Comparative Evaluation of a Rapid Assessment Methodology for Instream Flow Assessments with Intensive Physical Habitat Simulation (PHABSIM) Approaches

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Objectives

- Evaluate a short-cut methodology that incorporates site-specific data but only requires one/two days field effort
- Rely on existing high quality PHABSIM datasets as a reference library for the hydraulic simulations
- Develop reach level habitat versus discharge relationships comparable to full PHABSIM study results for assessing instream flows

Basic Premise of the Methodology

- Two cross sections having the same geometry and discharge should have the same hydraulic properties
- Selecting reference cross sections with the same geometry and a discharge and wetted width at a known calibration flow should provide an adequate estimate of the expected hydraulic properties for use in computing habitat versus discharge relationships

Outline of the basic methodology

- Select a river reach of interest
- Habitat map 30-50 channel widths for mesohabitat availability (i.e., proportions)
- Measure cross section profiles and wetted width in each mesohabitat(s) of interest
- Estimate the discharge at the time of data collection
- Extract all available reference cross sections from the reference database with a calibration discharge and wetted width within a user specified range of the field observed discharge and wetted width
- Discard any reference cross sections that do no match the observed channel cross section geometry for the input mesohabitat
- Use the known simulated hydraulic properties for each reference cross section and user supplied habitat suitability criteria to produce an average habitat versus discharge relationship based on the results from all reference cross sections
- Combine these average habitat versus discharge relationships using the reach level habitat mapping results to derive a final habitat versus discharge relationship at the reach level

Selection of Study Reach and Mesohabitats for Analysis

- Select a Study Reach based on location(s) needed for quantification of instream flows
- Habitat Mapping ~ 30 to 50 Channel Widths using simple mesohabitat types (i.e., run, pool, riffle, glides) to determine availability and their proportions
- Based on habitat mapping results select cross sections in 1-3 replicates of each mesohabitat type – Stratified Random Sampling or Professional Judgment

Required Field Data

- Collect cross section profiles within the active channel including substrates[1] at each vertical
- Cross sections do not have to be tied to a common bench mark
- Collect the water surface elevation
- Estimate the discharge at one cross section that is ‘good’ for this purpose
- [1] Substrates are not currently utilized but is hoped to be added to the tool if/when funding becomes available

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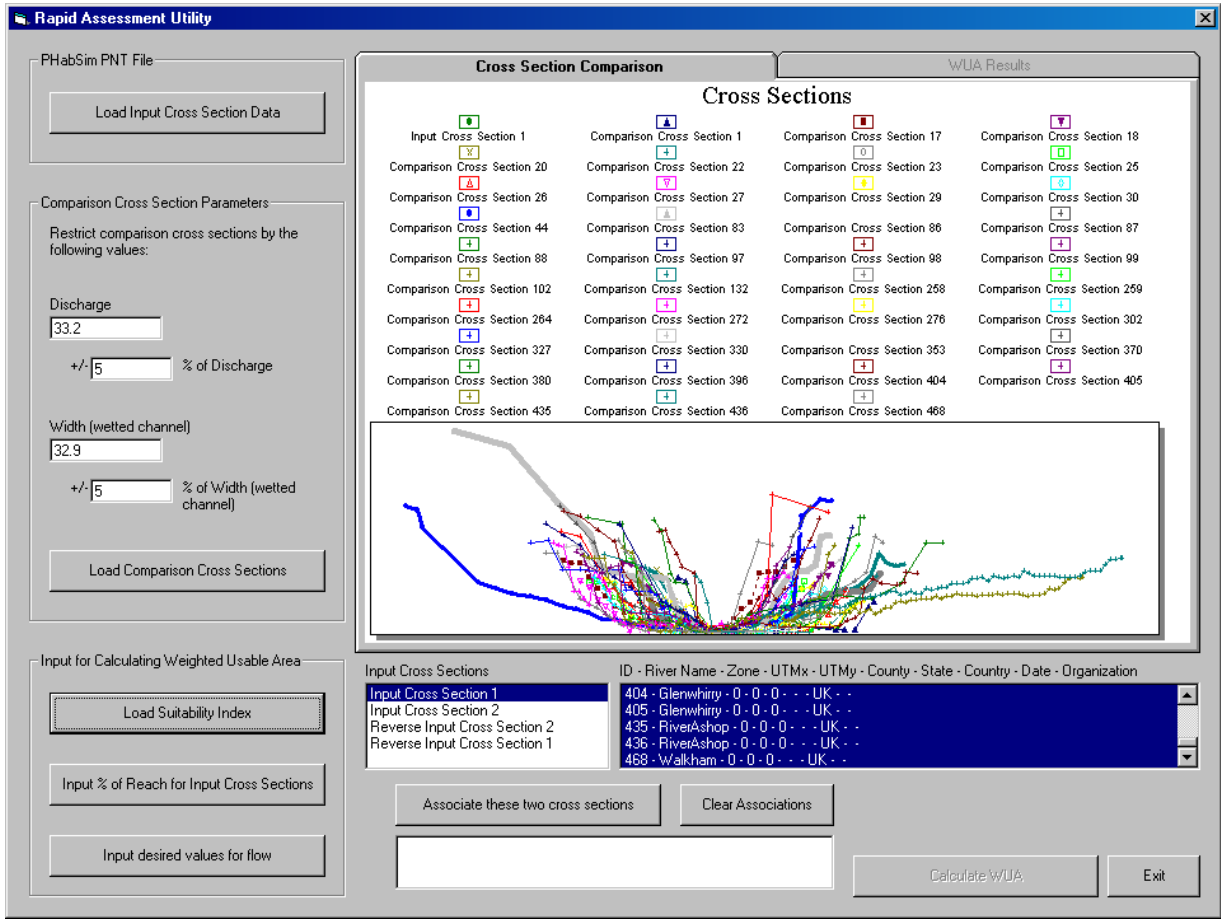
Existing US Reference Database

