Demonstrating Innovative River Restoration Technologies: Truckee River, Nevada

A Demonstration of the Ecosystem Functions Model (HEC-EFM)

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Project Team: Includes members of HEC, DRI, and ERDC

USACE, Hydrologic Engineering Center
Desert Research Institute

Urban Flooding and Channel Restoration in Arid and Semi-Arid Regions Demonstration Program

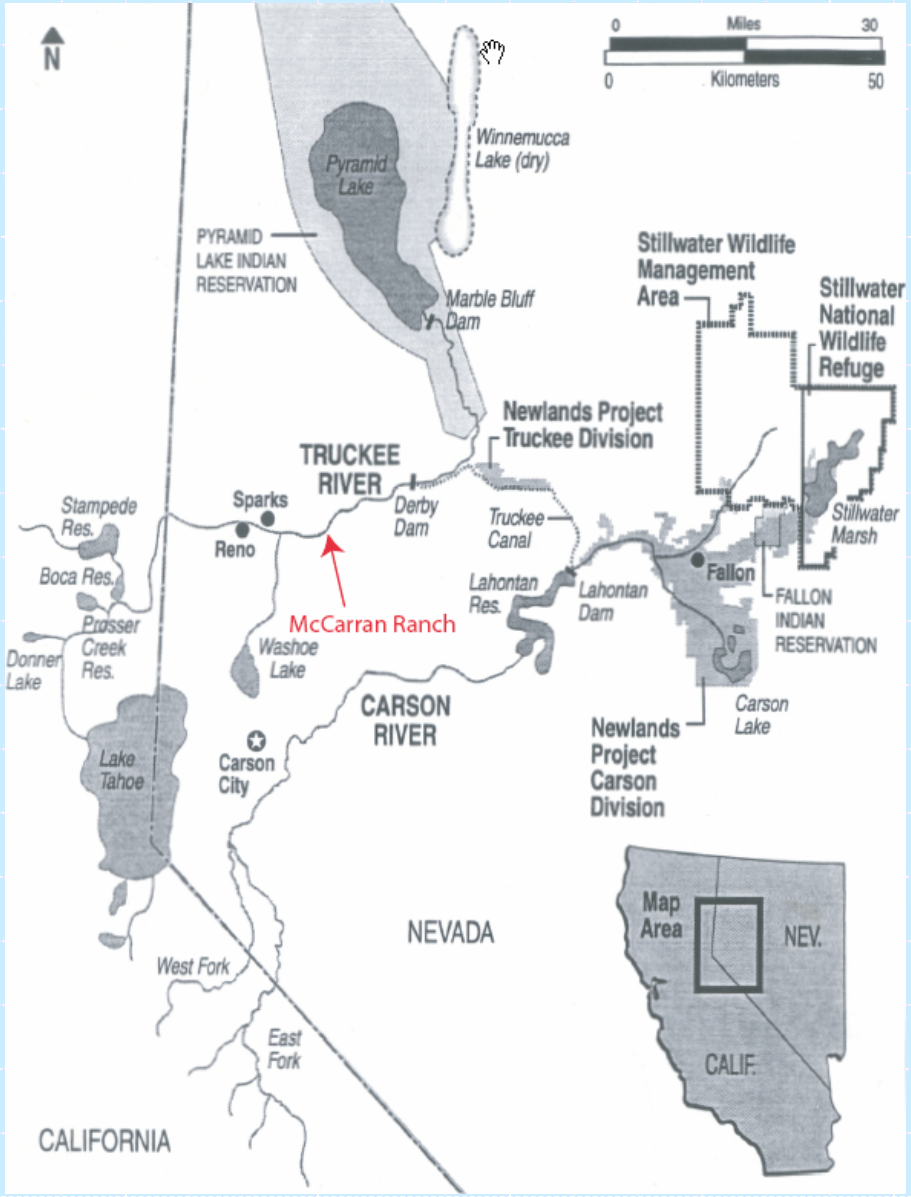
- Encourage collaboration between Corps and Desert Research Institute
- Take new or nearly completed urban flood and channel restoration R&D technologies and demonstrate them in the field
- Products must be useful to the field
- Regional program adapted for arid and semi-arid regions
- Teaming of ERDC, HEC, DRI, SPD, and local interests
- Envisioned as 5-year program with $2-3 million funding per year

Needs of Arid and Semi-Arid Regions

- Rapidly developing population centers
- Unique watershed management and demand issues
- Opportunity to meet the special needs of this region
- Expertise of Desert Research Institute
- National mission and expertise of Corps
- International potential for arid regions expertise
- High potential ROI benefits

