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The Delaware River is a unique system in that it is the longest un-dammed river east of the Mississippi and is home to two National Parks. It also contains what are likely some of the highest quality stretches of river east of the Mississippi; hence, a full three-quarters of the non-tidal portion of the Delaware are included in the National Wild and Scenic Rivers Systems. However, the Delaware River is only a gas tank away for about one-quarter of the people living in the U.S. and is under increasing pressure from anthropogenic activities.

Since 2001, the Delaware River Basin Commission (DRBC) has annually sampled virtually all of the riffles (n=25) distributed throughout the 200-mile extent of the non-tidal Delaware River. The purposes of this sampling are to:

- Determine the existing biological quality of the system for development of baseline biological criteria for water quality regulations consistent with the goals of the Wild and Scenic designation as directed by Congress;
- Protect water quality and ecological integrity of the Delaware River.

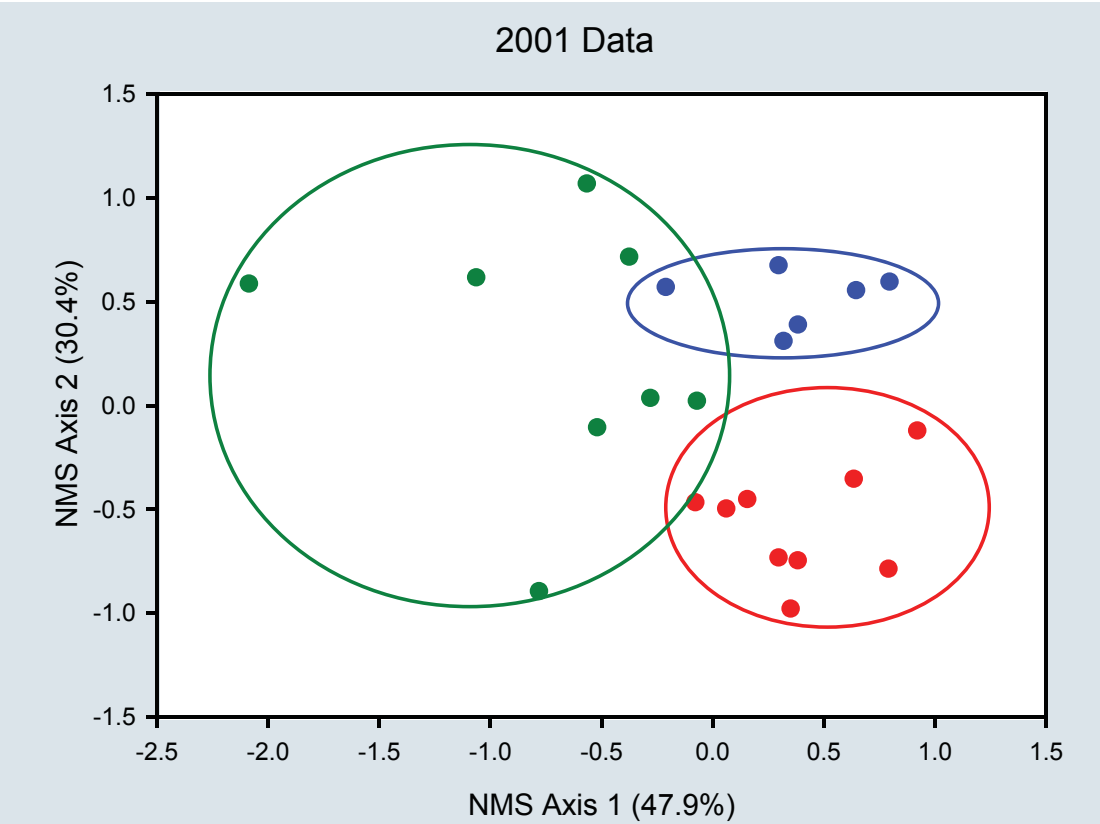
However, impairments in the river may be most evident in other habitats (i.e., glide/run, pool). To address this problem, a collaborative research project is underway to develop robust, yet efficient and sustainable, assessment and monitoring techniques and biological criteria for all major habitats of the 200-mile, non-tidal portion of the Delaware River Basin. A strong emphasis has been placed on documenting the current condition and detecting future changes, with the goal of preserving this rare resource for present and future generations.