- US Prototype Reference Database
  - Data is primarily from the western US
  - 629 cross sections
  - 139 rivers
  - All cross sections have three observed calibration flows with water surface elevations and at least 1 calibration velocity
  - All hydraulic model simulation results over valid ranges of simulated discharges have been QA/QCd before inclusion
  - Modeled flows range between 25,000 and 0.1 cfs
  - Wetted widths range between 400 to 0.1 feet
    - Substrates are not currently in database but are available at all sites
    - Reference database could be expanded to incorporate data from another 300+ rivers with over 2000 more cross sections

Existing United Kingdom Reference Database

- Prototype Reference Database - UK
  - Data is from Scotland, Northern Ireland, England and Wales
  - 460 cross sections
  - 54 rivers
  - All cross sections have three observed calibration flows with water surface elevations and at least 1 calibration velocity
  - All hydraulic model simulation results over valid ranges of simulated discharges have been QA/QCd before inclusion
  - Modeled flows range between 3128 and 0.4 cfs
  - Wetted widths range between 188 to 0.3 feet
    - Substrates are not currently in database but are available at all sites

Beta Software System



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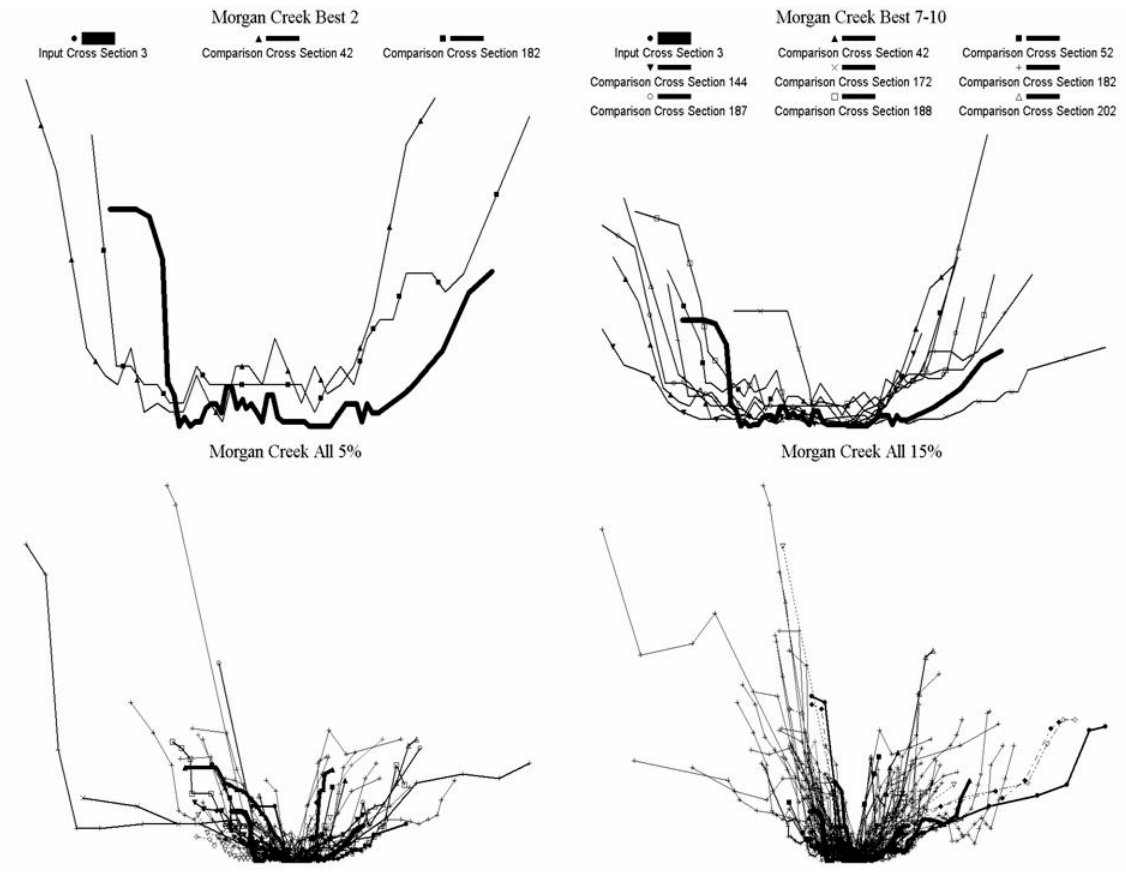
Existing Software Functionality

- User can input an unlimited number of field measured cross sections for evaluation
- User can import and use any number of habitat suitability curves
  - Currently limited to depth and velocity curves
- Default and user specified bounds for matching calibration discharges and wetted widths at the calibration discharges
- Interactive selection of extracted cross sections for matching channel geometries
- Automatic generation of reach level averaged habitat versus discharge relationships based on user assigned weightings for each input mesohabitat specific cross section

