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# Understanding relationships between hydrology, habitat, and managing species of concern

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SERDP • ESTCP SYMPOSIUM

2018 | Enhancing DoD's Mission Effectiveness

# Outline

- Southwestern Stream Systems
- DoD and EPA funded projects
  - Connections between hydrology, wildlife habitat, and/or management
- Summary

*An intermittent stream in Arizona, dry most of the year*

# Southwestern Stream Systems

- Hydrologically very different from mesic or humid systems
- "Episodic" → Ephemeral or Intermittent, flow only in response to local spring flow, or from rainfall as pulsed, flash floods, lasting hours or days
- Predominant fluvial form in arid and semiarid regions
  - 94% of stream miles in Arizona, 88% in New Mexico (per NHD)
- Important for watershed connectivity and support for perennial reaches
- Especially in water-limited areas, the flow of water links the ecosystems in a watershed
  - Transports nutrients, sediment, seeds, organic matter throughout the system
- Comprise less than 1% of land area in the West, but support high biodiversity (flora / fauna) and habitat values relative to drier uplands
  - Vegetation is denser, taller, more diverse → cover, food, nesting, travel corridors

# Hydrology & Habitat

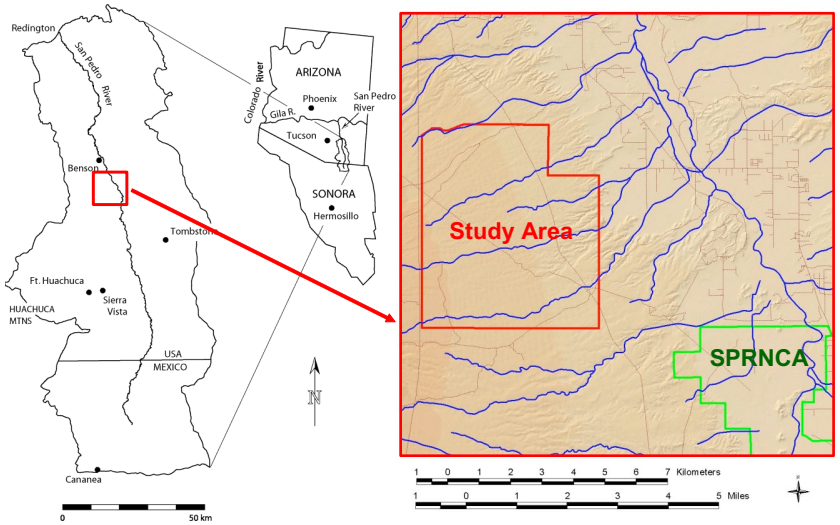
- About 80% of TER-S in the Southwest depend on riparian areas during some phase of their life cycle
- Understanding the hydrology of a system is a foundation for understanding species management
  - Hydrology drives habitat quantity and quality
  - Defines connectivity between populations and dispersal opportunities
- Understanding the interdependency of hydrologic, biogeochemical, and ecological processes can improve management of TER-S & training lands
- A watershed-based management approach is needed to protect water quality, riparian habitat, and TER-S
- Collaboration between hydrologists and ecologists is important!

