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# A New Tool for Mapping Forest Habitats in Rhode Island

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# 1 Introduction

The Forest Habitat Map (FHM) for Rhode Island was created to provide private land owners with a simple tool to analyze and map forest habitats at the scales of 1:5000 or more using licensed or free mapping GIS software. Seven existing land use and land cover data sets provide recent spatial data on forest habitats in Rhode Island (Table 1), but none provides complete coverage of the most important forest habitat types. As a result, it is necessary to combine data from several datasets to prepare a forest habitat map. This requires access to licensed GIS software and an understanding of the strengths and weaknesses of the available data sets. Furthermore, shrubland forest habitat is not adequately covered by any of the existing datasets. The FHM simplifies the process of mapping forest habitats by including eight major forest types in one dataset. The FHM was prepared by combining data from several existing datasets with a recently prepared shrubland dataset and a manual update of several forest categories.

# 2 Existing Spatial Forest Data Sets

Land Use of Rhode Island 2003/04 (RILU) is the most useful data set for preparing mapping forest habitat due its geographic feature accuracy, which meets the National Mapping Standards for 1:5000 scale mapping. However RILU has several major drawbacks for forest habitat mapping:

- RILU classifies 30% of the state by landuse without providing any information about habitat. Examples of these areas include power lines, graveyards, developed recreation, institutions. These areas contain significant areas of forest, shrubland and grassland habitat. For a list of RILU categories, see Table 5.
- RILU does not distinguish between wetland forests and upland forests.
- The RILU wetland category merges wetland shrubland with emergent wetlands.
- RILU underestimates the area of shrubland by misclassifying many areas of shrubland as forest.
- RILU includes major highways, but not smaller paved roads which impact forest habitat.

The Coastal Change Analysis Program (C-CAP), National Land Cover Data Set (NCLD), Northeast Habitat Classification and Mapping Project (NHCMP) and Novak-Wang data sets provide land cover data for the entire state. However, these raster data sets used a pixel size of 900 square meters (0.22 acres) which is appropriate for analysis at the town or state level but not for mapping individual properties, as an overlay with imagery will immediately demonstrate.

Wetlands 1988 provides a high resolution data set of wetlands in Rhode Island but the features of Wetlands 1988 are poorly aligned with RILU and recent imagery, making it inappropriate for large scale mapping in combination with RILU. NWI, on the other hand is better aligned with RILU.

RI Shrublands 2010 is a dataset of upland and wetland shrublands in Rhode Island which was originally based on 2008 imagery and has recently been updated to 2010.

**Table 1. Land cover/land use studies in Rhode Island**

| Acronym | Full Name | Year | Data and Documentation | Forest Coverage |
|---|---|---|---|---|
| C-CAP | Coastal Change Analysis Program. National Oceanic and Atmospheric Administration | 2005 | Data available at: http://www.csc.noaa.gov/index.html | All categories |
| NLCD | National Land Cover Data Set. United States Geological Survey and United States Environmental Protection Agency | 2001 | Data available at: http://www.epa.gov/mrlc/change.html | Combines wetland forest and wetland shrubland |
| Novak-Wang | Effects of Suburban Sprawl on RI Forests: LANDSTAT View From 1972-1999. Novak, A.B. and Wang, Y.Q. University of Rhode Island | 1999 | Data provided by authors. Documentation: Novak, A.B. and Y.Q. Wang. 2004. *Effects of Suburban Sprawl on Rhode Island's Forests: A Landsat View from 1972 to 1999.* Northeastern Naturalist **11**(1): p. 67-74. | Combines wetland shrubland with wetland herbaceous |
| NWI | National Wetland Inventory, United States Fish and Wildlife Service | Various | Data available at: http://www.fws.gov/wetlands/Data/Data Download.html | Wetlands only. |
| RILU | Land Use of Rhode Island (rilu0304). Statewide Planning Program, RI Department of Administration | 2003/04 | Data available at: http://www.edc.uri.edu/rigis/ | Combines wetland forest and wetland shrubland |
| NHCMP | Northeast Habitat Classification and Mapping Project | Various | Data available at: http://rcngrants.org/node/38 | All categories |
| Rhode Island Shrubland | Rhode Island Shrublands, University of Rhode Island | 2010 | Documentation: Buffum B, McWilliams SM, August PV. 2011. *A spatial analysis of forest management and its contribution to maintaining the extent of shrubland habitat in southern New England, United States.* Forest Ecology and Management 262: 775–1785 | Upland and wetland shrubland only |
| Wetlands 1988 | Wetlands (s44wwt93), Rhode Island Geographic Information System | 1988 | Data available at: http://www.epa.gov/mrlc/change.html | Wetlands only |

# 3 Using the Forest Habitat Map

The map can be accessed on ArcGIS Online, a free service that enables users to prepare maps without requiring any GIS software.[1] Using this service, users can easily zoom into their

[1] For a general description of ArcGIS Online, see: http://www.esri.com/software/arcgis/arcgisonline/index.html

property and prepare a map at any scale, and print or copy the map to a website. The Forest Habitat Map can be accessed at: http://bit.ly/xQLs3A

An alternate means to access the map is to open: http://www.arcgis.com/home/ and use the "find maps" box in the upper right corner to search for "Rhode Island Forest Habitats". The full dataset can also be downloaded from the RIGIS website for use with licensed ArcGIS software.

