HABITAT HYDRAULICS:

SENSITIVITY ANALYSIS AND HABITAT SUITABILITY MODELING OF RIO GRANDE SILVERY MINNOW

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BUREAU OF RECLAMATION

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OVERVIEW: (2) PROJECTS

In 2019, USACE-SPA entered interagency agreement with USACE-ERDC's Ecosystem Management Restoration Research Program.

- Conduct sensitivity analysis of hydrology and hydraulic parameters with field-measured Minnow population metrics.

In 2019, USACE-SPA entered interagency agreement with USBR.

- Map Habitat Suitability for the Rio Grande Silvery Minnow at (8) Habitat Restoration Sites in the San Acacia Reach.
- Develop **repeatable** methods to quantify "hydraulic habitat effectiveness".

Photo credit: Jennifer Bachus, USBR 2016

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OUTLINE

- Hydraulic habitat in theory;
- Findings from the Sensitivity Analysis;
- Findings from Restoration Site Mapping;
- Getting to praxis:
  - Implementing in project design and monitoring,
  - Data needs,
  - Modeling limitations.

Photo credit: Noel Mollinedo, UNM 2019

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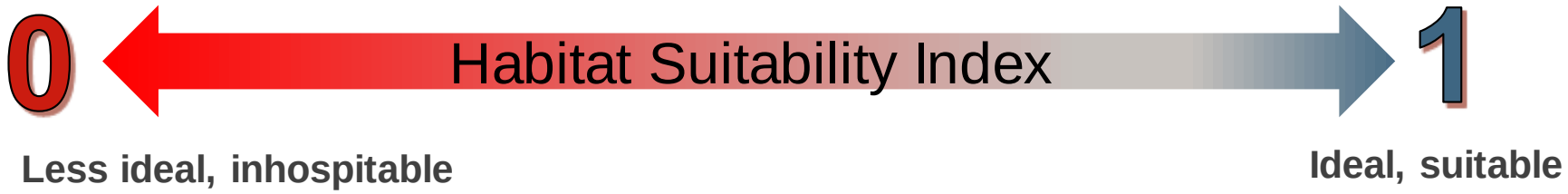
HYDRAULIC HABITAT SUITABILITY

THEORY: if we can correlate habitat criteria to environmental flows, to hydraulics, to spatial data, then we can use this information for design, implementation and monitoring.

- Focusing on the larval to juvenile life stage of the minnow.
- Some criteria for adults are available, but there is much more uncertainty.



This year, we discussed:

- Binary criteria (totally suitable or totally not) is not accurate.
- Other spatial criteria: substrate, landcover, etc. should be used in mapping suitable habitat.

