EFFECTS OF MACROHABITAT AND A LOW-HEAD DAM ON THE DISTRIBUTION OF MUSSELS IN THE NEVERSINK RIVER, NEW YORK

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ABSTRACT

Losses of mussel populations in rivers of North America are a growing concern. Underlying causes for declines in mussel distributions and species richness are generally unknown. The Nature Conservancy and U.S. Geological Survey conducted a study in 1997 to identify factors that affect common and rare mussel species across the Neversink River Basin in southeastern New York. Composition of mussel and benthic-macroinvertebrate communities, and selected macrohabitat, hydrology, physiography, and water-quality factors were characterized in 100- to 300-meter reaches at 28 sites. Partial regression and canonical-correspondence analyses defined the relations among environmental factors, macroinvertebrate species, threatened mussels (*Alasmidonta varicosa*), endangered mussels (*Alasmidonta heterodon*), and richness of mussel communities. Results indicate that (a) nonunionid-macroinvertebrate assemblages can be used to predict the incidence of rare mussel species, (b) environmental factors alone can explain 44 to 54 percent of the variation in mussel-community richness and distribution of mussel species; environment combined with space can explain 71 to 97 percent of the variation, (c) reach factors, such as water temperature, Ca, K, sulfate, nitrate, DOC, ANC, and mean channel width affect *A. heterodon* populations, and (d) the abandoned, low-head Cuddebackville Dam may further confine *A. heterodon* populations to the lower Neversink River.

BACKGROUND

- Worldwide losses of mussel populations suggest that habitat suitability and/or water quality has declined.
- Impoundments are known to alter flow and sediment regimes and disrupt riverine ecosystems and mussel communities.
- Populations of endangered dwarf wedgemussels (*Alasmidonta heterodon*) and threatened swollen wedgemussels (*Alasmidonta varicosa*) coexist with other Unionidae in the Neversink River of southeastern New York State (Fig. 1).

PROBLEM

- A large reservoir and small abandoned dam potentially affect distributions of common and rare mussels in the Neversink River Basin.
- *Alasmidonta heterodon* populations only occur in the lower basin downstream of an abandoned dam and *A. varicosa* occur in the lower and middle reaches.
- The limited distribution of *A. heterodon* suggests they are susceptible to local extinctions.
- Protecting and promoting *A. heterodon* populations in the Neversink River is problematic because --
  - o they typically occur in patchy mussel beds which make distributions difficult to quantify,
  - o the abandoned Cuddebackville Dam may restrict upstream movement of host fish species, and
  - o the specific habitat and landscape-level factors that affect rare and common mussel populations are poorly defined.