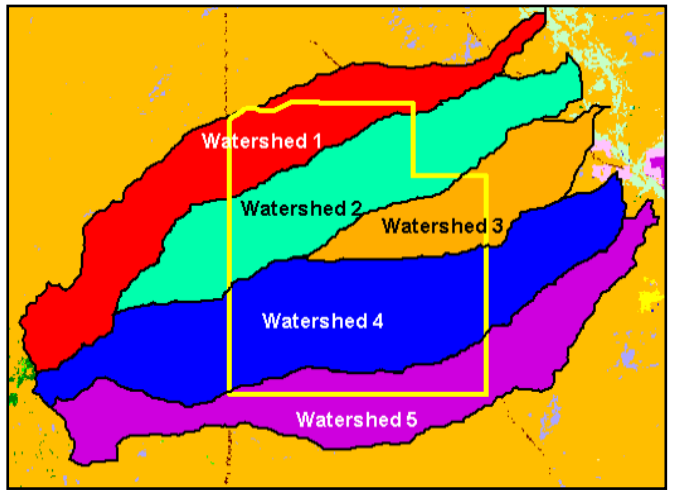
# DoD and EPA funded studies

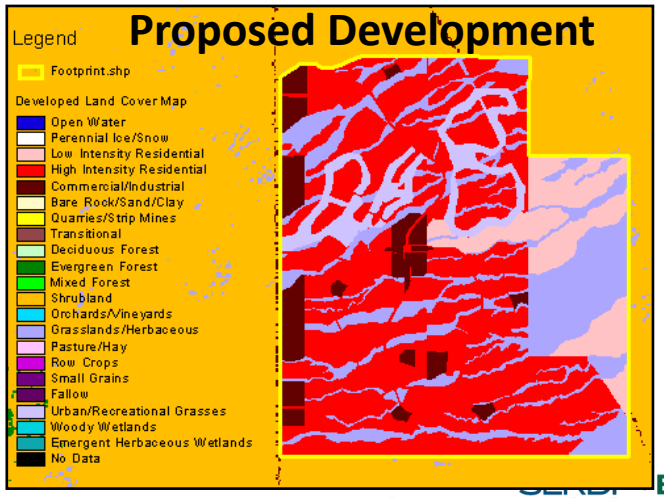
1. "Simulated Changes in Runoff and Sediment in Developing Areas near Benson, Arizona" (2006), EPA
2. "The Ecological and Hydrological Significance of Ephemeral and Intermittent Streams in the Arid and Semi-arid American Southwest" (2008), EPA
3. SERDP-ESTCP & Legacy Southwest Region Threatened, Endangered, and At-Risk (TER-S) Species Workshop (Tucson, 2007), "Hydrology & Ecology of Southwestern Intermittent Streams, Dry Washes, and Adjacent Riparian Zones"
4. SERDP RC-1727 (2010 – 2015): An Ecohydrological Approach to Managing Intermittent and Ephemeral Streams on DoD Lands in the Southwestern U.S.
5. ESTCP RC201308 (2013 – present): Automated Geospatial Watershed Assessment (AGWA) to Aid in Sustaining Military Mission and Training

# Simulated Changes in Runoff and Sediment in Developing Areas near Benson, Arizona

- Hydrologic Modeling study for EPA Region 9 (2006; CWA support)
  - Simulation of proposed 8,200 acre development along the San Pedro River, an important riparian area, TER-S habitat and migration corridor
  - How would modification of ephemeral streams impact the San Pedro River?
  - Automated Geospatial Watershed Assessment Tool (AGWA) & KINEROS2
    - "Relative Change" analysis of sediment and runoff, using design storms



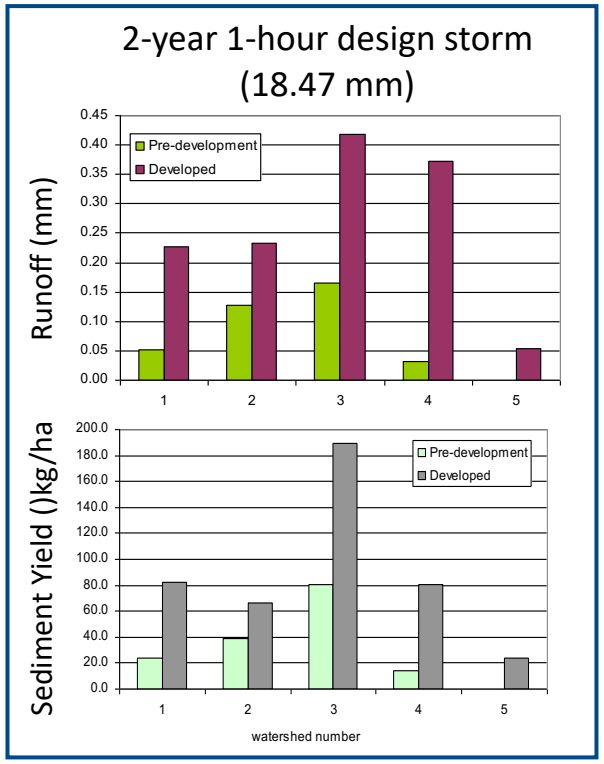
# Simulated Changes in Runoff and Sediment in Developing Areas near Benson, Arizona (cont.)