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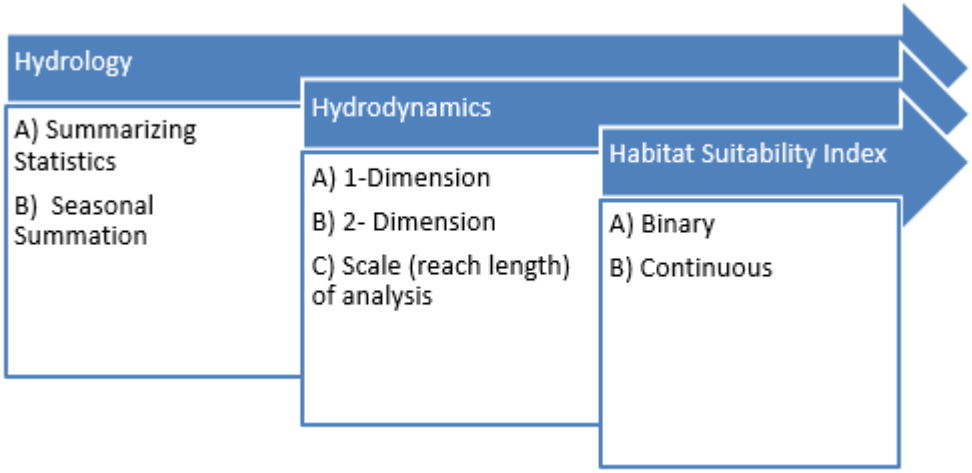
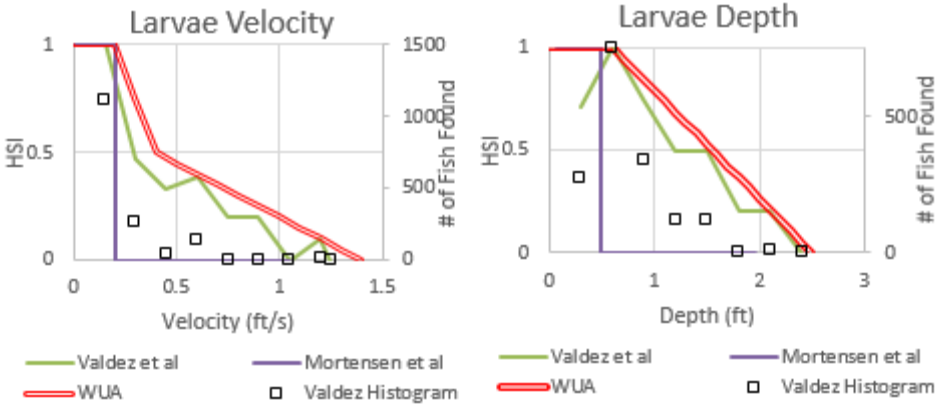
FIRST PROJECT: SENSITIVITY ANALYSIS



Objective:

Does increasing the complexity of analysis of the spring runoff generate better correlations with fish population data?



Tests our Assumptions:

Can the life cycle of the Minnow be reflected in summarizing noisy spring hydrographs?

Does hydraulic suitability over-generalize habitat characterization?

Is hydraulic information helpful?

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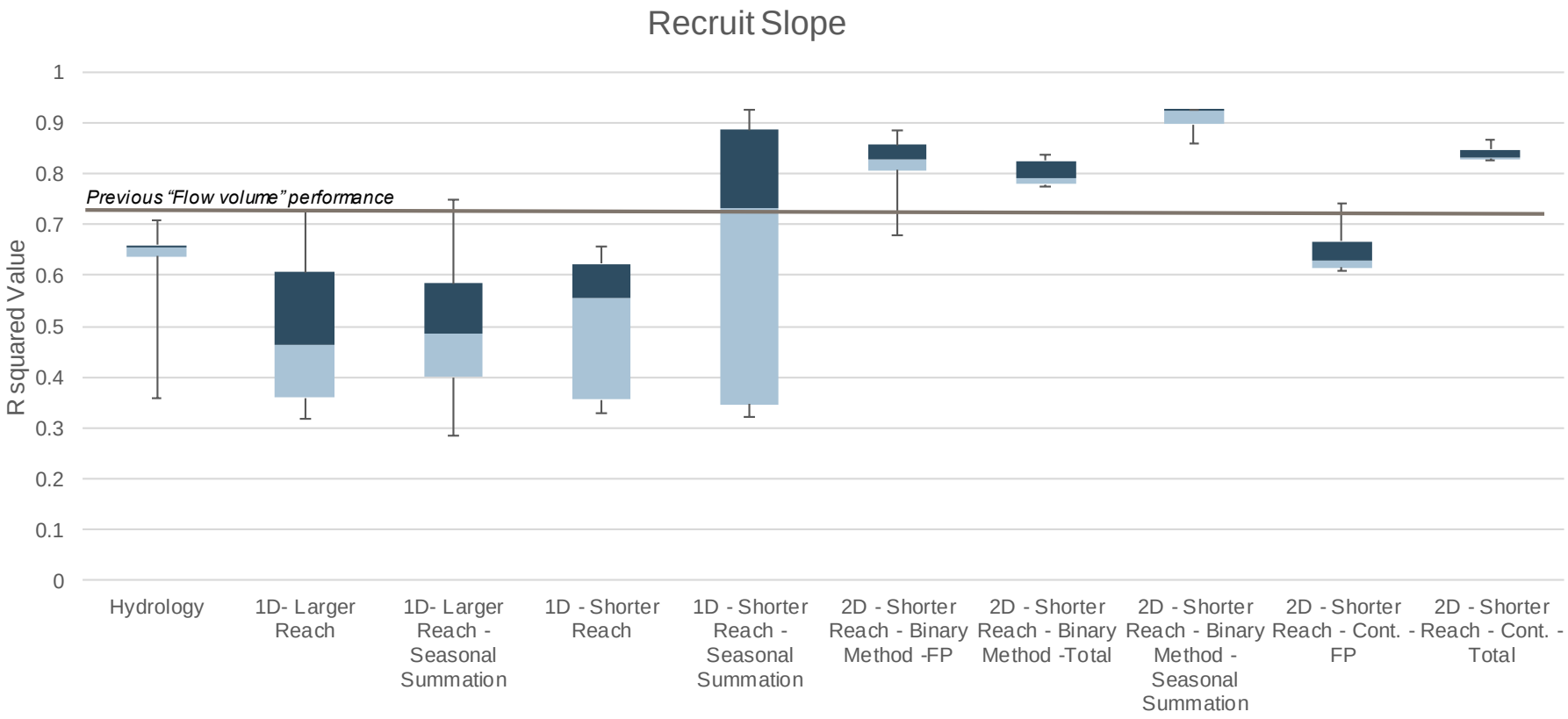
CORRELATION RESULTS

