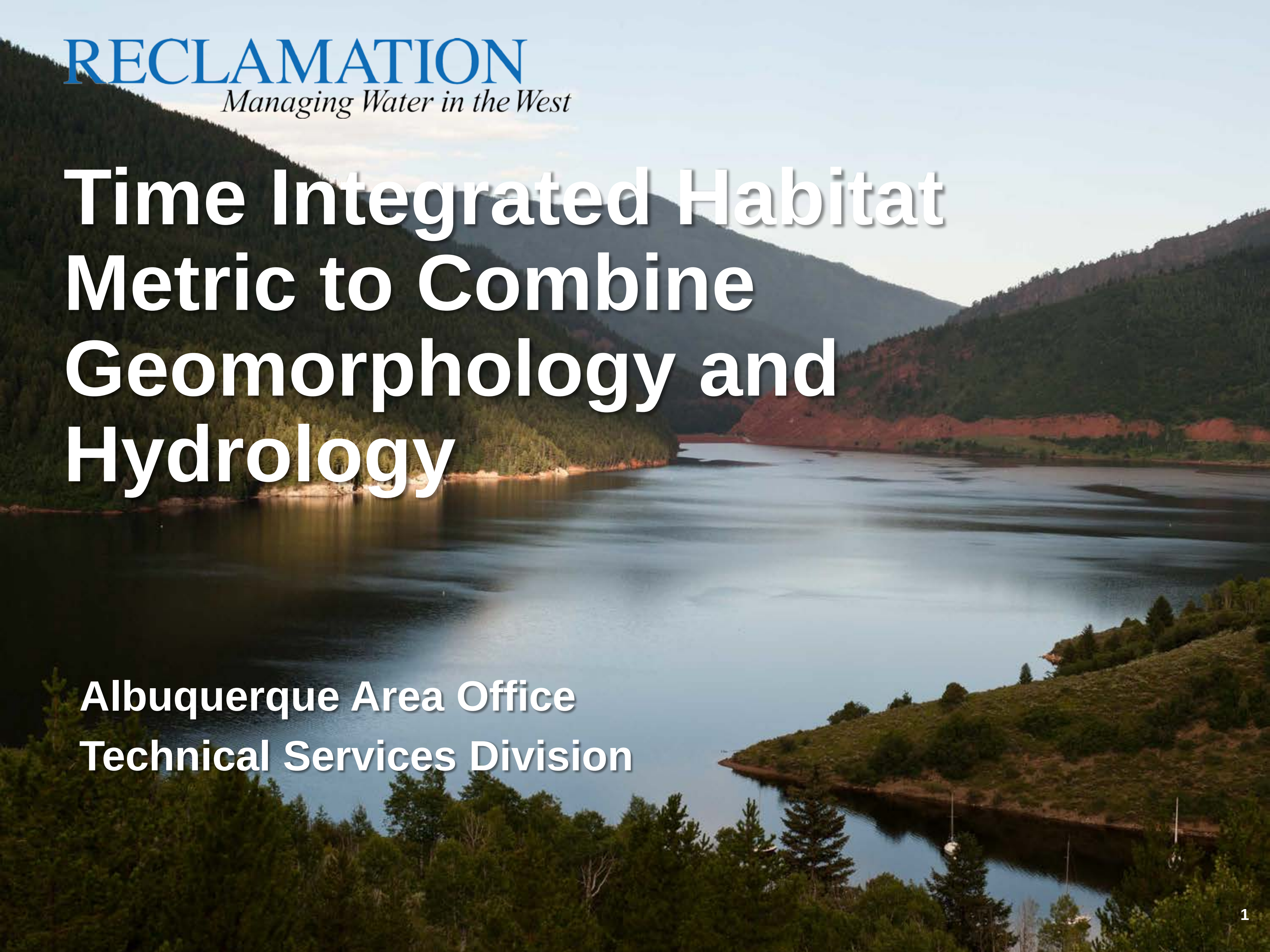
RECLAMATION
Managing Water in the West

Time Integrated Habitat Metric to Combine Geomorphology and Hydrology

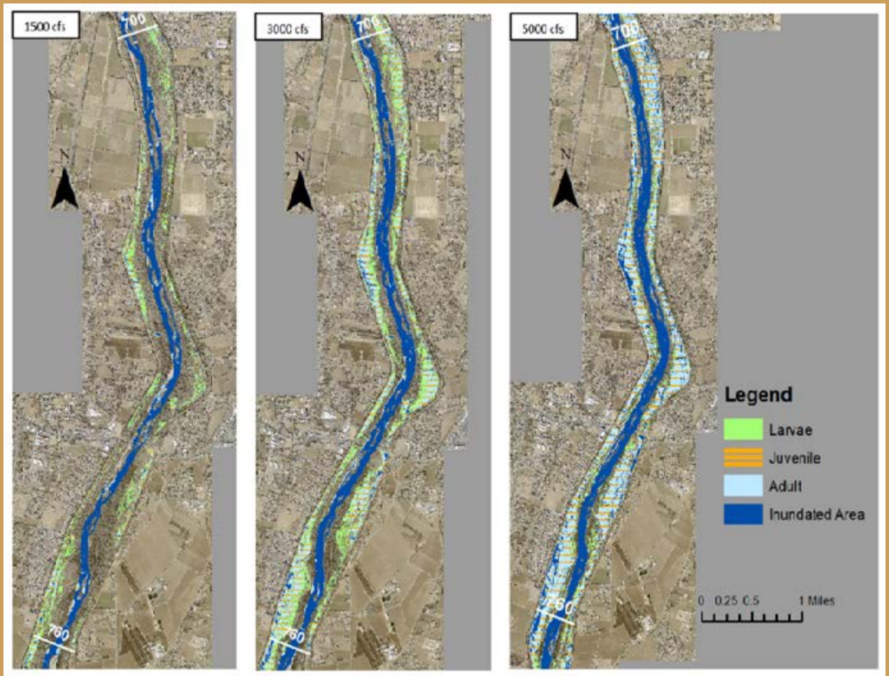


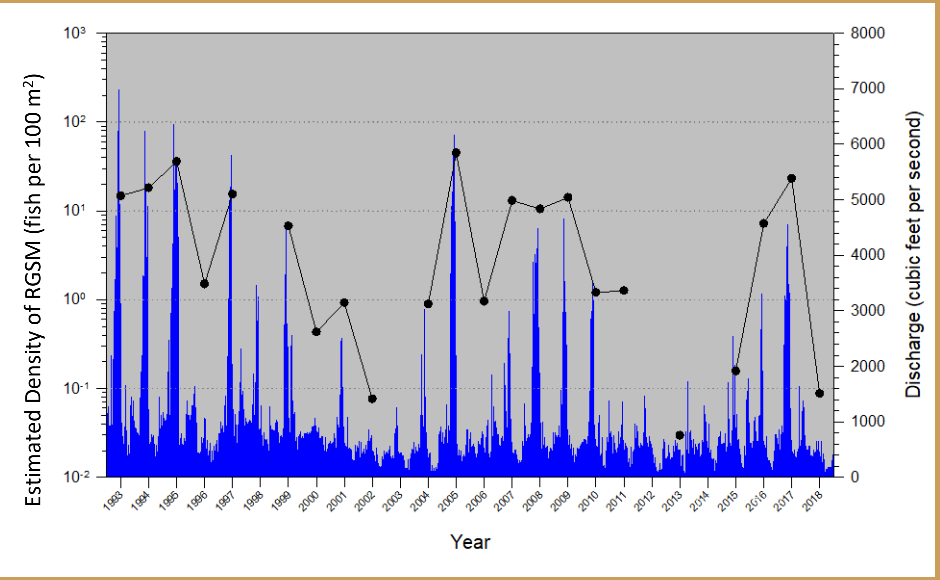
Albuquerque Area Office
Technical Services Division

Problem Statement

- Minnow population estimates on annual times step.