Programmatic Design Criteria

- The assessment strategy continues the DRBCs long-term monitoring of fixed riffle site sampling, yet incorporates a randomized component to sample other more dominant habitats (i.e., glide/run, pool).
- The assessment strategy is feasible and thereby sustainable using DRBCs existing field and laboratory resources.
- The resulting framework supports the bioassessment, monitoring, and reporting needs of multiple organizations concerned with the well-being of the system, thus effectively leveraging collective resources.

Study Design

Analysis of existing DRBC macroinvertebrate and abiotic data identified two or possibly three natural groupings that roughly corresponded to broad sections of the river (upper, middle, and lower). Based on these data, the river was divided into three sampling sections; the upper (river miles 330.7-254), middle (river miles 254-209.5), and lower Delaware (river miles 209.5-133.3). Interestingly, the top and bottom boundaries of the upper and middle Delaware sections roughly correspond to the boundaries of the upper Delaware and Delaware River Gap National Parks. Within each section, 25 sites were randomly selected from a pool of candidate sites spaced at 1/16 mile intervals (n=75, 84 including duplicates). Including the 25 riffle sites annually sampled by the DRBC, 100 sites were targeted for sampling.



Field Methods

Field sampling occurred within a 100 m zone along a single bank of the river. The targeted sampling zone ideally occurred far enough from shore to be in the permanently-wet channel, but not extend beyond a depth of 1 m or mid-channel.

Benthic Macroinvertebrate Sampling

The protocols used to collect a representative sample of benthic macroinvertebrates varied by the characteristics of the sample zone.

DRBC Protocol

Used at sites where the flow was sufficient to flush dislodged benthic organisms from the substrate into the net (e.g., >1 ft/sec; 0.3 m/sec).



Gear: Big Frame Net (BFN) (24 in x 36 in (60.96 cm x 91.44 cm; 595 µm mesh) Substrate Frame 2ft x 2ft (60.96cm x 60.96cm)

The substrate frame is used to delineate a 4 ft² (0.3716 m²) sampling area* where a semi-quantitative sample was collected. Three kick samples were collected (total area: 12 ft² [1.1148 m²]) and combined into a single composite sample for the site.

*This sample area was based on recommendations made by the National Park Service and Academy of Natural Sciences citing low densities and inconsistent distributions of macroinvertebrate communities in the Upper Delaware River (National Park Service, Report Nos. 01-5F, 01-7F).

m-PAD Protocol*

Used at sites where net movement was required to collect and capture dislodged benthic organisms (e.g., flow < 1 ft/sec, 0.3 m/sec).



