A Regional Wetness Index Model

With Application To Mapping Avian Habitat Associations

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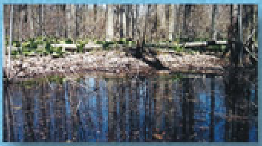
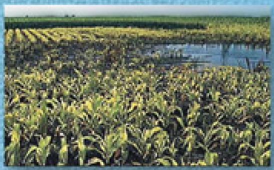
INTRODUCTION

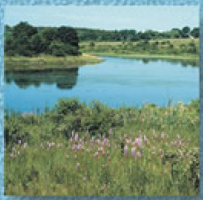


Vernal pools, ephemeral wetlands, sedge and fresh meadows, and wet prairies contain water for only part of the year, and are among the most threatened wetlands. These wetlands were once common in the prairie biome, but many have now been drained for farmland or filled for development. Ephemeral wetlands support a wide variety of flowering plants, crustaceans, insects, reptiles, amphibians, and mammals, and are important food and rest-stops for migrating birds. The Upper Midwest Environmental Sciences Center and its partners are mapping expected habitat for high priority bird species across large regions of the United States. We needed digital maps of ephemeral wetlands to predict abundances of wetland associated birds. Regional maps of ephemeral wetlands are not available primarily because they are difficult to identify using standard remote sensing technology. While wetlands maps are available by state, each state uses somewhat different approaches to mapping wetlands. Inconsistences in wetland mapping are most pronounced in the Midwest region.



OBJECTIVE

To provide a consistent and seamless surrogate to ephemeral wetlands at the regional geographic scale, we mapped a static wetness index (O'Loughlin 1986) for the Upper Midwest. Topographic indices such as the static wetness index have been widely applied in hydrology and were originally developed to predict zones of surface saturation, patterns of soil moisture, and saturation deficit. There are various measures of static wetness, but the measure we used is:



Natural Log (Catchment Area/Tangent Of The Slope Angle)

The catchment area is the up slope area draining into the location of interest. Shallow areas are more likely to catch water than steep areas, and ridge tops have less up slope contributing area than valley bottoms. At locations where accumulated drainage flux from up slope exceeds the product of soil transmissivity of the local slope, surface soil saturation may be expected.

METHODS

The hierarchy of geographic information system processes we used to produce this index required only digital elevation models and hydrological units as boundaries. We evaluated our model relative to the National Wetland Inventory, comparing wetness indices for specific wetland system-subsystem-class types.

RESULTS

The resultant map of static wetness predicted large areas of dry, upland habitat around the Mississippi River (Fig. 1); this is coincident with the Driftless Area, an area unmarked by the last glaciation. Upland (wetness < 6) and palustrine (wetness 6-7) habitat was well-distributed, whereas permanent wetlands (wetness >7) were rare and clumped in their spatial arrangement. Mean wetness for palustrine wetlands was intermediate to the lacustrine and upland habitats (Fig. 2).

Figure 1. Static wetness index mapped for the Bird Conservation Region 23, Prairie-Hardwood Transition.

The open water palustrine wetlands were most similar to perennial streams (8.40 vs 8.55), as one might expect. The remaining palustrine wetlands possessed mean scores between 5.74 and 6.79. Given the mapped wetness index, we then predicted the location of wet meadows and seasonally-inundated woodlands (Fig. 3 & 4).

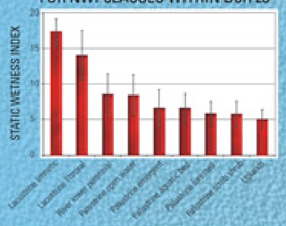


Figure 2. Static wetness index scores for wetlands identified by the National Wetland Inventory in the Upper Midwest US.

Figure 3. Sample location of moist grasslands in south central Wisconsin predicted by the static wetness index.

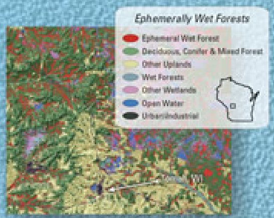


Figure 4. Sample location of ephemerally wet forests in south-central Wisconsin predicted by the static wetness index.

We found that the wetness index was an important predictor of *Dendroica cerulea* (Cerulean Warbler) abundance within the Prairie-Hardwood Transition Ecoregion (Table 1). Cerulean Warblers selected drier locations in the landscape; in the context of this model, these drier locations corresponded with ridge tops.

Parameter	μ_{Median}	2.50%	97.50%
YEAR	-0.06	-0.182	0.008
OBSERVER	1.263	-0.000	2.919
DECIDUOUS FOREST PATCH SIZE	0.166	-0.935	1.247
PERCENT OF WOODED WETLAND	1.254	0.356	2.462
STATIC WETNESS INDEX	-1.176	-2.436	-0.27
PRECIPITATION	1.467	-0.112	3.277
INTERACTION OF DECIDUOUS PATCH AND PRECIPITATION	1.739	0.127	3.661
INDEX OF SPATIAL STRUCTURE	-8.537	-11.65	-6.18

Table 1. Regression coefficients and credibility intervals for model predicting Cerulean Warbler abundance in the Upper Midwest US.

SUMMARY

The static wetness index predictions of NWI wetland classes are generally accurate at the regional scale, but high variation makes precise predictions at the local scale more inaccurate. Refinement of this analysis by incorporating measures of soil percolation and moisture retention by vegetation should improve results, but we found the static wetness index was a reasonable surrogate for identifying wetland types and for predicting effects of wetness on birds. Because ephemeral wetlands are important habitats for a wide variety of wildlife, further model development of wetness potential will have wide application.

LITERATURE CITED

O'Loughlin, E. M. 1986. Prediction of surface saturation zones in natural catchments by topographic analysis. Water Resour. Res. 22:784804.

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