EXECUTIVE SUMMARY

Parasiewicz, P. 2004, *Ecohydrology Study of the Quinebaug River*—Final Report to the Project Management Committee and the New England Interstate Water Pollution Control Commission. Presented by the Instream Habitat Program and the NY Cooperative Fish & Wildlife Research Unit, Department of Natural Resources, Cornell University, Ithaca, NY.

The Ecohydrology Study of the Quinebaug River in Massachusetts and Connecticut focuses on assessing the river's biophysical conditions, habitat deficits, and potential improvement measures. It is part of a multidisciplinary investigation required by the U.S. Army Corps of Engineers Section 404 permit program and by the Massachusetts Department of Environmental Protection (DEP) Section 401 Water Quality Certification for the Millennium Power Project in Charlton, Massachusetts. The Project Management Team in the original Section 404 Permit Special Condition No.18 (subsequently renumbered as No. 21) consisted of Millennium Power Partners, U.S. EPA, Massachusetts DEP, Connecticut DEP, U.S. Fish and Wildlife Service, and the Army Corps of Engineers. Afterward, the Massachusetts Division of Fisheries and Wildlife was added to the team. Membership on the team does not in any way preclude state and federal agencies from complying with their obligations under applicable state and federal laws, regulations, or policies, nor does it compel agencies to expend funds they would not otherwise spend.

The study began in Fall 1999 and was conducted by the Instream Habitat Program of the Department of Natural Resources at Cornell University. The results of the study will provide a basis for future decision-making processes and the design of an implementation plan.

The mesohabitat simulation (MesoHABSIM) model for the target fish community is one of the principal tools used in this investigation. In summer and fall 2000, 34 kilometers of the Quinnebaug River were mapped to assess habitat distribution at low flow. A sensitivity analysis of the quantitative distribution of hydromorphological units was used to identify the representative sites. The sites (combined length - 9.2 km) were then surveyed at three different flow situations, ranging from 0.3 cubic feet per second per square mile (cfsm) drainage to 2.5 cfsm.

Five dominant species typical of fluvial systems in New England—fallfish (*Semotilus corporalis*), common shiner (*Luxilus cornutus*), white sucker (*Catostomus commersoni*), longnose dace (*Rhinichthys cataractae*), and blacknose dace (*Rhinichthys atratulus*)—comprise the target fish community of the Quinebaug River. Despite the fact that anadromous species are presently absent in the study area, the spawning of (Atlantic salmon (*Salmo salar*) and American shad (*Alosa sapidissima*)) and bluback herring (*Alosa aestivalis*) occurred historically in the lower part of the study area (downstream of Cargill Falls). Because the physical characteristics of the river are similar up- and downstream of that barrier, the research team (a.k.a. study team) assumed that in specific seasons, flow conditions would provide habitat supporting these species. Therefore, salmon and shad were chosen as indicators of habitat quality in the fall and spring seasons.

Summer habitat selection criteria for five resident species were established by sampling fish with pre-exposed electroshock grids. Logistic regression was used to determine (1) significant species-specific habitat preference/avoidance factors and (2) the probability of fish presence in mesohabitats mapped during the survey of representative sites. The habitat selection criteria for the target species (resident and anadromous) during spawning were established using information found in scientific literature. Habitat/flow-rating curves for resident community and spawning species provided an assessment tool for simulating various management options, such as temporal and spatial manipulation of flows and improvements to the riverbed structure. The curves also facilitated the defining of seasonal recommendations for flow augmentation.

To further assess river health, 107 macroinvertebrate samples were collected in riffles at each site and analyzed for percent affinity, family richness, EPT taxa (the number of mayfly, stonefly and caddisfly taxa), species diversity, and biotic-index scores. Ten thermal recorders were placed along the study area, and temperatures were recorded over the summers of 2000, 2001, and 2002. Hydromorphology, fish habitat, fish density, invertebrate samples, and temperature data were analyzed in each section to determine the present condition of the river and its restoration potential.

The Quinebaug River is a fourth-order river with multiple impoundments and a history of industrial use. Within the study area, the river sections demonstrate a wide range in condition, type, and degree of environmental impact. The study identified a number of ecological deficits with regard to fish habitat, river morphology, flow and thermal regime, as well as the presence of pollution.