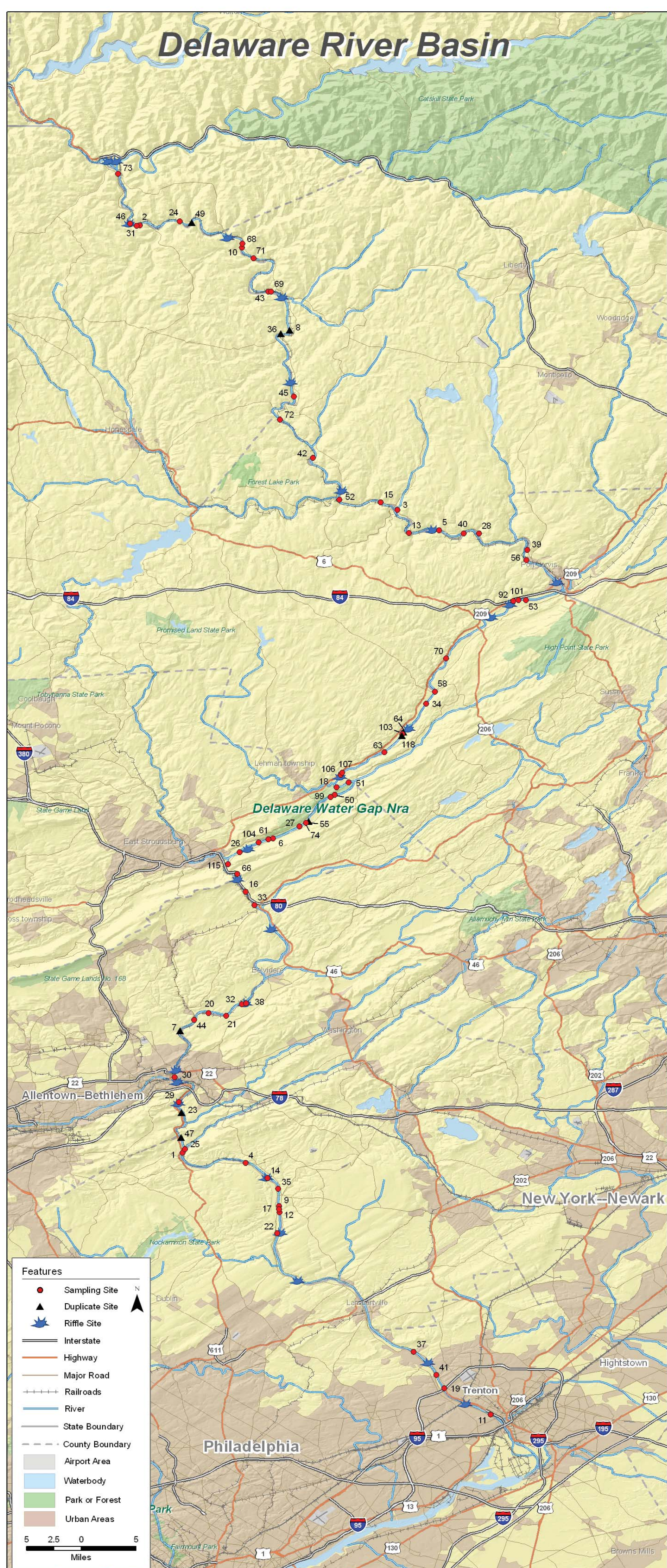
Gear: D-frame net (595 µm mesh; ~30 cm wide)

Six kick samples were collected each covering an estimated 0.15 m² of substrate (net width of 0.3 m x 0.5 m length of pass) for a total area sampled of 0.9 m² for the site. All six samples were combined into a single composite sample for the site.

*This protocol is a modified version of the Pennsylvania anti-degradation (PAD) method

Laboratory processing of samples:

Samples are currently being sorted in the laboratory to obtain approximately 300 (±10%; 270-330) organisms for identification. For purposes of taxonomic consistency across all laboratories involved, organisms are being identified to a predetermined level of taxonomic resolution.



Physical Assessment and Physicochemical Parameters

Focused on describing the in-stream habitat from which the sample is collected. These data will be used to explain differences observed among benthic macroinvertebrate collections from the system, and then to develop habitat categories that will be the basis for future sampling efforts.

Physical Parameters

- Wolman Pebble Count (100 count)
- Flow
- Depth

Water Quality Parameters (Instantaneous)

- Dissolved oxygen (mg/L)
- Air and water temperature (°C)
- Conductivity (mS/cm)
- pH,
- Turbidity (NTU)