Example of Channel Geometry Screening Step



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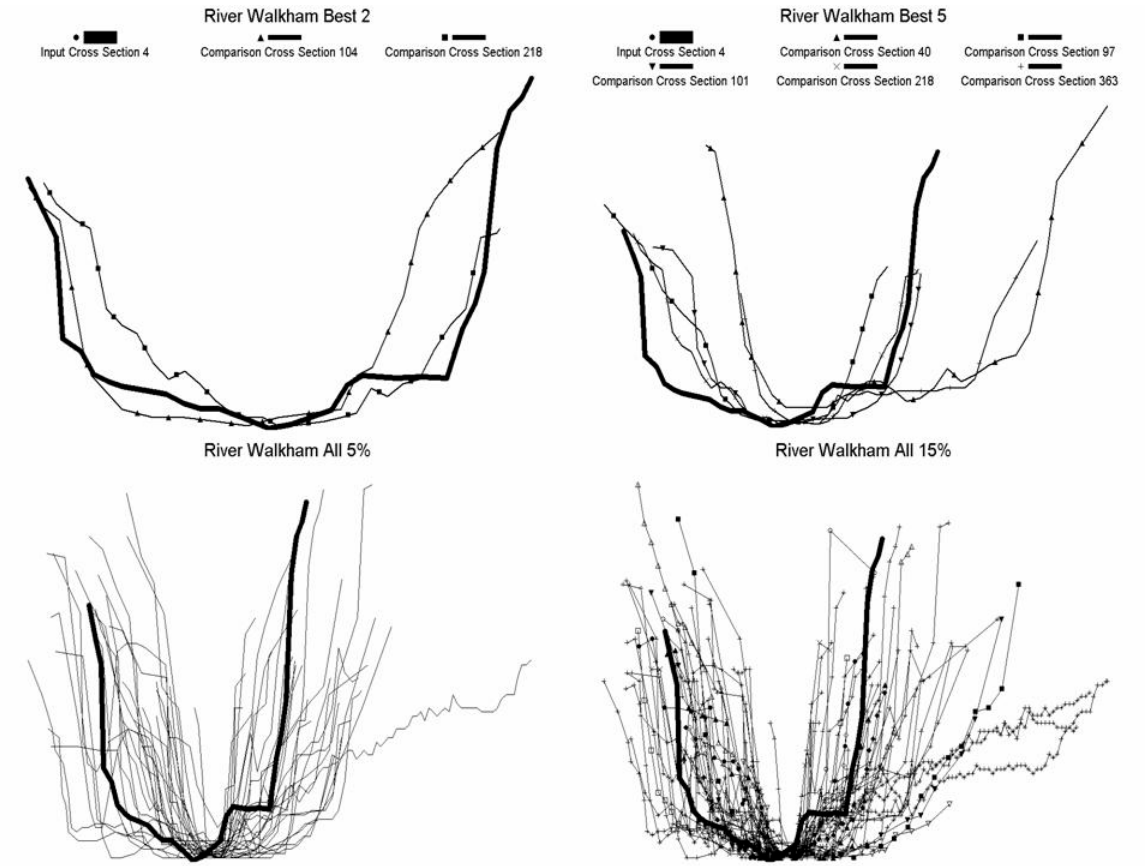