FHM includes eight categories of forest and nine non-forest categories (Table 2). The map also provides additional information for grasslands and developed areas.

**Table 2. Description of FHM Categories**

| **Categories** | | **Description** |
|---|---|---|
| Forest | • Upland Forest Deciduous | Upland areas dominated by trees with height > 5 meters (16 feet) and canopy cover >80% deciduous species. |
| | • Upland Forest Coniferous | Upland areas dominated by trees with height > 5 meters (16 feet) and canopy cover >80% coniferous species. |
| | • Upland Forest Mixed | Upland areas dominated by trees with height > 5 meters (16 feet) and canopy cover < 80% deciduous or coniferous species. |
| | • Upland Shrubland | Upland areas dominated by shrubs and small trees with height under 5 meters. |
| | • Wetland Forest Deciduous | Wetland areas dominated by trees with height > 5 meters (16 feet) and canopy cover >80% deciduous species. |
| | • Wetland Forest Coniferous | Wetland areas dominated by trees with height > 5 meters (16 feet) and canopy cover >80% coniferous species. |
| | • Wetland Forest Mixed | Wetland areas dominated by trees with height > 5 meters (16 feet) and canopy cover < 80% deciduous or coniferous species. |
| | • Wetland Shrubland | Wetland areas dominated by shrubs and small trees with height under 5 meters (16 feet). |
| Non-Forest | • Agriculture | Land used to grow row crops, usually with evidence of intense land management. |
| | • Grassland | Upland areas with vegetation dominated by grasses. Includes pasture, abandoned pasture, lawns, recreation fields, etc. Each grassland polygon includes info about the land use category. |
| | • Rock | Rock |
| | • Sand | Beaches and sandy areas |
| | • Freshwater Lakes/Rivers | Freshwater lakes and rivers |
| | • Wetland Freshwater Emergent | Freshwater wetland areas that do not contain shrubland or forest. |
| | • Wetland Marine/Estuarine | Marine and estuarine wetlands that do not contain shrubland or forest. |
| | • Barren | Areas with pervious surfaces but minimal vegetation, often with signs of recent soil disturbance. |
| | • Developed | Buildings with a 50 ft. buffer and roads. Each developed polygon includes information about which town it falls in. |

For grasslands, information is provided about the land use (pasture, developed recreation, residential, powerlines, etc.).[2] For developed areas, information is provided about the town to help the user navigate within the map.

A comparison of the acreage in FHM and RILU shows that FHM includes three times as much shrubland, four times as much wetland and two times as much grassland (Table 3). FHM includes slightly less forest than RILU, which is the result of conversion of forest to developed areas since 2003. Tables 4 and 5 provide the full summaries of FMP and RILU. The shrubland category of FHM is probably more accurate than any other dataset. The grassland category, on the other hand, only provides a general indication of the extent of grasslands. Even though FHM includes twice the acreage of grassland as RILU, it still underestimates the total area of grassland. This is because it does not include patches of grassland in residential areas with an area of less than 2 acres after the houses and roads were buffered by 50 ft. Classifying all of these areas was beyond the scope of the current project. Furthermore, the distinction between grassland and agriculture is based on RILU, and it was observed that many areas classified by RILU as agriculture in 2003 are currently used as pasture.

# 4 Process for creating the Forest Habitat Map

The 2010 FMP was created in the following steps:

a) Start with RILU
b) Add wetland data from NWI in four categories:
    - Wetland Forest Deciduous
    - Wetland Forest Coniferous
    - Wetland Forest Mixed
    - Freshwater Lakes/Rivers
    - Wetland Freshwater Emergent
    - Wetland Marine/Estuary
c) Add shrubland data from Shrublands 2010.
d) Reclassify all RILU categories that did not include land cover data (powerlines, graveyards, residential, etc) as follows:
    - Create a "developed" category based on Rhode Island Impervious Surfaces 2007; (RIGIS impervious07) with a 50 ft buffer.
    - Manually classify remaining pervious polygons with area $\geq$ 2 acres as one of the undeveloped categories (grassland, forest, barren, etc.).
e) Add roads which were not included in RILU based on Rhode Island Department of Transportation Roads (RIGIS RIDOTrds10) with a 10 ft. buffer. Classify all roads as "developed".
f) Manually classify any RILU wetlands that were not covered by NWI or Shrublands 2010.