    - Many studies compare population estimates to hydrology.
- Spatially continuous geomorphological data at decadal time step.
    - Many studies look at distributed habitat availability for available elevation data.

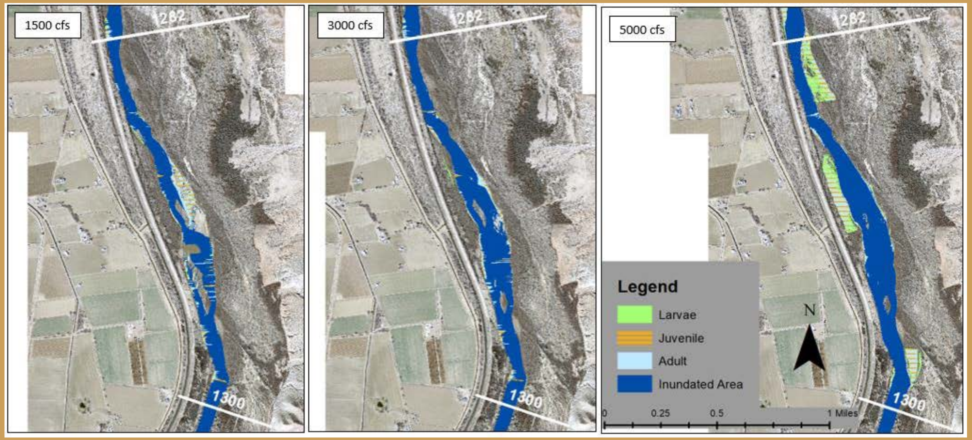
- **Is there a methodology that can combine these disparate temporal scales to assess habitat annually?**