Project Area

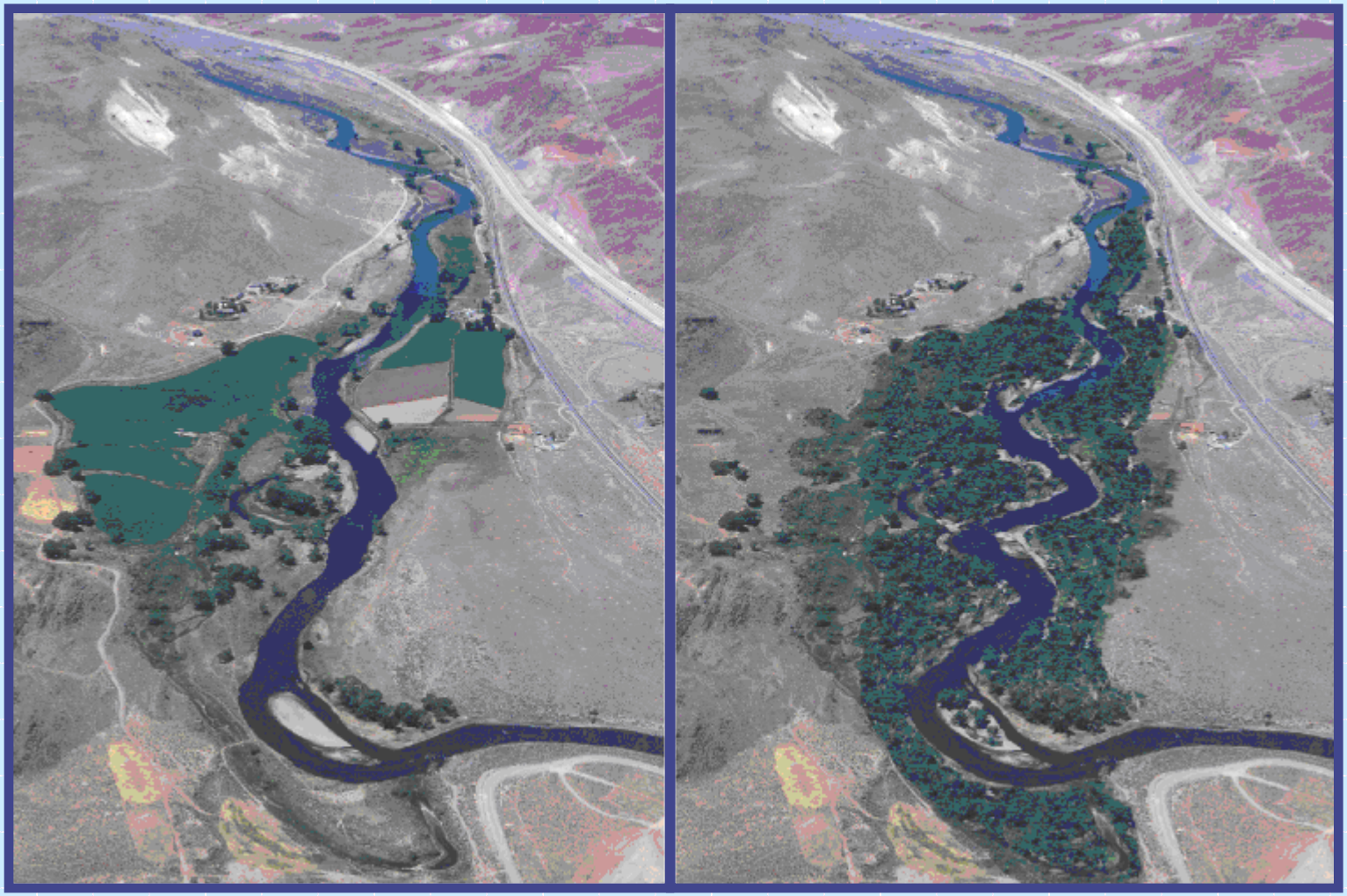
- McCarran Ranch – ~ 5 m
- Truckee River – ~ 100 m



Background –
McCarran Ranch/Truckee River Pilot Restoration Project

- Restore ~ 1 mi. of channel
  - Raise bottom
  - Narrow width from 200 down to 120 ft.
  - Add meanders
- Purpose - Reconnect channel to floodplain
- Highly leveraged by The Nature Conservancy, Cities of Reno and Sparks, US Fish and Wildlife Service, Nevada Division of Environmental Protection, Regional Water Planning Commission, National Fish and Wildlife Foundation and the US Bureau of Reclamation

McCarran Ranch/Truckee River Pilot Restoration Project



Our Purpose -

- Use and evaluate innovative approaches to assess the impact of river restoration activities on the Truckee River
  - Analyze/predict changes to ecosystem habitat caused by modifying channel geometry to more “natural” state.
  - Use the results from the intensively studied McCarran Ranch reach to later make decisions for the entire river.

Process Overview

- Apply the Ecosystem Functions Model (EFM) to identify flows that meet various physical parameters for existing and proposed channel modification.
- Run steady-state HEC-RAS and HEC-GeoRAS to produce floodplain maps of flows identified by EFM
- Process floodplain maps in GIS software to illustrate and quantify affects of channel modification on the various ecosystem habitats.