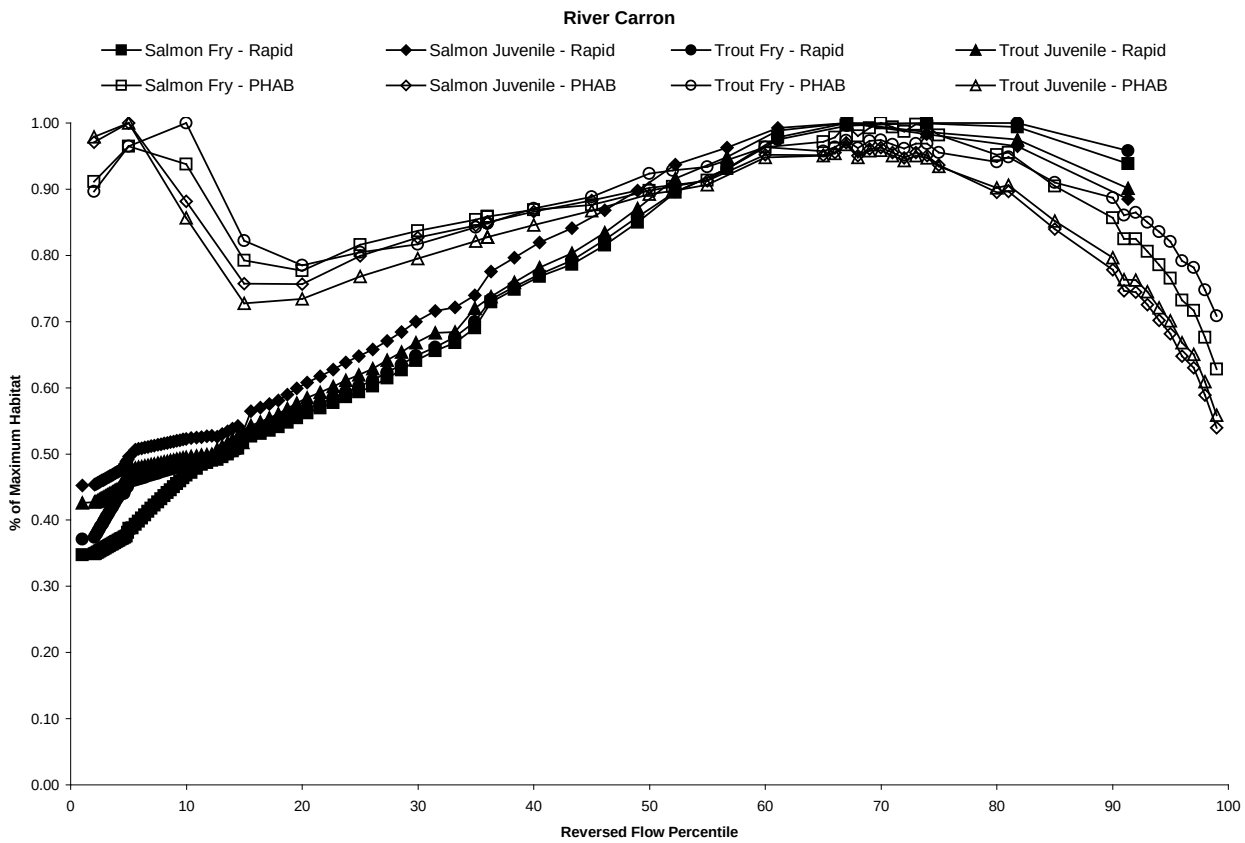
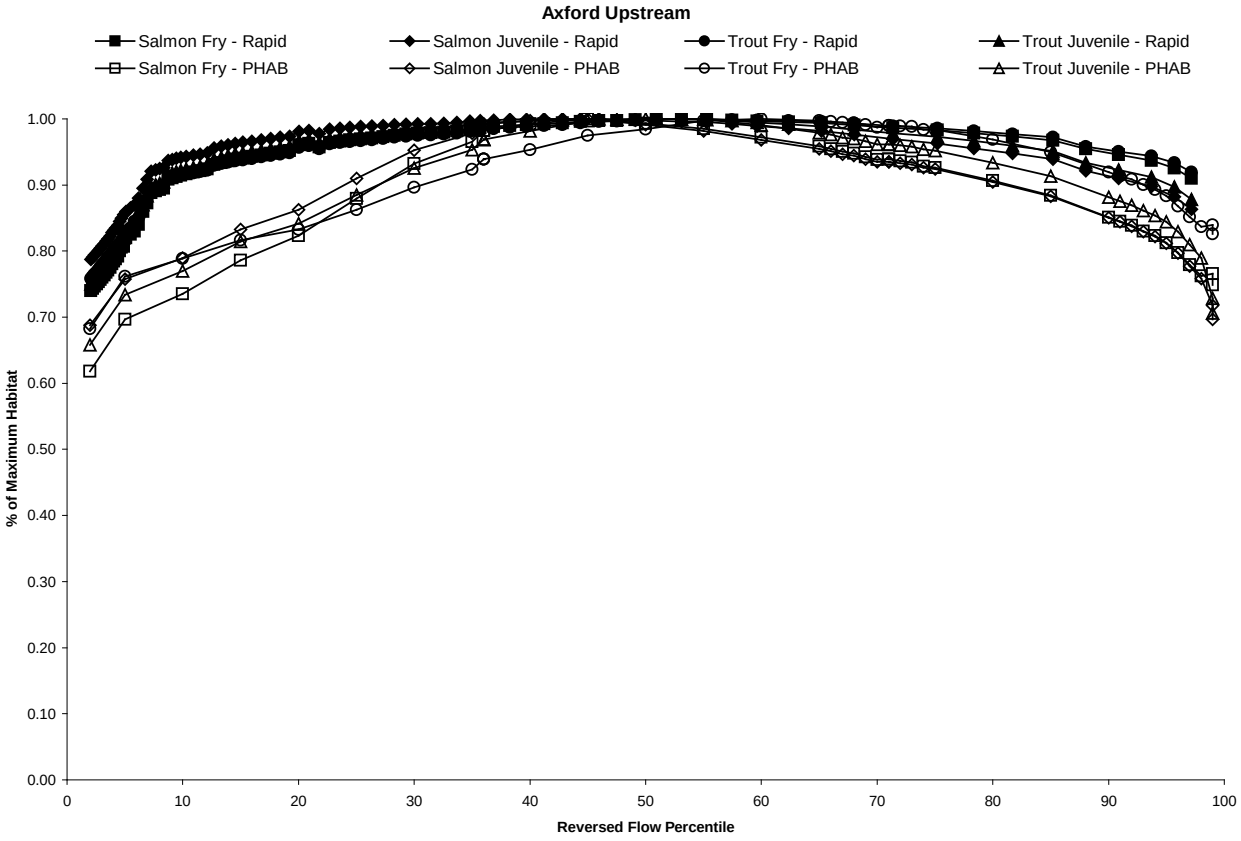