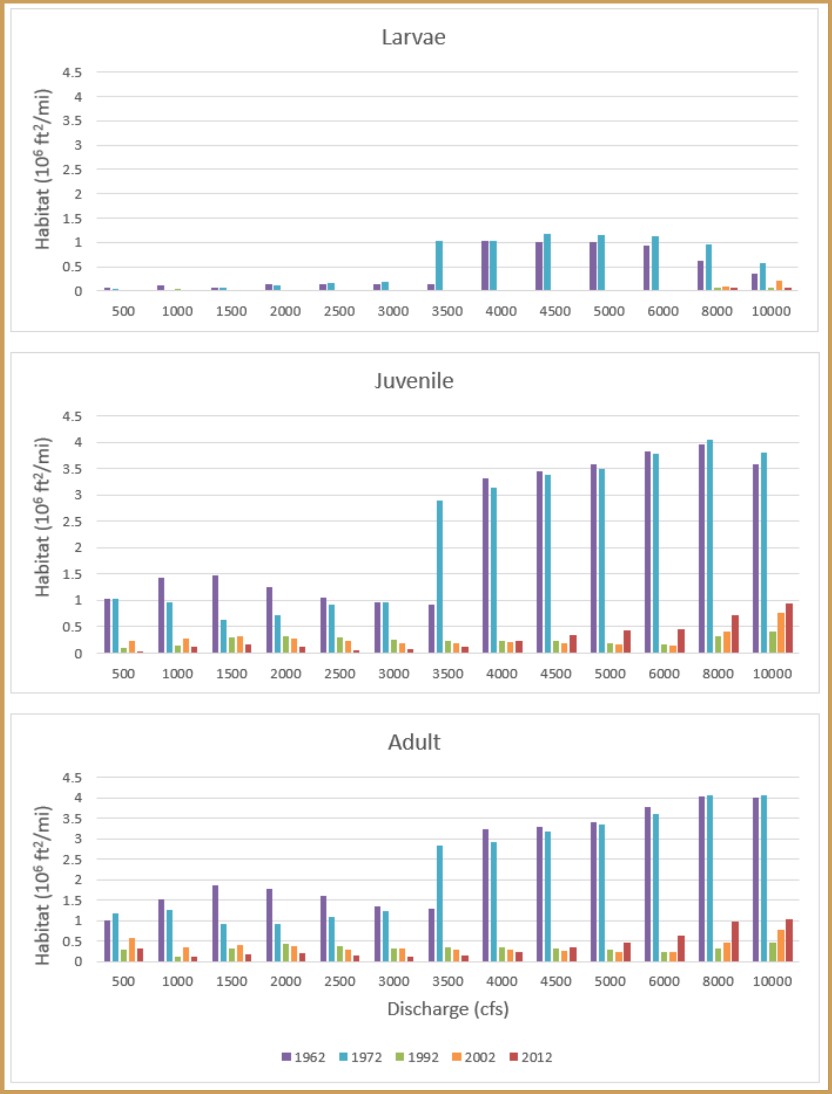




Spatially Distributed Habitat Metrics

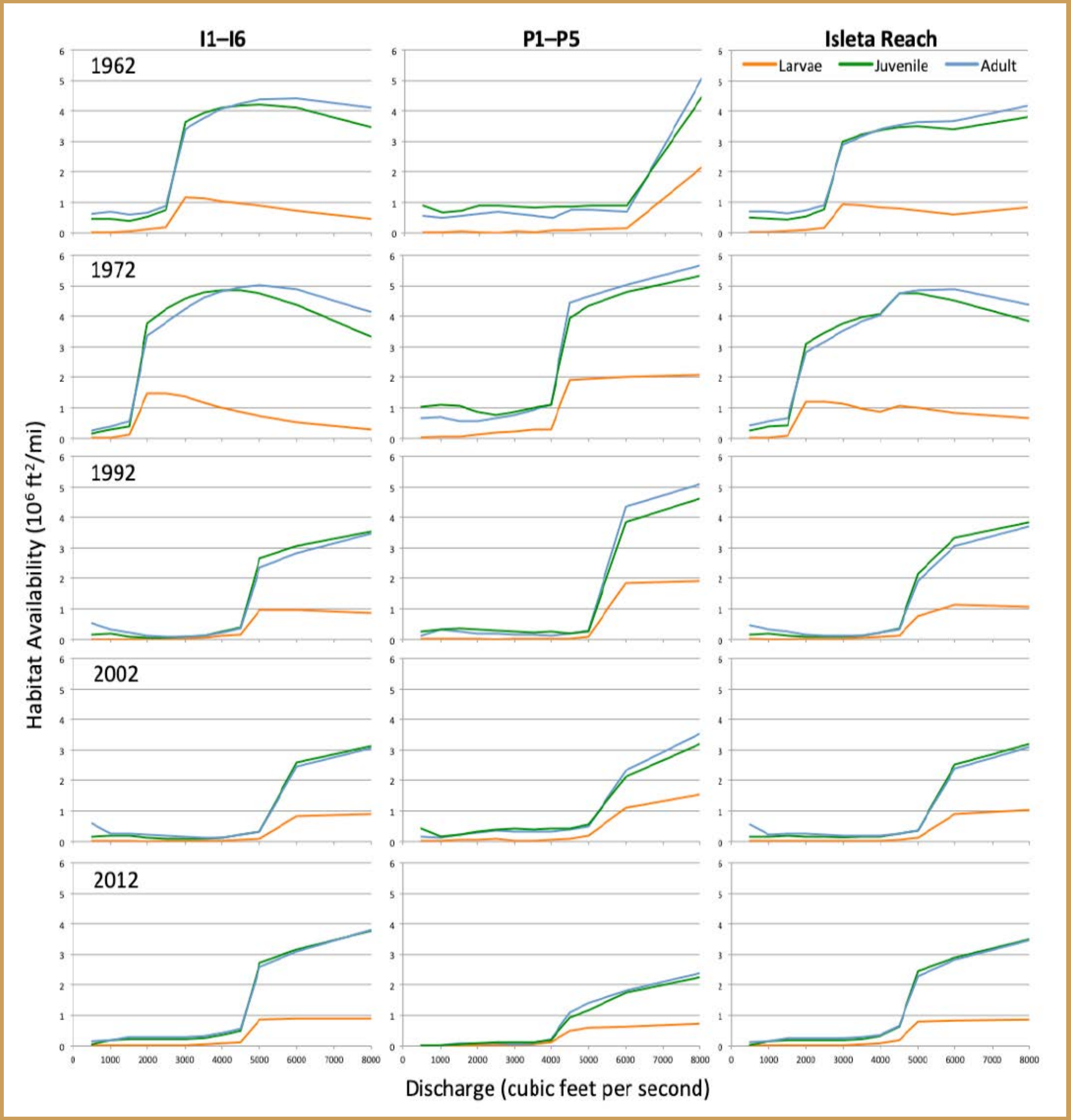
- Use hydraulic modeling to assess available habitat for different life stages.
- Do assessment for different discharges.
- Compile areas to integrate over some length of river.
- Limited to years of available data.





Habitat Discharge Curves

- Developed for years when data available.
- Can be used as metric for geomorphologic change over time.



Habitat Discharge Curves

- Can be related to particular geometry types, or cross section shapes.