What is the EFM?

- Planning tool used by biologists, engineers, geomorphologists, and environmental managers to assess how proposed changes to the flow regime (e.g., reservoir operations or channel modifications) will impact terrestrial and aquatic habitat
- Indicates the directions and relative magnitude of biological change
- Use hydrologic and hydraulic data to help predict biological response in rivers and adjoining floodplains, wetlands, and estuaries

Input and Data Requirements

What do you need?

- Statistical Assessment only…
  - Hydrologic Data - Period of Record
    - flow time series
    - stage time series
  - Relationships between ecology and hydrology
- …and for Spatial Features
  - Topographic Data (DTM)
  - Geo-Referenced Hydraulic Model
  - GIS Software and Data

EFM Relationships

To be Used as Indicators of Eco-Change

- Link the characteristics of hydrologic and hydraulic time series (flow and stage) to elements of the ecosystem through combinations of four basic criteria:
    1. Season
    2. Flow Frequency
    3. Duration
    4. Rate of Stage Recession
- Statistical analyses are performed on the time series records to determine the flow and stage that meet the criteria for each relationship

Relationships

- Have been developed to investigate a range of ecosystem elements, including fish spawning, fish rearing, fish stranding, recruitment of large woody debris, channel migration, riparian forest regeneration, and many others.
- Truckee application includes:
  - Cottonwood establishment
  - Cottonwood inundation
  - Substrate
  - Mayfly Habitat

Terrestrial Relationship

Flow Events Suitable for Plant Establishment

- Physical Parameter:
  - recurrence of overbank flows in germination periods that recede slower than a threshold rate
- Ecological Response:
  - cottonwood regeneration
- Relationship(s):

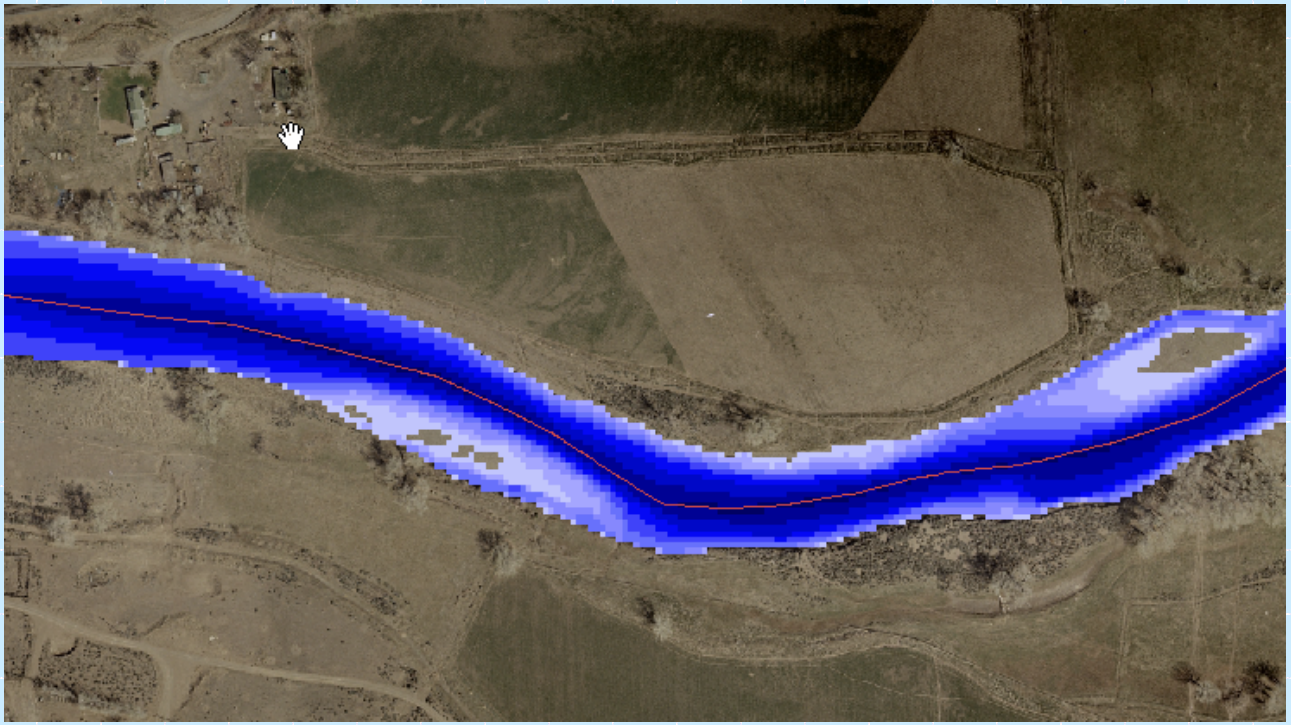
  1) June 15 – August 1 time period

  2) must have a stage decline of < 0.58 ft/wk

  3) for events meeting the above criteria, return period of < 10-years
- Output:
  - GIS layer of regeneration zones