Some Examples of CCM-RAM Results with Site-Specific PHABSIM Results



Examples Continued



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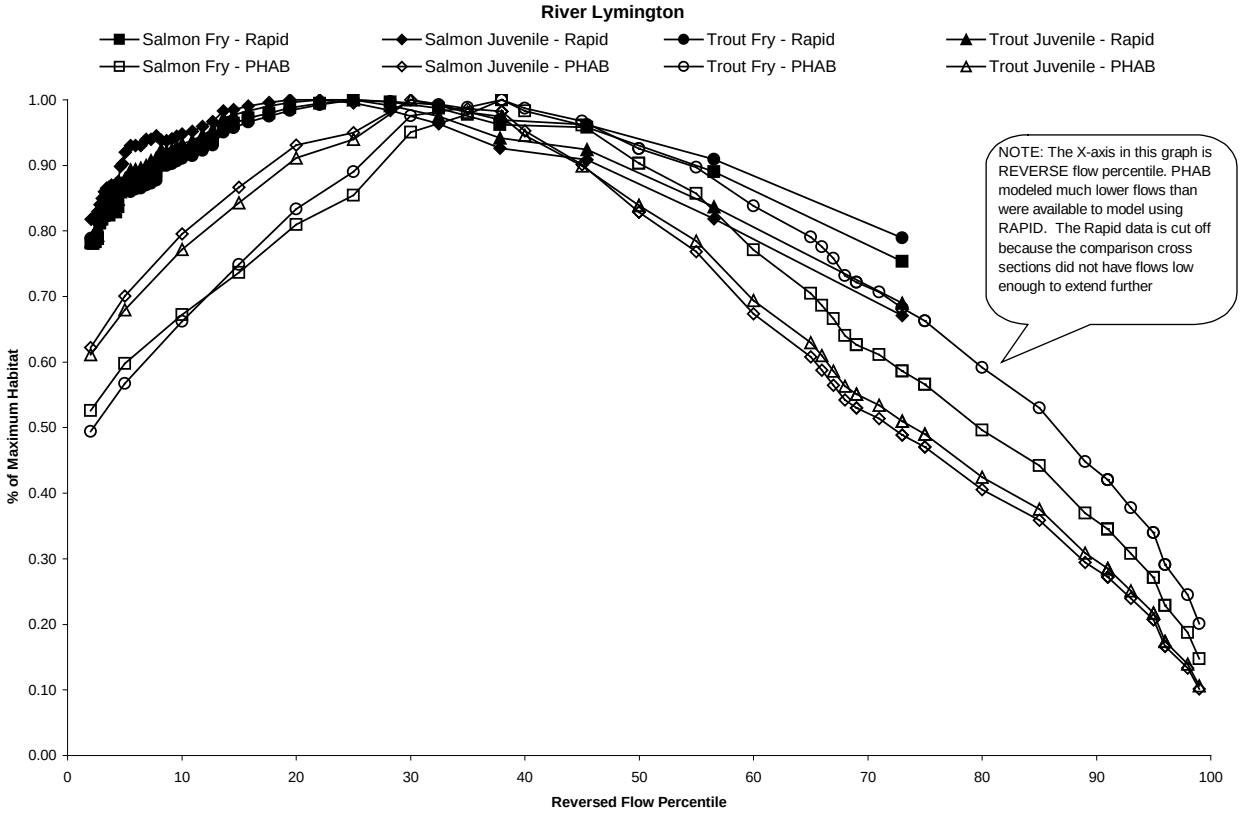