- Model results showed large relative (percent) increases in runoff & sediment in ephemeral streams & at the river from proposed development
  - Potential impacts to physical, chemical, and biological integrity of the San Pedro River (CWA & ESA implications)
- Highlights importance of local hydrology for decision making

Percent change (%) at the San Pedro River for each rainfall event, for each watershed, and as an average of all 5 watersheds

| watershed | watershed | 2yr 1hr event (18.47 mm) | | 5yr 1hr event (23.09 mm) | | 10yr 1hr event (28.67 mm) | |
|---|---|---|---|---|---|---|---|
| number | area (ha) | runoff | sed yld | runoff | sed yld | runoff | sed yld |
| 1 | 1717.01 | 345 | 248 | 46.0 | 61.2 | 22.5 | 36.6 |
| 2 | 1701.69 | 83.8 | 71.6 | 22.1 | 17.7 | 12.2 | 14.6 |
| 3 | 873.45 | 154 | 134 | 42.8 | 27.7 | 16.5 | 10.4 |
| 4 | 2553.50 | 1070 | 471 | 111 | 96.1 | 48.8 | 29.2 |
| 5 | 1755.11 | 134,000 | 8,650,000 | 40.1 | 42.3 | 17.3 | 26.1 |
| **avg % all watersheds** | | **†413** | **†231** | **52.4** | **49.0** | **23.4** | **23.4** |

†Average excludes results from Watershed 5 due to zero (0) flow prior to development which results in very large percent change.




L. Levick, D. Semmens, D. Goodrich, W. Kepner, J. Brush, R.A. Leidy, and E. Goldmann. 2006. Simulated changes in runoff and sediment in developing areas near Benson, Arizona. EPA/600/R-06/158; ARS/1873

# The Ecological and Hydrological Significance of Ephemeral and Intermittent Streams in the Arid and Semi-arid American Southwest

- "Ephemeral Streams report" for EPA Region 9, for CWA support
- Demonstrates the value of ephemeral and intermittent streams in the SW
  - Hydrology, biogeochemical functions, plant community support, faunal support and habitat
  - Connectivity to and support for perennial reaches
- Review of current literature and state of the science (2008)
- Conclusions
  - E/I streams are hydrologically connected to perennial systems
  - Hydrologic, biogeochemical, ecological processes are interdependent
  - A watershed-based approach is required to protect water quality and riparian habitat
  - Collaboration between hydrologists and ecologists is recommended

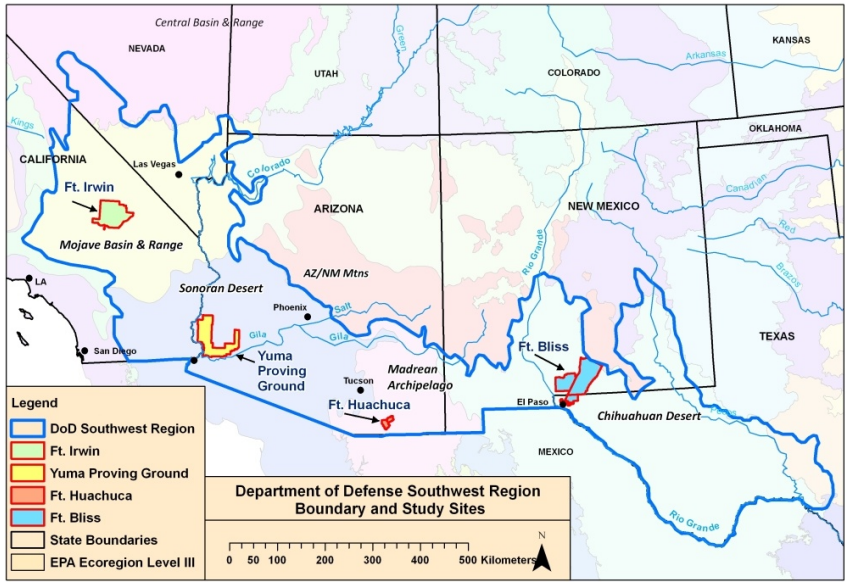
Levick, L., J. Fonseca, D. Goodrich, M. Hernandez, D. Semmens, J. Stromberg, R. Leidy, M. Scianni, D. P. Guertin, M. Tluczek, and W. Kepner. 2008. The Ecological and Hydrological Significance of Ephemeral and Intermittent Streams in the Arid and Semi-arid American Southwest. U.S. Environmental Protection Agency and USDA/ARS Southwest Watershed Research Center, EPA/600/R-08/134, ARS/233046, 116 pp.

