATER EXAMPLE)

(MODIFIED FROM HAVSTAD ET AL., 2007)

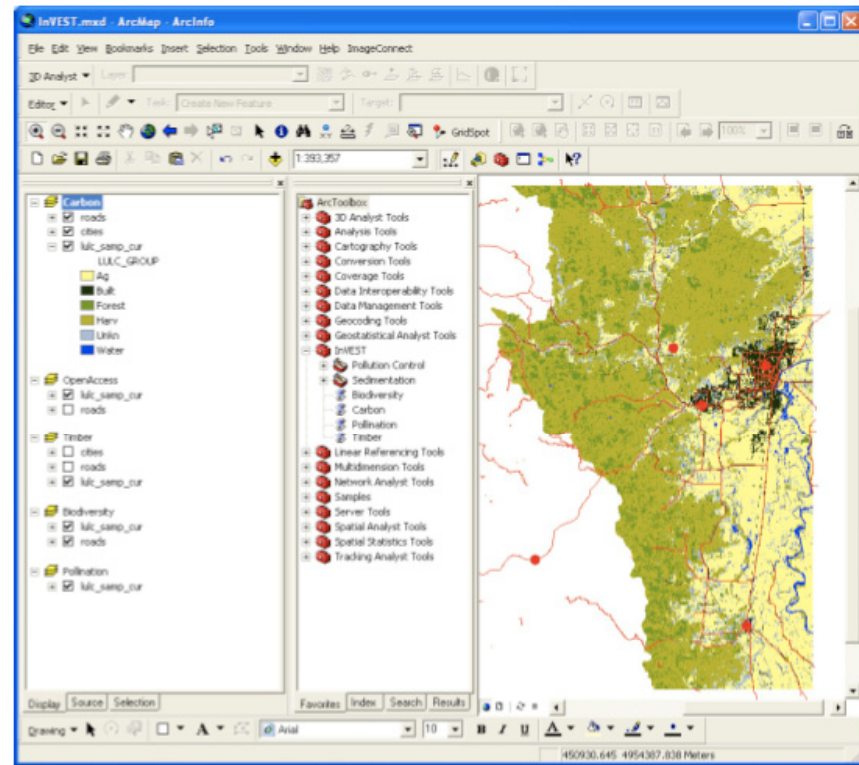


# HOW DO WE VALUE ECOSYSTEM SERVICES?

- Monetary and non-monetary valuation
  - Non-monetary does not exclude quantifying or formalizing values
  - Monetizing can be simple (e.g., market price for carbon) to complex (e.g., contingent valuation surveys)
- Methods
  - Primary valuation: conduct original study on economic value of ecosystem services
  - Benefit transfer: apply value estimates from an existing study to the site of interest
- Tools
  - Numerous tools have been developed in response to growing interest in ecosystem service valuation
  - This study examined two: InVEST and ARIES