[2] The landuse is adapted from RIGIS 2003 and includes 14 categories of grasslands based on landuse: airports, cemeteries, commercial/industrial, developed recreation, institutional, mines, pasture/idle agriculture, power lines, residential, roads/railroads/etc., vacant land, waste disposal, water/sewage treatment, and other.

g) Manually update developed areas by scanning undeveloped areas with a fishnet grid to identify large areas developed since 2003.

**Table 3. Comparison of FMP and RILU**

| Category | FMP | RILU | FMP/RILU |
|---|---|---|---|
| Upland Forest Coniferous | 46,624 | 52,835 | 88% |
| Upland Forest Deciduous | 205,874 | 245,994 | 84% |
| Upland Forest Mixed | 96,775 | 110,663 | 87% |
| Upland Shrubland | 15,854 | 6,820 | 232% |
| Wetland Forest Coniferous | 4,933 | | |
| Wetland Forest Deciduous | 29,886 | | |
| Wetland Forest Mixed | 13,162 | | |
| Wetland Shrubland | 7,024 | | |
| All Wetland | 62,905 | 12,513 | 503% |
| All Forest | 397,438 | 409,492 | 97% |
| All Shrubland | 22,878 | 6,820 | 335% |
| All Grassland | 29,165 | 14,246 | 205% |

**Table 4. Summary of Rhode Island Forest Habitat Map**

| Category | Acres |
|---|---|
| Agriculture | 22,096 |
| Barren | 920 |
| Developed | 179,873 |
| Freshwater Lakes/Rivers | 26,066 |
| Grass | 29,165 |
| Rock | 12 |
| Sand | 1,266 |
| Upland Forest Coniferous | 46,624 |
| Upland Forest Deciduous | 205,874 |
| Upland Forest Mixed | 96,775 |
| Upland Shrubland | 15,854 |
| Wetland Forest Coniferous | 4,933 |
| Wetland Forest Deciduous | 29,886 |
| Wetland Forest Mixed | 13,346 |
| Wetland Freshwater Emergent | 2,926 |
| Wetland Marine/Esturarine | 4,790 |
| Wetland Shrubland | 7,024 |
| Grand Total | 687,429 |

**Table 5. Summary of RILU 03/04 with FMP Equivalent**

| RILU 03/04 Category | Acres | FMP Equivalent |
|---|---|---|
| Airports (and associated facilities) | 2,094 | Developed |
| Beaches | 1,442 | Sand |
| Brushland (shrub and brush areas, reforestation) | 6,820 | Upland Shrubland |
| Cemeteries | 1,963 | Developed |
| Commercial (sale of products and services) | 12,687 | Developed |
| Commercial/Industrial Mixed | 1,214 | Developed |
| Commercial/Residential Mixed | 42 | Developed |
| Confined Feeding Operations | 6 | Developed |
| Cropland (tillable) | 20,201 | Agriculture |
| Deciduous Forest (>80% hardwood) | 245,994 | Upland/Wetland Deciduous Forest |
| Developed Recreation (all recreation) | 11,284 | Developed |
| High Density Residential (<1/8 acre lots) | 20,834 | Developed |
| Idle Agriculture (abandoned fields and orchards) | 1,239 | Grassland |
| Industrial (manufacturing, design, assembly, etc.) | 6,884 | Developed |
| Institutional (schools, hospitals, churches, etc.) | 7,556 | Developed |
| Low Density Residential (>2 acre lots) | 7,485 | Developed |
| Medium Density Residential (1 to 1/4 acre lots) | 46,034 | Developed |
| Medium High Density Residential (1/4 to 1/8 acre lots) | 40,308 | Developed |
| Medium Low Density Residential (1 to 2 acre lots) | 13,358 | Developed |
| Mines, Quarries and Gravel Pits | 3,788 | Developed |
| Mixed Barren Areas | 88 | Developed |
| Mixed Forest | 110,663 | Upland/Wetland Mixed Forest |
| Orchards, Groves, Nurseries | 2,619 | Agriculture |
| Other Transportation (terminals, docks, etc.) | 1,524 | Developed |
| Pasture (agricultural not suitable for tillage) | 13,007 | Grassland |
| Power Lines (100' or more width) | 2,810 | Developed |
| Railroads (and associated facilities) | 752 | Developed |
| Roads (divided highways >200' plus related facilities | 4,947 | Developed |
| Rock Outcrops | 233 | Rock |
| Sandy Areas (not beaches) | 658 | Sand |
| Softwood Forest (>80% softwood) | 52,835 | Upland/Wetland Coniferous Forest |
| Transitional Areas (urban open) | 1,723 | Developed |
| Vacant Land | 2,632 | Developed |
| Waste Disposal (landfills, junkyards, etc.) | 2,485 | Developed |
| Water | 26,370 | Freshwater Lakes/Rivers |
| Water and Sewage Treatment | 373 | Developed |
| Wetland | 12,513 | None |
| Grand Total | 687,467 | |