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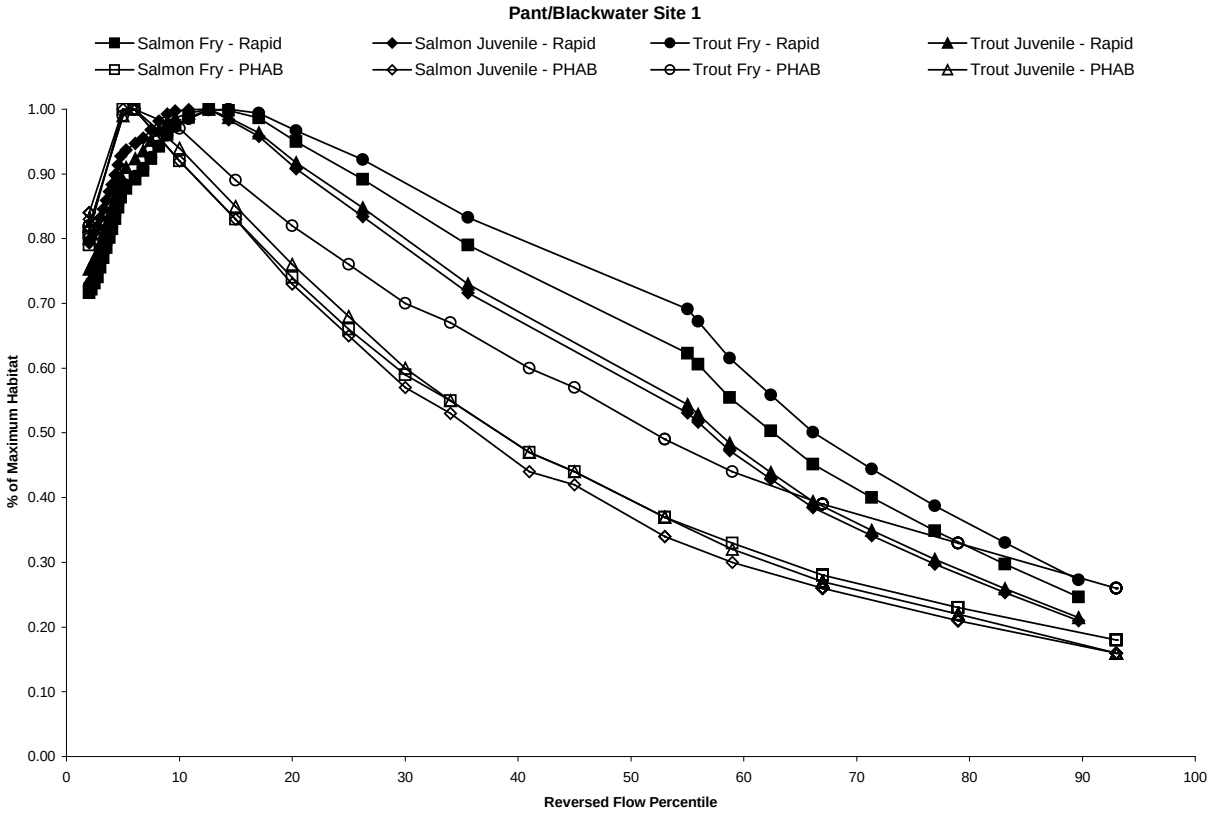
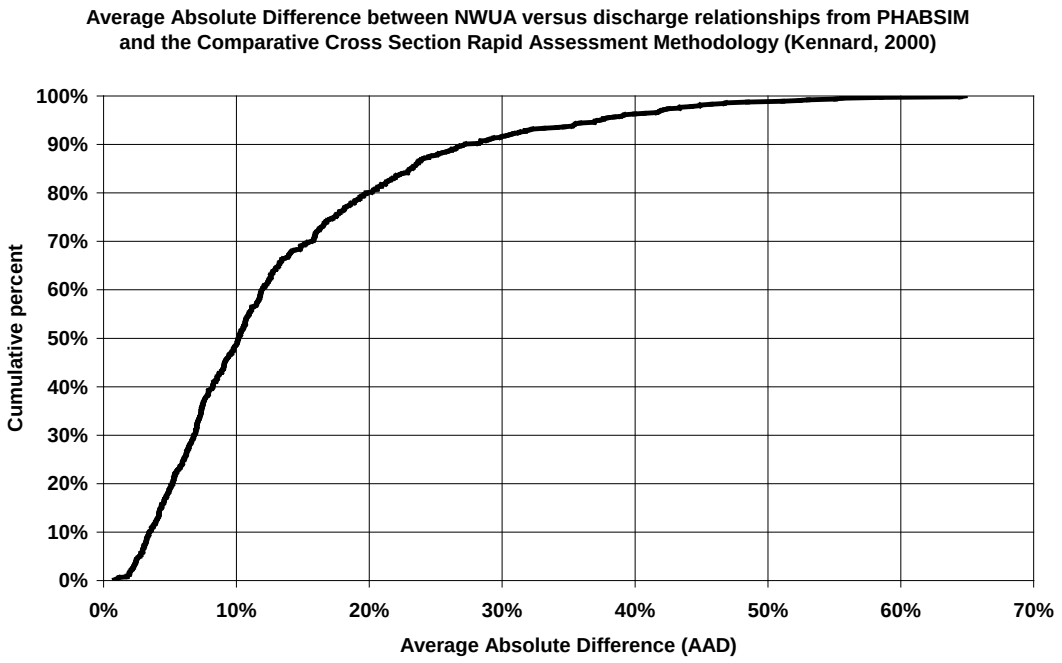