- Recruit Slope is the rate of change in Minnow population (CPUE) from May to August.
- 2D Hydraulics performed very well; the higher resolution hydrology data performed best.



- Hydrology: 7-, 14-, 21-day minimums and percent exceedance.
- Seasonal summation: daily discharge as an eco-value, summed for the season

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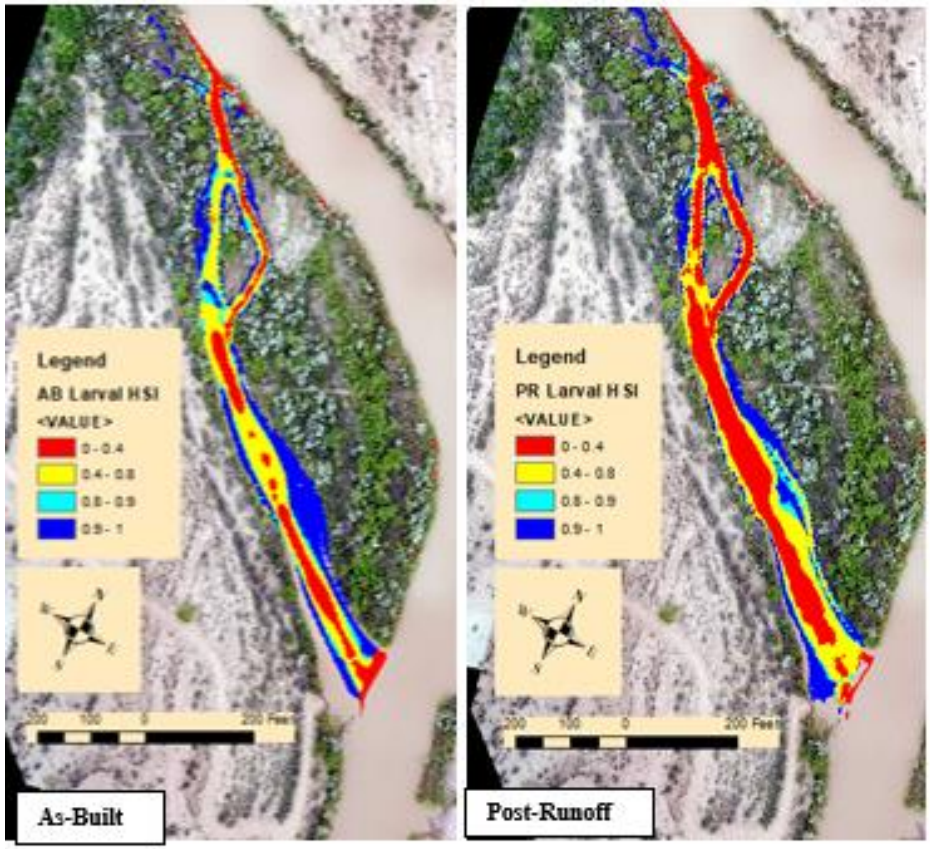