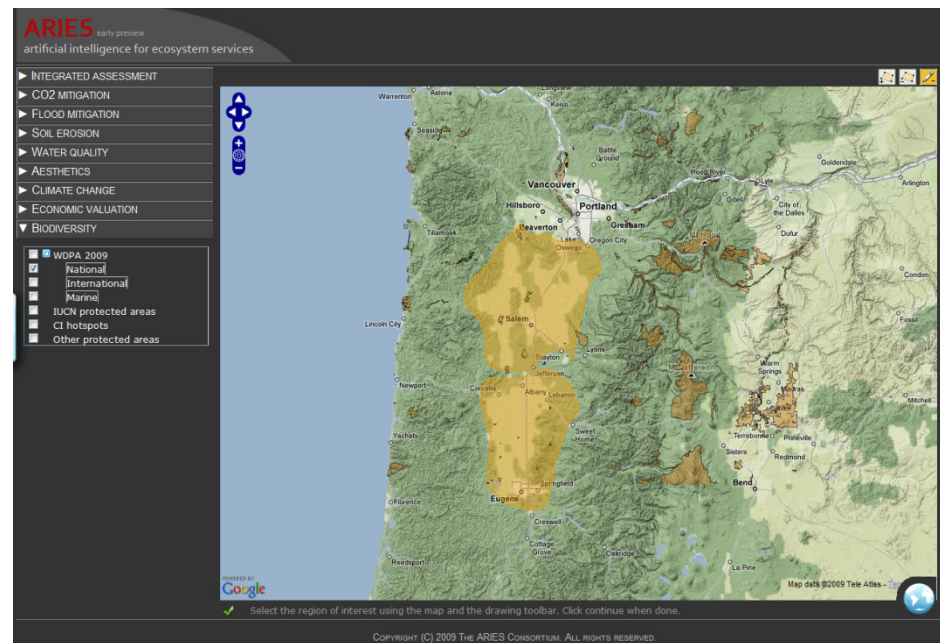
# INVEST: INTEGRATED EVALUATION OF ECOSYSTEM SERVICES AND TRADEOFFS

- InVEST is a family of free tools to map and value ecosystem goods and services
- Runs in ArcGIS
- Developed by the Natural Capital Project (WWF, TNC, Stanford University, and University of Minnesota)



# ARIES: ARTIFICIAL INTELLIGENCE FOR ECOSYSTEM SERVICES

- ARIES is a free application for mapping and valuing ecosystem services
- Web-based application
- Incorporates probability estimates and maps flows of services
- Funded by NSF; developed by a consortium including UNEP, University of Vermont, and Conservation International





## CRITERIA FOR EVALUATING TOOLS/METHODS

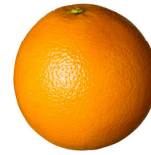
1. Does it measure ecosystem services or ecological processes?
2. Time requirements?
3. Open source: requirements for hiring consultants vs. using trained staff internally?
4. Current level of development?
5. Scalability & generalizability?
6. Ability to incorporate multiple cultural & valuation perspectives (i.e., monetary & nonmonetary, Native American/tribal values)?
7. Responsiveness to scenarios of possible change

# RESULTS: ARIES & INVEST MODELS



## Invest

- Carbon storage (tons)
- Combined surface and groundwater
- Biodiversity
- No uncertainty measure