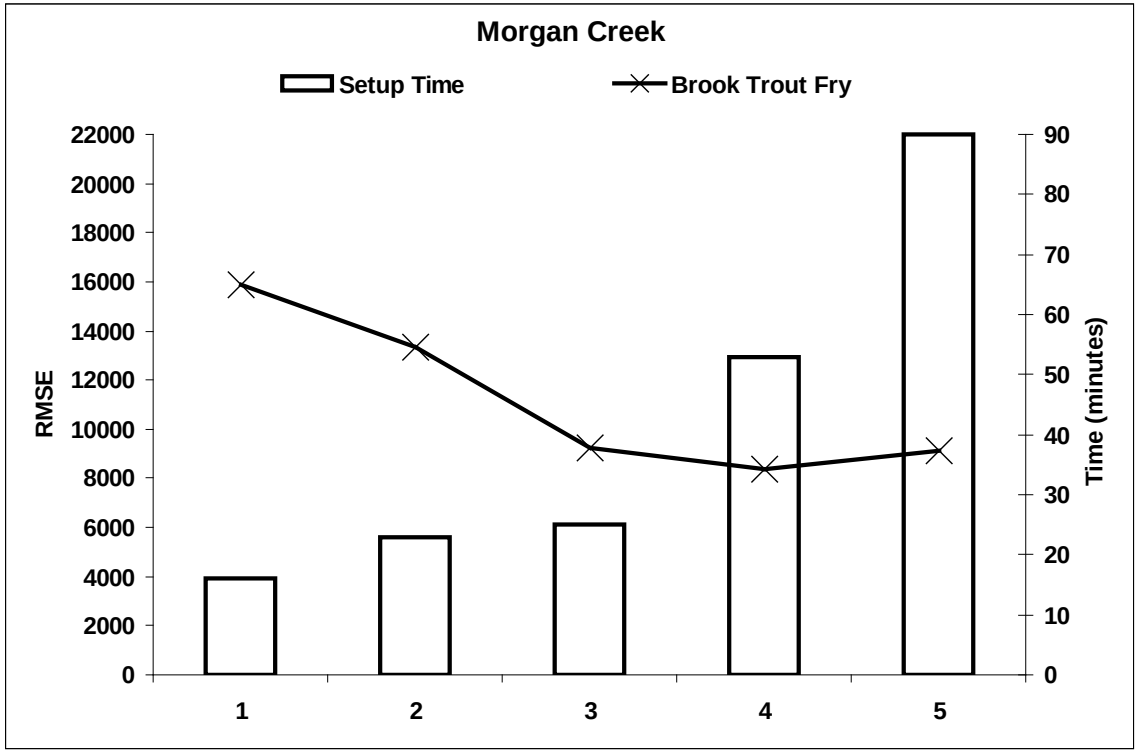


Overall Performance Comparison to PHABSIM Results



RMSE versus number of cross sections and analysis times