Additional Qualitative Habitat Parameters*

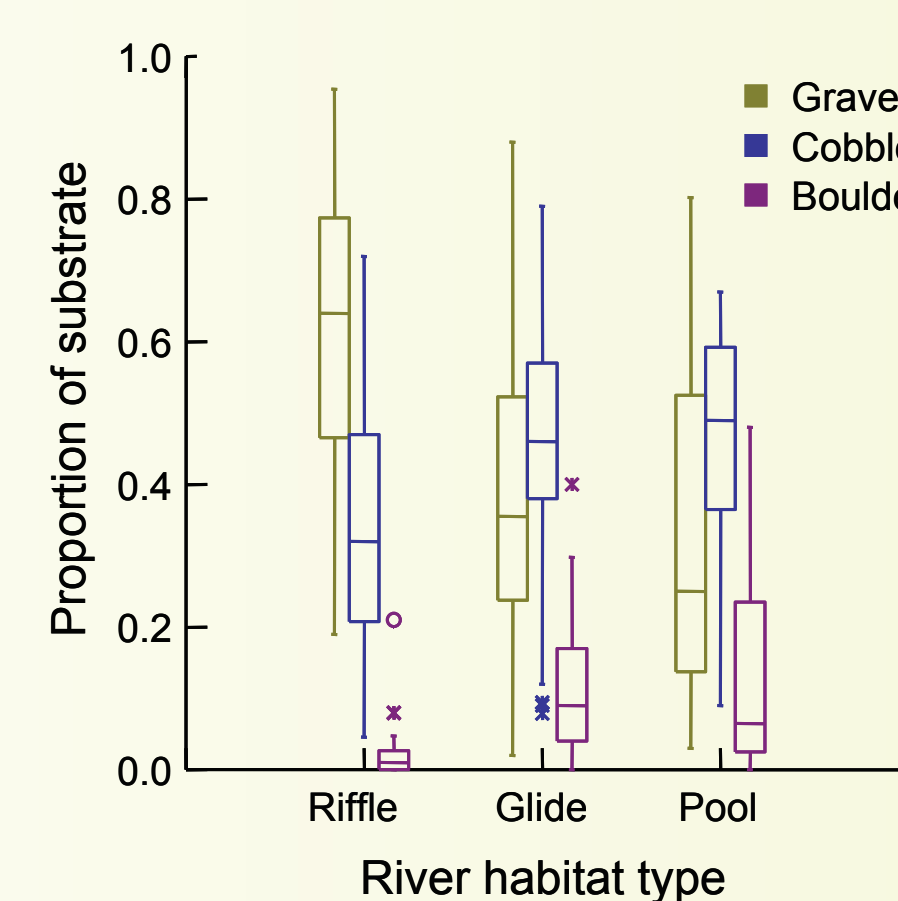
- Epifaunal Substrate/Available Cover
- Embeddedness
- Velocity-Depth Regime
- Sediment Deposition
- Channel Flow Status
- Channel Alteration
- Frequency of Riffles (or Bends)
- Canopy Cover
- Aquatic Vegetation

*These measurements approximate the in-stream health of the system and will be used as possible explanations for deficiencies found in the macroinvertebrate community.