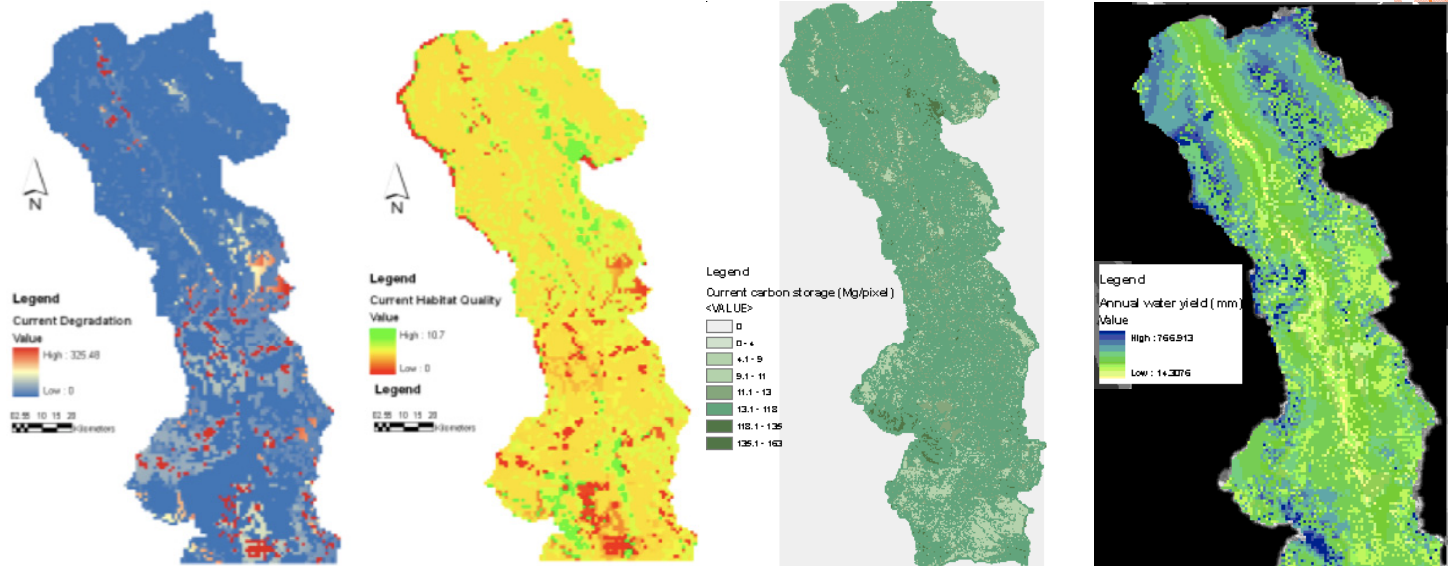
## ARIES

- Carbon storage (\$)
- Surface water only
- No biodiversity model
- Includes uncertainty measures