# DoD Southwest Region Threatened, Endangered, and At-Risk Species Workshop

- SERDP, ESTCP, and Legacy Workshop in Tucson, 2007
  - "…to determine how their limited research, demonstration, and management funds can best be invested to improve DoD's ability to effectively address its TER-S management requirements in the Southwest while maintaining the military training mission"
- Breakout session "Hydrology & Ecology of Southwestern Intermittent Streams, Dry Washes, and Adjacent Riparian Zones"
- Recommended priority research needs
  - Quantify the hydrologic regime of these streams
  - Distinguish dryland "stream types" by delineating variations in vegetation, hydrology, geomorphology
  - Investigate linkages between biological occurrence, stream hydrogeomorphology, and associated vegetation

# SERDP FY10 SON "MANAGING AND RESTORING SOUTHWEST INTERMITTENT AND EPHEMERAL STREAM SYSTEMS ON DoD LANDS"

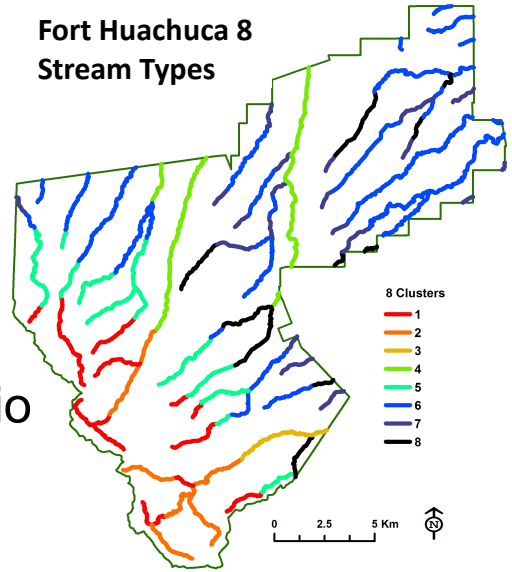
- An Ecohydrological Approach to Managing Intermittent and Ephemeral Streams on Department of Defense Lands in the Southwestern United States (Project RC-1727)
  - Develop a Stream Type Classification that characterizes the ecohydrologic variation of southwestern intermittent and ephemeral stream systems based on *hydrology, vegetation,* and *geomorphology*
  - Develop associations of Stream Types to wildlife habitat for TER-S management
    - Identify potential new habitat, areas for protection




- Fort Irwin, CA – Mojave Desert
- Yuma Proving Ground, AZ – Sonoran Desert
- Fort Huachuca, AZ – Madrean Archipelago
- Fort Bliss, TX – Chihuahuan Desert