Neversink River Basin

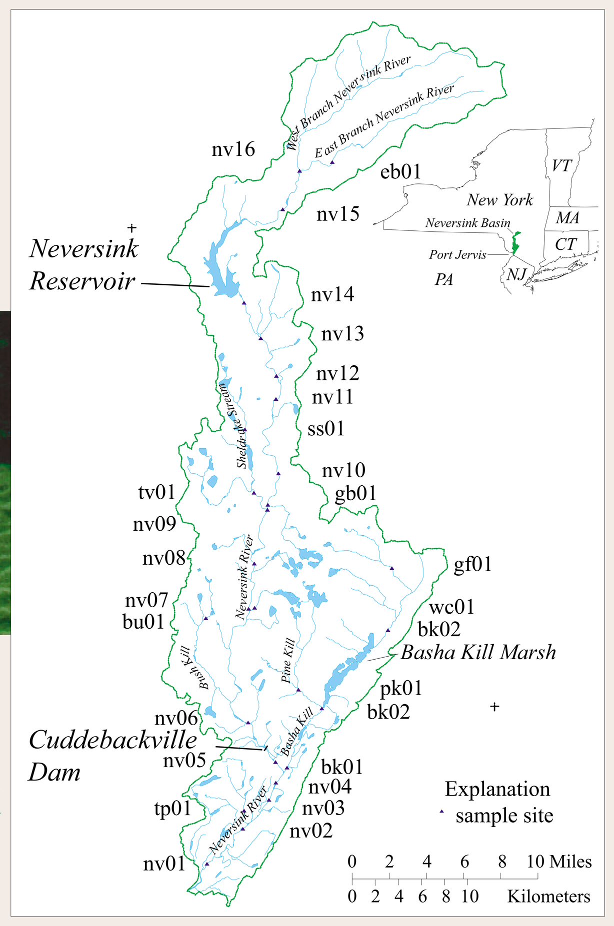

Figure 1. Locations of 28 sites sampled June - August, 1997 in the Neversink River Basin of southeastern New York State.

STUDY OBJECTIVES

- Document the spatial distribution of rare and common mussel species in the Neversink River Basin.
- Correlate observed patterns in mussel-community richness and the distribution of rare and common species to environmental factors.
- Evaluate the effect of the Cuddebackville Dam on the distribution of *A. heterodon* populations in the basin.

APPROACH

- Timed mussel searches were done to estimate percent total abundance and relative abundance for each species.
- A single grab sample at base flow was used to determine standard water-chemistry parameters.
- Traveling kick samples and 200-specimen counts were used to characterize macroinvertebrate communities.
- Point-transect methods were used to estimate channel-morphology, substrate-particle sizes, bank stability, riparian vegetation, and hydraulic characteristics.
- Unconstrained correspondence analyses (CA), constrained canonical correspondence analyses (CCA), TWINSPAN cluster, and multiple regression analyses were used to assess the relations between environmental (and spatial) variables and the:
  - o macroinvertebrate-species assembleges,
  - o mussel-species assembleges,
  - o richness of mussel communities, and
  - o distribution and relative abundance of *A. heterodon* and *A. varicosa* populations.