# RESULTS: ARIES & INVEST MODELS

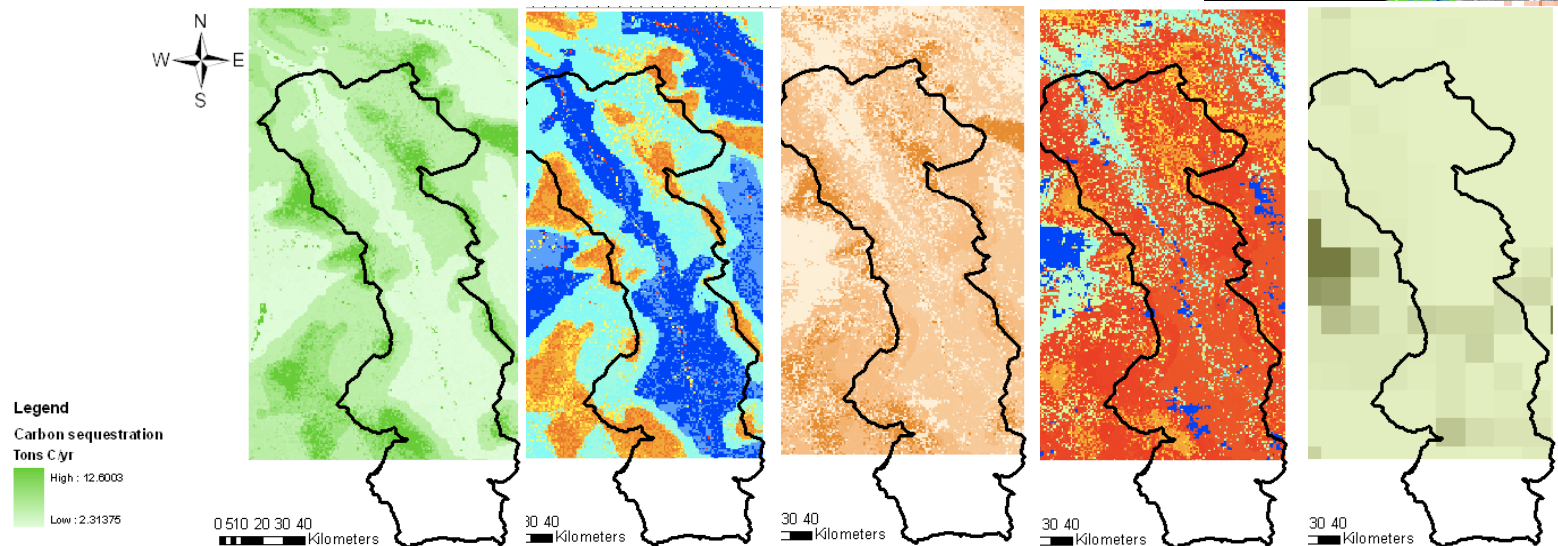
## InVEST

- Biodiversity
- Carbon
- Water yield results



## ARIES

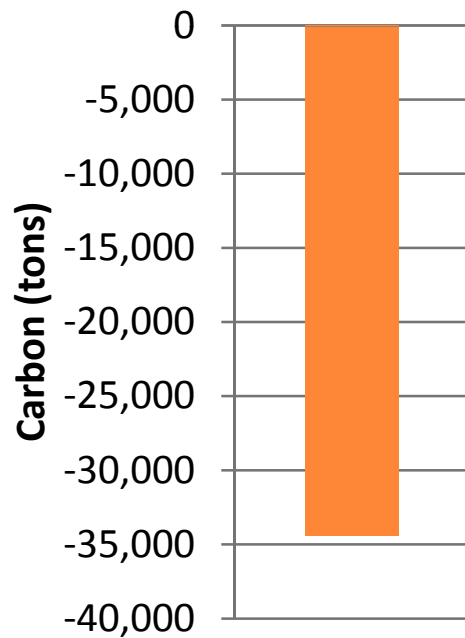
- Carbon results, incl. uncertainty maps