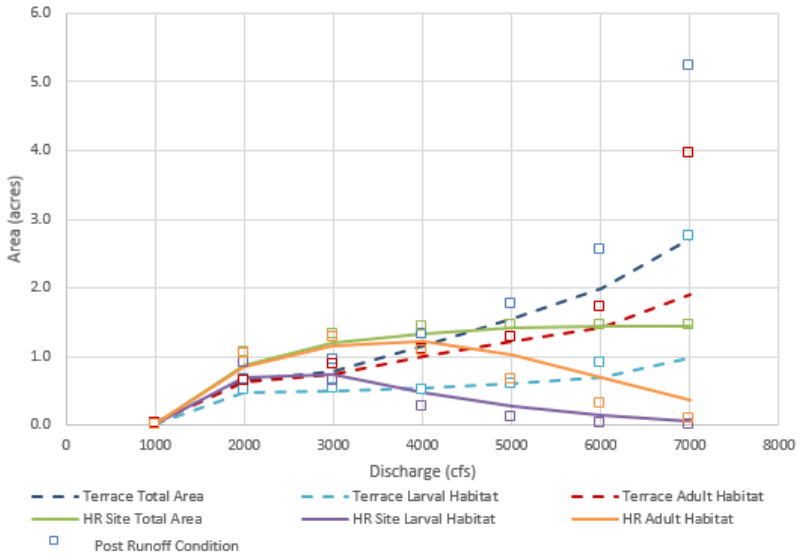
SECOND PROJECT: RESTORATION SITE HYDRAULICS

- The Reclamation Study is to quantify change from As-Built to Post-Runoff condition to justify site maintenance.
- Comparing surrounding terrace/floodplain versus constructed site.



RM 112



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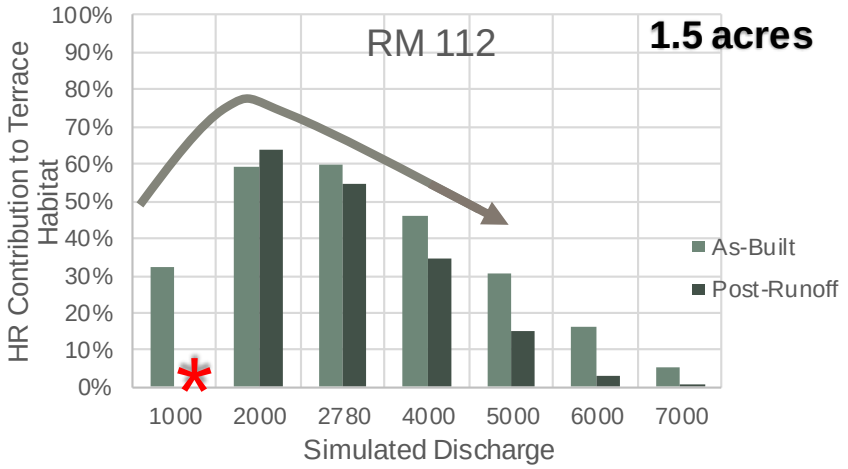
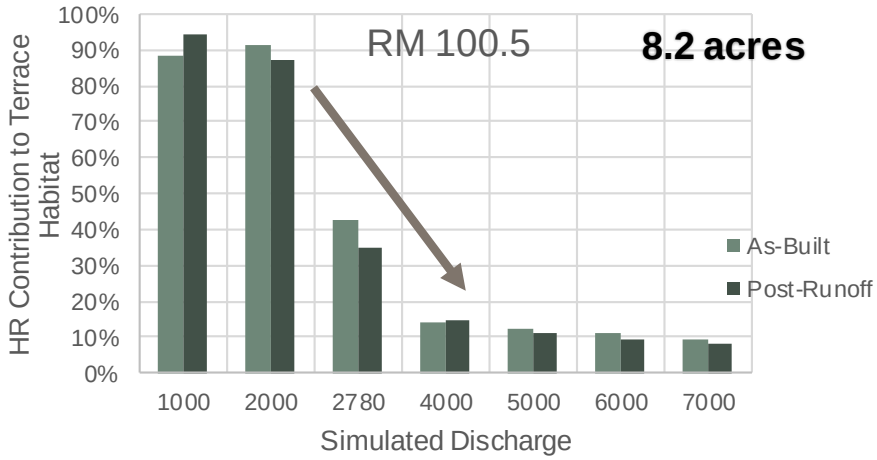
SITE PERFORMANCE