Criteria Area for Cottonwood Establishment

- Establishment
  - Flow = 1,256 cfs
  - Elev. = 4275.2



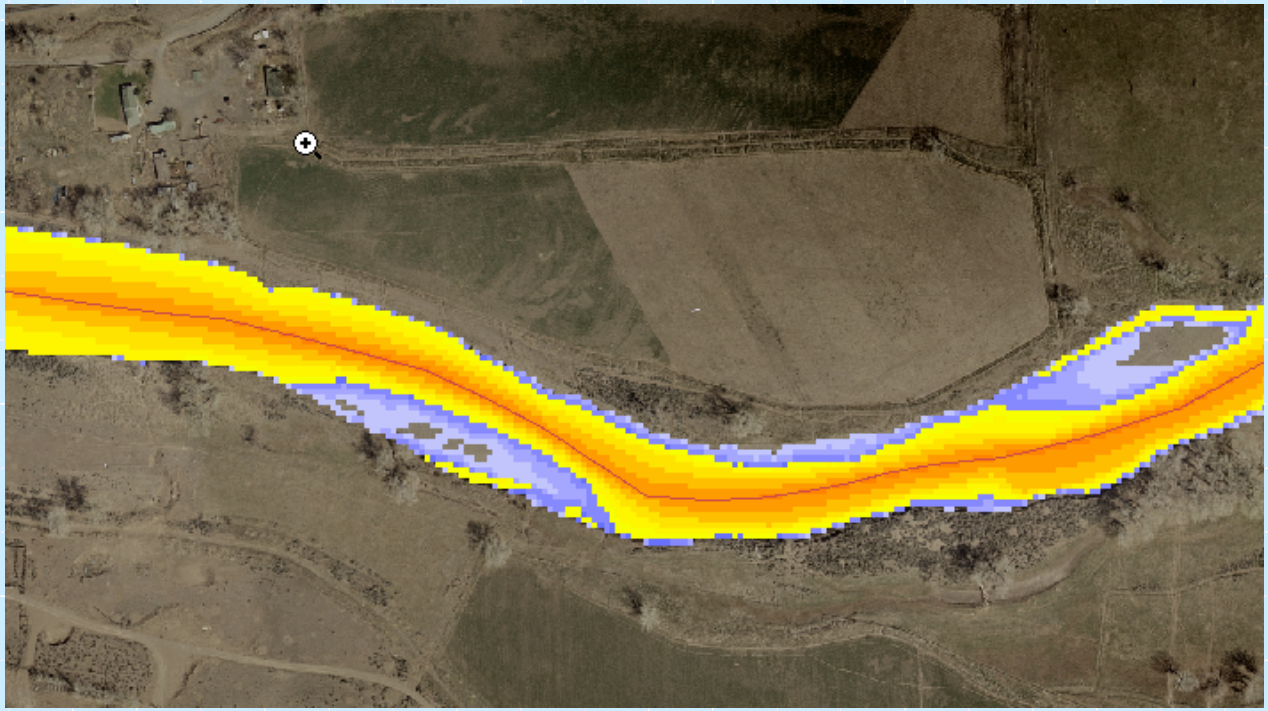
Terrestrial Relationship

Inundation of Habitat

- Physical Parameter:
  - sustained high stage during late growing season
- Ecological Response:
  - extent of seedling drowning
- Relationship:
  - highest stage sustained for twenty-one days from early August to mid-September during the period that germinate the seedlings
- Output:
  - GIS Layer of late season inundation extents

Fringe Habitat for Cottonwood Establishment

- Establishment
  - Flow = 1,256 cfs
  - Elev. = 4275.2
- Inundation
  - Flow = 385 cfs
  - Elev. = 4273.8