RESULTS & DISCUSSION

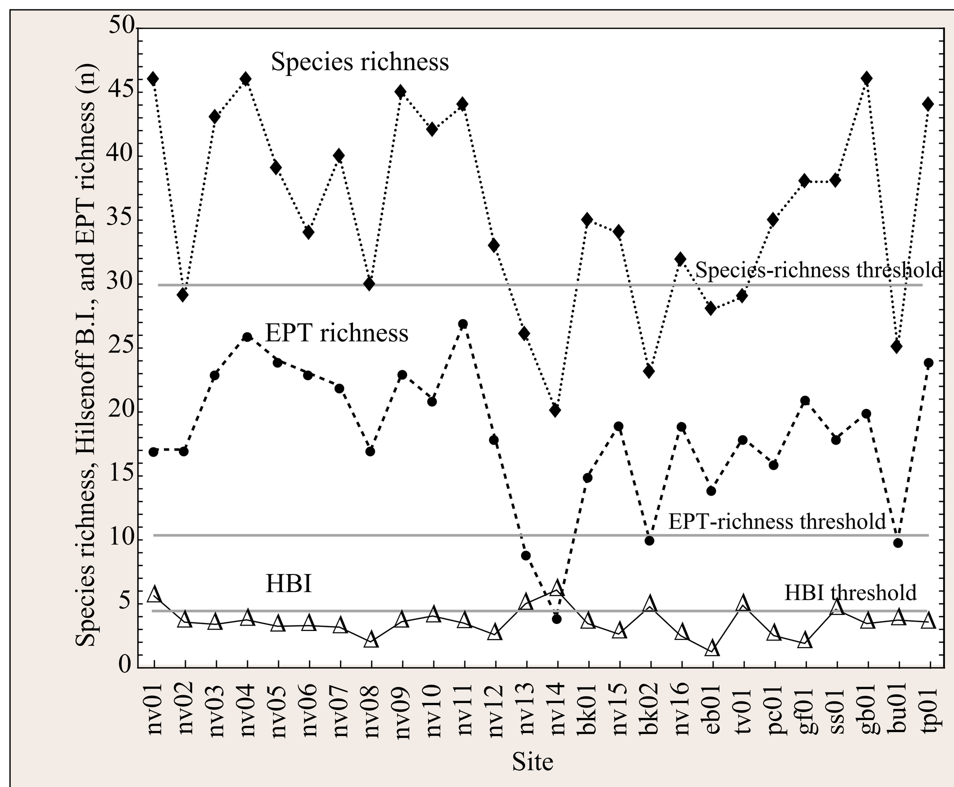

Figure 2. Species richness, EPT (Ephemeroptera, Plecoptera, and Trichoptera) richness (EPT), Hilsenhoff Index of Biotic Integrity (HBI), and New York State Department of Environmental Conservation (DEC) thresholds for slight water quality impacts at 26 sites in the Neversink River Basin, N.Y., July 1997.

- Macroinvertebrate communities at most sites were representative of streams in the Catskill Mt. Region.
- Communities at several sites may have been affected by poor water quality or unsuitable physical habitat.
- Unusual communities at several sites were excluded from CCA and regression analyses of mussel relations.

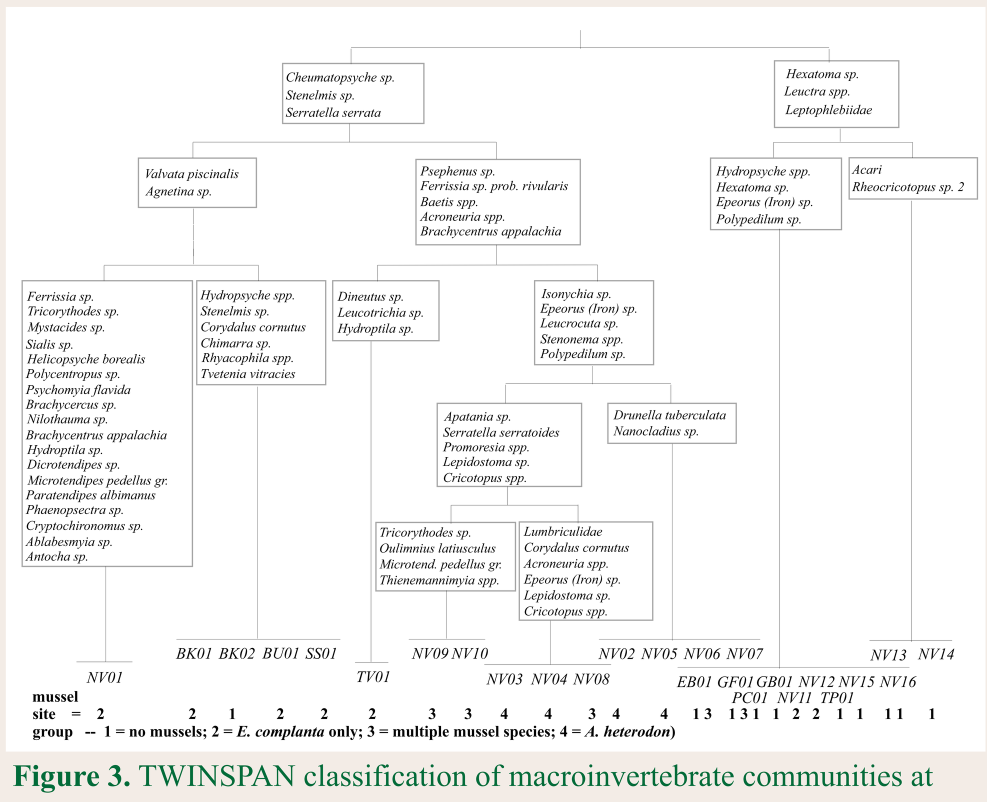

Figure 3. TWINSPAN classification of macroinvertebrate communities at 26 sites in the Neversink River, 1997.