- Different orientations: backwaters, lowered terraces, side channels;
  - ❑ Similar engineering objectives: inundate at lower discharges than the surrounding floodplain.
  - ❑ Similar points of failure at varying degrees: natural levee development at downstream outlets.
  - ❑ Size of contribution by dictated by excavated area.
- Different floodplain connectivity: lowered terraces, disconnected floodplains, perched areas.
  - ❑ Greatly affects areas of suitable hydraulics.





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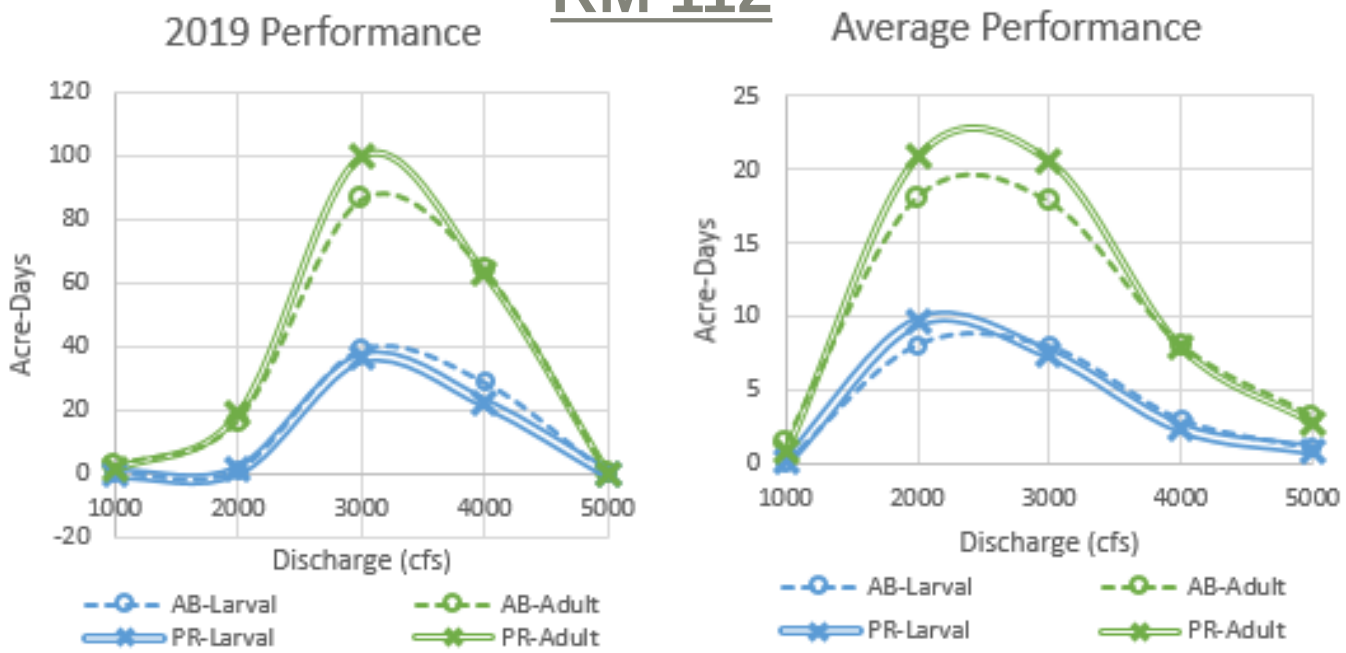
LINKING ANALYSIS TO HYDROLOGY

