Introduction

The Regional Restoration Initiative was initiated by the Partnership for the Delaware Estuary, an entity in the National Estuary Program. The goals of the initiative are to:

- Facilitate coordination among various conservation, enhancement, and restoration efforts under way.
- Apply scientific principles in evaluating ecosystem services resulting from different types of restoration efforts.
- Provide decision tools and a registry of high value projects for future restoration.
- Encourage ecosystem-based approaches that maximize natural resources benefits over long time scales within the Delaware Estuary and its watershed.

Up to four case studies will be completed, including urban waterfronts, tidal wetlands, shellfish, and headwater streams. The case study for urban waterfronts is described below.

Urban Waterfronts Case Study

Restoration activities within urban corridors can provide substantial benefits, however, urban restoration efforts face many challenges, including:

- High costs.
- Potential chemical contamination.
- Infrastructure impacts.

The Pennsylvania Environmental Council is leading the effort for the urban waterfront case study, which is focused on several sites along the tidal Delaware River.

Landscape Connectivity Modeling

In order to facilitate coordination among various conservation activities, the Regional Restoration Initiative was initiated by the Pennsylvania Environmental Council.

Landscape connectivity modeling reduces a landscape of habitat patches to a set of “nodes” and “edges” (Figure 2). The nodes are based on the location and quality of habitat patches in the landscape; edges are based on the distance that an organism can travel between habitat patches.

The relative ecological value of a habitat patch is expressed through the calculation of three parameters:

1. Production—measures the relative ability of a patch to contribute to overall recruitment potential by its local natality or mortality rates as influenced by patch area and the habitat quality.
2. Dispersal—represents the relative importance of a patch to the dispersal flux of individuals away from their patch or as part of a home range. A quality weighted dispersal score is also calculated; this score considers the effect of quality on the likelihood of dispersal in and out of the patch.
3. Traversability—relays the relative importance of a patch as a stepping stone between isolated habitat patch clusters in the landscape.

Methods

Species Selection

To select species relevant to the Delaware Estuary, we considered three species lists:

1. Pennsylvania’s State Wildlife List, which includes species of vulnerable, high level, or maintenance concern.
2. The Delaware Estuary Habitat Project 3532 report, which includes priority habitat species.
3. The Maryland, Delaware, and New Jersey Gap Analysis Project list of species with GIS habitat mapping data.

Habitat Quality

GIS habitat layers for each species developed for the Maryland, Delaware, and New Jersey Gap Analysis Project (McCorrck et al. 2006) were used to assign habitat suitability scores to geographic pixels. Habitat quality weighted dispersal scores were obtained through a search for home range and habitat dispersal in the general scientific literature. The following dispersal distances were used for the modeling:

- Black duck: 6,000 m
- Least bittern: 150 m
- Marsh wren: 2,000 m

Least Bittern

All of the potential restoration sites for the urban case study are located on the river bank and were rendered contiguous and indistinguishable from the river habitat by the modeling software. Considering the 6,000 m dispersal distance of black duck, a visual examination of the black duck GIS habitat layer in Figure 3 reveals that the landscape is very well connected for this species.

Least Bittern, Scenario 2: River corridor-based dispersal (80 km stretch of the Delaware River 24 km wide; 890 habitat patches [Table 2]):

- Quality, dispersal, and traversability scores were lower than the average patch score likely due to the short dispersal distance of least bittern.

Least Bittern, Scenario 1: Random dispersal pattern (20-km radius around the restoration sites, 943 habitat patches [Figure 4 and Table 1]):

- Quality scores for the restoration sites are higher than the average habitat patch
- Dispersal and quality-weighted dispersal scores are low due to the small dispersal distance of least bittern
- The traversability score for two of the potential sites (Saint Vincent’s and Pennypack Park) were extremely high; these sites could be very important in connecting isolated least bittern populations across the landscape.

Conclusions

Overall, the landscape connectivity modeling provided insights into the relative ecological value of the potential restoration sites that were different for each of the three species considered. All of the restoration sites have potential ecological value as well-connected dispersal sites and habitat for black duck and marsh wren, and two sites have high potential ecological value as stepping stones between distant habitat patch clusters for least bittern.

The Urban Waterfronts Case Study group will need to consider which aspect of connectivity is highlighted in the priorities represented by the connectivity score in the valuation matrix for the restoration sites.

References


P. Jensen and J. Sullivan
Integral Consulting Inc.
L.Walden, D. Krege, and P. Cole
Partnership for the Delaware Estuary
P. E. Racette
Pennsylvania Environmental Council

Figure 1. Potential Restoration Project Sites along the Tidal Delaware River in Northern Philadelphia Waterfront

Figure 2. The Reduction of a Landscape for Modeling

Table 1. Landscape Connectivity Modeling Results for Least Bittern in a Random Dispersal Scenario

Table 2. Landscape Connectivity Modeling Results for Least Bittern in a Corridor Dispersal Scenario

Table 3. Landscape Connectivity Modeling Results for Marsh Wren in a Random Dispersal Scenario

Table 4. Landscape Connectivity Modeling Results for Marsh Wren in a Corridor Dispersal Scenario

Table 5. Landscape Connectivity Modeling Results for Least Bittern in a Random Dispersal Scenario

Figure 3. The Black Duck-Specific Habitat Landscape with Insets Showing the Six Urban Case Study Restoration Sites and Black Duck GIS Habitat Layer Adjacent to the Delaware River Corridor

Figure 4. The Least Bittern-Specific Habitat Landscape with Insets Showing the Six Urban Case Study Restoration Sites and Least Bittern GIS Habitat Layer Adjacent to the Delaware River Corridor

Figure 5. The Marsh Wren-Specific Habitat Landscape Contained in the Landscape Connectivity Modeling, with Insets Showing the Six Urban Case Study Restoration Sites and Marsh Wren GIS Habitat Layer Adjacent to the Delaware River Corridor

Figure 6. The Prothonotary Warbler-Specific Habitat Landscape with Insets Showing the Six Urban Case Study Restoration Sites and Prothonotary Warbler GIS Habitat Layer Adjacent to the Delaware River Corridor