- Community similarity at various sites suggest that site groupings correspond well with four types of mussel communities, these are --
  1. sites with no mussels,
  2. sites with *E. complanata* and at the most 1 or 2 individuals of another species,
  3. sites with multiple mussel species but no *A. heterodon*, and
  4. sites with multiple mussel species and *A. heterodon*.
- Several macroinvetebrate species appear to be good indicators for the presence of *A. heterodon* (and *A. implicata*) populations.

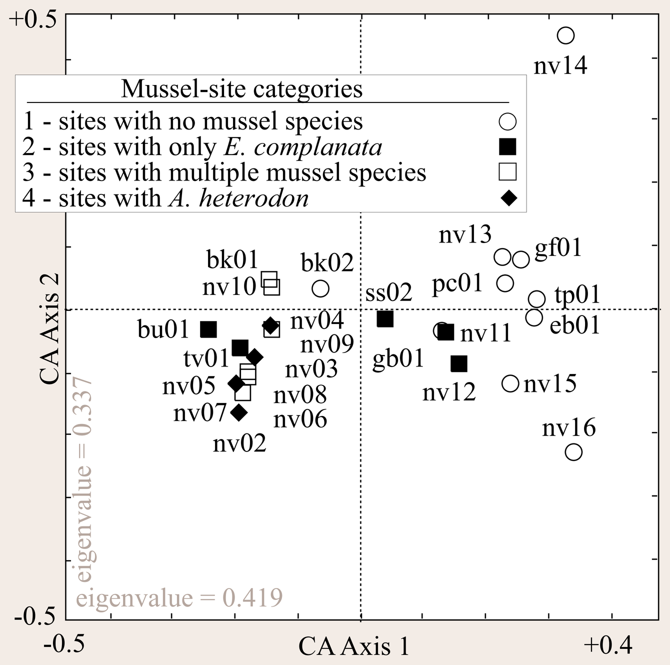

Figure 4. Unconstrained correspondance analysis ordination plot of sites in the Neversink River, 1997, based on the log-transformed (percentage) macroinvertebrate-species matrix.

- Measured variables can explain about 40% of the variation in the macroinvertebrate-species matrix.
- In general, plotting positions of sample sites:
  - o confirm the four site categories delineated by TWINSPAN classifications, and
  - o indicate that several sites upstream from the Cuddebackville Dam have macroinvertebrate communities similar to those downstream from the dam.
- Constrained canonical correspondance analyses (not shown) indicate that ANC, pH, mean channel width, percent open canopy, and space are strongly correlated with the axes (environmental gradients) that best explain the ordination of sample sites.