RM 112



- RM 112 generated 60 acre-days of suitable larval habitat inundation in 2019. In an average year, it generates 18 acre-days.
  - RM 112 increased performance by ~40% between as-built and runoff condition.
- RM 100.5 generated 700 acre-days of habitat in 2019. In an average year, it generates 124 acre-days.
  - RM 100.5 increased performance by 5%.

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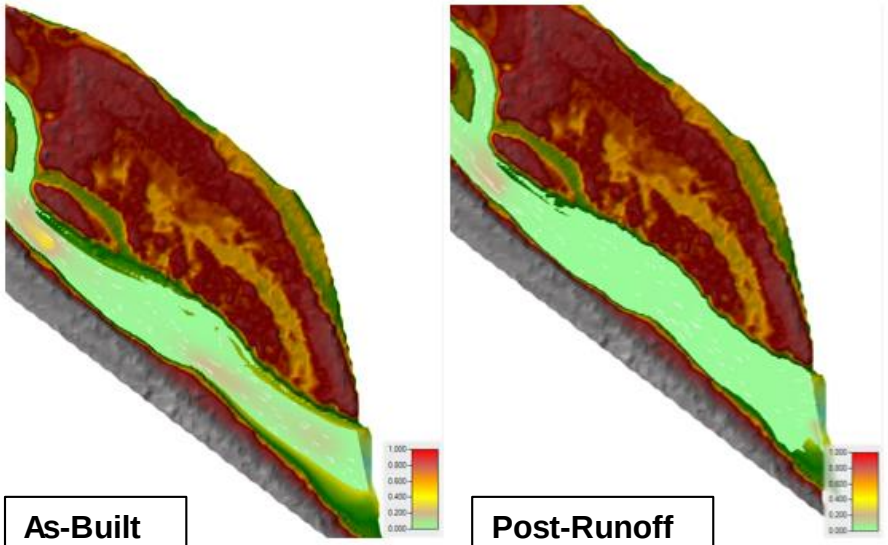
MODELING LIMITATIONS

- 2D models are much more appropriate for mapping suitable hydraulics than 1D.**
- Calibration and validation (monitoring) data is PARAMOUNT.
  - Models may run without error and be inaccurate.
  - Reclamation's 1D Agg-Deg Models are NOT calibrated to WSE for full-range of possible discharges.
  - We are lacking data at overbanking flows: >3000 cfs.
- Sediment analysis is needed.
  - Conveyance capacity of the Rio Grande CHANGES during high run-off events (Occam 2016).
  - Sedimentation/disconnection is point of failure for these restoration designs.
- Active channel domain, adult and egg life stages need more investigation.



Shear stresses at RM 112 indicate likelihood for sedimentation if As-Built design is repeated.