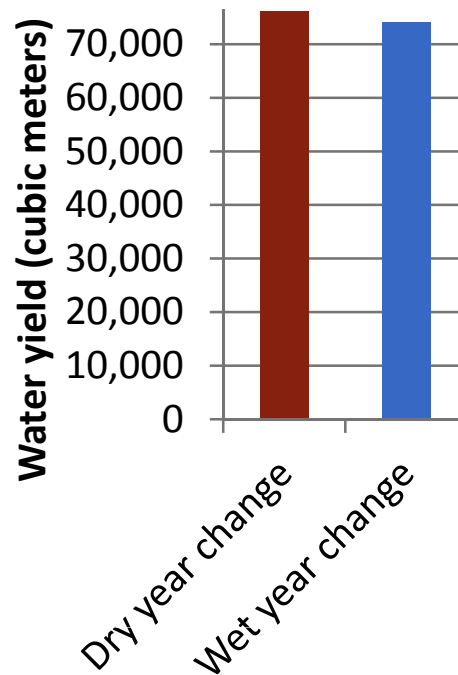
# SCENARIO RESULTS: MESQUITE MANAGEMENT

InVEST

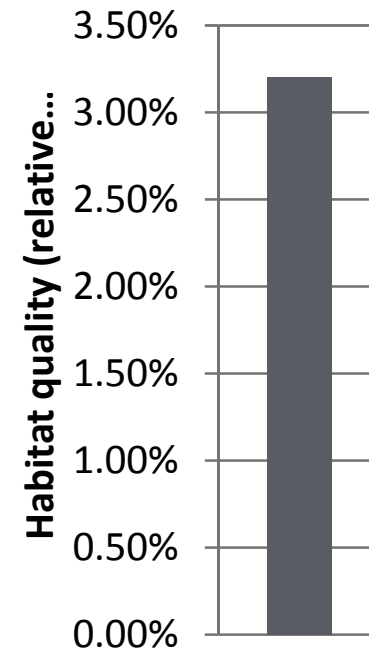
Change in carbon storage



Change in water yield



Change in habitat quality

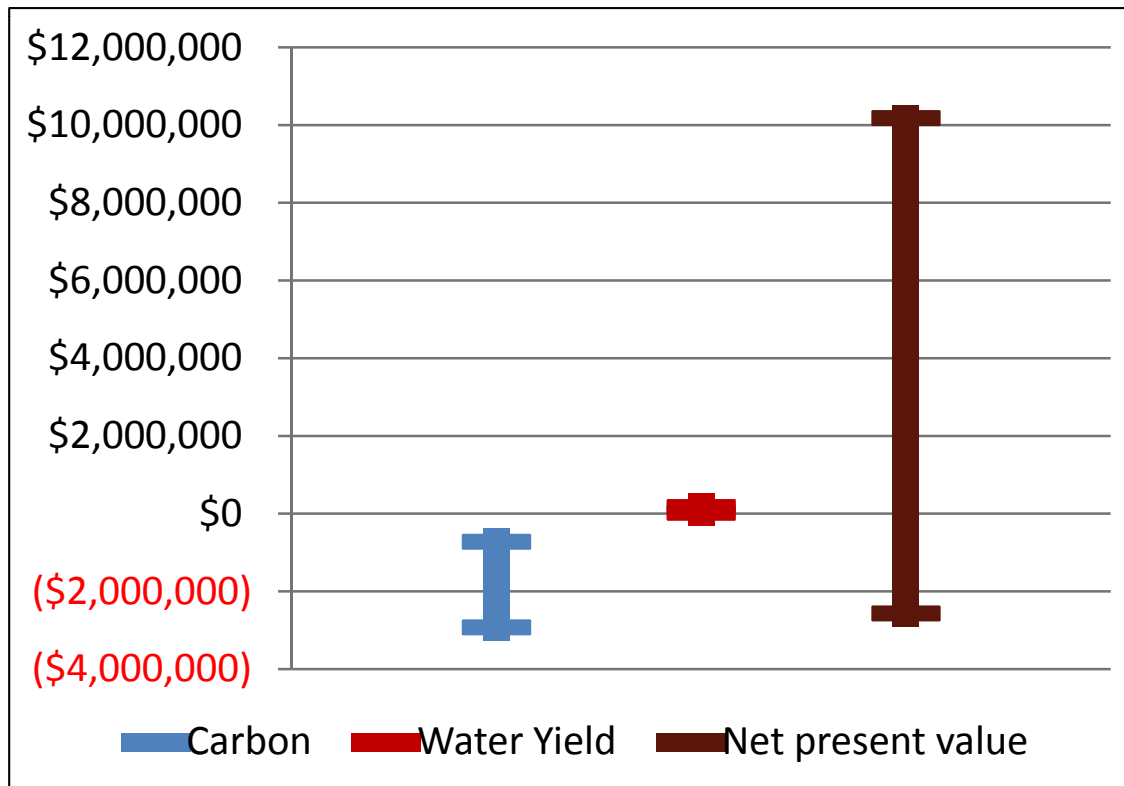




# SCENARIO RESULTS: MESQUITE MANAGEMENT

## InVEST (Monetization)

Range of values for carbon, annual water yield, and combined net present value (NPV)



**Monetary values depend on assumed price**

Service	Cost range
Carbon (ton)	\$21 to \$85
Water yield (m <sup>3</sup> / year)	\$0.33 to \$2.32
Discount rate	1% to 7%

## CONCLUSIONS: CHALLENGES

- Neither model produce reliable, high-quality outputs using reasonable resource levels to use on a Bureau-wide scale
  - Both models require very detailed data to support ecological and economic sub-models
  - Generalized models do not easily reflect local conditions
- Previously collected ecological & economic data do not always integrate well with model data needs

## CONCLUSIONS: GOOD NEWS

- The process works, but it requires substantial resources and time
- Given the rapidly changing landscape for ES tools, the models may rapidly improve development even in the short to medium-term (i.e., 6 to 12 months)
- Significant opportunities exist to reduce resource requirements to run these models (i.e., data management and sharing)
- Could improve the situation with:
  - Carefully-targeted funding
  - Incentives for collaboration between project teams & government, academic, NGO communities