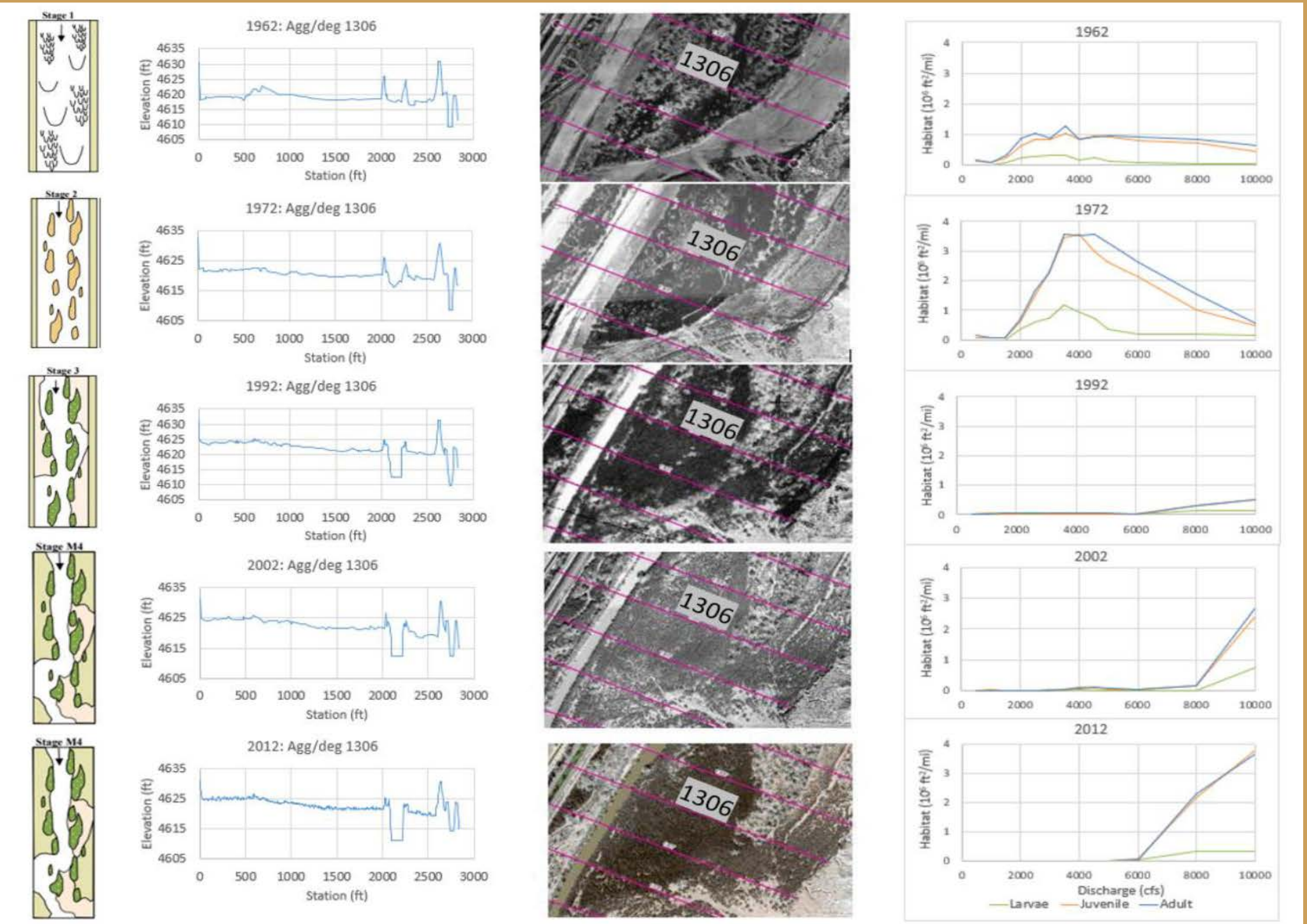
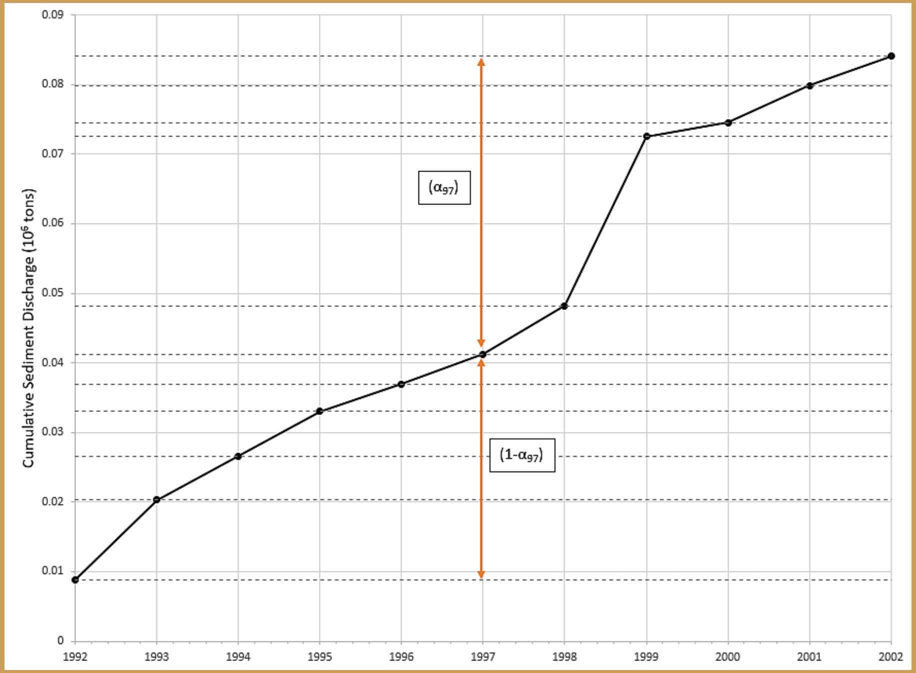