**Modeler Application Guidance for Steady v. Unsteady, 1D vs 2D Hydraulic Modeling. https://www.hec.usace.army.mil/publications/TrainingDocuments/TD-41.pdf

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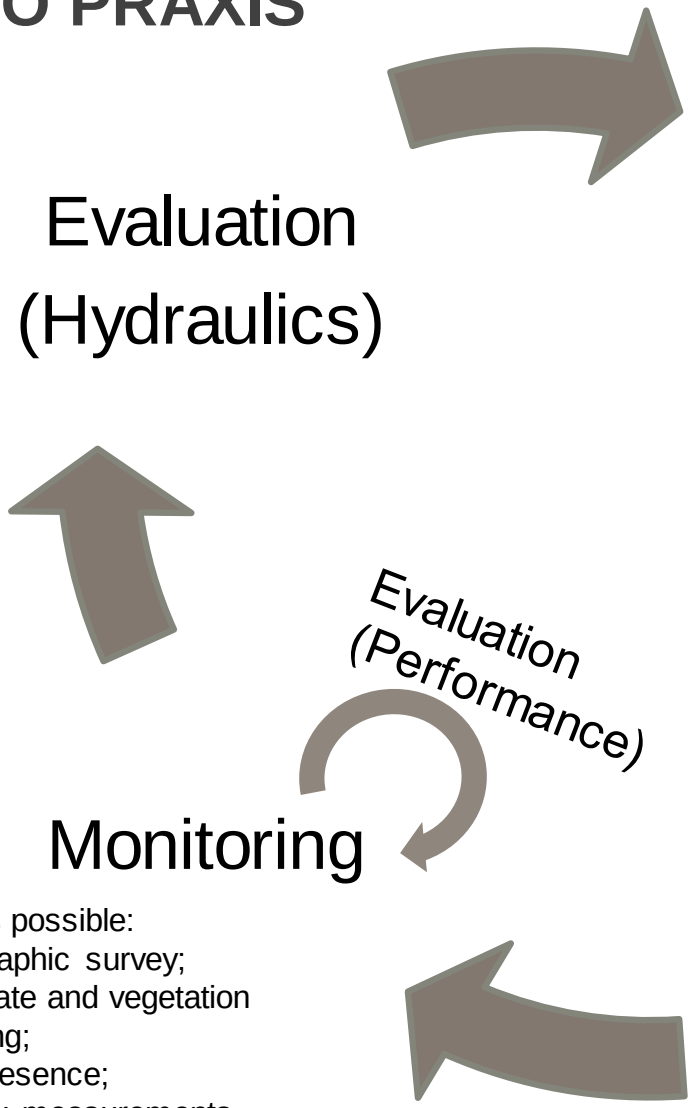
THEORY TO PRAXIS



5-10 yr frequency or triggered by poor performance evaluation:

- Expensive.
- Data availability.

Before every construction effort:

- Hydrology;
- 2D Hydraulics;
- Sedimentation.

Best alternative carried forward

As often as possible:

- Topographic survey;
- Substrate and vegetation mapping;
- Fish presence;
- Velocity measurements.

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PRAXIS CONT'D:
ECO-VALUE AND WATER MANAGEMENT

THEORY: if we can correlate habitat criteria to hydraulics..

- 2D hydraulics can be used to generate an ECO-VALUE curve.
- Water managers can use the eco-value curve for spring runoff environmental flow analysis.
- YOY and October Index population metrics did not perform as well under this analysis.
- This indicates more analysis is needed to link the Minnow life cycle with each year's seasonal hydrology.

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KEY FOR SLIDE 6

Hydrology	Duration hydrology (7-days to 21-days, mean of minimums or max of minimums) and Percent Exceedance to 3000 cfs
1D Larger Reach	30 –mile 1D model + Duration hydrology + Binary method for habitat hydraulics
1D Shorter Reach	10 – mile 1D model + Duration hydrology + Binary method for habitat hydraulics
2D Shorter Reach	10 – mile 2D model + Duration hydrology
Seasonal Summation	Instead of duration hydrology: summation of the season for larval hydraulics and of the year for adult hydraulics.
Binary Method	Binary "ideal" or "not most ideal" for ideal habitat hydraulics
Continuous (Cont.)	Weighted Useable Area using a curve for ideal hydraulics.
FP	Habitat hydraulics applied only to inundated areas on the floodplain
Total	Habitat hydraulics applied to total river cross section

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