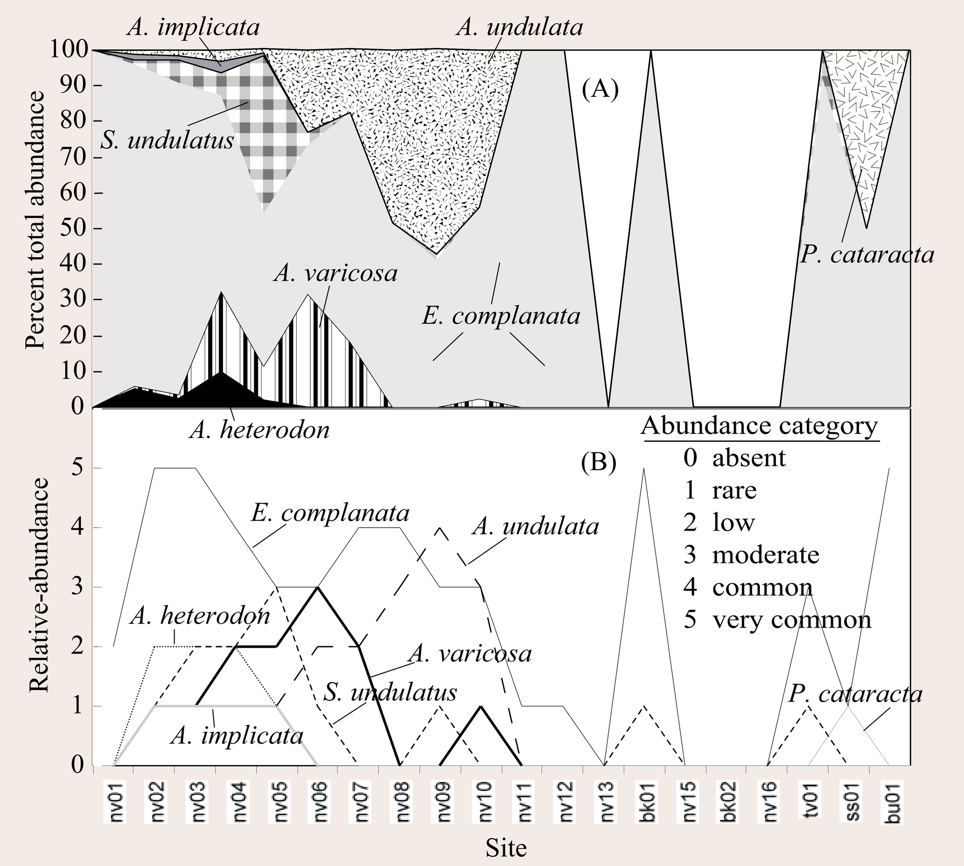

Figure 5. Percent total (A) and catogorical-relative (B) abundance of mussel species collected during surveys of 20 reaches in the Neversink River, 1997.

- *E. complanata* are widely distributed and may be tolerant to a wide range of environmental conditions.
- *A. heterodon* and *A. implicata* are narrowly distributed occurring only downstream of the Cuddebackville Dam
- The two rare species may have very narrow or limited environmental niches.
- No mussels occur in most tributaries and at the mainstem sites in the upper basin.
- Mussel-species richness was highest at sites in the lower basin.

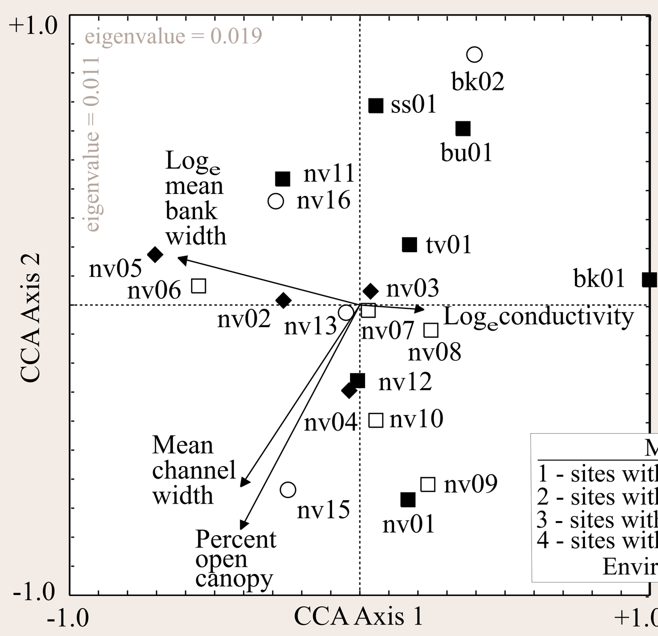

Figure 6. Canonoical correspondance analysis biplot of 20 sites in the Neversink River Basin, 1997, based on the relative abundance of the mussel-species matrix and constrained by final environmental variables and spatial covariables.

- Variations in mussel-species assemblages among sites are best explained by differences in mean channel width, percent open canopy, mean bank width, and water conductivity.
- Environmental variables alone explain about 52% of the variation in the mussel-species matrix.
- Spatial variables (the Cuddebackville Dam, latitude, and longitude) alone can explain about 20% of variation in the mussel-species matrix.