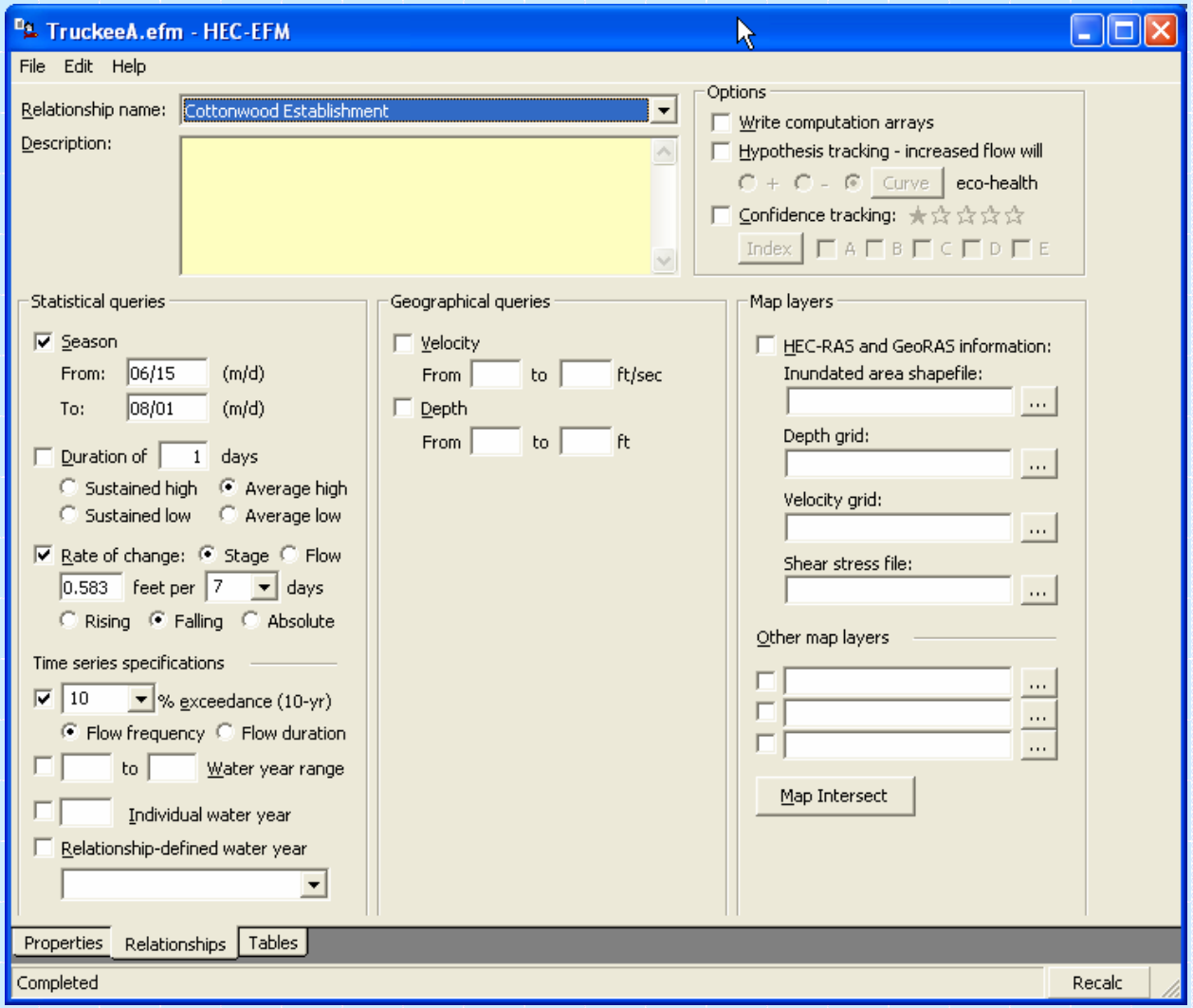
Truckee EFM Input Data

- Observed USGS flow/stage time-series records from 1972 to present
- Restored HEC-RAS model included cross-sections of restored design channel geometry from USACE SPK.
- Used representative restored channel geometry cross-section to derive restored stage time-series records