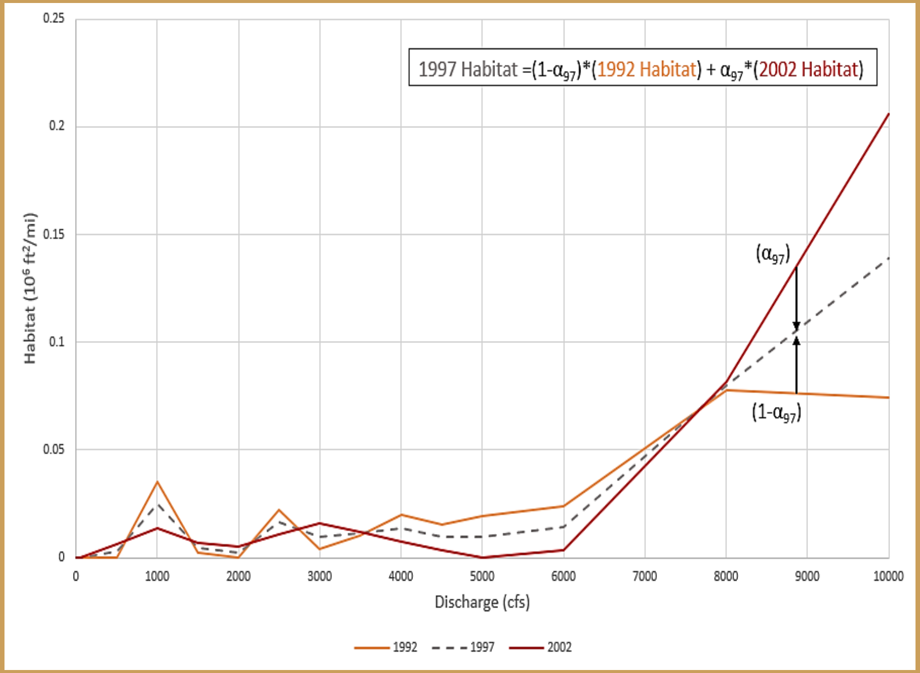
Figure 50 Evolution of cross-section 1306 from 1962 to 2012. Agg/deg line label on the aerial photographs refers to the line below

Minnow Populations and Hydrology

- Use cumulative sediment mass curve to interpolate between years.

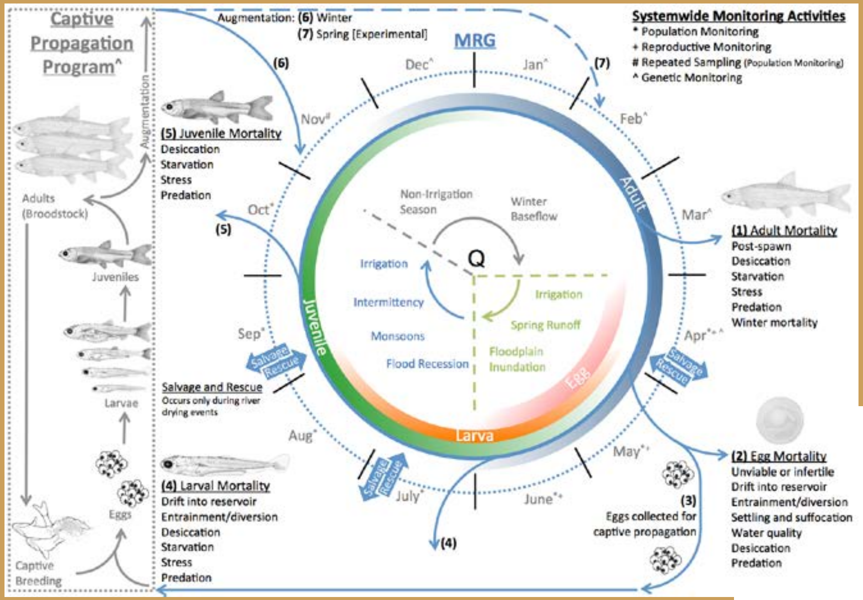
- Use interpolation metric to interpolate habitat curves between known years.





Hydrograph Division by Life Stage

- Use understanding of life stages to divide hydrograph.