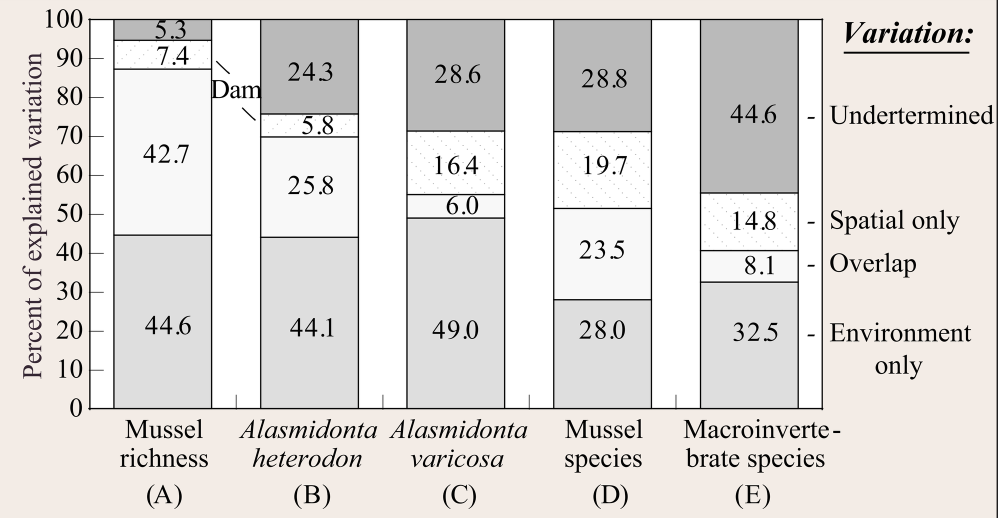

Figure 7. Percent variation in (A) mussel-community richness and relative abundance for (B) *A. heterodon* and (C) *A. varicosa* populations, (D) the mussel-species matrix, and (E) the macroinvertebrate-species matrix explained by environmental and spatial variables and the Cuddebackville Dam at 19 to 20 sites in the Neversink River using partial CCA and regression analyses.

- Environmental & spatial factors explain approximately:
  - o 95% of the variation in richness of mussel communities,
  - o 76% of the variation in relative abundance of *A. heterodon,*
  - o 72% of the variation in relative abundance of *A. varicosa,*
  - o 71% of the variation in the mussel-species matrix, and
  - o 55% of the variation in the macroinvertebrate-species matrix.
- Environmental factors alone explain from 28 to 49% of the total variation in macroinvertebrate &mussel indices.
- Spatial factors alone explain a large amount of variation in mussel richness, relative abundance of *A. heterodon* & *A. varicosa* populations, and the mussel-species matrix.
- From 5 to 45% of the variation is not explained by measured variables.
- The Cuddebackville Dam adds significant explanatory power to models for mussel-community richness and for relative abundance of *A. heterodon* populations.

CONCLUSIONS

- Indicator nonmussel-macroinvertebrate species or assemblages may predict the presence of rare mussel species in this basin.
- Macrohabitat features, such as percent open canopy, mean channel width, mean bank width; water-quality factors -- conductivity and pH; and site elevation and drainage area may affect mussel-community richness and the distribution of *A. heterodon* in the basin.
- Macroinvertebrate and habitat similarities at main stem sites upstream and downstream from the abandoned, low-head dam indicate that *A. heterodon* populations might be able to prosper upstream from the dam.
- The Cuddebackville Dam appears to restrict *A. heterodon* populations to the lower reaches of the basin.
- The Neversink Reservoir may have had a negative affect on the riverine ecosystem, however, increased hydrologic and bed stability may have benefited mussel populations in the middle and lower reaches of the basin.
- The effects that impoundments have on biodiversity of aquatic ecosystems need to be well understood for effective management of natural water and biological resources in rivers.

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