# GILA DISTRICT OUTCOMES

- The results of these analyses reflect results that we instinctively know, but using these models allows for quantification of effects and a language for discussing management impacts
  - Widespread urban growth carries real and measurable costs
  - Sole reliance on monetary values to guide restoration decisions not always appropriate
- Well-defined scenarios, accompanying data, and conceptual linkages to ecosystem services are necessary for models to produce useful results
- Ongoing ecosystem services modeling work at USGS can provide additional models and results
  - Can improve quality and applicability of results for BLM lands across the region



# OPEN QUESTIONS

- How do ecosystem services get defined, and what are the best ways to define them?
  - InVEST: carbon storage & change over time
  - ARIES: carbon sequestration, potential stored carbon release, greenhouse gas emissions, and associated uncertainty
- How do uncertainty estimates play into the decision process, and for what outputs are uncertainty estimates most helpful?
- What level of detail does BLM need to facilitate decisionmaking?
  - Transferrable (generalized) models sacrifice local detail, and highly detailed site-specific models are not transferrable
- What is the appropriate balance between internal and external capacity at the BLM?

# KEY VARIABLE: TIME REQUIREMENTS VS. ADDED INFORMATION

Method/ Tool	Est. hours, pilot study	Est. hours with high- quality data	Relative amt. of information provided	Comments
Synthesis of past primary valuation	60	20	Moderate	Time needed for review and synthesis of the literature; could be greater in areas where more studies have been completed (for example, Pacific Northwest).
Value transfer	10	10	Low	Estimate for the Wildlife Habitat Benefits Estimation Toolkit. Time requirements would be substantially greater to build new transfer functions, particularly if using a Bayesian approach.
Ecosystem Services Review	10	10	Low	Can be completed quite quickly but does not provide quantitative results; time to completion could be several times greater if a large number of stakeholders are involved.
InVEST (3 ecosystem services)	250	40	High	Time to complete could be drastically reduced with system for sharing data and underlying model assumptions.
ARIES (4 ecosystem services)	800	40	Highest	Included time to customize and extensively debug models, which will not be necessary for future applications. Spatial data management system reduces data input needs in future applications.

No tool performs perfectly against all 7 evaluative criteria; suggests a time and place for different tools.

# BLM-WIDE OUTCOMES

Feasible for immediate agency-wide use

- Ecosystem Services Review, Wildlife Habitat Benefits Estimation Toolkit

Feasible for agency-wide use given development of supporting databases

- Primary Valuation, Point Transfer, Function Transfer, InVEST

Feasible for agency-wide use given pending development of global models or expanded underlying datasets

- ARIES, EcoServ, SolVES

Proprietary tools, feasible for use in high-profile cases where contracting with consultants is possible

- EcoAIM, EcoMetrix, ESValue, NAIS

Place-specific tools that require extensive developer support

- Ecosystem Portfolio Model, Envision, MEASURES, MIMES

# ECOSYSTEM SERVICES IN MANAGEMENT

- When to use ecosystem services?
  - 1) When there are noted substantial social or environmental effects as identified in the NEPA process,
  - 2) When there is a strong or evident tradeoff between maintenance of ecosystem services and extraction of market goods (oil, gas, coal, minerals, timber, grazing), or
  - 3) When nonmarket valuation would contribute to an issue to be addressed in the NEPA process.
- Ecosystem services do not need to be monetized to be useful
- A long term goal: Develop acceptable practices and standard methodologies (e.g., NOAA Panel on Contingent Valuation)

## NEXT STEPS

- Interagency development of shared databases and models
  - Federal Roundtable on Ecosystem Services
  - National Science and Technology Council – Sustaining Ecosystem Services Work Group
- Pilot Project Phase II
  - Problem-focused (e.g. use of ecosystem service valuation in a RMP)
  - Possibilities:
    - Use commodity-based scenario development (e.g., oil and natural gas)
    - Connect with BLM's ecoregional assessment process



# PROJECT CONTACTS

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