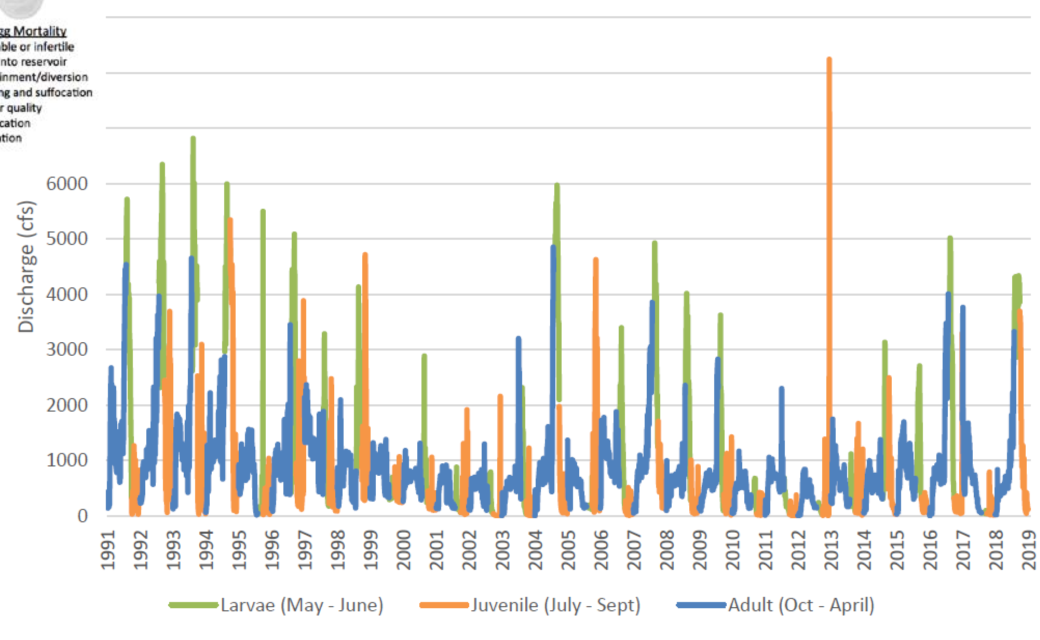
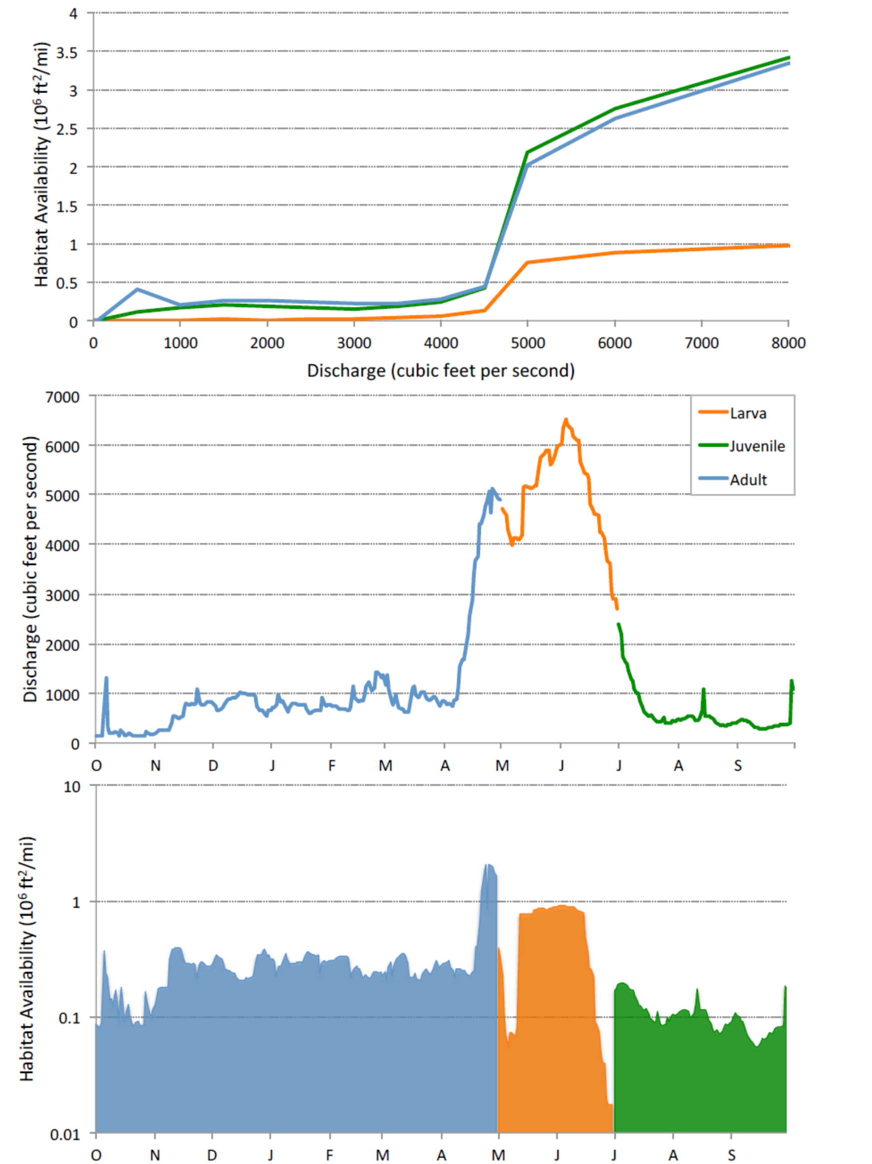


Figure 53 Rio Grande Floodway at San Acacia (08354900) hydrograph separated out by representative sampling periods