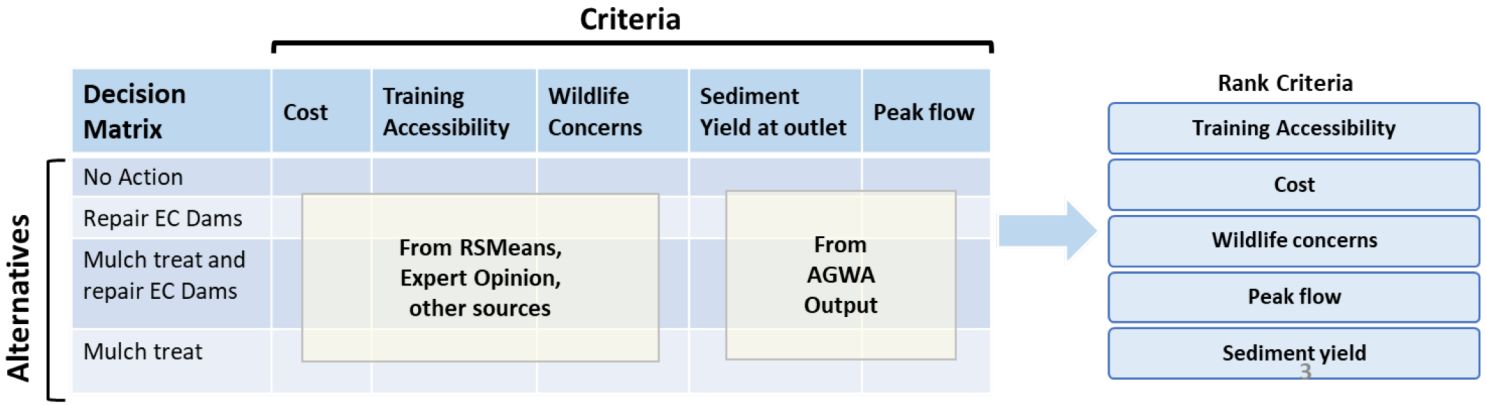
# Stream Type Classification

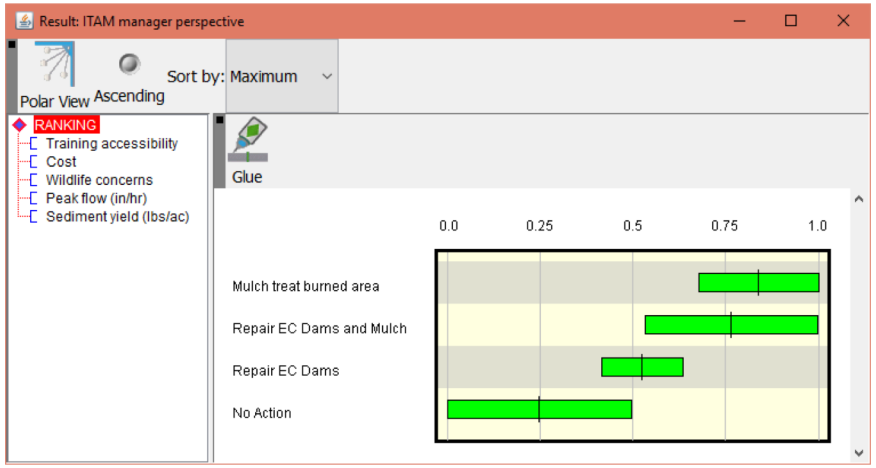
- NHD stream network, ~1 km stream reaches, GIS-based
- Input Variables for each stream reach
  - Hydrologic: flow permanence & peak flow, total stream power, rainfall seasonality index
  - Vegetation: percent cover & mean vegetation index (satellite imagery), vegetation structure (multi-return LiDAR)
  - Geomorphic: elevation, slope, drainage area, riparian width, entrenchment ratio
- Cluster Analysis → Stream Type for each stream reach
- CART → Variable ranges for each Stream Type (predictive model)
- Variable importance: Hydrologic → high annual rainfall or rainfall is highly seasonal; Vegetation → rainfall equally distributed; Geomorphic → low rainfall
- Applied Variables and Stream Types to identify wildlife habitat for riparian associated species to support TER-S management
  - Gray Vireo at Fort Bliss: elevation, vegetation structure & density most important (hydrology)
- More info: SERDP Project RC-1727 Final Report; J. Arid Environments



# Automated Geospatial Watershed Assessment (AGWA) to Aid in Sustaining Military Mission and Training

- ESTCP project RC201308, Demonstrate AGWA-Facilitator DSS to support management of training lands and decision-making
- Applied AGWA hydrologic models (KINEROS2 and SWAT) to identify areas at-risk from flooding or erosion due to:
  - Training disturbance, fire (wild or prescribed), range expansion, roads, urbanization
  - Affects wildlife and habitat
- Facilitator DSS, incorporates wildlife concerns



# Summary

- Understanding the interdependency of hydrologic, biogeochemical, and ecological processes can improve management of TER-S and training lands
- Ecosystems are linked by the flow of water, requiring a watershed-based management approach to protect water quality, riparian habitat, and TER-S
- Collaboration between hydrologists and ecologists!

# Thank You!

Flash flood on an ephemeral channel at Walnut Gulch Experimental Watershed, Tombstone, Arizona

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