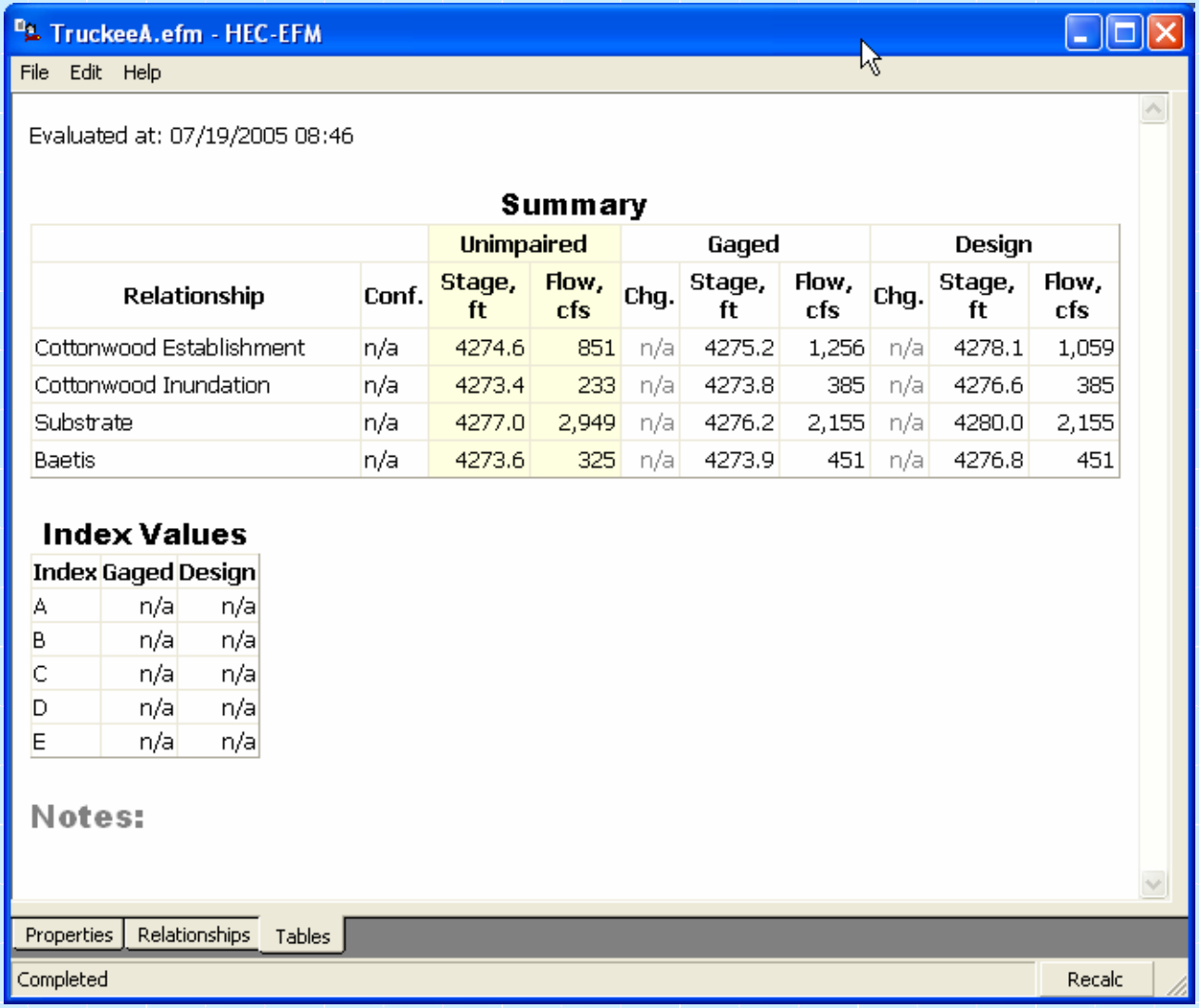
Truckee EFM Input Data

- DRI scientists provided relationships for:
  - Substrate
  - Cottonwood recruitment habitat
  - Mayfly habitat
- For results presentation in GIS software - generated restored DTM (TIN) by removing existing stream and integrating restored cross-sections with ArcView/Spatial Analyst tools.

EFM - Graphical User Interface (GUI)



Truckee EFM Application – Statistical Results



TruckeeA.efm - HEC-EFM

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Summary

Relationship	Conf.	Unimpaired Stage, ft	Unimpaired Flow, cfs	Unimpaired Chg.	Gaged Stage, ft	Gaged Flow, cfs	Gaged Chg.	Design Stage, ft	Design Flow, cfs
Cottonwood Establishment	n/a	4274.6	851	n/a	4275.2	1,256	n/a	4278.1	1,059
Cottonwood Inundation	n/a	4273.4	233	n/a	4273.8	385	n/a	4276.6	385
Substrate	n/a	4277.0	2,949	n/a	4276.2	2,155	n/a	4280.0	2,155
Baetis	n/a	4273.6	325	n/a	4273.9	451	n/a	4276.8	451

Index Values

Index	Gaged	Design
A	n/a	n/a
B	n/a	n/a
C	n/a	n/a
D	n/a	n/a
E	n/a	n/a

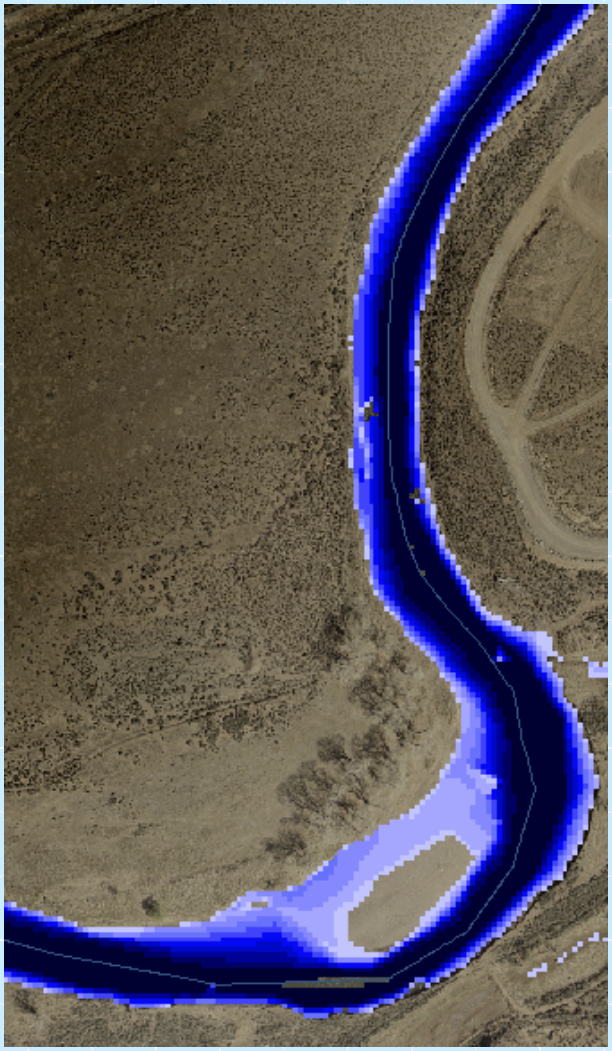
Notes:

Properties Relationships Tables

Completed Recalc

Spatial Analysis

- Statistical results (flows) are input to a hydraulic model (HEC-RAS) to develop:
  - water surface profiles
  - shear stress
- GeoRAS distributes RAS output into grids for GIS analysis and display
  - depth grid
  - velocity grid
  - inundation boundary maps

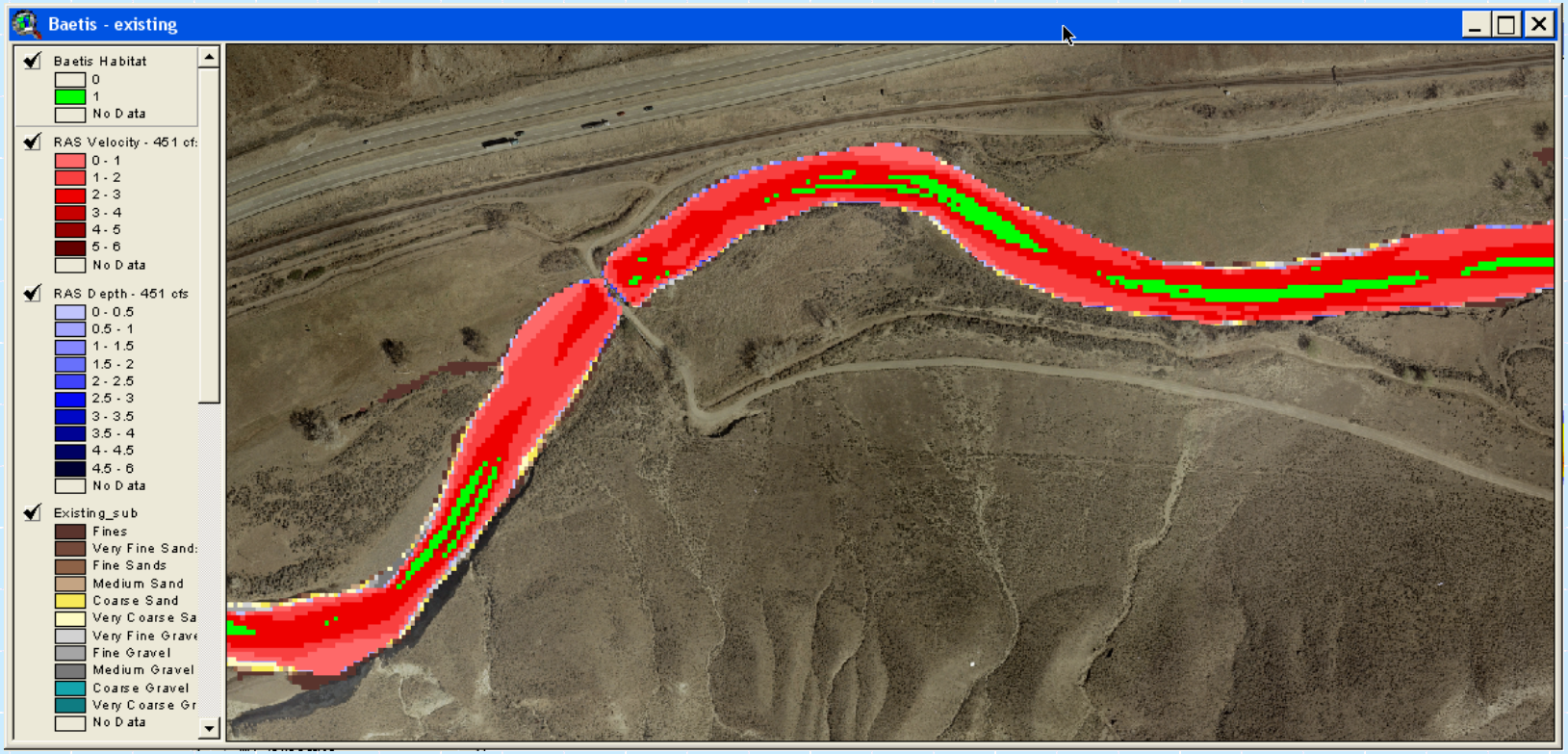


Truckee Relationships - Substrate

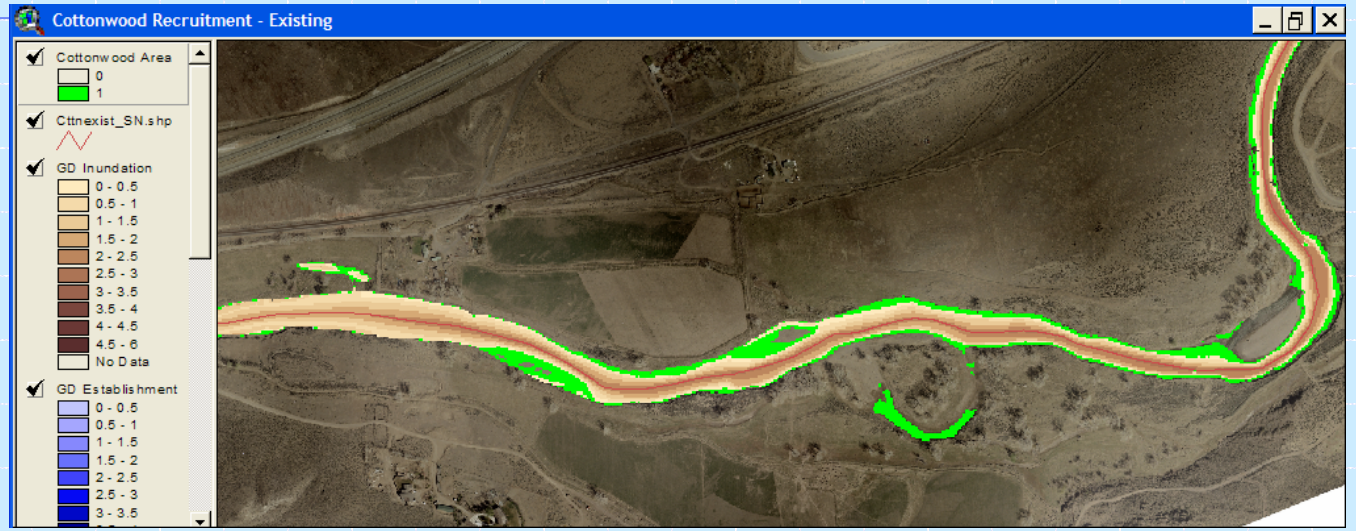
- Season – All year
- 2-year event (flushing flow)

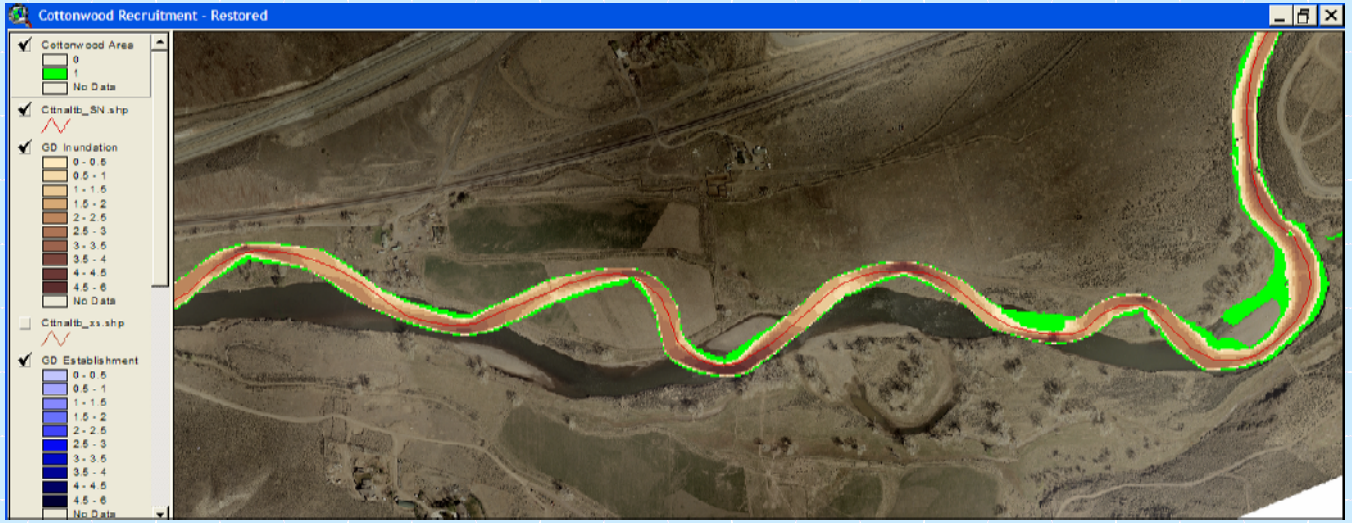
Truckee Relationships – Mayfly Habitat

- Season – Mid Aug through mid Sep
- 2-year event



Truckee EFM - Spatial Results





Truckee EFM Future

- Provided to DRI for ongoing research
- Post McCarran Ranch Restoration
  - Actual results can be measured against EFM results to measure EFM application merit
  - Lessons learned can be used for future EFM development and application
  - EFM can be used on other locations along the Truckee saving time and money

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