Minnow Populations and Hydrology

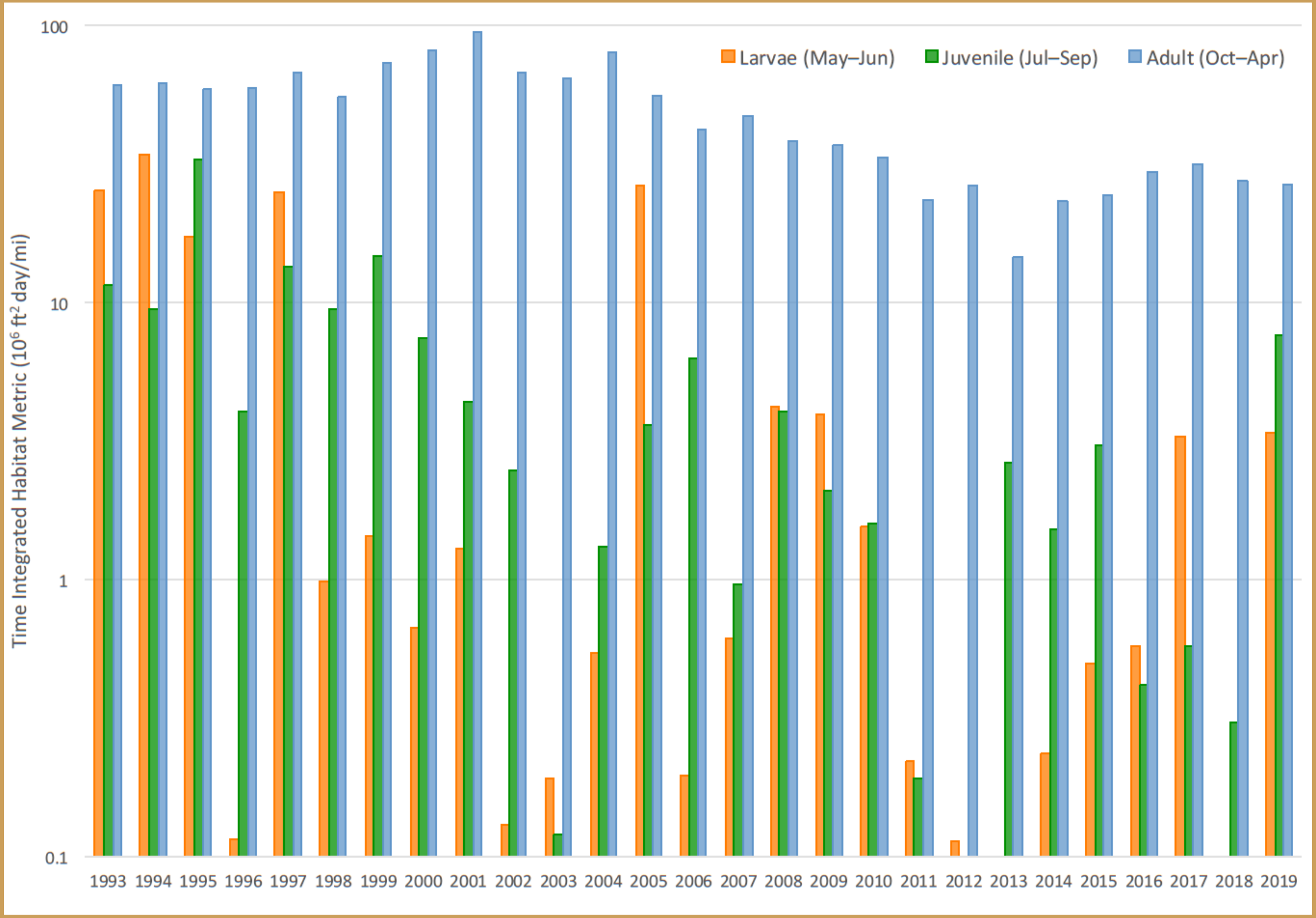
- Derive habitat curves for each life stage for specific year, based on interpolation metric
- Divide hydrograph into different life stages of Minnow
- Calculate habitat available in sq. ft/mile for each day of year.



21. Example of the Time Integrated Habitat Metric (TIHM) for the Isleta Reach during 2005. Top panel shows flow-habitat curves, the middle panel shows the hydrograph (by water year), and the bottom panel shows habitat availability; shaded areas represent the TIHM by life-stage.

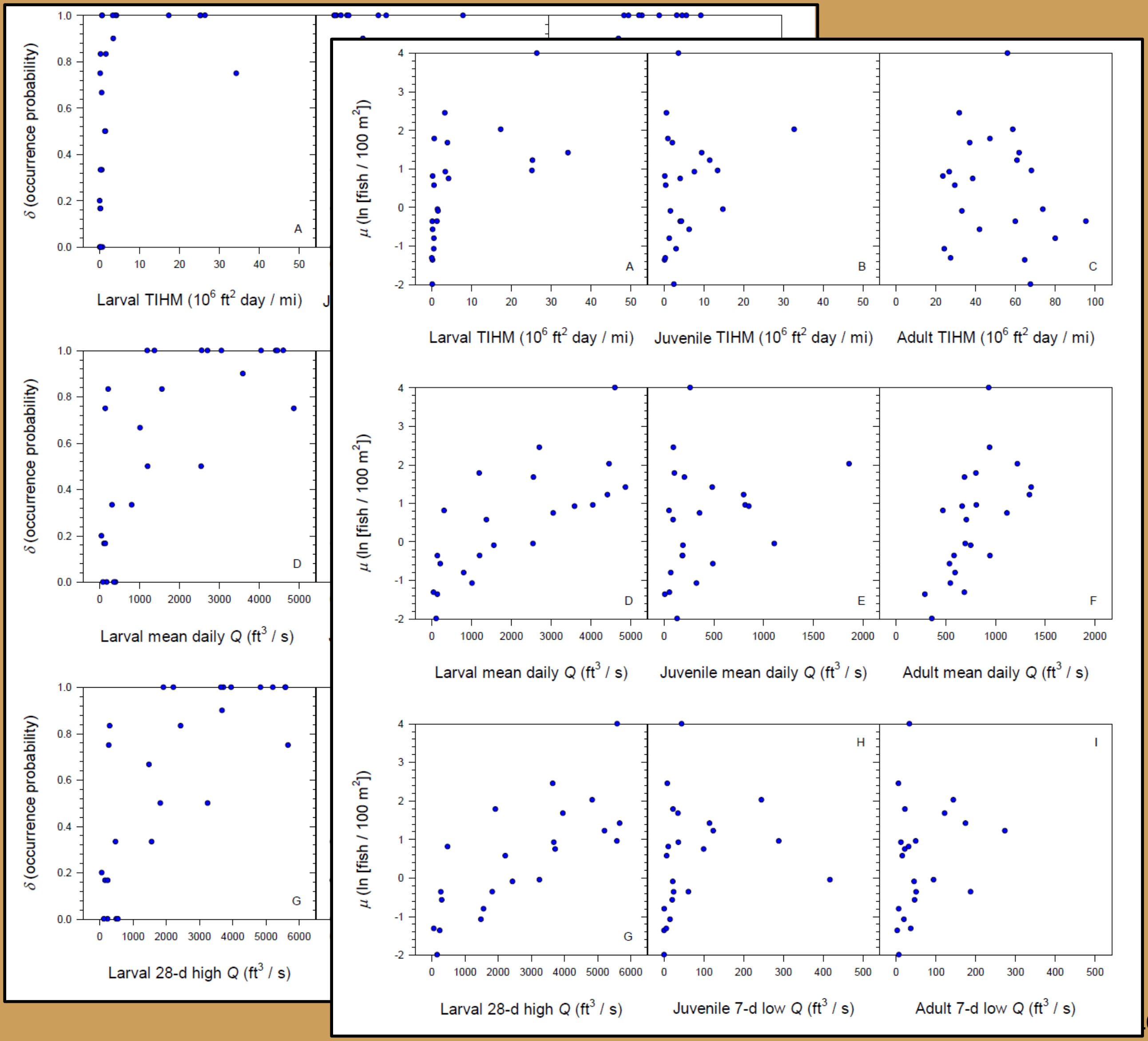
Time Integrated Habitat Metric (TIHM)