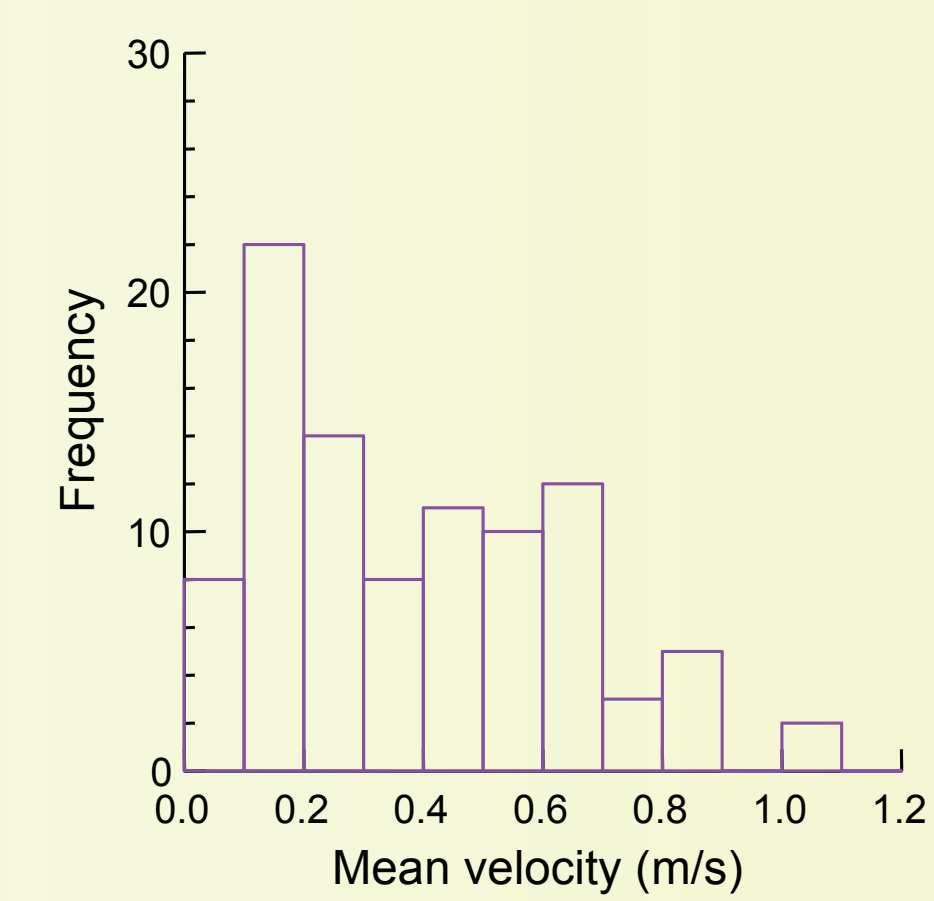
PRELIMINARY RESULTS

A total of 95 sites were sampled during the 2006 field season. All physical habitat data has been entered into a database. Of the sites sampled; 25 were subjectively classified as riffle sites, 54 glide/run sites, and 16 pool sites. Laboratory processing of benthic macroinvertebrate samples is ongoing.

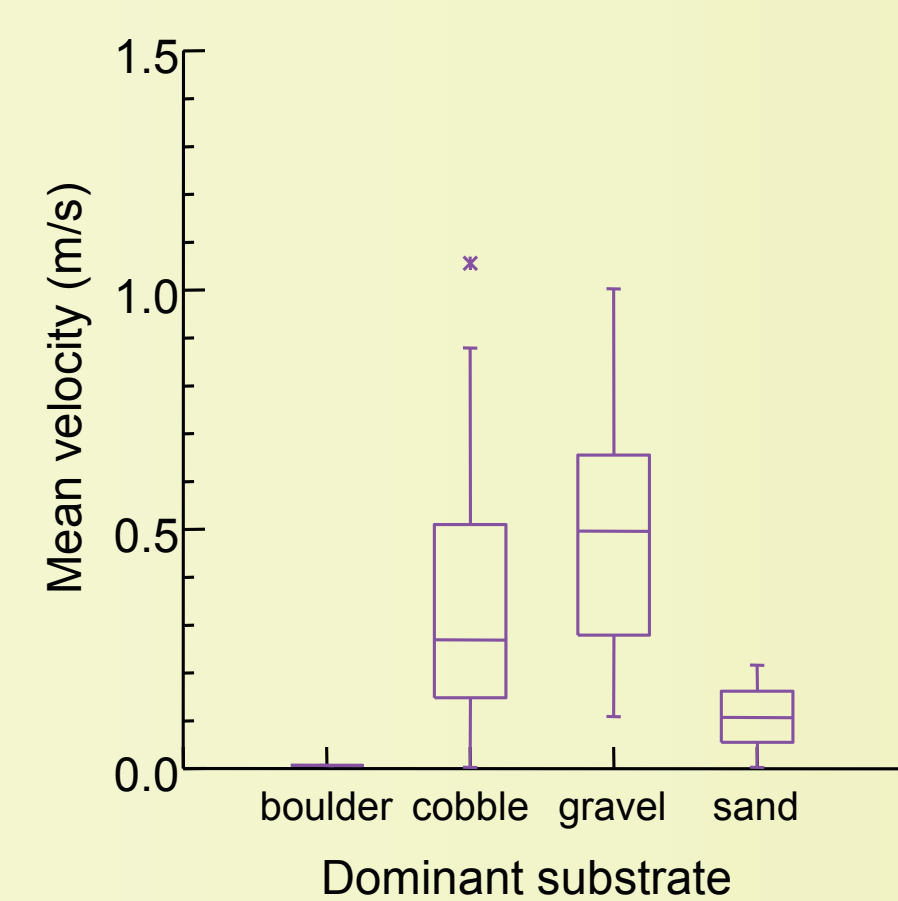
Preliminary examination of substrate and velocity data suggests that the field effort successfully sampled a good blend of dominate substrate types across velocities and principle habitats.



Proportion of gravel, cobble, and boulder substrate at sites subjectively categorized as riffle, glide/run, or pool by field crews.



Frequency of mean velocity categories across all sites.



Mean water velocities of sites by dominant substrate type.