The following list of integrative restoration recommendations has been provided by the research team to the Project Management Team for further consideration. This list is not all encompassing and could be expanded as knowledge increases in future years. Note, these recommendations do not represent the official opinions of the agency members of the Project Management Team.

Issues, Deficits, and Preliminary Recommendations.

The following issues and ecological deficits were identified during investigation of the study area:

- ✔ The resident target fish community is characterized by very low fish density.
- ✔ The anadromous species, historically migrating all the way to Cargill Falls, are extirpated due to the existence of multiple dams that block fish migration (no fish passage facilities).
- ✔ The main sources of impact on fish are long durations of severe low-flow events that cause high temperatures and increase concentrations of pollutants .
- ✔ Frequent and unpredictable instantaneous flow fluctuations result from uncoordinated releases from numerous reservoirs (federal and non-federal). The high degree of embeddedness found throughout the entire study area is a likely consequence of these fluctuations. Reach D is affected the most.
- ✔ The overall amount of habitat available for the target fish community is very low at all flows (less than half of its natural potential).

- ✔ The sections with a higher amount of available habitat had higher fish density and fish community structure, better corresponding with a target community structure. Recognizing that the level of thermal impact does not change significantly along the study area, it appears that areas with more physical habitat provide a higher level of resistance to environmental stress.

- ✔ The structure of habitat (proportions of habitat per species) in the river does not correspond well with the target community structure. For example, the proportions of habitat areas suitable for fallfish and longnose dace are lower than expected.

- ✔ The river suffers from a lack of high flows. This is most pronounced in Reach D, where the missing floodplain dynamic changes the entire character of the channel.

- ✔ Historical channel modification has a significant impact on aquatic fauna. In particular, the alluvial deposition zone between downtown Southbridge and Sandersdale is filled with industrial and commercial development, confining the river to a narrow corridor.

- ✔ Summer temperatures observed throughout the entire study area are high for the target fish. The longitudinal thermal pattern is unusual for running waters—the temperature declines downstream, increases rapidly in Southbridge, and then falls again further downstream. Temperature fluctuations are high and are likely worsened by increased temperatures of shallow impoundments.

- ✔ The status of benthic fauna indicates persisting chemical pollution problems downstream of Southbridge in Reach D.

- ✔ Reach D has the most complex problems, but it has the highest improvement potential.

- ✔ The largest amount of suitable habitat for the community is available at a flow of 0.6 cfsm.

The following measures were recommended to improve the ecological status of the river:

- ➤ Reduce the duration of continuous low-flow events by applying directed pulses of water from the reservoirs.

- ➤ Increase the frequency and duration of flows between 0.5 cfsm and 1.0 cfsm. This can be achieved through coordinated dam releases (that include flows from numerous non-federal facilities), efficient use of the existing storage capacity in the basin (e.g., federal and non-federal dams, ponds, wetlands), and improvement of watershed-wide retention (e.g., creating wetlands, stormwater management).

- ➤ Reduce instantaneous flow fluctuations to diminish their impact on juvenile fish life stages.

- ➤ Extend the sections that are best suited to fallfish and longnose dace. This will increase the amount of suitable habitat for these species and thus improve the target-community habitat structure. A good means for implementing this is through the removal of unnecessary dams. A simulation of the removal of three dams in the studied reaches (Fiskdale Mill, Buffle, and Russell Harrington) shows greatly increased availability of suitable habitat for target fluvial fauna.

- In Reach D, widen the river channel and restore its connection with the floodplain.

- Identify and implement measures that will help reduce temperature fluctuations and restore thermal continuity to the river.

- Investigate the feasibility of reducing pollution by improving the performance of the wastewater treatment plants and improving management of other point and non-point sources.

- Construct multi-species fish-passage facilities on other dams. This will increase the longitudinal connectivity of the sections while also improving fish habitat. The technology for such passage is readily available and widely applied worldwide.

- To the extent possible, consider implementing controlled high flows downstream of Southbridge. This area is surrounded by public and largely non-urbanized space to allow for seasonal flooding, thus providing the opportunity for floodplain restoration. This option needs further investigation.

Note: For recommendations specfic to the Quinebaug River segment downstream of West Thompson Dam, see Appendix 7.