- Done back to 1993 to compare to available Minnow data
- Presents more complete understanding of annual available habitat, combining hydrology and geomorphology



Minnow Populations Bi-variate Regressions: Hydrologic Metrics vs. THIM

- No clear stong correlation between THIM and either probability of occurrence or Minnow density.



Minnow Populations Multi-linear Regressions: Hydrologic Metrics vs. THIM

- Top THIM model (*d*[MayJunHab+*R*] *m*[MayJunHab+*R*]) received 51.7% of the weight (*wi*) out of the 64.
- Spring larval habitat covariate accounted for 15.7% of the deviance (P < 0.05).
- More larval fish habitat during spring best predicted the increased density and occurrence of Minnow

Model[1]	logLike[2]	K[3]	AIC_c[4]	w_i[4]
δ(MayJunHab+*R*) μ(MayJunHab+*R*)	267.27	9	286.58	0.5172
δ(JulSepHab+*R*) μ(MayJunHab+*R*)	269.25	9	288.56	0.1921
δ(*R*) μ(MayJunHab+*R*)	272.81	8	289.85	0.1009
δ(*R*) μ(*R*)	278.47	6	291.07	0.0547
δ(OctAprHab+*R*) μ(MayJunHab+*R*)	272.70	9	292.00	0.0343
δ(JulSepHab+*R*) μ(*R*)	278.09	7	292.89	0.0220
δ(MayJunHab+*R*) μ(*R*)	278.41	7	293.21	0.0187
δ(OctAprHab+*R*) μ(*R*)	278.42	7	293.22	0.0186
δ(*R*) μ(JulSepHab+*R*)	277.36	8	294.39	0.0104
δ(JulSepHab+*R*) μ(JulSepHab+*R*)	275.22	9	294.52	0.0097

- Top Hydrologic model (*d*[MayJun28dHigh+*R*] *m*[MayJun28dHigh+*R*]) received 55.8% of the weight (*wi*) out of the 196.
- Spring flow covariate accounted for 34.1% of the deviance (P < 0.001).
- Higher spring flows over a month best predicted the increased density and occurrence of Minnow

Model[1]	logLike[2]	K[3]	AIC_c[4]	w_i[4]
δ(MayJun28dHigh+*R*) μ(MayJun28dHigh+*R*)	250.67	9	269.97	0.5597
δ(MayJun28dHigh+*R*) μ(MayJunMean+*R*)	252.50	9	271.81	0.2238
δ(MayJunMean+*R*) μ(MayJun28dHigh+*R*)	254.08	9	273.39	0.1016
δ(MayJunMean+*R*) μ(MayJunMean+*R*)	254.22	9	273.53	0.0946
δ(MayJun28dHigh) μ(MayJun28dHigh+*R*)	263.54	7	278.34	0.0085
δ(MayJun28dHigh) μ(MayJunMean+*R*)	265.50	7	280.30	0.0032
δ(OctAprMean+*R*) μ(MayJun28dHigh+*R*)	261.56	9	280.87	0.0024
δ(OctAprMean+*R*) μ(MayJunMean+*R*)	262.60	9	281.90	0.0014
δ(OctAprMean+*R*) μ(OctAprMean+*R*)	263.06	9	282.37	0.0011
δ(MayJun28dHigh+*R*) μ(MayJun28dHigh)	268.59	7	283.39	0.0007

Conclusions

- It is unclear if increased instream habitat complexity and availability at moderate discharges (e.g., 500–3,000cfs) would be sufficient for retaining and rearing larval Rio Grande Silvery Minnow within the MRG during years with low water availability (i.e., unable to provide overbanking flows during May–June).
- Findings suggest that maintaining habitat availability through instream flows, particularly during seasonal low flow periods (July–September), is anticipated to produce positive population responses.
- Habitat metrics might not have fully captured spatial and temporal variations of floodplain inundation in the Isleta Reach.
  - For example, larval fish habitats were predicted to substantially increase with relatively small increases in discharge, which resulted in a uniformly strong habitat threshold response to flow.
  - Elevated and prolonged flows during the spawning/rearing season (i.e., primarily May–June) were closely related to the increased occurrence and density of Rio Grande Silvery Minnow.
  - Small differences in flows often had notable impacts on the predicted amount of larval habitat, across a long and varied reach over multiple years. These factors could also partially explain why flow metrics, as compared to habitat metrics, were consistently more predictive of the increased occurrence and density of this species over time.

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